

Electronics[®]

Outlook for cylindrical film memories: page 124

Cutting costs in color tv cameras: page 134

Multiplexing with MOS switches: page 152

November 11, 1968

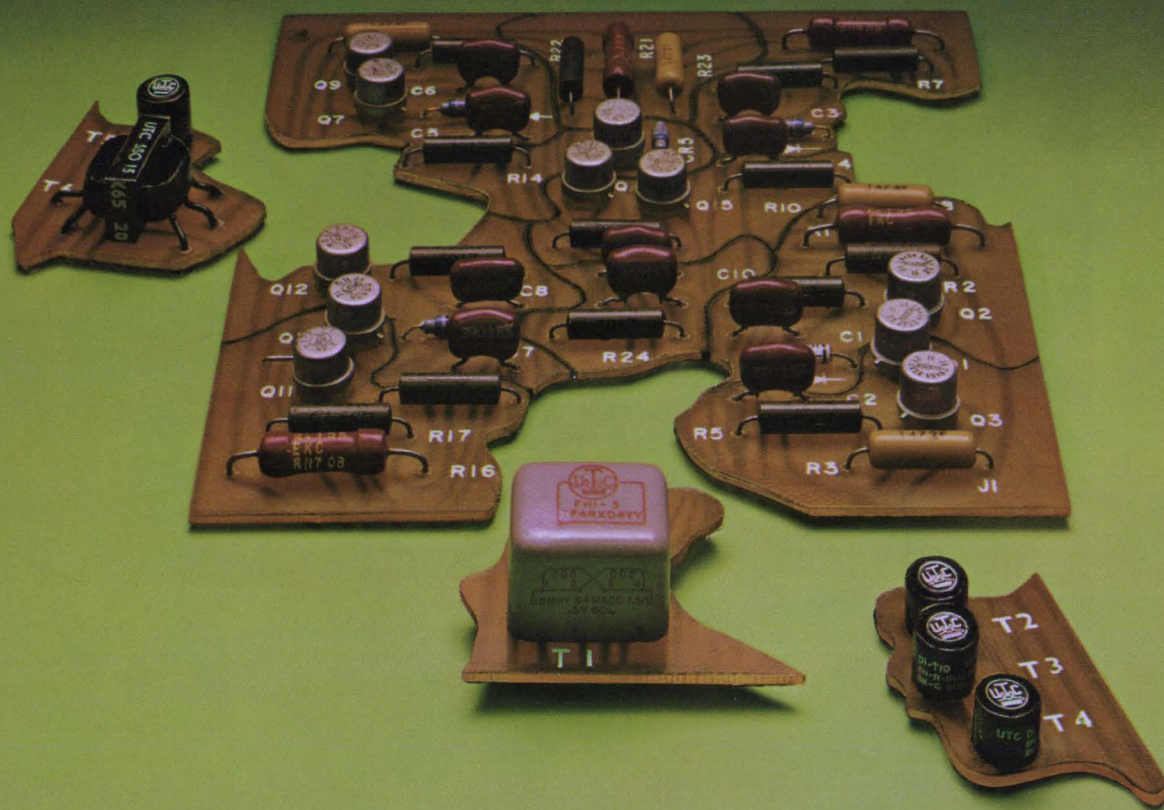
\$1.00

A McGraw-Hill Publication

Below: Pollution analyzer
scans the air, page 112



They're on our shelf



The "special" audio transformers you need
are "standard" at UTC.

When you're ready to specify transformers and inductors, before you turn to costly *specials*, check UTC. Chances are there's a *standard* unit that fits your special electrical and mechanical requirements exactly.

UTC has over 500 audio types in stock, ready for immediate delivery. And UTC engineers are constantly adding to the line. Microwatts to kilowatts. Less than $\frac{1}{4}$ Hz to greater than 1 MHz. MIL-T-27 or industrial. Metal-encased or open frame. Input, output, mixing, matching, modulating, phase shifting, hybrid,

baluns, ring modulator. All in continuous production for sample or high-volume requirements.

If the specific unit you need isn't on our shelf, we'll tailor a standard unit to your special requirements—saving the time and costs of starting from scratch. Check your local distributor for immediate off-the-shelf delivery. For catalog, write: United Transformer Company, Division of TRW INC., 150 Varick Street, New York, N.Y. 10013.

TRW
UNITED TRANSFORMER COMPANY



Speed Reader

HP's new 2012 series—the only data acquisition systems that can accurately measure noisy low-level signals at speeds to 40 channels per second. Quickly and easily expandable in input channel capacity, measurement capability and output recording devices with plug-in cards.

They're built around the 2402A Integrating Digital Voltmeter—a speedy quarterback that calls the signals—expands with plug-in cards from basic dc measurements to accept ac voltage, resistance, and fre-

quency. The new 2912A—a reed scanner with built-in programming capability—expands from 10 to 1000 input channels in 10-channel increments. The 2547A—a new, versatile coupler that mates with a wide variety of output recorders—has clock and manual data-entry plug-in options.

Ask your HP field engineer about the versatility that comes with the fast HP 2012 Data Acquisition Systems. Or write Hewlett-Packard, Palo Alto, Calif. 94304; Europe: 54 Route des Acacias, Geneva.

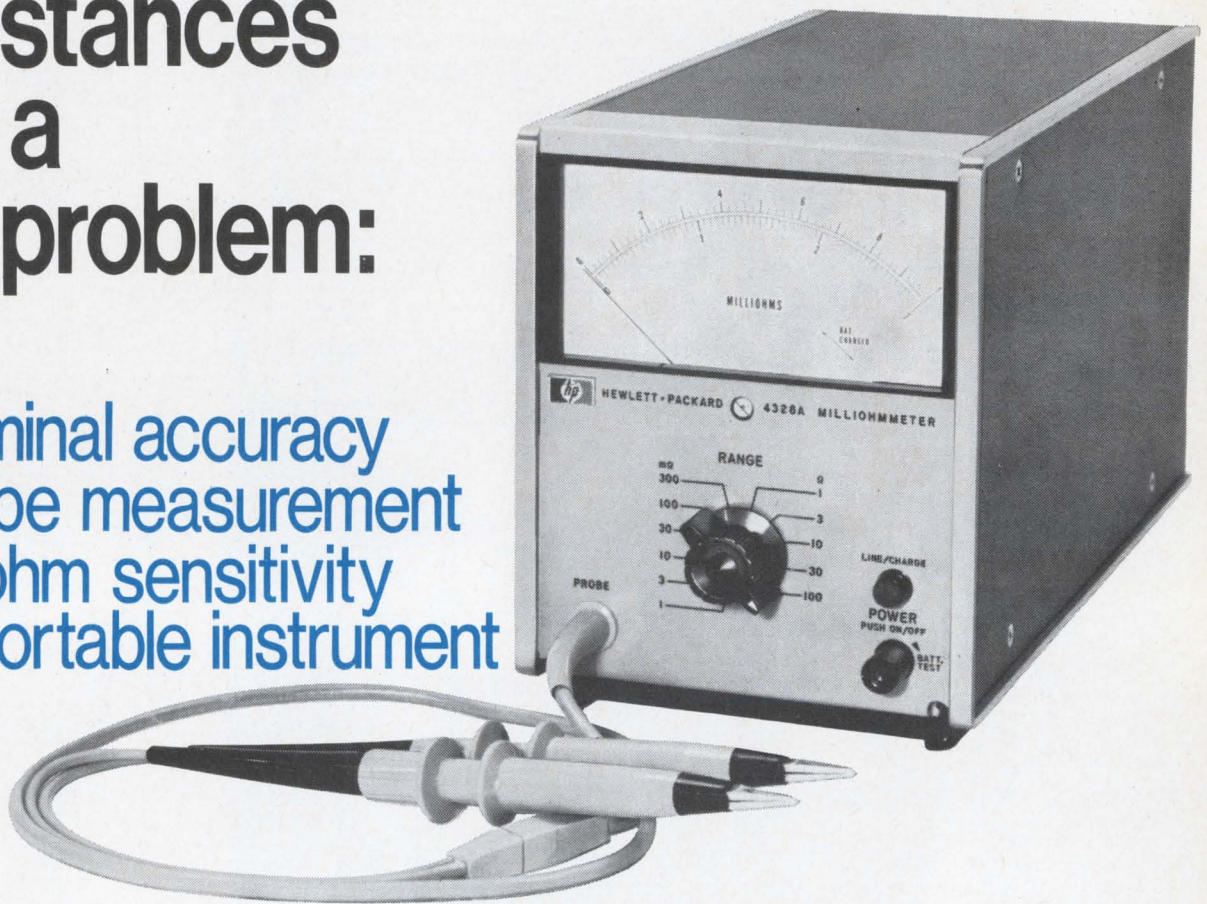
HEWLETT  PACKARD

DATA ACQUISITION SYSTEMS

06813

Where small resistances are a big problem:

4 terminal accuracy
2 probe measurement
50 μohm sensitivity
in a portable instrument



The new Hewlett-Packard 4328A Milliohmeter, with 50 μohm sensitivity, improves on 4-probe resistance measurements by incorporating both current and voltage drive in one probe. It provides this great sensitivity by using a Kelvin Bridge technique, combining an oscillator and a phase-

sensitive voltmeter to offer today's most convenient measurement of extremely small resistances.

The 50 μohm sensitivity is excellent for measuring contact resistance of relays, switches and connectors; in trouble shooting to test the quality of grounds and other short-circuit phenomena; for making lead and end wire resistance measurements on pots.

Range of the 4328A is 100 ohms to 1 milliohm full scale in a 1, 3, 10 sequence. A built-in phase discriminator lets you make precise resistance measurements on samples with a series reactance up to *twice* full-scale

resistance, a feature that makes the meter useful for magnetic core material measurements.

Applied voltage is limited to 20 millivolts RMS by special sensing circuits, regardless of the measurement range, and extra protection for sensitive devices is afforded by having the oscillator function *only* when a resistance is connected to the probes.

The 4328A Milliohmeter, in addition to its 2-probe convenience, is fully portable... weighs only 7 lbs., is offered with an optional rechargeable battery. Price: \$450 (\$25 more for the battery option; fitted leatherette field case \$15).

For more information call your local HP field engineer or write Hewlett-Packard, Palo Alto, California 94304; Europe: 54 Route des Acacias, Geneva.

HEWLETT  PACKARD

News Features

Probing the News

- 185 **Electronics abroad:** Manana is today in Mexico
- 193 **Advanced technology:** Laser safety issue burning bright
- 199 **Industrial technology:** Fluidics stays barely above water

Electronics Review

- 53 **Integrated electronics:** High-voltage IC's; High-gain transistors; Hughes sights ion implantation
- 56 **Displays:** Sylvania delivers flat-screen electroluminescent prototype display
- 58 **Packaging:** Fairchild jettisons Fairpak
- 60 **Industrial electronics:** Government studies vehicle-location system
- 62 **Military electronics:** Fixed-price contracts under fire
- 66 **Advanced technology:** Beyond microwave IC's
- 68 **Communications:** Crowded spectrum
- 70 **Components:** Practical precision resistor ladder networks
- 72 **For the record**

Electronics International

- 307 **Japan:** Scribe fabrication eliminates etching after IC beam leads are formed; LSI is applied to calculator
- 308 **West Germany:** Phantom-jet purchase is letdown for aircraft and avionics industries; Electronica spurs optimism
- 309 **Great Britain:** Hi-fi preamplifier uses op-amp circuit
- 309 **Indonesia:** Shares in fabricating operation offered to smaller firms
- 310 **Soviet Union:** Kremlin demands that research pay off better and sooner

New Products

- 223 TTL cuts cost, size of digitizer
- 226 **Components review**
- 226 GaP boosts photomultiplier gain
- 230 Coating prevents flaking in crt
- 232 Circuit breaker lightens jet load
- 239 **Instruments review**
- 239 Plug-ins expand digital test line
- 244 Metering auto exhausts
- 250 **Subassemblies review**
- 250 IC's help trim tape-memory cost
- 254 Random switch is programable
- 258 Laser modulator takes plug-ins
- 260 Recorder handles tape gently
- 266 Coupler matches many recorders
- 269 **Microwave review**
- 269 Double cavity widens Gunn range
- 275 **Production equipment review**
- 275 Probe light verifies logic state
- 278 Crystal grower uses plasma beam
- 283 **Semiconductor review**
- 283 Fourth terminal widens SCR job

Title R registered U.S. Patent Office; © copyright 1968 by McGraw-Hill Inc. All rights reserved, including the right to reproduce the contents of this publication in whole or in part.

Technical Articles

- Industrial electronics** 112 **Pattern-recognition logic analyzes infrared signals**
Pollution detector uses active parallel filters and logic to identify contaminants
Alan Bessen, Ford Instrument Division, Sperry Rand Corp.
 - Circuit design** 119 **Designer's casebook**
 - Synchronizing a camera with a flash tube
 - High-current switch is driven by an IC
 - Differential amplifier uses two IC's
 - Crystal gives precision to astable multivibrator
 - Current limiter improves power supply
 - Zener triggers a-c alarm circuit
 - Capacitor slows down stabilized power supply
 - Memory technology** 124 **Plated wire: a long shot that's paying off**
George A. Fedde, Univac division, Sperry Rand Corp.
 - 128 **Rods look like wires, act like cores**
Donal A. Meier, National Cash Register Co.
 - 131 **Weaving wires for aerospace jobs**
Richard Flores, Librascope group, Singer-General Precision Inc.
 - Broadcasting** 134 **Shortcuts in tv camera design make for big cuts in price**
Some controls are eliminated in studio-quality vidicon unit
Frederick J. Haines, International Video Corp.
 - Lasers** 142 **Liquid lasers: promising solutions**
Still in the lab, these devices may one day challenge solid state and gaseous types
Harold Samelson, GT&E Laboratories
 - Design theory** 148 **Calculating Gunn-diode output**
Simplified analysis of domain movement speeds predictions of generated power
Mohammed N. Al-Moufti, Stanley V. Jaskolski and T. Koryu Ishii, Marquette University
 - Components** 152 **MOS multiplexer switches can do well at high frequencies**
Mathematical models of circuits enable designers to exploit the devices
Per Morgensen and Wallace Chan
Fairchild Semiconductor
-
- ### Departments
- 4 Readers Comment
 - 54 Index of Activity
 - 8 Who's Who in this issue
 - 87 Washington Newsletter
 - 14 Who's Who in electronics
 - 288 New Books
 - 22 Meetings
 - 293 Technical Abstracts
 - 31 Editorial Comment
 - 298 New Literature
 - 33 Electronics Newsletter
 - 305 International Newsletter

Electronics

Editor-in-Chief: Donald Christiansen

Associate managing editors

Technical: Stephen E. Scrupski
News: Robert Henkel
Copy: Sally Powell

Senior associate editors

Joseph Mittleman, Harry R. Karp

Department editors

Avionics & Space: Alfred Rosenblatt
Computers: Wallace B. Riley
Communications: William Buccì
Components: George Watson
Consumer electronics: John D. Drummond
Design theory: Joseph Mittleman
Industrial electronics: Harry R. Karp
Military electronics: Richard Gundlach

Domestic bureaus

Boston: James Brinton, manager
Chicago: Frederick Corey, manager
Los Angeles: Lawrence Curran, manager; Burton Bell
New York: Howard Wolff, manager
San Francisco: Walter Barney, manager; Peter Vogel
Washington: Robert Skole, manager; Paul Dickson, William F. Arnold

Foreign bureaus

Bonn: John Gosch
London: Michael Payne
Tokyo: Charles Cohen

Copy editors

James Chang, Larry Miller

Graphic design

Art director: Gerald Ferguson
Assistant art directors: Valerie Betz, Susan Hurlburt
Production editor: Arthur C. Miller

Editorial research:

Kay Fontana
Editorial secretaries: Lorraine Longo, Claire Goodlin, Patricia Gardner, Barbara Razulis

McGraw-Hill News Service

Director: Arthur L. Moore; **Atlanta:** Fran Ridgway; **Chicago:** Robert E. Lee
Cleveland: Arthur Zimmerman; **Dallas:** Marvin Reid
Detroit: James Wargo; **Houston:** Barbara LaRoux
Los Angeles: Michael Murphy; **Pittsburgh:** Louis Gomolak
San Francisco: Margaret Drossel
Seattle: Ray Bloomberg; **Washington:** Charles Gardner, Daniel B. Moskowitz, Herbert W. Cheshire, Seth Payne, Warren Burkett, William Small, William D. Hickman

McGraw-Hill World News Service

Bonn: Robert Dorang; **Brussels:** James Smith; **Hong Kong:** Wes Perry;
London: John Shinn; **Mexico City:** Gerald Parkinson; **Milan:** Ronald Taggiasco, Jack Star;
Moscow: Jack Winkler; **Paris:** Robert E. Farrell, Stewart Toy
Rio de Janeiro: Leslie Warren; **Tokyo:** Marvin Petal

Reprints: Susan Nugent

Circulation: Isaaca Siegel

Publisher: Gordon Jones

Electronics: November 11, 1968, Vol. 41, No. 23

Published every other Monday by McGraw-Hill, Inc. Founder: James H. McGraw 1860-1948.

Publication office 99 North Broadway, Albany, N.Y. 12202; second class postage paid at Albany, N.Y.

Executive, editorial, circulation and advertising addresses: McGraw-Hill Building, 330 W. 42nd Street, New York, N.Y. 10036. Telephone (212) 971-3333. Teletype TWX N.Y. 710-581-4235. Cable address: MCGRAWHILL N.Y.

Subscriptions solicited only from those professionally engaged in electronics technology. Subscription rates: qualified subscribers in the United States and possessions and Canada, \$8.00 one year, \$12.00 two years, \$16.00 three years; all other countries \$25.00 one year. Non-qualified subscribers in the U.S. and possessions and Canada, \$25.00 one year; all other countries \$50.00. Air freight service to Japan \$50.00 one year. Single copies: United States and possessions and Canada, \$1.00; all other countries, \$1.75.

Officers of McGraw-Hill Publications: Joseph H. Allen, President; J. Elton Tuohig, Executive Vice President; David J. McGrath, Senior Vice President-Operations; Vice Presidents: John R. Callahan, Editorial; Paul F. Cowie, Circulation; John R. Emery, Administration; John M. Holden, Marketing; David G. Jensen, Manufacturing; Jerome D. Luntz, Planning & Development; Robert M. Wilhelm, Contoller.

Officers of the Corporation: Shelton Fisher, President and Chief Executive Officer; John L. McGraw, Chairman; Robert E. Slaughter, Executive Vice President; Daniel F. Crowley, Donald C. McGraw, Jr., Bayard E. Sawyer, Senior Vice Presidents; John J. Cooke, Vice President & Secretary; Gordon W. McKinley, Vice President & Treasurer.

Title © registered in U.S. Patent Office; © Copyright 1968 by McGraw-Hill, Inc. All rights reserved. The contents of this publication may not be reproduced either in whole or in part without the consent of copyright owner.

Subscribers: The publisher, upon written request to our New York office from any subscriber, agrees to refund that part of the subscription price applying to copies not yet mailed. Please send change of address notices or complaints to Fulfillment Manager; subscription orders to Circulation Manager, Electronics at address below. Change of address notices should provide old as well as new address, including postal zip code number. If possible, attach address label from recent issue. Allow one month for change to become effective.

Postmaster: Please send form 3579 to Fulfillment Manager, Electronics, P.O. Box 430, Hightstown, New Jersey 08520

Readers Comment

Image makers

To the Editor:

With reference to Toshiba's ultrasonic acoustic image converter [Sept. 2, p. 169], I disagree with the statement that "Toshiba . . . will probably be the first to put one on the market."

James Electronics has produced and marketed an ultrasonic image converter since 1964. Our system was the first to be available commercially in a practical form for industrial nondestructive testing or laboratory research. It offers a 2-inch aperture at any frequency between 1 and 10 Mhz, compared to the Toshiba limitation of 1 inch.

The James system can also be supplied with acoustic phase sensitivity, presenting the phase information in color on a standard broadcast color television monitor. The color form of the image converter is sensitive to changes in acoustic impedance as small as 1 part in 10⁸.

One of the most important applications for the ultrasonic image converter, apparently overlooked by Toshiba, is in acoustic holography, which offers the promise of removing many of the limitations inherent in use of the image converter to produce ultrasonic shadowgrams.

John DuBois

Director of engineering
Instrument Division
James Electronics Inc.
Chicago

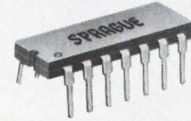
Earlier work . . .

To the Editor:

In reference to your story on lasing plastic [Sept. 16, p. 55], our client, the Korad department of Union Carbide, reported the same thing more than a year ago. Korad physicist B.H. Soffer and B.B. McFarland, in the "Applied Physics Letters" of May 15, 1967, specifically reported lasing a solid sample of Rhodamine 6G in polymethylmethacrylate (i.e., plastic), as well as alcoholic solutions of Rhodamine 6G.

Related articles appeared in

Add Sprague Series 7400A to your prints for Series 74N TTL circuits. They're pin-for-pin identical.



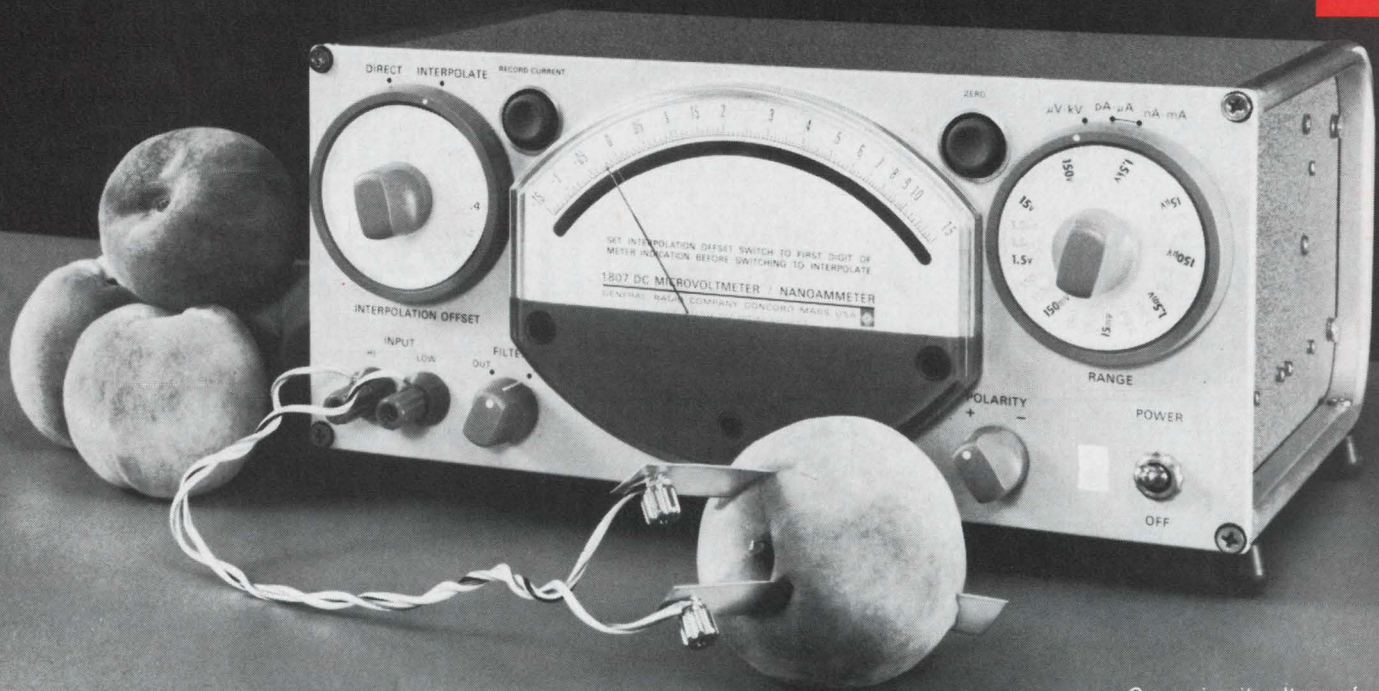
SERIES 74N	FUNCTION	SPRAGUE PART NO.
SN7400N	Quad 2-Input NAND	USN-7400A
SN7401N	Quad 2-Input NAND (No Collector Load)	USN-7401A
SN7402N	Quad 2-Input NOR	USN-7402A
SN7410N	Triple 3-Input NAND	USN-7410A
SN7420N	Dual 4-Input NAND	USN-7420A
SN7430N	Single 8-Input NAND	USN-7430A
SN7440N	Dual 4-Input NAND Buffer	USN-7440A
SN7450N	2-Wide 2-Input Expandable AND-OR-INVERT	USN-7450A
SN7451N	2-Wide 2-Input AND-OR-INVERT	USN-7451A
SN7453N	4-Wide 2-Input Expandable AND-OR-INVERT	USN-7453A
SN7454N	4-Wide 2-Input AND-OR-INVERT	USN-7454A
SN7460N	Dual 4-Input Expander	USN-7460A
SN7470N	D-C Clocked J-K Flip Flop	USN-7470A
SN7472N	J-K Master Slave Flip Flop	USN-7472A
SN7473N	Dual J-K Master Slave Flip Flop:	
—	Single chip, pin 11 GND	USN-7473A
—	Single chip, pin 7 GND	USN-74107A
SN7474N	Dual D-Type Edge-Triggered Flip Flop	USN-7474A
—	Dual AC Clocked J-K Flip Flop	USN-7479A
COMPLEX ARRAYS		
SN7441N	BCD-To-Decimal Decoder/Driver	USN-7441B
SN7475N	Quadruple Bistable Latch	USN-7475B
SN7480N	Gated Full Adder	USN-7480A
SN7482N	2-Bit Binary Adder	USN-7482A
SN7483N	4-Bit Binary Adder	USN-7483B
SN7490N	Decade Counter	USN-7490A
SN7491AN	8-Bit Shift Register	USN-7491A
SN7492N	Divide-By-Twelve Counter	USN-7492A
SN7493N	4-Bit Binary Counter	USN-7493A

For complete technical data on Series 5400 and 7400A circuits, write to Technical Literature Service, Sprague Electric Co., 35 Marshall St., North Adams, Mass. 01247



'Sprague' and '®' are registered trademarks of the Sprague Electric Co.

SPRAGUE WORCESTER...the world's finest microcircuit facility



Open-circuit voltage of peach is 0.398V (0.4V on switch dial minus 0.002V on meter).

A Peach of a Reading, $\pm 0.2\%$, at a Peach of a Price, \$665.

Is a low-level dc voltmeter essential to your measurements work? You'd probably like one as accurate as the economies of your measurement allow. How about one that's $\pm 0.2\%$ accurate, measures below $1\mu\text{V}$ and costs only \$665?

Need more than just a voltmeter? Besides being a microvoltmeter, the GR 1807 also is a nanoammeter, null detector, and differential voltmeter at the same $\pm 0.2\%$ accuracy . . . as a microvoltmeter the 1807 offers nine decade ranges from $15\mu\text{V}$ full scale to 1500V . . . as a nanoammeter, currents can be measured from 15 pA full-scale to 10 mA . . . as a null detector the 1807 has a common mode rejection of greater than 160 dB plus a 3-second recovery speed for overloads up to $1,000,000:1$; and, used as a differential voltmeter, this 1807 offers accuracies 10 times better than conventional voltmeters. You might say that the GR 1807 fills in

the accuracy gap that's been created between analog and digital voltmeters.

What's the secret? Nothing really. By using differential techniques, the first one or two digits can be moved off the meter and put on a switch. This allows the meter to do just the fine work — the interpolating. You can do this by setting the interpolation-offset switch to subtract from the input a calibrated voltage equal to the most significant figure of the unknown, and then read the difference directly from a meter. Thus, the 1807 achieves digital accuracies but still preserves the versatility of an analog device.

Other features . . .

High input impedance, greater than $500\text{M}\Omega$ on most ranges, eliminates practically all loading errors . . . The use of a photochopper modulator minimizes noise, drift, and offset problems . . .

Excellent common-mode rejection is achieved by using Teflon throughout the 1807 to isolate high and low terminals from ground. The meter readout is also unique — it is logarithmic above 10% of full scale and linear below 10% of full scale. The meter zero is offset upscale

by about 20° to permit easy reading around zero . . . D-C amplified output is provided to drive chart recorders . . . Problems arising from thermoelectric voltages generated by junctions of dissimilar metals have been eliminated by copper-to-copper junctions at all points in the input circuitry . . . a built-in switchable RC low-pass filter with a 1.5-Hz cut-off is provided to eliminate any ac hash that might be superimposed on the input dc signal . . . And, you have a choice of either battery or line-voltage operation.

For complete information, write General Radio Company, West Concord, Massachusetts 01781; telephone (617) 369-4400. In Europe: Postfach 124, CH8034 Zurich 34, Switzerland.

GENERAL RADIO

Readers Comment

"Chemical & Engineering News" (June 19, 1967) and in "Laser Focus" (July 1967). The news stories included references to the lasing of a dime-store plastic triangle. (Actually, both the original Korad achievement and Bass and Deutsch's repetition involved lasing of the dye in the plastic, not the plastic itself.)

It is true, though, that the Electronics story emphasized the economy of plastic as a laser material, whereas Korad's emphasized the continuous tunability of organic dye lasers.

James B. Marine
Public relations director
Bowes Co.
Los Angeles

... on lasing plastic

To the Editor:

Concerning your description of the work of two Raytheon scientists on the laser properties of acrylic plastics containing Dayglow pigments [Sept. 16, p. 55], these pigments are dyes related to fluorescein.

In an Office of Naval Research project at the Polytechnic Institute of Brooklyn, A. Baczynski (now of the University of Torun, Poland) and I demonstrated in 1965 stimulated emission from polymethylmethacrylate rods containing fluorescein. The work was reported at an international symposium in Paris in June 1966 and is described by me (in English) in the January

1967 issue of the Journal de Chimie Physique.

We showed that the acrylic plastic must be produced in such a way as to remove strains. This apparently explains why the Raytheon workers failed with commercial plastic rods but had success with plastic sheets, the latter being of better quality because of their method of manufacture.

Gerald Oster
Department of Biochemistry
Mount Sinai School of Medicine
New York

Information please

To the Editor:

I would be interested in hearing from any of your readers who can supply historical or technical data about the mechanical-scanning tv receivers built by the Western Television Corp. of Chicago (circa 1930).

I am restoring one of these receivers and would also like to locate a "kino lamp" and other components used in these sets.

Ed Bukstein
Northwestern Electronics Institute
Minneapolis
Minn.

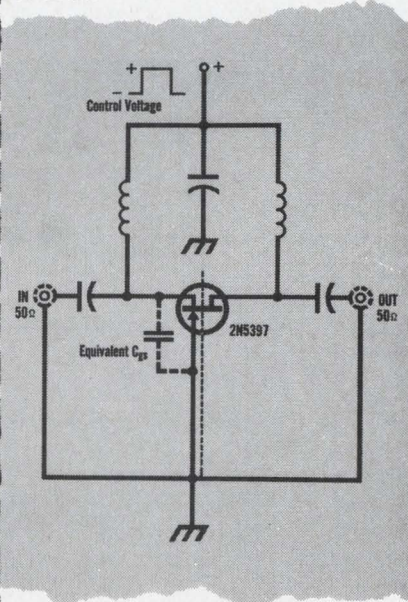
Readers' letters should be addressed:
To the Editor,
Electronics,
330 West 42nd Street, New York,
N.Y. 10036

Application For

FET VIDEO SWITCHES

PROBLEM: High OFF attenuation
— Low ON loss

SOLUTION: Grounded gate FET —
controlled at the drain and
source.



Turn this circuit off and the RF is shunted to ground through the FET's equivalent C_{gs} . OFF attenuation is greater than 65 dB for small signals. ON loss is less than 6 dB. With the 2N5397 these figures hold true around 200 MHz.

Write today for complete information on this and five other RF circuits that function best with high-performance Siliconix FETs. We'll include complete data on all RF FETs, too. Just ask for the Siliconix RF FET Data Packet.



Siliconix incorporated

1140 W. Evelyn Ave. • Sunnyvale, CA 94086
Phone (408) 245-1000 • TWX: 910-339-9216

SUBSCRIPTION SERVICE

Please include an Electronics Magazine address label to insure prompt service whenever you write us about your subscription.

Mail to: Fulfillment Manager
Electronics
P.O. Box 430
Hightstown, N.J. 08520

To subscribe mail this form with your payment and check new subscription renew my present subscription

Subscription rates: qualified subscribers in the U.S.: 1 year \$8; two years, \$12; three years, \$16. Non-qualified: 1 year \$25. Subscription rates for foreign countries available on request.

CHANGE OF ADDRESS

ATTACH LABEL HERE

If you are moving, please let us know five weeks before changing your address. Place magazine address label here, print your new address below.

name

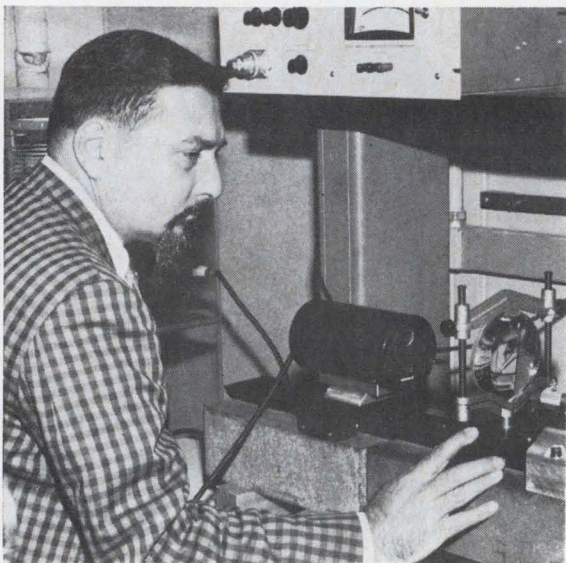
address

city

state

zip code

Who's Who in this issue



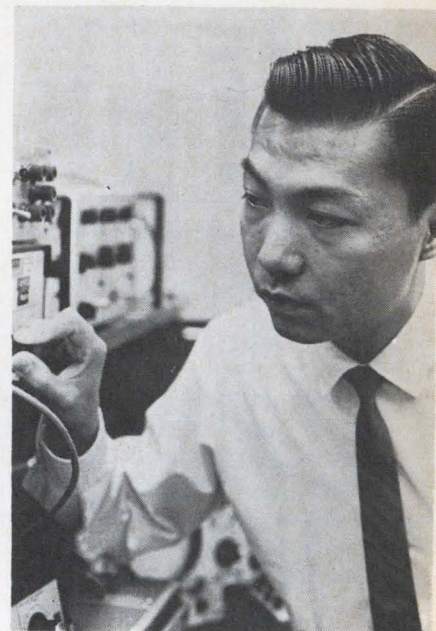
Samelson

The growth of single crystals of II-VI compounds and the study of thin optical and electrical properties were Harold Samelson's primary interests up to 1961. Since then his field has been liquid lasers. Samelson, author of the article on liquid lasers on page 142, participated in the discovery and subsequent development of chelate lasers, and since 1966 has been engaged in research on inorganic liquid lasers based on aprotic solvents. He has been with the General Telephone & Electronics labs since 1956.

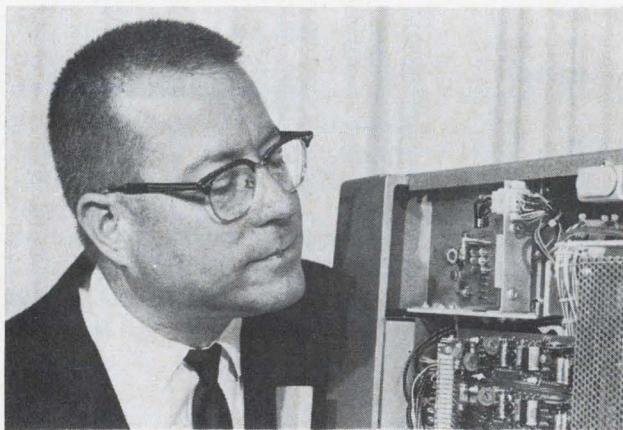
Copenhagen to Canada to California has been the itinerary of Per Mogensen's professional career. Co-author of the article on metal oxide semiconductor multiplexer switches on page 152, Mogensen is a 1962 MSEE graduate of the Danish Technical University. He worked in Toronto before joining Fairchild in 1965. For Wallace Chan, the state of the art has been California. He holds a BSEE from the University of California at Berkeley and is working for an MSEE at San Jose State College. Chan, who joined Fairchild in 1967, is working on a six-channel multiplexed analog-to-digital converter on a single MOS chip.



Mogensen



Chan



Haines

Almost from the day he graduated from Syracuse University 15 years ago, Frederick J. Haines has been involved in the development of television cameras and studio systems for closed-circuit or broadcast applications. He credits General Electric, where he spent 10 year designing cameras and other tv broadcast equipment, for most of his training in the field.

Before joining International Video in 1967 as a project engineer, Haines, the author of the article on page 134, was engineering manager for video products at Granger Associates in Palo Alto, Calif. Before that, he was a project engineer at Sylvania Electric Products.

The successful meeting of East and West at Marquette University is evidenced by the article on Gunn devices on page 148. Japan's T. Koryu Ishii, a professor at Marquette, is currently working on millimeter-wave and microwave solid state systems. Stanley V. Jaskolski, another professor, is now conducting research on the high-field effect in various semiconductors. And Mohammed Al-Moufti, from Iraq, did research for his master's thesis on r-f transmission lines using bulk-effect devices.



Meier

Inventor and developer of the magnetic rod elements used in NCR's 315 RMC computer, Donal A. Meier, author of the article on page 128, holds nine U.S. patents and heads a research section at NCR that's working on LSI memories.

The author of the plated-wire survey on page 124, George Fedde heads Univac's data processing technology group. He has been at the firm for 12 years and holds an MSEE degree from MIT.

Joining Librascope in 1960, Richard Flores is now manager of the plated-wire memory department there. He's the author of the article on woven-wire memories on page 131.

A systems engineer by experience, Alan Bessen has been involved during the past few years in the expanding field of electro-optics. He has developed the infrared contamination detection system described on page 112, as well as an optical miss-distance indicator, and has major experience in inertial navigation and fire-control systems.

Bessen holds a BEE degree from Cooper Union, where he subsequently taught courses in physics, and an MSEE degree from Columbia. He joined the Ford Instrument division of Sperry Rand 15 years ago and is now an engineering project supervisor in the special-purpose computers department. He is a member of Tau Beta Pi and the IEEE.

Do you have this new capacitor data?



DIPPED MICAS . . . for entertainment and commercial equipment

Single-film silvered-mica capacitors cost less than stacked mica or ceramic types. These capacitors are rated at 300 WVDC and have good stability and retrace characteristics over their operating temperature range of -55°C to $+85^{\circ}\text{C}$. Capacitance values from 10 to 360 pF, $\pm 5\%$ are available. Put this quality and performance into your next design. Ask for Engineering Bulletin 1010.

CIRCLE READER SERVICE NUMBER 220



SPARK GAPS . . . for TV tube protection

Sprague spark gaps suppress transient voltage surges and protect your expensive picture tube and allied circuitry. They are available in 1.5 kV and 2.5 kV ratings, and have a maximum capacitance of 0.75 pF, providing an economical means of safely bypassing transient overvoltages. All Sprague spark gaps are 100% tested to insure your circuitry. Use them to protect your picture tube warranty. Ask for Engineering Bulletin 6145A.

CIRCLE READER SERVICE NUMBER 221

DISC CERAMICS . . . for general, temperature-compensating, and low-voltage applications in industrial, commercial, and consumer equipment



Cera-mite® general application discs for bypass and coupling at low cost. Nine disc sizes from .300 to .875 inches have 100, 250, 500, and 1000 WVDC ratings, in standard or temperature-stable formulations. Dual-section discs have up to $.022\mu\text{F}$ @ 1000 V. Ask for Engineering Bulletin 6101D.

CIRCLE READER SERVICE NUMBER 222



Cera-mite temperature-compensating discs for controlled capacitance change with temperature in R-F oscillators, precision amplifiers, timing circuits, other critical applications. Select from ten linear temperature coefficients from NPO to N2200. Capacitance values from 1 to 2200 pF with 1000 WVDC ratings are available, plus popular values at 3000, 4000, and 5000 WVDC for TV yoke circuits. Mini-fied units in 250 WVDC ratings may be obtained with capacitance values ranging from 22 to 990 pF. Ask for Engineering Bulletin 6102B.

CIRCLE READER SERVICE NUMBER 223



Hypercon® ultra-high capacitance discs for low-voltage circuits. Replace electrolytics with non-polar Hypercon capacitors only a fraction as large. The $2.2\mu\text{F}$, 3 volt disc has a diameter of .875 inches; the $0.1\mu\text{F}$, 25 volt unit measures .750 inches. Ask for Engineering Bulletin 6141F.

CIRCLE READER SERVICE NUMBER 224

For bulletins in which you are interested, write
Technical Literature Service, Sprague Electric Co.,
 35 Marshall St., North Adams, Mass. 01247

SPRAGUE COMPONENTS

CAPACITORS
 TRANSISTORS
 RESISTORS
 INTEGRATED CIRCUITS
 THIN-FILM MICROCIRCUITS
 INTERFERENCE FILTERS

PACKAGED COMPONENT ASSEMBLIES
 FUNCTIONAL DIGITAL CIRCUITS
 MAGNETIC COMPONENTS
 PULSE TRANSFORMERS
 CERAMIC-BASE PRINTED NETWORKS
 PULSE-FORMING NETWORKS



*Sprague and ® are registered trademarks of the Sprague Electric Co.



COMPONENT CAPSULES

New 3 amp hermetic A15 replaces costlier rectifier diodes

GE now offers a higher rated companion to its field-proved, 1 amp A14 rectifier at a significantly lower cost than other stud or lead mounted units (depending upon configuration). The A15 is rated 3 amps at 70°C and the 200 to 800 volt models are

Microwave Circuit Modules reduce design cycles and improve system performance

While producing lower overall costs, these design benefits result from:

- Optimum integration of active devices in package form
- Over two decades of microwave circuit development
- The industry's most

New benefits from GE's hermetically sealed reed relays

Glass to metal seals and steel housing now provide true hermetic enclosure for reed relays. The GE 3SBN reed relay has:

- Increased sensitivity
- Immunity to magnetic interference effect
- Very low thermal

New low-cost miniature indicating lights ideal for limited space applications

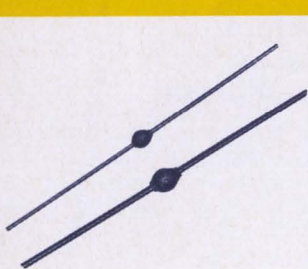
GE's new, low-cost CR-103HE indicating lights are only 1 $\frac{1}{8}$ inches long and mount with a speed nut in a $\frac{3}{16}$ inch diameter hole — perfect for applications where space is at a premium.

Flush and cylindrical lens types are available. The cylindrical lens pro-

GE computer-grade capacitors offer over 1/2 farad at 5 volts

New GE 86F500 High-Capacitance computer-grade capacitors now provide up to 540,000 μ f at five volts (34,000 μ f at 100 volts) in a single case.

These enlarged-capacity units are excellent choices where large blocks of capacitance



Microwave Circuit Modules (MCM)



New 3S BN



CR103HE



86F500's

transient voltage protected up to 1000 W for 20 μ S in reverse direction.

A15's dual heat sink design means low thermal impedance. Easy adaptation of axial leads to PC boards reduces installation cost below stud mounted units.

Both the A15/A14 are hermetically sealed in an all-diffused, glass passivated junction structure. No internal cavity means more resistance to environmental stresses ... thus increased reliability.

High-power A15 is now available through GE distributors for applications including power supplies, battery chargers, TV damper diodes, communication equipment and small portable appliances. Circle Number 231.

advanced tube technology

MCM's used as: oscillators, amplifiers, multipliers, detectors, mixers, etc. Available in a variety of individually designed configurations.

Compare MCM features:

- * Stable frequency performance in severe adverse environments
- * Small size and light-weights—as low as 1 cubic inch and 2 ounces with high power to volume ratio
- * Fast warm-up—3 seconds or less capability
- * High performance from a single active device

GE is your one source for full R&D backup, critical testing experience and facilities and an unequalled output of highest performance active components including coaxial and planar gridded tubes. Circle Number 232.

emf's in contact circuits

- Protection of contact capsules and coils, because of rugged construction
- A lower weight than plastic encapsulation

This new relay comes in Form A, 1-6 poles and Form C, 1-5 poles and is only 0.350 inches high. The relay is available in a wide range of system voltages and is ideally suited for printed circuit board applications.

For more information Circle Number 233.

trudes only $\frac{3}{16}$ inch, and is ultrasonically welded for maximum strength. Both are available in four lens colors: clear, amber, red and white. Four body colors are available: gray, white, beige and black.

The standard light has a 6 inch lead stripped $\frac{1}{2}$ inch, but special lengths are available. Leads are staked into the body of the unit to insure that no movement takes place inside the light.

The CR103HE is UL listed for 120V, 240V, and 460V, and is ideally suited for applications where visual display and appearance is important. For more information Circle Number 234.

are required—as in power supply filters, for example. 86F500 units are rated for continuous operation at 65C or at 85C with proper voltage derating.

GE's new computer-grade capacitors provide highest capacitance per case size, high ripple current capability, low ESR, long shelf and operating life.

Units are available in nine case sizes—diameters 1 $\frac{3}{8}$ " to 3", with lengths up to 8 $\frac{5}{8}$ "—for operation up to 100 VDC. Circle Number 235 on your reader service card.

A TECHNICAL DIGEST FOR INNOVATORS OF ELECTRONIC EQUIPMENT

Versatile GE meter relays are ideal for hundreds of applications

Including: temperature control, equipment overload protection, "go—no go" production line testing, and alarm sounding for a pre-selected value.

Accurate, repeatable control action over the entire scale is possible because there are no contacts on the unit's

Computer tape reel drives—one of many applications for these motors

The excellent commutating ability, fast response, and long insulation life of GE 3 $\frac{1}{16}$ ", 4 $\frac{1}{8}$ ", and 6 $\frac{1}{8}$ " diameter fhp motors meet computer tape reel demands for continuous duty, low maintenance, and reliability. And, applications don't end here.

Here's your key to low cost voltage stabilization

Every GE voltage stabilizer supplies constant output voltage to within $\pm 1\%$, even with input fluctuations up to 15%. For special economy, core-and-coil units provide the lowest cost voltage regulation obtainable. They help meet tight space require-

Fill your needs for sensitive temperature control with GE thermistors

Want extreme sensitivity to relatively minute temperature changes? You get it with GE thermistors (temperature-sensitive resistors). These devices also have temperature-compensating capability.

High sensitivity and small size make GE

New circuitry combines TVG's in pairs for easy HV crowbarbing

New developments in firing circuitry now make it convenient to crowbar high-voltage power supplies by utilizing GE's companion Triggered Vacuum Gaps in tandem.

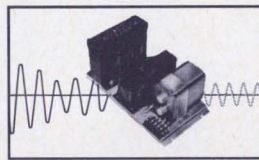
And what's more—attaché-case size sensing and firing circuitry is now possible. A unique



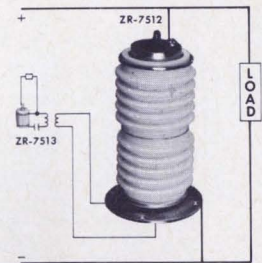
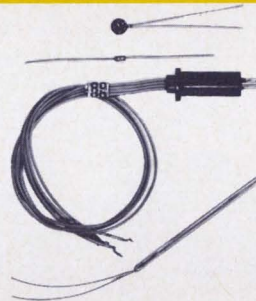
Big Look[®] Meter Relay



D-C Reel Drive Motor



AC Voltage Stabilizer



indicating pointer to cause mechanical interference. All units feature automatic ON-OFF reset control action. They easily adopt to manual reset.

No amplifier necessary. The unit's solid-state switch is connected in series with the coil of the load relay which operates it directly. Standard 120-volt a-c operation means no special power supply is needed.

The unit's "piggyback" control plug-in module design saves installation time, and eliminates the need for separate mounting.

For complete information about this meter relay and GE's full line of panel meters Circle Number 236.

Stall torque ratings from 3 to 120 ounce-feet and higher and various motor voltages span many application needs. This means these d-c motors can be custom tailored for almost all peripheral equipment needs.

Special mounting flanges, brake mounting arrangements on the commutator end, and shaft extensions can be furnished to your requirements. Also available: cooling air duct inlets at convenient locations. For more data, Circle Number 237.

ments, make wiring connections easier, and provide all the mounting flexibility you can ask for.

Voltage stabilizers are available in rating from 15 to 15000 volt-amperes in both standard and custom-designed models. Ask your GE sales engineer for publication GEA-7376 or circle magazine inquiry card Number 238 for details.

thermistors ideal sensors for SCR and transistorized controllers.

Operation over a wide temperature range permits thermistors to compensate the combined effects of copper windings and temperature-sensitive electromagnetic core materials.

GE thermistors are available as elements or in a wide variety of probe assemblies to suit your applications. Circle Number 239 for more facts.

pulse transformer allows fault sensing at ground potential, even where the TVG trigger is at high negative voltage.

Use General Electric's ZR-7512/13 TVG combination shown in the sketch for protection at 45-KV, or other combinations covering from 300 volts to over 75 KV. For more information Circle Number 240.

FOR THE NEW IDEAS IN ELECTRONICS, look to General Electric—your best single source for electronic components.

ELECTRONIC COMPONENTS SALES OPERATION

GENERAL  ELECTRIC

**I'm Edson deCastro,
President of Data General.
Seven months ago we started the richest new
small computer company in history.
This month we're announcing our first product:
the best small computer in the world.**

Data General wasn't started on a shoestring.

My associates and I had been with a company where we developed the most successful line of small computers in the business. And we knew the only way to go was big. Right from the beginning.

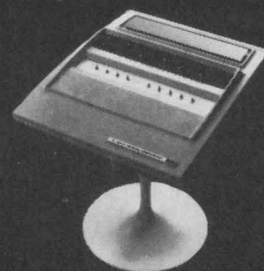
So we got the financing to be big. To build a plant that'll knock out these computers by the hundreds. To develop a large enough technical service organization to really support our customers.

And we designed a revolutionary computer. The NOVA.

Other small general purpose computers are built around an obsolete architecture based on an old technology. NOVA is built around medium scale integration. It's the first with multi-accumulator/index register organization. The first with read-only memory you can program the same way you do core. The first low cost machine that allows you to expand memory or build interfaces within the basic configuration.

One more thing. The price with a 4096 16-bit word memory and Teletype interface is only \$7950. And we're offering the best discounts in the business.

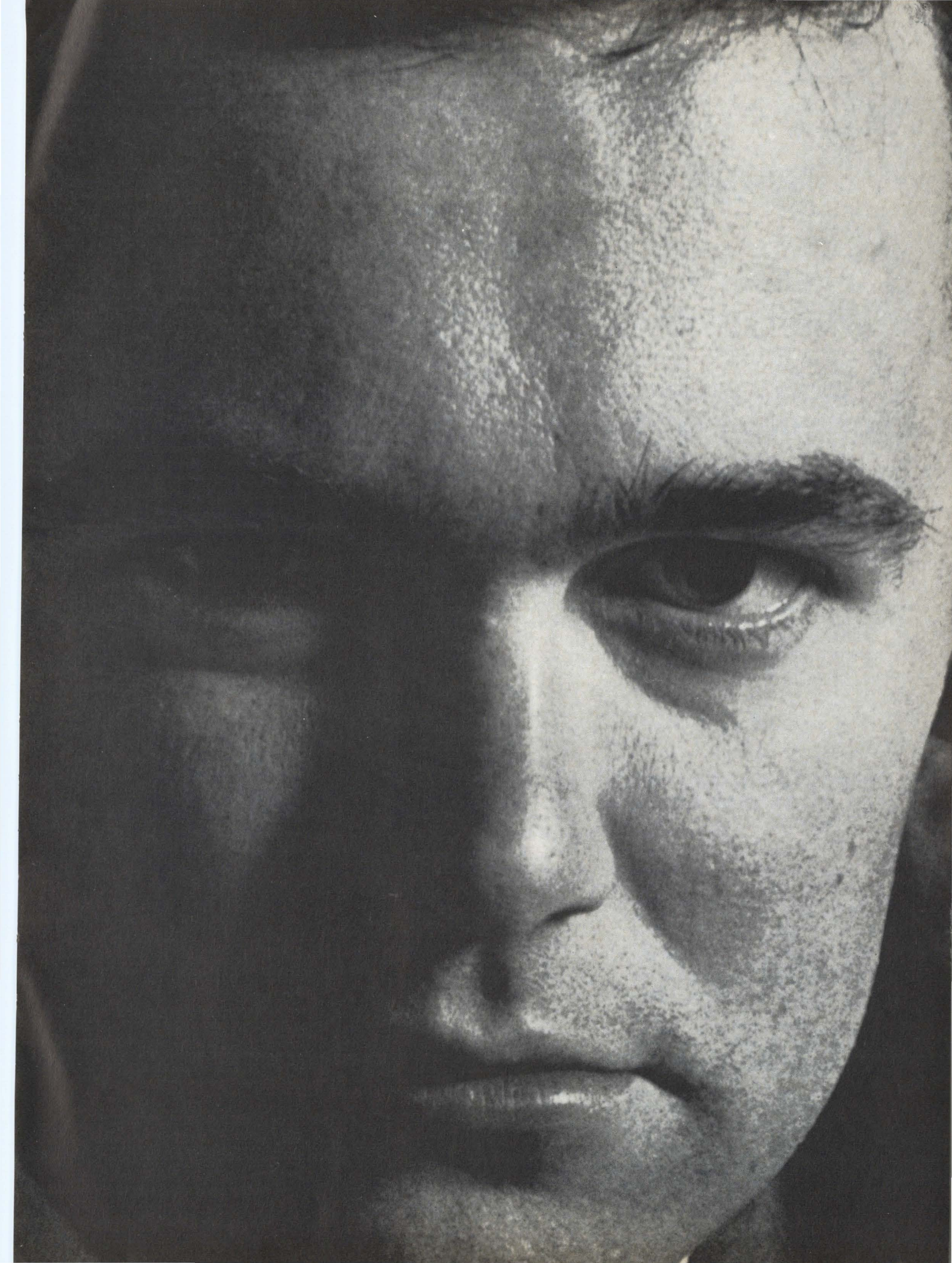
Because if you make a small inexpensive computer, you have to sell a lot to make a lot of money. And we intend to make a lot of money.



**DATA GENERAL
CORPORATION**
275 Cox Street, Hudson, Mass. 01749

Specifications: NOVA is a 16-bit word general purpose computer. It has four accumulators, two of which may be used as index registers. It offers a choice of core or read-only memory of 1K, 2K, 4K, 8K, and up to 32K 16-bit words (or twice that many 8-bit bytes). NOVA comes in the desk top console shown here or a 5 1/4" tall standard rack mount package. Both the desk and rack versions can hold up to 20K 16-bit words of memory or interface for a large number of peripheral devices. NOVA has the most flexible I/O facility ever built into a machine of its class. It will include a high-speed Data Channel and automatic interrupt source identification as standard equipment. Write for more information today. Or see us at the Fall Joint Computer Conference on Wednesday.

Circle 12 on reader service card





E F C fiberoptics for computer applications

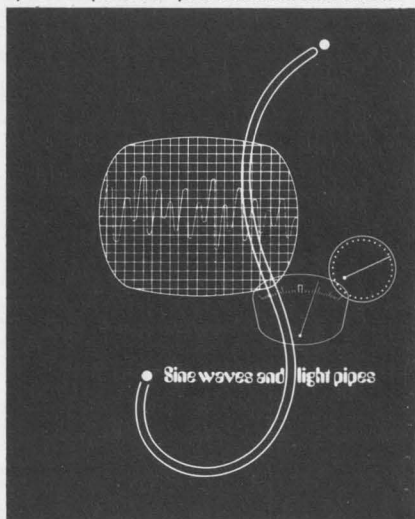
**Punched Card and
Tape Readers
Reflective Readers
Light Piping**

For designers, specifiers and buyers of fiberoptic components in the computer or peripheral equipment industries, there is now a single source of design and manufacturing capability to meet your requirements... with competitive prices, firm deliveries and conscientious service. For more information, write or call

ELECTRO FIBEROPTICS CORPORATION

45E Water Street, Worcester, Mass. 01604
Phone 617 791-7391

Write for this booklet called **Sine Waves and Light Pipes**—an introduction to Electro Fiberoptics Corporation—plus technical data sheets.



Who's Who in electronics



Cox

The appointment of Marshall G. Cox as marketing director of the Components division of the Raytheon Co. signals an entirely new direction for the division's Semiconductor operation. Cox, 33, comes to Raytheon from Fairchild Semiconductor, where he was in charge of computer marketing, Fairchild's biggest sales target. Raytheon has been known as a "hi-rel" military house, specializing in low-quantity, high-price, and high-reliability orders. No more.

Electronic data processing, Cox says, will account for 45% of integrated-circuit sales by 1971. If Raytheon is to grow, it will have to enter the volume fields; the hiring of Cox was one step of division manager Nevin Kather's plan for such entry. "The plan in 1968 was to add to our revenue by concentrating on existing markets," Kather says. "Now we have to diversify our customer base." Adds Cox: "By the end of 1969 we will have penetrated the commercial market with both proprietary and second-source products."

Faster TTL. The specific areas where Raytheon wants to compete are transistor-transistor logic, semiconductor memories, linear circuits, and—somewhat downstream—sub-nanosecond emitter-coupled logic in complex medium-scale integration.

Raytheon already second-sources Sylvania in both SUHL 1 and SUHL 2, the brand of TTL with the highest performance ratings. But it will also offer, by the end of the year, eight complex circuits in the popular Texas Instruments series 54/74, and will introduce a whole line (25 elements) of its own TTL.

This proprietary TTL, now going under the house name of Ray 3, will have propagation times of under 4 nanoseconds—less than two-thirds the typical rating of SUHL 2. It will be pin-compatible and electrically compatible with SUHL ("It's really super-SUHL," Cox says with a grin.), but with a single masking change it can be made compatible with the series 54/74 as well. Moreover, the power dissipation will be the same as SUHL's.

"We have made a formal marketing study and found many makers of small- and medium-sized computers who want superfast SUHL for the central processing unit, peripheral equipment, and even terminals," Cox says. The new line will be out early next year.

All in plastic. In memories, Raytheon will first aim at the scratch-pad market. The company has already announced a 16-bit scratch-pad, and it will have a 64-bit device in the first quarter of next year and a 256-bit beam-leaded chip in the second quarter. Other plans are for hybrid packages with from four to eight beam-lead chips.

It will be hard to compete in memories in the future without a metal oxide semiconductor line, and Raytheon sold its MOS operation to Hughes last year. But, says Kather, "we will be back in MOS by 1970, or whenever it's necessary."

In linears, Raytheon now second-sources Fairchild's 709 and 741 operational amplifiers and National Semiconductor's LM101 op amp, and makes its own fully compensated version of the 101. It plans to introduce an improved version of the 741, a fully compensated circuit.

To underline the completeness of Raytheon's change, Cox notes that the company will offer every circuit in a plastic package by the

MACHLETT



New Machlett tetrode... for single tube design at high power levels

Vapor-cooled ML-8785 (or ML-8786,
water-cooled) is particularly suitable
for these applications:

High Power Communications

Class C Telegraphy...to
350 kW

Linear RF Power Amplification

Class AB—Suppressed Carrier Service
to 260 kW PEP

Pulse Modulation or Amplification

40 kv	DC Plate Voltage
50 kv	Peak Plate Voltage
500 a	Pulse Cathode Current
1000 μ s	Pulse Duration
.01	Duty
Pulse Power to 15 Mw	

Write today for details on these
versatile "single-tube-design" tetrodes.
The Machlett Laboratories, Inc.,
1063 Hope Street,
Stamford, Conn. 06907.

RAYTHEON

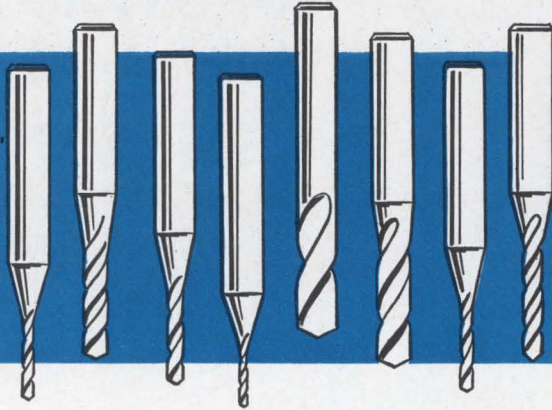
THE MACHLETT LABORATORIES, INC.

A S U B S I D I A R Y O F R A Y T H E O N C O M P A N Y

SERIES
260
AND
265

1/8"
SHANK

SOLID CARBIDE CIRCUIT BOARD DRILLS



Choice of 58 drill sizes from No. 80 to 1/8"
ALL WITH COMMON 1/8" DIAMETER SHANKS

for precision drilling
with every drill size!



You can now maintain location and hole size tolerances to extremely close limits . . . at drill feeds up to 15 feet per minute! The unequalled rigidity of solid carbide plus the added support of 1/8" shanks gives maximum deflection-free performance in drilling all diameter circuit board holes. All drills precision ground with unique four facet drill point configuration. Common 1/8" shank design eliminates need for collet and bushing inventory for each drill size. Your Metal Removal distributor provides vital sales and engineering liaison . . . call him or write for Catalog D67.



THE METAL REMOVAL COMPANY
1859 West Columbia Avenue • Chicago, Illinois 60626
Plants Located in CHICAGO/LOS ANGELES/SAN JUAN

MASTER TOOL AND WHEEL MAKERS FOR THE WORLD
END MILLS / DRILLS / REAMERS / BURS / SPECIAL TOOLING

Who's Who in electronics

end of the first quarter of 1969.

All of these plans, of course, will require increased production capacity, and the Semiconductor operation is now investigating foreign assembly facilities; its present plants are in Paso Robles, Calif., and Mexicali, Mexico.

If ever there existed an organization that depended on digital data—in fact, whose very lifeblood is real-time, transaction-oriented information—it's the New York Stock Exchange. In the single-minded world at the southern tip of Manhattan that is the financial district, anything that promises to increase the efficiency with which that data is delivered gets as warm a welcome as the latest hot issue.

The exchange now has a new man in charge of promoting efficiency: Robert B. Grant, vice president and director of the Electronic System Center. The 46-year-old Grant, who came to Wall Street in August from the Celanese Corp., is responsible for the exchange's computer activities and for devising new data-handling methods.

Over the horizon. It's in the latter area that the cigar-smoking Grant has his work cut out for him. "We have more to do in the long-range planning area. We have to plan for tomorrow and, equally important, beyond tomorrow—so that when we get to tomorrow we know where we're going from there."

But Grant hasn't turned his back on hardware problems. He can't, because the exchange's problems are unique. Not only does it have an unusually large number of real-time requirements, but its computers must have a level of data integrity that off-the-shelf hardware simply doesn't provide. Custom modifications must be made.

"We also must have multiprocess redundancy," explains Grant, "in which one machine monitors the other, spots degradation, and calls in other equipment or itself—a kind of shoulder-tapping operation. The hard truth is that we simply cannot tolerate more than 15 seconds of down time."

new

4

WAY INDUSTRIAL CERMETS

MODEL 3059



...with *BOURNS* Reliability Sealed in!

"4-way" means our new industrial Model 3059 is available in two printed circuit pin configurations of MIL-R-22097 (RJ-11 and RJ-12), as well as solder lugs and stranded insulated leads.

It was designed that way because as the newest member of the growing line of Bourns cermet potentiometers, it must—like every Bourns product—offer more by design and deliver more by performance.

The Model 3059 has a maximum temperature coefficient of 150 ppm/°C for all resistances; a power rating of 1.0 watt at 70°C, and an operating temperature range of -55 to +150°C. In addition, each unit is individually inspected for performance to guaranteed electrical and physical characteristics.

Complete technical data on the new industrial cermet Model 3059 potentiometer is available from the factory or your local Bourns field representative.



SPECIFICATION TABLE

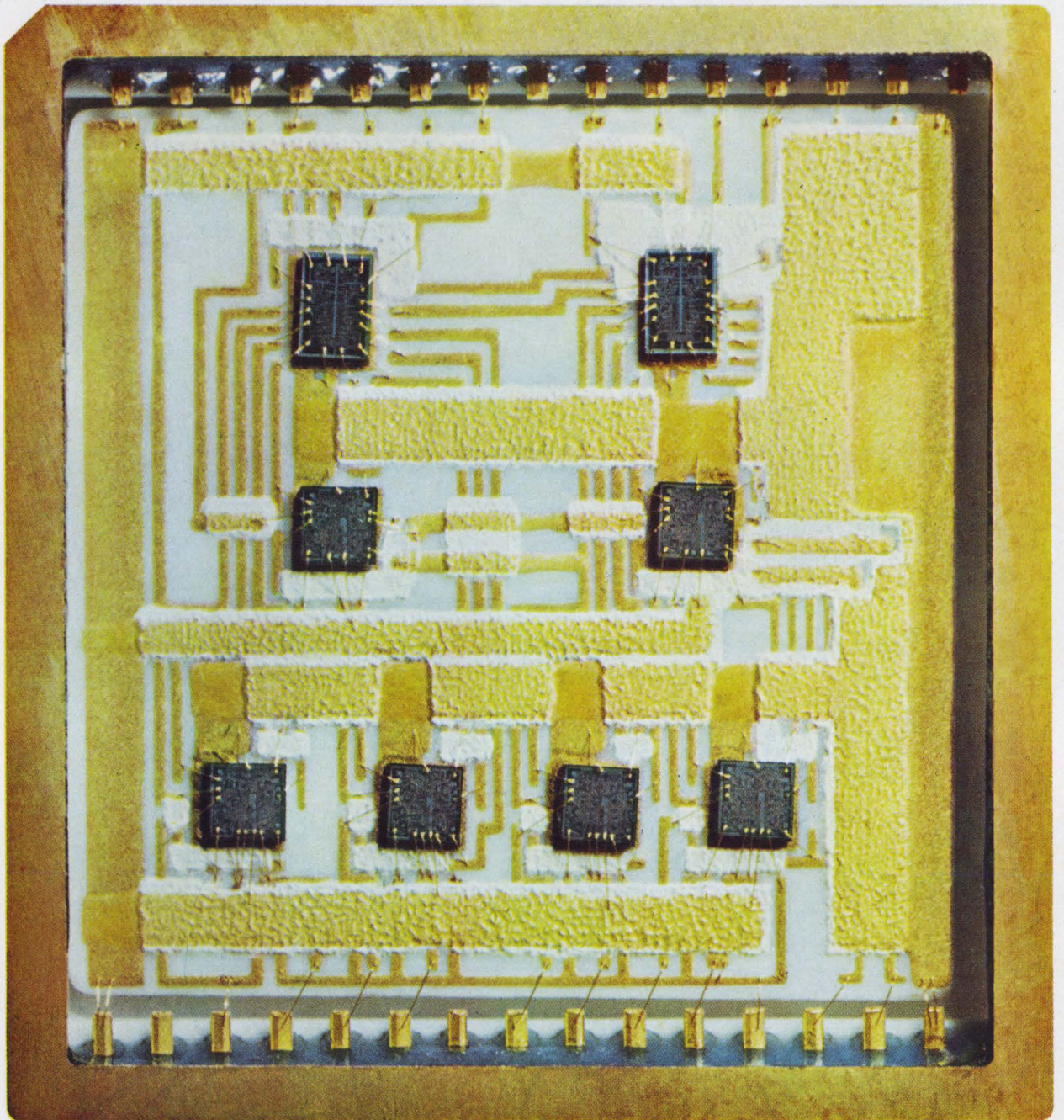
Standard Resistance Range	10 ohms to 1 megohm
Resistance Tolerance	±10%
Power Rating	1.0 watt
Operating Temperature Range	-55 to +150°C
Temperature Coefficient	±150 ppm/°C maximum*
Seal	Mil-Spec Immersion
Terminals	RJ-11 and RJ-12 Printed Circuit Pins, also Solder Lugs and Stranded Insulated Wires.

*100 ppm/°C available



BOURNS, INC. TRIMPOT PRODUCTS DIVISION
1200 COLUMBIA AVENUE, RIVERSIDE, CALIFORNIA 92507
714 584-1700 • TWX 910 332-1252 • CABLE BOURNSINC

Fairchild can make more hybrids in



an hour than you can use in a month.



We can make any hybrid, in any quantity, using any method: Thick film. Thin film. Thin film on silicon.

We can make them faster than anyone in the industry. And deliver them quicker to anyone in the world.

We'll take any functions you need and package them any way you want. Our list of hybrid components has everything from a simple diode to a complex LSI array.

For your less complex applications, we have a line of off-the-shelf standard hybrids priced like discretes.

If this commitment makes sense in general, we'd like to send you the whole story in detail. Our brochure is called Fairchild Hybrid Microcircuits. It can give you more ideas in an hour than you could use in a year. Write for it.

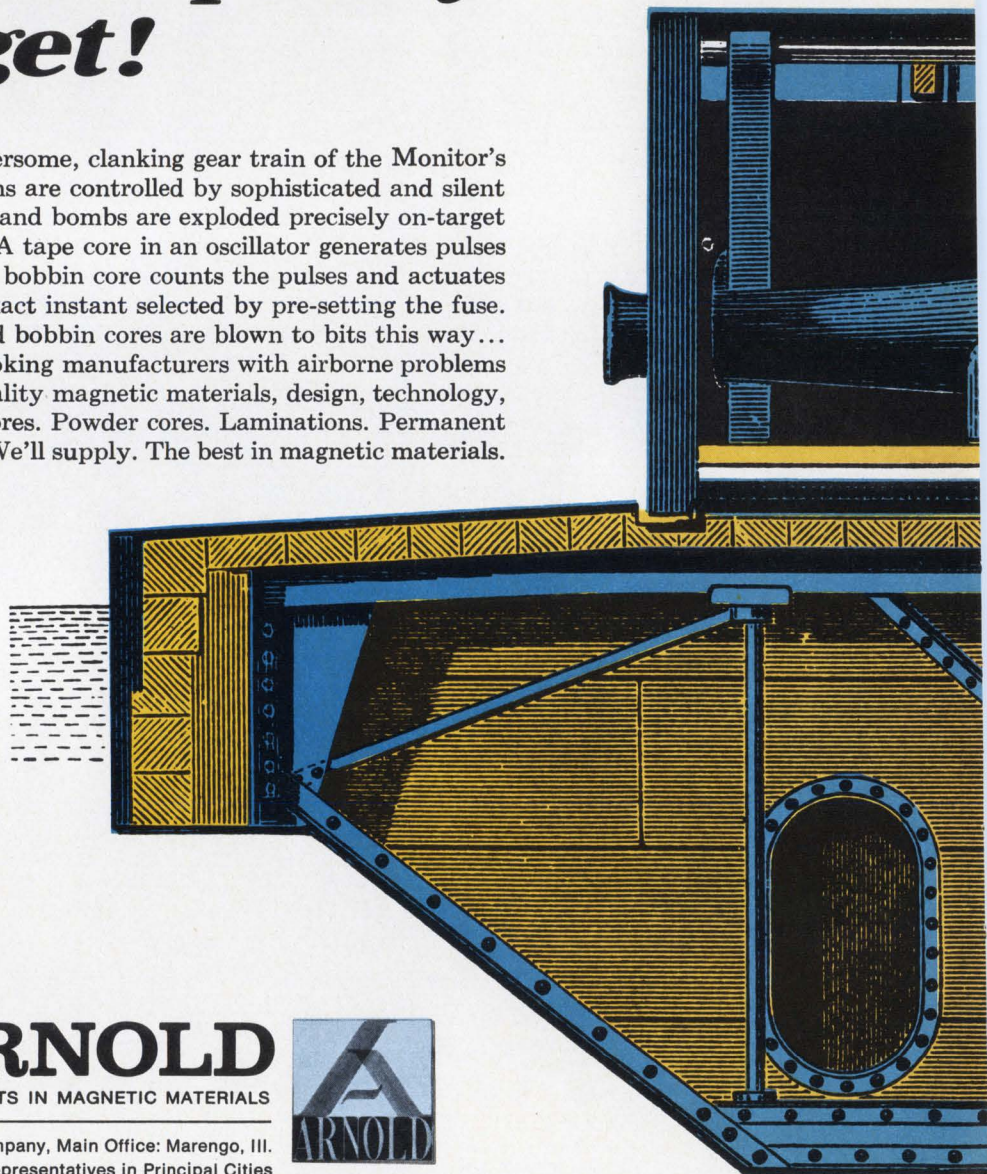
Fairchild Semiconductor/A Division of Fairchild Camera and Instrument Corporation//313 Fairchild Drive, Mountain View, California 94040 (415) 962-5011 TWX: 910-379-6435

FAIRCHILD
SEMICONDUCTOR

MAGNETICS

keep weaponry on target!

Unlike the cumbersome, clanking gear train of the Monitor's cannon, today's weapons are controlled by sophisticated and silent means. Artillery shells and bombs are exploded precisely on-target by delayed action fuses. A tape core in an oscillator generates pulses for a timing circuit. A bobbin core counts the pulses and actuates the explosive device at the exact instant selected by pre-setting the fuse. Some of our best tape and bobbin cores are blown to bits this way... but they do their job. Forward-looking manufacturers with airborne problems look to Arnold for high-quality magnetic materials, design, technology, components. Magnetic cores. Powder cores. Laminations. Permanent magnets. You ask. We'll supply. The best in magnetic materials.



ARNOLD
SPECIALISTS IN MAGNETIC MATERIALS

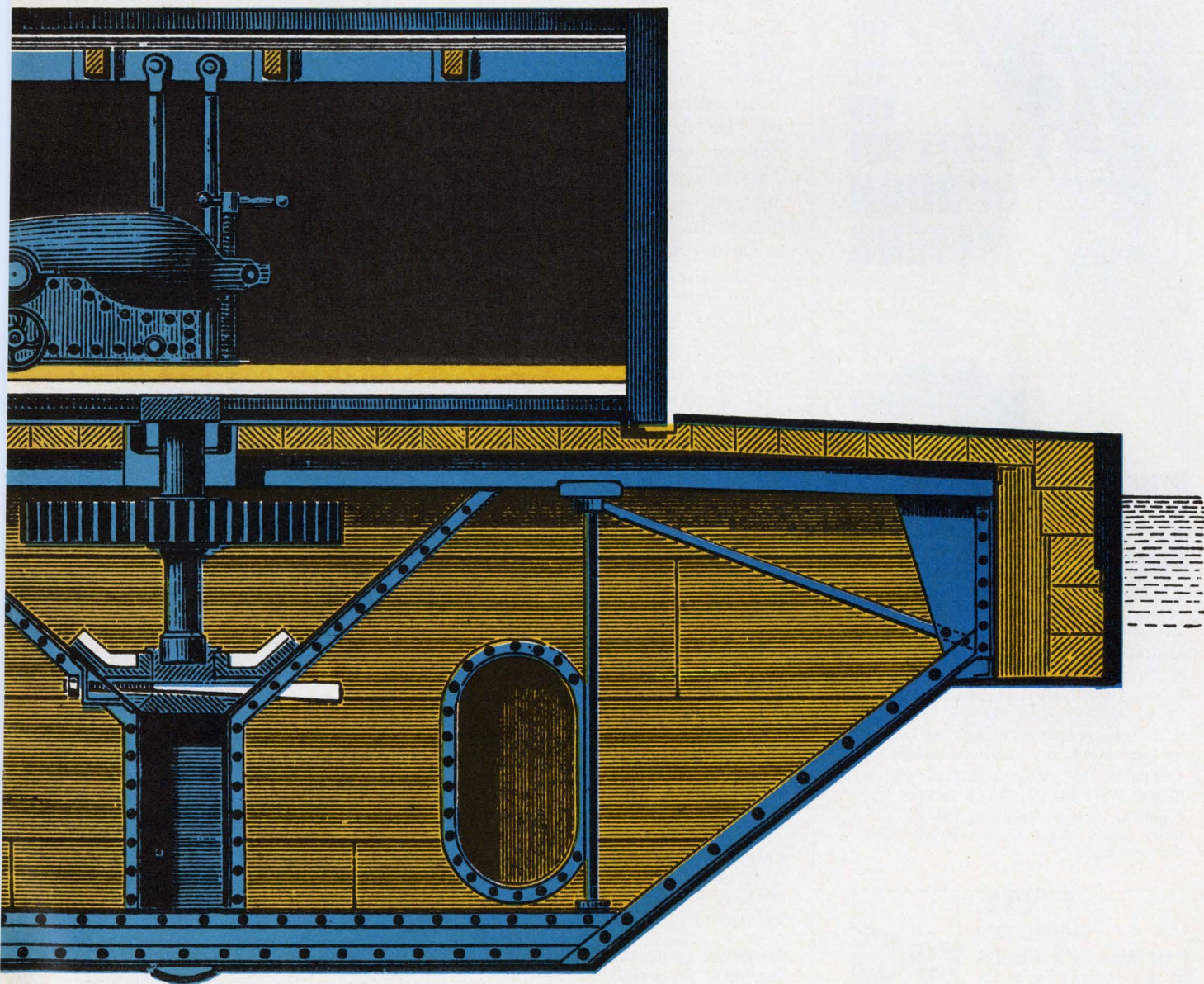


The Arnold Engineering Company, Main Office: Marengo, Ill.
Branch Offices and Representatives in Principal Cities

Write for your free guide to the only complete line of magnetic materials.

Other Arnold products are up in the air too: bobbin cores and MPP cores in aerospace telemetering • Supermendur in smaller, lighter transformers for jets and aerospace • iron powder cores in radio/TV coils • Alnico and Arnox in loudspeakers for radio/TV and communications • Alnico for microwave equipment.

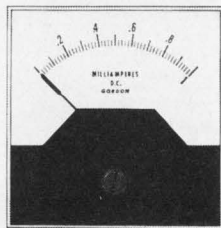
BY ARNOLD



WE'RE UNVEILING



THE
ALL
NEW
SERIES 8000
GORDON
METERS

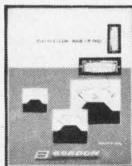


- Quality, reliability and styling from Gordon, famous for instruments since 1914!
- Tops for your OEM equipment or black-box applications, GORDON METERS feature covers of clear, high-impact G.E. Lexan®.
- Core magnets are high-coercive Alnico for the sustained accuracy you need.
- Spring-backed sapphire pivot bearings and one-piece bridge construction standard.
- Popular 2½", 3½" and 4½" models; square; edgewise; DC and AC rectifier type.
- Custom design available, too, in color masks, scales, ranges, resistances and pointer style and color.

FREE
GORDON
PANEL METERS
BULLETIN 1-800

4042

Write Today



PDC GORDON
A SUBSIDIARY OF
PNEUMO DYNAMICS CORPORATION
5710 KENOSHA ST. RICHMOND, ILL. 60071

Meetings

Reliability physics: problems of connection

Connecting elements in an integrated circuit presents a continuing problem: the combination of properties demanded of the interconnection material is hard to get. And the problem is worse for large-scale and medium-scale integration, because two or more layers of interconnections are needed. So serious is the difficulty that it's to be the focus of attention at this year's Symposium on Reliability Physics (formerly Physics of Failure in Electronics) in Washington Dec. 2 to 4.

An entire session, for example, will be devoted to electromigration of interconnections in IC's. This effect, which causes openings in the aluminum interconnection paths, was originally thought to be a result of evaporation due to internal heating. It is now known that the aluminum atoms in the interconnection migrate as a result of momentum transferred by impinging electrons.

J. R. Black, an engineer with Motorola, will lead off the session with a survey of present knowledge of the effect and a report of his work on a prediction model that incorporates the effects of temperature, current, and composition on electromigration.

M.J. Attardo, A.H. Landzberg,

W.E. Reese, and G.T. Wenning, researchers at IBM's Components division, will give the results of their study of the precise nature of the effect in long interconnection paths. And electromigration is not limited to aluminum, as T.E. Hartman and J.C. Blair of Texas Instruments report in their paper on electromigration in gold film conductors.

Surface studies. Some of the problems of multilayer LSI interconnections (and the corollary dielectric layers) are discussed in papers by G.L. Schnable and R.S. Keen on failure mechanisms, and by Schnable and E.S. Schlegel on test structures for studying surface effects. All are with Philco-Ford.

One of the sessions will be devoted to scanning electron microscopes and electron-beam microprobes—among the most powerful and popular analytic tools to become available to the semiconductor industry. P.R. Thornton of the University College of North Wales will survey applications in an invited paper. The use of electron-beam techniques to study IC metalization problems will also receive attention in this session.

For more information, write Joseph Vaccaro, Rome Air Development Center, Griffiss Air Force Base, N.Y. 13440.

Calendar

Automatic Support Systems Symposium for Advanced Maintainability, IEEE; Sheraton-Jefferson Hotel, St. Louis, **Nov. 12-14.**

Conference on Thermal Conductivity, Department of Commerce; National Bureau of Standards, Gaithersburg, Md., **Nov. 13-15.**

Analytical Symposium Advanced Technical Program, American Chemical Society, Society for Applied Spectroscopy, American Microchemical Society; Statler Hilton Hotel, New York, **Nov. 13-15.**

Meeting of the Anti-Missile Research Advisory Council, Advanced Research

Projects Agency and the U.S. Naval Postgraduate School; Monterey, Calif., **Nov. 14-16.**

Symposium on the Applications of Lasers to Photography & Information Handling, Society of Photographic Scientists and Engineers; Airport Marina Hotel, Los Angeles, **Nov. 14-15.**

Conference on Engineering in Medicine & Biology, Biomedical Engineering Society; Shamrock-Hilton Hotel, Houston, **Nov. 17-20.**

Conference on Magnetism and Magnetic Materials, IEEE and the American Institute of Physics; Hilton Hotel, New York, **Nov. 17-21.**

(Continued on p. 24)



IS ELECTRONICS ALL AMERICAN?

Not when we have more than 80,000 non-American readers.

Or you can point the finger at our international advertisers. They consistently place more advertising in **ELECTRONICS** than in any other worldwide electronics publication.

And *we* can point (with pride) to our editorial staff in 64 different countries. They're responsible for our **ELECTRONICS INTERNATIONAL** section. It's a new identity for the increasingly monolithic electronics market.

ELECTRONICS INTERNATIONAL gives

advertisers the opportunity to pinpoint this market with fractional as well as full pages. Subscribers are prime prospects for worldwide advertisers in every segment of the market:

% who purchase or specify	
Manufacturers of electronic components & equipment	78.5%
Manufacturers using electronic equipment	81.1
Government & military	82.1
Independent research & development	88.8
Operators of communications equipment	90.0
Service & installation	77.3
Educational institutions	93.5
Distribution	not asked

Proof of its importance to non-American readers can be found in their loyalty. More than 88% read 3 out of every 4 issues.

% who purchase or specify	
Manufacturers of electronic components & equipment	91.3%
Manufacturers using electronic equipment	94.9
Government & military	94.6
Independent research & development	93.0
Operators of communications equipment	90.7
Service & installation	92.6
Educational institutions	88.9
Distribution	94.4

If you're in the international electronics market, **ELECTRONICS INTERNATIONAL** wants **YOU!**

EXTRA DRY



In a martini, it's a matter of taste — in a K-Grip Jr. RF connector in wet, humid climate, it's essential. That's why our new series of plugs and jacks is moisture-proof.

The dry is extra. All the rest is K-Grip Jr. — the lowest cost, high-reliability RF connector installed. Almost 50% smaller, 50% lighter, it's a crimp type version of our standard RF connector reduced to its simplest form. Assembly is foolproof — in seconds.

With K-Grip Jr. RF connectors it's a matter of savings. We save you time, weight, space and, in our new series of plugs and jacks, we save you from weather-worry. Write for details.

KINGS

ELECTRONICS CO., INC.
40 Marbledale Road/Tuckahoe, N.Y. 10707
(914) SW 3-5000 / TWX 914-793-5879

Meetings

(Continued from p. 22)

Photovoltaic Specialists Conference, IEEE; Jet Propulsion Laboratory, Pasadena, Calif., Nov. 19-21.

Microelectronics Packaging and Interconnection Conference, Society of Automotive Engineers; Rickey Hyatt's House Hotel, Palo Alto, Calif., Nov. 20-22.

Winter Annual Meeting & Energy Systems Exposition, American Society of Mechanical Engineers, Hilton Park Sheraton, New York, Dec. 1-5.

Conference on Applications of Simulation, Association for Computing Machinery, IEEE; Hotel Roosevelt, New York, Dec. 2-3.

Reliability Physics Symposium, IEEE; Hilton Hotel, Washington, Dec. 2-4.

Vehicular Technology Conference, IEEE; Hilton Hotel, San Francisco, Dec. 3-4.

Entry Vehicle Systems and Technology Meeting, American Institute of Aeronautics and Astronautics; Williamsburg, Va., Dec. 3-5.

Circuit Theory Symposium, IEEE; Hilton Plaza Hotel, Miami Beach, Fla., Dec. 4-6.

Symposium on Theory & Measurement of Atmospheric Turbulence & Diffusion in the Planetary Boundary Layer, Sandia Corp. and the Atmospheric Sciences Laboratory of the Army Electronics Command; Albuquerque, N.M., Dec. 5-7.

Vehicular Technical Group Conference, IEEE; Hilton Hotel, New York, Dec. 6-8.

Electrical Insulation Conference, IEEE; Biltmore Hotel, Los Angeles, Dec. 8-12.

National Electronics Conference, IEEE; Conrad Hilton Hotel, Chicago, Dec. 9-11.

Fall Joint Computer Conference, IEEE; Hilton Hotel and Civic Center, San Francisco, Dec. 9-11.

Consumer Electronics Symposium, Conrad Hilton Hotel, Chicago, Dec. 9-10.

Symposium on Adaptive Processes, IEEE and UCLA; University of California at Los Angeles, Dec. 16-18.

Winter Institute in Computer and Information Sciences, University of Florida; Gainesville, Dec. 17-21.

American Association for the

(Continued on p. 26)

Systron-Donner worked till we could give you a line of DVM's clearly superior to any others on the market today. Take the tiny Model 9000 you see here:

We gave it a clean, modern design and pivoted the display so you can adjust it to be read without stooping and craning your neck.

We gave it a quick response input amplifier to eliminate hunting and enable it to track varying inputs. That means you don't have to wait while the digits flicker every time you tweak a pot.

We used the best conversion technique—dual

slope integration—to give it 80 db noise rejection and maximum long-term accuracy.

We made it read current and resistance as well as voltage to broaden its utility.

We made it show polarity, decimal point and unit of measurement so just about anyone can use it without risk of error.

And we gave it a price tag you can afford: \$395.

Little Model 9000 is but the smallest of an elegant new family that includes .01% DVM's and multimeters in easy-to-carry cases or flat Thin Line configurations that take only 1-3/4" of rack space.

We perfected the imperfect DVM —and gave it class too.



SYSTRON  DONNER

888 Galindo Street, Concord, California 94520. Telephone (415) 682-6161



Temp-R-Tape® T

One of a series of self-adhering tapes of skived Teflon* TFE. High elongation provides excellent conformability for tight wraps around irregular surfaces.

Temp-R-Tape HM-350

Made of skived Teflon TFE. A unique CHR manufacturing process imparts lower elongation and higher breaking strength. Good conformability.

Temp-R-Tape C

Extruded Teflon FEP film has extremely high electric strength, highest of all Temp-R-Tapes. Transparent for easy read-through. Excellent conformability.

Temp-R-Tape Kapton*

Made from a polyimide film. Has outstanding thermal endurance. Retains physical and electrical properties at elevated temperatures. *T.M. OF DUPONT

Temp-R-Tape GV

Closely woven glass cloth. Good conformability and flexibility. Strong. Puncture and tear resistant. Excellent abrasion resistance and thermal stability.

Temp-R-Glas®

Glass fabric coated with Teflon TFE. Four thicknesses. Resists Teflon cold flow. Strong. Puncture and tear resistant. Also available without adhesive.

WE MAKE SIX DIFFERENT TYPES OF WIDE TEMPERATURE RANGE ELECTRICAL TAPES.

THAT WAY WE'LL HAVE ONE THAT'S JUST RIGHT FOR YOUR APPLICATION.

Temp-R-Tape is operational from -100 F to +500 F, has excellent electrical and physical characteristics. Pressure sensitive silicone polymer adhesive. Stocked by a national network of distributors capable of technical assistance and fast delivery. Look under CHR in industrial directories or micro-film catalogs. Or write for details and sample. The Connecticut Hard Rubber Company, New Haven, Connecticut 06509.

Subsidiary of U.S. Polymeric, Inc.



Meetings

(Continued from p. 24)

Advancement of Sciences; Dallas, Dec. 26-31.

Reliability Symposium, IEEE; Palmer House, Chicago, Jan. 21-23.

Second Hawaii International Conference, Department of Electrical Engineering, University of Hawaii, Honolulu, Jan. 22-24.

Winter Power Meeting, IEEE; New York, Jan. 26-31.

International Symposium on Information Theory, IEEE; Nevele Country Club, Ellenville, N.Y., Jan. 28-31.

PMA Metrology Conference, Precision Measurements Association; The Ambassador, Los Angeles, Feb. 3-5.

Winter Convention on Aerospace & Electronics Systems, IEEE; Biltmore Hotel, Los Angeles, Feb. 11-13.

International Solid State Circuits Conference, IEEE; University of Pennsylvania and the Sheraton Hotel, Philadelphia, Feb. 19-21.

International Convention & Exhibition, IEEE; Coliseum and Hilton Hotel, New York, March 24-27.

Conference on Lasers & Optoelectronics, IEEE; Southampton, England, March 25-27.

Semiconductor Device Research Conference, IEEE; Munich, West Germany, April 11-14.

Joint Railroad Conference, IEEE; Queen Elizabeth Hotel, Montreal, April 15-16.

International Magnetics Conference (Intermag), IEEE; RAI Building, Amsterdam, Holland, April 15-18.

Geoscience Electronics Symposium, IEEE; Marriott Twin Bridges Motor Hotel, Washington, April 16-18.

Conference on Switching Techniques for Telecommunications Networks, IEEE; London, April 21-25.

Electrical & Electronic Measurement and Test Instrument Conference, Instrumentation & Measurement Symposium, IEEE; Skyline Hotel, Ottawa, Canada, May 5-7.

Frequency Control Symposium, Electric Components Laboratory, U.S. Army Electronics, Shelburne Hotel, Atlantic City, N.J., May 6-8.

(Continued on p. 286)

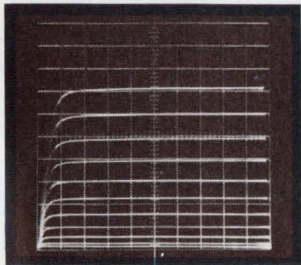
A REAL WINNER

2N5452
@
\$14.95 EA.

(IN LOTS OF 1-99)

TWICE THE DEVICE AT A THIRD OF THE PRICE

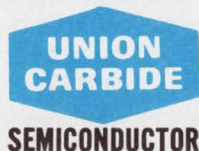
That's right! Now you can buy the industry's finest Matched Dual FET at this amazingly low price. Use it in your Modular, Hybrid, Differential or IC amplifier designs and be a winner!



Definition	2N5452
Offset Voltage	5 mV Max.
Offset Voltage Drift -55° to +125°	5 μ V/°C Max.
Output Admittance at f = 1 kHz	0.35 μ mho Typ. 1.0 μ mho Max.
Output Admittance Match at f = 1 kHz	0.05 μ mho Typ. 0.25 μ mho Max.

All Parameters measured at
 $V_{DS} = 20V$, $I_D = 200 \mu A$

On your
**Union Carbide
Distributor's
shelf now**
— buy one today.



Union Carbide Semiconductor/P.O. Box 23017/8888 Balboa Ave./San Diego, Calif. (92123)/tel: (714) 279-4500

WINNERS

Most people never dreamt we'd go this low. Here are 10 that did. A dream of a device at \$14.95. For the 82% of you who guessed too high you'll find the greatest reward is in using the 2N5452.

Henry DeBrain
Chicago, Illinois

W. L. Halleck
Groton, Conn.

Richard Kane
Philadelphia, Pa.

R. T. Pfeiffer
Ottawa, Canada

O. M. Potvin
Moosup, Conn.

J. Prager
Burlington, Mass.

Ernie Sanchez
Concord, Calif.

R. E. Williamson
Patrick AFB, Florida

George Yakoubianir
Cos Cob, Conn.

Laszlo F. Zala
Cleveland, Ohio

Circle 27 on reader service card

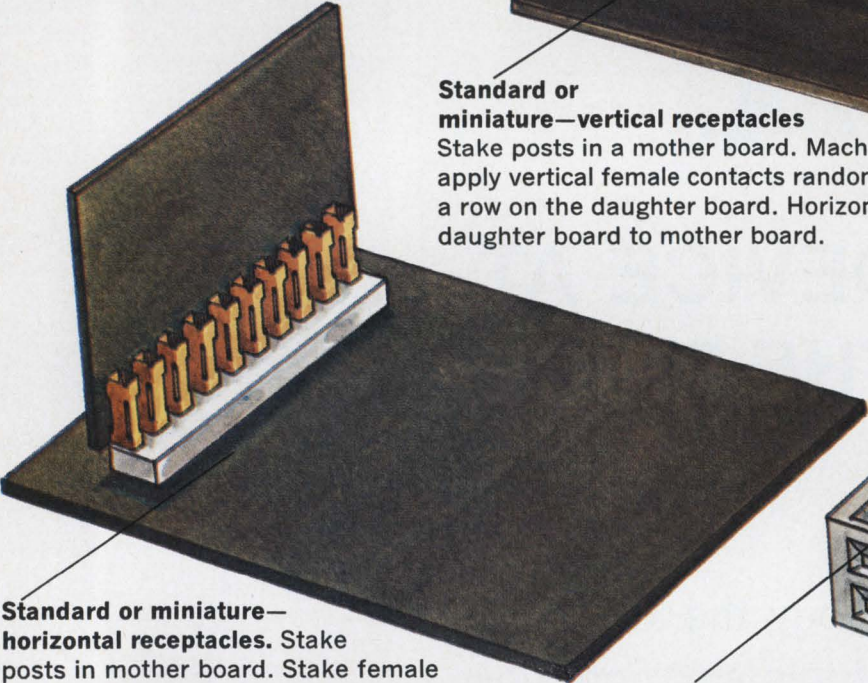
The Electronic

For the modular man, the do-it-yourself AMPMODU* Interconnection System solves your interconnection problems for modular packaging. You start with a post and a receptacle—and you build from there. Two sizes: Standard which uses .031 x .062 posts and Miniature which uses .025 x .025 posts.



Standard or miniature—vertical receptacles

Stake posts in a mother board. Machine apply vertical female contacts randomly or in a row on the daughter board. Horizontally plug daughter board to mother board.



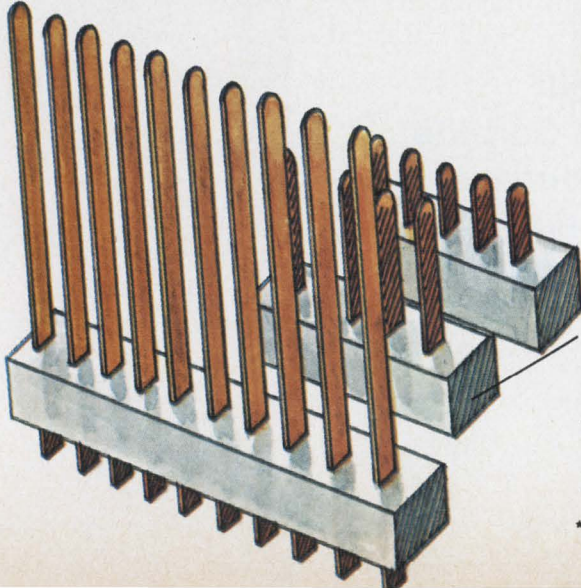
Standard or miniature—horizontal receptacles.

Stake posts in mother board. Stake female contacts horizontally on edge of daughter board and plug daughter board vertically into mother board. Posts can be placed randomly or in even patterns in both horizontal or vertical approach.



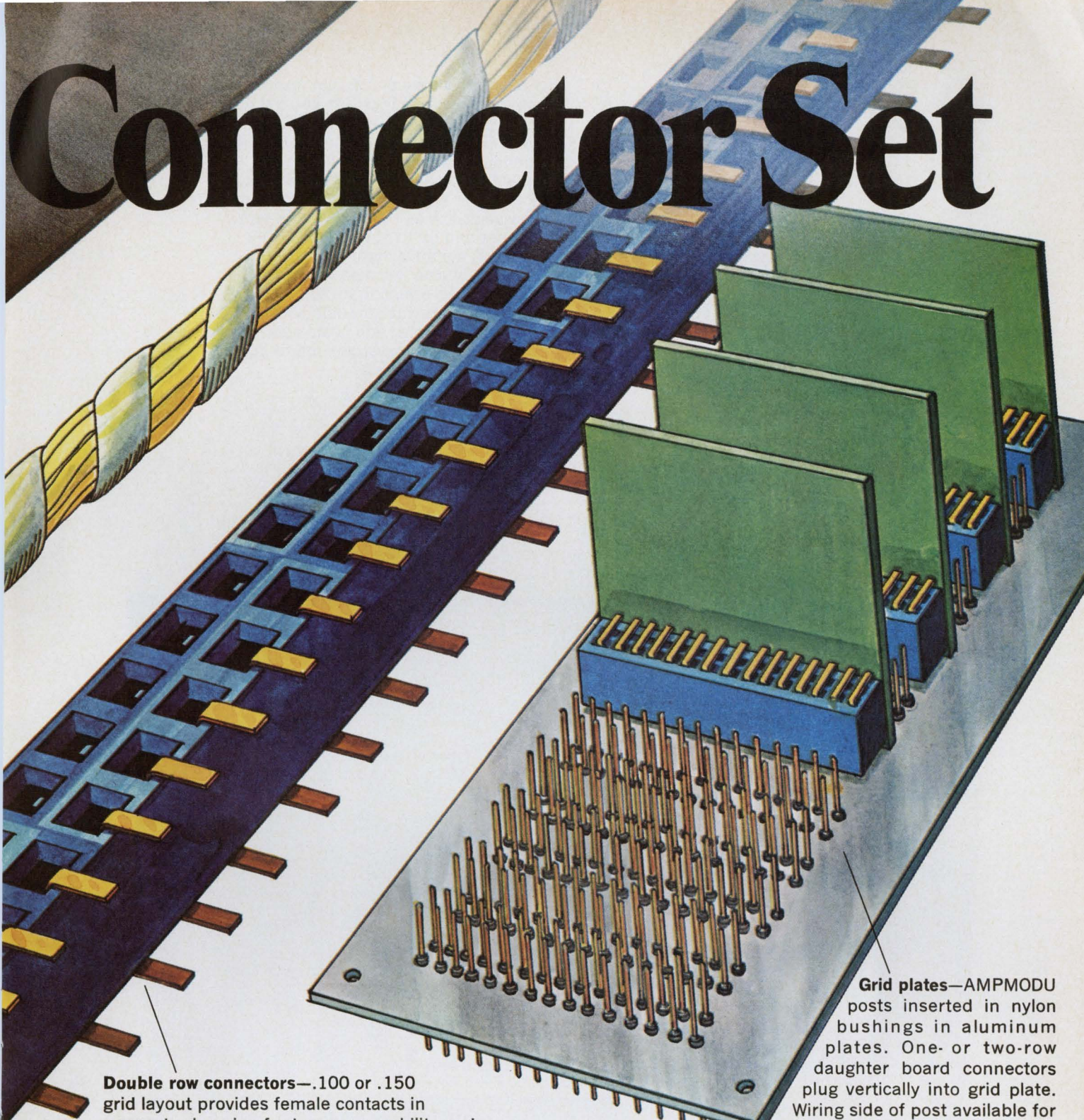
Crimp-snap-in connectors.

.150 and .100 centers—miniature size only. Crimp female contacts on wire. Snap them into connector housing. Mates with posts installed on printed circuit board. Also for input/output jumpers for grid plates. When not used in a housing, similar contacts can also be crimped to flat flexible cable.



Incremental nylon connectors provide standard size posts in three different lengths. Permits one, two or three daughter boards to be stacked horizontally to mother boards. Where metallic chassis are required, posts are available in snap-in nylon blocks.

Connector Set

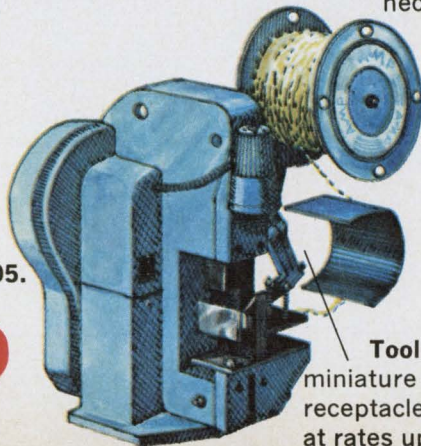


Double row connectors—.100 or .150 grid layout provides female contacts in connector housing for two row capability and individual protection of contacts. Single row connectors also available.

Grid plates—AMPMODU posts inserted in nylon bushings in aluminum plates. One- or two-row daughter board connectors plug vertically into grid plate. Wiring side of post available for **TERMI-POINT**★ or wrap-type connections.

The **AMPMODU** Interconnection System is your electronic building block connector set providing you design flexibility and cost advantage unmatched by other systems. Complete details are available by writing **AMP INCORPORATED, HARRISBURG, PA. 17105.**

AMP
INCORPORATED

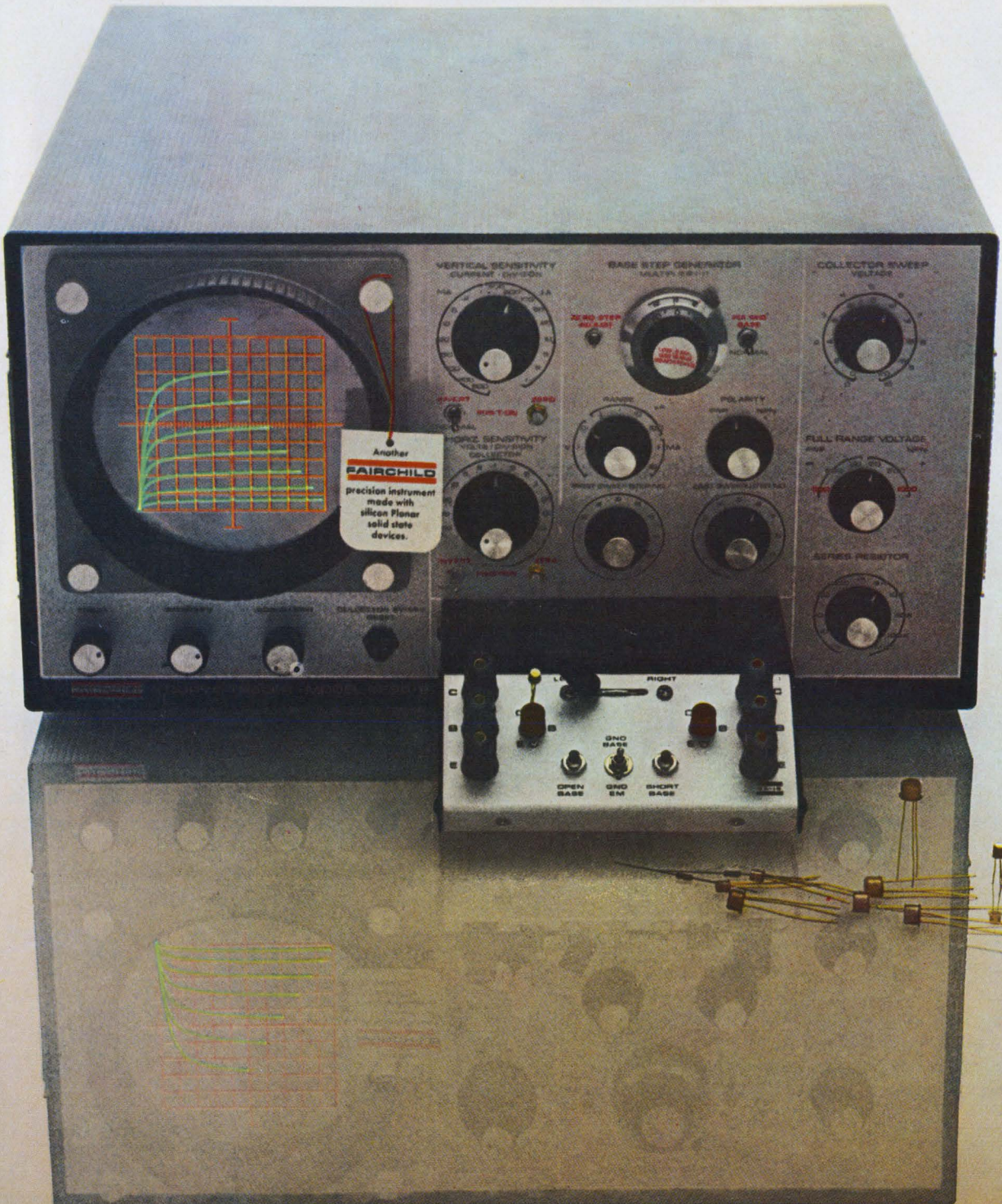


Tooling: The **AMP-O-LECTRIC**★ with miniature applicator inserts AMPMODU receptacles and posts into circuit boards at rates up to 2000 an hour.

Circle 29 on reader service card

**Versatile
curve tracer.**
FET/SCR capability:
\$1575.

Fairchild's Model 6200B can test a greater variety of devices than any curve tracer in its price range. It operates FETs, MOS-FETs, bipolars, unijunctions, diodes, tunnel diodes and SCRs. It provides 1000V for high voltage measurement and 5 amps for high current tests. Base drive can be as low as 100nA for high-gain devices and up to 35V for FETs. The 6200B is compact, lightweight and rack-mountable. We also have a programmable version for high-volume production applications: the 6200B/P. It does a lot more. And costs a little more. We'll gladly tell you about one or both. Ask for our data sheets.



Editorial comment

A challenge from the power industry

Foolproof delivery and round-the-clock availability are the minimum specifications the electric power industry demands for its only product—kilowatts. Can the electronics industry—actually the offspring of the power industry—help achieve these goals? If programs undertaken by the Los Angeles Department of Water and Power and the Houston Lighting & Power Co. are indicative, the answer is yes. Both utilities will use a real-time computer system for load switching and dispatching.

But there are skeptics in the power industry. Some doubt the adequacy of the programing, others the accuracy of the monitoring and peripheral equipment [Electronics, Sept. 30, p. 125].

The skeptics notwithstanding, it seems inevitable that closed-loop systems will be developed with an infallibility assured by redundancy and the use of high-reliability components. There appears to be no better way to meet the demanding requirements of power systems already too complex for men to handle. As we see it, the power industry needs electronic gear in these areas:

- communications
- sensing and switching
- processing (conversion and inversion).

At the International Electron Devices Meeting in Washington last month, Leonard Linde, an engineering consultant with nearly 40 years of experience in the power field, challenged engineers to develop a vast computer-based system of "protective intelligence" that would continuously monitor all sections of a power system and jettison parts of it when necessary to protect the remainder. Today's relay systems protect only assigned and relatively small zones.

Because speed is all-important in isolating parts of a system or diverting power, a reliable system will have to be exceedingly fast. Furthermore, because the measuring of systems trends (changes in frequency, voltage, or power factor) consumes precious time, trend prediction will be increasingly critical.

The electromechanical relays used to protect today's power systems are likely to be replaced by solid state devices. Relays are subject to the fallibility of mechanical devices and require significant power. The transition will not be without hitches, Linde notes. Problems of compatibility between old

and new systems must be resolved, and speed, accuracy, and power requirements will have to be set for the new systems.

Public utilities will probably bypass the common carriers in meeting their special data transmission needs. Instead they'll look to the electronics companies to develop microwave telemetry gear capable of transmitting lots of data reliably and at very high speed.

The potential market involves more than just monitoring and supervisory equipment. Linde, in discussing consumer needs, suggests that the development of a reliable and economical fuel cell could revolutionize the power field. Customers using such cells for direct current would need more electronics to provide multiple frequencies and voltages.

The transmission of d-c power at high voltage will also create a demand for electronic gear. The first U.S. application of hvdc will be to transmit power from the Columbia River to Los Angeles. In such a system, conversion and inversion of power could be accomplished with grid control mercury rectifiers that are cascade-connected to get the needed voltage rating. But a better way now being tried in Sweden involves the use of cascaded thyristors. Circuit interruption technique—still pretty much of a black art—will have to be improved for hvdc systems, in which voltage recovery transients can be as high as 5 kilovolts per microsecond.

Cooling to superconductive temperatures—too expensive and exotic a process for power companies to use in the past—may deserve another look as a means of handling overloads on a limited scale.

Despite the clear challenge to electronics engineers posed by the power industry, the most perspicacious forecaster would be hard put to predict how rapidly the power market will grow. Nevertheless, it's worth noting that new capital investment in the domestic power industry last year totaled \$7.8 billion, a figure that's expected to exceed \$10 billion annually by 1972.

The quick and efficient application of electronics to the power field depends on good communications between electronics engineers and power people, but even more on the ingenuity of the electronics industry.



If your TWTs don't play because of coercive force problems, our HyCo Alnico 8 is the solution.

What can HyCo do for your traveling wave tubes that no other alnico can? Offer you the highest coercive force of any alnico, for one thing: 1900 oersteds, in our HyCo 8H. From samples to production quantities, HyCo is consistent in high coercive force, resistance to demagnetization, and temperature stability. — Want to avoid the exacting process of calibrating your magnets and stacks? We're the only manufacturer

offering production quantities of calibrated TWT assemblies (and we'll even sell you a calibrator). When it comes to residual induction, our HyCo 8B is the highest among all the alnico 8 types. Look to HyCo 8 materials to save weight and space in applications like klystrons, BWOs, reed switches, relays, motors, generators, meters and instruments. Write for

all the HyCo details to Mr. C. H. Repenn, Manager of Sales, Indiana General Corporation, Magnet Division, Valparaiso, Indiana.

Typical Properties	HyCo 8B	HyCo 8H
Residual Induction (Br) gauss.....	8500	7000
Coercive Force (Hc) oersteds.....	1600	1900
Energy Product (B ₀ H ₀) max.....	5.00x10 ⁶	5.00x10 ⁶
Peak Magnetizing Force—oersteds....	6000	6000
Permeance Coefficient at (B ₀ H ₀) max....	.525	4.25

INDIANA GENERAL
Making Magnetics Work



Electronics Newsletter

November 11, 1968

Camera-vtr combo will cost \$400-\$500

Engineers at Dubow Chemical Corp. in New Hyde Park, N.Y., have developed a 7-pound, battery-operated combination camera and video tape recorder that looks and operates like a home movie camera. Using Du Pont's chromium dioxide half-inch tape in an endless-loop cartridge, the helical-scan vtr records black-and-white pictures under normal room lighting. Each tape cartridge records for up to 6 minutes.

At a private demonstration in New York last week, the camera-recorder took pictures that were flawlessly played back on a standard monochrome tv set. To play back, the unit is connected to the tv set's antenna leads.

Nick Mascara, Dubow's executive vice president, says the unit will sell for between \$400 and \$500 and will be available at dealers some time next fall.

Dubow is now negotiating with an electronics manufacturer to produce and market the unit.

GE readies 5-watt IC

GE will soon put a low-cost, 5-watt integrated circuit for use as a power amplifier on the consumer hi-fi and industrial markets. Insiders say the key to the high power is an improved plastic dual in-line package that provides low thermal resistance between the chip and the attached heat sink.

The IC, the PA246, will be the first U.S.-produced device that can supply 5 watts of continuous audio power. Sinclair Radionics of Cambridge, England, recently announced that it would soon market a similar 5-watt integrated circuit at a price of about \$7. But it now may delay the introduction "several months" [for details, see p. 306].

Erbium-yag laser said to be safer

Because of the hazards of laser use [see p. 193], increasing attention is being focused on an erbium-doped yttrium aluminum garnet laser. The material, under development at Martin-Marietta's Orlando, Fla., division, is stirring interest because the division's researchers say that its wavelength, at 1.6 microns, is less dangerous to the eye.

The 1.6-micron region is relatively safe because this light is more easily absorbed in the cornea and the aqueous medium; less light gets to the retina, where it can cause serious damage.

The device could be used in military range-finding and tracking systems. The output energy of the pulsed laser is 120 millijoules, and although efficiency is only 0.05%, the developers expect to raise it to 0.5%, adequate for most military systems.

Another problem is that available detectors, such as germanium avalanche diodes, aren't frequency-compatible with yag. The company is trying to develop improved germanium photodiodes or mercury-cadmium-teluride devices instead.

Motorola expands radiation-resistant IC capabilities

Motorola's Semiconductor Products division is broadening its capacity to produce radiation-resistant monolithic integrated circuits. The firm has set aside 17,000 square feet at its Mesa, Ariz., IC center for an independent group that will design and build standard dielectrically isolated IC's, and plans to hire additional engineers to augment the group already turn-

Electronics Newsletter

ing out radiation-hardened circuits for such programs as Minuteman 2. Seven modified Series 930 diode-transistor-logic IC's will be the first standard radiation-resistant circuits Motorola will offer. They'll be ready in a few months and will be followed early next year by a dielectrically isolated plug-in replacement for the 709 operational amplifier.

These moves are apparently aimed at keeping Motorola up with Fairchild Semiconductor and Radiation Inc., which recently won contracts to set up production lines for radiation-resistant IC's for the Poseidon missile guidance computer [Electronics, Oct. 28, p. 52]. A companion contract went to Motorola, but that award covered only transistors.

FCC may clear way for private network of microwave links

A network of private microwave links serving large commercial users may soon spring up. The President's Task Force on Telecommunications hopes to persuade the Federal Communications Commission to permit the establishment of private data-transmission services subject only to the availability of frequency space [see related story, p. 68].

The task force, due to report its findings to the White House before Dec. 1, contends that private microwave systems do not compete directly with existing common carriers, and it will urge the FCC to drop regulations protecting common carriers from microwave operators promising lower rates.

A test case is now before the FCC. Microwave Communications Inc. is seeking authorization to set up a flexible data-transmission voice-circuit service between St. Louis and Chicago. The commission is believed to be deadlocked on the issue but H. Rex Lee, who assumed his seat late last month, will probably cast a tie-breaking vote in favor of the company's application.

The granting of a license in this case would encourage the many other firms planning similar links and there's a movement afoot to fashion the small microwave operations into a loosely organized grid or network, though details haven't been worked out.

Union seeks to link layoffs to imports

The International Union of Electrical, Radio, and Machine Workers (IUE) is expected to demand U.S. Tariff Commission hearings on its charges that electronics imports are causing layoffs. The IUE will cite the television industry as a major example of this trend, but will claim that the situation exists "throughout the electronics industry."

One complaint is that electronics companies have violated those provisions of the Tariff Act that require added compensation for workers laid off because of imports.

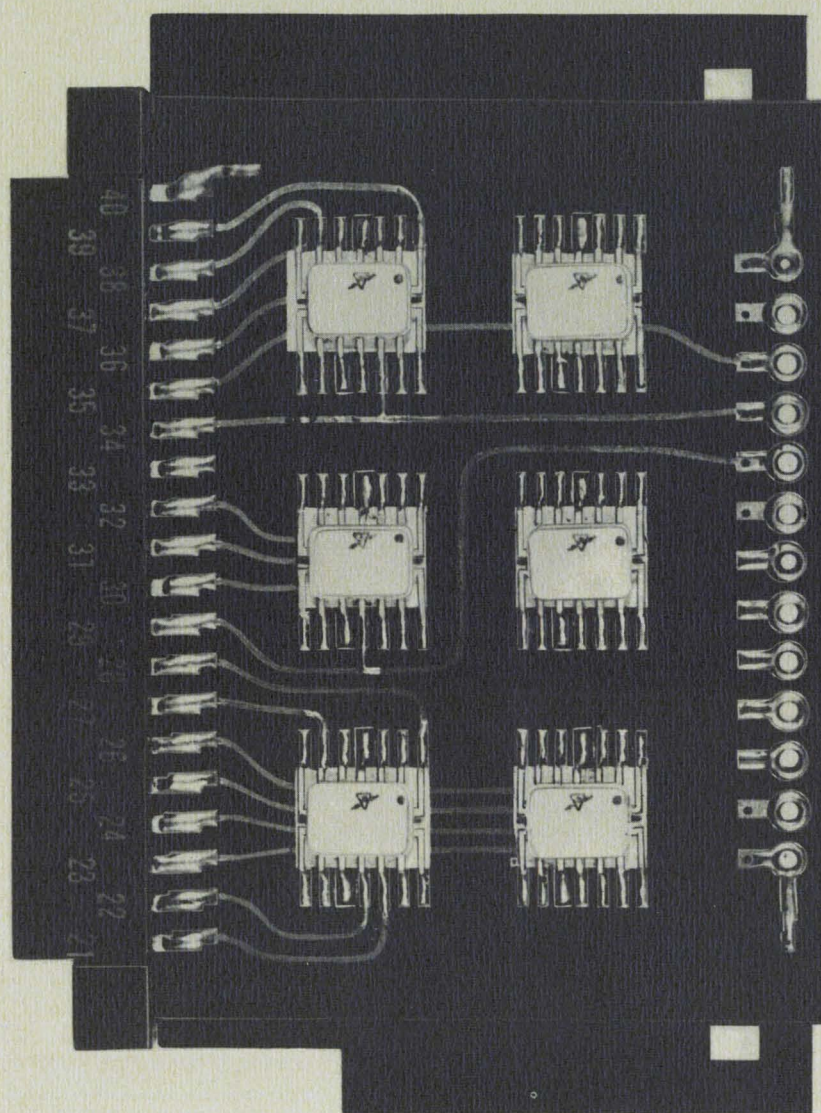
Addenda

The Air Force says it will let two contracts by the end of the year for competitive approaches to a multifunction modulation technique for its integrated communications, navigation, and identification (I/CNI) system. The Rome Air Development Center is now evaluating proposals for the exploratory studies. The awards will be the first in the I/CNI program, according to a Rome spokesman [Electronics, Aug. 19, p. 33]. . . . NASA's Electronics Research Center is seeking companies to study requirements for an "experimental Saturn 5 television broadcast satellite system." NASA apparently feels that a satellite-borne transmitter can achieve the required radiated power, but no money has yet been earmarked for the hardware.

IDEAS/Circuit Assemblies

**Solve your noise problems
with circuit modules.**

We told you in the past how our circuit modules reduce noise. Now we've improved them even further.



Multilayer construction of Sylvania circuit cards brings IC leads within 1/64" of power and ground planes.

An additional reduction in noise figures of from 30 to 50 percent has been obtained by circuit improvements in Sylvania's popular line of circuit modules. The 13 new modules added to the line are completely compatible with previous units.

The key to improved noise reduction is the addition of a leadless low-inductance capacitor between the power and ground planes. This improvement is in addition to the already low noise figure of our circuit card that is achieved by

Continued on next page

This issue in capsule

Information Displays

New CRT brightens picture for air traffic controllers.

Spark Gaps

Compact surge arrestors offer low-cost circuit protection.

Integrated Circuits

How to design with the SA-20 wide-band amplifier.

Microwave Diodes

For short pulse detection: Try back diodes.

EL Readouts

Electroluminescent clocks will time Apollo flights.

Manager's Corner

How synergism brings you new and better circuit assemblies.

New Circuit Module Cards

Type	Function
262	Memory card (2 bit x 64 word)
263	Memory select driver card
264	Encoder
265	Dual eight-bit register
266	Quad four-bit register
267	Quad four-bit binary divider
268	Up/down counter
269	Series/parallel converter
270	Dual four-bit/five-word storage register
271	Five-bit comparator with storage
272, 273	5.55 MHz bi-phase clock
276	13-bit digital delay generator
285	Test card

its unique construction and inherent low noise of Sylvania's SUHL integrated circuits.

Until the development of our circuit modules you couldn't take full advantage of the speed capability of our SUHL II 50-MHz logic. Noise levels limited practical operation to speeds of about 20 MHz. Now you can approach the full 50-MHz capability of these devices when you buy them on our circuit boards.

The circuit module is made up of two four-layer boards mounted on either side of an aluminum "backbone." Each board has two signal planes plus distributed power and ground planes. When necessary, the signal planes can be electrically interconnected with plated-through holes. The distributed power and ground plane construction allows every IC lead on the board to be within 1/64" of the power and ground planes. The result is extremely short lead lengths and, thus, low noise pickup.

Typical of the new circuit boards is our #262 memory card and #263 memory select driver. Here, we've done your memory design work for you. The #262 is a 128 bit card (2 bits x 64 words). Combined with the #263 memory driver, it gives you a sophisticated systems-oriented building block that can solve your memory problems with a minimum of interconnections.

CIRCLE NUMBER 300

New CRT brightens picture for air controllers.

Scan conversion system using Sylvania CRT makes airport tower radar displays visible in bright sunlight.

Airport towers, where lighting conditions can vary from darkness to 4,000 foot-candles, put tough demands on the contrast and brightness of radar displays.

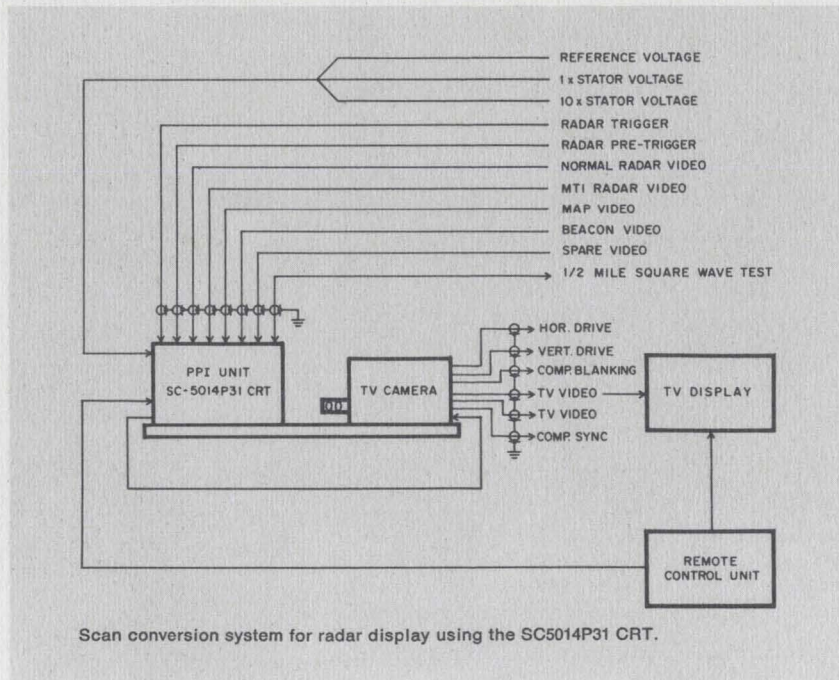
As a result of considerable research and development work within the Federal Aviation Administration, bright radar displays for use by air traffic controllers have become a reality. Based on an FAA-issued specification, ITT Industrial Laboratories, Fort Wayne, Indiana has come up with an optical scan conversion system that solves the problem for FAA flight controllers. The system uses a special long-lag vidicon camera optically coupled to a Sylvania 5-inch CRT to convert the PPI radar display into a high-brightness 945-line TV display.

The high-resolution requirements put a stringent demand on the CRT used in the conversion process. To meet the need, Sylvania developed the SC-5014P31. This tube provides a 0.0015-inch line width on a 5-inch optically flat faceplate. The neutral gray non-browning faceplate is designed to give optimum photographic quality. Brightness is enhanced by the use of an aluminized screen.

In operation the PPI unit in the diagram accepts the normal radar inputs and displays the radar video on the face of the Sylvania CRT. The vidicon camera is focused on the CRT display and converts it to a uniform bright TV display. The long-lag photoconductive surface of the vidicon retains images of moving aircraft so that a minimum of five trails are visible to indicate direction of movement.

The composite EIA video signal is fed to a special 12-inch CRT for viewing by the flight controller. The display has a highlight brightness of up to 500 foot-lamberts giving the controller an acceptable display in the tower at any time of the day or night.

It is in applications like this, where the demands on CRTs are exacting, that Sylvania's experience and technical know-how really pay off.



Scan conversion system for radar display using the SC5014P31 CRT.

CIRCLE NUMBER 301

How compact surge arrestors offer low-cost circuit protection.

The gas-filled spark gap surge arrestor is one of the simplest ways to protect equipment against damaging voltage surges. But just because it's simple, don't underestimate its capability.

A spark gap represents an almost ideal device for the job of protecting equipment against voltage surges. Under normal load conditions it presents a very high impedance (100 megohms). If a surge occurs, the gap breaks down and appears as a virtual short circuit. When the over-voltage drops below the extinguishing voltage of the gap, the device immediately returns to the high impedance state.

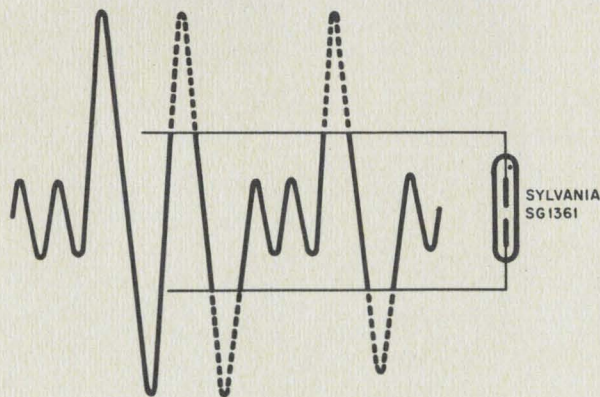
Sylvania's SG-1361 argon-filled spark gap is a miniature unit designed to protect low power components such as relays, capacitors, coils, and active devices from overloads. It has a nominal firing voltage of 600 V at 60 Hz and a firing voltage range of 500 to 900 V, 60 Hz. Maximum firing current is 25 mA.

The SG-1361 can be used with higher energy circuits if a series resistor is used to reduce the amount of energy transferred by the spark gap to ground. When used as a secondary protector, along with a primary surge arrestor, the SG-1361 can protect components against lightning strikes and other high-transient overloads.

Its small size ($\frac{3}{4}$ -inch long and 0.215-inch in diameter) and its simple economical construction make the SG-1361 an easy component to fit into any system. Since it comes with pretinned Dumet leads the device can be wired directly into the circuit without the use of adapters or clip-type holders.

SG-1361 Electrical Data

Firing Voltage at 60 Hertz	600 volts
Firing Voltage Range (at 60 Hertz)	500-900 volts
Maximum Firing Current (time duration = 30 sec. max.)	25 mA
Maximum Operating Temperature	80°C
Minimum Open Line Impedance	100 Meg.



Voltage spikes are shunted to ground by Sylvania's SG-1361 spark gap.



How to design with the SA-20 wideband amplifier.

External access to every element of Sylvania's SA-20 linear amplifier makes it easy for you to modify its characteristics to fit your application.

Sylvania's SA-20 is a versatile general-purpose wideband amplifier. Its characteristics include a high gain-bandwidth product, large signal swing and excellent linearity.

The SA-20 has three direct-coupled NPN transistors in a single-ended configuration. Bias for the input transistor is established internally by divider R_1 and R_2 (Fig. 1). Zener diode D_Z raises the bias level of Q_2 to permit operation of Q_1 in the linear range. Emitter follower Q_3 buffers the output load circuit from the intermediate stage, Q_2 , thereby giving a higher total open-loop circuit gain even with low-value loads. Series DC negative volt-

age feedback is applied from the output of the emitter follower to the emitter of Q_1 by divider R_4 and R_6 .

The major power supply current path is through the output transistor, Q_3 . Total device current drain is therefore strongly related to the quiescent output voltage and the value of R_6 . The output transistor has a maximum current capability of 50 mA. Maximum junction and case temperature for the device are 200°C and 155°C, respectively. Worst-case thermal gradients of the dual inline package used for the SA-20 are $\theta_{JA} = 0.15^\circ\text{C}/\text{mW}$ and $\theta_{JC} = 0.075^\circ\text{C}/\text{mW}$.

In most instances the base current of the input tran-

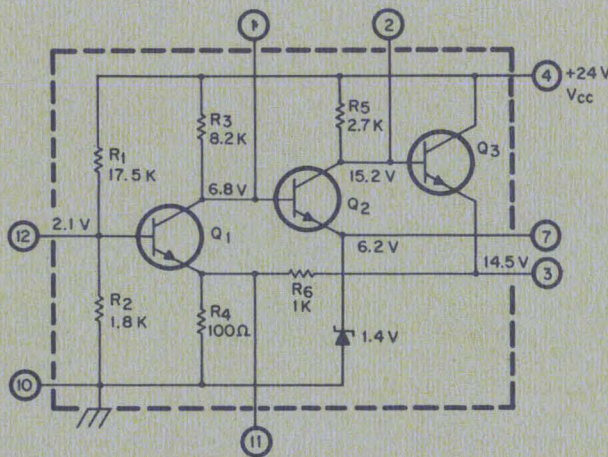


Fig. 1 Circuit of SA-20 linear amplifier.

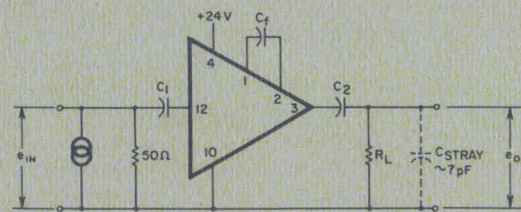


Fig. 2 Standard configuration for SA-20.

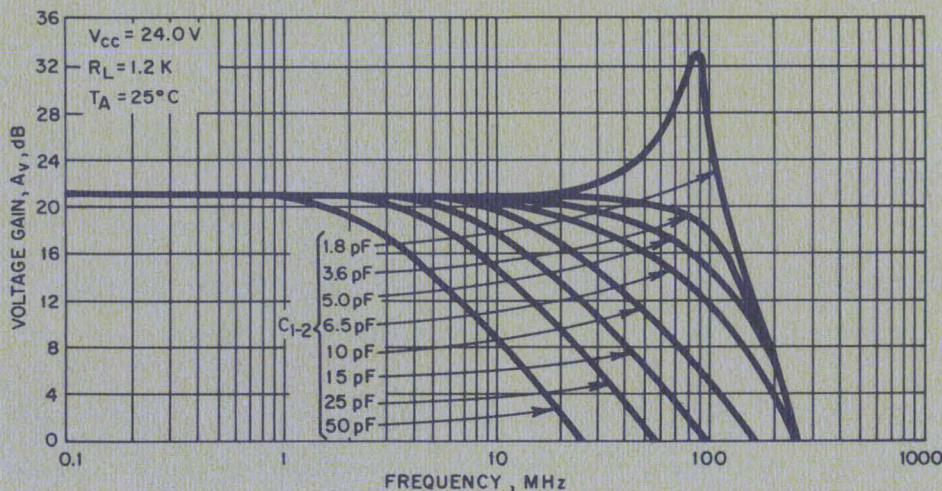


Fig. 3 Typical gain-versus-frequency curves for SA-20 in standard configuration.

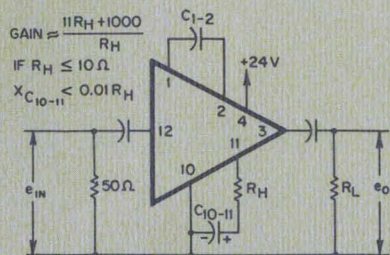


Fig. 4 High gain configuration for SA-20 linear amplifier.

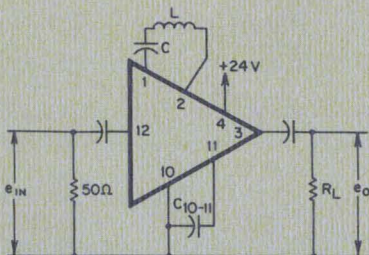
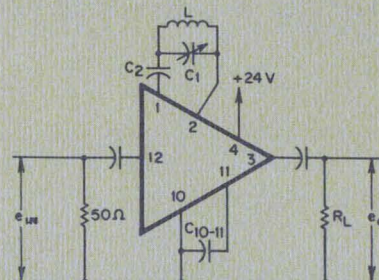


Fig. 5 Selective amplifier configuration with C and L in parallel and series connections.



sistor is small relative to the current in the input divider. Under these conditions input quiescent voltage is:

$$V_{Qin} = (V_{CC}R_2) / (R_1 + R_2)$$

Bias level of the input transistor may be varied by shunting resistors R_1 or R_2 . However, consideration must be given to the effect of a change in V_{Qin} on such factors as current drain and output quiescent voltage.

The output quiescent voltage, V_{Qout} , is:

$$V_{Qout} = \frac{R_6 + R_4}{R_4} \left[\left(\frac{V_{CC} R_2}{R_1 + R_2} \right) - (V_{BE}) \right]$$

V_{Qout} can thus be changed by external resistive shunting of any of the four resistors in the expression.

The maximum voltage swing of the device with an $R_L = \infty$ is essentially a function of the supply voltage and the zener-diode voltage. In the positive direction the voltage is limited by the voltage drop across R_5 and the base-emitter voltage of Q_3 . The voltage swing in the negative direction is limited by the zener voltage plus the saturation voltage of Q_2 minus the junction drop of Q_3 . With a high R_L the device will normally swing between 22.5 V and 6.5 V. If the quiescent output voltage is at the optimum level of 14.5 volts, the AC swing at the output, assuming negligible resistive loading, is approximately ± 8.0 V.

Current restrictions limit the maximum possible voltage swing when using AC-coupled resistive loads of more than approximately 600 ohms.

In the case, when R_L is low, the maximum output voltage is

$$e_{o \max} = \frac{V_{CC} - V_{BE} + [(R_5 V_{Qout}) / (\beta_3 + 1) (R_L)]}{1 + (R_5) / (R_L) (\beta_3 + 1)}$$

Assuming a typical device with $V_{CC} = 24$ V, an AC-coupled 50-ohm load and $\beta_3 = 100$ which is normally the case, the maximum absolute voltage level as seen at the emitter of Q_3 is $e_{o \max} = 16$ V.

The maximum positive swing as seen at the load is therefore 1.5 V. The negative-going swing from the quiescent voltage level is a function of the quiescent current of the device. In terms of absolute voltage the minimum output voltage, $e_{o \min}$, of the device with low value of AC coupled load is:

$$e_{o \min} = V_{Qout} - \left[\frac{V_{Qout} - (V_{Qin} - V_{BE})}{R_6} \right] R_L$$

Again, assuming a typical device and AC-coupled load of 50 ohms, $e_{o \min} = 14.5 - 0.675 = 13.8$ V.

The maximum linear swing with an AC coupled 50-ohm load is therefore 1.5 V above and 0.67 V below the quiescent voltage.

It is possible to increase the swing capability of the device in the negative-going direction when driving low-resistance loads by increasing the quiescent current. This may be accomplished by a DC resistive load or current source. A 1000-ohm DC resistive load increases the negative-going voltage swing across an AC-coupled load from 0.67 V to $0.67 + [(14.5 \text{ V}) 50 / 1000]$ or 1.4 V. Thus the swing can be made symmetrical.

The three-stage open-loop gain of the SA-20 is about 900. Closed-loop voltage gain is:

$$A_{VCL} = \frac{A_{VOL}}{1 + A_{VOL} \beta}$$

where $\beta = R_4 / (R_6 + R_4)$.

Resistors, R_4 and R_6 , are 100 and 1000 ohms, respectively. Since the quantity $A_{VOL} \beta$ at low and medium frequencies is significantly greater than 1, the expression for closed-loop gain simplifies to $A_{VCL} = 1/\beta = 11$. By shunting R_4 or R_6 with an external resistor, the gain of the circuit can be varied. However, as shown previously, other characteristics such as V_{Qout} and associated parameters are also changed by padding either of these resistors. To change the mid-frequency gain without affecting the quiescent level, it is necessary to shunt the internal resistor with a series RC network.

To maintain AC stability a shunt-type feedback loop using an external capacitor is required between the base and collector of Q_2 . Phase margin of a typical device is $> 45^\circ$ when the feedback capacitor is 3.6 pF.

The SA-20, when connected in the standard configuration, as shown in Fig. 2 exhibits the characteristics shown in Fig. 3. It can be seen that by varying the value of the shunt-feedback capacitor, C_f , the bandwidth of the device can be varied considerably.

In the maximum-gain configuration shown in Fig. 4, AC series feedback is removed from the circuit by shunting R_4 with a capacitor. With the device connected in this manner, the shunt-feedback capacitor which is normally connected between pin 1 and pin 2 is not required. The gain of the amplifier with all forms of AC feedback removed, is about 60 dB up to 5 MHz. From 5 MHz to 100 MHz, the amplifier rolls off at an average rate of -8 dB/octave.

In the selective-amplifier configuration of Fig. 5, the circuit functions as bandpass and notch amplifiers. Series or parallel tuned circuits are used in the shunt feedback loop to achieve the desired response.

For short pulse detection: try back diodes.

High sensitivity, low video impedance and low 1/f noise make back diodes ideal as short pulse detectors.

Microwave designers have a wide choice of devices when it comes to video detectors. Few of these choices, however, have all of the advantages of back diodes when it comes to short-pulse response and fidelity. Among the features of back diodes are high sensitivity, low video impedance and low 1/f noise.

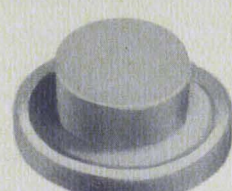
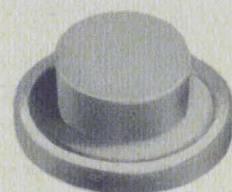
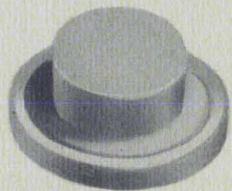
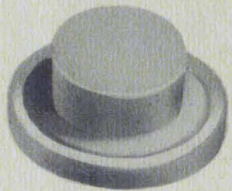
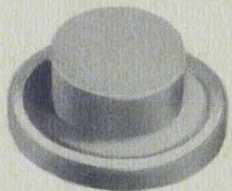
Sylvania's new planar germanium back diodes have all of these features plus a few others including high reliability, and improved temperature stability.

Typical values of tangential signal sensitivity range from -56 dBm (10 MHz video bandwidth) at L-band to -50 dBm at X-band. Low video impedance is a unique feature of back diodes and it is obtained without the use of any noise-generating DC bias. Impedance values in the

hundreds of ohms range are commonly obtained, and in some cases can be as low as 100 ohms. Impedance levels like these mean shorter time constants in the video output circuit, which in turn means better pulse fidelity. Noise figure is another area where back diodes shine. Even where a substantial self-bias current or a DC bias is a must, 1/f noise is minimal thanks to the low resistance and inherent physical qualities of the device.

In Sylvania back diodes, ruggedness and reliability are assured by the use of bonded, brazed and welded construction. The Sylvania diodes are available in the 048 pill package that is ideal for stripline circuitry. They are also available in other package configurations or in chip form.

CIRCLE NUMBER 304

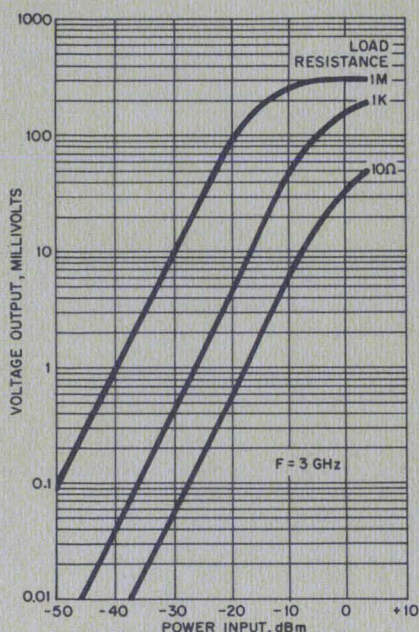


Back Diode Electrical Characteristics

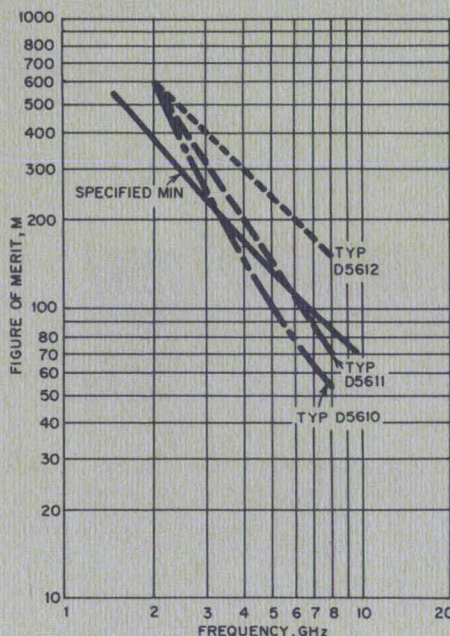
	Test Frequency GHz	Tangential ¹ Signal Sensitivity (TSS) -db min	Figure of Merit ² (M) min	Video Impedance (R _v) ohms max
D5610	2	56	400	1,000
D5611	4	52	180	1,000
D5612	8	49	85	1,000

¹Video Bandwidth = 10 MHz

² $M = \frac{\gamma}{\sqrt{R_v}}$ where $\gamma = \text{mv/mw}$ measured at -20 dbm in an optimized holder.



Voltage output versus power input as a function of load resistance.



Back diode figure of merit versus frequency.

Electroluminescent clocks will time Apollo flights.

When astronauts head for the moon they'll be reading flight times from Sylvania EL displays.

A total of 46 electronic clocks have been designed and built by Sylvania Electronic Systems for use in upcoming Apollo missions. The clocks display hours, minutes, and seconds on a 2 x 4½ inch electroluminescent display panel. Two clocks are used in each Apollo command module and one is used in the lunar excursion module.

Electroluminescent readouts were selected for a number of reasons: they are not prone to catastrophic failure, they give off almost no heat and require much less power than conventional light sources. Since the EL readout is a planar display there are no parallax problems when viewed from an angle.

The clocks used in the command module are used to keep a record of mission time and provide a reference for activities prescribed in the astronaut's flight plans.

The clock in the lunar excursion module will be used to time the landing and take-off on the moon. This seven-

digit clock can display elapsed time up to 1,000 hours.

Both the clocks and the electroluminescent displays are hermetically sealed. They are designed to withstand extremes of shock and vibration over a temperature range from 0°F to 140°F.

In addition to these basic clocks, the Apollo astronauts will also carry a number of Sylvania electroluminescent timers. These are designed to time individual experiments on board the lunar module. These units display minutes and seconds on a 2 x 4 inch electroluminescent panel.

Sylvania's electroluminescent panels are available in a wide range of display patterns. The relative ease with which they can be modified makes them readily adaptable to a wide variety of display applications.

CIRCLE NUMBER 305



SEE OUR SPECIFICATIONS IN
VSMF
MICROFILM CATALOG FILE

Use Sylvania's "Hot Line" inquiry service, especially if you require full particulars on any item in a hurry. It's easy and it's free. Circle the reader service number(s) you're most interested in; then fill in your name, title, company and address. We'll do the rest and see you get further information by return mail.

BUSINESS REPLY MAIL

No Postage Stamp Necessary if Mailed in the United States

FIRST CLASS
Permit No. 2833
Buffalo, N.Y.

POSTAGE WILL BE PAID BY

Sylvania Electric Products Inc.
Sylvania Electronic Components
1100 Main Street
Buffalo, New York 14209

Dept. C 9 9 9

How synergism brings you new and better circuit assemblies.

A business-oriented definition of synergism might be: "The total strength of an organization is greater than the sum of its individual strengths." At Sylvania Electronic Components, this definition is continually being applied to satisfy both industry needs and company objectives. Certainly, our newest addition, the Circuit Assemblies Operation, is a perfect example of this type of synergism at work.

The key consideration in any successful product development, regardless of company goals or objectives, must be user benefit. Put in a different way, if our new products don't help solve a problem for you, then it's just a wasted effort for Sylvania.

With our new Circuit Assemblies Operation, however, we feel we're on safe grounds. Electronic circuitry is becoming increasingly more sophisticated, and bigger performance is being demanded from smaller systems. The result is that package design and density have become crucial considerations to the circuit engineer. The industry need, therefore, is for economically produced circuit assemblies manufactured with high reliability and in high volume. And that's what our new operation is all about.

In addition to user benefit, however, there are two other criteria that must be met. The new product must have profitability and viability (the ability to grow). Thus, before entering the circuit assembly mar-

ketplace, Sylvania went through several stages of product evolution.

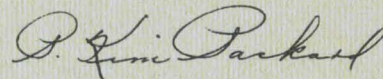
First of all, there was an *exploration* stage which quickly showed that circuit assemblies would allow us to optimize the total spectrum of technologies within Sylvania Electronic Components. This included the capabilities to manufacture not only the basic circuit boards, single, double sided or multilayer, but also integrated circuits, diodes and rectifiers, hybrid thick-film circuits, and even vacuum tubes. These capabilities provide a giant step toward the concept of added value.

Then, a *screening* stage proved the idea to be pertinent enough to merit further study. Next was a *business analysis* stage which confirmed that the explosive growth in electronic hardware had established significant trends in the circuit assembly business.

Then *development, testing, and commercialization* were undertaken. In this case, these stages were easily achieved since a full-scale circuit-board facility was already operating as a feeder plant to Sylvania Electronic Systems. It was simply a matter of taking their products to the customer. And that's being accomplished by the efforts of the Sylvania Electronic Components sales force.

With circuit assemblies, therefore, the synergistic effect has combined the efforts of a number of strong elements within the Sylvania Electronic Components group to produce a new and better product line for you.

But the synergistic part was the easiest part to achieve—it was already there.



P. K. Packard
Product Marketing Manager, Circuit Assemblies

This information in Sylvania Ideas is furnished without assuming any obligations.

SYLVANIA

A SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS

NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

C9

NAME _____ PLEASE PRINT

TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

Circle Numbers Corresponding to Product Item

300 301 302 303 304 305

Please have a Sales Engineer call

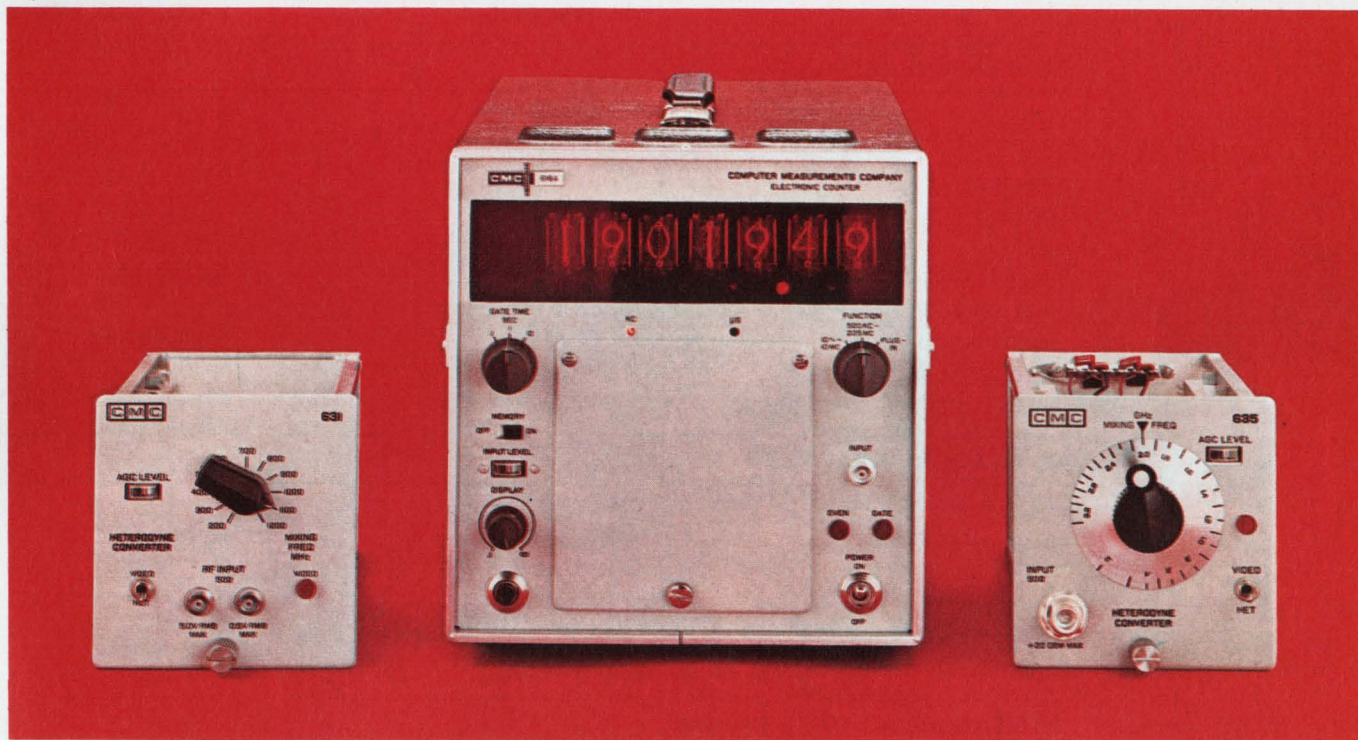


HOT LINE INQUIRY SERVICE

Need information in a hurry? Clip the card and mail it. Be sure to fill in all information requested. We'll rush you full particulars on any item indicated.

You can also get information using the publication's card elsewhere in this issue. Use of the card shown here will simplify handling and save time.

Now! Get 225 MHz for less than \$2K and add 3.3 GHz for less than \$1K!



But how does the competition look?

GREEN!

Who else offers a counter that provides frequency measurements up to 225 MHz for only \$1975, plus the options of two plug-ins to boost the range to either 1.3 GHz for \$775 or to 3.3 GHz for only \$825? That's what you get from CMC with the Model 616 Counter and the new Models 631 and 635 Heterodyne Converters. But that's not all.

Look at the rugged portable design of the CMC Model 616, with its sturdy valise grip and its solid well-balanced frame. Here's an instrument that's equally at home in the lab, on the production line, or in the field. You can rack mount it, too. And its all-silicon solid-state circuitry gives it an extended operating range from -20°C to $+55^{\circ}\text{C}$.

Already a popular workhorse, the 616 is in common use for alignment of frequencies in UHF communication links, for calibration of high frequency signal generators, for

direct monitoring of radio/TV transmitter carrier frequencies, and for production checkout of radio transmitters. But now, with the addition of two great heterodyne converters — and a TIM plug-in if you want it — here's a low-cost, portable family that's hard to beat for application versatility!

For the full specs on the counter and plug-ins, just circle the reader service card. And to arrange for a demonstration, contact your local CMC representative.



A Division of Pacific Industries

12970 Bradley/San Fernando, Calif. 91342/(213) 367-2161/TWX 910-496-1487

How to select the best DVM in the medium price range:

	HP 3440 SERIES	FAIRCHILD 7000 SERIES
TO MEASURE DC VOLTS		
price	\$1295	\$1275
ranges	3	4
overranging	5%	20%
accuracy—		
24 hours	.05% r. ± .01% f.s.	.01% r. ± .01% f.s.
3-month stability	.05%	not specified
noise rejection		
common mode, 60 Hz	30 - 70 dB	not specified
normal mode, 60 Hz	30 db	30 dB
input resistance—10-volt range	10.2 megohms	1000 megohms
TO MEASURE MILLIVOLTS		
price	\$1610	—
accuracy—100 mV	.10% r. ± .05% f.s.	—
3-month stability	.05%	—
input resistance	10.2 megohms	—
common mode noise rejection	100dB	—
autoranging—100 mV to 1000 V	yes	—
TO MEASURE AC VOLTS (100 kHz)		
price	\$1775	\$1725
ranges	3	4
basic accuracy	.10% r. ± .02% f.s.	.10% r. ± .02% f.s.
auto ranging	no	yes
common mode noise rejection	not specified	not specified
TO MEASURE OHMS		
price	\$1525 (incl. mV and current)	\$1385
ranges	5	5
basic accuracy	.30% r. ± .01% f.s.	.05% r. ± .02% f.s.
max. voltage across unknown	1.0v	1.2v
MULTIMETER CAPABILITY		
price	—	\$1895
functions	—	dc, ac, mV, ohms, current
source of data	catalog—1968	#7000 - 8/67

NLS X2 SERIES

DANA 4400 SERIES

\$1180	\$1150
3	4
20%	20%
.02% r. \pm .01% f.s.	.01% r. \pm .01% f.s.
not specified	.01%
100 dB	100 dB
30 dB	60 dB
10 megohms	1000 megohms
\$1630 (incl. ohms)	\$1395
.06% r. \pm .05% f.s.	.01% r. \pm .01% f.s.
not specified	.01%
100 megohms	100 megohms
not specified	100 dB
no	yes
\$1480	\$1450
4	4
.05% r. \pm .02% f.s.	.10% r. \pm .02% f.s.
yes	yes
not specified	60 dB
\$1630 (incl. mV)	\$1795 (incl. mV and ac)
5	5
.02% r. \pm .06% f.s.	.01% r. \pm .02% f.s.
16v	1.2v
\$2230	\$1795
dc, ac, mV, ohms, current, ratio	dc, ac, mV, ohms
#002 - 6/67	catalog - 1968



The rest of the series 4400 specs are in our new brochure along with those on all the Dana DVM's. A letterhead request will get you a copy.
 Dana Laboratories, Inc., 2401 Campus Drive, Irvine, California 92664.





25 winners in our collection of op art

nobody, but nobody makes more discrete op amps than Philbrick/Nexus

Philbrick/Nexus is avant-garde in operational amplifiers. Covers the spectrum of op amp capabilities — from mini-cost to maxi-performance. Standard products, as well as mixed products, match your needs economically. Use them. They'll color you bright. Op art masterpieces like these are but a few of the total Philbrick/Nexus exhibit:

Economy Grade

SQ-10A — MINI-PRICED, but a top performer in general purpose applications. Only \$10.50 each in hundred quantities.

QFT-5 — LOWEST PRICED FET. General-purpose performance, low leakage. Only \$15 each by the hundred.

1009 — LOW COST, HIGH PERFORMANCE FET. Input impedance 10^{12} ohms. Input bias current 5 pA. Priced at \$20.50 each in quantities of 100.

General Purpose

CIA-2 — LOW PROFILE, HIGH PERFORMANCE. Thick-film hybrid, 80,000 gain, $\pm 5\mu\text{V}/^\circ\text{C}$ input voltage offset.

SQ16 — HIGH PERFORMANCE. Gain 150,000, $\pm 5\text{mA}$ guaranteed minimum output at ± 11 volts. Low noise, $1\mu\text{V}$ rms broadband.

Q102A — ULTRA-HIGH PERFORMANCE. Gain 200,000, $\pm 2\mu\text{V}/^\circ\text{C}$ input voltage offset typical at -25 to $+85^\circ\text{C}$. Internally trimmed to 0.5mV max.

QFT-2 — TOP-GRADE PERFORMER. Gain 200,000, slew rate $10\text{V}/\mu\text{sec}$, 10 pA input bias current.

Q103A — HIGH INPUT IMPEDANCE, LOW BIAS CURRENT. Input voltage offset $\pm 2\mu\text{V}/^\circ\text{C}$. Only \$25.50 each by the hundred.

High Reliability

Q10A — ALL-PURPOSE TOP-GRADE. -55°C to 100°C operating temperature range.

P65A — PREMIUM GRADE. Wide application usage, proven performance, low broadband noise $1\mu\text{V}$.

CDA-3A — PROVEN PERFORMANCE. Input bias current 1nA, differential input resistance 2 megohms.

Q25AH — WIDEBAND FET HYBRID. 600,000 hours of operation with no failures. Small size TO-8 package, hermetically sealed.

Wide Band

PP45U — 100 MHz BANDWIDTH. Slew rate $200\text{V}/\mu\text{sec}$. Excellent for broadband inverter applications.

1016 — FAST, HIGH POWER. $f_p > 1$ MHz. Full output of $\pm 10\text{V}$, ± 100 mA to 1 MHz. CMRR 100,000. E_{os} T.C. is $10\mu\text{V}/^\circ\text{C}$. A_o at 750,000.

1011 — LOW PROFILE, FAST SETTLING TIME FET. 15 MHz bandwidth, slew rate $70\text{V}/\mu\text{sec}$. Delivers $\pm 11.5\text{V}$ output. Settles in 1.5 μsec to .01%, 0.4 inches high max.

Universal

ESL-1 — WIDE SUPPLY VOLTAGE RANGE, ± 8 to $\pm 16\text{V}$. CMRR 1,000,000:1, common mode input resistance 1.5 G ohms.

USL-1C — HIGH STABILITY. Wide range of supply voltages from ± 8 to $\pm 26\text{V}$. Input voltage offset $\pm 1\mu\text{V}/^\circ\text{C}$. Low drift.

High Voltage

MLF-100 — ± 100 VOLT OUTPUT at 10mA. FET input amplifier. Short circuit protected.

Micro-Power / Low Voltage

Q-200A — BATTERY OPERATED. $\pm 50\mu\text{A}$ quiescent drain. Ideal for OEM battery operated and airborne instrumentation.

1402 — MICROCIRCUIT FET HYBRID. Bias current 5pA. Input impedance 10^{12} ohms. Output $\pm 14\text{V}$, $\pm 5\text{mA}$. Supply voltage from ± 4 to $\pm 24\text{V}$. Quiescent current $\pm 0.5\text{mA}$. In TO-8 case, hermetically sealed.

High Performance

1003 — LOW-NOISE FET. 3,000,000:1 CMRR $\pm 1\mu\text{V}/^\circ\text{C}$ input offset voltage $+10^\circ\text{C}$ to $+60^\circ\text{C}$. Uses hermetically sealed active components.

1700 — LONG-TERM STABILITY. Input voltage offset $\pm 0.15\mu\text{V}/^\circ\text{C}$. Full output to 1.2 MHz. Gain 10^9 . Long-term stability .2 μV per day.

1018 — ULTRA-LOW DRIFT. Gain 1.5 meg E_{os} , $0.5\mu\text{V}/^\circ\text{C}$ and I_{bias} .02nA/ $^\circ\text{C}$.

Monolithic IC's

S-52 — LOW, LOW COST IC. Easy to stabilize. Dual in-line package. \$5 each in quantity.

T-52 — A REAL BUY. Same as S-52, but in TO-5 package. Same low price.

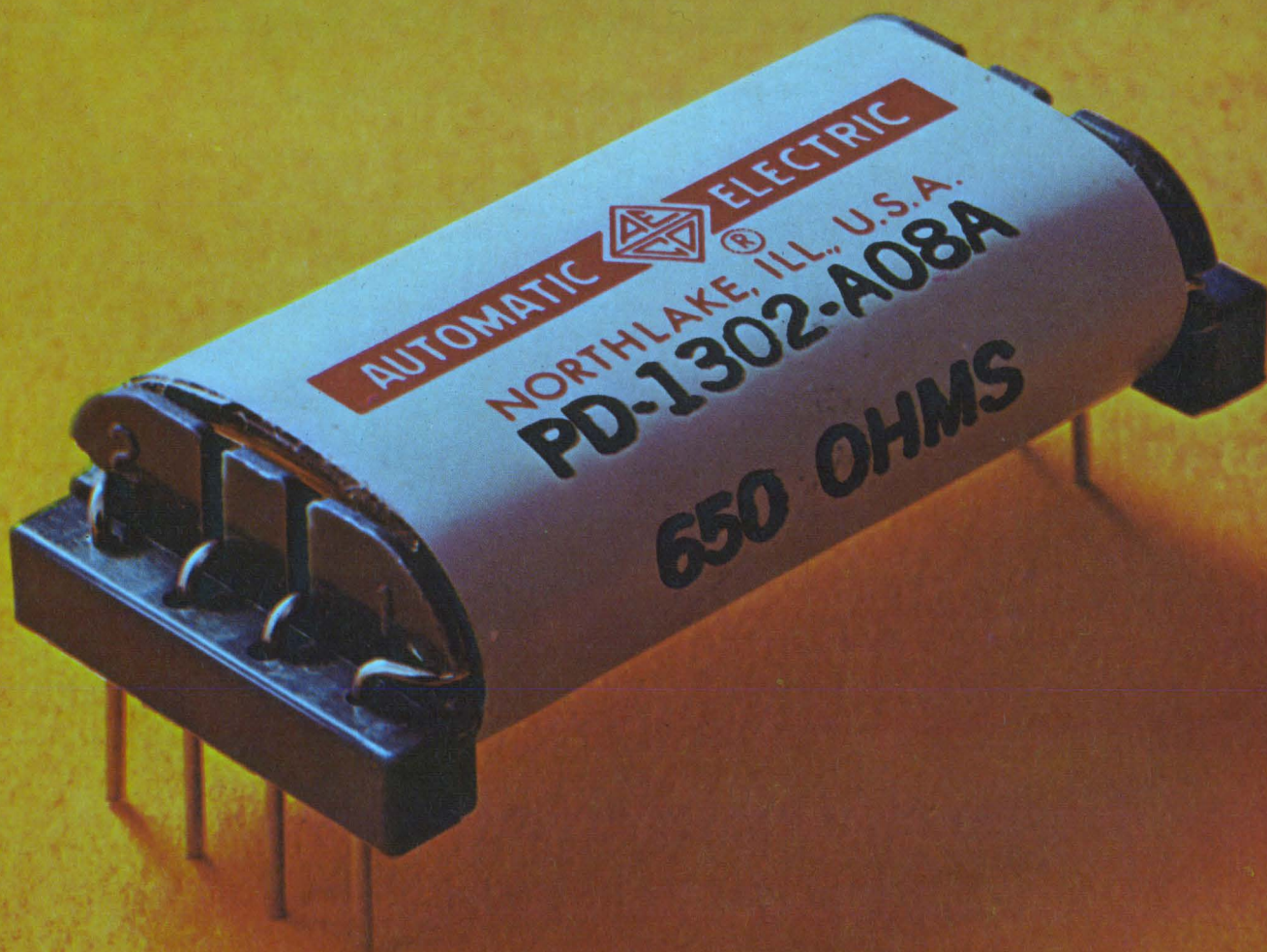
Your Best-Of-Show selection brings with it, at no extra cost and available nowhere else — unequalled integrity resulting from superb artistry in things analog. For other op amp prize winners, too numerous to mention, contact your Philbrick/Nexus sales representative for complete specifications, prices and applications assistance. Or write, Philbrick/Nexus Research, 22 Allied Drive at Route 128, Dedham, Massachusetts 02026.



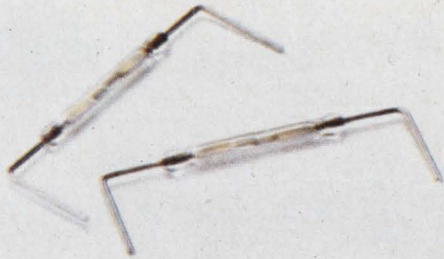
PHILBRICK/NEXUS RESEARCH

A TELEDYNE COMPANY

**Everyone talks
correed reliability,**



here's the way it looks.



Switches under glass.

The heart of every AE correed is a reed switch consisting of two overlapping blades. For protection, we seal them inside a glass capsule. But only after we pull out all the dirty air and pump in a special, pure atmosphere. That way there's no chance of contact contamination or oxidation. Ever.

Notice our terminals are one piece. A special machine delicately forms them to precision tolerances. It's a lot of work, but one-piece terminals have distinct advantages over the two- and three-piece kind.

For one thing, there's no extra joint so you're always assured of a positive contact. Also, one piece terminals are more reliable when the correed is used to switch low-level analog signals. That's because thermal EMF is reduced to practically zero.

A different kind of bobbin.

Since we go through so much trouble with our correed capsules, we designed a special bobbin to protect them.

It's molded of glass-filled nylon. (You know how plastic chips and cracks.) Moisture and humidity have no effect on this stubborn material. No effect means no malfunctions for you to worry about. No current leakage, either.

Running the full length of the bobbin are a series of slots. They pamper the capsules and keep them from getting damaged or jarred.

And to help you remember which terminal is which, we mold the terminal numbers into the end of the bobbin. You can read them at a glance.

Little things mean a lot.

Reliability means that we pay attention to the little things. Like the tiny pressure rods we use in every miniature correed. They're placed at

each end of the bobbin, across the one-piece terminals. What they do is prevent stresses from being transmitted from the terminals to the reed blades. This keeps the contact gap right on the button. All the time.

The contacts are normally open. To provide them normally closed, we employ another little device—a tiny magnet. It's permanently tucked into a slot next to the reedcapsule. The magnetic action keeps the contacts normally closed.

Coiled by computer.

Once all the parts are secure in the bobbin, we cover them with protective insulation. Around this, we wind the coil. You can be sure the coil winding is correct. It was all figured out for us by computer.

Our next step is to protect the coil. We do that with more protective insulation.

A coat of iron.

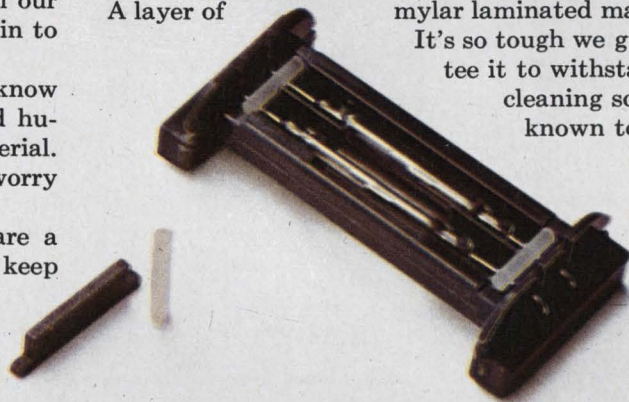
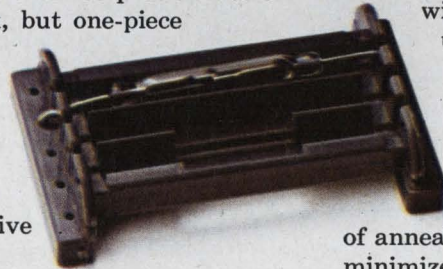
On top of the insulation goes a layer of annealed iron. It acts as a magnetic shield and minimizes interaction between coils. Also, it improves the sensitivity of the entire unit. A coat of iron is standard on all AE correeds.

Finally comes super wrap.

To wrap it all up, we use some very special stuff. A layer of

mylar laminated material.

It's so tough we guarantee it to withstand all cleaning solvents known to man.



It's attention to detail that helps us keep our miniature relays miniature. Now we're just waiting to show you how perfectly it measures up to your specifications. Automatic Electric Company, Northlake, Illinois 60164.

AUTOMATIC ELECTRIC

SUBSIDIARY OF GENERAL TELEPHONE & ELECTRONICS



Cimron's environmental multimeter is a pretty insensitive brute

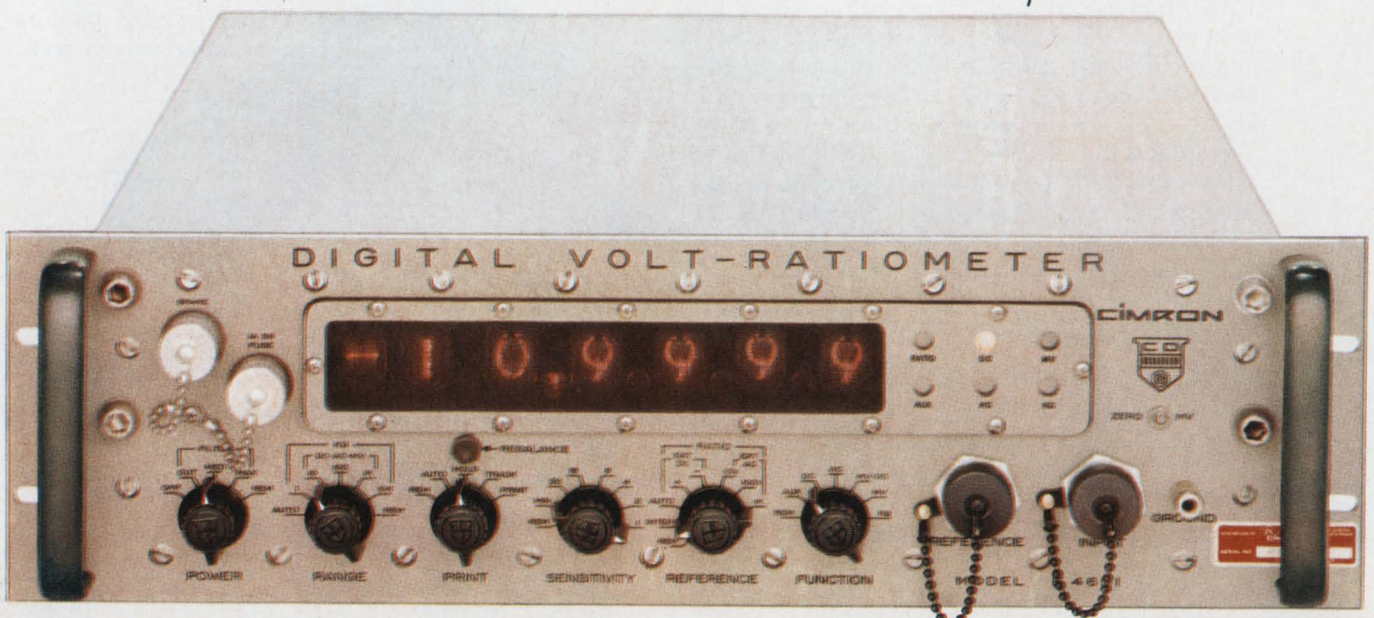
To abuse, that is! Not that we actually took a club to it, but no ordinary multimeter could take the punishment it has and still run, let alone provide accurate measurements. Built to meet Mil Spec T-21200F, Class 3, this instrument is rugged enough to give you lab precision anywhere from the arctic to the jungle. And it's the second generation design. Over 300 first generation models are now in use in harsh environments around the world. Certified test data show it has an accuracy

of .001% F.S. + .005% of reading, can take a 15g shock, vibration up to 55 Hz, and run through extremes of temperature and humidity. 6 digits, including 10% overrange. Solid state logic tracks as fast as the voltage changes; response time is faster than 100 milliseconds. And with it goes all of Cimron's customer concern — the technical support that helps you get all the performance it can give. For details on Model E4600, write to Cimron®, Dept. C-114, 1152 Morena, San Diego, California 92110.

LEAR SIEGLER, INC.



CIMRON DIVISION



Go 90-Watt Plastic In Your General Purpose, Silicon Power Designs!

You can set new standards of economy and performance in the power transistor portions of your system designs with the new, MJE3055 Thermopad* silicon power transistor — metal-spec'd but plastic-packaged version of the popular, general-purpose 2N3055.

The 12 A, 60 V NPN device furnishes a full 90 watts of power through an exclusive, direct, chip-to-heat-sink thermal path of only 0.030" — first power transistor to break the higher-wattage, plastic-package barrier. Beta is spec'd at two points, too, affording the engineer a complete picture of its high-gain capabilities.

For those wanting a fast, economical switch the MJE3055 offers high frequency response and good switching time. The unit is also ideal for series and shunt regulators and high fidelity amplifiers and exhibits excellent beta linearity over its entire operating temperature range.

\$1.00† buys the new MJE3055...a call to your franchised Motorola distributor puts one on your prototype workbench the same day!

Eighteen other rugged and reliable Thermopad plastic power transistors — including the broadest line of NPN/PNP complementary pairs for cost-cutting, circuit-simplifying, direct-coupled designs — are also available from your Motorola distributor. Write Box 20912, Phoenix, for data sheets on Motorola Thermopad plastic silicon power transistors — then design them in!

90 W Power Dissipation

Type	Polarity	I_C (Cont) A	V_{CEO} (Sus) V	h_{FE} @ I_C (min)	$V_{CE(sat)}$ @ I_C (max)	f_T MHz
MJE3055	NPN	12	60	20 @ 4A 5 @ 10A	1.1 @ 4A	2

40 W Power Dissipation

2N5190, 91 & 92	NPN	4	40, 60 & 80	25 @ 1.5A	0.6 @ 1.5A	4
2N5193, 94 & 95	PNP					

30 W Power Dissipation

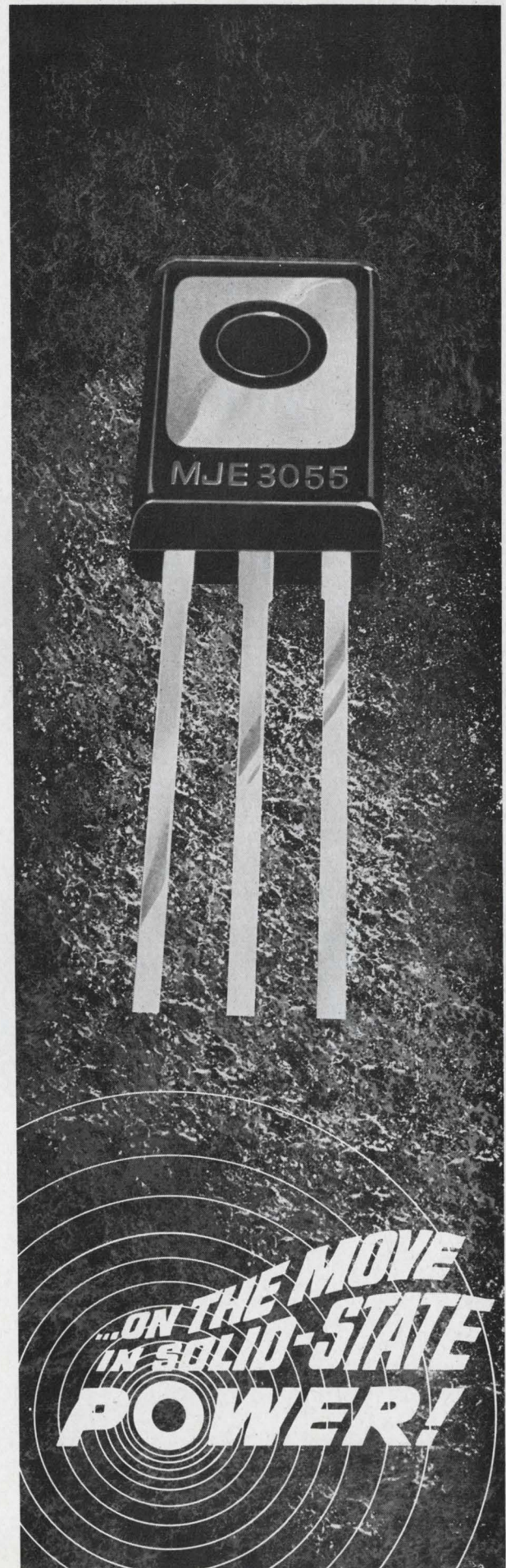
2N4918, 19 & 20	PNP	3	40, 60 & 80	20 @ 0.5A	0.6 @ 1A	3
2N4921, 22 & 23	NPN					

*Trademark Motorola Inc.

†100-up



MOTOROLA
Power Transistors
-where the priceless ingredient is care!



Investigate Random or Periodic Processes with Correlation Function Computers

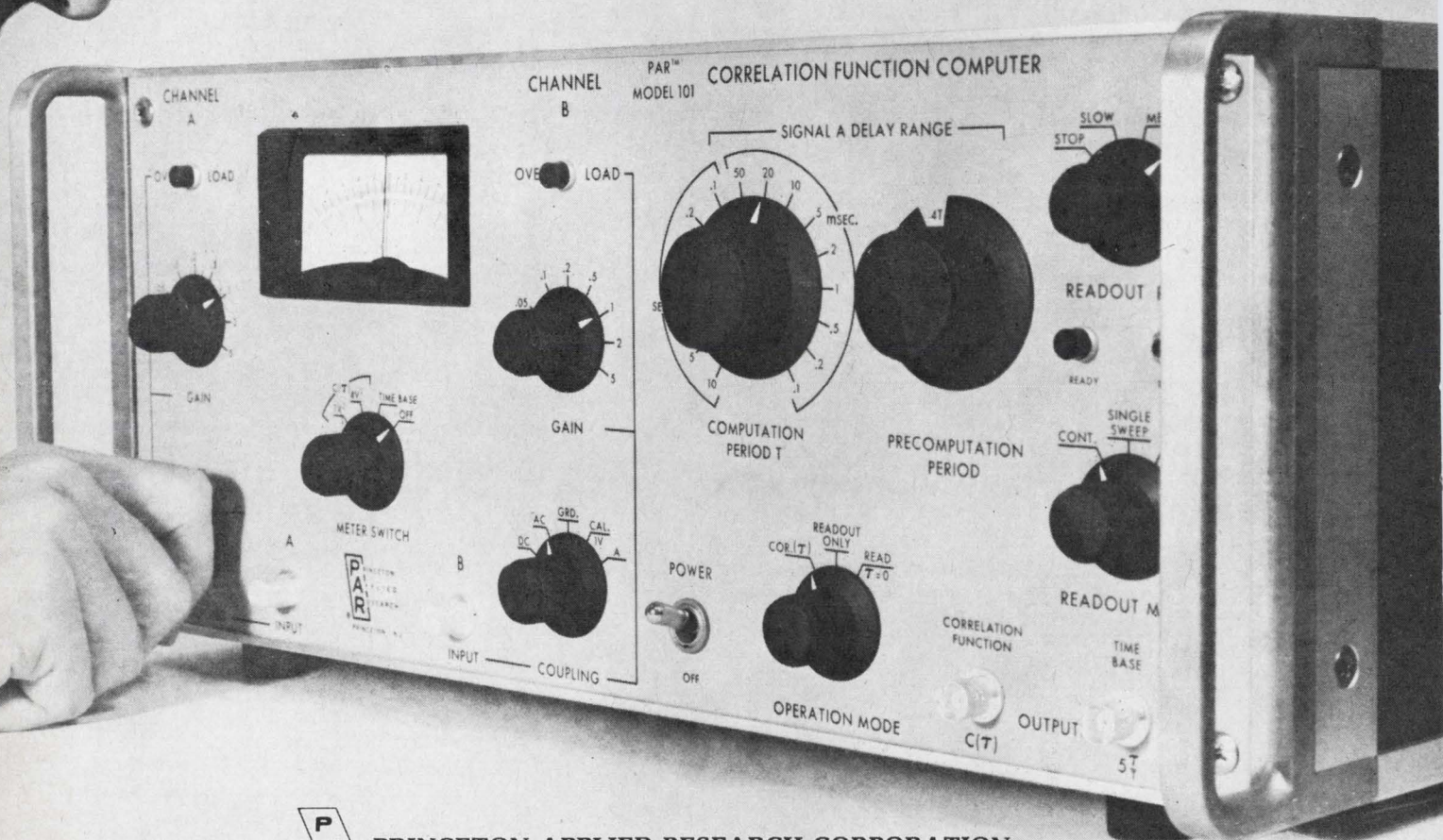
Correlation functions occupy a cardinal position in modern information theory and are basic to the analysis of random or periodic processes and the complex signals they produce. In many application areas, autocorrelation analysis allows noisy periodic or random signals to be defined, whereas crosscorrelation can determine the degree of conformity between two different noisy signals as a function of their mutual delay.

PARTM Models 100 or 101 Correlation Function Computers simultaneously compute 100 points of the auto- or crosscorrelation function in real time over delay spans from 100 microseconds to 10 seconds. The Model 101 includes the capability for insertion of fixed delay increments ahead of the 100 computed points of the function, thereby providing greater resolution. The correlation function readout which may be obtained continuously as it is computed, is available at various rates consistent with the speed of the external readout device, e.g. oscilloscope or X-Y recorder.

Vibration analysis, radio astronomy, laser research, geophysics, radar, plasma physics, aero- and hydrodynamics, and biophysics are only a few of the fields where correlation techniques are useful.

Price of the Model 100 is \$8,500. The Model 101 is priced at \$9,500 to \$12,900. Export prices are approximately 5% higher (except Canada).

For additional information, write Princeton Applied Research Corporation, Box 565, Princeton, New Jersey 08540 or call 609-924-6835.



PRINCETON APPLIED RESEARCH CORPORATION

Electronics Review

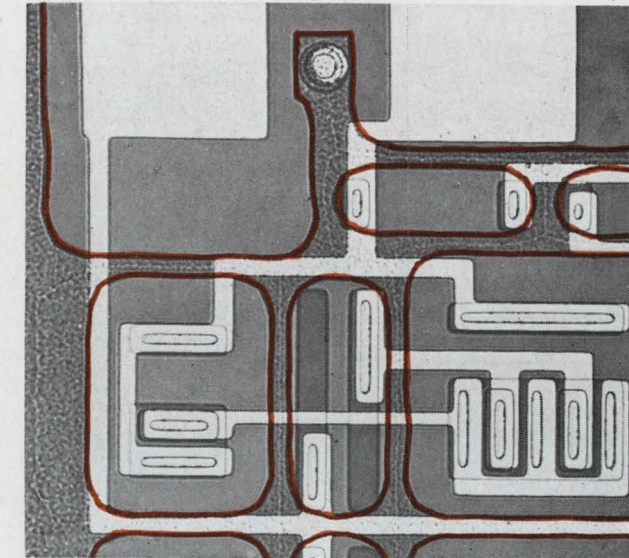
Integrated electronics

High-voltage IC's

Breakdown voltages in integrated circuits are generally limited to about 50 volts for two basic reasons. Positive charges in the surface oxide pull electrons toward the surface, reducing the resistivity of the internal silicon and thus lowering its breakdown voltage. And a high-resistivity n epitaxial layer can be grown on a p substrate only with great difficulty; this makes high breakdown voltage hard to achieve even without the surface-charge problem.

But the Signetics Corp. has found ways of circumventing these problems and has developed IC's that won't break down even at 300 volts and more.

The company will begin market-



Starter. Signetics first high-voltage IC will be a video amplifier. In this development version the operating voltage is 150 volts and the gain is 50. The frequency response extends to 7 megahertz, and the total power dissipation is 300 milliwatts. The red indicates isolation channels.

ing its high-voltage circuits around June of next year as video amplifiers and deflection amplifiers. By the end of next year, the IC's will

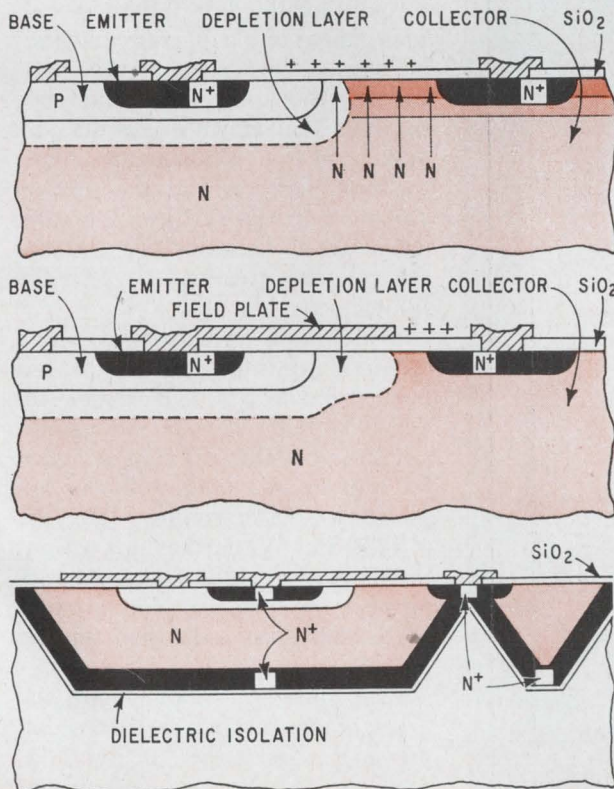
be offered as operational amplifiers and regulators.

In the bulk. Signetics avoided the surface-charge problem by designing a "field plate" structure on the surface. The field plate is connected to the most negative potential available to neutralize the positive oxide charge. It therefore prevents electrons from accumulating at the surface; breakdown occurs in the bulk and at a much higher voltage.

To get high-resistivity n material on a p substrate, Signetics adopted dielectric isolation. With this process, the collector region is formed from grown and refined silicon, rather than epitaxial material, so that it's possible to get an almost defect-free region of virtually any desired resistivity.

The company uses an anisotropic etchant to isolate the components on the silicon chip; the widths and depths of the isolation channels are precisely related to the widths in the mask pattern because the etchant attacks the silicon only along certain crystal planes.

Less power. The high-voltage IC's will consume less than a third



Repulsion. Ionic charges in the SiO₂ layer at the surface of a planar device (top) increase the electron concentration there, resulting in low breakdown voltage. A metallic field plate, however, pushes the depletion layer deep into the device, where breakdown occurs at a much higher voltage.

Selective. Signetics anisotropic etching process removes silicon selectively, along certain crystal planes.

the power of the discrete circuits they'll replace, according to Leonard Brown, marketing manager for linear IC's.

The industrial and consumer markets will be the primary targets. Signetics attaches particular importance to color tv, a market IC's haven't been able to penetrate extensively because of their voltage limitations.

"Now," says Brown, "we can economically make high-voltage monolithic circuits with enough passive devices to get high-frequency performance."

He sees as a suitable application any high-voltage display system in which the cost of discrete devices and a surfeit of external components have created insurmountable design limitations.

High-gain transistors

If the emitter of a transistor on a monolithic integrated circuit is diffused deeply into the base, the transistor will have extremely high current gains, of around 5,000—even at collector currents of less than 1 microamp. This is 10 times the gain of discrete transistors. But because the collector and the emitter are nearly shorted in this so-called "punch-through" transistor, it has a breakdown voltage as low as 5 volts. Designer Robert J. Widlar of National Semiconductor has devised a way of using the high current gain while sidestepping the low breakdown voltage.

At the Northeast Electronics Research and Engineering Meeting (Nerem) in Boston last week, Wid-

lar described an operational amplifier with four transistors in the input stage: two bootstrapped high-beta primaries, operated at zero volts, cascaded with two high-voltage secondaries. The technique takes advantage of the high gain of the input transistors and uses it to get a high voltage from the secondaries.

Widlar says an op amp designed with this type of input stage could provide an input current two to three orders of magnitude lower than those of present designs.

Low input. The point is to allow the op amp to operate at extremely low input currents, so as to minimize offset voltage in the differential input stage, yet still produce sufficient current at the output.

Junction field effect transistors, which have excellent current gains, are widely used in discrete op amps, but they are extremely difficult to match on an IC chip. Bipolar transistors match very well, but they have low current gain at low currents.

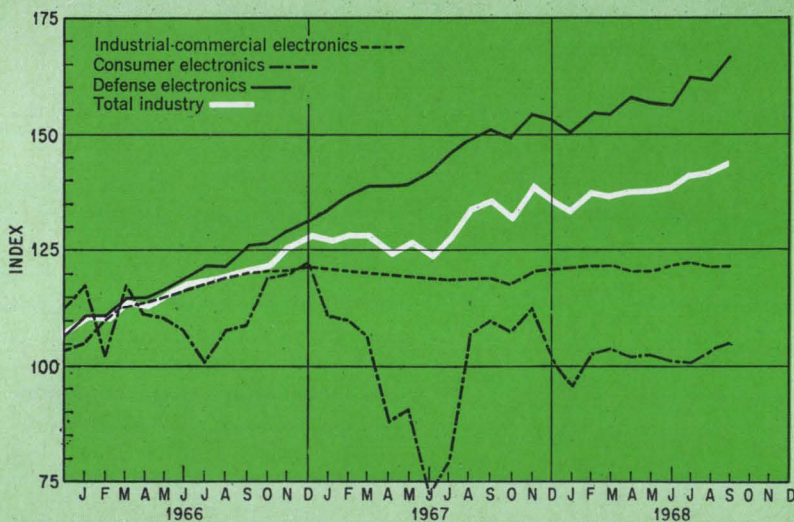
Widlar points out that bipolars can be made with high gains if one is willing to live with the low breakdown voltage. "It is interesting to note that transistors that have been driven into punch-through exhibit less fall-off of current gain at low collector currents," he says. "This probably happens because there is a large difference between the emitter-base turn-on voltage in the bulk near the collector-base junction and the turn-on voltage near the surface. A greater difference in these voltage reduces the collector current at which the fall-off occurs."

Widlar has already designed a circuit using this design, and it has been marketed by National for nearly a year. This is the LM102, a high-impedance op amp designed for unity-gain voltage-follower applications [Electronics, Jan. 22, p. 173]. But Widlar has not yet put the new input stage into a general-purpose op amp; the Nerem paper is the first clear indication that he intends to.

Last month, National cut the price of the LM101, Widlar's improved version of his 709, by 50%. At the same time, the company in-

Electronics Index of Activity

November 11, 1968



Segment of industry	Sept. 1968	Aug. 1968*	Sept. 1967
Consumer electronics	105.8	104.1	109.2
Defense electronics	166.4	162.1	153.1
Industrial-commercial electronics	121.7	121.6	118.5
Total industry	143.0	140.4	135.5

Electronics production advanced 2.6 points in September from August and 7.5 points from September 1967. The largest gain was in defense electronics: for the month the gain was 4.3 points and for the year 13.3 points. The consumer index advanced 1.7 points in the month but fell 3.4 points in the year. The industrial-commercial index inched up 0.1 point in September and rose 3.2 points from 1967.

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

roduced a new op amp, dubbed the LM101A; it sells for the same price as the old 101, but performance over the entire military temperature range has been drastically improved. The 709 and the 101 have input offset current of 500 nanoamps, bias current of 1,500 and offset voltage of 6 millivolts; in the 101A, the values will be 20-na offset current, 100-na bias current, and 3-mv offset voltage.

Sticky and tricky. "To go from the 709 to the 101A was a matter of improving the process," Widlar says. "But to do more merely by raising transistor current gains is sticky. You run very quickly into the tradeoff transistor current gain and breakdown voltage."

Fabrication of the chip requires an extra processing step, since the transistors are made with separate emitter diffusions—one deeply diffused for high current gain and the other with a normal diffusion for breakdown voltages above 50 volts.

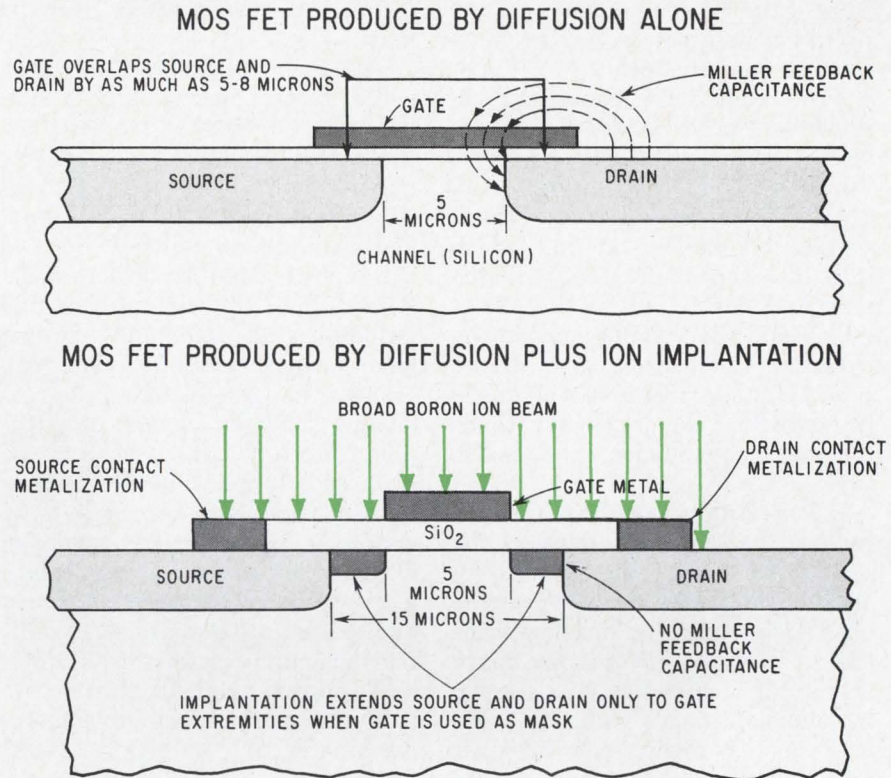
However, Widlar points out, the processing itself is much less critical than for a conventional design, since the diffusion need not be so closely controlled. Pushing current gains at the expense of breakdown voltage can lead to some very tricky diffusions, Widlar says, since there is a danger of going into punch-through unwittingly. Eliminating the tradeoff also eases the diffusion tolerances.

National is mum on when a successor to the 101A can be expected, but in his Nerem paper, Widlar predicted that the primary application of punch-through transistors in IC's would be in general-purpose op amps. With a year's experience on the 102, National may not have to delay too long on the general-purpose circuit.

Ion-implant serendipity

A dash of serendipity went into the recipe that has put Hughes Aircraft within reach of using ion-implantation techniques to produce metal oxide semiconductor field effect transistor arrays [Electronics, Oct. 14, p. 33].

The happy tale is told by Rob-



ert Bower, manager of the applied solid state research department at the Hughes research laboratories, Newport Beach, Calif. By coincidence, a strong effort to improve MOS FET and microwave devices was under way at the labs simultaneously with an ion-implantation program. During the work the lab realized that MOS FET's happened to be a good vehicle for ion implantation because they have a single p-n junction. They don't require the complex dopant profile needed for double-junction devices such as bipolar transistors.

Barring breakdown. Bower says Hughes has overcome many of the problems that caused others to despair of mastering ion implantation through a good silicon dioxide layer. These problems included implanting at room temperature or below; damaging the oxide, causing disturbed passivation characteristics; and charging the surface of the p-channel devices positively to a very high voltage, causing it to break down.

Hughes implants boron ions at 100,000 volts and temperatures of 250° to 350°C, then anneals out any implantation damage in the silicon crystal structure by soaking

wafers at 550°C for a few minutes. "We also pin the surface potential—prevent it from charging positively—by showering the whole surface with low-energy electrons," Bower explains. Many more electrons than boron ions arrive at the surface, he notes. But the neatest trick—using the gate as the source-drain mask—is the step that ensures full compatibility with production techniques.

Using diffusion alone, three masking operations are required to diffuse the p+ source and drain regions into the p-type silicon at high temperatures—about 1,100°C. Then the oxide layer is grown at a slightly lower temperature, and a fourth mask is used to form the gate that covers the p-type channel between the source and drain. Bower notes that with conventional diffusion the aim is to keep the gate narrow enough (5 microns is recommended) to minimize stray capacitance between the gate and channel.

Excess capacitance. But inter-mask tolerances are such that the gate must overlap the source and drain by 5 to 8 microns to be sure of covering the entire channel. As a result, parasitic capacitances

from gate to source and gate to drain are as great as that between the gate and channel.

"You have three times the capacitance needed, degrading device performance," Bower says. "But things get worse. When you operate a three-terminal device, there's a voltage gain that multiplies the capacitance between the gate and drain. This is the Miller effect, and the voltage gain on the average circuit is two, so that a typical high-quality MOS FET made by diffusion alone has five times the input capacitance needed," he says.

In the Hughes method, the p+ regions that will form parts of the source and drain are diffused in, and the gate oxide is grown in the usual way, but the mask spaces the p+ regions 15 microns apart, instead of 5 as in MOS FET's made by diffusion alone. The gate oxide is then selectively removed over parts of the diffused source and drain to allow formation of the gate electrode and source-drain metallic contacts, so that metalization takes place before implantation. Although the gate is only about 5 microns wide, it acts as a mask, and when boron ions bombard the structure, they penetrate the exposed oxide region and form a p-n junction about 0.4 micron deep into the channel region.

Faster devices. With ion implantation, there is virtually no lateral spread of the dopant as there is with diffusion. This means that the junction has the exact dimensions of the mask. There is no overlap of the gate over the source and drain areas, and consequently no parasitic capacitance between source and gate and drain and gate. The source and drain are extended during implantation beyond their diffused-in dimensions, but only to the edges of the gate acting as a mask.

By combining diffusion and ion implantation, then, Hughes can put the gate down before implantation and after all diffusion has taken place. This makes implantation and annealing the last steps before wafer passivation and dicing, and because implantation is done at low temperatures, a normal gate

metal, such as aluminum, can be used.

The input capacitance is cut to a fifth of that occurring with simple diffusion. Hughes' studies show that reducing parasitic capacitance will make MOS devices—shift registers, large-scale integrated arrays, and commutator switches—three to five times faster than devices made with simple diffusion. About 100 ion-implanted MOS FET wafers have been processed. Tests with an MOS integrated-circuit ring oscillator showing average propagation delays per stage of 4 to 4.5 nanoseconds for diffused and ion-implanted devices—versus 20 to 25 nanoseconds for devices made by diffusion alone—lead Bower to project a speed of 30 megahertz for a dual 25-bit, two-phase MOS shift register within six months. Today's best speed is about 10 Mhz.

Bower says an ion-implantation machine costing \$30,000 to \$35,000 that's much simpler than the engineering model in use now will put the Newport Beach facility into production with ion-implanted MOS circuits next year.

Displays

Controlling the view

Almost four years ago, the Electronic Systems division of Sylvania Electric Products got a contract from the Air Force's Rome Air Development Center for a flat-screen display. The model, using

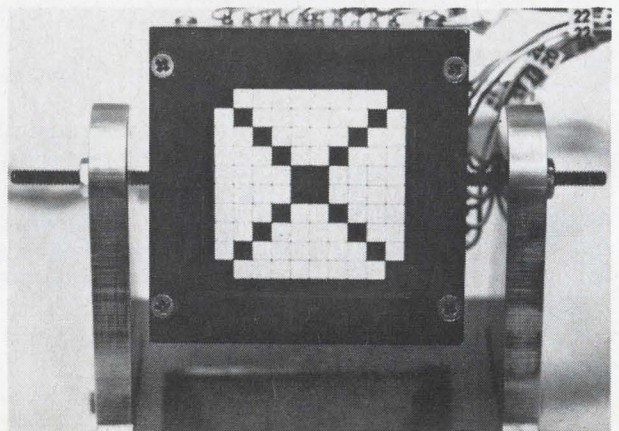
tiny electroluminescent panels, was to prove the feasibility of displays 8 to 10 feet on a side [Electronics, July 25, 1966, p. 144].

Now the Needham, Mass., operation has delivered, and though the EL array is only about 1¼ inch square, Joseph L. Hallett, display and simulation laboratory section head, says it convinces his men that large displays could be made—perhaps at about 40 cents per glowing element.

Diode drawbacks. The military is trying several routes toward large-screen display technology, among them laser, film, and cathode-ray-tube projection systems. According to Hallett, such systems are costly to operate and maintain. And the space required for their projectors and projected beams, he says, makes them "just about impossible for airborne control centers."

"For alphanumeric data, a wall-screen, random-access, dot matrix display is most practical," says Hallett. This includes not only Sylvania's EL scheme but also diode displays. Failures of light-emitting diodes, however, tend to be catastrophic, while EL elements dim gradually, says Hallett. What's more, he points out, the high current densities diodes require make for interconnection problems, especially if the display is to be built in an IC-like format. Finally, he adds, it's not always possible to get a desired color with diodes. "Some display schemes even use an image converter to change the diodes' output to visible radiation, and that's costly and inefficient,"

EL display. This 1¼-inch-square, 100-unit display may be the forerunner of 10-foot-square models. Larger displays could have as many as a million units.

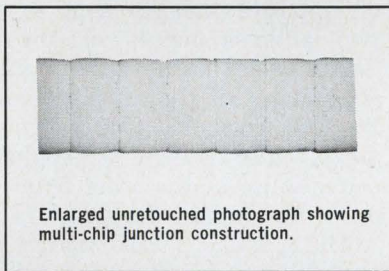


“Ministic,” the high voltage silicon rectifier for the engineer who wants more of a good thing.

A new device technology developed at Semtech Corporation has revolutionized the multi-junction rectifier. This breakthrough has greatly improved reliability and lowered costs.

Discrete multi-junction devices and sticks made up of such devices are now suited for previously impractical applications. They can compete directly with vacuum tubes and selenium sticks.

Typical applications include focus rectifiers, rf power supplies, power supplies for CRT's and image tubes, and especially, state-of-the-art voltage multipliers of all types. This breakthrough involves the internal construction of multi-junction rectifiers allowing for a corona free package with minimum voltage gradients.



Enlarged unretouched photograph showing multi-chip junction construction.

“Ministic” specifications include:

Peak Inverse Voltages . . . 10 kV to 40 kV
Average Rectified Current 5.0 mA
One Cycle Surge Current 2 amps
Reverse Current @ PIV 100 μ A
Forward Voltage @ 10 mA . . . 30 V to 120 V
Size 25" D x 1.125" to 4.275" L
Available with 100 ns. reverse recovery time.

“Ministic” incorporates junctions metalurgically bonded at high temperature producing a high-strength multi-junction unitary stack. This process allows Semtech to use the Supratalaxial junction (liquid phase epitaxial) proven to be superior for high-voltage, fast-recovery devices. This is an extension of the technology employed in the Semtech “Ministac” available in voltages from 3 kV to 7 kV. For more about “Ministac,” get your copy of “Ministac — Design Freedom with New High Voltage-Low Current Rectifiers.”

Available in large quantities —
see your Semtech representative.

San Francisco—941 E. Charleston, Suite 10, Palo Alto, California 94303 / (415) 328-8025
Chicago—140 N. La Grange Road, La Grange, Illinois 60525 / (312) 352-3227 / TWX: 910-683-1896
Dallas—402 Irving Bank Tower, Irving, Texas 75060 (214) 253-7644
New York—116-55 Queens Blvd., Forest Hills, New York 11375/(212) 263-3115/TWX: 710-582-2959
European Sales—Bourne A. G. Alpenstrasse 1, Zug, Switzerland / (042) 4 82 72/73



SEMTECH™
CORPORATION

652 Mitchell Road, Newbury Park, California 91320
(805) 498-2111, (213) 628-5392 / TWX: 910-336-1264

the Sylvania official adds.

Sylvania's display has had problems of its own. Most deal with control of the EL units—singling out one while keeping others off; making sure the display stays lit; switching the high voltages needed while minimizing leakage during the off state.

Few connections. Sylvania tried five circuit designs before settling on one that met the criteria: the fewest external connections, the fewest power supplies, and the lowest power consumption. The final circuit (there are 100 in the model, one for each EL unit) has only four connections: two for address, one for B+ current, and one for the EL unit. Control and switching are handled by a pair of silicon controlled rectifiers—one high- and one low-voltage—plus four resistors and two zener diodes. Making this circuit was the toughest problem; the 100-element panel was adapted from the company's standard product line.

The high-voltage SCR must have low leakage, because the EL units use about 250 volts a-c but only about 200 microamps in the on state.

With such a small current requirement, leakage through the SCR would have let unused elements glow, reducing contrast. Hallett's group estimated that it could allow only 2 picofarads of leakage in the high-voltage switch.

Good isolation. The engineers rejected diode isolation as having

too much short-circuit potential. Oxide isolation would have required moats on the chip 7 or 8 mils deep and wide. They finally settled on beam leading for both the high-voltage SCR and the other circuitry. The beam-lead format resulted in good isolation and, by getting the SCR out of its package, reduced parasitic capacitances. "This is a unique SCR," says Hallett. "It has no commercial counterpart."

The circuit that controls it is also beam-led. This time, breakdown voltages of only 7 to 9 volts are enough, so all the other components of the circuit (zeners, low-voltage SCR, and so forth) can be put in one IC and assembled on an alumina substrate with the high-voltage switch to form the control circuit.

This circuit depends on pulses of opposite polarity sent to the two address inputs of the IC. These pulses indicate the x and y coordinates of the EL panel to be lit. The control circuitry ignores any x pulse without a simultaneous y pulse at the other input, so only the desired EL panel is lit.

The x and y pulses' relative potential exceeds the zener voltage for the diode pair in the gate leg of the low-voltage SCR. This triggers the switch, which in turn triggers the high-voltage device. To keep from having to "refresh" the display, Sylvania used a latching arrangement. B+ current holds the high-voltage switch on until

two simultaneous erase pulses appear at the address inputs to turn off the low-voltage SCR, and thus the high-voltage one.

On view. Hallett's group had set goals of a 15-microsecond switching time and a display brightness of 20 foot-lamberts. The model exceeds both marks; switching takes 3.6 microseconds at worst, while brightness is easily in the 35-to-40-foot-lambert range—enough for easy viewing in a lighted room.

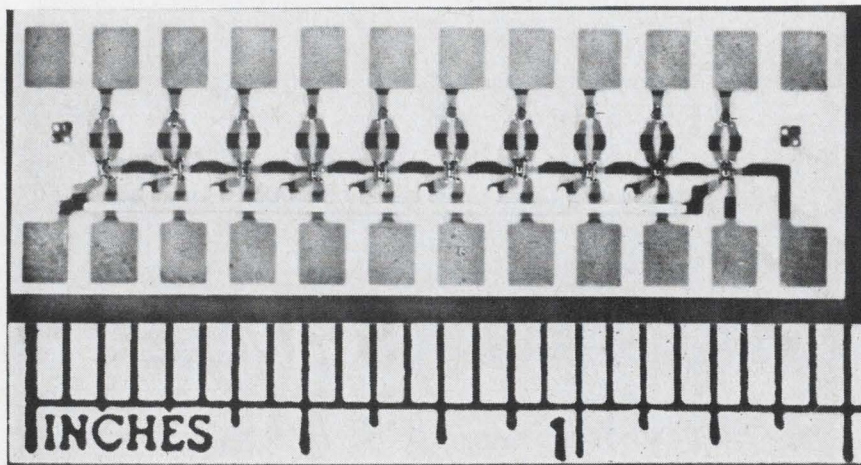
Part of Sylvania's task was price prediction for large displays, perhaps with a million EL units. Hallett figures that EL displays could be made for 40 cents per unit—including the control circuits. To reach this price, he would combine the control IC and the high-voltage SCR into a single beam-lead chip, and perhaps adapt the EL panel for duty as a hybrid substrate. Thus a future display might have EL units on one side of a single substrate and control circuitry on the other.

The Air Force, however, would like a cost of about 10 cents per unit. Hallett doubts that any present technique can reach this level but says batch processing and monolithic fabrication are being studied to find out how much they would cut costs.

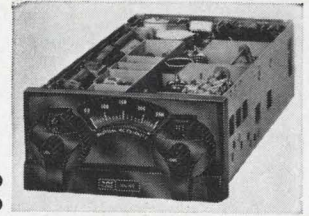
Packaging

Fairpak finale

The new boss of integrated-circuit production at Fairchild Semiconductor is former Motorola executive Eugene Blanchette, and—in the Motorola tradition—he has already taken drastic steps to cut costs and boost volume. One of his first actions upon moving to Fairchild was to stop production of the Fairpak, the flip-chip package that had defeated all cost-cutting attempts since the company introduced it nearly two years ago. Then last month, in an unrelated action, Blanchette hired John Husher, an IC production specialist, away from Sprague Electric's semiconductor

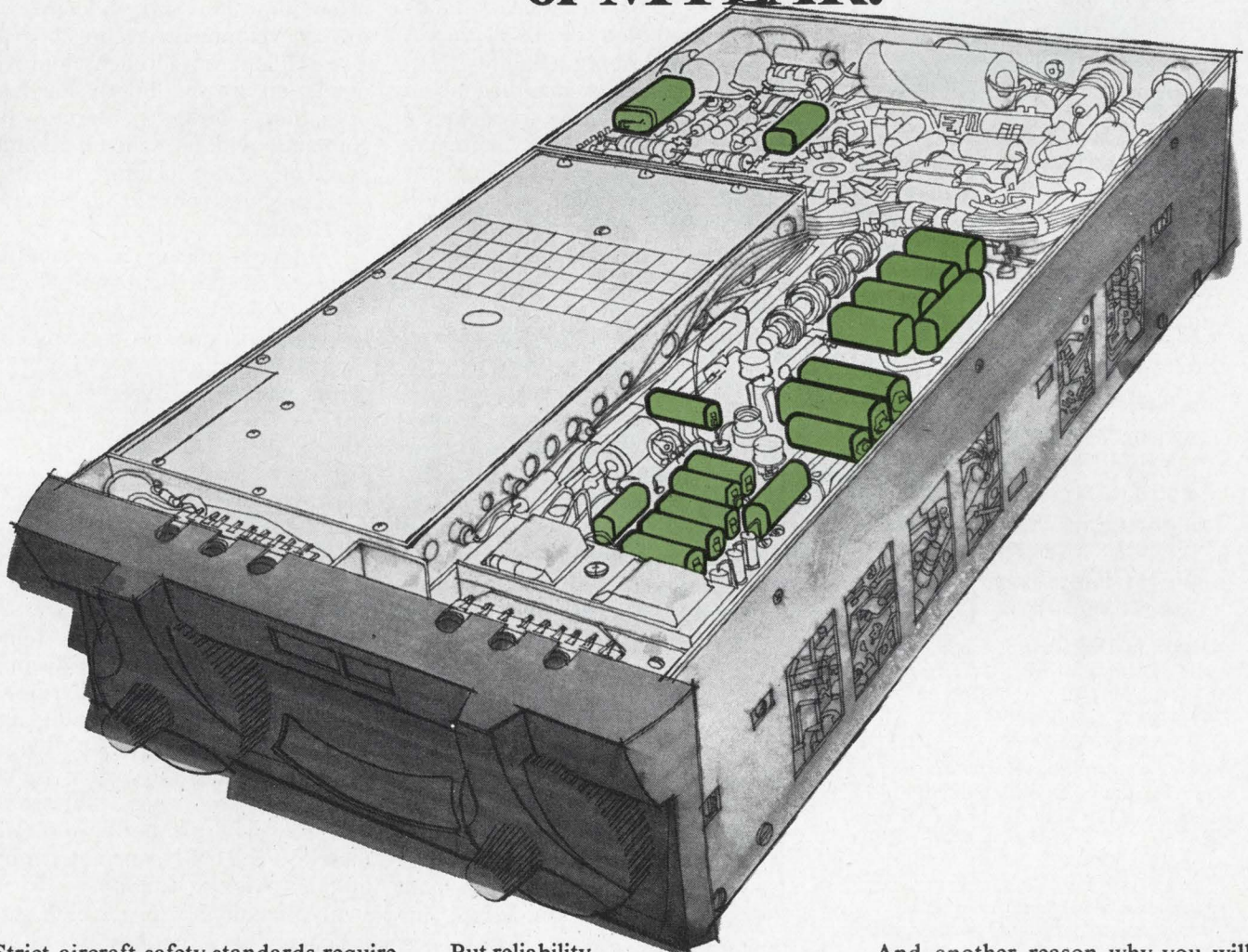


In command. In the control circuitry for the electroluminescent display, beam-lead IC's and SCR's on this hybrid pick one of 10 EL units, switch on the high voltage needed to make it light up, and keep the display refreshed.



**King Radio needed:
capacitors that stay reliable even
with extreme cold, humidity
and vibration.**

**So King Radio chose: capacitors
of MYLAR.**



Strict aircraft safety standards require the most reliable navigation equipment available. That's why King Radio Corporation uses capacitors of MYLAR* for their Distance Measuring Equipment. MYLAR can take temperature extremes from -60° to $+150^{\circ}\text{C}$; MYLAR remains constantly stable under humid conditions.

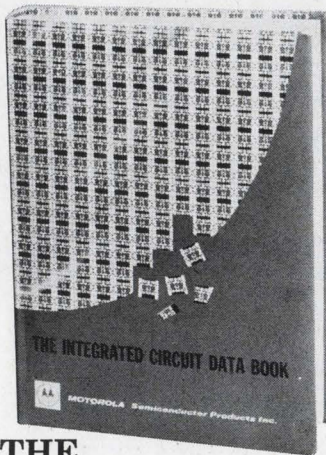
But reliability isn't the only reason King Radio chose MYLAR. The extremely high dielectric strength of MYLAR permits its use in thinner film, thus helping King Radio to build the lightest and most compact distance measuring unit on the market. MYLAR is available in films as thin as 15 gauge.

And another reason why you will want to investigate using capacitors of MYLAR: they usually cost no more than others. Write for complete technical data to DuPont Company, Room 4960A, Wilmington, Delaware 19898. (In Canada, for information write Du Pont of Canada Ltd., Post Office Box 660, Montreal, Quebec.)



*DU PONT'S REGISTERED TRADEMARK FOR ITS POLYESTER FILM.

The First Authoritative Single-Volume I/C Reference



...THE INTEGRATED CIRCUIT DATA BOOK

Here is the industry's most complete data guide and the most comprehensive source of general I/C information.

Nearly 1,000 fact-packed pages contain detailed specifications for all Motorola linear and digital integrated circuits, plus:

- INTERCHANGEABILITY CROSS-REFERENCE
- DIGITAL AND LINEAR APPLICATION SELECTION GUIDES
- SELECTED KEY APPLICATION NOTES
- SUPPLEMENTS — UPDATING SERVICE SUBSCRIPTION RESERVATION
- ALPHA-NUMERIC CIRCUIT IDENTIFICATION INDEX

Individual sections of the book treat each of the Motorola I/C families: MECL, MHTL, MTTL, MDTL, mWMRTL and MRTL, MOS, Complex Arrays, and each of the linear types. No single I/C information source offers so much toward the intelligent selection of the right device for the specific job . . . yet the price is only \$3.95 per copy.

Integrated Circuit Data Book Coupon
My check (payable to Motorola Inc.) is enclosed.
(\$3.95 per copy)

Name _____

Company _____

Address _____

City _____ State _____ Zip _____

MOTOROLA
Semiconductor Products Inc.
P.O. BOX 20912 • PHOENIX, ARIZ. 85036

Electronics Review

operation and put him in charge of a unique satellite operation at Fairchild's South Portland, Maine, facility.

Blanchette had never been enchanted by the Fairpak; shortly after arriving at Fairchild he noted that "the metalized ceramic substrate puts it out of the ballpark for really low cost."

The coup de grace for the package may have been the development of a radically new kind of aluminum beam-lead device that's produced by a technique far simpler than Bell Laboratories' air-isolated, back-etch method for gold beam leads. Devices have already been assembled by this process and are undergoing reliability tests. Blanchette is closemouthed about how they're made or when they'll be introduced, but this aluminum beam-lead approach is the only one of four methods of one-shot bonding to which he has assigned a development task force. (The others under study at Fairchild are gold beam leads, spider bonding for plastic-packaged flip-chips, and bumped chips for multichip packages.)

The Fairpak, the first commercially available flip-chip package [Electronics, Feb. 20, 1967, p. 49], contains aluminum-bumped chips bonded face down on a metalized ceramic substrate and capped with a little glass-ceramic seal. Fairchild introduced it for four diode-transistor-logic circuits, switched it over to its slow-selling transistor-transistor-logic line shortly thereafter, and has resolutely refused to publicize it after the first splash. Blanchette says the company will still make it for anyone who insists.

Independent. The South Portland experiment will be the total responsibility of Husher. The operation will do its own scheduling, make its own masks, and fabricate IC's from the wafer level through packaging.

In general, South Portland will produce the older lines of Fairchild IC's—DTL, CTL, and the 9000 line of TTL. Mountain View, Calif., will concentrate on linear circuits, medium-scale integration, micro matrixes, computer-aided design,

MOS, and memories. When Mountain View needs space to turn out new products, the older lines will be transferred to South Portland.

"In 1971, the IC market will amount to \$800 million," Blanchette says. "If Fairchild, as a leader, is to have a quarter of that market, there has to be another plant in which to make the circuits. And we also have to find a way to move the newer, more sophisticated products onto the market fast but without ignoring the volume lines."

Husher will become a director under Blanchette. He will be headquartered at the parent plant in Mountain View and will have his own development group to pass research and development improvements on to the South Portland operation. Orders entering the company will be scheduled independently—"but in total visibility," as Blanchette puts it delicately—by Husher.

The move means a substantial increase in the engineering staff at South Portland. Blanchette says new—and presumably automated—assembly techniques will be introduced there in 1969.

Industrial electronics

Keeping in touch

Municipal police forces may someday have an easier time keeping track of their wayward "Car 54's." The Department of Housing and Urban Development is studying a program called Pulse (for public urban locator service) that would give dispatchers of public and commercial vehicles a constant picture of the vehicles' location.

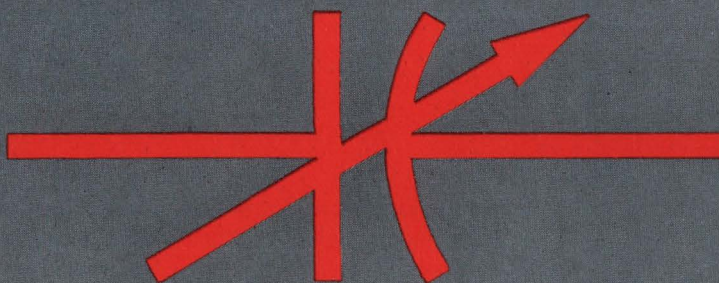
HUD would like to develop such a system as a nationwide public utility, ensuring coordinated planning by requiring private and public customers to use the same service.

To get an assessment of the program, the agency last month sponsored a technical conference in Washington attended by 20 electronics firms. Most of the engineers present agreed that such a system

ERIE

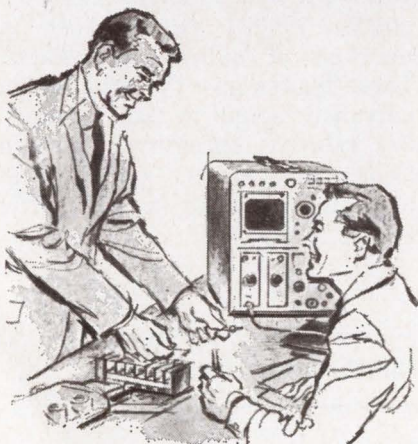
TECHNOLOGICAL

PRODUCTS, INC.



Quality **TRIMMER CAPACITORS** *by* **ERIE**

AIR • CERAMIC • GLASS • QUARTZ • PLASTIC



Call or wire **TODAY** for
complete new Trimmer data.

YOUR ERIE MAN HAS JUST THE RIGHT TRIMMER CAPACITOR... AT JUST THE RIGHT TIME

Your Erie Man won't sell you a particular type of trimmer capacitor... but he will help you choose the right trimmer from the world's most complete selection... AIR, CERAMIC, GLASS, QUARTZ, and PLASTIC — more than 1000 styles. With ERIE you save valuable time by talking with one expert rather than several representatives handling limited trimmer lines. And you know the trimmer you choose will be ideal for your application. So call in your ERIE man for your complete trimmer requirements.

ERIE is qualified to MIL-C-81 and MIL-C-14409

ERIE TECHNOLOGICAL PRODUCTS, INC.

644 WEST 12th STREET • ERIE, PENNSYLVANIA 16512 • PHONE (814) 456-8592

"PIXIEPOT"™

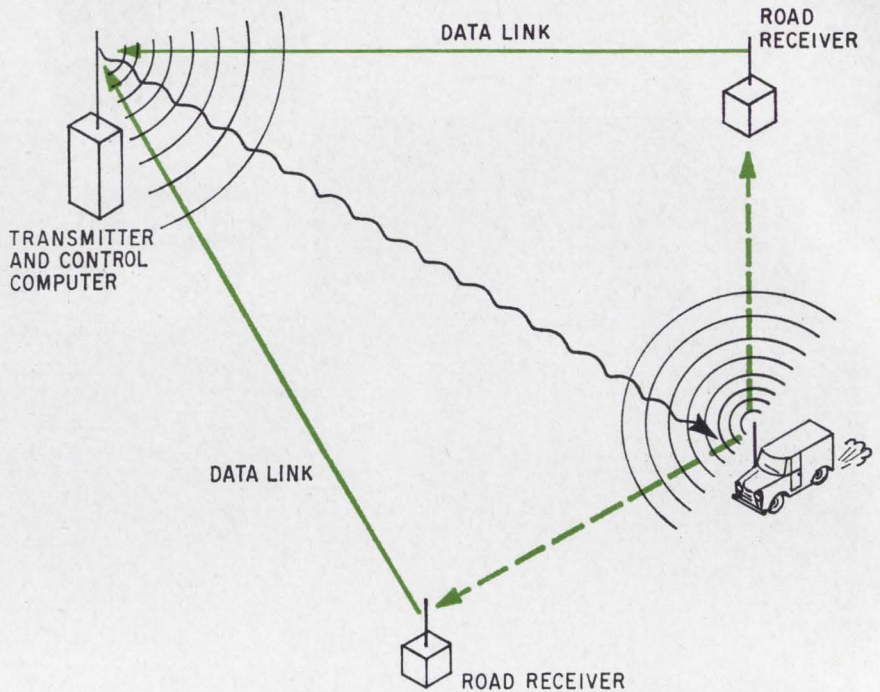


LITTLE PRICE BIG FEATURES

The biggest little \$3.97 precision 10-turn wirewound pot in the world!

The Duncan "PIXIEPOT" potentiometer gives you the big features at a little price. It is the one and only precision 10-turn miniature pot for under \$4 that has all these features: ■ Length: ONLY 3/4" ■ Diameter: ONLY 7/8" ■ Linearity: ±0.25% ■ Resistance Range: 100 ohms to 100K ohms ■ Power Rating: 2 watts @ +20°C ■ Temperature Range: -25°C to +85°C ■ Resolution: Better than ANY wirewound pot TWICE its size ■ Slotted Stainless Steel Shatt/C ring ■ Now you can save big dollars on your instrument and system requirements. Specify Model 3253 "PIXIEPOT" for as low as \$3.97 each in production quantities and only \$5.95 each for 1-24 units. In-stock delivery, of course. Call, write or wire Duncan today for complete specifications.

DUNCAN electronics, inc.
 A DIVISION OF SYSTRON-DONNER CORPORATION
 2865 FAIRVIEW ROAD,
 COSTA MESA, CALIFORNIA 92626
 Phone: (714) 545-8261



Traffic signals. System under study by the Government would keep track of vehicles and display their locations.

was feasible. It was noted, though, that the capital and installation costs might be prohibitive.

Meeting of minds. Surprisingly, most of the companies at the meeting had independently arrived at similar conclusions as to the best technical approach to the system. Generally they suggest that the vehicles involved be equipped with inexpensive transponders that would pulse out short-range radio signals. Each vehicle would have its own code signal, and this would be picked up by receivers strategically spotted around the city. Hundreds of receivers might be necessary in a large city. The message from the receivers would be flashed via telephone lines or coaxial cables to a central computer, which would then calculate the location of the vehicle and store or display the data as needed.

The hardware market created by a nationwide system would be tremendous—millions of vehicle transponders, thousands of location receivers, and possibly hundreds of computer-display complexes.

One setup involving scattered remote receivers is now being built by Motorola for the Chicago Transit Authority at a cost of \$1.2 million. Two-way radios are being in-

stalled aboard 500 city buses under this system, which will monitor bus progress.

Further study. Both private and Federal officials concede that a nationwide program requires a great deal more study. Under a \$200,000 grant, HUD has hired two Washington consulting firms—the Institute of Public Administration and Teknektron—to probe further into the system.

With technical details so vague, few are willing to estimate what a nationwide system would cost. When pressed, industry and Government officials put the cost "in the tens of billions of dollars." These figures give the program an unrealistic sound to many officials. But industry representatives see a tremendous market opening up even if the system is only partly implemented.

Military electronics

Counterrevolution

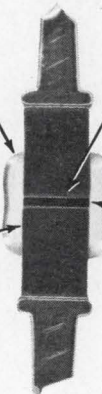
Most successful revolutions sooner or later have to struggle with counter-revolutionary forces. And the

**You can't tell
from this picture that these are
the only monolithic
fused-in-glass
JAN TX type 1N4942
fast recovery
controlled avalanche
rectifiers
in the business.**

So take a look at this actual section

Hard glass fused to all silicon and pin surfaces creates a voidless monolithic structure. Perfect seal against all moisture and contaminants.

Temperature coefficient of glass and pins is matched to silicon. No degradation under severe thermal stress of high transients or repeated temperature shock even from -195°C to 300°C .



Metallurgical bond of pins to die faces at 1000°C allows extremely high surge capability, low thermal resistance. Virtually indestructible construction.

Controlled avalanche and permanently stable surface leakage characteristics. Hyperclean silicon surface fused only in hard glass. No oxides, silicones, or varnish are used.

ACTUAL SIZE

JAN and JAN TX-1N4942 Series

I_o @ 55°C 1.0 Adc

Surge 15 A

JAN 1N4942 200V

JAN 1N4944 400V

JAN 1N4946 600V

Recovery Time 150 nsec

And you can't tell by looking at the picture that Unitrode not only makes them, but has them on the shelf, ready to ship, no waiting, 3 ratings. So . . .

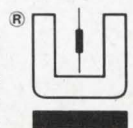
If you're in a real hurry, why not call Dave Greene collect, at (617) 926-0404.

If you're not in that much of a hurry, we'll be glad to send you our data sheet, with all the specs.

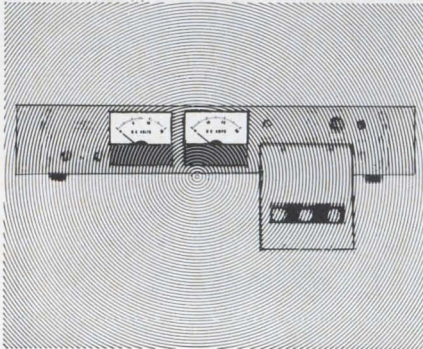
Samples anyone? Just call Compar or Daniel & Co. . . . or drop us a line.

580 Pleasant Street, Watertown, Mass. 02172 (617) 926-0404

UNITRODE



TRYGON HAS THE POWER



**to deliver wide slot
range performance in
ratings to fit every
system... from \$119.**

- Rack mounted and modular.
- Meter and control options, integral.
- All silicon design—precision performance.
- Adjustable current limiting—optional overvoltage protection.
- Remote sensing and programming.

LIBERATORS from TRYGON...the ultimate in IC and transistor system power in minimum size at lowest possible cost. Specs like 0.5mV ripple, 3mV P-P noise, MIL Spec. performance and overvoltage protection.

FULL-RACK MODELS: voltages to 160V; output currents up to 40 A (3½") and 70 A (5¼"), 0.005% regulation and 0.01% stability, plus load share automatic paralleling.

SUB-RACK MODULAR MODELS: voltages to 160VDC, output currents from .25 A to 25 amps, 0.01% regulation and 0.03% stability. Write today.



TRYGON POWER SUPPLIES

111 Pleasant Avenue, Roosevelt, L.I., N.Y. 11575
Trygon GmbH 8 Munchen 60, Haidelweg 20, Germany
Write for Trygon 1968 Power Supply Handbook.
Prices slightly higher in Europe.

Electronics Review

"management revolution" led by former Defense Secretary McNamara is proving to be no exception. The weapons commonality idea has been under fire [Electronics, Oct. 28, p. 70], and now McNamara's firm fixed-price contracting policies are also under attack.

The Aerospace Industries Association recently complained to the Pentagon that too many fixed-price contracts were being used in major weapons systems development. Soon afterward, the department's own Armed Services Procurement Regulations (ASPR) Committee, in an apparently unrelated move, issued new rules that appear to meet some, but not all, of the objections. Both actions reflect growing suspicion that fixed-price contracts can impede technological advances and cut profits, especially in research and development efforts.

Bad feeling. Initiated several years ago, the fixed-price contracting policies were basically intended to save the Pentagon money on production contracts. But many service R&D commands felt they had to comply also and used the policies on contract definition and the following research and engineering phases of a system's life cycle.

Consequently, the AIA asserts that a contractor under a firm fixed-price or fixed-price incentive contract may see his profit decline when he has to solve one of the unforeseen technical problems common in the contract-definition phase. Often, too, subcontractors get saddled with rigid, unpleasant contracts. In every major weapons system development reviewed by the AIA, the company had to make substantial technical changes to meet the contract specifications.

Such fixed-price contracting occasionally led to bad feeling between contractors and the service command and, within the command, between the program officer who had the final say on selection of the type of contract and the technical and legal sections.

Flexibility. The AIA suggests instead that the choice of the final contract type for engineering development be made after the contract-definition phase and that the

contracts be made flexible to accommodate the degrees of technical difficulty involved in the system. The AIA, however, strongly opposes "any return to older contract practices which rely upon cost-plus-fixed-fee contracting for major weapon systems development."

Specifically, the AIA recommends that the Pentagon:

- Choose the contract for each individual weapon system that is appropriate for the technical uncertainties involved.
- Establish a board to review each contract.

The new ASPR regulations make the contracting officer the final arbiter of contract type, but he must make his decisions with the advice of the technical sections, discuss the types of contracts to be used with the contractors (who may offer alternate suggestions), and make a written report of his reasons for choosing a certain contract type. The ASPR changes don't satisfy the AIA desire for a central Pentagon review board. The AIA thinks that the decisions on contract type are made by middle managers who are hard to reach and whose decisions can't be appealed.

Unk unks. As the complexity and cost of programs increase, the AIA contends, the problems and uncertainties of contractors will multiply. Engineering development costs are currently from 60% to 70% of total development costs and from 10% to 30% of life-cycle costs, it notes.

The chief cause of the industry's complaints are the "unk unks"—the unanticipated unknowns—that cannot be forecast on the basis of paper design and analytical studies, the AIA says. These are contrasted to the anticipated unknowns, "the things you know you don't know."

The AIA sees a trend of diminishing profits caused by more companies bidding on the fewer but bigger contracts available. The Pentagon discourages "buying in" (purposely bidding low to get in a favorable position to bid for the production contract), but the AIA says the current defense market is unintentionally producing a similar

New! Multi-Color Performance from RCA Single-Gun CRT's

How many colors do you want in CRT read-out? RCA can give you two, and the shades between, from a single-gun CRT. What's more you have a choice of tube size for the display of all types of visual information — waveforms, alphanumeric, pictorial or any combination of these three.

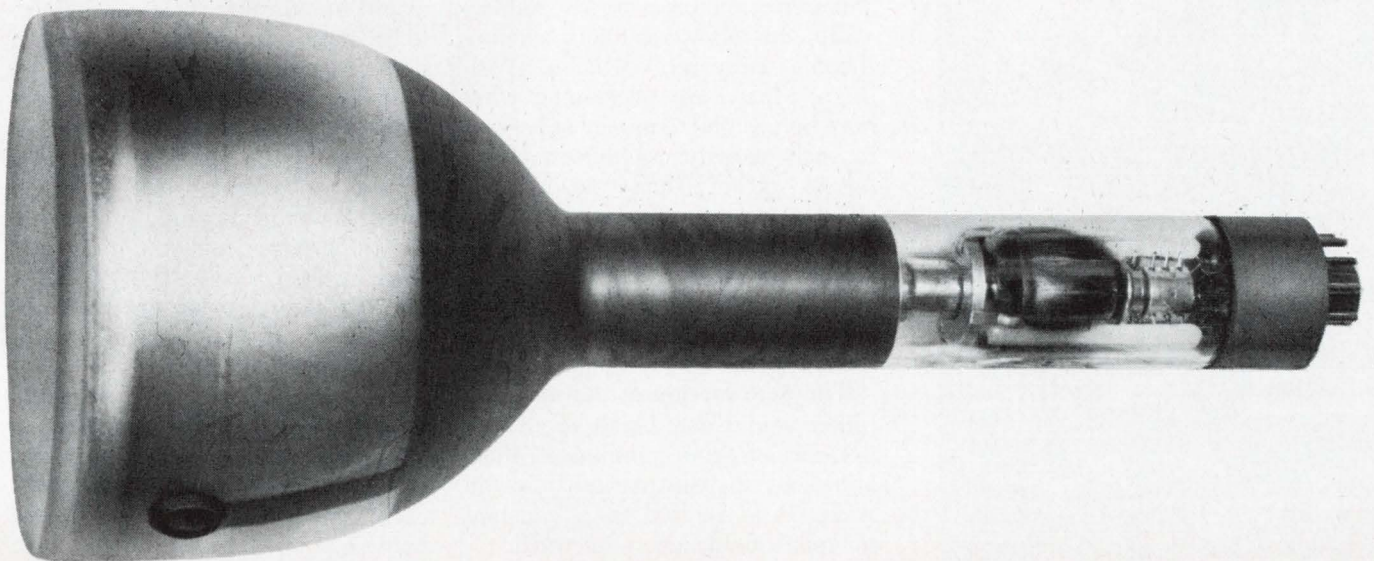
Here's your answer to air-traffic control systems, military IFF systems, stock market quotation displays, airline and other transportation status boards. Utilize RCA's new capability in teaching machines, electronic test instruments, computer read-out equipment—anywhere a multi-color display makes understanding easier.

The RCA multi-color CRT is made with two phosphor layers. The multi-color performance is obtained through the application of different anode voltages.

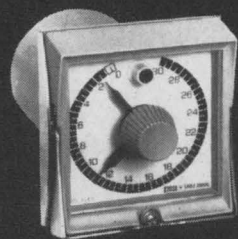
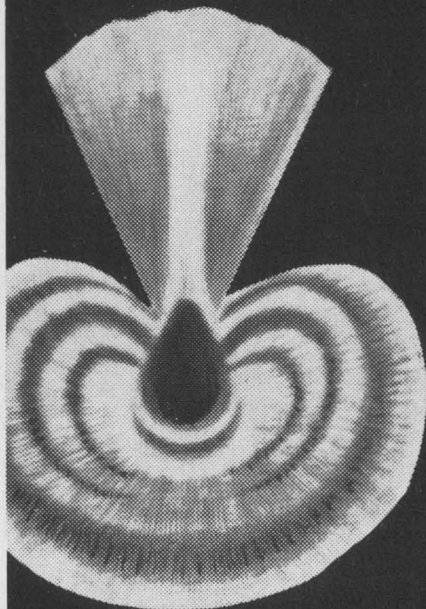
Whatever your choice of colors and display, the read-out is as sharp and bright as black and white. And the single electron gun means simple back-up circuitry.

For more information on RCA multi-color CRT's and other RCA Display Devices, see your RCA Representative. For technical data, write: RCA Electronic Components, Commercial Engineering, Section No. K-19Q-1, Harrison, N. J. 07029.

RCA



LOW COST AUTOMATION takes many forms



Our famous plug-in Cycl-Flex® electromechanical and solid state time and count controls cut down-time... are replaceable in 5 seconds or less.

Get the facts on these and 560 other forms of low-cost automation. Send for Catalog 15.

BLISS  **EAGLE SIGNAL**

A GULF + WESTERN COMPANY
DAVENPORT, IOWA 52808

Service-In-Depth...
Local Engineering, Stock, Repair

Electronics Review

result. Companies may opt for a large profit on total business by stringing together tiny profits on many contracts.

No official Pentagon reaction to these complaints is expected until the new Administration takes office in January.

Advanced technology

Beyond microwave IC's

Even as microwave integrated circuits gain their first large markets, researchers are trying to make them obsolete with the new technique called praeterionics. Using microwave-frequency sound waves interacting with piezoelectric and semiconductor materials, they are already building the first models of parts for praeterionic signal-processing systems and other sections of radar and communications gear.

Lately, schemes using waves propagating over the surface of such materials have come into vogue, replacing similar acoustic devices that use waves propagating through the bulk of the material. But a key part of any surface-wave system — a microwave-frequency amplifier — is still lacking. Surface-wave amplifiers have yet to operate above about 300 to 500 megahertz because the transducers that convert electromagnetic energy to acoustic surface waves become so small that they are hard to make and performance is unrepeatable.

Up, up. Now scientists at Raytheon's Research division, Waltham, Mass., are developing what may be a high-frequency successor to such acoustic amplifiers. Using ferrite rather than piezoelectric substrates, scientific fellow Ernst F. Schlomann and senior research scientist Carl E. Patton have developed an amplifier design that should work into the 3- to 4-gigahertz region, and perhaps beyond.

The first version of the new amplifier would use a slab of yttrium iron garnet about a millimeter thick and 1 by ½ centimeter long and wide. It is bathed in a constant magnetic field across its width.

Lying flat. At either end of the flat surface of the garnet is a short stub antenna that allows microwave energy to be converted into magnetoelastic waves, which then propagate over the surface of the YIG.

This in itself isn't enough to cause amplification, although according to Patton, the YIG is just about lossless. To amplify, an overlay of high-mobility semiconductor such as indium antimonide is placed atop the slab in a layer as thin as 3,000 angstroms. A d-c pulse is applied to the ends of the semiconductor layer through ohmic contacts, with the direction of current flow the same as that of the magnetoelastic waves.

Positive feedback. Now, as waves propagate through the YIG, the weak magnetic fields accompanying them will extend into the semiconductor and induce a current flow at right angles to the applied d-c. This new current will have a magnetic field of its own, which will augment the magnetoelastic waves.

"It's a positive feedback system," says Schlomann, "since each of the two magnetic fields strengthens the other. This is how we hope to achieve gain."

The new device would be very small, since its size would be determined by the wavelength of microwave frequencies propagating in solid materials. Other workers in the field of praeterionics would have said that by switching from waveguide to acoustical or magnetoelastic propagation it would be possible for a centimeter-long circuit to do the work of a mile of waveguide or coaxial cable.

Unlike surface-wave amplifiers using piezoelectric materials rather than YIG, the Raytheon device would be tunable over a broad band. It would be tuned by varying the otherwise constant magnetic field applied across the width of the YIG slab: the stronger the applied field, the higher the amplifier's center frequency.

Schlomann and Patton hope to have their first model operating in late November or early December. In the meantime, Schlomann will detail the device and the theory behind it in a paper at the 14th

Ground station capacity in a portable recorder!

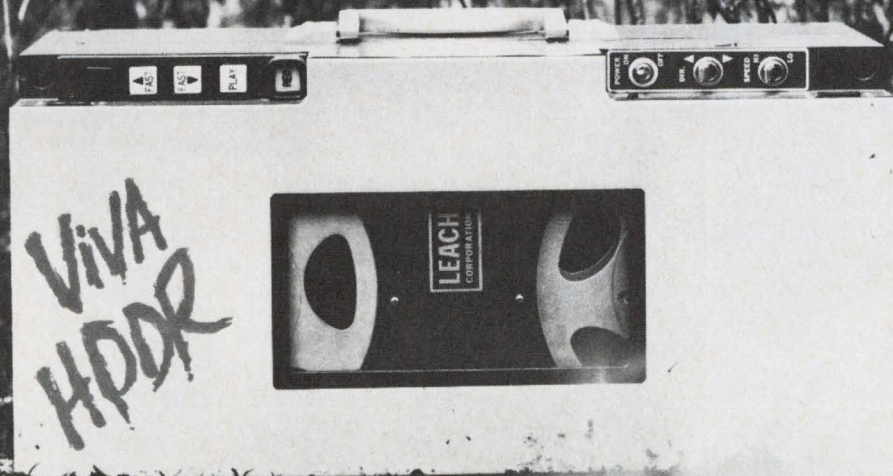
Our new MTR-3500 should start a revolution in the hinterlands. It not only records 2.4 billion bits of digital data but does so with virtually no errors. Using a unique new design technique called High Density Digital Recording (HDDR, patent pending), the 3500 packs 6,000 bits per track inch on 2400 feet of one inch, 14-track tape. And although we guarantee

an error rate of 1×10^8 , we've yet to drop a single bit with HDDR.

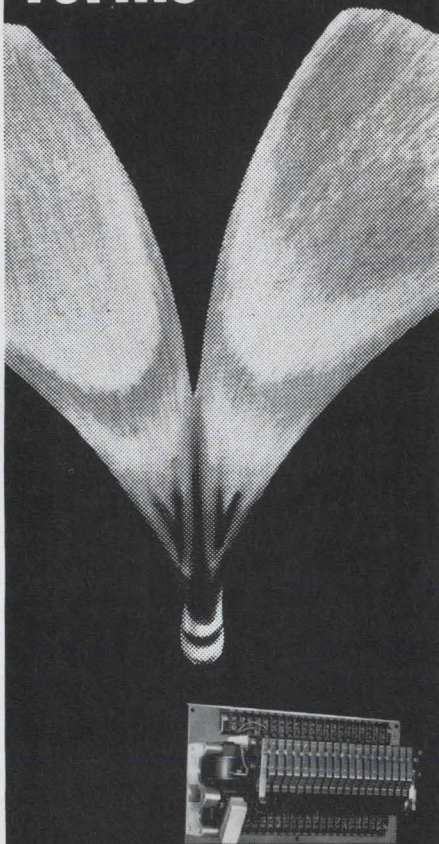
The new 3500 is ideal for field use. Rigid construction permits operation in such rugged environmental conditions as 10g—11ms $\frac{1}{2}$ sine shock, 10g rms random vibration, and 25g acceleration. It's compact (8.6" x 9.5" x 20"), and weighs only 54 lbs. Best of all, the new MTR-3500 with HDDR is available now.

For more complete information write Leach Corporation, Controls Division, Department E, 717 North Coney Ave., Azusa, Calif. 91702. (213) 334-8211.

LEACH



LOW COST AUTOMATION takes many forms



With this super-simple MT Sequence Programmer you control up to 19 independent 10 amp load circuits in a predetermined sequence with random inputs. The MT isolates... interlocks... remembers... it's almost a computer. Should be the beginning of every control circuit design... eliminates many costly components.

Send for new Bulletin 910.

BLISS  **EAGLE SIGNAL**

A GULF + WESTERN COMPANY
DAVENPORT, IOWA 52808

Service-In-Depth...
Local Engineering, Stock, Repair

Electronics Review

International Conference on Magnetism and Magnetic Materials in the New York Hilton Hotel Nov. 18 to 21.

Communications

Opening up the spectrum

In about three weeks, the President's Task Force on Telecommunications will report what everyone in the electronic business has known for a long time: there is no shortage of space on the frequency spectrum, just an unfortunate lack of understanding about how to use it.

The report, which isn't intended for public distribution until after the election, outlines a comprehensive plan for improving the utilization of frequency space [Electronics, Sept. 16, p. 67].

Not surprisingly, the Presidential panel will point to the Government itself as the leading culprit. It will charge that the Government has reserved too much of the microwave bands for potential satellite needs and is holding too much spectrum space for anticipated Federal law-enforcement needs.

New agency. The far-ranging report will suggest that users pay a license fee based on the amount of frequency space used and the profit realized by using it. It will call for the establishment of a new agency with broad frequency-allocation powers, and will advocate the transfer of some spectrum now reserved for ultrahigh-frequency tv to land-mobile radio operations.

Many of the recommendations aren't new, but the task force may succeed where others have failed in getting them implemented. How well it succeeds will be up to the new Congress and Administration.

The task force, headed by Presidential adviser Eugene V. Rostow, has been working on the report since August 1967. Most members of the panel are officials of various Government agencies and none are engineers. The technical staff was drawn from Federal agencies.

In brief, the group will urge the Government to:

Make any frequency space available to other users if the one to which it was allocated lets it lie dormant.

Establish and continuously update equipment standards and operating practices (including criteria for frequency sharing, channel loading, or both) to cut down on nonproductive "pollution" of the spectrum.

Phase out point-to-point trunking with high-frequency bands (3-30 megahertz) except as a backup to satellite and cable facilities, and use this space exclusively for maritime and aeronautical mobile services.

Allow present users of the 30 to 1,000 megahertz range to continue their use, but institute operational constraints (such as power and frequency controls) and frequency-sharing to permit land-mobile use of the space.

Set up new equipment and operating standards for land-mobile operators to ensure that the same frequencies can be used by base stations short distances apart.

Encourage the development of common-user and common-carrier mobile radio systems with intermittent requirements by sanctioning joint licensing arrangements.

Auction land-mobile frequency space to the highest bidder when a dispute among applicants cannot be resolved on its merits.

End the distinction between local and Federal police frequencies so the local forces can make use of the sparsely used Federal bands.

Begin a broad, comprehensive study of the technical and economic feasibility of moving television broadcasting to higher-frequency bands—the microwave or millimeter-wave regions.

Be prepared to consider ending tv broadcasts in the uhf bands when cable and other tv distribution means become practical.

Establish improved modulation and antenna directivity standards to permit greater frequency re-use in the microwave bands (1-10 gigahertz).

Continue sharing the 4- to 6-GHz band between communications satellite and radio relay systems until a domestic satellite system has been

Photocells ain't what they used to be...



they're a heck of a lot better

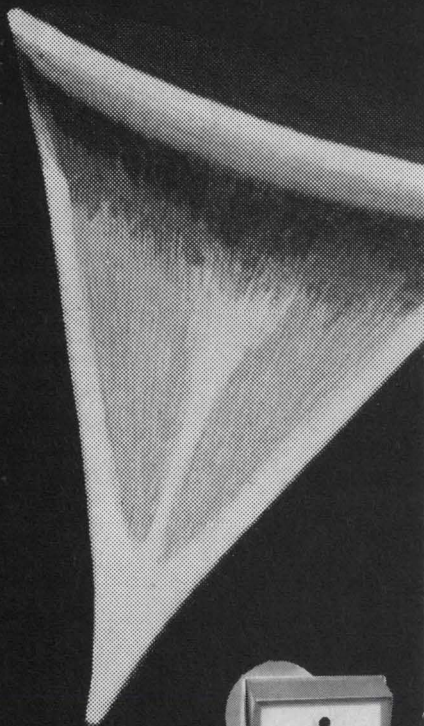
Photocells are doing jobs today that they couldn't have done ten—five—
or even two years ago. There have been that many improvements!

HIGHER STABILITY
MORE UNIFORM RESPONSE TO COLOR TEMPERATURE
HIGHER SPEED RESPONSE
WIDER VARIETY OF PACKAGES AND SIZES
INCREASED EFFICIENCY
HIGHER LINEARITIES

Let us show you how the "light touch in automation and control" can
help solve your problems. Call (212) 684-5512 or write Clairex, 1239
Broadway, New York, N. Y. 10001.

CLAIREX ELECTRONICS, INC.[®]

LOW COST AUTOMATION takes many forms



New plug-in Cycl-Flex 2 & 3 digit totally solid state I/C counters. 100% accurate. Up to 1200 counts per minute. Available in higher count rates. Easy-to-set thumb wheels.

Get Catalog 15, describing these and 560 other forms of low-cost automation.

BLISS  **EAGLE SIGNAL**

A GULF + WESTERN COMPANY
DAVENPORT, IOWA 52808

**Service-In-Depth ...
Local Engineering, Stock, Repair**

Electronics Review

fully worked out.

Authorize the sharing of the 7- and 8-GHz bands, now allocated solely to Government (military) systems, by both domestic and military satellite systems.

Encourage the trend among common carriers toward low-noise systems in the microwave bands. This involves the use of horn-reflector antennas, and of wide-deviation frequency-modulation and pulse-code modulation, for example.

Create a new executive-branch agency to handle both Government and private allocations. (Under this plan the FCC would continue to parcel out specific frequency licenses, but the block designations would be made by the new agency).

Appoint regional coordinators to supervise allocations and assignments.

Consolidate spectrum research and development in the new agency, except the mission-oriented research of other agencies. Sharply increase Federal funding for spectrum R&D.

Instruct the agency to take an interdisciplinary approach to spectrum utilization by employing engineers, economists, lawyers, and social scientists.

Components

Up the ladder

Until recently, precision resistor ladder networks with an accuracy of 14 bits have been laboratory items, and the integrated-circuit digital-to-analog and analog-to-digital converters that rely on hybrid or discrete resistor ladder networks have been limited by ladder accuracy. But three new developments from the microcircuits operation at Beckman Instruments' Helipot division have just been incorporated in the division's model 811 hybrid thick-film cermet ladder network, making 14-bit ladders available in quantity.

The new developments are a cermet material that will yield typical resistor temperature-tracking capabilities of 0.5 part per mil

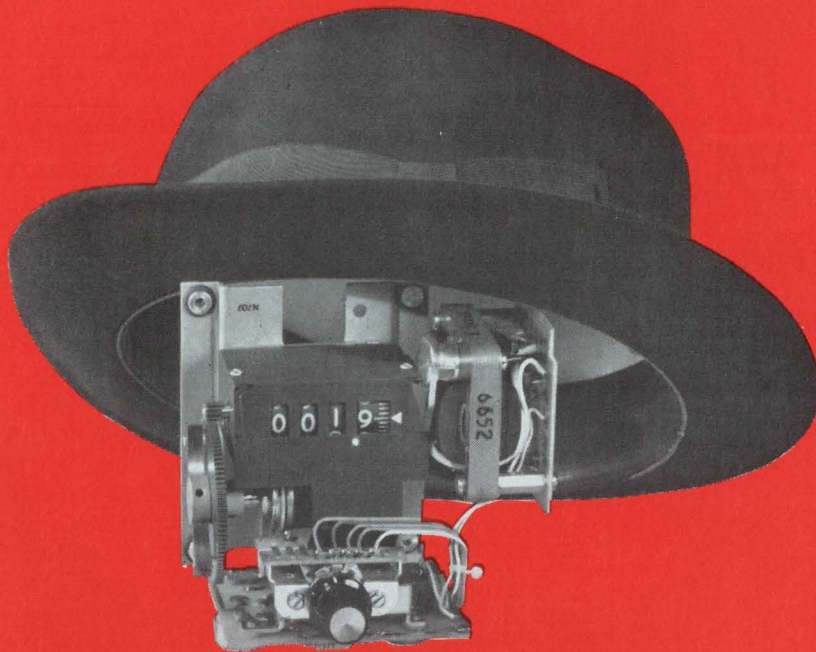
lion per degree C, tailoring equipment that will trim the ratio of each resistor to within 5 ppm of others in the network, and measuring equipment that can test ladders with accuracies up to 14 bits to within ± 2 ppm of the desired ratio. It tests 200 to 300 of these an hour.

Perfect tracking. William Kelly, materials supervisor in the microcircuits operation and the man chiefly responsible for the new cermet material, says all resistors in a precision ladder network should have the same temperature coefficient. If they do, they are said to have perfect resistor-temperature tracking. Kelly says Beckman's best previous cermet materials gave them typical resistor-temperature tracking of 2.5 ppm/degree from -55° to $+125^{\circ}$ C.

This kind of tracking allowed Beckman to produce many ladders with accuracies of 10 and 11 bits, and some with 12 bits. Commercially available materials (most of which are silver-palladium) that Beckman has tested show typical resistor-temperature tracking of 10 ppm/degree C. With them, Kelly says, a good many 9-bit ladders can be made, but only a few with accuracies of 10 and 11 bits.

Details of the new Beckman cermet are secret. Kelly says only that it is not silver-palladium and that it is produced by close control of three factors—particle-size distribution, thickness of the material to get an even deposition on the substrate, and firing temperature. "It's very important," he continues, "that firing temperature be rigidly controlled so that each resistor in a network 'sees' the same temperature—because once they're formed, their stability and temperature coefficient are locked in."

Ratio tailoring. Beckman engineers are equally stingy with information about their precision tailoring and measuring equipment. They point out, however, that they know of no other equipment that does ladder-network ratio tailoring. Other trimmers adjust to absolute resistance values. George Smith, supervisor of product design in the microcircuits operation, points out that commer-



panel meters are old hat at

D I G I T E C

5 years ago DigiTec made a major breakthrough with the first low cost modular digital panel meter...
DigiTec continues to lead the industry with two new advances in low cost digital panel meters



SERIES 180
High Resolution DPM

\$225 list

Generous quantity discounts available
Non-Linear Functions Available for OEM Users



SERIES 270
All Solid State

\$249 list

Generous quantity discounts available
Third Generation DPM

DIGITEC by **UNITED SYSTEMS CORPORATION**

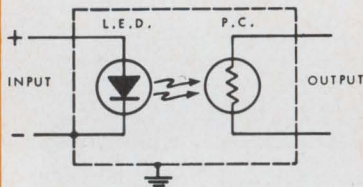
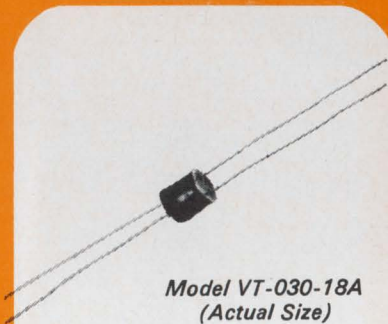
Stocking Representatives
Throughout the World

918 Woodley Road • Dayton, Ohio 45403 • (513) 254-6251

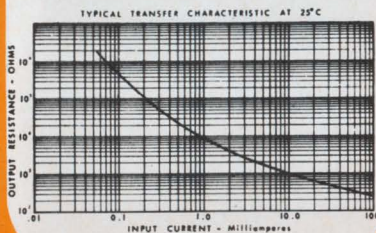
NEW!

VACTEC

Light Emitting Diode/Photoresistor Control



Case common to negative terminal on LED



- All solid state LED Vactrol Input-Output Device with true electrical isolation.
- Light emitting diode coupled with an ohmic photo-conductive cell.
- Extremely low input power requirement with operation as low as 1-milliwatt input.
- Ideal for battery operation.
- Wide range control, 1000 to 1 or greater light to dark ratio.
- Less than \$8.00 in quantity of 1000.

Two sizes, TO-8 hermetic and TO-18 axial. Write for Bulletins LEDV-1 and LEDV-2.

VACTEC, INC.

2423 Northline Ind. Blvd.
Maryland Hts., Mo. 63042 • (314) 432-4200

Electronics Review

cially available trimming equipment is accurate to only 5,000 ppm absolute of the actual resistance value.

The real key to Beckman's tailoring equipment is the electronic system, designed in-house to control the air-abrasion trimmer. "We have to do everything possible to prevent harm to the cermet material," Kelly points out, "so we've designed control electronics that allow us to trim and measure the adjustment as rapidly as possible and not change the cermet properties."

Beckman engineers had to design the final test equipment themselves because they couldn't buy hardware that tested to the accuracies they needed. The system, built outside, looks and works much like an IC tester. It has five wells containing liquid Freon at -55° , -20° , $+25^{\circ}$, $+80^{\circ}$, and $+125^{\circ}\text{C}$. A socket accepts the finished ladder network pins. For the rate of 200 to 300 per hour, an analog signal triggers a light bulb showing the ladder has an accuracy of 9, 10, 11, 12, 13, or 14 bits.

Print-out data. A printed tape similar to that fed out by desk calculators is produced by the tester if detailed information on a given ladder network is sought. For example, in testing a 12-bit ladder, the machine will print out a ratio error for each of three application resistors compared with the ladder. This, in effect, tests the ladder in a circuit, with the applications resistors performing like feedback resistors, in an operational amplifier. The ratio printed out for the application resistors is the ratio of the feedback resistance to the Thevenin equivalent resistance of the ladder network.

Then each of the 12 bits in the ladder is switched in and its ratio error in ppm is printed out. Finally, the operator can push a button and get a summation of the errors of each of the 12 bits. Smith says the summation is the information the man using the ladder wants to know, but Beckman gives him the application resistor print-out as well to give him an idea of how the ladder will work in a system.

For the record

Geiger gauge. The Lockheed-Georgia Co. has successfully demonstrated a nucleonic fuel-measuring system in its C-141 Starlifter and says it can be used in any type of aircraft. The system is simplicity itself: a radiation source sends gamma rays through a fuel tank and a Geiger Mueller tube on the other side of the container detects them; the amount of radiation reaching the detector is inversely proportional to the amount of fuel in the tank. For a plane the size of the giant C-5 transport, as many as six systems would be used for each of the 12 fuel tanks.

Because this setup, unlike conventional fuel monitoring systems, requires no probes inside the tank, there's no need for safeguards against electrical arcing or for internal maintenance. Lockheed says readings are unaffected by fuel densities, temperature fluctuations, or changes in aircraft attitude because the system measures the mass of the fuel rather than sensing levels.

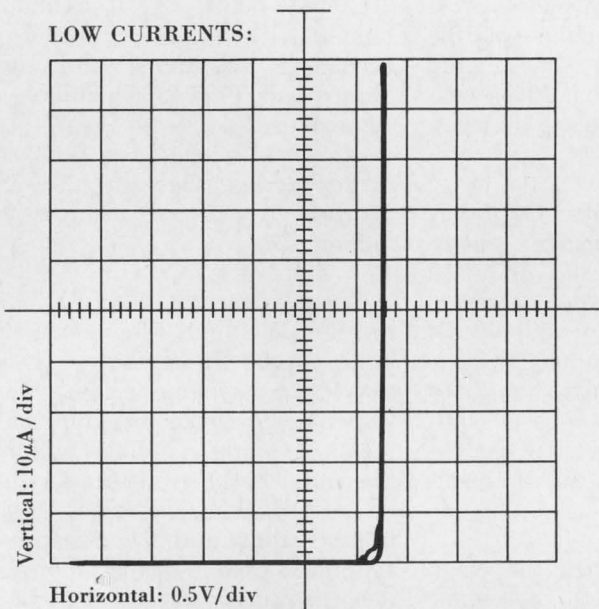
The idea isn't new, but Lockheed's will be the first operational system of this type. Giannini Controls (now Conrac) tried in 1964 to develop a similar system for the Apollo program but was unable to meet specifications.

If at first . . . This week NASA will launch the second of four Orbiting Astronomical Observatories. The shot comes about 30 months after the first OAO achieved orbit but failed in its second day because of malfunctions in the power supply and high-voltage arcing in the star-tracking apparatus. The second and more complex OAO has a completely redesigned battery-charging system. The star trackers have also been modified to prevent corona discharges and the high-voltage arcing. More sophisticated than previous U.S. unmanned satellites, OAO carries 11 optical telescopes.

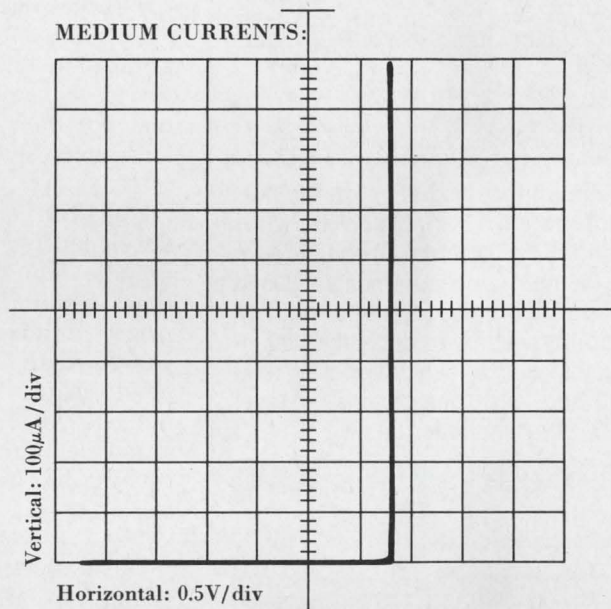
Evasive action. Trying to avoid antitrust action, IBM has trans-

The deflection plate aligner

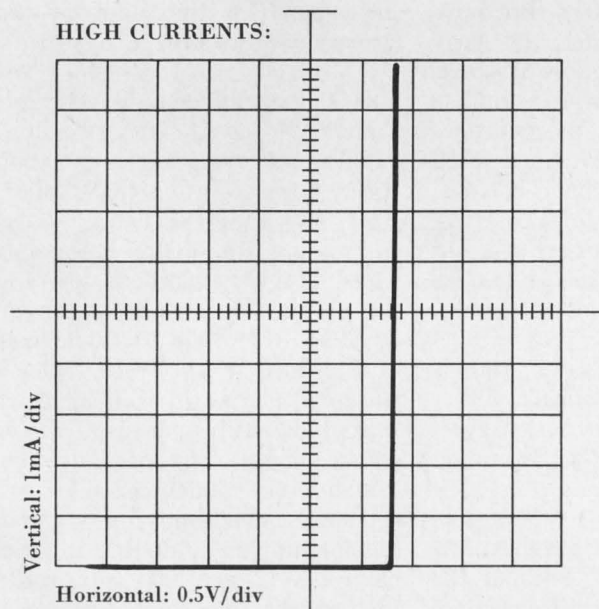
LOW CURRENTS:



MEDIUM CURRENTS:



HIGH CURRENTS:



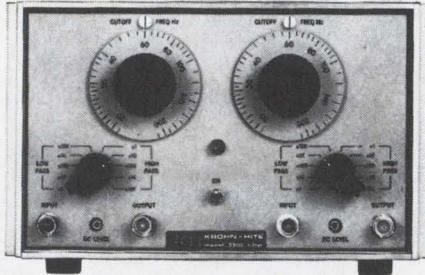
\$4.50 buys you the only zener that can give you these traces. At any of ten voltages from 5.6V down to 2.4V. Or all the way down to 2.2V, 2.0V and 1.8V if you insist. And the voltage you choose will typically vary 15mV from $100\mu\text{A}$ to 1mA (or 125mV over its full $10\mu\text{A}$ to 10mA range).

Ask for it by name—the LM103.

National Semiconductor

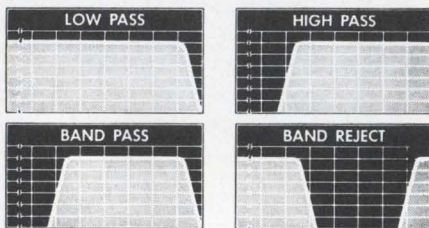
2975 San Ysidro Way, Santa Clara, California 95051. (408) 245-4320.

WITH **KH** ALL-SILICON
**MULTIFUNCTION
 VARIABLE FILTERS
 YOU GET MORE
 THAN HIGH-PASS and LOW-PASS
 PERFORMANCE**



MODEL 3202 provides continuously adjustable high-pass, low-pass, bandpass and band-reject functions over frequency range of 20 Hz to 2 MHz. Two-channel bench unit shown; 5¼" x 8½" x 15¼"-rack units available.

The unlimited flexibility of the K-H Multifunction Variable Filters is essential for complex frequency- or time-domain measurements. Don't settle for limited single-function capability when you can take advantage of K-H's two-channel Model 3202 or the one-channel Model 3200. See functions, below.



These responses are fully adjustable and may be set independently. This performance typifies the extra value you get from modern Krohn-Hite electronic instruments. Other values increase user confidence further by providing simpler, faster and lower-cost operation.

Functions: Low-pass — direct coupled with low drift. High-pass — upper 3 db at 10 MHz. Bandpass — continuously variable. Band rejection — Variable Broad Band or Null.

Two Response Characteristics: (1) fourth-order Butterworth or (2) simple R-C (transient free)

Zero-db Insertion Loss: all-silicon amplifiers provide "lossless" passband response. Steep (24 or 48 db per octave) attenuation slopes extend to at least 80 db.

90-db Dynamic Range: Low hum and noise (100 microvolts) eliminates costly preamplifiers.

Output Impedance: 50 ohms, or lower. There's more in K-H Data Sheet 3200/3202. Write for a copy.

KH KROHN-HITE CORPORATION
 580 Massachusetts Avenue, Cambridge, Mass. 02139
 Telephone: 617/491-3211

Electronics Review

ferred its time-sharing subscriber services from the Data Processing division to its independently operated subsidiary, the Service Bureau Corp. A 1956 antitrust consent decree prohibits IBM from operating a service bureau business as part of the parent company's operation.

Early last month it was learned that the Justice Department was investigating the possibility of taking legal action to force IBM out of the time-sharing business. Possibly related to the move was the accusation by other time-sharing service companies that IBM's centers got their computers at much lower prices.

Roll 'em. The Kalvar Corp. has developed a vesicular photographic film that's said to be 10 times faster than present counterparts, although it's still much slower than conventional silver-halide films. Vesicular film does not use silver; it is exposed with ultraviolet light, and is processed by heat and light instead of chemicals.

Dash dashed. When the Navy started its unmanned helicopter program, called Dash, it expected the drones to be able to hunt down and destroy submarines. But now, some seven years later, the Navy admits that the program has been something less than a complete success; in fact, no more drones will be bought. So far, more than 230 of the choppers have crashed, many after only a few hours of total flying time, at a cost of about \$25 million. The crashes have been attributed to avionics problems. Often, says the Navy, the craft respond to spurious radio signals and end up in the drink. Other failures were laid to faulty gyroscopes, altimeters, or decoding equipment.

Laser in the field. Hughes Aircraft, which in 1960 became the first firm to demonstrate laser action, received a \$2.7 million Army contract to produce laser range finders for the M-60 tank. Hughes says the devices will be the first completely militarized lasers.

Vin automatique. That little ol' wine maker is remote controlled at the Pleasant Valley Wine Co. The Hammondsport, N.Y., winery has installed an electronic system to handle all processing from the time the grape juice leaves the presses. It controls temperatures, blending, fermentation, racking, clarification, filtering, storing, and bottling. The wine is sold under the trade name Great Western.

Comsat gains. The Communication Satellite Corp. reported an earnings surge in the first three quarters of 1968 to \$5 million, or 50 cents a share, from \$2.8 million, or 29 cents a share, in the year-earlier period. Operating revenue climbed to \$22 million from \$12 million.

Crystal growing. Tyco Laboratories of Waltham, Mass., says that under an Air Force contract it has developed a technique for producing single-crystal sapphire filaments as long as 100 feet. The filaments can be grown in a variety of shapes—thin and thick tubes, ribbons, rods, and T's. Because of sapphire's unique dielectric properties, the processed crystal might be useful in lasers and fiber optics, and as a substrate for thin-film circuits or a base for the epitaxial overgrowth of silicon for IC's.

3-D in sequence. Holographic "movies" have been made at Hughes Aircraft's research laboratories with a system that's said to have 10 times the energy output of previous stop-action holographic units. Hughes scientists use a giant-pulse ruby-laser oscillator and amplifier that delivers 30-nanosecond pulses at up to 10 joules to produce a stream of images; the output is fully coherent at full pulse energy. The oscillator is a 4-inch-long, ¼-inch-diameter ruby rod sandwiched between two linear flash lamps in a double elliptical cavity. A 12-inch-long ruby rod ⅝ inch in diameter and pumped by four linear flash lamps makes up the amplifier. The system's maximum peak power output is 300 milliwatts. The oscillator has a 3-milliwatt output.

From the leader in
Epitaxial Reactors
 and Cold Wall Furnaces



Only Hugle Industries offers you this large range of models, then makes them available in either semi-automated or fully automated modes. The automatic units feature our exclusive HI integrated circuit process controller. Software and installation are furnished free with these models.

Choose the model and mode that suits your operation.

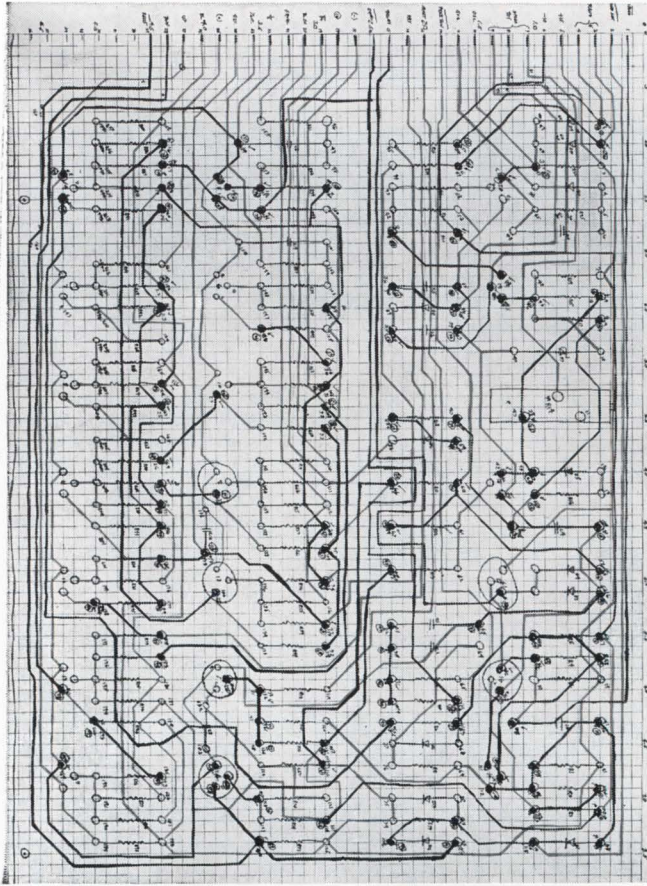
HIER I	14-1" wafers or 4-2" wafers	HIER IV	60-1" wafers or 12-2" wafers
HIER II	25-1" wafers or 4-2" wafers	HIER VI	85-1" wafers or 18-2" wafers
HIER III (Thin Film)	14-1" wafers or 4-2" wafers	HIER VII	108-1" wafers or 27-2" wafers
And Our Newest Addition . . .		EPI GRANDE (Barrel)	140-1" wafers or 40-2" wafers

Other Hugle Industries' products include: Diffusion Doping Systems D100 Series Epitaxial Doping Systems Model 100 Infrared Microscope Model 1300 Ultrasonic Wire Bonder Model 1400 Beam Lead Bonder Model 2000 Flip Chip Bonder PCD Process Controller.

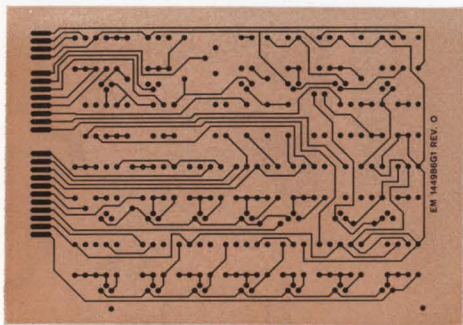
Call Mr. Dave Davis, Marketing Manager, at (408) 738-1700 for further information.



HUGLE Industries



complete
PC film masters
direct from
engineering sketch...



FROM SKETCH TO ETCH IN 8 HOURS

or less! The SLO-SYN Photo-Optical Positioner System slashes $\frac{4}{5}$ of manual preparation time . . . guarantees error-free negative or positive film masters up to 12" x 18".

. . . positive control of every PC board production step is punched on tape . . . allowing duplicate film masters to be made at any time.

Fast, accurate and versatile . . . this basic tape program is used to prepare tapes for drilling and even eyelet and component insertion. Positioning accuracies to $\pm .001''$.

Get all the facts on how this unique positioner system can drastically reduce PC board production time . . . and increase your profits!

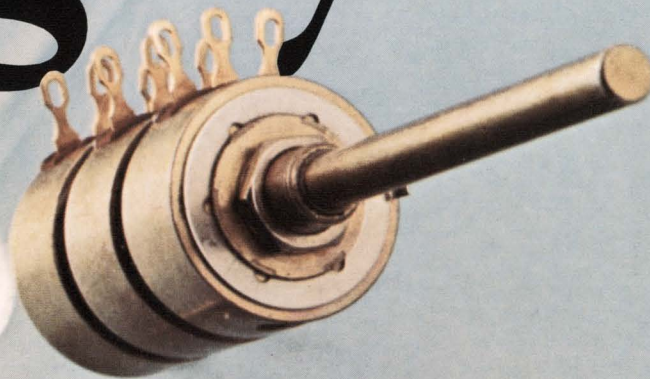
Call, write or wire:



**THE
SUPERIOR ELECTRIC
COMPANY**

405 Middle Street
Bristol, Connecticut 06010
Telephone: 203/582-9561
Field Engineering offices in principal cities

Tough guys



These variable resistors and trimmers from PEC are the tough guys. Tough electrically. Tough mechanically. Actually exceed mil specs. Designed to take it. Tested to prove it.

Insensitive to thermal shock and vibration. PEC potentiometers are hot-molded by an exclusive process incorporating resistive element, insulator, and collector in a rugged integral unit.

Heavy terminals, insulated supporting base and a bridging contact brush of honed carbon resist mechanical damage, thus assuring circuit integrity.

PEC's new metal ceramic trimmers are made from a specially developed material guaranteeing excellent temperature coefficient characteristics and resetability. These multi-turn trimmers offer infinite resolution and are tough enough to stand extended cycling without degradation.

If you're meeting tough specs with products destined for a tough life... call on PEC for tough guys to help.



From the passive innovators at PEC Ltd.

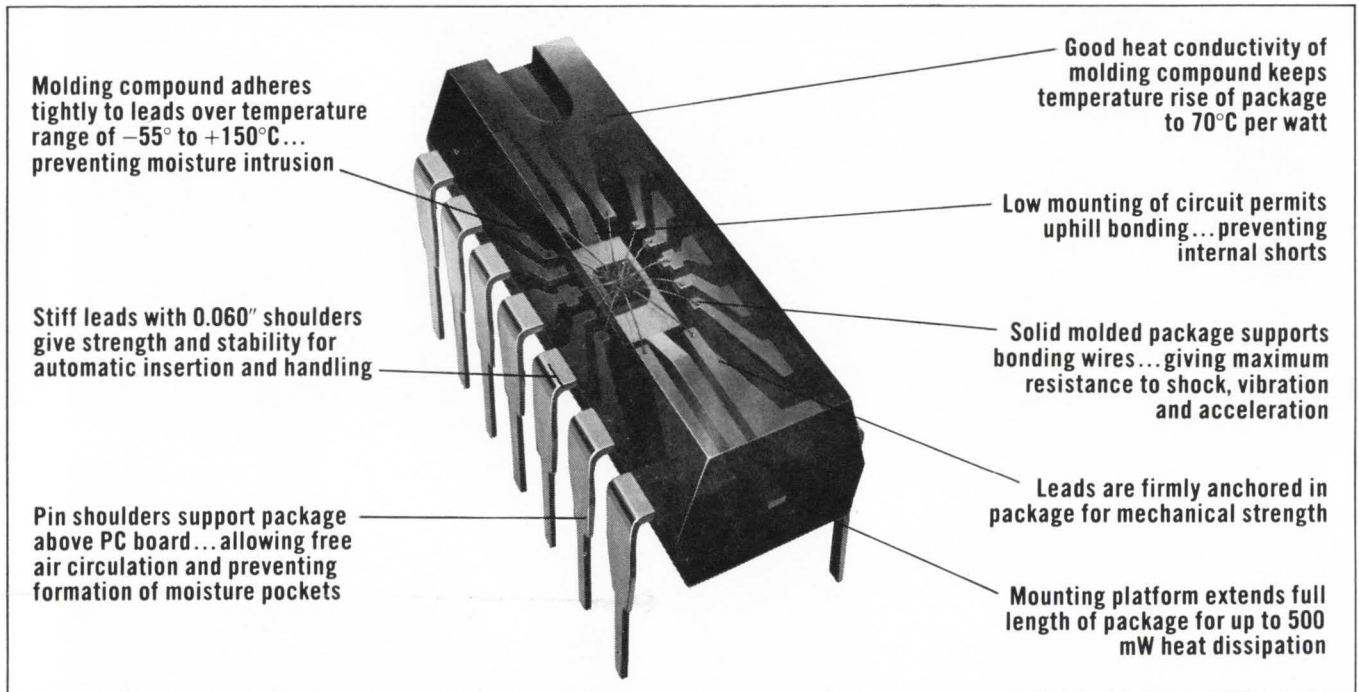
AN AFFILIATE OF **AIRCO** Speer Electronic Components



PRECISION ELECTRONIC COMPONENTS LTD., manufacturers of variable resistors and trimmer potentiometers.
Bradford, Pa. 16701 (814) 362-5536; 19 Hafis Road, Toronto, Ontario (416) 241-4491

20,000,000 customer-proven TI plastic ICs are doing their job...

more are available now to do yours...
from DEECO



If your plans call for economical, reliable plastic integrated circuits, don't settle for substitutes...get TI plastic. We carry large stocks of TI plastic ICs—TTL, DTL, and linear—so we can fill your orders promptly.

You don't have to worry about reliability when specifying *TI* plas-

tic. Over 1500 customers have purchased more than 20 million circuits in three years. This user experience has been so satisfactory that TI plastic is the industry's fastest growing package design.

Ideal for industrial/commercial applications and preferred for a growing number of military/avi-

onic projects, TI plastic ICs are stocked in depth for industrial and military temperature ranges.

If you need prices or delivery information, call us direct and get quick answers to your questions. For a documented report on plastic IC reliability, circle 230 on the reader service card.

DEECO  **Inc.**

DISTRIBUTORS — SERVING INDUSTRIALS EXCLUSIVELY

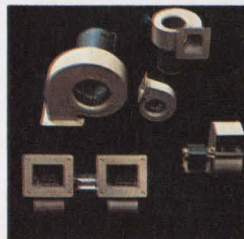
618 FIRST STREET N. W. • CEDAR RAPIDS, IOWA • PHONE 319 365-7751

AUTHORIZED
DISRIBUTOR 

Moving air is easy . . . controlling it takes an expert



Clearing a path in traffic is seldom a problem for the trucker who has mastered the dock-walloper's whistle. Ear-splitting in its audibility, that shrill, sharp blast says "Move it Mac" with an authority few mortals would care to dispute. It figures. Anyone capable of channeling air with such finesse has little trouble communicating with even the most literal-minded audience. Take Torrington's team of engineers. When it comes to controlling the movement of air, they're experts at making themselves understood. The language they talk is pure CrossfloTM, centrifugal, vane- or tube-axial. Got a big or small air flow problem requiring straight interpretation? We've got the specialists to help you. The Torrington Manufacturing Company.



TORRINGTON

United States: Torrington, Conn./Van Nuys, Calif./Rochester, Ind. Canada: Oakville, Ont. England: Swindon, Wilts. Belgium: Nivelles Australia: Sydney

Circle 79 on reader service card



New flame resistant **GLASKYD[®]** **7100 FR**

Alkyd Molding Compound

for economical high performance connectors

This card-edge printed circuit connector won't singe your reputation.

Made with GLASKYD 7100 FR, it's replacing DAP for some mighty good reasons. Point 1—it provides comparable wet electrical properties at a much lower material cost. Point 2—it's economical in other ways, too. In slug form, its fast molding cycle increases production significantly. Point 3—it has low weight loss at elevated temperatures and permanent flame resistance exceeding normally accepted requirements. So specify New

GLASKYD 7100 FR alkyd molding compound over DAP for savings and quality right down the line.

Among the many types of GLASKYD available, chances are there's a GLASKYD molding compound that will meet your needs . . . for flexural strength, impact strength, arc resistance, low water absorption, flame resistance, heat resistance, dimensional stability, and many more advantages. Write today for technical brochure to American Cyanamid Company, Plastics Division, Wallingford, Connecticut 06492.

CYANAMID

SALES OFFICES IN: CHARLOTTE • CHICAGO • CLEVELAND • DALLAS • DETROIT • LOS ANGELES • MINNEAPOLIS
OAKLAND • PHILADELPHIA • TUKWILA, WASHINGTON • WOODBRIDGE, CONNECTICUT • ALSO AVAILABLE IN CANADA.

You Supply the Light — Centralab Optoelectronic Devices Will Control:

object counters • punched tape readers • card readers • position indicators • object orienting equipment • liquid level indicators • optomechanical programmers • analog to digital converters • recognition equipment • precision motor speed • film sound track pickups • automatic illumination • TV automatic brightness • exposure meter and aperture • burglar alarms and security systems • doors • infrared detectors • X-ray • ultraviolet • flame failure detectors • smoke and fire detectors

Consult Centralab in the early stages of your design to see how photovoltaic, photoconductive and photoemissive sensors can be used. You'll be assured of a degree of control not possible through other methods. Centralab has experience in all the areas listed above and our devices feature advanced designs and fabrication techniques developed as the world's largest producer of solar cells. If Centralab is there during the planning stages, we can lighten your load.

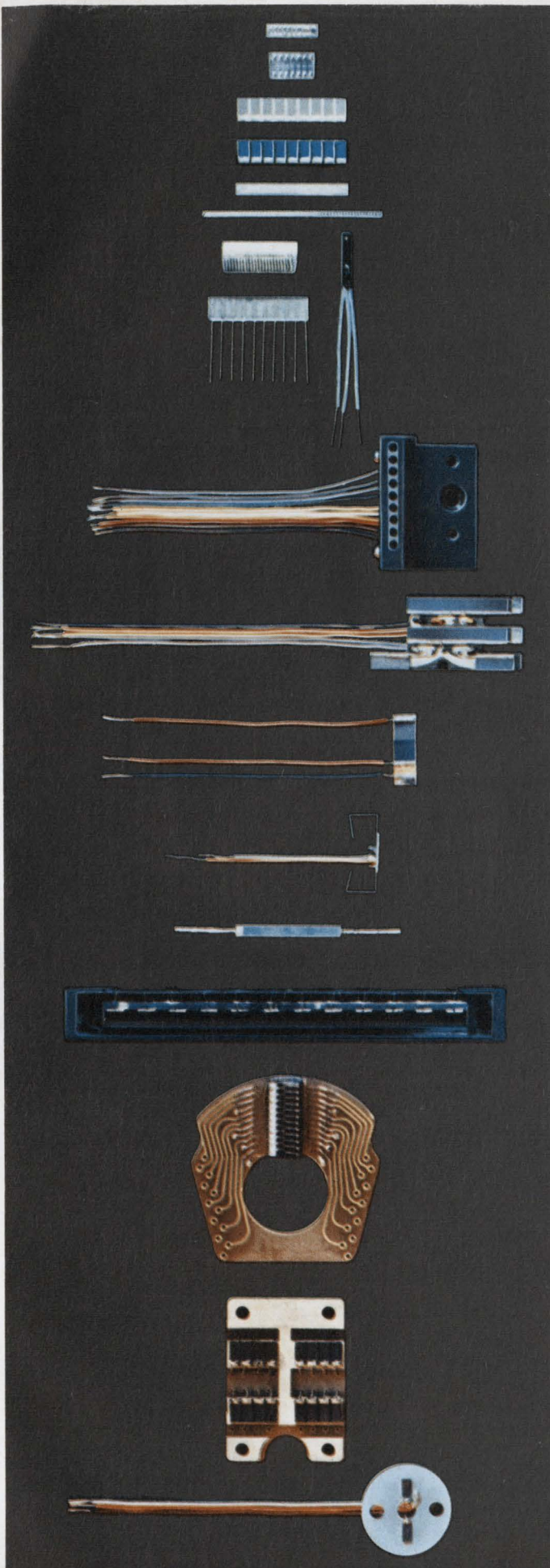
For more information and a comprehensive catalog on our optoelectronic devices, write Centralab Application Engineering Today.

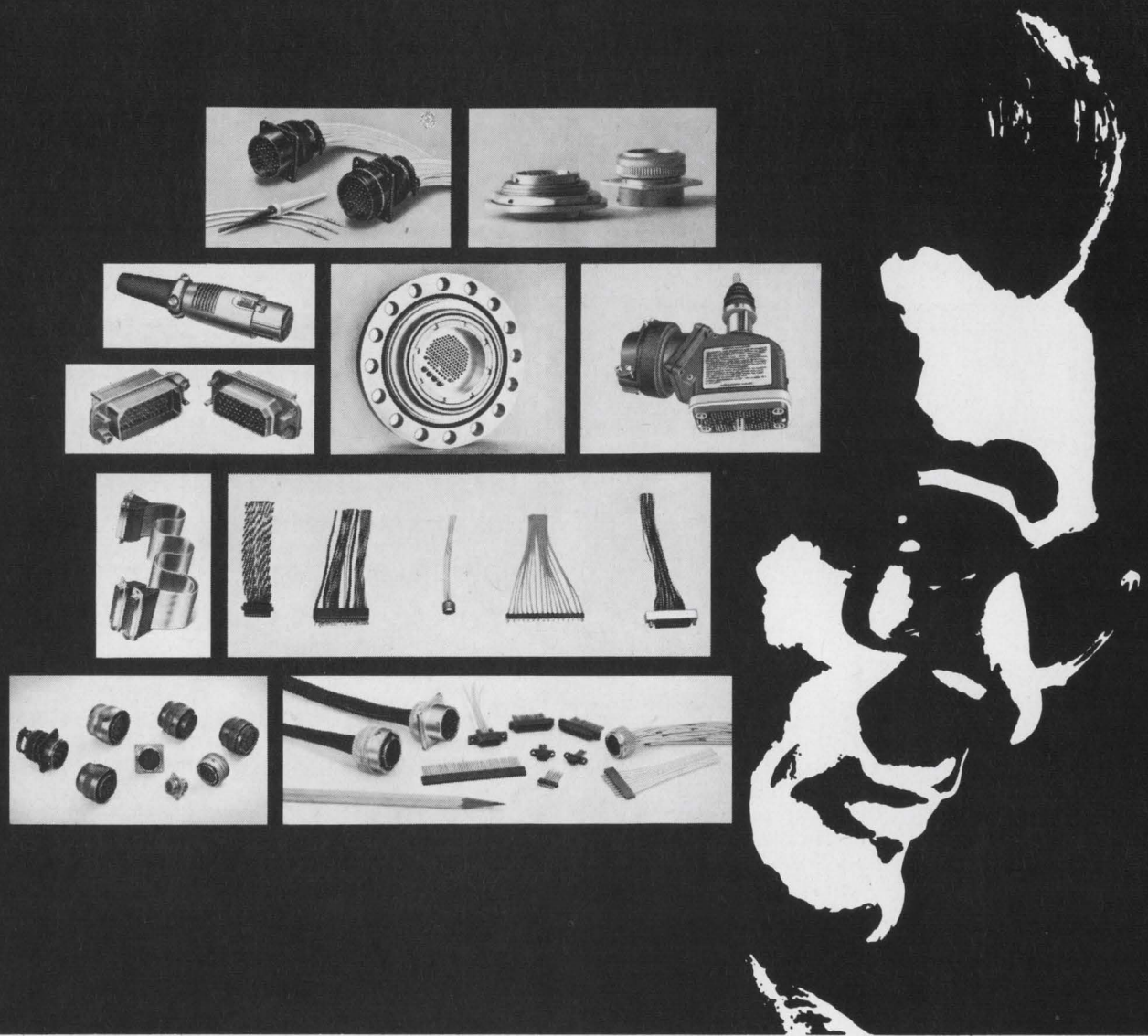


CENTRALAB

Electronics Division
GLOBE-UNION INC
5757 NORTH GREEN BAY AVENUE
MILWAUKEE, WISCONSIN 53201

M-6829





What you can imagine...ITT Cannon provides.

We've pioneered every important stage in connector design.

Imaginative engineering that's unmatched in the industry distinguishes ITT Cannon connectors as the standard for reliability in space vehicles, ground support equipment, or any application where highly engineered connectors are paramount requirements.

Backed by a rigorous reliability program, including identification and traceability when required, ITT Cannon offers the widest

selection of connectors available — for every application and environment — microminiature, subminiature, miniature, and standard to solve every conceivable connector problem such as hermetic sealing, heat, radiation, shock, vibration, non-outgassing.

ITT Cannon is also the foremost supplier of special, highly engineered connectors for missiles and space vehicles, including breakaway-umbilicals, interstage disconnects, harnesses,

and associated equipment. If you have a special requirement, contact ITT Cannon, the world's most experienced and imaginative manufacturer of electrical connectors.

Write for our "Connector Selection Guide." ITT Cannon Electric, 3208 Humboldt Street, Los Angeles, California 90031. A division of International Telephone and Telegraph Corporation.



CANNON ITT

whatever direction
your design takes...

Allen-Bradley thick film networks will put you out front in...

Packaging—Advanced manufacturing capability covers virtually every type and every configuration of resistive and/or capacitive networks—single or dual in-line, as well as flat-packs, with or without hermetic sealing.

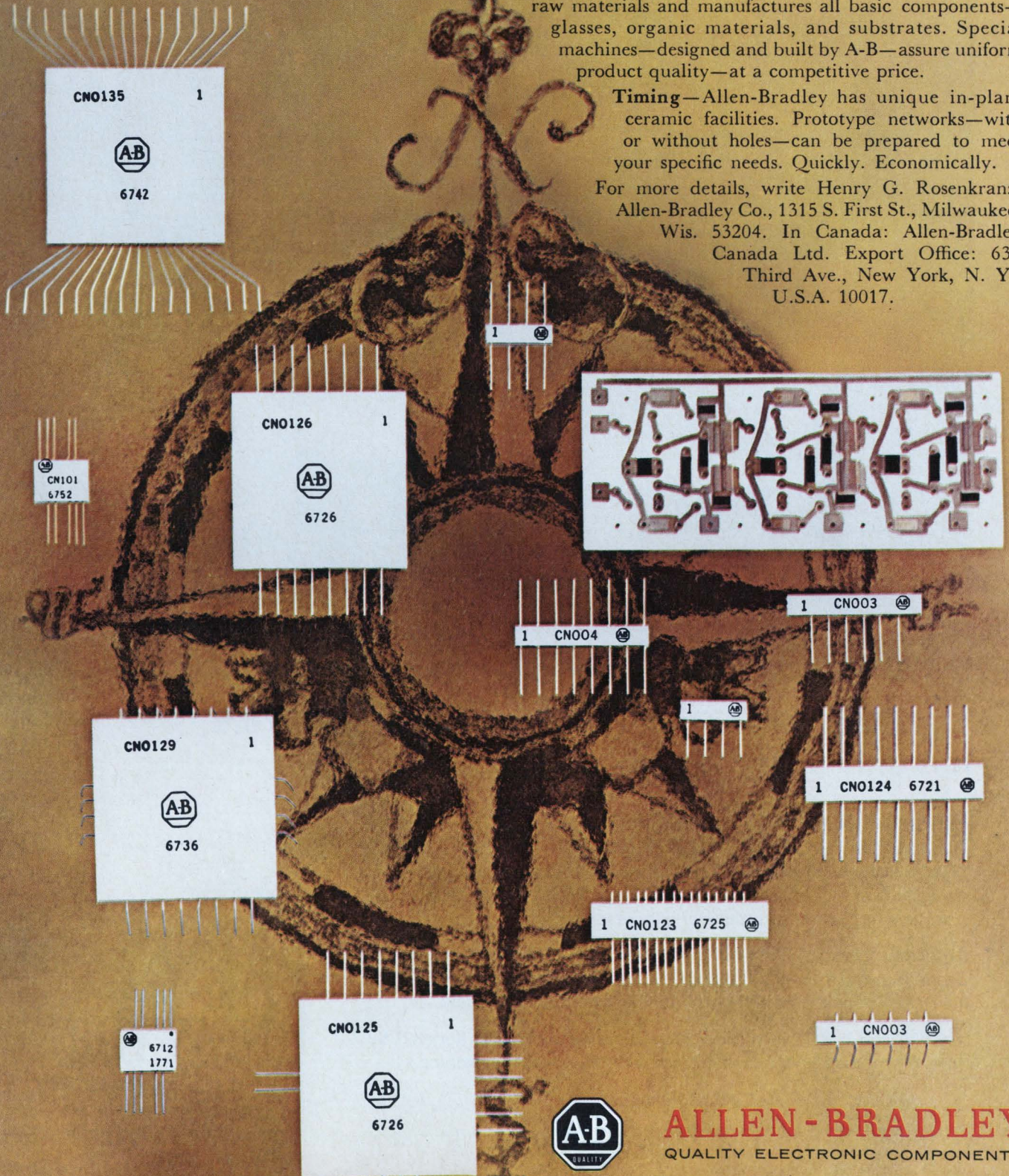
Characteristics—Exclusive and patented formulations enable A-B to provide resistance values from 1 ohm to 5.0 megohm. Ratings to 20 watts/in² at 85°C. Capacitance values from 10 pfd to 0.5 mfd with voltage ratings to 50 volts. Applications include precision tuned circuits.

Performance—Standard resistance tolerance $\pm 10\%$. For critical circuitry, tolerances to $\pm 0.1\%$ can be furnished—with resistances and TC's matched. Temperature coefficient less than 250 ppm in all cases. Special units to 100 ppm or less. Load life stability of 1% in 10,000 hours can be achieved.

Reliability—Allen-Bradley has precise control over all raw materials and manufactures all basic components—glasses, organic materials, and substrates. Special machines—designed and built by A-B—assure uniform product quality—at a competitive price.

Timing—Allen-Bradley has unique in-plant ceramic facilities. Prototype networks—with or without holes—can be prepared to meet your specific needs. Quickly. Economically.

For more details, write Henry G. Rosenkranz, Allen-Bradley Co., 1315 S. First St., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd. Export Office: 630 Third Ave., New York, N. Y., U.S.A. 10017.



ALLEN-BRADLEY
QUALITY ELECTRONIC COMPONENTS



**we
know
the
game**

The Electronics Group of The Bank of New York has only full time industry specialists.

If your needs involve financing, corporate or product development, mergers, acquisitions, stockholder relations, options, pensions or other considerations, no one is better equipped than our full time "electronics bankers" to assist you in finding the solutions for continued growth and increasing profits.

On a comprehensive, first-hand level, the officers in our Electronics Group, Special Industry Banking Division, have a unique ability to give your company the most experienced attention in the field.

Ask yourself if you can afford to have your financial needs handled by other than a banker who concentrates exclusively in Electronics.

... a specialist from The Bank of New York

Write for our new Electronics Group booklet.

**THE
BANK
OF
NEW YORK**

ELECTRONICS GROUP

Special Industry Banking Division

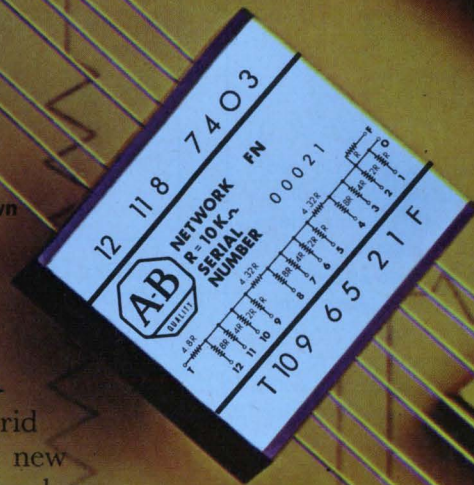
48 Wall Street • New York, New York

ALLEN-BRADLEY
Metal-Grid resistor networks
combine a new measure of

precision, stability and performance in a sealed, compact package



Precision Metal-Grid resistor network shown
approximately 1½ times actual size



The advanced capabilities—developed from years of manufacturing Allen-Bradley Metal-Grid resistors—are now applied to a new line of resistor networks. This technology enables the production of complex resistive networks on a single substrate.

Allen-Bradley's exclusive simultaneous deposition method is used to obtain the best resistance tolerance and temperature coefficient matching. The reliability of interconnections on the common resistance plane is incomparable. Uniformity and quality are inherent in A-B networks. To illustrate, 2 PPM temperature tracking is normal.

A-B Metal-Grid networks offer a wide range of values—with individual resistances as low as 25 ohms and as high as 2.0 megohms. Both the inductance and capacitance are low, permitting efficient operation at high frequencies.

A-B engineers will be pleased to cooperate in developing networks for your specific need. For additional details, please write to Henry G. Rosenkranz, Allen-Bradley Co., 1315 S. First Street, Milwaukee, Wisconsin 53204. In Canada: Allen-Bradley Canada Ltd. Export Office: 630 Third Avenue, New York, N. Y., U.S.A. 10017.

BRIEF SPECIFICATIONS

Resistor Networks

Tolerances: $\pm 1.0\%$ to $\pm 0.01\%$
Resistance Matching: to 0.005%
Temperature Range: -65°C to $+175^{\circ}\text{C}$
Temp. Coef.: to ± 5 ppm/ $^{\circ}\text{C}$
Load Life (Full load for 1000 hr @ 125°C): 0.2% maximum change

Ladder Networks

Full Scale Accuracy: 10 bits or less, better than $\pm \frac{1}{4}$ least significant bit. More than 10 bits, better than $\pm \frac{1}{2}$ least significant bit.
Frequency Response: Less than 100 nanosecond rise time or settling time
Temp. Coef.: Less than 10 ppm/ $^{\circ}\text{C}$
Temperature Range: -65°C to $+175^{\circ}\text{C}$

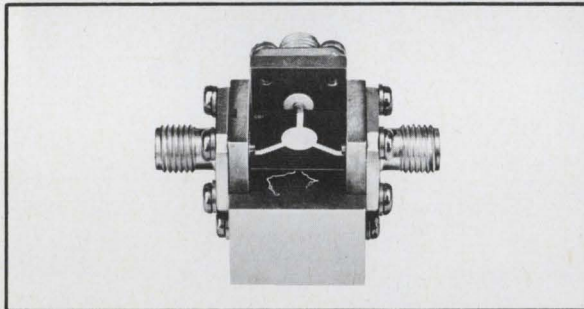
ALLEN-BRADLEY
QUALITY ELECTRONIC COMPONENTS

PACT cuts losses in latching microstrip circulators 80% in twelve months

Engineers at work in Sperry's PACT (Progress in Advanced Component Technology) Program have announced outstanding success in an intensive 12-month campaign to cut insertion losses of external loop latching microstrip circulators.

When the effort began, the loss figure was 2.5 db at X-band; today, Sperry has built external loop latching circulators with insertion loss of only 0.5 db at the same frequency.

PACT's latching circulator work actually began with an internal loop configuration. YIG substrates were prepared with loops of .005" and .010" platinum wire fired in place. Test data were taken at substrate thicknesses of .100", .075" and .055". Results showed that, while fixed bias performance improved as thickness decreased, other factors caused latching performance to deteriorate.

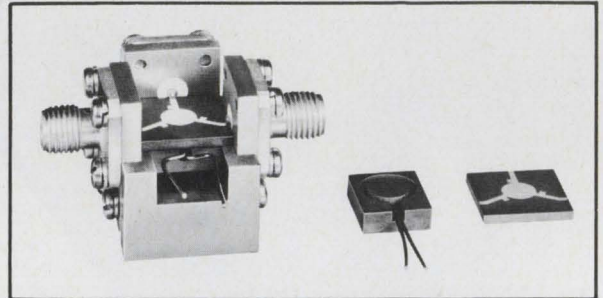


INTERNAL LOOP X-BAND LATCHING CIRCULATOR

While the test results obtained with the internal loop device were generally satisfactory, PACT engineers felt that the configuration had some inherent disadvantages. Among these were difficulty and expense of fabrication, and unsuitability for use in modules. This led to extensive investigation of the external loop design.

PACT personnel found one immediate advantage: when working with external loop, they could consider the substrate and the latching plate independently. Intrinsic and physical properties of the substrate material could be chosen for good

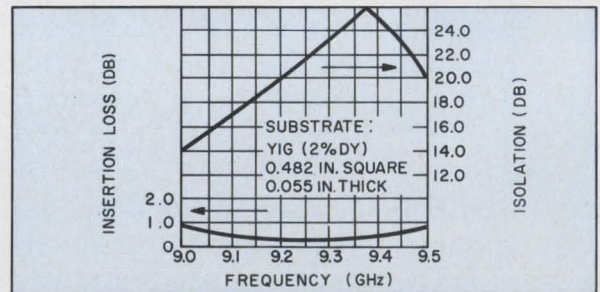
microwave performance, while latching plate design need only consider hysteresis and other switching parameters.



EXTERNAL LOOP X-BAND LATCHING CIRCULATOR, WITH LATCHING PLATE AND SUBSTRATE SHOWN SEPARATELY

Since temperature and high power stability are prime design parameters, the program settled on a design using .482" square x .055" thick hybrid YIG substrate. Lithium ferrite — a material with saturation magnetization of about 3500 gauss, a coercive field of 2.0 oe, and a very square hysteresis loop — was chosen for the latching plate. The switching loop was four turns of #24 copper wire.

Using this configuration, PACT engineers have achieved switching times of less than 1 microsecond, with performance as indicated in the accompanying curve.



PERFORMANCE OF EXTERNAL LOOP LATCHING CIRCULATOR

For further information about PACT work on latching microstrip circulators and their coming application in microwave IC's, contact your Cain & Co. Representative, or write Sperry Microwave Electronics Division, Sperry Rand Corporation, Clearwater, Florida.

*For faster microwave progress,
make a PACT with people
who know microwaves.*

SPERRY
MICROWAVE ELECTRONICS DIVISION
CLEARWATER, FLORIDA

Washington Newsletter

November 11, 1968

**'McNamara line'
probably had role
in bombing halt . . .**

Electronics probably played a major role in President Johnson's decision to stop all bombing of North Vietnam. It appears that U.S. field commanders went along with the halt because of the successful operation of the top-secret "McNamara line"—the electronic guard along the demilitarized zone [Electronics, Sept. 18, 1967, p. 52]. The sensor network enables them to keep track of troop and supply movements into the south. The makeup of the network has been kept so secret that, according to one anti-intrusion radar manufacturer, "We don't even know what we're doing for it." Several code names are said to be used in procuring equipment.

The system consists of many short links because most sensors operate best at short range. Sensors had to be operational last year when the go-ahead was received to build the top-priority line. An elaborate telemetry network links every sensor—many kinds are used in a random mix—to a control station. Sensors that were available for the net included active-infrared, seismic, pressure, magnetic-strip, acoustic, and simple breakwire devices [Electronics, Aug. 7, 1967, p. 46].

**. . . and Army eyes
new tactical radar**

Though the "McNamara line" apparently is working well with existing sensors, the Army is moving toward a major procurement of new portable tactical radars for battlefield surveillance and infiltration detection.

Designated AN/PPS-9 and AN/PPS-10, the 10-pound radars are now being field-tested in Vietnam and are reported to be meeting military requirements. Both General Dynamics Electronics and RCA have delivered units for the tests, but a half-dozen or more manufacturers will compete for production orders, estimated at \$15 million or more in this fiscal year.

**Mariner-Mars may
take on a new look**

NASA's 1973 Mariner-Mars missions appear to be undergoing significant changes in emphasis. The program fared so poorly in the fiscal 1969 budget that space agency officials apparently feel that they might as well start again from scratch.

As originally proposed, the probes were to have culminated in rough landers, but NASA's Langley Research Center has just been briefed by firms doing study work, and it's known that soft landers are being seriously considered.

The space agency would like to use Titan 3C boosters for these missions and for other launches, including the ATS-F and G. It will try to get them by joining forces with the Air Force in the budget scramble; the rationale is that both will stand a better chance of success if they submit their requests for the rocket as a single volume order.

**Tacsatcom, DSCS
may be consolidated**

Pentagon planners are now seriously considering combining the third-generation Defense Satellite Communications System (DSCS) and the next stage of the Tactical Satellite Communications program into a single global system. The DSCS was originally envisioned as a system of small satellites relaying strategic trunkline traffic to large ground stations, while Tacsatcom plans call for a big satellite and small tactical ground terminals. But these distinctions have been blurred in second-

Washington Newsletter

phase DSCS designs, which slate spacecraft about as powerful and complex as the Tacsatcom's [Electronics, July 8, p. 64].

Design of the next generation of Tacsatcom and DSCS satellites will begin early next year, or soon after the contract for the second-generation DSCS is awarded. It's also possible that the Defense Department will simply add to DSCS-2 as the need arises, replace the entire system, go ahead and build two separate systems, or use the two for both tactical and strategic communications.

The present timetable gives the Pentagon ample time to decide. The **Air Force Space and Missile Systems Organization will receive contractor proposals for the DSCS-2 in two weeks.** The \$100 million-to-\$200 million award, expected as early as February, will cover six stationary satellites, including backups. Delivery is expected 22 months after award. The experimental Hughes-built Tacsat is to be launched next year.

Added Nimbus job proposed by IBM

An additional mission that could lead to more accurate weather forecasts has been proposed for the Nimbus program of experimental meteorological satellites. IBM gave NASA an unsolicited proposal to study the space hardware needed to chart cloud motion on a global basis. Such information could be used to make a worldwide index of wind velocity. Meteorologists say the index could improve forecast accuracy for periods up to two weeks.

One problem, however, is that the plan would require four satellites. A NASA official points out that the Nimbus program is unlikely to have more than two spacecraft up at once, even though four launches are scheduled in the next four years. Other craft, such as future Applications Technology or ESSA satellites, would have to be used.

Television cameras and infrared radiometers on the satellites would send data to the ground for analysis by a digital computer. IBM suggests low-orbiting craft but points out that synchronous types could be used.

Army will choose PWI system soon

The Army expects to choose soon—possibly this month—between Bendix and Honeywell designs for a lightweight pilot warning indicator (PWI) for slow aircraft. Five firms originally submitted off-the-shelf units for evaluation at Ft. Rucker, Ala., but the Motorola, Goodyear, and Melpar entries washed out.

Designed for use with the TH-13 training helicopter, the 8-to-10-pound PWI's use either vhf or doppler radar signals to give pilots both audio and visual warnings of other craft within 2,000 feet of them. **The units could also be used in civilian aircraft.**

Addenda

The Navy has received Pentagon permission to complete its Omega navigation system by adding four stations to four already in operation. The new very-low-frequency shore-based transmitters will be situated in the areas of the western Pacific, Tasmanian Sea, and Indian Ocean, and in southern South America; they should be operational by late 1972. The U.S. will receive some foreign financial support for the system, which could be used by commercial vessels as well as warships. . . . The Army is again considering Ryan Aeronautical's AN/APN-182 doppler radar navigator. The set was bought by the Navy for ASW helicopters but has twice flunked Army tests.

0-20Vdc @ 1000A

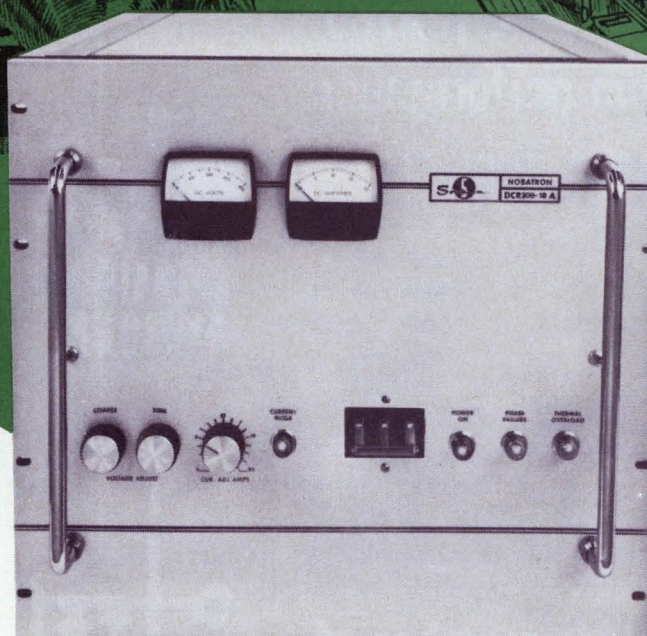
0-150Vdc @ 70A

0-150Vdc @ 35A

0-300Vdc @ 35A

0-300Vdc @ 18A

0-600Vdc @ 18A



New Sorensen High Power DCR's:

The addition of 6 new models now brings the total number of Sorensen regulated, high power, high efficiency DCR's to 34—the widest product line from the industry's leader in both DC and AC power supply technology and production.

The DCR Series covers the voltage ranges of 0-20/0-40/0-60/0-80/0-150/0-300/0-600/ and even up to 6000Vdc at power levels of 400, 800, 1500, 2400, 5000, 10,000 and 20,000 watts. And—Sorensen's 25 years experience in design and manufacture makes it possible to offer these power supplies from stock at prices as low as 19¢/watt.

The DCR Series offers all of the standard features found in state-of-the-art power supplies including Voltage/Current Regulation,

Low Ripple, Remote Programming, Remote Sensing, Operating Temperatures to 71°C and compliance with MIL-I-26600 and MIL-I-6181D.

FREE! An illustrated data package containing detailed electrical and mechanical specifications for each DCR power supply and a new CATALOG featuring 176 different Sorensen regulated DC and AC power supplies.

Contact your local Sorensen representative or Raytheon Company, Sorensen Operation, Richards Avenue, Norwalk, Connecticut 06856. TWX 710-468-2940

RAYTHEON

for more data on this versatile instrument . . . **Call Sorensen: 203-838-6571**

If you don't know the μ A709 has been replaced, we have a little surprise for you: The μ A741.

The μ A741 is the only monolithic operational amplifier that has frequency compensation built right on the chip. It's a pin-for-pin replacement for the μ A709. An improvement in performance without an increase in price:

Differential Input Voltage	$\pm 30V$ min.
Offset Current	200nA max.
Offset Voltage5mV max.
Input Resistance300k min.
Output Swing	$\pm 12V$ min.
Power Dissipation	5mW with $\pm 5V$ supplies typ.
No latch-up when the common mode range is exceeded.	
Package	hermetic DIP
Order Number	U6E7741393
Price	\$3.25 (100 up)

The μ A741 is a key member of Fairchild's family of Second Generation linear integrated circuits. Basic building blocks for virtually any linear application. New devices with better component matching, better specifications, increased chip size and higher complexities.

31

Starting October 9, 1967, Fairchild promised to introduce a new integrated circuit each week for 52 weeks. This is number

μ A741 FREQUENCY COMPENSATED OPERATIONAL AMPLIFIER

The μ A741 is a monolithic operational amplifier with built-in frequency compensation. It's the successor to the μ A709 and a pin-for-pin replacement for it. Performance characteristics of the μ A741 far exceed those of the μ A709. But, the two devices are comparably priced.

The μ A741 has a wide differential input voltage range of $\pm 30V$. There's no latch-up when the common mode range is exceeded. Offset current is 200nA and offset voltage is 5mV. Input resistance is 300k and output swing is $\pm 12V$. Minimum open loop gain is 50,000. Power dissipation is only 5mW with $\pm 5V$ supplies. A 10k-ohm potentiometer is all you need to zero the input offset voltage. The adjustment range is $\pm 25mV$ without degrading common mode or power supply rejection. And, there's no internal positive feedback to cause transfer function hysteresis.

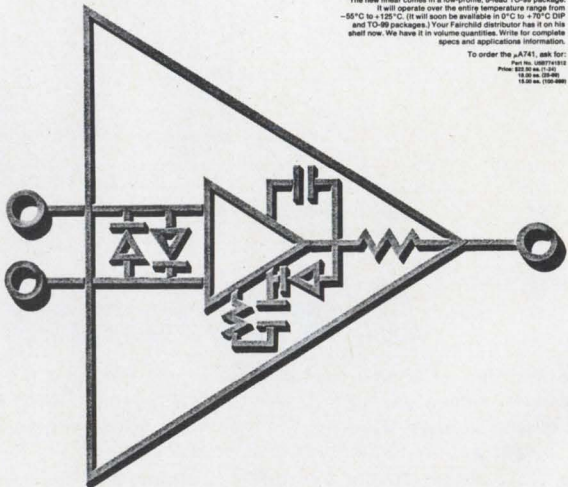
You don't need stabilization components for closed loop operation because the μ A741 has internal frequency compensation. (The compensation circuitry includes a 30pF MOS capacitor.) The amplifier can withstand indefinite short circuits to ground or supplies because the output stage is current limited.

The μ A741's excellent stability and performance characteristics are the result of proven, monolithic high-yield processes used in the production of all Fairchild Second-Generation linear integrated circuits. It's actually the third Second-Generation linear IC we've introduced this year. (Other members of the family include the μ A722 Programmable D/A-A/D Converter Current Source and the μ A727 Temperature-Controlled Differential Preamp.)

You can use the μ A741 any place the μ A709 can be used. And, many places where the μ A709 can't be used. The μ A741 can function as an integrator, differentiator, summing amplifier, voltage follower or comparator in such applications as airborne fire control systems, process control systems, analog computers and ground support systems.

The new linear comes in a low-profile, 8-lead TO-98 package. It will operate over the entire temperature range from $-55^{\circ}C$ to $+125^{\circ}C$. (It will soon be available in $^{\circ}C$ to $+70^{\circ}C$ DIP and TO-98 packages.) Your Fairchild distributor has it on his shelf now. We have it in volume quantities. Write for complete specs and applications information.

To order the μ A741, ask for:
Part No. U6E7741
Price \$3.25 (100 up)
100 up, \$280

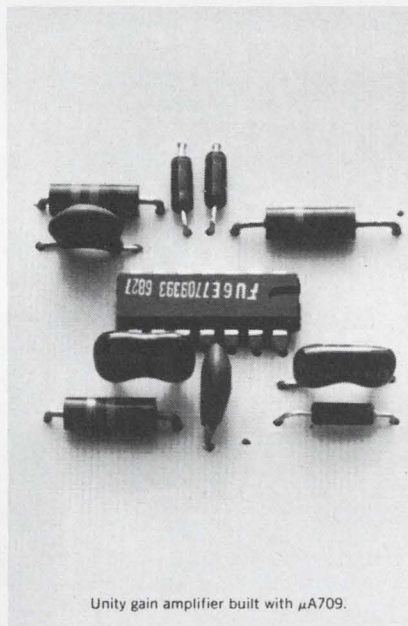


FAIRCHILD

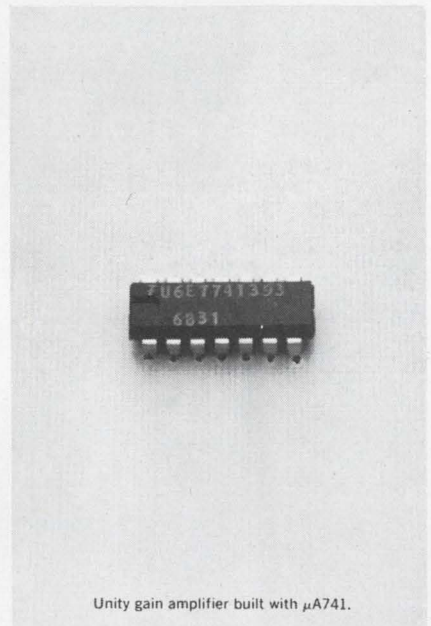
FAIRCHILD SEMICONDUCTOR A Division of Fairchild Camera and Instrument Corporation

375 Fairchild Drive, Mountain View, California 94035, (415) 961-0111 Telex: 232-674-0000

Other members of the family include the highly versatile μ A723 Precision Voltage Regulator, μ A727 Temperature-controlled Differential Preamp, μ A733 Wide Band Differential Amp-



Unity gain amplifier built with μ A709.



Unity gain amplifier built with μ A741.

lifier and the μ A722 MSI Programmable D/A - A/D Converter Current Source. Compare our Second Generation Linears with any Linear ICs on the Market. You'll find there's a big difference between price/performance and price-per-product. Write for detailed specs on the entire linear family.

FAIRCHILD
SEMICONDUCTOR

Fairchild Semiconductor A Division of Fairchild Camera and Instrument Corporation 313 Fairchild Dr. Mountain View, Calif. 94040 (415) 962-5011 TWX: 910-379-6435

Sealok™: new Burndy micromodular interconnection system is ultra-reliable

**withstands
temperature, vibration,
shocks, wire training,
moisture and most
fluids and gases.**

Whew!

Developed to provide density for critical applications, the new Burndy Sealok system eliminates current intermittencies and variations in millivolt drop.

Designed so that they are unaffected by severe training of wires, modules are protected by a rigid outer shell. Exclusive with Burndy, this protects the sealing grommet and other internal components and provides a guide for proper insertion and extraction of contacts. The inner

construction (illustrated far right) insures that every contact is held firmly against the bus bar.

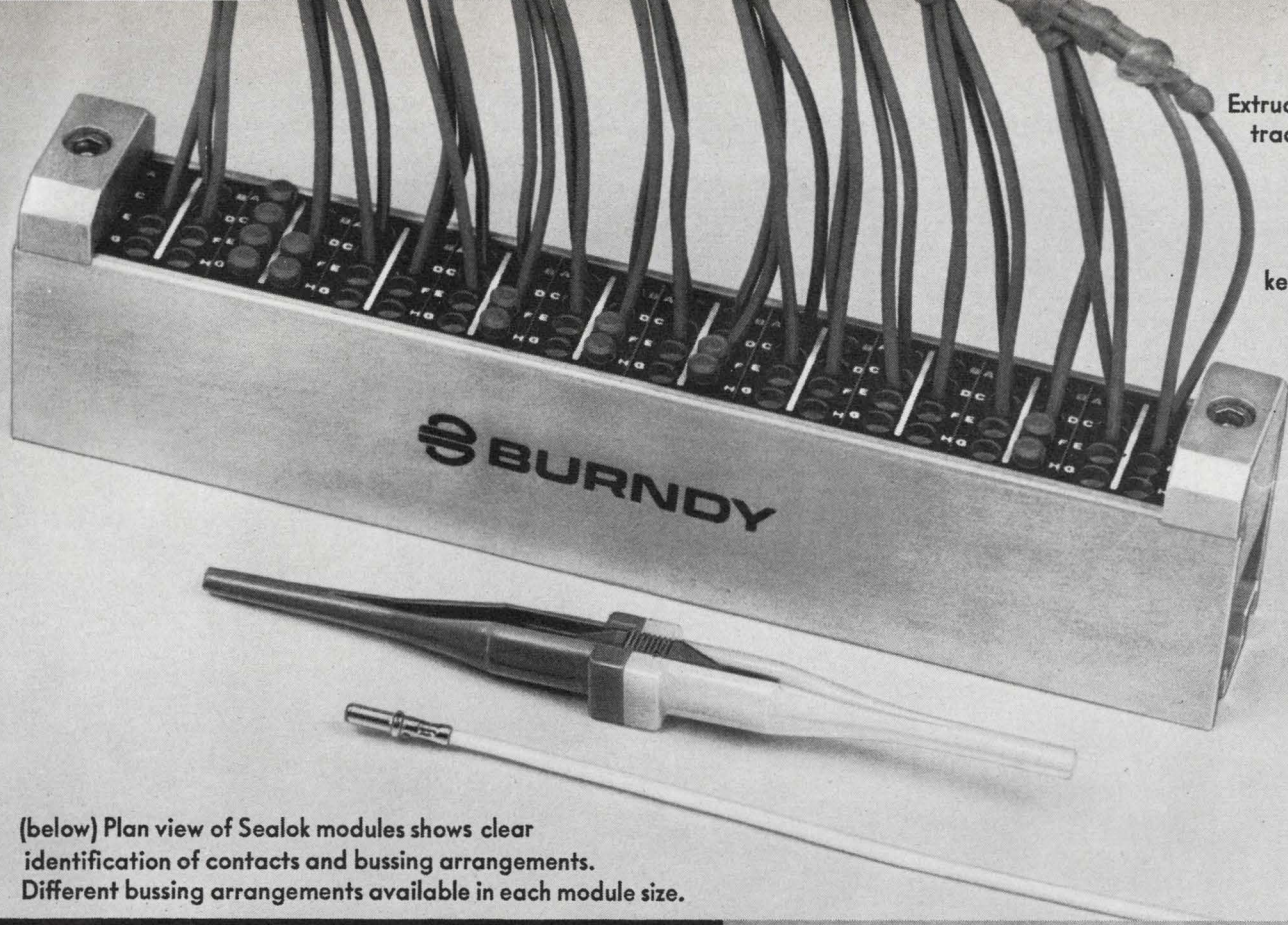
Sealok modules and contacts are available in sizes 20, 16 and 12, with one hybrid module which accommodates both 16 and 20. Contacts cover a wire range of 24 thru 12 and are easily and quickly installed with standard tooling. Sealing plugs for unused positions are also available. Write for catalog giving full details.



BURNDY

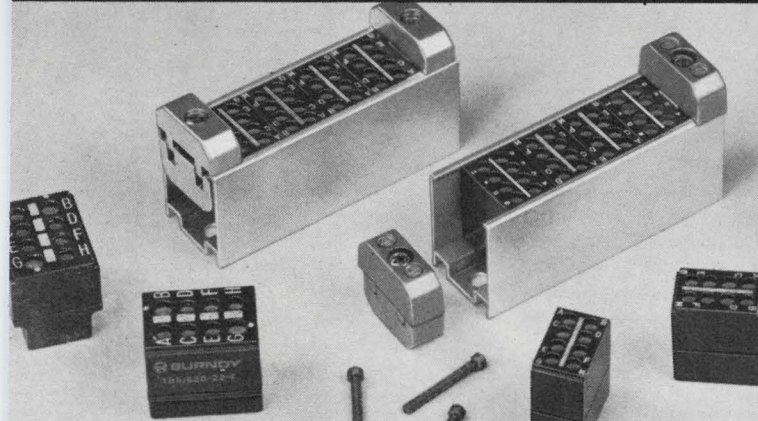
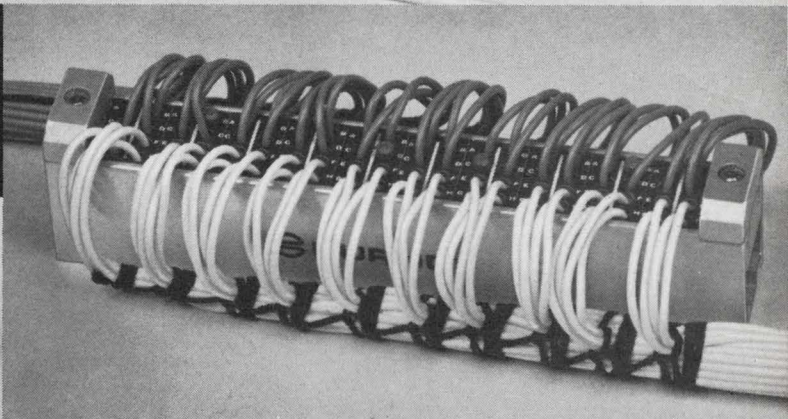
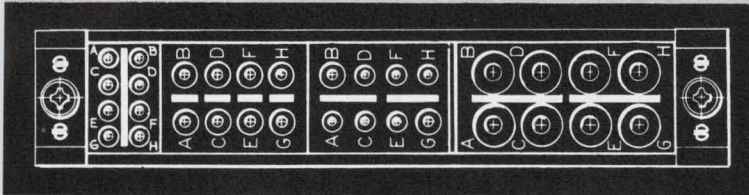
Norwalk, Connecticut

INTERNATIONAL SALES HEADQUARTERS AND MANUFACTURING FACILITIES:
CANADA: Scarboro, Ontario / ENGLAND: St. Helens, Lancs. / BELGIUM: Mechelen / MEXICO: Naucalpan de Juárez / BRAZIL: Sao Paulo / JAPAN: Tokyo / Sales Offices in Other Major Cities

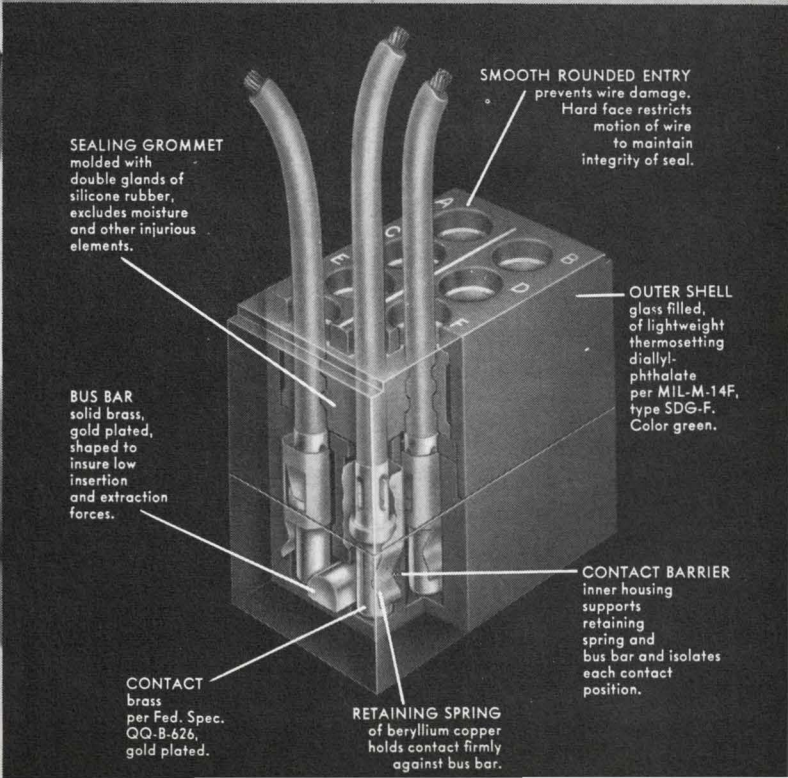


Extruded aluminum track is available in 6-foot lengths or to specification. End clamps keep modules in track and provide mechanical rigidity.

(below) Plan view of Sealok modules shows clear identification of contacts and bussing arrangements. Different bussing arrangements available in each module size.



Track features recessed mounting hardware so there is no interference with removal of modules. Two-piece end clamp construction permits insertion from ends or top anywhere along track.



SEALING GROMMET molded with double glands of silicone rubber, excludes moisture and other injurious elements.

SMOOTH ROUNDED ENTRY prevents wire damage. Hard face restricts motion of wire to maintain integrity of seal.

OUTER SHELL glass filled, of lightweight thermosetting diallyl-phthalate per MIL-M-14F, type SDG-F. Color green.

BUS BAR solid brass, gold plated, shaped to insure low insertion and extraction forces.

CONTACT BARRIER inner housing supports retaining spring and bus bar and isolates each contact position.

CONTACT brass per Fed. Spec. QQ-B-626, gold plated.

RETAINING SPRING of beryllium copper holds contact firmly against bus bar.



Modules can be easily inserted and removed with inexpensive stainless steel tool.

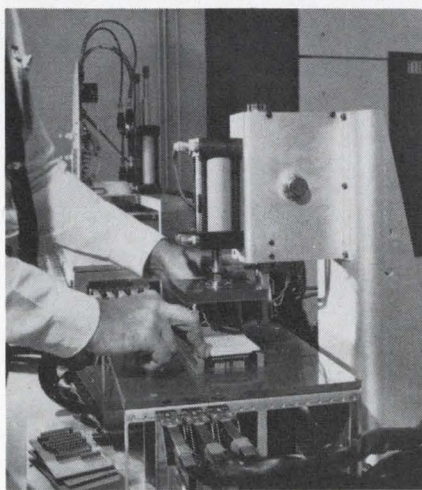


Specify TI multilayer boards

...whether you need one in two weeks—or 2,500 a week!

When your needs are critical for fast delivery of high performance, reliable multilayer boards, specify Texas Instruments. Recently for one customer, TI went from schematic, through design, to delivered prototype of an automatrix multilayer board in just two weeks. For another customer, TI is currently delivering 2,500 complex multilayer boards a week!

Whatever your program requirements, call upon Texas Instruments for complete interconnection system support. Customer services available include complete computer design from schematic or data list level, computer generated artwork from your layouts, or manufacture



Reliability assured — through 100 percent electrical test of every board.

of boards from your artwork.

Processes, production facilities, and manufacturing procedures meet military specifications.

How about TI multilayer board reliability? Through 15 October we have recorded 400 million joint hours of operational testing *without a single joint failure*.

When you need multilayer boards, many or just one fast prototype, and you require quick, accurate design and high reliability, call (214) 238-2903, or write: Advanced Circuit Board Department, Texas Instruments Incorporated, P. O. Box 5303, M.S. 979, Dallas, Texas 75222.



TEXAS INSTRUMENTS
INCORPORATED

Scotchpar's producer uses more supporting players than any other big name film producer.

3M Company has the largest sales force—all engineers and insulation specialists calling exclusively on the electrical market—to make sure SCOTCHPAR® polyester film turns in a stellar performance for its customers.

They're supporting a great film. It's thin, tough, transparent, flexible

and durable. It also has high dielectric strength, great temperature stability, and resistance to moisture and solvents.

Our men help capacitor manufacturers get the right kind of SCOTCHPAR film for their product—they can choose from a complete lineup of thin films down to .25 mils, plus SCOTCHPAK® film if they want heat sealable features.

They work equally hard for manufacturers who use SCOTCHPAR film as insulation in transformers, motors, wire and cable.

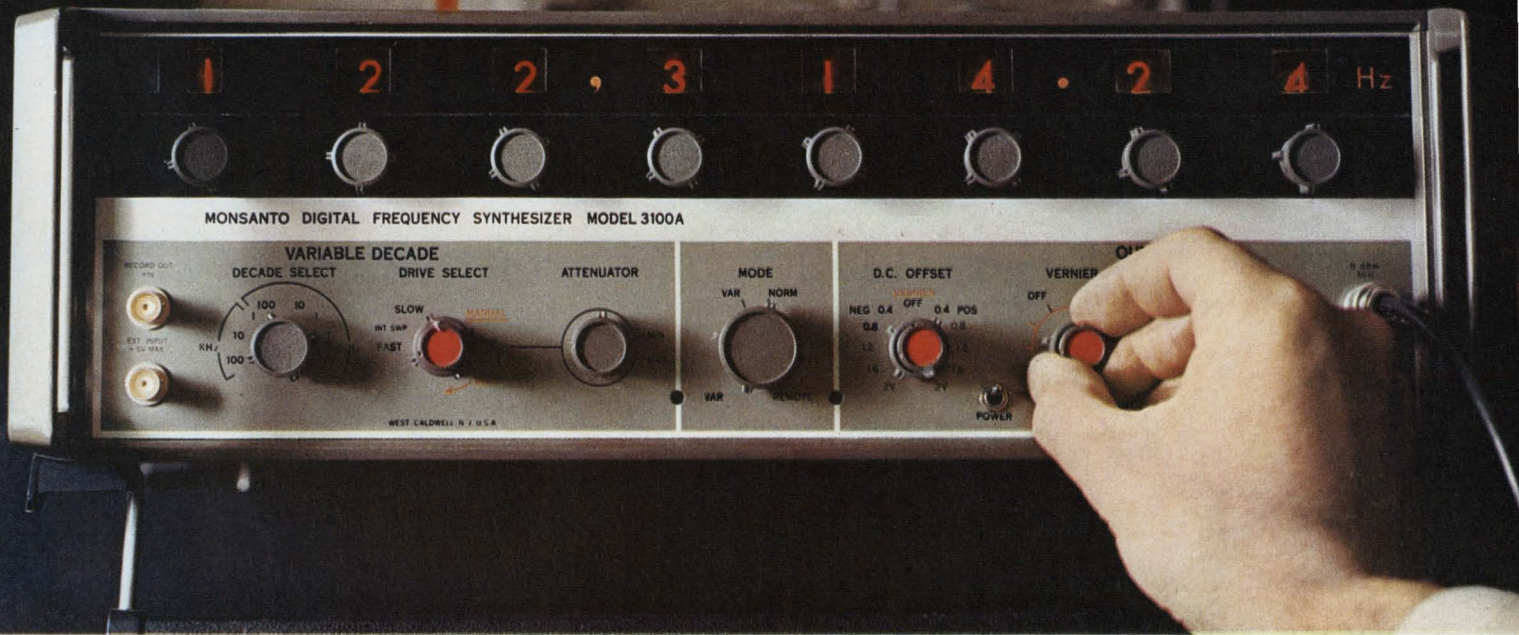
With all these men on the job, we still work harder than anybody else helping electrical men get the most out of polyester film.

All because we want our SCOTCHPAR film to win over a very critical audience. 3M Company, Film & Allied Products Division, 3M Center, St. Paul, Minnesota 55101.

Scotchpar 3M
BRAND POLYESTER FILM COMPANY



From Monsanto: 130,000,000 discrete frequencies with almost perfect purity.



**New "4th generation"
digital frequency synthesizer achieves new level of
perfection in signal generation
with computer-aided design
and I-C construction.**

Monsanto's new Model 3100A Digital Frequency Synthesizer obsoletes just about every present concept of general purpose signal sources.

Pick your frequency from 0.1 Hz to 1.3 MHz in 0.01 Hz steps. The result—signal purity you can get only from Monsanto, with a stability of one part in 10^9 per day.

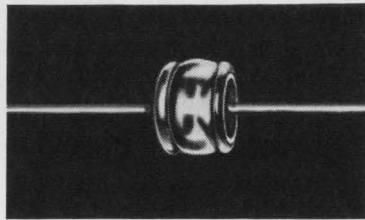
Other refinements include: internally supplied rapid or slow sweep and provision for external sweep; continuous control of output level over a 90 db range; provision for both amplitude modulation and frequency modulation or both, simultaneously; in the remotely programmable version, switching time is less than 20 microseconds.

You can put this *better* way of signal generation to work for you for only \$3950.00, FOB West Caldwell, N. J.

For a demonstration, or for full technical details, call your local Monsanto Field Engineer now or contact us directly at: Monsanto Company, Electronic Instruments, West Caldwell, New Jersey 07006, (201) 228-3800.



**Do you have
the question
to this**



answer?

The only limits to the questions answered by the Siemens Gas-filled Surge Voltage Protector are your needs, and your imagination.

Tiny, lightweight, a handful can protect a ton of sensitive electronic equipment, especially supersensitive solid state circuits. They give you tailor-made protection in hundreds of places throughout circuitry. With current carrying capacities up to 5,000 amps. With DC striking voltages from 90V to 1000V. With reaction speeds in the nanosecond range. And with a cost of less than \$1 in quantity.

Lightning strokes, static charges, internal switching, short circuits—all these transient dangers are guarded against by these tiny, tireless sentries—Siemens Gas-filled Surge Voltage Protectors. If you've got a protection question, call Siemens America Incorporated for immediate protection delivery.

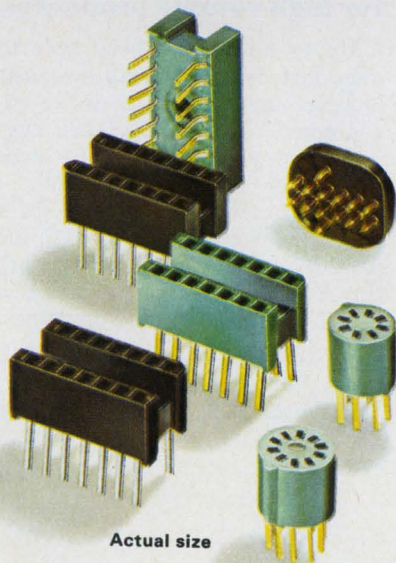
Send us your questions!

SIEMENS AMERICA INCORPORATED
350 Fifth Ave., New York, N.Y. 10001 • (212) 564-7674



CINCH PRECISION MINIATURE SOCKETS

INSURE EQUIPMENT DEPENDABILITY



Actual size

Equipment design frequently involves problems of field maintenance or circuit updating. Cinch component sockets provide inexpensive and effective solutions without compromising reliability.

DIP sockets for 14 and 16 lead DIP's are typical of Cinch specialized miniature sockets. Available in GP black phenolic or SDGF diallyl phthalate, they have extremely high resistance to shock, vibration, humidity and corrosive atmospheres. Contacts are gold or cadmium plated beryllium copper with low contact resistance.

IC sockets for 6, 8 and 10 pin TO-5 cased devices, miniature *NIXIE Tube* sockets and *Subminiature relay* sockets are just a few of the other component sockets Cinch manufactures.

For information on DIP sockets and other Cinch interconnection devices, write to Cinch Manufacturing Company, 1501 Morse Avenue, Elk Grove Village, Illinois 60007.

C-6818

CINCH
DIVISION OF UNITED-CARR

MEMBER

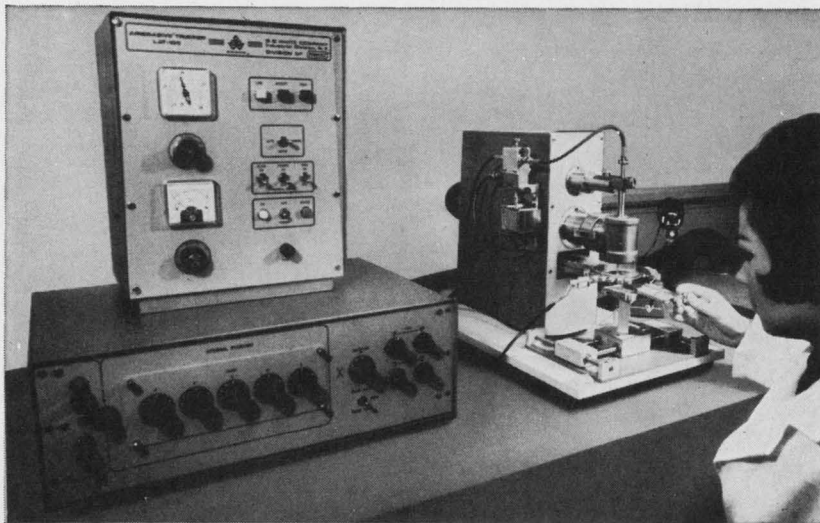


CONSISTING OF CINCH MANUFACTURING COMPANY, CINCH-GRAPHIK, CINCH-MONADNOCK, CINCH-NULINE, UCINITE (ELECTRONICS) AND PLAXIAL CABLE DEPT.

Circle 99 on reader service card

Model LAT-100

The \$6,000* Resistor Trimming System



The number to call is 212-661-3320 for a demonstration like this—and you can bring your wife along if you like.

CALL us collect or write to arrange for a demonstration of S. S. White's new LAT-100, the complete, low-cost resistor trimming system for R & D and prototyping.

The LAT-100 automatically trims, monitors, and inspects PAF resistors to tolerances within 1%. That's guaranteed. In tests, 0.5% is often achieved. A precise 4-wire Kelvin bridge is integral to the system, which, with the optional plug-in decade box, permits the system to be programmed through five digits and three multipliers—from 0 to 10K and from 0 to 1M. Tolerances may be programmed from 0 to $\pm 11\%$. Panel controls permit operator to override the automatic cycle at will.

A holding fixture takes substrates up to 2x2 inches. A precise X-Y stage has 4"x4" movement. The trim slide has an automatic fast-return to place it exactly for the start of each trim. Tungsten carbide probes are mounted in a 14-position mounting ring. An efficient dust-removal system permits the LAT-100 to be operated in clean rooms. Installation requires a 110 VAC outlet and a level spot.

*Base price, \$5,950.00 each. With optional decade box, illuminator, foot-switch operation, \$6,350.00.

Without further detail, the LAT-100 does everything its bigger brothers the AT-701 and AT-704 do—a little less accurately, to be sure, and not nearly as fast—but what can you expect for a trifling \$6,000?

A step up from the LAT-100 is the AT-701, a no-nonsense production machine. The AT-701 can produce 600 trims per hour with guaranteed accuracy of 0.5% and attainable accuracy of 0.1% when

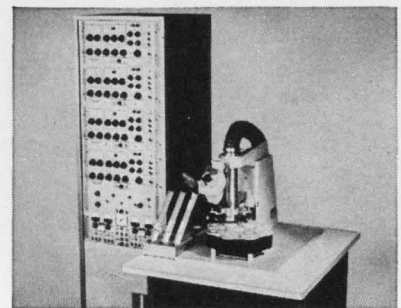


Model AT-701 garners accolades at IEEE show—top scientist says "Gee whiz."

things are going your way. The AT-701 with a decent amount of employment (say 1000 hours per year) produces trims at about $\frac{1}{2}\text{¢}$ each—including labor, materials, maintenance, and amortization. How about *that*?

But say you're big. Really big. We've got our big Bertha model for you, otherwise called the AT-704, which produces 4,000 trims per hour with accuracy and cost similar to those of the AT-701.

S. S. White resistor trimming systems are based on the proven Airbrasive® concept, controlled by precision electronics. The Airbrasive method of removing resistance material produces neither heat nor shock, does not alter substrate—yields of 100% can be attained with any of the S. S. White resistor trimming systems at some sacrifice of speed and tolerance. Each of the systems trims and monitors simultaneously and inspects after each trim.



Big Bertha: Model AT 704 trims at 4,000/hour pace for high volume producers.

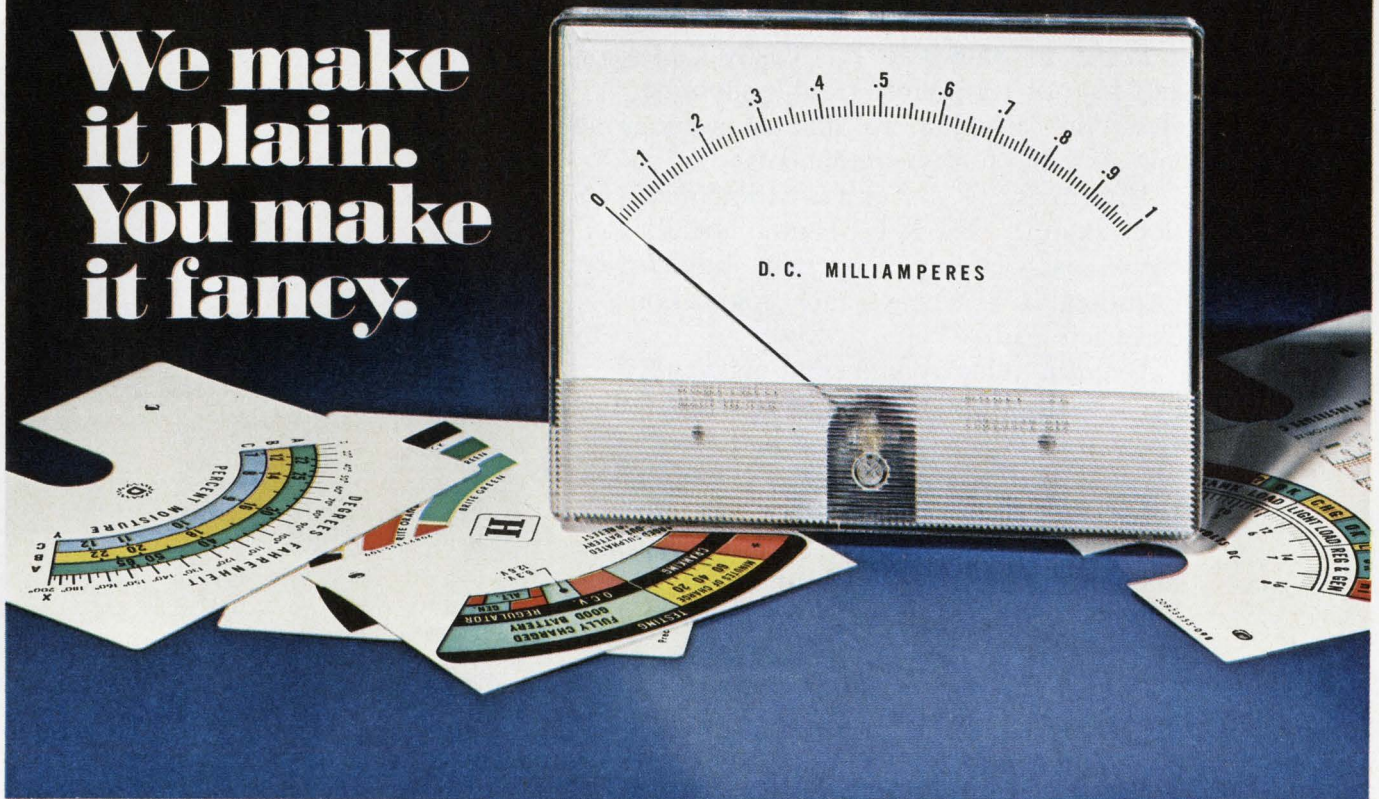
Up to now we've been able to offer fast delivery on all systems; however the enthusiasm we've encountered over the LAT-100 suggests that you'll be wise to place your order early for this model.

Call us or write to arrange for a demonstration of the LAT-100, the AT-701, or (if you're really big) the AT-704. Or ask for bulletin RT-14—it's great to read on planes.

Inquire, S.S. White Industrial, Dept. R, 201 East 42nd Street, New York, N.Y. 10017. Telephone 212-661-3320.

S. S. WHITE INDUSTRIAL
A DIVISION OF PENNSALT CHEMICALS CORPORATION

**We make
it plain.
You make
it fancy.**



If you buy any of Honeywell's standard Series 70 Taut-Band Meters, here's what you'll get:

The Basics.

A plain square case.

A clear Plexiglas cover.

Large, plain markings. (You can read them at arm's length without squinting.)

And the simplest meter mechanism known to man: Honeywell's new Auto-Torque mechanism. (It has about 50% fewer parts than pivot-and-jewel.)

This is a meter with no frills.

The options.

However, frills are available: Fancy dials, with multiple scales and multi-colored sectors. (A fancy dial looks great on a plain meter.)

Lighted dials.

Mirrored scales.

Behind-panel mounting with a bezel. (For 2½", 3½" and 4½" meters.)

Plus just about any other modification you might have in mind.

The specs.

The taut-band mechanism is completely frictionless, so it re-

sponds to the slightest inputs. Hysteresis-free, so its repeatability is near perfect.

And it costs less than pivot-and-jewel.

Honeywell's Series 70 Meters come in 33 standard ranges. And 5 sizes (1½", 2½", 3½", 4½" and 6").

We sell a lot of them.

(We'd like to send you a catalog. Write Honeywell Precision Meter Division, Manchester, New Hampshire 03105.)

The Just Plain Meter from Honeywell

It takes all kinds of meters to make the Honeywell line.

Automatic Trouble-shooter

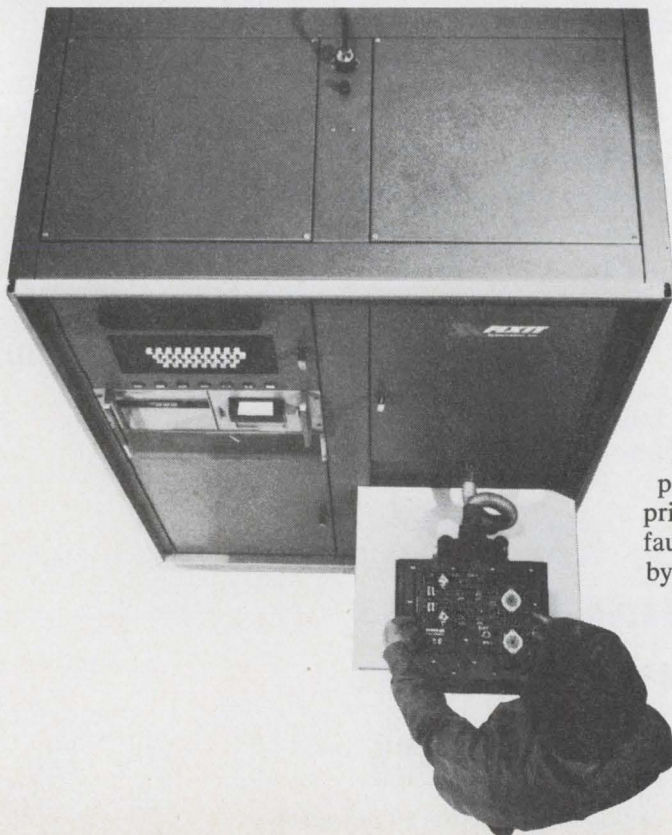
Want to eliminate the costly confusion and tedious turmoil of trouble-shooting electronic circuitry to find manufacturing mistakes and faulty components?

Use F·I·X·I·T -- *Fault Isolation by Inspection Testing*. F·I·X·I·T automatically checks each circuit component individually, including IC's. Checks each connection and each lead.

By visual display and print-out you'll know -- instantly -- exactly where the trouble is, what to repair or replace, and which production line operation needs correction. F·I·X·I·T turns trouble-shooting into an assembly-line function; saves space, time, manpower and money. Is universal to any electronic assembly. Can pay for itself in 90 days.

And F·I·X·I·T is so ingenious, it even checks itself!

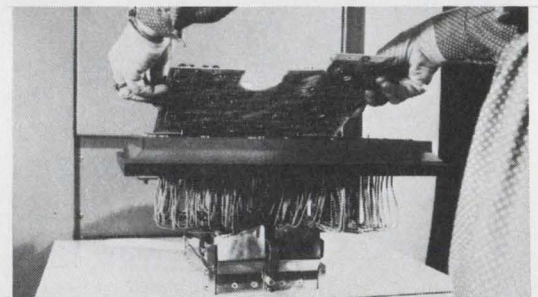
For more information about how F·I·X·I·T will trouble-shoot automatically, improve product quality and increase your manufacturing capability, write or phone. . .



Systemation Inc.

140 ERIE BLVD./SCHENECTADY, N. Y. 12305
TEL. 518/393-3638

Manufacturers of F·I·X·I·T, GUARDOHM®. Consultants in and manufacturers of electronic, mechanical and optical engineering products and systems. You name it; we'll automate it.



Place circuit board on test block. Automatic vacuum control draws board down to make precise contact with spring-loaded pins. F·I·X·I·T tests entire board in seconds -- component by component -- and gives you a separate print-out for each board tested. If no-go, each faulty component or mis-manufacture is identified by number and location.

Deluxe F·I·X·I·T provides up to 600 access points with which circuits containing up to 1000 components can be checked. Checks IC's, too.

Goldilox™ built-in protection system gives DTLs high noise margin with Mil Spec reliability.

And that's no fairy tale.

Function		Prices (100 or more)
WCZ 261	Dual NAND gate	\$1.60
WCZ 236	Triple NAND gate	1.65
WCZ 226	Triple NAND gate	1.65
WCZ 216	Triple NAND gate	1.65
WCZ 266	Quad NAND gate	1.75
WCZ 246	Quad NAND gate	1.75
WCZ 298	Monostable	1.65
WCZ 220	Dual driver	1.65
WCZ 275	Dual J-K flip flop	3.85

Only from Westinghouse — the WCZ 200 series of high threshold logic, with a noise margin of 5 Volts DC, and operating on the popular 12 Volt power supply.

This series of DTLs also has the exclusive Goldilox protection system that's built right into the product. Goldilox protects ICs against current leakage, moisture, and the interaction of different metals at the contact points. The WCZ 200 series is capable of collector OR-ing, is compatible with standard DTL devices, and comes in dual-in-line packaging.

Look at these prices. Then you'll know why the WCZ 200 series with Goldilox protection is your best buy in high threshold logic. For full application data, call our local sales office, or Westinghouse Molecular Electronics Division, Elkridge, Maryland (301) 796-3666.

J-09150

You can be sure... if it's

Westinghouse



Goldilox ICs block out noise.



If you want to know what wire costs, don't look at a price list. Ask people.



Ask these London bobbies. Their mobile radios are smaller because the hookup wire is insulated with TEFLON, whose electrical properties permit thinner insulation. This is "value-in-use".

ASK A DESIGNER... He measures an insulation by what it lets him accomplish. Before you specify the insulation for your next design, make a value-in-use analysis of TEFLON*.

ASK A PRODUCTION MAN... He'll emphasize the cost savings that come from fast, trouble-free production. The resistance of TEFLON (TFE) to solder-iron heat speeds production, reduces rejects and minimizes rework.

ASK AN ACCOUNTANT... He'll give you an estimate of the cost of an insulation failure—a cost you may avoid by using TEFLON.

ASK YOUR SUPPLIER about the many wire and cable constructions insulated with TEFLON...including composite constructions...that offer extra value-in-use for your most exacting applications. For further information, write Du Pont Company, Room 6669-C, Wilmington, Delaware 19898.

*Reg. U. S. Pat. Off. for Du Pont fluorocarbon resins and film.

TEFLON...the sure one



REG. U. S. PAT. OFF.
Better things for better living
...through chemistry



How Sel-Rex
can help you
save money in
precious metal plating...

The five cost factors in ...and the advantages to you of the

The ultimate cost of precious metal electroplating is affected by a number of factors—both within and outside your plant. Five of them are the keys to vendor selection. These factors are interrelated, and if not considered as a whole, there is a likelihood that your precious metal electroplating may cost you more than it should.

1. The Process Itself

The selection of the “right” precious metal plating process is not a casual matter. We work diligently with our customers to make sure that the processes they use give optimum results. With almost two dozen Sel-Rex gold-plating processes alone for industrial applications, there’s no need to compromise on results. Equally important is a review of your needs from time to time, to verify optimum performance in light of current conditions.

More companies use Sel-Rex precious metal electroplating processes than those of any other supplier in the world. Because of this, there’s a greater likelihood we can meet your needs more precisely than anybody else.



2. The Equipment

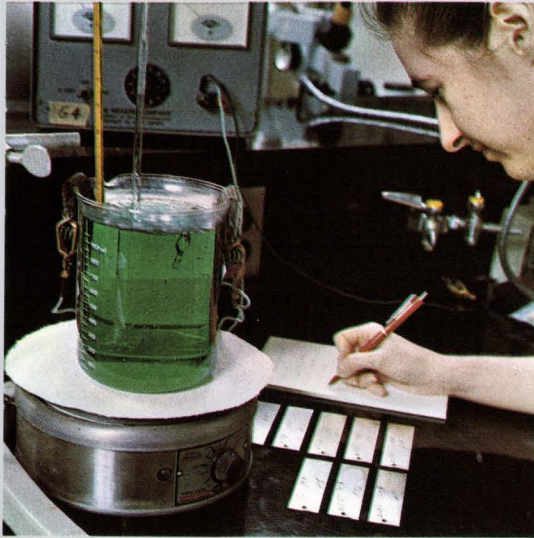
The Meaker Company (a Sel-Rex subsidiary) specializes in equipment to meet the unique needs of the electronics manufacturing industry, watchcase and jewelry manufacturers, and others who demand absolute precision in plating. Not only does properly designed equipment facilitate the processing of your product, it also provides for efficient maintenance of plating baths and other solutions.

Meaker manual and automatic equipment is designed not only with your present needs in mind, but also in keeping with the direction of your growth. Modular “packaged” equipment by Meaker has been a significant contribution to the field — saves time and money in setting up, in operating, and in modifying to meet changing needs.



precious metal electroplating

Sel-Rex "total approach" to your problem



3. Technical Assistance

We regard our relations with our customers as a partnership. To this end, the largest and finest technical service staff in the industry is committed to helping our customers obtain maximum benefits in their precious metal electroplating activities. Analytical and metallurgical laboratories, and modern prototype plating facilities are located not only at our central headquarters, but also in the field, to be closer to you.

All in all, with Sel-Rex you have access to the greatest storehouse of technical experience in the precious metal plating field. You save down-time and gain work-time with this kind of service.

4. Research Support

Your ultimate costs may be more directly affected than you realize by the quality of research available to you from your supplier. Sel-Rex research can be a competitive advantage to you. Our long-range research has led to such developments as the first bright gold, the first acid gold, and the first non-cyanide gold processes for industry. But we are also continually "researching" our present processes to make them work better for you.

A constant interface between our research and technical service groups brings new developments to bear on your needs quickly and efficiently. By giving additional valuable characteristics to pure gold deposits. Sel-Rex research recently helped more than a few of our customers reduce costs substantially. Significant cost reductions are also being obtained at a number of accounts with our new 18-Karat (75% gold alloy) deposits—suitable for both decorative and engineering applications.

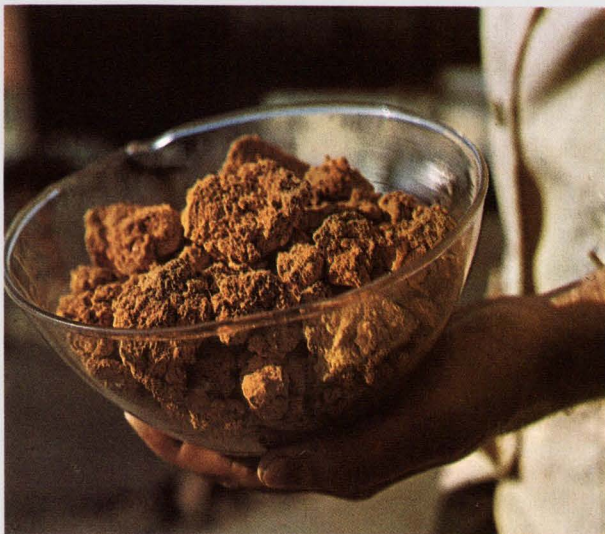


5. Recovery Service

We want you to use our gold—not lose it. For plating lines, we have developed ion-exchange equipment that keeps precious metals from going down the drain. But our services wouldn't be complete without a concern for total precious metal accountability in your plant.

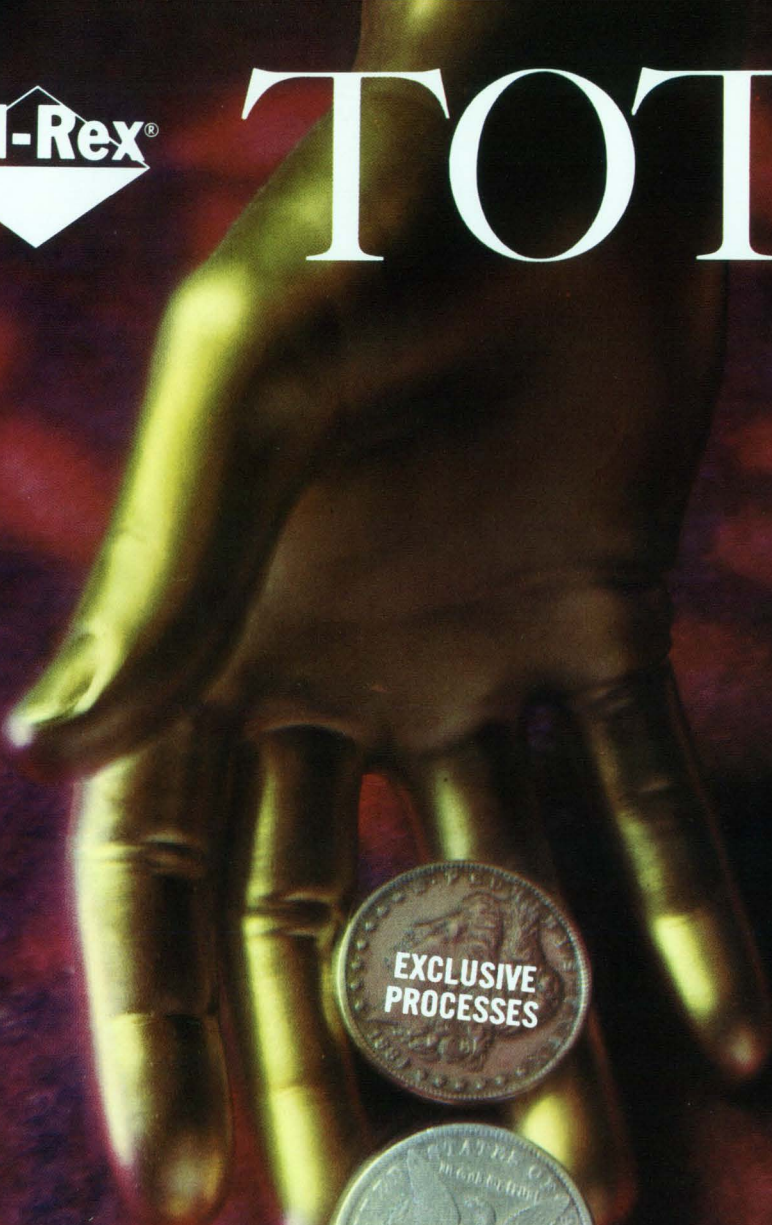
We start with a review of scrap segregation and salvage procedures in your plant to insure minimum refinery handling charges. We utilize the latest techniques for sampling and assaying. Our first-of-its-kind published schedule lets you know the value of all forms of precious metal material. A recently expanded refinery devoted solely to precious metal recovery provides the capability to extract maximum value from your scrap. Another Sel-Rex factor in keeping your costs down.

Save with Sel-Rex. We have listed five specific areas in which we can help you control costs. Together they make up our Total Approach to your precious metal electroplating needs.





TOTAL



**EXCLUSIVE
PROCESSES**

**EQUIPMENT
SYSTEMS**

**TECHNICAL
SERVICE**

**RESEARCH
SUPPORT**

**MAXIMUM
RECOVERY**

Add to the five factors listed here one more
—Sel-Rex serves you wherever you are.

Subsidiaries and associated companies in
Canada, Great Britain, Switzerland, France,
Holland, and Japan, together with a network
of technically skilled distributors, provide
Sel-Rex products and services throughout
the world. So, whether you reckon your
costs in dollars or any other currency, you
can save with Sel-Rex.

Sel-Rex Corporation
Nutley, New Jersey 07110

APPROACH

700V HIGH VOLTAGE NPN Silicon Power TRANSISTORS from **Solitron**



80W @ 100°C
1.25°C per W



40W @ 100°C
2.5°C per W

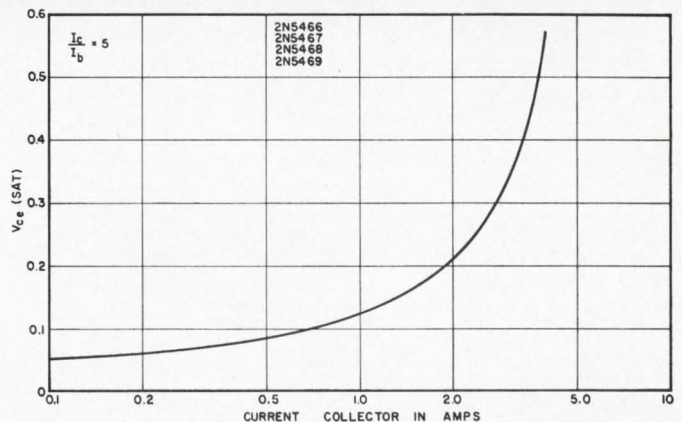
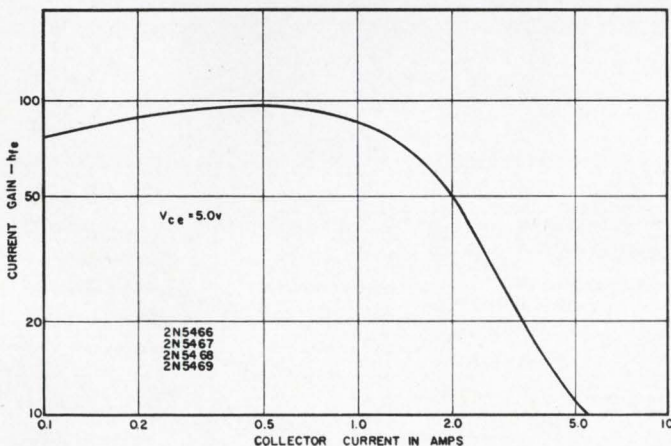
SPECIFICATION RATINGS:

$V_{CEX} = 700V$ min
 $V_{CEO(sus)} = 400V$ min
 $h_{FE} = 15-60$ @ 3.0A
 $V_{CE(sat)} = 0.5V$ @ 3.0A

Also available in 500 Volt V_{CEX} versions, 2N5466 and 2N5468; all other specifications identical.

High voltage, triple-diffused silicon power transistors are now available from Solitron, with V_{CEX} up to 700 Volts. Typical applications include horizontal deflection circuits, ignition systems, CRT sweep systems, high voltage switching mode regulators, high voltage pulse amplifiers and high voltage pass series regulators. Priced low, they are available in TO-3 and TO-66 cases.

TYPICAL GAINS AND SATURATION VOLTAGES



Dial 1-800-327-3243 for a "No Charge" telephone call and further information

SEMICONDUCTOR DIVISION
Solitron DEVICES, INC.

1177 BLUE HERON BLVD. / RIVIERA BEACH, FLORIDA / TWX: (510) 952-6676

hybrid microcircuits from the “total capability” source

There's a reason why Burroughs is a preferred source for hybrid microcircuits. It's TOTAL CAPABILITY. TOTAL CAPABILITY is the unique ingredient that keeps Burroughs ahead in hybrid circuit leadership and enables you to reduce system size with increased reliability.

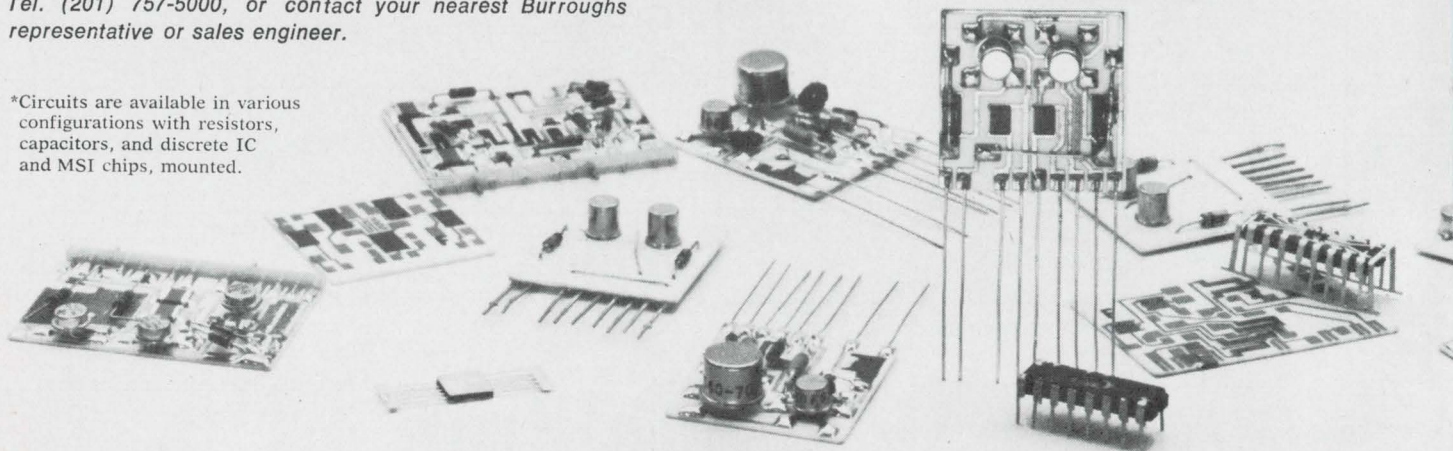
Burroughs now offers the entire circuit package* and its components — all designed and fabricated under the eyes of experts in one complete in-house operation, providing economy, high reliability, quality control and prompt delivery.

■ Hermetic Packaging ■ MSI Capability ■ Computer Test Facility ■ Fully Documented to MIL-Q-9858A and MIL-I-45208

Buy your hybrid microcircuits NOW from Burroughs, and discover what Burroughs Total Capability can do for you.

Call or write Burroughs Corporation, Electronic Components Division,
P.O. Box 1226, Dept. H1, Plainfield, New Jersey 07061.
Tel. (201) 757-5000, or contact your nearest Burroughs
representative or sales engineer.

*Circuits are available in various configurations with resistors, capacitors, and discrete IC and MSI chips, mounted.



Burroughs 

Circle 110 on reader service card

Technical Articles

**Analyzing air pollution
with infrared and logic
page 112**



Parallel active filtering and pattern-recognition logic give a prototype pollution analyzer more versatility than conventional models. The electronics portion of the system takes over many functions usually performed by the optics, allowing the analyzer not only to detect polluting substances but to identify them, distinguishing among those with similar infrared spectra. The

electronics carries out Fourier-transform spectroscopy and indicates whenever a contaminant exceeds an acceptable level.

**Where things stand with
cylindrical film memories
page 124**

Cylindrical film memories are coming into their own. Authors from three companies specializing in these types have contributed articles to Electronics' continuing series on memory technology. Since commercially introducing plated wire two years ago, Univac is forging ahead with this technology, and its prospects are good. National Cash Register has gone all out with plated rods in its Century computer, unveiled earlier this year. And Librascope, a division of Singer-General Precision, continues to develop woven-wire memories for aerospace applications.

**Taking shortcuts
in color tv cameras
page 134**

Highly stable solid state circuitry permits the elimination of many sophisticated trimming circuits in a new color television camera costing a quarter the price of conventional studio units. And even with such inexpensive optical components as vidicon pickup tubes and standard 35-millimeter lenses, the camera, when used with an image enhancer, produces broadcast-quality pictures.

**MOS multiplexer avoids
high-frequency hazards
page 152**

When signal frequency goes much above 1 kilohertz, the performance of metal oxide semiconductor switches can deteriorate seriously. The signal can feed through from an off channel to one that's on, it can be attenuated significantly, and the switching transients can become very large. Fortunately, however, mathematical analysis of these effects makes it possible to design circuits that are immune to them.

Coming

**Faster IC
chip connections**

A wide-ranging look at various efforts to improve semiconductor chip mounting by such schemes as beam leads, spider bonding, and flip chips.

Pattern-recognition logic analyzes infrared signals

Prototype pollution detector uses an optical interferometer but can identify several contaminants because its logic and active parallel filters enable it to distinguish among those with similar spectra

By Alan Bessen

Ford Instrument Division, Sperry Rand Corp., Long Island City, N.Y.

Long a junior partner to optics in infrared contamination analyzers, electronics assumes the senior role in a prototype unit with the addition of parallel active filters and standard logic elements. This new analyzer not only detects several pollutants but identifies them accurately. The electronic data-analyzer unit carries out Fourier-transformations and decision rules, and turns on a light when a given contaminant exceeds a threshold level.

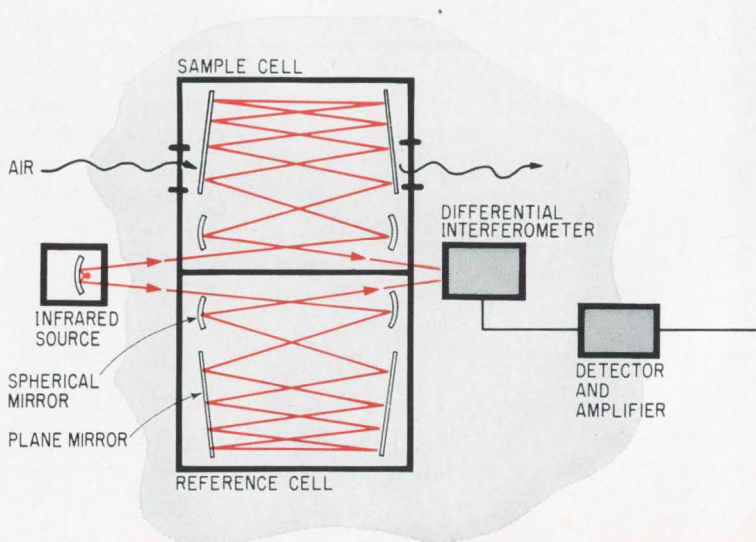
Most conventional instruments are designed to measure only one contaminant—sulfur dioxide, for example—at a time. When the environment contains several contaminants with similar spectral patterns, such instruments can't tell them apart and can thus produce erroneous readings. And the use of a battery of analyzers, each responding to only one contaminant, may be very costly in such applications as area surveys. While it's possible to use several conventional analyzers, with more sophisticated optical configurations to improve selectivity, doing so can sharply increase cost and mechanical complexity.

The prototype analyzer, however, can handle several contaminants without changing optics because its filtering and logic enable it to discriminate between those with similar spectra. An optional interferometer that periodically scans a wide range of the infrared spectrum detects traces of gases, vapors, and aerosols that absorb energy in this region. The resulting signal is processed using Fourier-transform and decision-theory methods. The analyzer can be tuned to distinguish another set of pollutants by simply changing the logic cards.

One data analyzing unit can handle several re-

mote sensors, giving a readout from each location every second. Since its output signal ranges from 70 to 100 hertz or some other frequency band in the audio range, the sensor can be connected to its central logic unit by fixed wiring or telephone lines.

Infrared absorption spectroscopy depends on the natural vibrations of atoms held together by chemical bonds within a molecule. These motions produce a corresponding periodic change in the molecule's dipole moment, causing the oscillating dipoles to interact with radiant energy of the same frequency in a kind of resonance. The result of this phenomenon is that incident radiation is absorbed at these frequencies. Since the absorption frequencies are unique to the type of molecule involved, the resulting infrared spectrum identifies the sub-



stance. Furthermore, the concentration is directly related to the amount of absorption at a given frequency and over a given path length.

Many solid, liquid, and gaseous substances possess an infrared spectrum that can be detected under suitable conditions. Gases such as sulfur dioxide and carbon monoxide—most important in air-pollution studies—exhibit characteristic spectra in the intermediate infrared region. Others, like carbon dioxide and water, are relatively transparent in at least part of this region and won't interfere with measurements. Normal atmospheric constituents such as nitrogen and oxygen absorb no energy in the intermediate i-r band.

In the sensor shown on the preceding page, an infrared source illuminates two absorption cells with beams of equal intensity. The cell containing the sample of air is continuously refilled. The other holds air that's free of the pollutants being sought; this air is used as a reference and is periodically changed. Normally, there's only negligible absorption due to atmospheric constituents in the reference cell.

The outputs of the two cells go to the interferometer, which measures the spectrum of the absorption difference between the two beams. The differential nature of the measurement makes the system relatively insensitive to such things as variations in the intensity of the infrared source and changes in electronic-amplifier gain since these

factors affect both signals equally. And interfering "background" materials (dust particles, ozone) with absorption characteristics within the system's pass-band usually turn up in equal amounts in the sample and reference cells so their effect is also largely cancelled out.

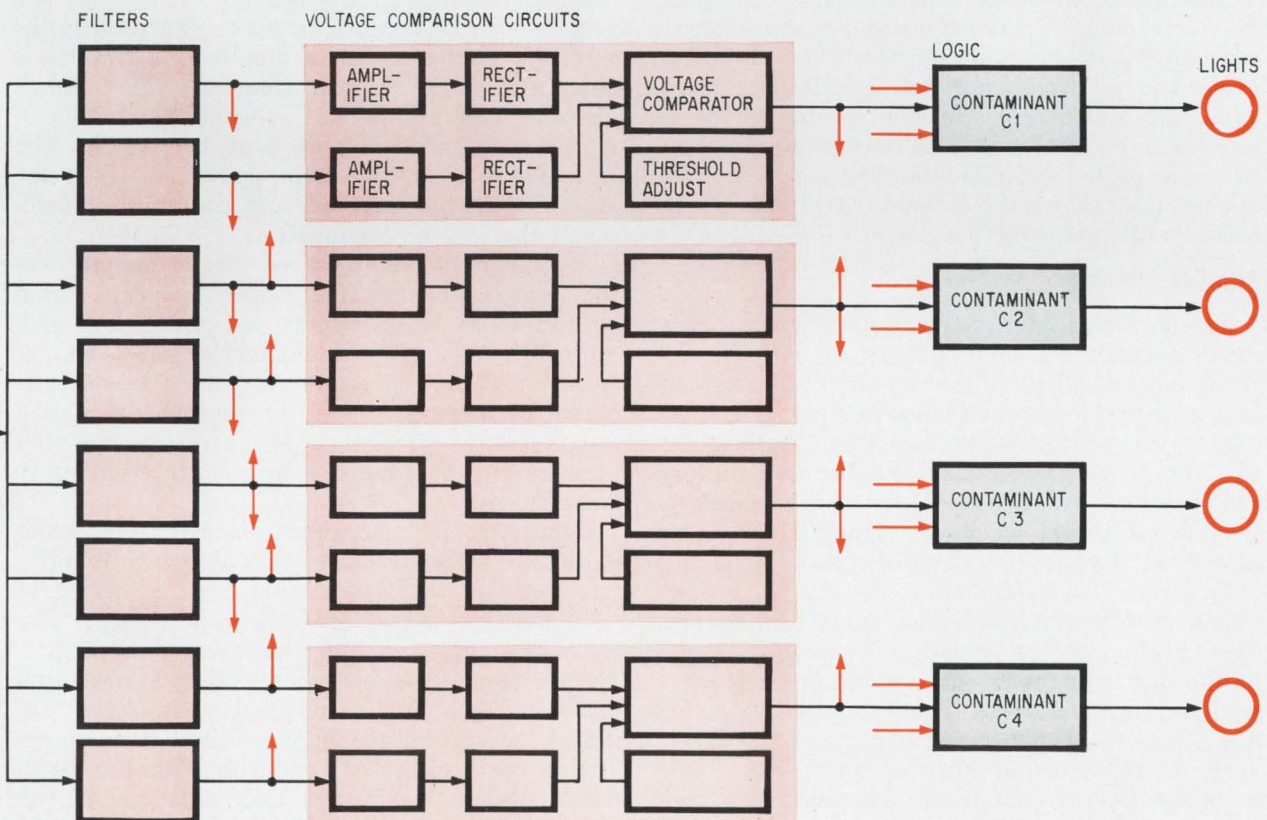
All these effects would be taken care of by the discrimination capability of the logic anyway, of course, but the differential approach—equivalent to common-mode rejection—reduces the required dynamic range of the electronics.

The changes in energy level resulting from radiation absorption are so small that the interferometer must have excellent sensitivity. The rapid-scan Michelson interferometer is thus better in this application than the conventional infrared spectrometer.

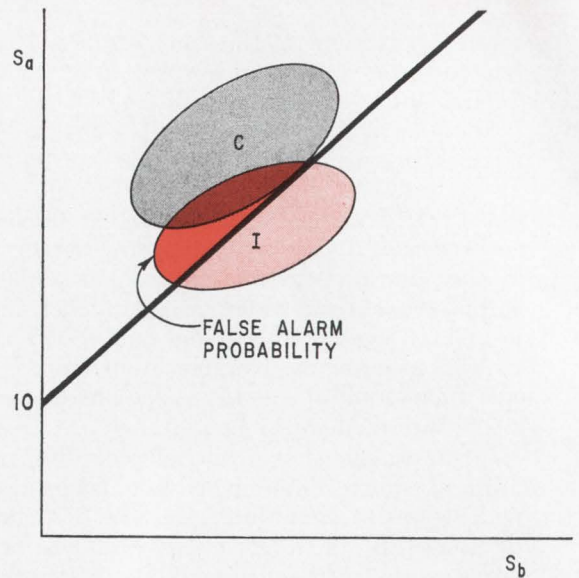
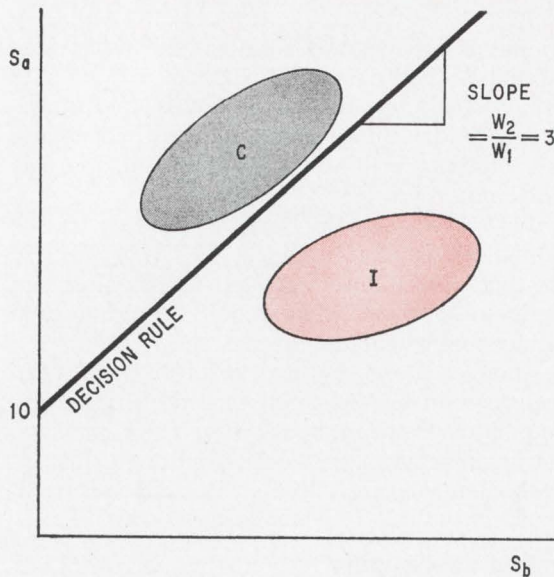
Separating wavelengths

Conventional spectrometers generally employ the dispersion provided by a prism or grating to separate the radiation into its spectral bands. The energy within a particular band of the dispersed radiation is selected by a narrow slit and measured by an i-r detector, while the energy in other bands is wasted.

As the prism or grating rotates, the detector sees each band sequentially and measures its relative intensity. To enhance the signal-to-noise ratio by data averaging, the detector should look at each



Discriminating. Because the filter and voltage-comparison circuit outputs can be connected to any channel (as indicated by colored arrows) the same logic packages can distinguish among many contaminants.



Decisive. A reading above the decision rule means contaminant is present in the air sample.

band for as long as possible. However, this limits the speed at which the optics rotates.

For a given resolution, then, signal-to-noise ratio can be traded off for speed. Similar restrictions apply to a spectrum analyzer using the recently developed optical wedge filter, a thin-film interference device with a narrow passband and a transmission wavelength that varies continuously over a range as the filter is rotated.

The limitations of the conventional spectrometer are overcome by Fourier-transform spectroscopy, a technique that's based on the use of the rapid-scan Michelson interferometer and which permits, in effect, all wavelengths in the spectral range of interest to be measured simultaneously for the entire scan cycle. And since the Michelson interferometer doesn't require a narrow slit, there's no loss of radiation-gathering power.

Parallel filtering

The use of an interferometer spectrometer introduces a problem in data analysis, though. The device's output, called an interferogram, is a voltage that varies with time and whose frequency components represent the desired spectrum. Mathematically, the interferogram is the Fourier transform of the power spectral density of the sensed radiation, but since it is not a spectrum, it can't be compared directly to the known spectra of contaminants.

To reproduce the spectrum, the inverse Fourier transform of the interferogram must be obtained. This can be done by digital and analog computer processing, analysis by an audio-frequency wave analyzer, or other means. The computer processing techniques are expensive, though, and the wave-analyzer technique requires such a time-consuming tuning procedure that it's impractical for a real-time instrument system.

A tunable-wave analyzer must be swept through its range and the speed at which this can be done

is limited by the transient response of the tuned circuit. Since the time constant of the tuned circuit is inversely proportional to its bandwidth, high selectivity and fast tuning can't be achieved at the same time.

In the prototype atmospheric-contamination detector, the interferometer's output is analyzed by a comb filter, a paralleled set of highly selective electronic bandpass filters with fixed center frequencies as shown on page 113. The filters are active networks that use an RC combination in the feedback path of a linear amplifier to develop a sharp peak at the resonant frequency. The outputs give the same information as would the output of a wave analyzer tuned to the same frequencies. The more filters used, the more points at which the spectrum can be sampled, and the more contaminants that can be identified.

An important advantage of this technique over the sequentially operating wave analyzer is that all the comb filter outputs are available simultaneously, making for rapid instrument response. After detection, the output of each filter is integrated by a low-pass filter to improve the signal-to-noise ratio. All filter signals are used together in a spectrum-comparison procedure to identify contaminants.

Conventionally, a substance is identified by comparing the continuous shape or contour of its infrared spectrum with one like it from a catalog of corresponding shapes for known substances. The Michelson interferometer, however, doesn't produce a continuous spectrum; discrete measured data from the filters corresponds to sampled values of the spectrum only at selected frequencies. There's some uncertainty about the data too. Electrical noise in the system and variations in the composition of the background cause a statistical distribution of the sampled spectral values so that they're represented by a circle or oval rather than

a point, as shown at the left. The pattern formed by the data denoting the presence or absence of a contaminant can be recognized by computer logic.

To identify a contaminant and to distinguish it from similar interfering substances requires a discrimination test. One suitable test compares a linear combination of sampled spectral values with a decision level D :

$$\sum_i^N W_i S_i \geq D$$

where S_i is the amplitude of the sampled spectrum at the i th wavelength and W_i is a weighting factor for this wavelength. The particular linear combination is called a decision rule.

If the measured data meets or exceeds the decision level for a particular case, the specified contaminant is considered to be present; otherwise, it's considered absent. The weighting factors assigned to a given contaminant can accentuate the difference between contaminant and interferent. Qualitatively, this can be done by assigning a relatively large weighting factor at wavelengths where there is a large difference between the average spectra of the contaminant and of the class of possible interferents. Similarly, a relatively small weighting factor would be assigned where the statistical dispersion in either spectrum is large. If the contaminant is more absorbent than the interferent at one wavelength but less absorbent at another, the contrast between the two substances can be increased by assigning weighting factors of opposite sign at these two wavelengths.

Consider the illustration on page 114, which shows the distribution of sampled spectral values S_a and S_b for a contaminant C and interferent I at wavelengths a and b . The decision rule here is $S_a - 3S_b \geq 10$. In one set of measurements there's

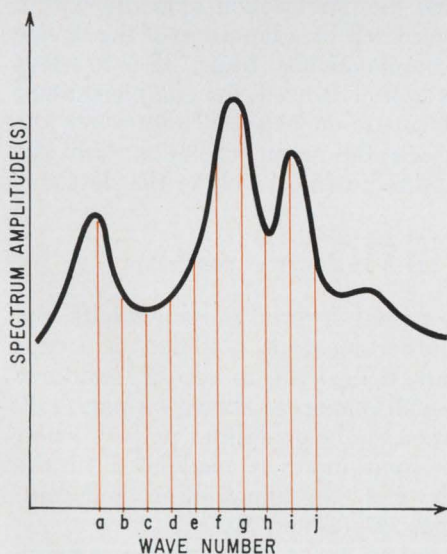
no overlap between the areas C and I , so the decision rule clearly separates the substances. There is an overlap, though, in another set of measurements. The same decision rule will always identify the presence of the contaminant, but since the interferent may also appear to be a contaminant, it may register a false alarm, as indicated by the shaded area.

The quantitative determination of the best weighting factors for given criteria regarding the detection and false-alarm probabilities is a classic problem in statistical decision theory. However, statistics on the spectra of contaminants and interferents aren't readily available, so a simplified identification technique—implemented by standard diode-transistor logic functions—was used in the prototype system.

The difference between sampled spectral values at various pairs of selected wavelengths are determined and compared with corresponding threshold decision levels. In the typical situation illustrated below, the particular contaminant is identified as being present if the differences in all four wavelength pairs exceed their corresponding thresholds. The thresholds were chosen to at least exceed the electrical noise level of the system.

Furthermore, the wavelengths used for comparison in each test were chosen so that spectra of other contaminants and selected interferents would fail to satisfy at least two of the tests and thus would not cause false alarms. In this manner, logical tests enhance the selectivity of the contamination detection system.

The spectral comparison technique depends on the relative intensities of absorption bands in a spectrum as well as the wavelengths at which these bands occur. The characteristics of the spectrometer system will, however, modify the shape of a measured spectrum. A detailed analysis of the



LOGICAL TEST FOR C1	RESPONSE OF OTHER SUBSTANCES					
	C2	C3	I1	I2	I3	I4
$S_f - S_d > D_{fd}$	PASS	FAIL	PASS	FAIL	FAIL	PASS
$S_g - S_j > D_{gj}$	PASS	PASS	FAIL	PASS	FAIL	FAIL
$S_a - S_c > D_{ac}$	FAIL	FAIL	FAIL	PASS	FAIL	PASS
$S_i - S_n > D_{in}$	FAIL	PASS	PASS	FAIL	FAIL	FAIL

Making the grade. When pairs of spectral samples, left, are compared with their decision levels, and the four pairs pass their test, the complete logical test indicates the presence of contaminant 1.

system has been made to determine the precise nature of these spectral modifications; a mathematical model defining the pertinent characteristics of the spectrometer, infrared absorption cell, and data processing circuitry was developed and programed on a digital computer to simulate the operation.

In the basic Michelson interferometer shown at the right, the incident radiation, a, is divided into transmitted, b, and reflected, c, components of equal intensity by the beam splitter. After reflection by the stationary and moving mirrors, each component is again divided by the beam splitter. Part of the radiation in each component is transmitted to the detector in direct beam, d, and part is reflected back to the entrance window in a complementary beam, e.

Consider only the direct beam, d, and assume a monochromatic input of radiant power $E_i(\nu)$, where the wave number, ν , is the reciprocal of the wavelength. The moving mirror's position is shifted along a straight line so that the difference in the optical path lengths of components b and c varies with a constant velocity, v . As a result, the relative phase between the components that combine to produce the direct beam varies linearly, causing alternate constructive and destructive interference. Specifically, $E_D(\nu)$, the resulting power in the direct beam, varies according to

$$E_D(\nu) = \frac{1}{2} E_i(\nu) (1 + \cos 2\pi\nu vt)$$

The time-varying term in the above equation

$$I(t) = \frac{E_i(\nu)}{2} \cos 2\pi\nu vt$$

contains the information that results in an interferogram.

The interferometer thus acts as a modulator;



Interferogram. Output of Michelson spectrometer is a time-varying signal, this one of a broadband i-r source.

for a monochromatic radiant-source input, the interferogram is a cosine wave with an amplitude proportional to the intensity of the radiation, E_i , and frequency, $f = \nu v$ proportional to its wave number. By proper choice of the moving mirror's velocity, the output frequency will lie in the audio range and may readily be sensed and converted to an electrical signal (70 to 100 hz) by an infrared detector such as a thermister bolometer bridge.

Generally, though, the input radiation is not monochromatic, but has a continuous spectrum. For such an input source, the output is proportional to the integral of the above equation, so that the interferogram is

$$I(t) = \frac{1}{2} \int_0^{\infty} E_i(\nu) \cos 2\pi ft \, d\nu$$

where $E_i(\nu)$ now represents the power spectral density of the input radiation. The interferogram for a Nernst-glowler (a heated metal-oxide element) continuous-spectrum input is shown below.

An interferogram contains the same basic information as the spectrum of the input radiation that generates it. In fact, the interferogram is the cosine Fourier transform of the desired input power spectral density. As noted earlier, to reconstruct the input spectrum it's necessary to determine the inverse Fourier transform, which, for the ideal interferometer described above, is

$$E_i(\nu) = \int_0^{\infty} I(t) \cos 2\pi ft \, dt$$

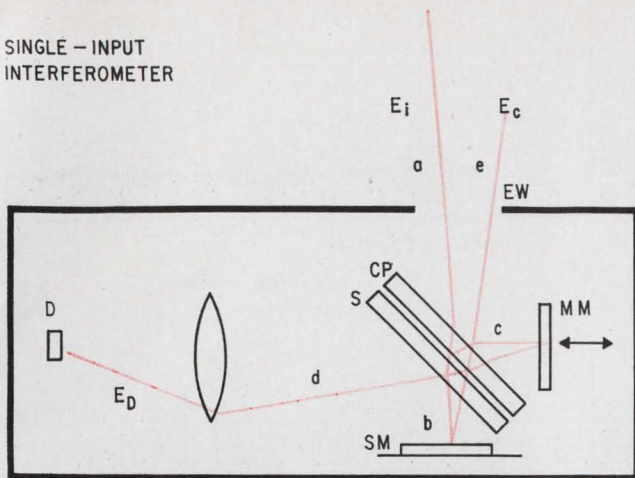
Before describing the determination of the input spectrum, it's important to consider the generation of a difference spectrum. This could be found by measuring the spectra of the sample and reference cells individually—either with two interferometers or by time-sharing a single unit—and then subtracting one from the other electronically. However, it's simpler to do this subtraction optically within the interferometer itself by adaptation of the device involving the complementary beam. If a low-loss dielectric beam splitter is used, the complementary beam in the schematic on page 117 represents the difference between the input radiation and the radiation in the direct beam reaching the detector.

$$\begin{aligned} E_C(\nu) &= E_i(\nu) - E_D(\nu) \\ &= \frac{1}{2} E_i(\nu) (1 - \cos 2\pi ft) \end{aligned}$$

To make differential spectral measurements, the conventional interferometer is modified to accept a second input, $E_i'(\nu)$, via a second entrance window and a small mirror, as shown on page 117. $E_i'(\nu)$ is incident on the beam splitter perpendicular to $E_i(\nu)$. The second input is modulated in the same way as the first to produce direct and complementary beams, $E_D'(\nu)$ and $E_C'(\nu)$.

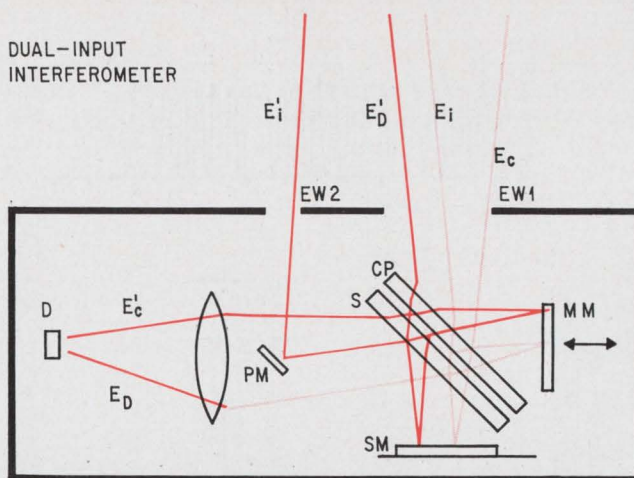
Output E_D' appears at the first entrance window and output E_C' at the detector. The spectral power sensed by the detector thus consists of the direct

SINGLE-INPUT INTERFEROMETER



- SM - STATIONARY MIRROR
- MM - MOVING MIRROR
- S - BEAM SPLITTER
- CP - COMPENSATING PLATE
- EW - ENTRANCE WINDOW

DUAL-INPUT INTERFEROMETER



- EW1 - FIRST ENTRANCE WINDOW
- EW2 - SECOND ENTRANCE WINDOW
- D - DETECTOR
- FM - FOLDING MIRROR

Beam splitters. Basic Michelson interferometer, left, doesn't use the complementary beam, e put the dual-beam type at right does use it to optically subtract beams from the sensing cells.

beam of the first input plus the complementary beam of the second.

$$E_o(\nu) = E_D(\nu) + E_{C'}(\nu)$$

$$= \frac{E_i(\nu)}{2} (1 + \cos 2\pi ft) + \frac{E_i'(\nu)}{2} (1 - \cos 2\pi ft)$$

In the detection system, the first interferometer input is the output of the sample cell and the second is the output of the reference cell. When the cells are empty of air, the two inputs have the same spectral power and each is proportional to the spectral radiance of the source multiplied by the spectral reflections or transmittance of the various elements of the optical system.

When the sample cell contains an absorbing material with spectral transmission $\tau(\nu)$, the direct beam of the first input is attenuated by this factor. Assuming no absorption in the reference cell, the complementary beam of the second input remains unchanged. The time-varying component of the detected signal, the interferogram, is therefore

$$E_o(\nu) = -\frac{E_i(\nu)}{2} \alpha(\nu) \cos 2\pi ft$$

where $\alpha(\nu) = 1 - \tau(\nu)$

is the spectral absorption coefficient of the sample. By optical subtraction, then, the amplitude is proportional to the difference between radiation inputs to the two windows at the corresponding wave number.

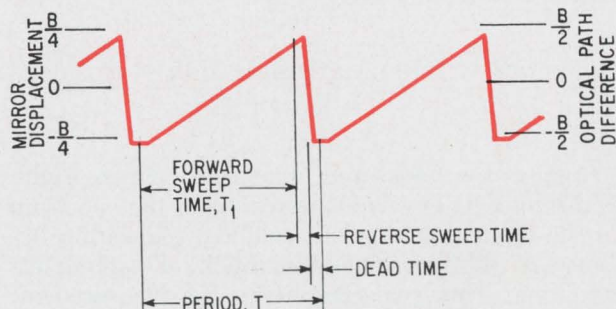
Until now it has been assumed that the interferometer mirror moves indefinitely and produces a nice continuous signal. But for practical rea-

sons, this motion must be limited to a rather small excursion. As a result, the spectral content of the interferogram differs somewhat from that of the radiation to be measured. The mirror is driven by an electrically controlled actuator in a sawtooth fashion, as shown below. Each forward sweep of the mirror, which occurs at a constant velocity, generates an interferogram, during each rapid-return sweep, for a monochromatic input at wave number ν_a , the interferogram consists of a repeated sequence of cosine wave segments, as shown on page 118, rather than a continuous cosine wave.

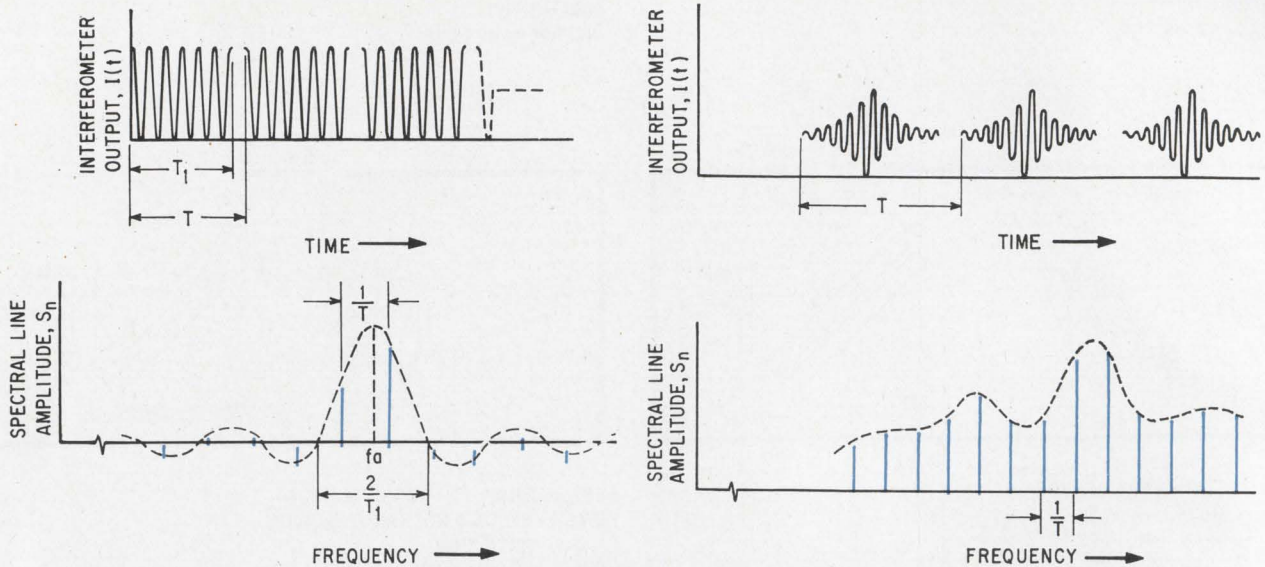
Since this waveform is periodic, its spectrum is given by the coefficients of a Fourier series expansion rather than by the Fourier transform. Good approximations of these coefficients are

Monochromatic source—

$$S_n = KE_i(\nu_a) \alpha(\nu_a) \frac{\sin \pi T_1 (f_n - f_a)}{\pi T_1 (f_n - f_a)}$$



Blackout. Moving mirror sweeps a limited distance, so a signal develops only during forward sweep.



Consider the source. A monochromatic i-p source would weld chunks of cosine waves (left). But interferograms for a broadband source looks like those at right. Discrete spectral amplitudes are shown at bottom.

$$e_o (\text{rms}) = \left[\frac{1}{2} \sum_{n=1}^{\infty} \left| Y \left(\frac{j 2\pi n}{T} \right) \right|^2 \int_0^{\infty} K E_i (\nu) \alpha (\nu) \frac{\sin \pi T_1 (f_n - f)}{\pi T_1 (f_n - f)} df \right]^{1/2}$$

where f_a is the frequency corresponding to ν_a or ($f_a = B\nu_a/T_1$); f_n is the n th harmonic frequency or ($f_n = n/T$); and K is the proportionality constant.

The resulting discrete spectrum, shown above, left, consists of harmonics at integral multiples of the repetition frequency, n/T . In practice, a monochromatic radiant source won't be used. The prototype contamination system needs a heterochromatic—or broadband-input—source, the Nernst glower.

For heterochromatic radiation, the interferometer output consists of a repeated sequence of interferograms such as those above, right. The expressions for the spectral lines may be obtained by integrating the Fourier series coefficients over all frequencies present in the input spectrum.

Heterochromatic source—

$$S_n = \int_0^{\infty} \frac{K E_i (\nu) \alpha (\nu) \sin \pi T_1 (f_n - f)}{\pi T_1 (f_n - f)} df$$

Again, the measured spectrum shown right, is discrete. Its envelope approximates the spectrum of the input radiation but exhibits a smearing because of the constrained duration of each interferogram. This smearing limits the measurement resolution — the ability to distinguish between closely spaced spectral lines in the input.

Resolution is also affected by the electronics in

the system. Since each filter analyzing the interferometer output has a finite bandwidth around its center frequency, its output contains contributions from all interferogram frequencies in its bandwidth.

This effect can be expressed quantitatively by considering the response of a bandpass filter represented by a frequency response function, $Y(j\omega)$, to a complex periodic waveform represented by the integrated Fourier series coefficients above. That is, the combined effect of the interferometer and filter can be found by considering the harmonic components of the interferometer output as the filter's input. The filter-output equation, without further mathematical development, is shown immediately above.

This combined-effect equation, which represents a mathematical model of the system, was used in the computer simulation mentioned earlier to determine the identification logic. The simulation program took into account the effects of the infrared source's emission spectrum, the reflection and transmission spectra of the optics, and the interferometer and filter response functions.

A given computer run yielded the response of each filter channel to the absorption spectrum of a specified substance. Using experimental data on the spectral characteristics of the system components and published data on the spectral properties of various contaminants and interferents, the system response to each substance was determined.

Designer's casebook

Synchronizing a camera with a flash tube

By Robert C. Wenz

Alpine Geophysical Associates Inc., Norwood, N.J.

During the manufacture of underwater cameras the cam-actuated contacts for the flash unit must be synchronized with the shutter. With a 1/50-second focal-plane shutter, the entire frame is open for only 2 or 3 milliseconds. It's during this short interval that a flash must be triggered to ensure that the entire frame is exposed.

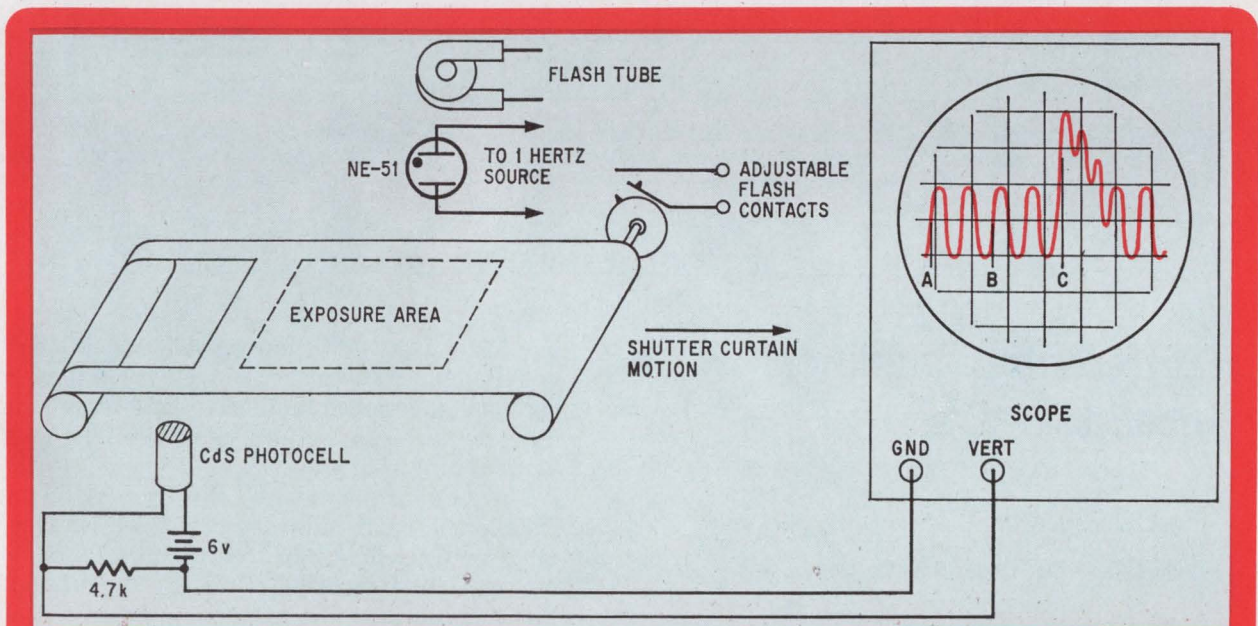
A simple, low-cost photoconductive cell can be used to adjust the synchronization. Cadmium selenide types are satisfactory and require no further amplification.

A neon lamp such as the NE-51H is placed in front of the shutter and supplied with a 1-kilohertz voltage source. The photocell is placed inside the camera behind the leading edge of the shutter

curtain, with all ambient light excluded. A 6-volt d-c supply is used with a 4.7-kilohm load resistor in series with the cell. Finally, an oscilloscope with a triggered sweep is connected across the load resistance so the firing point can be determined.

As the shutter is released, the oscilloscope will display the series of timing pulses produced by the exposure of the photocell to the neon lamp for the duration of the shutter opening. Since the lamp is excited by a frequency of 1 kHz, each pulse represents 1 msec. The flash unit is placed in front of the shutter so some of its light will also enter the camera. As the shutter is tripped, the series of pulses are displaced vertically on the scope at the instant the flash is detected. The exact time of the flash in relation to the shutter opening is determined by counting the pulses up to the point of displacement. Measurement accuracy can be increased by simply raising the frequency of the exciting voltage to the neon lamp.

One of the advantages of this system is that the measurement is independent of the characteristics of all components, including the time base of the scope.



In sync. Cam actuated switch for a strobe light is adjusted by counting pulses on an oscilloscope. The neon lamp is excited by a 1-kilohertz source and thus the scope displays 1-millisecond pulses. When the strobe is triggered, the pulses are displaced and the exact firing point can be determined.

High-current switch is driven by an IC

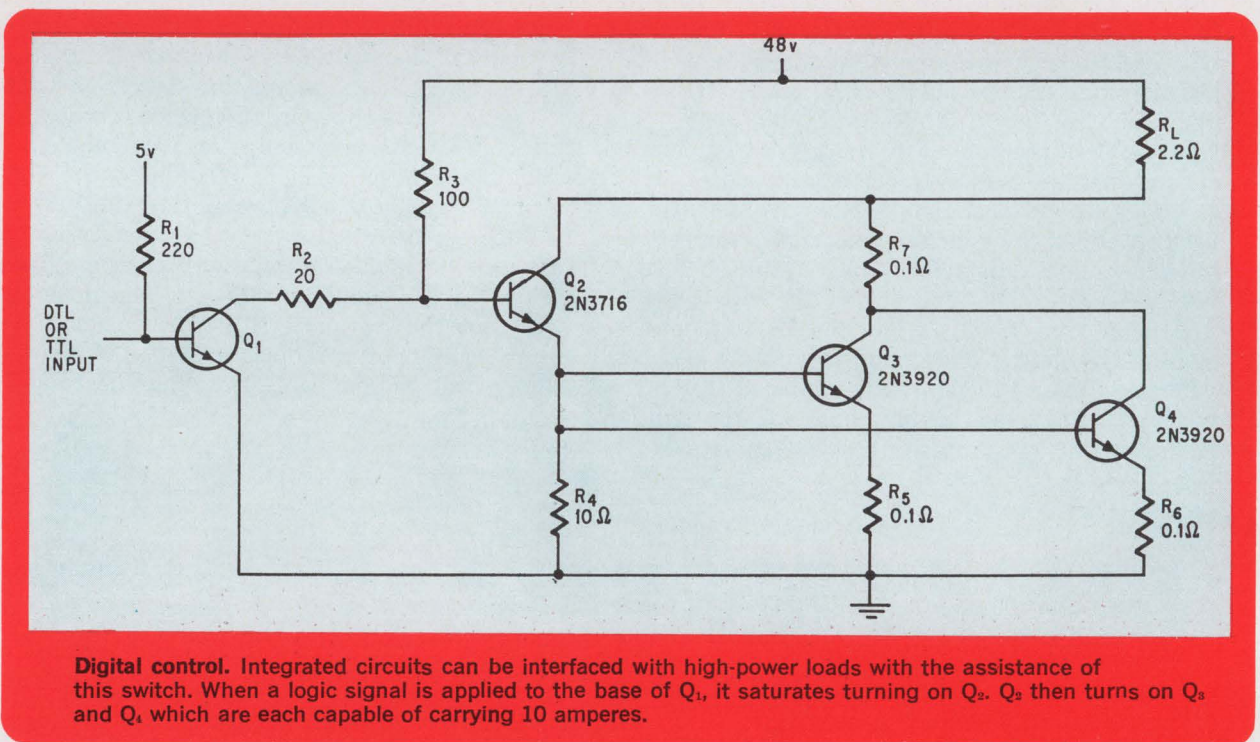
By Lynn S. Bell

Burr-Brown Research Corp., Tucson, Ariz.

A complementary compound switch, operated by a buffer transistor, interfaces current loads as high as 20 amps with conventional digital integrated-circuit logic elements.

Resistor R_1 provides the base drive required to saturate the buffer transistor, Q_1 , when the input logic level is high. R_2 sets enough Q_2 base current to turn on Q_3 . Transistors Q_3 and Q_4 saturate because of the current through R_7 , thus minimizing the circuit's power dissipation.

Turn-off switching losses are reduced by supplying reverse base current to Q_2 , Q_3 , and Q_4 by means of the voltage drop across R_3 , R_4 , R_5 , R_6 , and the load. If fast turn-off isn't required, R_5 and R_6 can be eliminated, further reducing dissipation. If this is done, Q_3 and Q_4 must be matched to ensure that the load current is properly shared between them.



Digital control. Integrated circuits can be interfaced with high-power loads with the assistance of this switch. When a logic signal is applied to the base of Q_1 , it saturates turning on Q_2 . Q_2 then turns on Q_3 and Q_4 , which are each capable of carrying 10 amperes.

Differential amplifier uses two IC's

By C.J. Ulrick

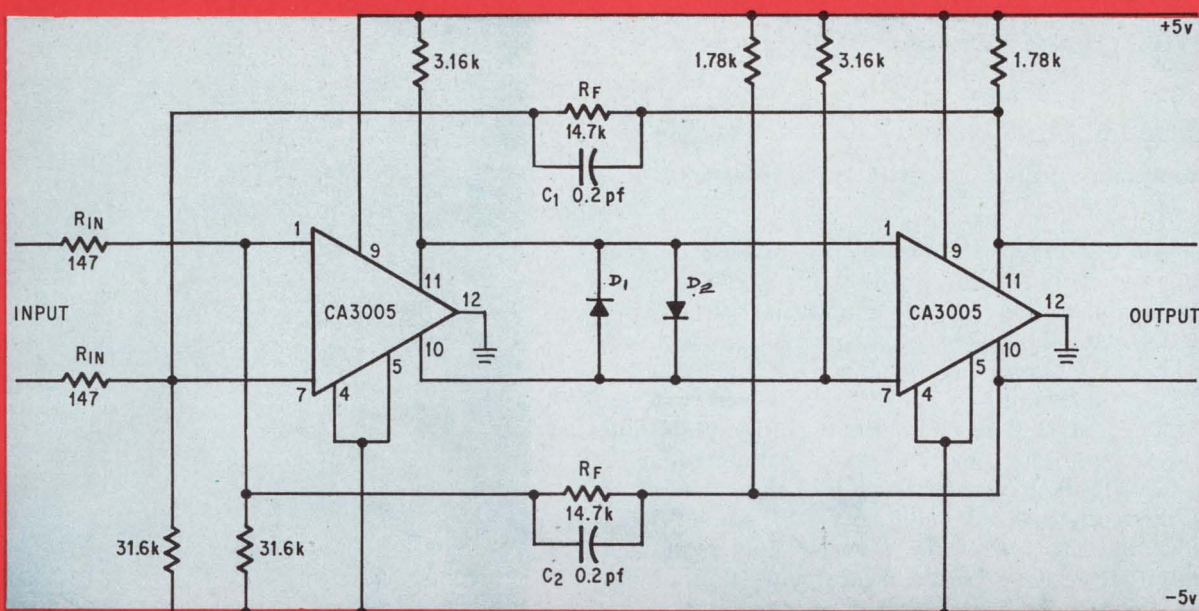
Collins Radio Co., Cedar Rapids, Iowa

Monolithic r-f amplifiers are often useful for functions other than those intended by their designer. The circuit shown, for example, uses two such r-f

amplifiers as a stable and reliable wideband differential amplifier. The gain is set by a resistor ratio, as in an operational amplifier; in the circuit shown, the gain is R_F/R_{IN} —in this case, 100. The gain can be varied by changing R_{IN} .

The rolloff capacitors, C_1 and C_2 , may be needed to hold the bandwidth down if there isn't enough inherent capacitance in the resistors used for R_F . The capacitors must be chosen so that the gain is less than unity at the frequency where the amplifier's phase shift is 180° , or the amplifier will oscillate.

Clamp diodes D_1 and D_2 are required when the



Pair. Two RCA CA 3005 r-f amplifiers combine to form a wideband differential amplifier. The gain is controlled by the ratio of R_F/R_{IN} . Capacitors C_1 and C_2 aren't needed if the two R_F resistors have enough inherent capacitance.

amplifier will be driven into overload by large differential inputs. The diodes cause the output to clip symmetrically and ensure fast recovery.

The bias and load resistors are not critical, but

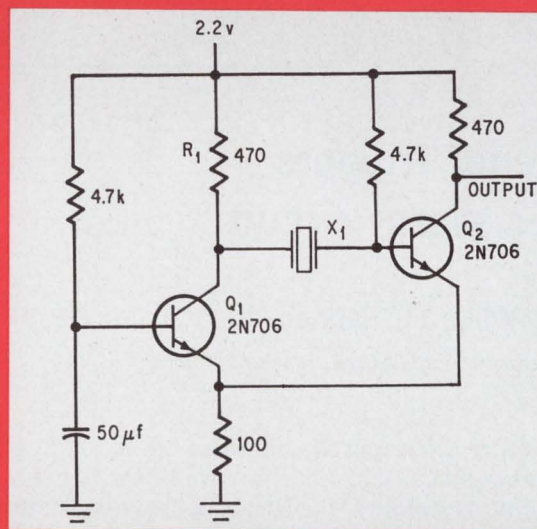
they should be 1% units so that the gain will stabilize at the desired value. For the values shown, the amplifier has a bandwidth of 20 megahertz and a delay time of 20 nanoseconds.

Crystal gives precision to a stable multivibrator

By Gordon W. Harrison

Randwick, Australia

A crystal-controlled squarewave oscillator was needed to drive a chain of synchronized divide by 10 multivibrator stages for use in calibrating the time bases of precision oscilloscopes. An emitter-coupled multivibrator using a crystal instead of a timing capacitor makes an excellent pulse generator. The circuit operates like any conventional multivibrator, except that the output of Q_2 is used to excite the crystal instead of charging a capacitor. Because of this, the circuit is forced to oscillate at the crystal frequency and is thus more accurate.



Crystal swap. Crystal replaces a capacitor in an emitter-coupled multivibrator to form a highly-accurate pulse generator.

Current limiter improves power supply

By Jan K. Studebaker

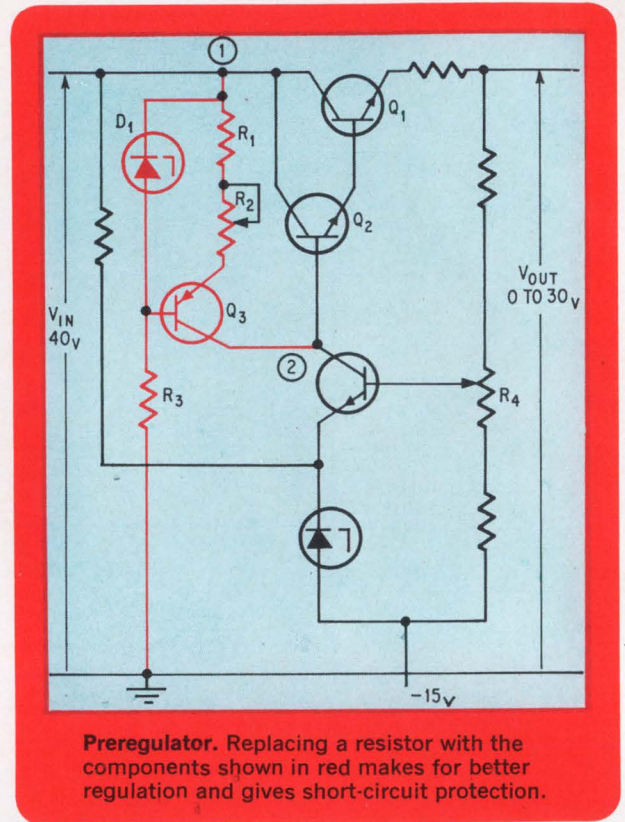
Los Alamos Scientific Laboratory, Los Alamos, N.M.

Simple additions to a variable transistor-regulated power supply results in better regulation, less ripple, and complete overload and short-circuit protection, including a variable current limit.

The added components, shown in red, replace a resistor that would normally be connected between points 1 and 2. The voltage between points 1 and 2 varies with the power supply's output voltage—as the output decreases, there is a higher potential difference between 1 and 2 and thus more current flows through Q_1 . If the power-supply load is a high resistance, very little current flows through Q_1 . But if the load resistance is lowered—by a short-circuit for example—the current increases, causing Q_1 to draw too much current. If the resistance between points 1 and 2 were higher, the overconduction of Q_1 could be eliminated, but the power supply would no longer regulate properly.

The substitution of a current source between points 1 and 2 permits the power supply to regulate over a wide range and restricts the short-circuit current to a value determined by the current source and the equivalent beta of Q_1 and Q_2 .

In operation, R_1 functions as a maximum current limit control. The higher the resistance in the emitter circuit of Q_3 , the lower the current from the current source. The variable high-resistance



potentiometer R_2 , in series with R_1 , allows the maximum current limit of the supply to be lowered, from the value preset by R_1 to any smaller value. R_3 should be large enough to prevent burn-out of D_1 , and small enough to ensure that the current through D_1 is at least 20 times the base current of Q_3 .

Zener triggers a-c alarm circuit

By Willard L. Fadner

Mankato State College, Mankato, Minn.

A zener diode can fire and turn off an alarm circuit without backlash. And because of the zener's temperature stability, the firing point is constant over a wide temperature range.

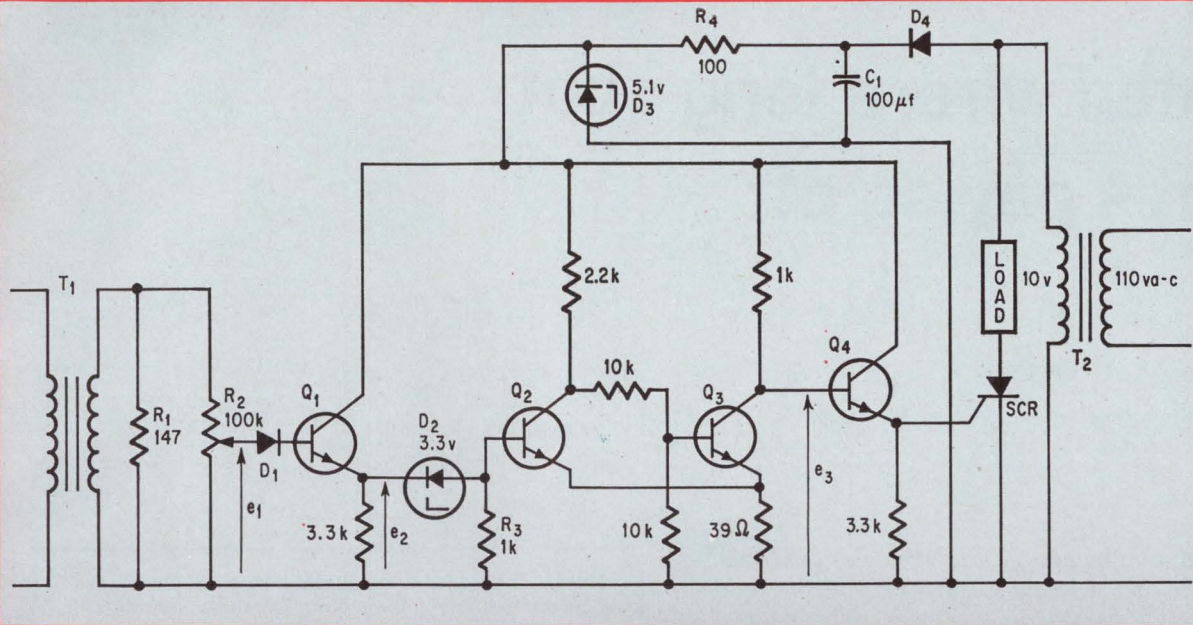
A current of up to 40 amperes flowing through the primary of T_1 produces a voltage drop across R_1 . A portion of this voltage is picked off by R_2 ,

which sets the firing point of the alarm, and is rectified and fed to the emitter follower, Q_1 . This stage is needed to limit the current through R_2 and D_1 and thus limit the current that D_2 draws.

If e_2 is greater than the zener voltage—3.3 volts here—the Schmitt trigger composed of Q_2 and Q_3 is fired. As a result, e_3 rises abruptly to the power-supply level, causing Q_4 to conduct and triggering the SCR. The load, in this case an alarm buzzer, is fired once every half cycle. Q_4 is used to match the impedance between the SCR and Q_3 .

R_3 is needed to prevent thermal runaway of Q_2 , but it's large enough to draw very little current through D_2 , D_3 , D_4 , R_4 , and C_1 form the circuit's power supply. For proper operation, the secondary of T_2 must be in phase with e_1 .

The circuit can also be used for a d-c alarm



Alternating sound. Alarm circuit can be set to trigger at a precise point because the firing is controlled by a zener diode. The zener, D_3 , fires a Schmitt trigger that turns on the SCR. Depending upon the type of transformer used for T_1 , up to 40 amps can initiate operation.

by eliminating T_1 and D_1 . And part of the circuit —all components except T_1 , R_1 , R_2 , D_1 , and the SCR

—can replace the Schmitt trigger in a high-frequency, pulse-shaping circuit.

Capacitor slows down stabilized power supply

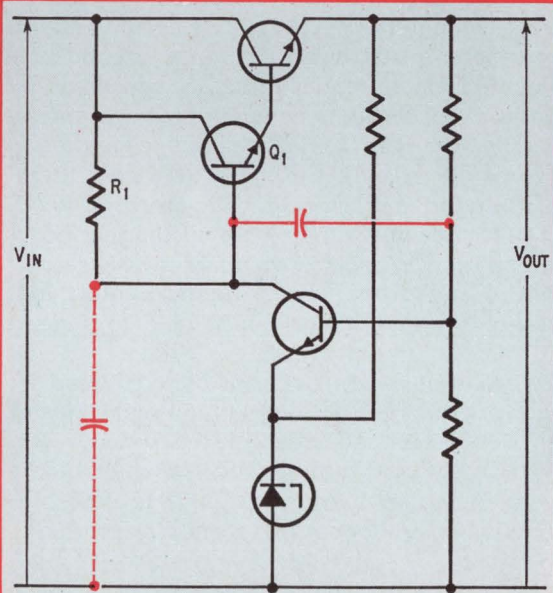
By A.G. Ogilvie

Holstebro, Denmark

It's often desirable to turn on a high-voltage power supply slowly. For example, if the full supply voltage is suddenly applied to a hi-fi amplifier, a loud pop is heard when the output capacitor charges up and the speaker may be damaged. With the addition of a capacitor, the series regulator circuit can be modified to turn on slowly.

In a basic series regulator, the voltage at the base of Q_1 rises exponentially as C charges through R ; hence the output voltage gradually increases. To obtain a rise time of 3 seconds, for example, a 400-microfarad capacitor is required.

The same rise time can be obtained by connecting the capacitor in the manner indicated by the solid red line. Since the effective capacitance is $(h_{fe} + 1)C$, a much smaller capacitor can be used.



Users' choice. Capacitor can be connected as shown by dotted or solid lines. The latter offers longer delays for smaller capacitance.



Plated wire: a long shot that's paying off

By George A. Fedde

Univac division, Sperry Rand Corp., Blue Bell, Pa.

Eighteen months ago, plated wire was described as "Univac's bet to replace toroidal ferrite cores." Well, Univac is still in the game, which now has many more players than it did then. The division has met its cost-performance goals and is reasonably confident in predicting major improvements.

Production of plated-wire memories is expanding at about six times as fast a rate as the over-all production of random-access memories in the U.S. This is partly due to the fact that the base rate is very small, but it also indicates that significant progress has been made overcoming production problems. Current annual output of plated wire is about 2.5% of the estimated total for all types of random-access memory this year, and most of this production is going on at Univac for the division's 9000 series computers.

By and large, plated-wire memories are being used in new products requiring higher speeds and lower costs than ferrite technology can provide. For example, the Univac 9000 series computers wouldn't operate at both the speed and cost that they do if they had ferrite-core memories. Plated wires aren't replacing ferrite-core memories, nor are they expected to replace them, in the sense of production changeovers. They're being applied in areas that core arrays haven't been able to penetrate.

But an evolutionary replacement of ferrite cores in the main memories of new computers is just starting. This period of profitable coexistence is expected to last at least through 1972, at which time plated-wire units may account for 10% to 20% of the production of random-access memories production in the U.S.

Bandwagon

Univac's decision to develop and produce plated-wire memories has been followed recently by similar decisions at other firms. Their present substantial efforts, added to Univac's, are moving plated-wire technology at an accelerating pace.

This is the second installment in a series of articles on memory technology. The first installment, which included articles on ferrite core memories and planar thin films, appeared in the October 28 issue of Electronics. —W.B.R.

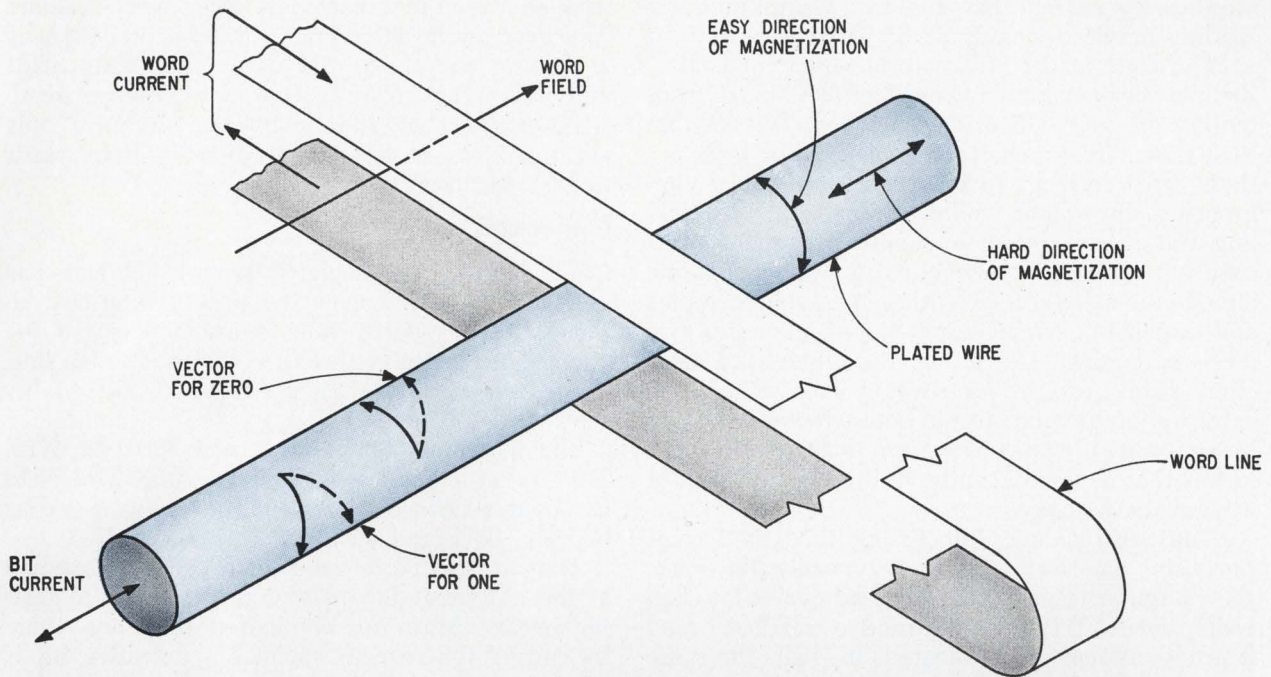
For example, Honeywell Inc. is now building plated-wire memory stacks for Government-funded programs [see cover photo] and may soon offer them commercially. Toko Inc. of Japan and its licensee, the Librascope Group of Singer-General Precision Inc., also offer plated-wire memories and stacks [see p. 131]. The National Cash Register Co. has been producing plated wire with somewhat different magnetic characteristics for some time [see p. 128], and the volume may soon increase substantially in the wake of the company's recent announcements of new equipment using the wire.

Other companies working on various aspects of the technology include the Electronics division of the Lockheed Aircraft Corp.; Electronic Memories Inc.; RCA; the Autonetics division of the North American Rockwell Corp.; the Stromberg-Carlson Corp., a subsidiary of the General Dynamics Corp.; the Indiana General Corp., the Ferroxcube Corp. of America; Philips' Gloeilampenfabrieken; Plessey, Ltd.; the Nippon Telephone & Telegraph Public Corp.; Siemens A.G. and government-supported laboratories in France and Japan.

Definition

Plated wire is a specially cleaned and prepared beryllium-copper wire 5 mils in diameter that's electroplated with a layer of magnetic alloy about 30 microinches thick. The alloy is about 80% nickel and 20% iron, and, like most thin films, is magnetically anisotropic—it can be more easily magnetized in one direction than in another.

A current in the wire during the plating process



One-turn coil. A current in the word line tilts the vector magnetization from its rest position, shown in solid lines, toward the hard axis of magnetization, generating a pulse in the plated wire.

establishes the magnetic easy axis circumferentially around the wire. Thus a particular spot on the wire can be magnetized either clockwise or counterclockwise, corresponding to the 1's and 0's of binary data. The same current applied while the wire is heated in a reducing atmosphere at the end of the plating process anneals the wire and stabilizes the film so that it retains its magnetic properties indefinitely. Without this step the wire's characteristics would deteriorate too rapidly for practical application.

The closed flux path offers significant advantages over the open path that is characteristic of single planar thin-film elements. With an open flux path, the element would tend to demagnetize itself unless it were made of a material with high coercive force—particularly if it were small. But with the closed path, the film thickness is not dictated by considerations of self-demagnetization. With no gaps in the path, the minimum bit current is obtained for a given material and path length.

Twenty bits can be stored in each inch of the wire, which is plated, annealed, and tested in a continuous process, and then cut into segments a foot or two long for incorporation into a memory system.

The size and position of the bit storage cell is set by the interaction of the magnetic drive field generated by current in the word line, as shown above, with digit write current in the wire. Each word line forms a solenoid of a few turns around all the parallel wires in a memory module, or one turn around 160 wires in Univac's 9000 series.

The plated wires are inserted in "tunnels" 30 mils apart in a layer of plastic, and the word lines

are on printed-circuit boards on both sides of the plastic. An unplated dummy wire is inserted in intermediate tunnels at intervals as a noise source to cancel the common-mode noise in the plated wire, and six unconnected plated wires at each edge of the array provide the same magnetic environment for the outermost connected wires as for wires in the center.

This storage element has a number of special characteristics that are particularly interesting when compared with those of conventional ferrite cores and planar thin films. Also, the single drive line in a plated-wire storage element is its own sense-digit line. Also, plated wire has an explicit output for a 0 readout. Cores ideally would have no output, but they always generate a little noise. Planar films have explicit 0 outputs, but in most versions, the signals for 1 and 0 are smaller than those in cylindrical films; the flux path of a single planar element is open, and that of two coupled planar elements has two air gaps in it. The one disadvantage of plated wire at the present state of the art is its relatively low bit density.

Nondestructive readout

But plated wire is capable of nondestructive readout, which isn't available with the mass-produced versions of the other two types of memories. This NDRO capability reduces the amount, and therefore the cost, of the peripheral electronic circuitry required by a two-dimensional memory, and permits an organization similar in some ways to the 2½-D ferrite core layout, which attains high speed at low cost even in small module sizes. Plated-wire memories are most economical when the

word drive current has the same amplitude for reading nondestructively as for writing.

[The alert reader will note an apparent contradiction between this statement and Al Bates' contention on page 115 of the October 28 issue that NDRO is more expensive than DRO. But both authors are correct, given their companies' approaches. Burroughs would achieve NDRO by tickling the memory with a smaller current than is used for writing. This would require either separate circuits for reading and writing, or a more complex and expensive circuit capable of delivering two levels of current. Univac, on the other hand, uses equal word currents for reading and writing; the extra wallop to wipe out old data when new data is being written comes from the bit current. This means that new data can be written in only part of a word if necessary.]

NDRO also reduces processing time in a computer by one-third, if, as is typically the case, the computer takes about four read cycles for each write cycle. With nondestructive readout, read instructions can be executed in half the time required by a ferrite-core or other DRO memory. Reading out a core clears, or destroys, the data

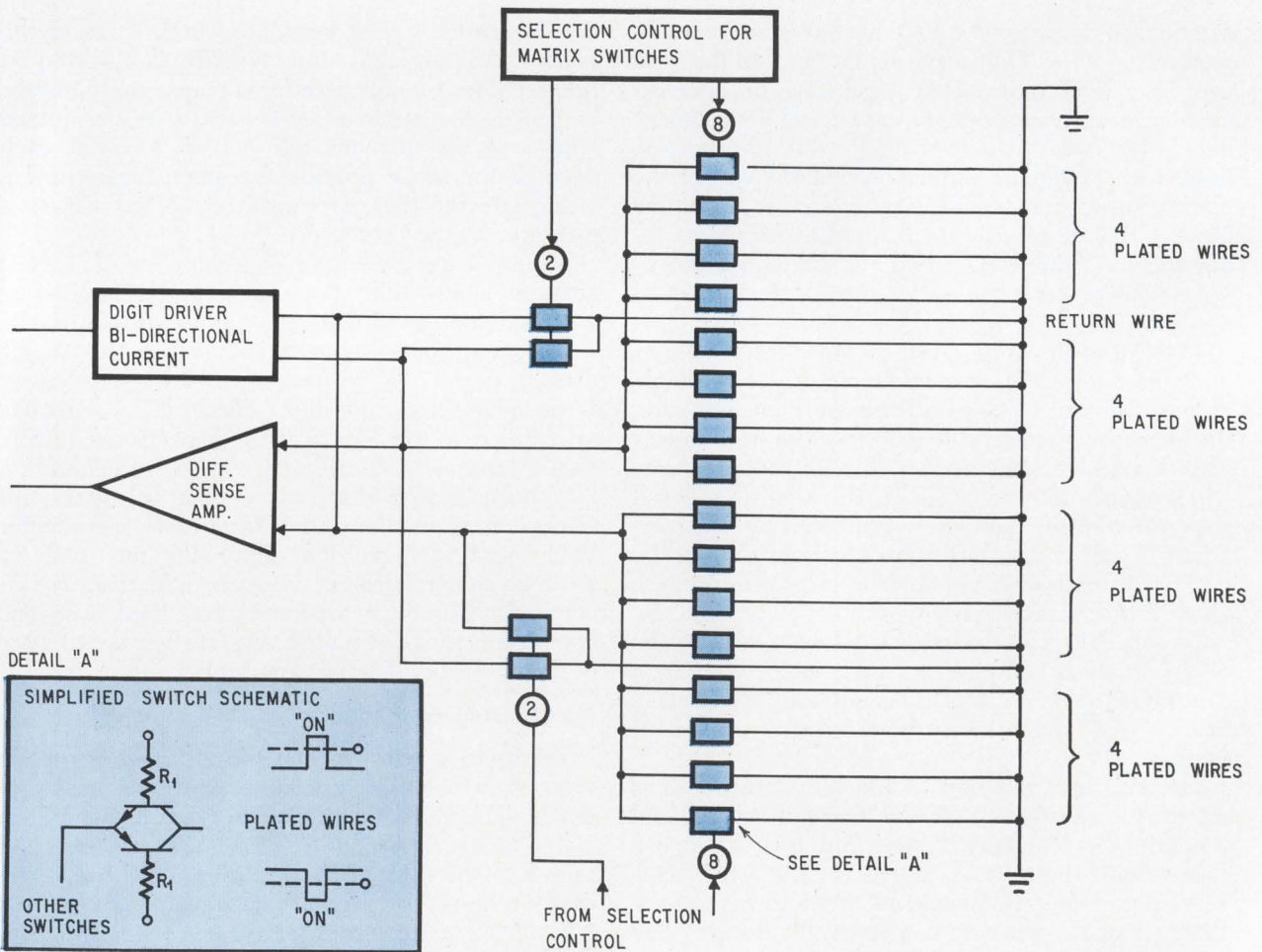
in it, so a rewrite is necessary after every readout. And every write instruction must be preceded by a clearing out of the old data. Thus four reads and one write require 10 operations—five read-write pairs. The same instructions require only six operations in this NDRO memory: four reads and one clear-write pair.

Few rejects

The production of plated wire at Univac has more than doubled over the past two years. Although this is partly due to an increase in the number of plating machines in the production line, it also reflects improvements in yield and quality control.

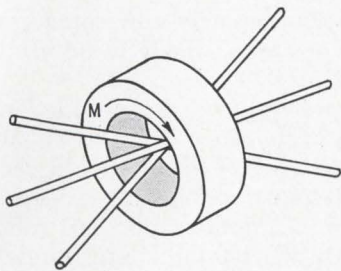
The individual bit yield is now 99.61%. With 270 bits on a single length of wire, the wire yield is about $(0.9961)^{270}$ or 0.445; actually it varies between 35% and 60%.

Thus an average of one bit in every 256 is bad at the output of the plating process, where testing occurs. Most are eliminated then and there by cutting the wire as soon as a defective bit is located. A few slip through, and a few wires are found to have bad spots later on. Nevertheless,

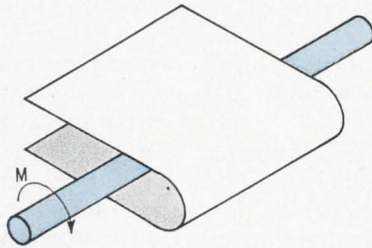


Sixteen to one. One sense amplifier or bit current driver is connected to one of 16 plated wires and to one of two dummy wires through a matrix of switches that permit high-speed operation at low cost.

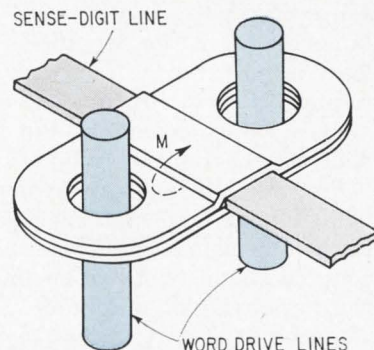
FERRITE CORE

TWO SELECTION WINDINGS-
ONE SENSE WINDING

PLATED WIRE

ONE WORD
DRIVE LINE

FLAT FILM



Competitors. Plated wire, like planar thin films, switches 10 to 30 times as fast as ferrite cores with perhaps 1/15 the energy per element, and occupies about 1/100 the volume. Both plated wire and planar films have bipolar output signals, but the wire's output is about 10 times as large as the film's, and 1/4 as large as the core's.

only about one in 10,000 bits is defective after the memory plane is assembled.

It's become possible in the past year to measure and control the magnetostriction coefficient, a very important parameter, on the moving wire in the plating machine.

The relative concentrations of nickel and iron in the plating bath are now being controlled continuously. This maintains the optimum levels more closely than formerly, when discrete portions of each element were added as needed.

The electronic circuits and the memory planes containing the plated wires are undergoing evolutionary changes, most of them represent attempts to improve the signal-to-noise ratio. They include a new low-gain preamplifier stage, layout changes in the sense amplifier and signal strobe circuits, and improved low-level switching circuits.

These low-level switches connect one sense amplifier or bit current driver to one of 16 sense-bit circuits, as shown at left, and to one of the two unplated dummy wires associated with the 16 circuits. Write current passes along both wires. If a read operation is to ensue immediately, either both the plated wire being read and the selected dummy wire must have been used in writing, or neither of them. Otherwise, one of the wires would have a decaying voltage on it that the sense amplifier would see as noncommon-mode noise.

Through any given cycle, 15 switches are off to prevent the unselected sense lines from reducing the sense signal available to the amplifier or from diverting bit current from the selected plated wire during a writing.

Three goals

Current research and development programs are giving special attention to semiconductor circuits in three particular areas.

For one thing, if the plated-wire memory is to have a 100-nanosecond cycle time, it needs a new low-level switch. The present switch produces an offset voltage when it's on; a switch made with a field-effect transistor would have no offset volt-

age, but wouldn't operate at cycle times much below a microsecond. The switch must also be capable of carrying the 40-milliampere digit drive current. The right combination of fast turn-on and turn-off times with low capacitance, resistance, and cost is being sought.

All plated-wire memories require a magnetomotive force of 750 to 1200 ma-turns. When a one-turn word coil is used, the necessary current is easily carried by discrete or hybrid-chip semiconductors. To use monolithic integrated circuits in the drive circuits, the amount of current must be reduced to about 30% to 40% of its present value. Experiments indicate that low-reluctance paths for the word-line flux may make such a reduction possible. Such paths can be established through a magnetic keeper—a layer of magnetic material on top of the word lines.

Present plated-wire memories operating at 500-nsec cycle times have a diode in series with each word line, permitting a very economical transistor switch matrix to select the word lines. These matrixes would be feasible down to about 150 nsec. An alternative scheme, which would work at both faster and slower speeds, would replace the diode with a transistor whose base and emitter are connected to switch matrixes. This method would be especially attractive with monolithic integrated circuits, and would reduce the noise coupled into the sense lines by permitting the grounding of one end of the word lines.

Not that all research and development on the plated-wire element has come to a screeching halt. A whole new optimum set of magnetic parameters will probably have to be worked out for tomorrow's high-speed systems, covering such things as film thickness, coercive force, and anisotropy field. Coercive force is the minimum magnetic-field intensity required to remove the residual magnetism from a saturated material; anisotropy field is a measure of the magnetic field that saturates an anisotropic film in its hard direction.

A thinner film would mean fewer milliampere-turns required in the word line, higher coercive

force, and a smaller change of flux coupled to the sense line during readout. The output signal would be smaller, but that would be compensated for, at least in part, by the fact that a very fast memory requires a short rise time on all input and output signals, which maintains the peak amplitude and shortens the signal duration.

Some researchers are exploring the advantages of a thinner wire. For a given film thickness and bit length, a smaller diameter would reduce the flux coupled to the word drive line, without affecting the output signal's amplitude. Slimmer wires would also permit the word lines to be placed closer together, reducing the fringing of the drive field to adjacent bits and possibly leading to a higher bit density. But the thinner wire would be harder to handle than the present variety, and would tend to increase signal attenuation because of its higher resistance.

For all this, though, today's R&D efforts should produce memory systems in the not too distant future with module capacities of 100,000 to 1 million bits, cycle times of 100 nsec, and access times of 55 to 60 nsec—at a cost only slightly higher than that of present 500 to 600-nsec cycle memories. Plated wire is also attractive for very large memories of up to 100 million bits. These memories were estimated early in 1967 to cost significantly

less than one cent per bit, but recent developments indicate that the estimate was quite conservative. However, until production capacity can catch up with demand, plated wires aren't likely to be used commercially in such sizes.

The next step will probably be the production of larger modules with cycle times down to about 200 nsec. The next three to five years should see the introduction of 100-nsec random-access memories with capacities up to a million bits, and sub-microsecond memories in the 100-million-bit range.

Bibliography

- W.O. Freitag, J.S. Mathias, and G. DiGuilio, "The Electrodeposition of Nickel-Iron-Phosphorus Thin Films for Computer Memory Use," *Electro-chemical Society Journal*, January 1964, p. 35.
- H.O. Leilich, "The Chain—A New Magnetic Film Memory Device," *Journal of Applied Physics*, March 1966, p. 1361.
- J.P. McCallister and C.F. Chong, "A 500-Nanosecond Main Computer Memory Utilizing Plated-Wire Elements," *American Federation of Information Processing Societies, Conf. Proc.*, vol. 30 (Fall Joint Computer Conference), 1966, p. 305.
- G.A. Fedde, "Plated-wire memories: Univac's bet to replace toroidal ferrite cores," *Electronics*, May 15, 1967, p. 101.
- S. Waaben, "High-Speed Plated-Wire Memory System," *IEEE Trans. on Electronic Computers*, June 1967, p. 335.
- J.R. Brown Jr., "Internal Memory Systems," *Modern Data Systems*, February 1968, p. 62.
- C.F. Chong and G.A. Fedde, "Plated-Wire Memory, Present and Future," *Proc., International Conference on Magnetism*, 1968.

Memories VI



Rods look like wires, act like cores

By Donal A. Meier

National Cash Register Co., Hawthorne, Calif.

Cylindrical, thin magnetic films plated on wire with axially oriented storage states have replaced ferrite cores as the storage medium in high-performance digital computer memories at the National Cash Register Co. Unlike those used in other forms of plated-wire and thin-film memories, these films are isotropic and are made of a material with a high coercive force.

These two film characteristics give the wires, or rods, a number of advantages. Like cores, the films retain their magnetic characteristics indefinitely without annealing even though the flux path is open. This is true whether they are repeatedly switched back and forth or made to retain a fixed magnetic state for a long period of time.

Also, the plating process can be relatively speedy—much faster than the plating of wires with a circumferential anisotropic film. Finally, problems of magnetostriction, skew and dispersion, which plague designers of planar thin-film memories and plated wires with circumferential storage states, are avoided here. [An article on skew and dispersion problems will appear in a future issue of *Electronics*.]

Magnetic rods, which are organized in arrays like cores, have been used in many experimental and commercial memories. Of these, the most practical have been the two-dimensional organization in NCR's 315 RMC computer, the 2½-D form in the company's new Century series computers, and a

structure with two rod elements per bit. This setup, analogous to the two-core-per-bit arrangement, was used in an experimental memory that achieved 100-nanosecond cycle times.

First of its kind

Rods were introduced in the 315 RMC (for rod memory computer) machine, the first commercial computer with an all-thin-film memory. The 315, brought out in 1965, is being phased out of production, having been superseded by the recently announced Century series.

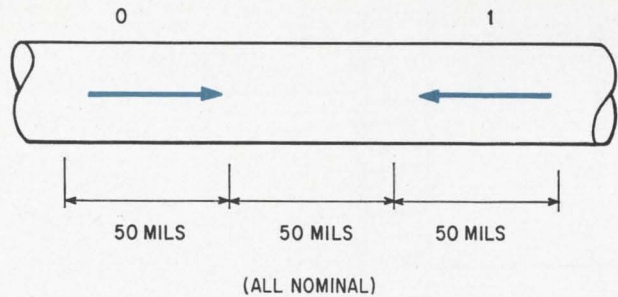
In the rods, the axially oriented magnetization reverses its direction by 180° when switching between binary 1's and 0's, as shown at right. The continuous plating, an alloy of 98% iron and 2% nickel, switches when subjected to a magnetizing force greater than 16 oersteds. [The corresponding energy is about 2×10^{-10} joule; compare this with the plated-wire figure of 1×10^{-10} joules.]

The rods used in the RMC processor are made from a continuous length of beryllium-copper wire 10 mils in diameter. This wire is passed at a speed of 15 feet per minute through a series of baths that deposit the plating material on it. When the wire emerges from the last bath it is immediately and continuously tested, helically wound with a copper ribbon, and cut into pieces seven inches long.

Fine wires wound on these lengths of wire establish the bit cells, typically 10 of them per linear inch of rod. The windings are interconnected between bit cells and between rods in a two-dimensional arrangement, as shown below. Word windings are machine-wound solenoids of 10 turns over a distance of 50 to 60 mils along the wire; digit-sense windings are continuous machine-wound helices of about 95 turns along the entire 7-inch rod. The solenoid's intersection with the helix defines a storage cell. Yield for the whole 7-inch length has been greater than 85% during the four years in which this RMC memory has been in production.

New whiskers

The newer Century series computers contain rod memories of a different design suitable to semi-automatic fabrication in large batches without the



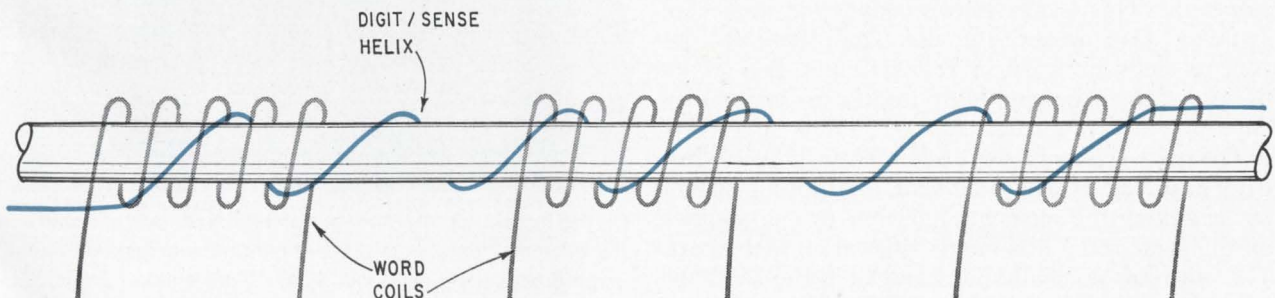
Reversal. Magnetized thin film on a rod is oriented parallel to the rod's axis, in opposite directions corresponding to binary 1's and 0's.

yield problems usually associated with batch fabrication.

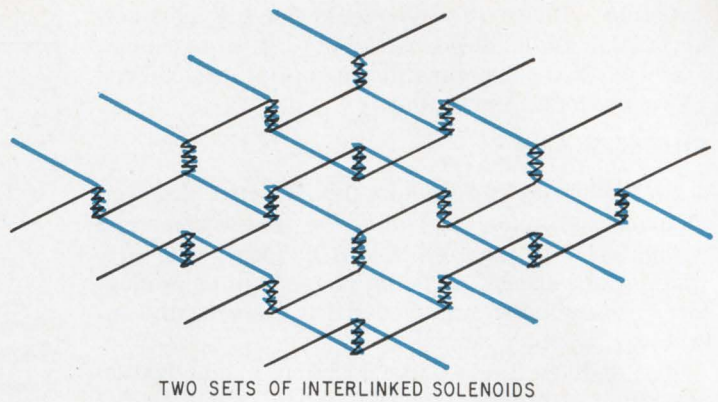
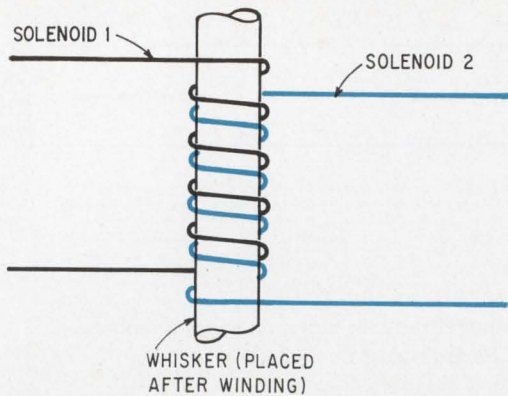
In the Century, the memory is assembled from modules of approximately 16,000 bytes. Each module contains 32 planes of 4,608 bits in a 64-by-72 array. Each bit is stored in a separate length of rod, or "whisker," about 1/10 inch long and 6.5 mils in diameter, with its own set of windings.

Whiskers are made in essentially the same way as rods except for the on-line cutting. Following a testing step primarily aimed at monitoring the plating process, the wire is coated with 0.2-mil layer of plastic to keep the iron from oxidizing. It is then baked and wound on a take-up spool. In a separate off-line process, the wire is tested again and cut mechanically into whiskers at a rate of 1,000 per minute.

The solenoid array in which the whiskers are mounted is made in a frame by a machine that winds interlinked 10-term solenoids in each of two perpendicular directions (page 130, top). A sheet of plastic is then vacuum-formed across one side of the array to establish a "bottom." The rods are automatically dropped into place in the interlinked solenoids, using a mask and an alternating magnetic field. The mask is placed over the solenoid array, an oversupply of whiskers is poured on it, and the whole is placed in the magnetic field. The field causes the whiskers to stand upright and dance about; when the array is tilted, the whiskers march across the surface and fall into the individual



Double helix. Two windings over a section of a seven-inch rod define a bit cell on the rod. One of the windings is continuous along the full length of the rod; the other is about 1/10 inch long and connects with coils on other rods.



Interlinked. Two solenoid windings are interlaced in a special machine that winds them both at the same time, in a pattern for the whole plane that resembles a chain link fence. One whisker fits in each solenoid (photo, right).

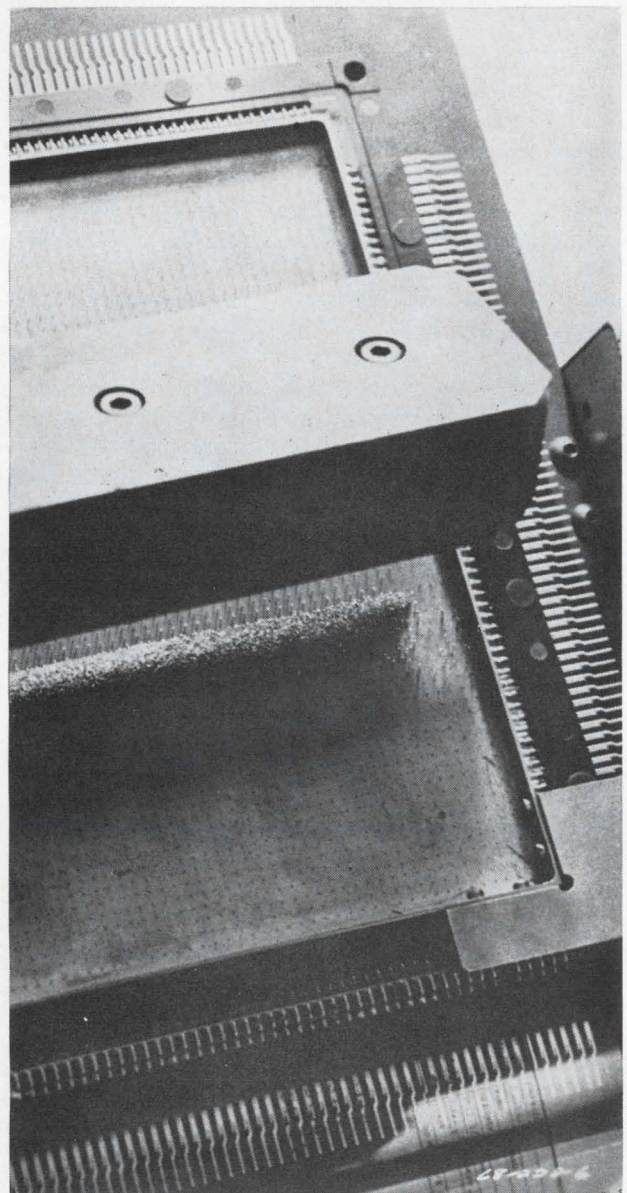
solenoids through holes in the mask, as shown at right. Surplus whiskers pile up at the edge of the array, and are lifted off with the mask. Another layer of plastic is formed over the top to encapsulate the array, which is then tested as a unit. If a bad whisker happens to find its way into the array, it can be removed individually and replaced by another without endangering the array in any way.

Familiar pattern

Modules made from this standard array are laid out in a two-wire, $2\frac{1}{2}$ -D organization for good performance at low cost. The interconnections and operation are essentially the same as those in the two-wire, $2\frac{1}{2}$ -D ferrite-core array. This causes the delta noise, induced in the sense winding by half the whiskers, to cancel that induced by the other half. As a result, superimposed oscilloscope traces of all 4,608 bits in a single plane are remarkably similar to the oscilloscope trace for a single bit.

Memory cycle time in the Century series is 800 nanoseconds. In the case of the experimental 2-D, two-element-per-bit experimental organization that attained a cycle time of 100 nsec, the rods were only partially switched—that is, only part of the film under each winding was axially magnetized. The part that was magnetized was nevertheless saturated. This is possible because, just as a core switches first around the hole and then in concentric rings outward, a rod switches first at its midpoint and then in both directions toward its ends.

The two elements for each bit must be electrically and magnetically identical, a requirement met by arranging the elements adjacent to one another on the same rod a few hundredths of an inch apart. The wiring is basically the same as in the 315 RMC memory, except that the roles of the digit and word lines are interchanged and two digit lines are selected for each bit instead of one. The two ele-



On the march. An alternating magnetic field set up under the large horizontal pole piece stands the whiskers on end and marches them across the plane. One whisker drops through each tiny hole into a pair of linked solenoids beneath the plane. Surplus whiskers accumulate at the edge of the plane and are lifted off with the mask.

ments store complementary bits; when writing, the noise from these bits, which doesn't decay until well into the subsequent read cycle, appears at the sense amplifier as common-mode noise, and is therefore rejected. Because the sense amplifier can recover quickly from this noise, the memory can operate at high speed.

The experimental 100-nsec rod memory contained 10 bits per linear inch of rod, even with the doubled-up windings. With further research and de-

velopment, strip lines could be substituted for the digit solenoids to produce a large-capacity, high-performance rod memory.

Bibliography

D.A. Meier and M. Arbab, "A 10-Megacycle DRO Rod Memory," Proc. International Colloquium on Memory Techniques, Paris, 1965, p. 641.

Paul Higashi, "A Thin-Film Rod Memory for the NCR 315 RMC Computer," IEEE Trans. on Electronic Computers, August 1966, p. 459.

Memories VII

Weaving wires for aerospace jobs

By Richard A. Flores

Librascope Group, Singer-General Precision Inc., Glendale, Calif.

Woven plated-wire memories have demonstrated their mechanical and electrical integrity when operated in a simulated aerospace environment. They dissipate very little power and potentially can be manufactured very economically.

The Librascope group of Singer-General Precision Inc. has since 1964 devoted a research and development program to devising woven-wire memories capable of nondestructive readout and producible at low cost. This effort has produced a line of NDRO memory products for use in severe aerospace and military environments. They're made from wide-tolerance plated wire by a weaving process that reduces the number of connections required by other manufacturing techniques.

Librascope's work is carried out under terms of a license from Toko Inc. The Japanese firm has continued developing the process for commercial applications, and recently announced arrangements for the use of the woven memories in a Japanese version of Univac's 9000 series computers [Electronics, Sept. 16, p. 236].

Warp and woof

In the first step of the manufacturing operation, the wire is plated, tested, and cut to length. [This much of the process is basically similar to Univac's, described on page 124.] The wires are then inserted in tunnels in a mat woven on an automatic loom. These mats, typically 4 inches square, consist of straight wires 5 to 8 mils in diameter—what textile weavers call the woof—with smaller wires—the warp—woven across them in an over-and-under pattern. When the larger wires are

pulled out of the mat, they leave tunnels into which the plated wires can be inserted. The mat can be woven directly on the plated wires, but at some risk of putting kinks in them that would affect their magnetic properties.

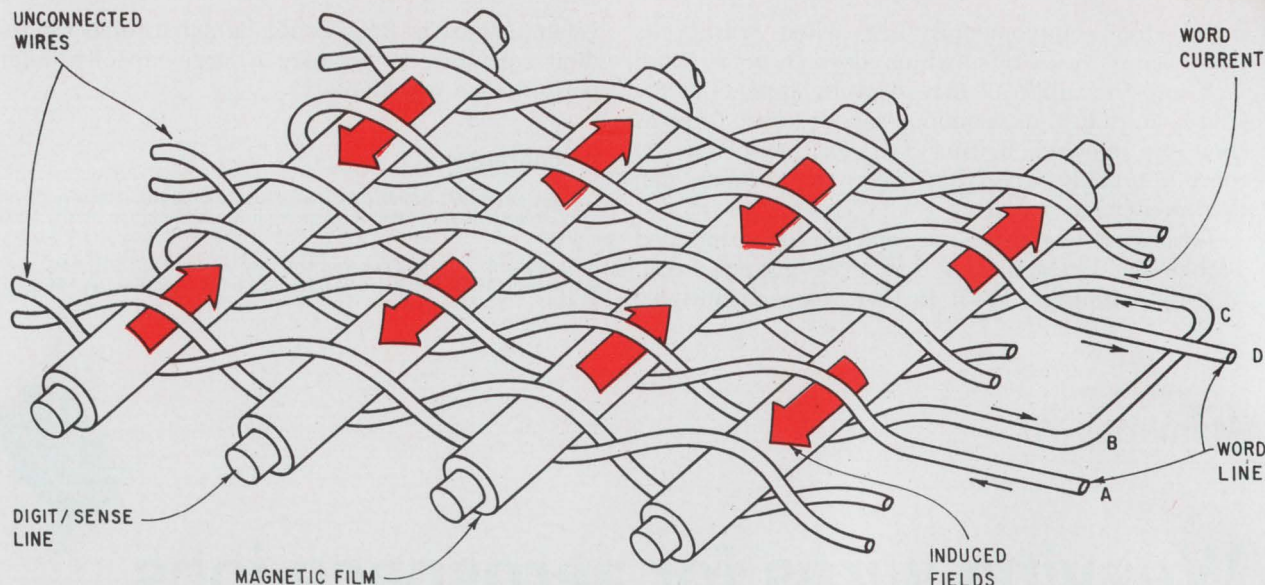
Wherever the smaller wire crosses the plated wire, it defines a bit cell on the plated wire. These smaller wires are spaced typically 40 to the inch along the plated wire, although their exact spacing depends on the intended application.

A particular advantage of the weaving technique is that it can produce rather complex multiturn coils that require lower word currents and less expensive electronics than single-turn coils, and dissipate less power.

For example, in the word-line pattern shown on page 132, an individual line weaves across the array of plated wires in an over-and-under fashion and returns in an under-and-over pattern. The result is that every plated wire has a current loop around it with exactly one turn, and the turns around adjacent wires are in opposite directions. That line can be the word line by itself if the application requires it, or it can be connected in series with other word lines to produce coils of as many turns as desired; the diagram shows a two-turn coil. Alterations in the weaving process produce different numbers of turns and different directional patterns in a practically infinite variety.

Two other important features of the weaving technique appear in the diagram. First, some of the warp wires are left unconnected to provide spacing within and between the word coils. Because of this, the field can be shaped for optimal operation in a





Woven plane. Word lines passing among plated wires in an over-and-under pattern make coils that can be interconnected to produce any of a wide variety of field patterns (color) in the plated wire.

specific application and for reduced interaction between coils.

Second, adjacent coils can have opposite magnetic polarity so that the magnetic fields are closed through them rather than between them. Thus, current entering a terminal A and passing over the first plated wire, returns under it to point B. But this is connected to C, from whence the current passes under the wire and returns over it to terminal D. The polarity reversal reduces the line's self-inductance, so that low-voltage constant-current drive circuits can be used. These circuits further cut electronic costs and power dissipation.

Besides the spacer wires and coils, the mat con-

tains a magnetic keeper wire plated with permalloy in somewhat the same way as is the main plated wire. It increases the homogeneity of the drive field and reduces creep between bits—a characteristic of films that under certain conditions can destroy the data in a particular bit cell when the adjacent cell is repeatedly cycled. The keeper wire is essentially a low-reluctance path between word coils on a single word line, as at top right.

When adjacent word coils are opposite in polarity, these low-reluctance paths between them permit each coil to produce a larger field without disturbing the bits under adjacent coils. And the coils produce a sufficient field with word currents

Over the hurdles

The computer industry has been rife with rumors about Librascope's difficulties with the woven-wire memory. The company has indeed had problems, but it seems to have largely overcome them.

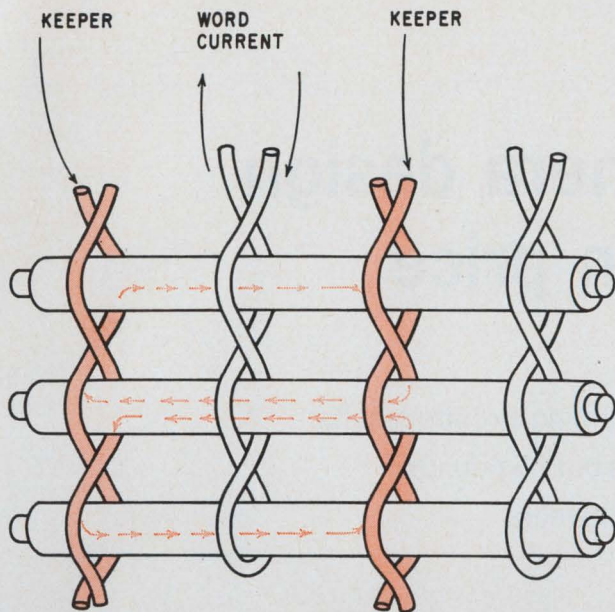
One of the biggest cropped up a year or so ago when Librascope built an 8,000-bit breadboard model for an aerospace customer. The breadboard worked well and Librascope was asked to build a larger version, but the customer's funds were curtailed. So, under a cooperative compromise, Librascope built two more stacks and the customer built the associated electronic circuitry. Unfortunately, these memories didn't turn out too well; the weaving technique still had some bugs in it, and the customer's electronics didn't mate properly to the stacks. But the customer had to accept the memories because both his money and time were running out.

Along with these woes, some of Librascope's key people chose that moment to seek greener pastures.

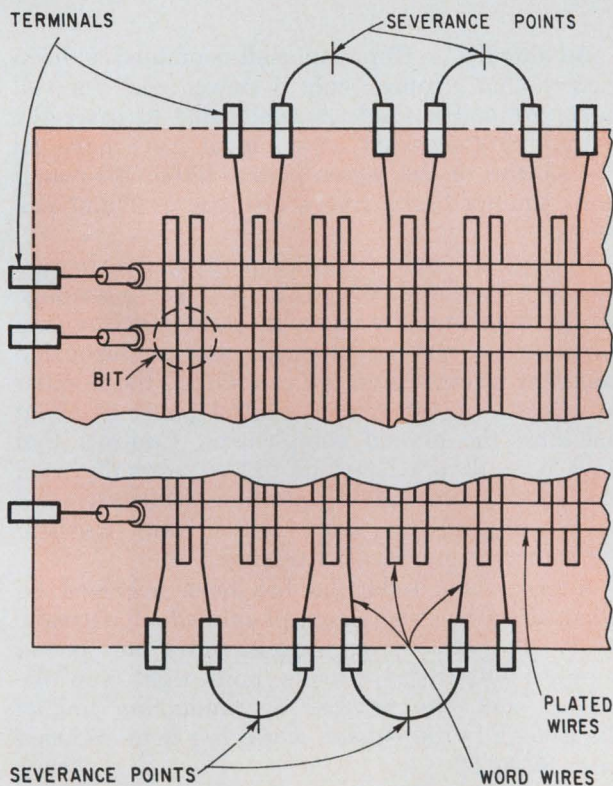
Nevertheless, development has continued; the company has set up a pilot production line and landed three contracts that could lead to substantial production rates later on. Based on the 64,000-bit module it announced last summer [Electronics, July 8, p. 176], Librascope can turn out perhaps 100 stacks a year with its present equipment and people. The company considers that module its basic building block; it is now concentrating on cost reductions.

Librascope's disk memories, made by the same division that handles woven wires, have been so successful that they've been rewarded with more R&D money than woven wire. But the latter isn't quite a poor relation. When the Singer Co. acquired Librascope's parent, General Precision, Inc., last spring, it took a hard look at the woven-wire operation and seems convinced of the technique's utility and potential market.

—Lawrence Curran, Wallace B. Riley



Keepers. Plated wires woven into the mat along with the word lines improve memory operation.



Continuous. A single wire woven into the mat can be cut afterward, simplifying interconnections.

that are reduced 25% by the use of a keeper. Likewise, output voltages are increased by a similar percentage because the field is homogeneous.

The effect of the keeper is localized—it does not load all the word coils, as a continuous ferrite keeper would. The latter is a sheet of magnetic

material laid down over the mat or array of wires, also to provide a low-reluctance path; some experimenters have tried it.

The weaving operation takes place on a converted textile loom, which can weave any number of configurations and has two significant features:

- It can weave word line coils as one continuous strand with terminals at the ends of each coil. This minimizes the number of interconnections, thus reducing fabrication costs and increasing the reliability of the woven mats. In the most common pattern for a random-access plane, the wires are cut after weaving at points between word coils, as shown at bottom left.

- It has a Jacquard head, allowing individual control of each wire, and of the weave pattern, by either punched paper tape or punched cards. With this control, woven-wire mats can be fabricated with the data permanently and unalterably woven into the matrix, a capability unique to woven-wire technology. The loom controls the way a word coil intersects a digit line, thus producing special patterns automatically. The polarity of each bit location within a word coil is established when the weave goes over or under that particular location.

Weaving for read-only

For example, an adjacent pair of plated digit wires can be connected in series and segmented in 0's and 1's, depending on whether the word-coil pattern is over-and-under or under-and-over at a particular bit cell. If the word pulse current travels under the first digit wire and over the second, the bit stored will be a 1. If the converse is true, it will be a 0.

These permanently woven read-only memories provide nondestructive readout storage that cannot be altered and is unsurpassed for holding repetitive data such as tables, fixed programs, or reference information.

Using this basic technology, Librascope has demonstrated fully operational stacks at the shock, acceleration, and vibration levels called for by the appropriate military specifications.

A full memory system has been breadboarded and tested over a temperature range from -20° to $+85^{\circ}$ C. This system, weighing less than $4\frac{1}{4}$ pounds and displacing less than 40 cubic inches, stores 4,096 words of 20 bits each and dissipates 250 milliwatts of power when cycling at 100 kilohertz. Its standby dissipation is only 5 mw.

The cost advantage of woven-wire batch fabrication has yet to be demonstrated. However, fully automating the processes of wire fabrication and testing will reduce the basic costs of a woven plated-wire memory. The weaving process is inexpensive. Soldering mat connections to the printed-circuit board that supports it could be done quite rapidly, and inserting the plated wire into the woven mat and connecting the wire to the circuit board could be greatly speeded by inexpensive tooling. It therefore appears quite feasible to build a low-cost aerospace memory on a production-line basis.

Shortcuts in tv camera design make for big cuts in price

Elimination of some controls and expensive trimming circuits results in a vidicon color unit for studio use that weighs but 65 pounds and costs 75% less than the average broadcast camera

By Frederick J. Haines

International Video Corp., Mountain View, Calif.

"The first thing broadcasters ask us about our newly acquired IVC color camera is 'what's missing?'," says Ron Renaud, chief engineer at WWJ-TV, NBC's associate station in Detroit. The reason, he explains, is the camera's low price—about one-quarter the cost of other studio cameras—and the mistaken belief that vidicon tubes can't be used to produce good color pictures at normal studio lighting levels.

Sharp contrast

Color tv pictures generally lack the sharpness of the black-and-white variety. They have a tendency to become soft, and the colors reproduced aren't always of the right shade. Studio engineers attribute this problem at least partly to the wide use of Plumbicon tubes, which have low resolution and limited spectral response. This has caused camera designers to make compromises that result in color errors.

A new technique called image enhancement has been introduced within the past year to correct the problem. The method essentially improves resolution and color fidelity by rearranging the elements of a color picture.

Developed at CBS Laboratories, the image-enhancement circuit takes a single line of video and compares it, element by element, with the lines preceding and following it. Any differences are added to the original signal in the proper phase to reinforce the difference between the lines compared, thereby enhancing the picture outlines and contrast.

John D. Drummond

Admittedly, a 65-pound, self-contained vidicon camera that requires only a power cord for full operation and a single coaxial cable to carry the output NTSC-encoded color signal can't have all the niceties of the higher-priced 130-to-400-pound units equipped with image orthicon or Plumbicon tubes.

But not a single essential performance feature has been sacrificed. We've simply taken advantage of the high stability of solid state circuitry and eliminated a number of costly and sophisticated trimming circuits. And we've reduced the number of controls on the remote control panel to about one-third the normal complement. Controls that have been dropped include SKEW, normally used to eliminate registration distortion; SHADING, used to compensate for color shifts; and GAMMA, for trimming gray scale response.

A major cost reduction has been achieved by eliminating the camera control unit, which normally houses the video processing circuitry and power supply. With these circuits built right into the camera unit, the number of conductors linking the camera to the outside world has been reduced from 80 to 50.

Innovations

Because the vidicon target drive voltage had to be reduced considerably—typically to 15 volts from 40 to 60 volts—to reduce the tube's inherent lag, or persistence characteristics, it was necessary to design special low-noise, high-gain preamplifiers.

And a number of important innovations have been made in the optical system to allow more light to reach the image tubes. Standard silver-surfaced reflecting mirrors have been replaced by



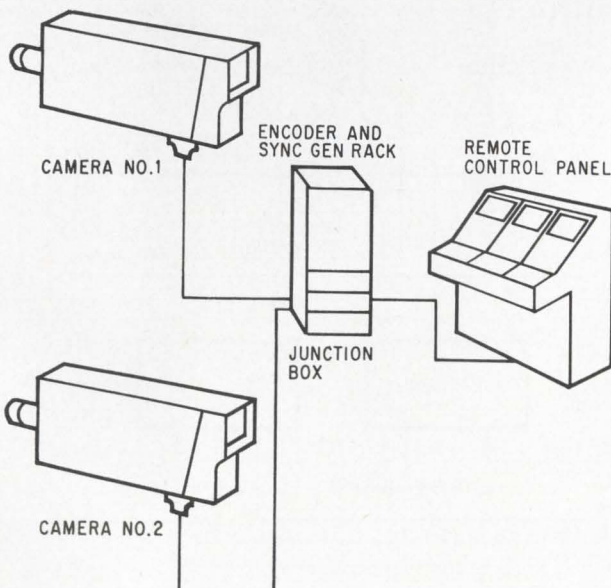
Self-contained. Equipped with three separate mesh vidicons, the camera includes 6:1 zoom lens, external color encoder, studio junction box, and remote controls.

dichroic mirrors with a thin-film coating. The chemical formula for this coating was calculated with the aid of a computer, which factored in the dispersion of the materials. By using expensive precision tooling to achieve extremely close man-

ufacturing tolerances, it was possible to set the mirrors in slots in the base casting and then seal them in place permanently with epoxy, eliminating any need for adjustments.

The net result is a camera that can be used with the CBS image enhancer—standard gear in most tv studios—to produce quality color pictures indistinguishable from those turned out by the more expensive studio cameras. And the price of the new camera is only \$18,500, compared with an average of about \$75,000 for most studio units.

Despite its compactness, the International Video Corp.'s camera is quite versatile. For closed-circuit tv, it can produce an NTSC-type picture for display on a monitor or for recording on a video tape recorder. It's also compatible with standard studio cabling, junction boxes, remote-control panels, external encoders, and master sync generators, as shown at left. All remote controls are on its control panel, including master gain, master pedestal, centering trims, and red-green-blue targets and pedestals.

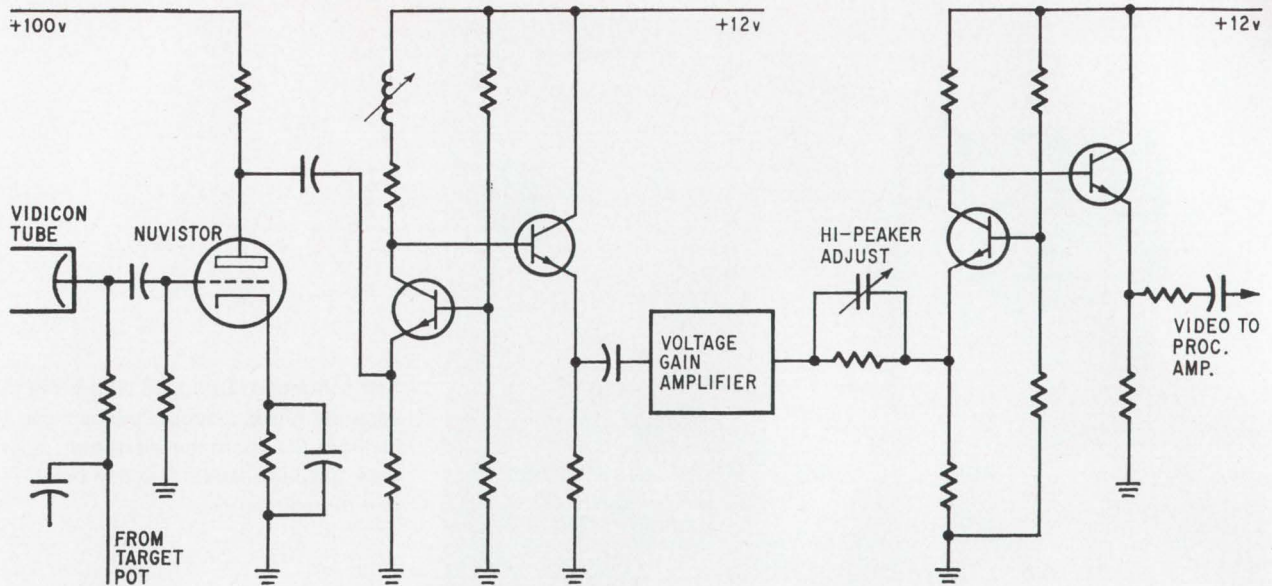


Hookup. In a broadcast application, the cameras are linked to standard studio equipment without interfaces.

Getting a boost

Special low-noise preamplifiers are needed to boost the low-level red, green, and blue signals from the vidicons to a usable level—typically 200 to 300 millivolts.

The over-all signal-to-noise ratio of the camera is effectively determined by the signal-to-noise

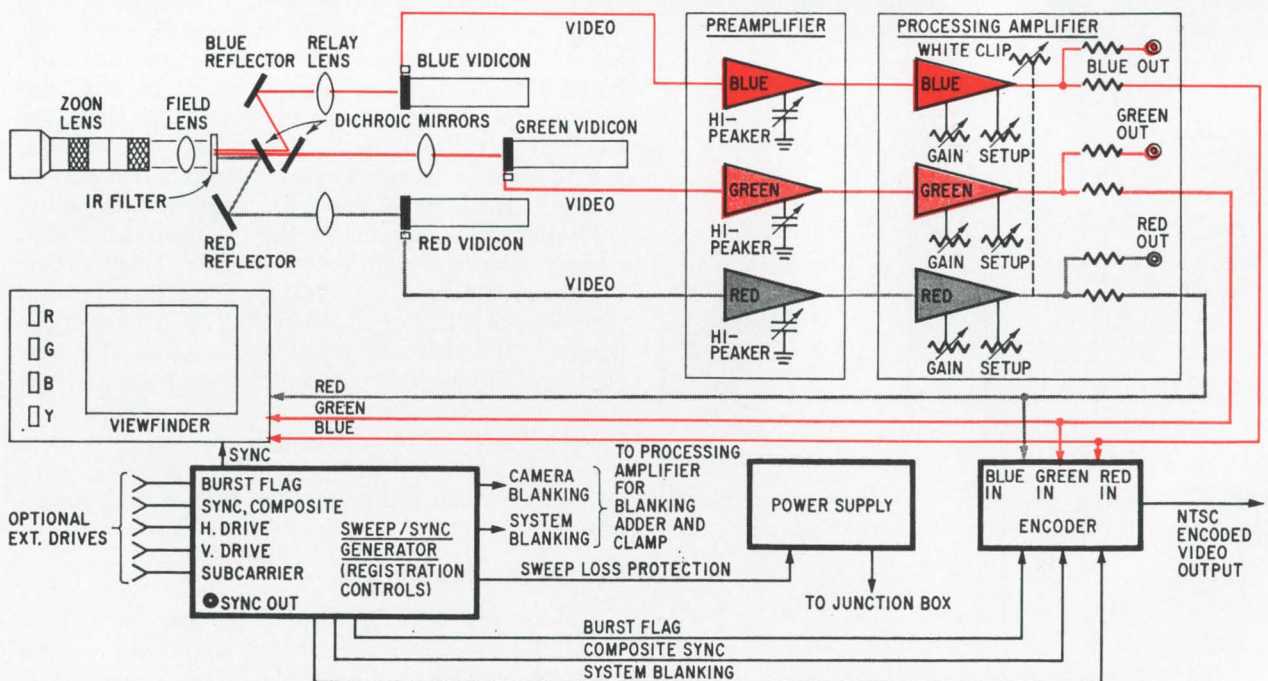


Video preamplifier. Low-level signals from the red, green, and blue vidicon tubes are boosted to desired levels by the preamplifiers, which feature a hybrid cascode input stage for low signal-to-noise ratio.

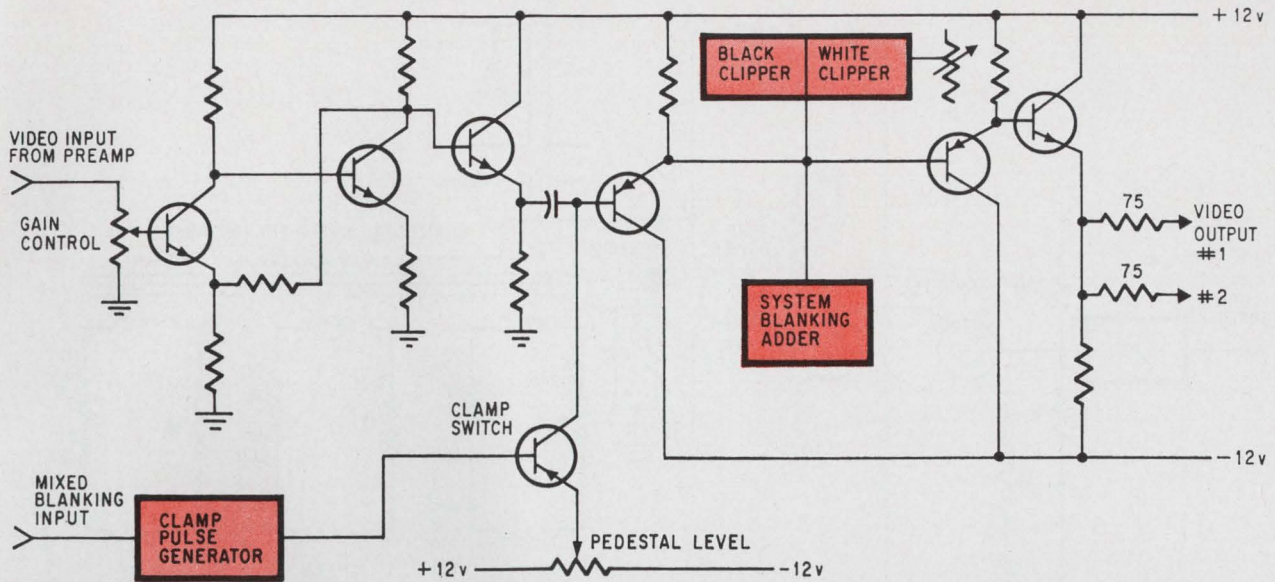
ratio of the pickup tubes' preamplifiers. Since transistors act as noise generators at lower frequencies, a hybrid Nuvistor-transistor stage is used at the amplifier input, as shown in the simplified schematic diagram above. The cascoded input stage is emitter-coupled to a voltage gain amplifier followed by a common-base amplifier and another emitter-follower stage. The output goes to the video processing amplifier. The hi-peaker capacitor trimming of the amplifier frequency re-

sponse to correct for the high-frequency rolloff produced by stray capacitance, which shunts the high output impedance of the vidicon tube.

The processing amplifiers provide video gain control for the respective channels, as well as a line-by-line clamping to restore low-frequency response. They also add system blanking and remove voltage spikes and other irregularities that might be introduced into the video signal by the image pickup tubes.



Data flow. The information from the vidicon tubes is fed to red, green, and blue inputs on the internal encoder circuit board. The encoder combines these signals to produce an NTSC-compatible video.



Processing amplifier. In addition to gain and pedestal control, this circuit restores low-frequency response, adds the system blanking, and provides black and white video clipping to limit overshoot of the video signal peaks.

As the schematic shown above indicates, the amplifier also includes circuits to limit peak video signals to preset black and white levels. The video output is either applied to the encoder and the viewfinder switching matrix, or fed to an external studio encoder.

Simplified encoder

The encoder accepts separate outputs from the processing amplifiers' red, green, and blue channels and combines them into a compatible NTSC color signal. As the most complex circuit in the camera system, it represents a major cost factor.

Since a decision was made at the outset of development to eliminate the camera control unit, it was necessary to devise an encoder circuit small enough to fit into the camera package. The result is an encoder mounted on a double-sided printed-circuit board measuring 6 by 7 inches.

In a standard broadcast encoder, the "I" signal channel, which handles colors ranging from cyan to orange, has a 1.5-megahertz bandpass; the "Q" channel, which produces colors from yellowish green to purple, is given only a 0.5-Mhz bandpass. Because of its wider bandpass, the I signal has a shorter delay than the Q, and a delay line has to be inserted in the I channel to provide time compensation. The problem with the delay line is that it introduces a phase difference that must be canceled out by additional circuitry.

The IVC encoder circuit doesn't operate that way, however. Instead of working with I and Q signals, it matrixes the red, green, and blue signals into R — Y and B — Y chrominance signals. This scheme greatly simplifies the circuit since the bandpass of both channels can be identical, eliminating any need for a delay line and compensating circuits. In the new process, the burst-flag signal is

added to the B — Y signal before band limiting is effected; hence, the R — Y and B — Y signals are in phase and no special burst-flag delay or color-burst phase control is required.

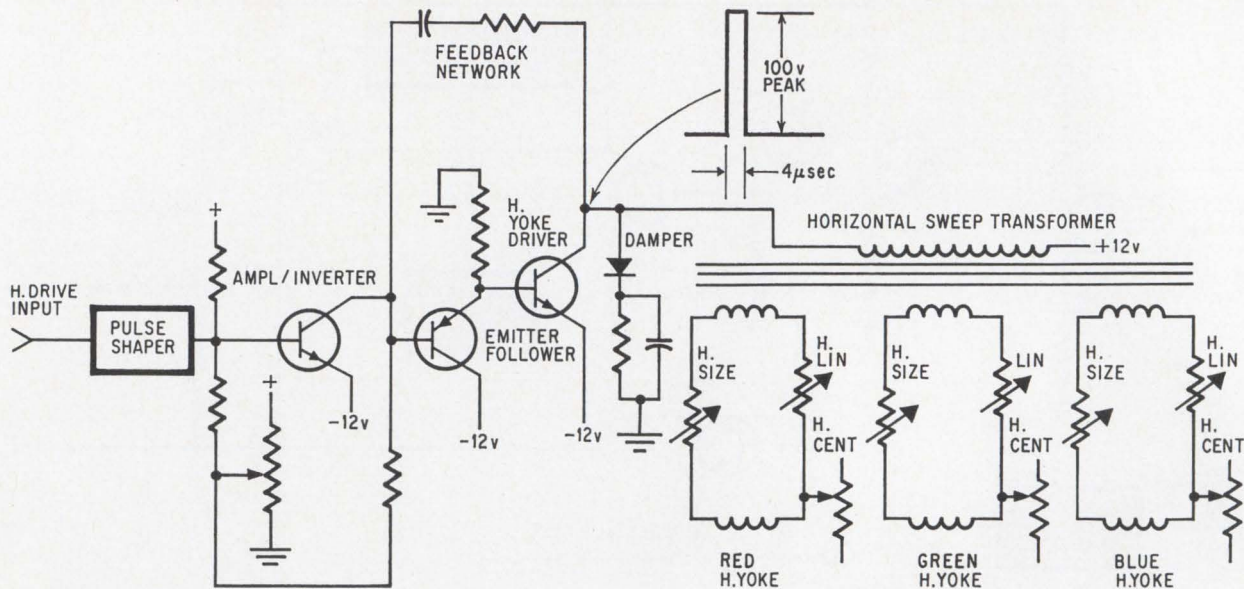
In operation, the R — Y and B — Y signals directly modulate the subcarrier in a quadrature relationship—the phase of the subcarrier being modulated by the B — Y signal lags behind the R — Y-modulated subcarrier by 90°. The color subcarrier is essentially invisible even at close viewing distances, and therefore needn't be locked to the scanning frequencies. This feature permits the use of a sync generator independent of the color subcarrier, which is produced by a free-running crystal oscillator in the encoder. However, the encoder can also accept an external color subcarrier and can therefore encode a signal with locked color if that is desired.

Surprisingly, the greatly simplified encoder circuitry doesn't in any way cause a degradation of the reproduced color information since all available viewing devices, including studio monitors and home receivers, employs R — Y, B — Y, or equivalent bandwidth decoders, and the higher potential resolution promised by the I-Q system is never fully achieved in practice.

Luminance signal

To derive the Y (luminance) signal, the red, green, and blue information is added or matrixed in proper proportions, and the combined signal is amplified and inverted.

The luminance signal is processed in an aperture-correction network that enhances the higher-frequency information attenuated by the camera pickup components. However, the aperture correction may be turned off, if desired. After aperture correction, the luminance is band-limited, delayed,



Horizontal sweep. Multiple secondary transformer windings effectively isolate all d-c components, permitting horizontal centering of each channel without interaction. Linearity and size controls are also shown.

and combined in correct time and phase with the chroma signal to create the composite color video signal. Sync is then added to this signal at the output of the encoder.

A separate optical channel has been provided so that green can be used as luminance, but the two chrominance signals are still created as previously described and the composite color video output signal is entirely compatible with the NTSC signal. Use of the optional "luminance-from-green" circuit provides a measure of horizontal image enhancement, though it does introduce slight errors in color saturation.

An optional self-contained EIA synchronizing generator gives frequency interlace and equalizing pulses during the vertical blanking interval. The time base jitter of this sync generator is in the order of 8 to 10 nanoseconds, against typical figures of 30 to 80 nanoseconds for other systems. This level is achieved largely through a countdown originating from 14.32 Mhz, rather than the usual 3.58 Mhz.

For use in closed-circuit tv, where NTSC standards need not be followed, the camera is provided with a built-in, 2:1 interlace sync generator that produces all the pulses needed for sweep, blanking, color burst, and synchronization; these are added to the encoder video signal. A 31.47-kilohertz crystal is used to drive a binary countdown circuit that produces the 59.94-hertz color vertical-drive frequency. In broadcast generators, the countdown from 31.47 khz is initiated from the 3.58-Mhz color subcarrier oscillator or from some multiple of 3.58 Mhz.

In the IVC camera, as noted earlier, the 3.58-Mhz color subcarrier is produced on the encoder board by a crystal oscillator whose frequency is unrelated to the horizontal or vertical drives in the sync gen-

erator. During closed-circuit operation, therefore, the IVC camera isn't color-locked (frequency interlaced) with the sync generator. It's color-locked only when it's under control of the built-in EIA generator or an external studio sync generator. But regardless of how the camera is used, the color produced by the built-in generator is indistinguishable on a color monitor from that produced by the color-locked generator.

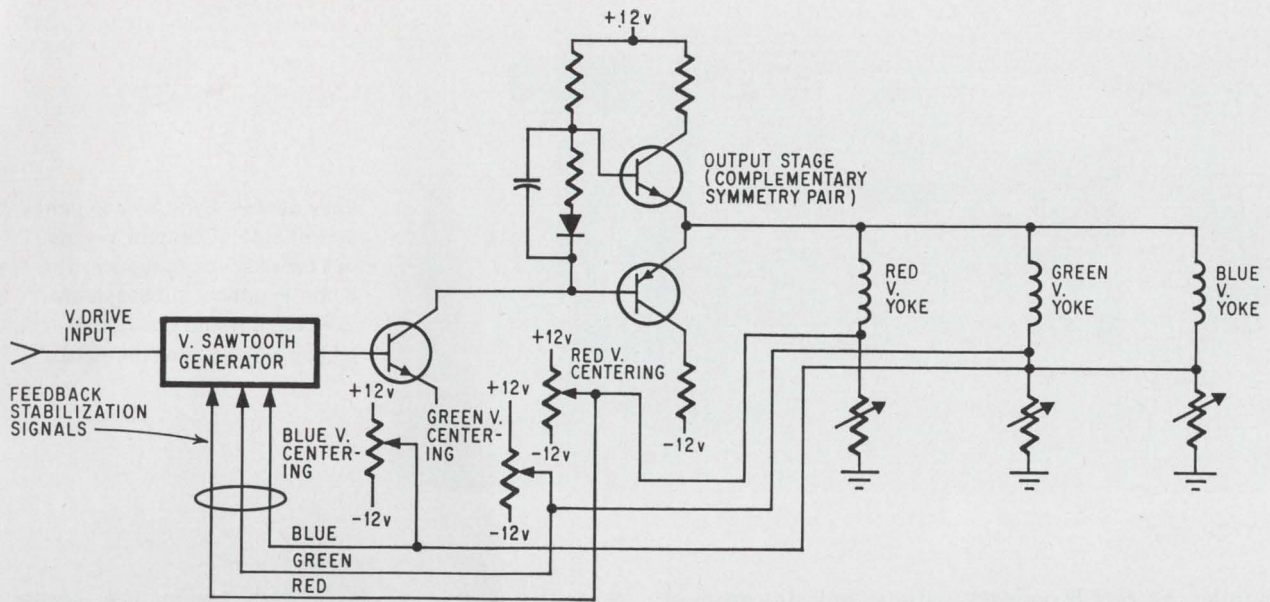
Besides the binary countdown circuitry the generator uses integrated-circuit logic to produce the horizontal-drive, vertical-drive, mixed blanking and sync, and burst-flag pulses.

Deflection

For purposes of economy and ease of operation, a simple yet stable deflection system has been developed for the vidicon. Vertical and horizontal deflection for each yoke are controlled by a common generator. As shown in the simplified schematic, the horizontal coils are effectively paralleled by multiple secondary windings of the transformer. This feature serves to isolate the d-c components so that a current-bridge technique can be used for centering.

Because the voltage waveform across the transformer primary is closely controlled by feedback, the deflection currents can be set by the yoke inductances. The sweep circuit provides individual size, linearity, and centering controls for the horizontal system. In operation, it accepts horizontal-drive pulses from the sync generator and from them generates new pulses with controlled rise times and durations. The reconstituted pulses are then used to apply a high-voltage pulse across the primary of the horizontal sweep transformer.

Any ringing is eliminated by a damper diode and RC network. A significant feature of the circuit is



Vertical deflection. The deflection yokes are driven by the complementary-symmetry transistor pair in the output stage. The diode and RC network in the base circuit ensure against crossover distortion.

that the driver transistor is cut off during the 4-microsecond retrace period and serves as a highly stable feedback amplifier during horizontal scan. With separate transformer secondaries, d-c centering currents can be injected without interaction.

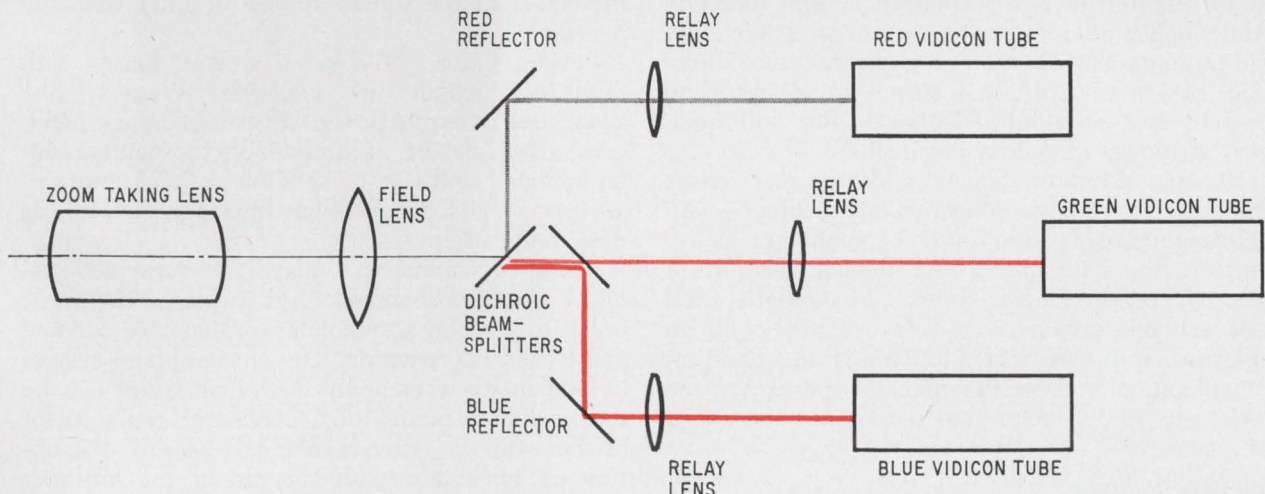
In the vertical deflection circuit shown above, the yokes are driven in parallel by a transistor pair arranged in complementary symmetry and operating in series for d-c components. The diode and RC network in the base circuit correct for crossover distortion, which would show up as a black horizontal line near the center of the picture. Like its horizontal counterpart, the vertical circuit is designed with carefully chosen feedback values to ensure the best possible sweep stability. Changes in the centering currents are sensed and compen-

sated for.

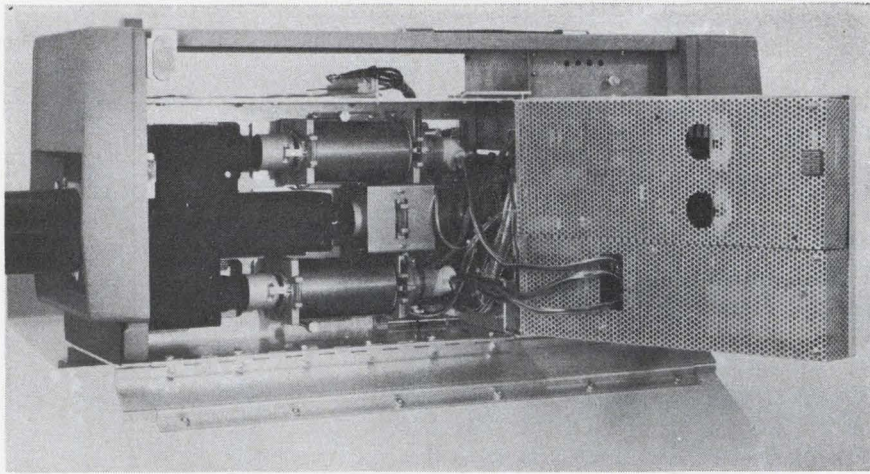
During camera operation, the horizontal and vertical waveforms are monitored to protect the vidicon target layers from the effects of sweep-circuit failure.

Optical system

The innovations introduced in the optical system are aimed essentially at cutting the cost of the package without seriously degrading the over-all performance of the camera. For example, rather than adopt the widely used and costly 40-millimeter image orthicon taking lens, the engineers specified a standard 35-mm single-lens-reflex-format design that can be purchased off the shelf. These lenses, with an image diagonal of about 43 mm—are very



Optics. The image created by the taking lens is focused through a field lens on dichroic beam-splitters. The red, blue, and green particles of the scene are directed to the vidicon tubes through relay lenses.



Easy access. Sync/sweep panel on left side of camera swings out for easy maintenance. The dichroic optical subassembly is at the left and the vidicon pickup tubes are at the right.

similar to the broadcast variety but, because of volume production, a lot less expensive.

The exact lens employed is an Auto-Nikkon $f/4.5$, 50-to-300-mm zoom lens, the type used in Nikkon F photographic cameras. The relatively slow speed of this lens is effectively increased to $f/1.9$ by using relay lenses as on page 139, to increase the back focus of the taking lens.

The relay lenses also demagnify the effective zoom range to between 18.5 and 110 mm. The ratio of the image diagonal of the 43-mm taking lens to the image diagonal of the vidicon tube's faceplate, which measures 15.88 mm, is approximately 2.73:1. Therefore, both the f stop and the zoom range are altered by that factor, in the direction of improved performance, by demagnification of the image size.

The first color cameras with image orthicon tubes had optical systems designed for a 1 to 1 ratio between the size of the image on the taking lens and the one on the pickup tube. This was a quite costly scheme because of the difficulty of producing relay lenses with unit magnification. In order to achieve an $f/2$, for example, the lens has to be capable of $f/1$ at infinity in one direction while being able to project a sharp image onto the target or film at close range in the other direction. In other words, fast lenses are designed to operate best at infinite distances, but still quite well at ranges of only a few feet.

Because of limited demand and high cost, lenses designed for 1:1 magnification are seldom available commercially and must be made up as required. But with the 2.73:1 demagnification of the IVC color camera system, a standard $f/1.4$ lens can be operated as a relay element with an aperture equivalent to $f/1.9$. This is an important consideration because the effective aperture of the relay lens is the factor that determines the speed of a camera.

Passing the light

The optical paths from the zoom lens to the vidicons have been greatly simplified to ensure

that all of the available light from the scene reaches the tubes' target surface. To this end, the usual color trimming filters and the neutral density filters for the red and green channels have been left out. But this doesn't degrade the camera performance in any way. Highly efficient dichroic trimming reflectors are used with the main dichroic beam-splitters to shape the red and blue light-transmission characteristics. And because more light can pass through to the target, over-all sensitivity is greatly improved.

The bottom surface of the first dichroic beam splitter reflects the red light onto the red reflector, which in turn directs it through a relay lens to the red vidicon. The blue and green elements of the spectrum pass through to the second dichroic beam-splitter. The blue elements are reflected to the blue reflector, which directs them to the blue pickup tube; the green light elements aren't reflected and pass through to the green pickup tube.

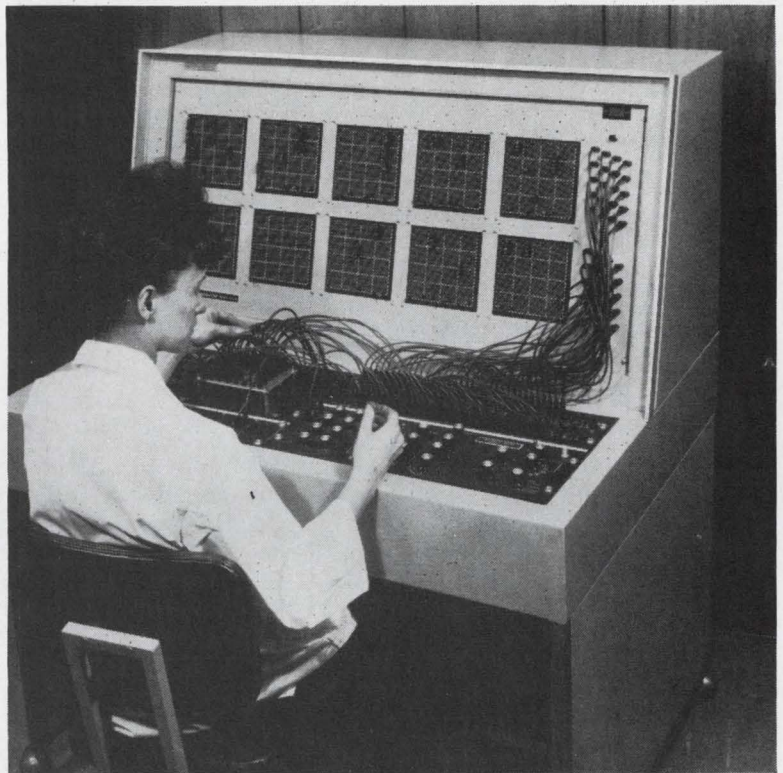
A field lens mounted on the taking lens in an adapter tube ensures that all the light leaving the taking lens is directed to the relay lenses, thereby avoiding any "port-holing"—an effect that makes the center of the screen appear brighter than the periphery.

Besides the 6:1 Nikkon zoom lens, lenses with fixed focal lengths are available. Where a 10:1 zoom lens is required, the lower-cost image orthicon variety can be used. In fact, the camera can be operated with lenses as slow as $f/5.3$ and still provide a vidicon equivalent aperture of $f/1.9$, as described earlier.

During assembly, the relay lenses are set precisely and permanently locked in place. The three image-tube yoke assemblies are likewise aligned and locked into position. The entire optical system is held in the camera by dowel pins and can be removed in a matter of seconds for replacement of the vidicons. After a tube is replaced, the optics are reinstalled with the aid of the indexing pins to achieve exact realignment. And, unlike other systems which must be realigned on occasion, it needs no further adjustment.

solution to the LSI test dilemma:

the
new
n.a.e.s.



LSI test console

large programmable word generator,
supported by:

word level converter panel;
adjustable four-phase clock generator;
comparator, error detector;
interchangeable array holders.

offers many features not found on
costly computer-driven testers,
yet without the programming
and maintenance problems.



The N.A.E.S. Large Scale Integration Tester offers a practical and economical solution to the testing dilemma of designers who are plagued with short runs of different circuits, each requiring special word drivers. It is specifically designed for use where different arrays will be tested. It can be programmed in 15 minutes for almost any array, without punched cards, paper tape or magnetic tape. With a 40-100 Word Generator, several different testing programs may be stored at one time.

This LSI Tester is rugged enough for factory testing as well as engineering evaluations, and may be used at both MOS wafer probe and final test stations. For testing PC cards containing many integrated circuits or MSI, this machine is ideal because the word outputs prior to the converter circuits are directly at DTL levels.

Modular construction permits you to order only those panels in the size and complexity you require for your arrays. This building block concept provides for easy, economical expansion if more complex testing is required in the future, greatly reducing the possibility of obsolescence.

The N.A.E.S. Tester has no moving parts and requires virtually no maintenance. All solid state design, with plug-in integrated circuits, insures complete reliability in performance, yet permits easy replacement of parts if necessary. No special cooling or air conditioning is required. Normal delivery within 60 days.

For complete information, write or telephone:

North American Electronic Systems

DIVISION OF EDUCATIONAL COMPUTER CORPORATION

Sicklerville, N.J. 08081

Phone: 609-629-4141

Liquid lasers: promising solutions

Problems of cost, optical damage, and low average power may dissolve when these organic and inorganic devices emerge from the laboratories

By Harold Samelson

General Telephone & Electronics Laboratories, Bayside, N.Y.

Intense luminescence—the basis of laser action—occurs in solutions of many organic and inorganic compounds when they're excited by light. Harnessing this luminescence has produced a new kind of laser that may become competitive with solid state and gaseous types.

Though liquid lasers are only at an early stage of development—comparable to that of solid state lasers five years ago—they're already cheaper to build, and their potential for high average powers is impressive. Already inorganic lasers using solutions of neodymium ions put out up to 40 joules in a 200-microsecond pulse—a pulse of 200 kilowatts.

At high power levels, circulation of the active liquid medium helps remove heat. The recent development of a lower-viscosity solvent has opened the way to using simpler circulating pumps, thus greatly simplifying the liquid laser. Both the inorganic and organic types now operate in the pulsed mode only, but researchers predict that a properly designed circulating pump will make it possible for inorganic liquid lasers to emit continuously.

Organic lasers won't be able to do this, because their transitions are so fast that an inordinate amount of energy would have to be pumped in and because their energy states aren't of the right type. However, they have one important advantage: they emit light over an enormously wide range of the spectrum—from about 4,000 to 11,000 angstroms. Their frequencies can be changed by simply changing the compound or its concentration in the solution.

Organic lasers can be adjusted to emit anything from virtually monochromatic light to light spread over wavelengths of 400Å. Inorganic liquid lasers also can be made monochromatic, but their bandwidths are considerably narrower—between 15 and 30 Å. Both types can be mode-locked [Electronics,

Sept. 16, p. 112] to produce short, high peak power pulses, about 10 megawatts for the organic and up to a gigawatt for the inorganic. Pumping the organic laser with a mode-locked laser produces a mode-locked output, so picosecond pulses can be generated throughout the visible spectrum.

The liquid laser is being studied in this country and in France, Japan, and the Soviet Union. General Telephone & Electronics Laboratories, for instance, is seeking to develop the inorganic type for use both as an oscillator and an amplifier.

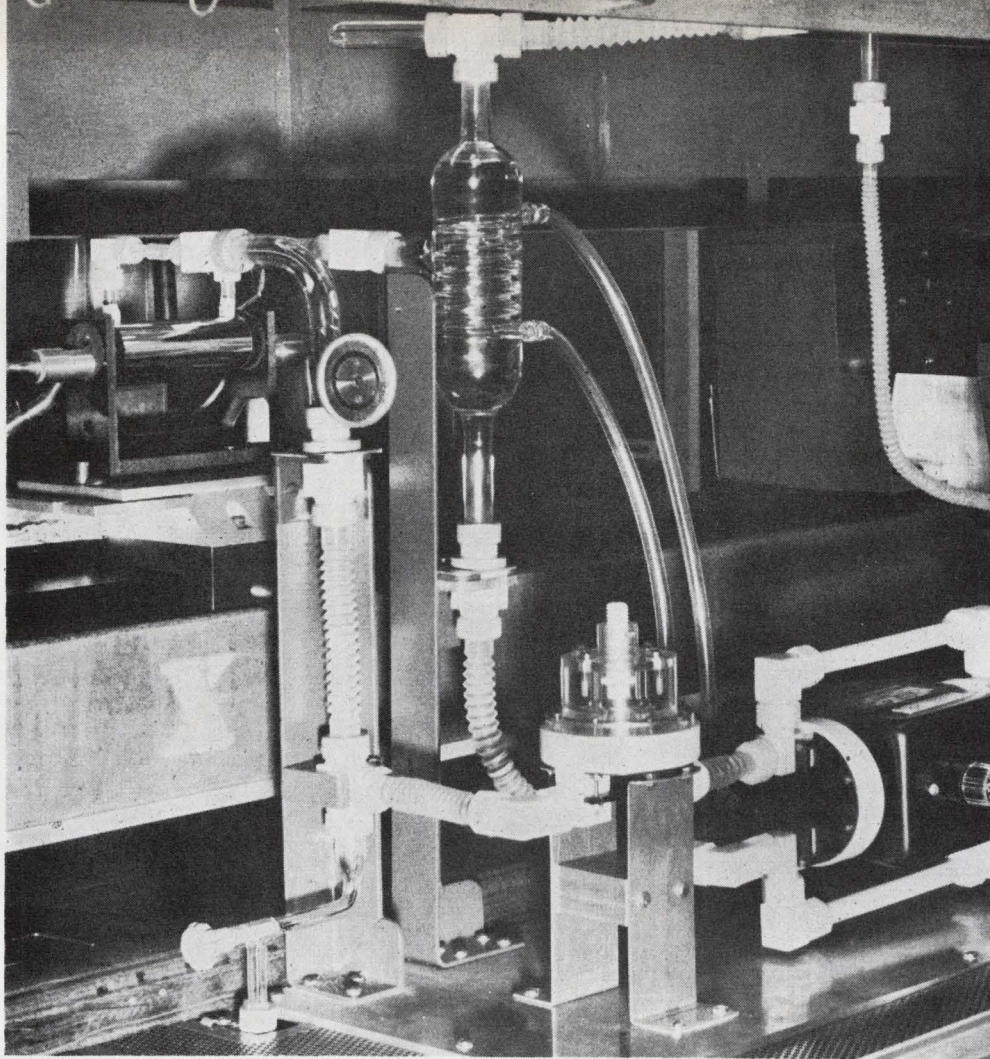
Caged light

The first liquid laser, developed in 1963, was a fusion of the present organic and inorganic types. Called a chelate laser, it consisted of a solution of organic, cage-like molecules surrounding a europium ion.

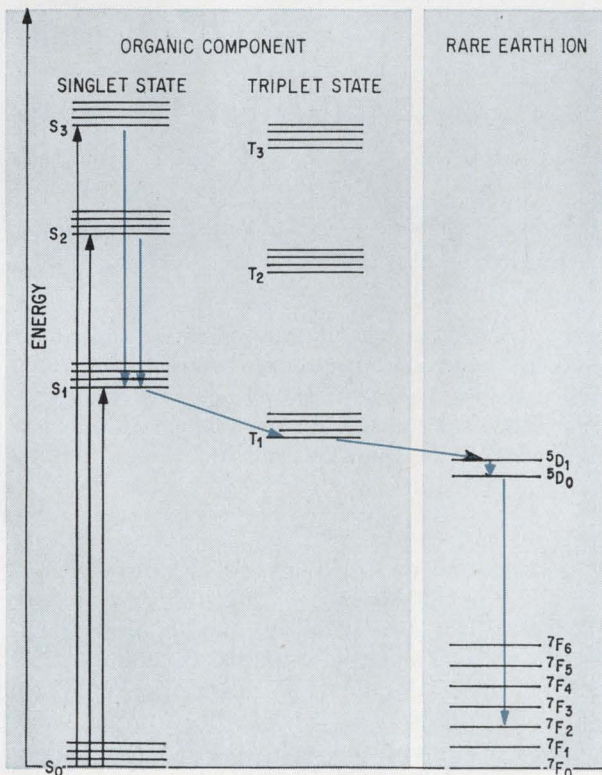
Then—as now—the trick was finding a way of dissolving the active materials and protecting them from elements with a low atomic weight, such as hydrogen, in the solvent. The energy levels of these elements are such that they tend to absorb energy emitted from the excited materials. Thus, the rare-earth ion could give up its energy to a hydrogen-containing molecule if it were not shielded, and laser action wouldn't take place.

However, the organic molecule in the chelate laser keeps the solvent from contacting the rare-earth ion, preventing the hydrogen-containing molecule from removing the excitation energy. In addition, the organic compound acts as a very efficient absorber of pump energy, which it then transfers to the europium ion.

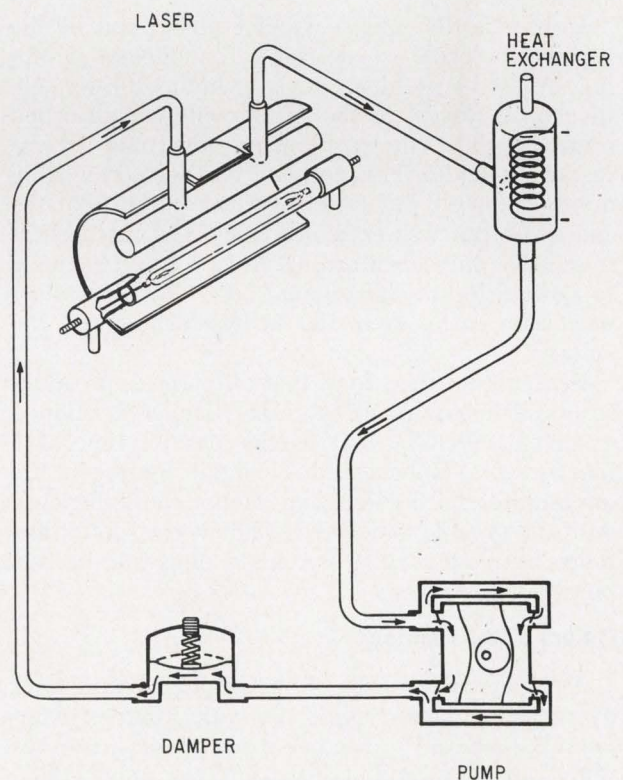
The energy-transfer mechanism in this early liquid laser was based on the fact that electrons in the organic molecule can exist in either a singlet state (two electrons spinning in opposite directions) or a triplet state (two electrons spinning in the same direction). The ground state—that is, the



Keeping cool. In GT&E inorganic laser, the liquid is pumped past a coil, that removes heat, easing cooling problems at high average powers. With a properly designed circulating pump, c-w operation should be possible.



Energy structure. Transitions in chelate laser are basic to understanding inorganic and organic types.



Circulation. Damper smooths out pulsations of the diaphragm pump used in GT&E's circulating liquid laser.

one with the lowest energy—is a singlet in almost all molecules. Many rotational and vibrational states, each with its own discrete energy level, are associated with both the singlet and triplet states. The standard notation is $S_0 \dots S_n$ for the singlet and $T_1 \dots T_n$ for the triplet.

Normally, electrons can absorb or give up energy in transition from one state to another within either a singlet or triplet, but can't change from the singlet to the triplet state or back. However, substituting a rare-earth element in the molecule, as in the chelate laser, makes such transitions possible by perturbing the electronic structure. In this type of liquid laser such a crossover transition is an essential step.

The organic part of the chelate laser thus absorbs the pump energy, and the electrons are excited to one of the higher singlet states. Transitions back to the S_1 singlet are very rapid, taking about 10^{-12} second. Then energy in the S_1 state is transferred to the T_1 (metastable) triplet state of the organic compound. If the energy level of the state, T_1 , is located properly with respect to one of the excited states of the europium ion, it transfers its energy to the ion, which then returns to the ground state, giving up its energy as radiation.

Too much of a good thing

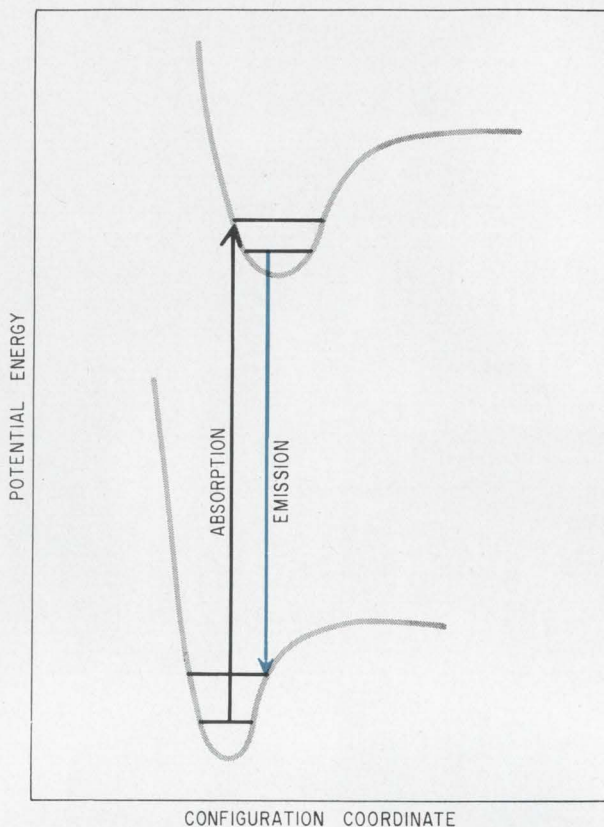
Researchers discovered a number of organic compounds and many solvents in which the europium ion ultimately was excited to the 5D_0 state and gave off a large number of photons in making transitions to the 7F_2 state. (These standard classifications describe such properties as angular momentum and spin.)

However, the intense singlet absorption of the organic molecule—so desirable for efficient pumping—created a problem. In the cylindrical laser cell, the liquid closest to the glass container absorbed a great deal of energy, blocking absorption by the rest of the liquid. This problem was solved by using a very thin cell, but it held so little liquid that the energy output was extremely low. And researchers found that only a few rare-earth ions could be made to radiate light. The organic cage doesn't protect most rare earths from the hydrogen atoms in the solvent.

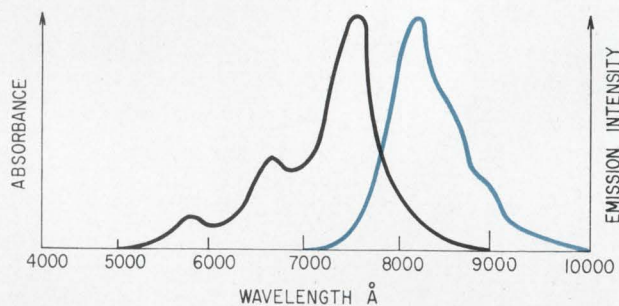
Researchers then took two different approaches to liquid lasers. At GT&E Adam Heller developed a solvent, $SeOCl_2$, that would dissolve the Nd^{+3} ion. Since the solvent didn't contain hydrogen, the ion required no shielding and Heller could dispense with the organic molecule. At about the same time, Peter Sorokin at IBM got laser emission from a purely organic dye.

Colors of the rainbow

A distinct advantage of the organic liquid laser over the inorganic type is the wide range of compounds that can be used. Various classes, such as phthalocyanines and carbocyanines or polymethine dyes, have enabled the organic laser to span all of the visible as well as the near-infrared parts



Organic states. There's a shift in distances between the various nuclei of the organic compound for the excited and ground states. As a result, the absorption and emission bands overlap somewhat.

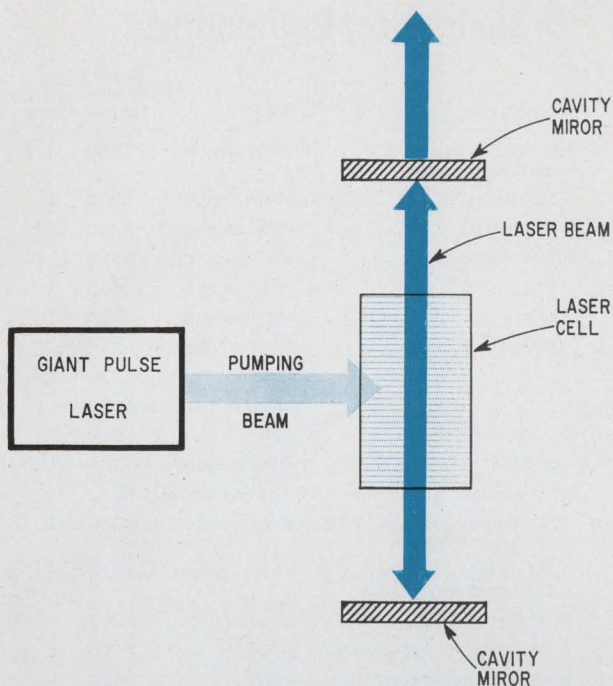


Tuning. The overlapping of the absorption and emission bands can be put to good advantage by varying the concentration of the organic dye, changing the balance of absorption and emission at a given frequency. It's thus possible to tune this type of liquid laser.

of the electromagnetic frequency spectrum.

These types of lasers generate high peak-power pulses either with a wide bandwidth of frequencies or with essentially a single frequency. And they can generate either one pulse or a repetitive mode-locked train. They should be of great value in spectroscopy and photochemistry.

When these lasers are pumped they are excited to the higher states of the singlet system and make transitions from them to the lowest excited

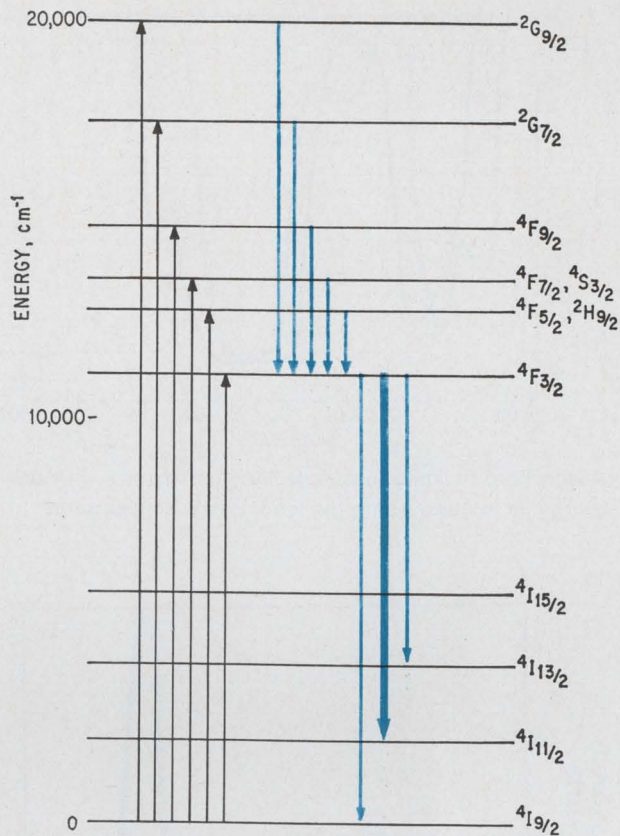


Pumping. In this typical experimental arrangement, an organic laser is pumped transversally by a high-powered pulsed laser. A frequency-doubling crystal can be inserted between the giant pulse laser and the liquid laser if pumping with the second harmonic is desired. Ruby-pumped organic lasers put out 6 megawatts of peak power with conversion efficiencies of 25%.

state in about 10^{-12} second. At this point, one of two things can happen. The molecule can give up its energy radiatively or nonradiatively from S_1 to S_0 in about 10^{-9} second, nonradiatively from S_1 to one of the triplet states in about 10^{-7} second, and then radiatively or nonradiatively from the lowest excited triplet state to the singlet ground state in about 10^{-3} to 10^{-6} second.

The emission spectra of organic lasers generally consists of a number of broad bands resulting from transitions from the lowest excited singlet to the various vibrational states of the ground singlet. There's a shift in distances between the various nuclei of the organic compound for the excited and ground states. As a result, absorption and emission bands overlap somewhat. This can be put to good advantage by varying the concentration of the organic dye, changing the balance of absorption and emission in a given frequency range. Thus, the organic lasers can be tuned to a particular frequency or frequencies.

The rapid transition rate between S_1 and S_0 requires that this laser be pumped with a short-duration pulse. The organic compound must be excited with enough power for population inversion to take place. An upper limit on the length of the pumping pulse is set by the probability of transitions to the triplet state. Selection of the organic compound is also vital. If there's any significant overlap between the triplet absorption



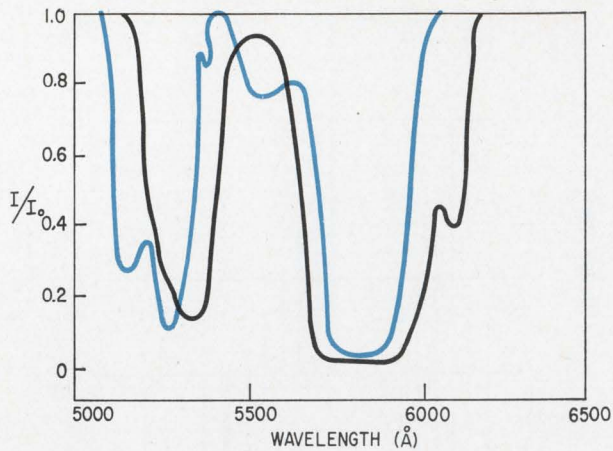
Popular ion. In a neodymium ion emission occurs from the $4F_{3/2}$ state to the lower $4I$ energy states.

and either the pump bands or singlet emission states, laser action won't take place or will be very weak.

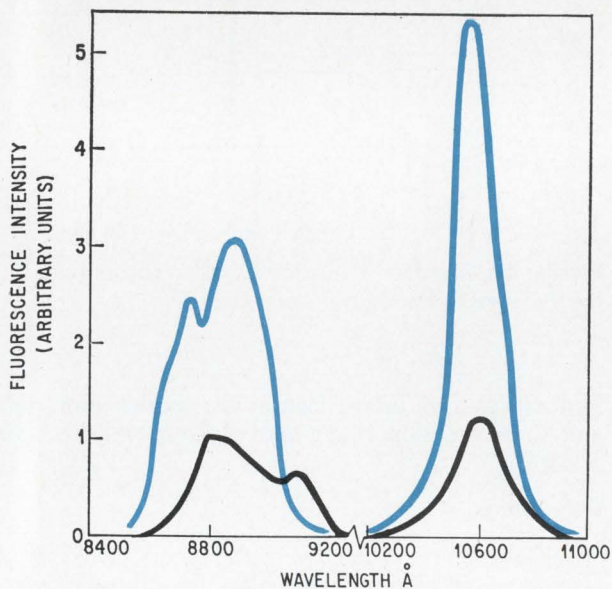
Beginnings

Initially, Sorokin used a high-power pulsed ruby laser to pump a solution of chloroaluminumphthalocyanine. Since it is possible to double the frequency of ruby and neodymium-doped lasers with reasonable conversion efficiency, a number of other organic compounds became candidates. But it's only in the past year that flashlamp-excited organic lasers have been developed. This not only made these lasers simpler and cheaper but also extended the list of possible organic compounds and increased the number of available output frequencies.

Outputs of the organic lasers depend on both the material and the pump. When a Q-switched laser pump or flashlamp pump is used with mode locking, the pulses are short—anywhere from 10 microseconds down to picoseconds—and the peak powers are high. A ruby-pumped organic laser, for instance, puts out 6 megawatts of peak power and has a conversion efficiency of 25%. Flashlamp-pumped organic lasers have peak powers of 0.1 megawatt and efficiencies close to 1%. Their energy output is about 0.2 joule. Their beam divergences are excellent—about 0.5 milliradian in a suitable cavity. Pulse repetition rates of about one



Absorption. In liquid (color) neodymium absorbs as much energy as in glass where the ion is more concentrated.



Light output. The ion's emission intensity in liquid (color) is much greater than it is in glass.

per second have been achieved.

As better flashlamps are developed, efficiencies and energy outputs of these lasers should climb. But the presence of the various triplet states makes continuous operation unlikely.

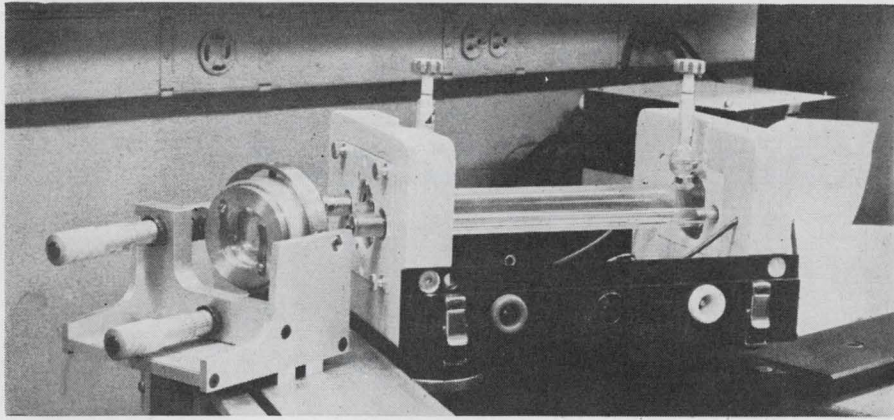
The problems precluding c-w operation in organic lasers—high pump powers and the triplet system—aren't present in inorganic lasers so that it should eventually be possible to operate the latter type continuously. In this laser, energy is pumped in to excite the Nd^{+3} ion from the $^4\text{I}_{9/2}$ ground state to the $^4\text{F}_{3/2}$ excited state and states above it. Laser emission takes place in the transition from the $^4\text{F}_{3/2}$ to the $^4\text{I}_{11/2}$ energy state. The neodymium ion absorbs less energy than does the organic compound in the other type of liquid laser, but absorption is far from negligible. Properties of the inorganic laser are similar to those of crystal

Organic Laser Compounds

Compound	Solvent	Laser Wave-length	Pump
chloro-aluminum phthalocyanine	ethyl alcohol	7550	L
3, 3' diethyl thia TC iodide	ethyl alcohol	8030	L
acridine red	ethyl alcohol	5800	L, F
rhodamine 6G	ethyl alcohol	5500	L, F
	ethyl alcohol	5650	L
eosin	ethyl alcohol	5400	L
fluorescein	ethyl alcohol	5270	L, F
	water	5270	L
	water	5390	L, F
	water	5350	L
acridone	ethyl alcohol	4370	L
3, 3' diethyl TC bromide	methyl alcohol	8130	L
1, 1' diethyl γ nitro 4, 4' DC tetrafluoroborate	ethyl alcohol	8050	L
1, 1' diethyl γ acetoxy 2, 2' DC tetrafluoroborate	methyl alcohol	7970	L
1, 1' diethyl 2, 2' DC iodide	glycerol	7700	L
1, 1' diethyl 4, 4' C iodide	glycerol	7450	L
3 ethyl aminopyrene 5, 8, 10 trisulfonic acid (sodium salt)	water	4410	L
2, 4, 6 triphenyl pyrrilium fluoroborate	methyl alcohol	4850	L
rhodamine B	ethyl alcohol	6080	L, F
3, 3' diethyl oxa DC iodide	methyl alcohol	6580	L
acriflavin hydrochloride	ethyl alcohol	5100	L
rhodamine B	ethyl alcohol	5770	L
rhodamine G	ethyl alcohol	5850	L
4 methyl umbelliferone	water	4540	F
3, 3' diethyl 2, 2' (5, 6, 5', 6' tetramethoxy) thia TC iodide	acetone	8530	L
3, 3' diethyl 2, 2' (4, 5, 4', 5' dibenzo) thia TC iodide	acetone	8600	L
3, 3' diethyl 10 chloro 2, 2' (4, 5, 4', 5' dibenzo) thia DC iodide	acetone	7740	L
3, 3' diethyl 10 chloro 2, 2' (5, 6, 5', 6' dibenzo) thia DC iodide	acetone	7140	L
1, 1' dimethyl 4, 4' QC iodide	glycerine	7490	L
1, 1' diethyl 4, 4' QC bromide	glycerine	7540	L
1, 1' diethyl 2, 2' QTC iodide	acetone	8980	L
1, 1' diethyl 4, 4' QTC iodide	acetone	10000	L
1, 1' diethyl 11 bromo 2, 2' QDC iodide	glycerine	8150	L
1, 1' dimethyl 11 bromo 2, 2' QDC iodide	glycerine	7450	L
1, 1' diethyl 11 bromo 4, 4' QDC iodide	methanol	8300	L
3, 3' diethyl 2, 2' oxa TC iodide	acetone	7420	L
3, 3' dimethyl 2, 2' oxa TC iodide	acetone	7440	L
1, 3, 3, 1', 3, 3' hexamethyl 2, 2' indo TC iodide	acetone	8190	L
3, 3' diethyl 2, 2' seleno-TC iodide	acetone	8260	L
3, 3 diethyl 2, 2' (5, 5' dimethyl) thiazolino TC iodide	glycerine	7170	L

Abbreviations used in this table are as follows:

Tricarbo-cyanine	TC
Dicarbo-cyanine	DC
Carbo-cyanine	C
Quinocarbo-cyanine	QC
Quinotricarbo-cyanine	QTC
Quinodicarbo-cyanine	QDC



Static laser. Most experiments with inorganic liquid lasers at GT&E have been done with noncirculating types such as this one. The data provides a reference for work with the newer circulating lasers.

and glass lasers, since the emission mechanisms are similar.

It wasn't until recently that scientists realized why fluorescence in liquids was so weak. They had been puzzled because the spectroscopy of solutions of rare earth ions suggested that their energy level structure was similar to that of the same ions in solid materials. Then it was realized that proton- or hydrogen-containing species in the solvent can deactivate rare-earth ions and quench fluorescent emission.

Based on this reasoning, Heller produced the first solvent that didn't contain hydrogen and could dissolve Nd^{+3} in high concentrations. However, this solvent, a mixture of selenium oxychloride and tin tetrachloride, was highly corrosive and toxic. To get around this difficulty, quartz and Teflon—both essentially unaffected by the solvent—were used to fabricate components in the inorganic laser. However, care had to be taken to guard against leakage of the toxic solvent.

Then, in the last few months, researchers developed a phosphorous oxychloride (POCl_3) solvent that is less corrosive and considerably less toxic. They found at first that they couldn't make a solution of dry phosphorous oxychloride and tin tetrachloride. However, by adding water and then carefully distilling it away, they got a stable solution. They suspect that the water reacts with the phosphorous oxychloride to form another phosphorous compound, stabilizing the solution.

Evaluations of this new solvent are by no means complete, but spectroscopic studies indicate that the potential power and efficiency of neodymium liquid lasers using this solvent would equal those of glass and yttrium-aluminum-garnet types.

For example, absorption spectra of neodymium-doped glass and neodymium-doped SeOCl_2 are quite comparable. Emission from the neodymium-doped solution is significantly greater than that from glass and laser emission is limited to many fewer wavelengths. Actually, the gain of the liquid neodymium laser lies between those of the glass and yag lasers.

Most experiments have been performed with noncirculating inorganic lasers. In the GT&E ver-

sion of these devices, the cell holding the liquid is a hollow quartz or Pyrex cylinder mechanically and optically finished so that its ends are flat, parallel, and normal to the axis. End windows can be fastened into place in a variety of ways, and the seal between the window and cell is made with a Teflon-coated rubber O-ring. The energy output depends upon length; for example, a 6-inch cell puts out 10 joules with a slope efficiency of about 1%, and a 20-inch cell puts out more than 30 joules with even greater slope efficiencies.

The inorganic lasers can also be Q-switched and mode-locked by conventional techniques to produce up to gigawatt peak powers. They have an unusual property similar to one observed only in ruby lasers. If their cavity Q is adjusted to be low—that is, if the mirror reflectivity is decreased—their output consists of giant spikes. No additional active or passive element is required to produce the effect.

The reason isn't clearly understood, but this self Q-switching appears to be related to stimulated Brillouin scattering in the solution. A model has been suggested in which the laser cavity interacts with some highly polarizable component of the solution. As a result, there is a pronounced back scattering of the radiation—in effect, the light is reflected backward. Since the cavity has been adjusted to have low feedback, the sudden increase in reflectivity leads to a giant pulse.

Mobile medium

The real future of inorganic lasers, however, lies with the circulating system. The circulation not only cools the liquid but also compensates for any local inhomogeneities in the refractive index. Optical damage from high-powered laser beams doesn't occur, as it does in some solid state lasers. If a volume of a few hundred cubic centimeters of the liquid is used, circulation alone is sufficient to cool the laser—even at high pulse repetition rates.

The development of POCl_3 suggests that solvents that can dissolve other rare-earth ions may be developed. Researchers would like, for example, to make use of the europium ion. To date, however, they've been unable to get it to emit coherent light except in the chelate environment.

Calculating Gunn-diode output

Use of equal-area analysis and Fourier transforms provides a simple and straightforward method of predicting generated microwave power

By Mohammed N. Al-Moufti, Stanley V. Jaskolski, and T. Koryu Ishii

Department of Electrical Engineering, Marquette University, Milwaukee

The recent marketing of Gunn-effect microwave diodes is a prime example of the surprising speed with which devices based on new principles are moving from research lab to engineering bench. At the same time, the devices themselves exemplify how engineering techniques often lag behind technological innovations. For despite all the work that's been done on the domain physics of Gunn diodes, until recently there was no simple way to calculate the output of these power sources.

There is one now, based on an equal-area analysis of a curve relating the average carrier velocity to voltage. From this, the portion of the applied voltage absorbed by the moving high-field domain can be found. The generated r-f voltage can then be determined by a Fourier analysis of the sawtooth waveform assumed for the domain voltage, and with this, the output power can be calculated.

Earlier techniques were no more quantitative and a great deal more complicated. J.R. Gunn, the device's inventor, devised a method of determining the current waveform from a sample voltage, and a more general theory of the diode's efficiency was presented by W. Heinle, who employed a drift-velocity, field-strength characteristic to describe the device's dynamic behavior. But the new technique provides a far more straightforward way of computing absolute output power.

Domain propagation

During Gunn oscillations, a high-field domain forms at the cathode of the bulk-effect device and propagates through the bulk semiconductor sample to the anode where it vanishes. Another domain then forms and starts the process over again. The voltage absorbed by this domain is related to the generated microwave voltage, V_{rf} , and the microwave output power is equal to $V_{rf}^2/2Z_L$, where Z_L is the microwave load impedance.

Part of the external bias voltage, V , applied

across the diode is absorbed by the high-field domain, whose voltage is V_D . The remaining bulk sample voltage (outside the high-field domain), V_L , is low. Thus:

$$V = V_D + V_L$$

To find V_L , a graph of the average carrier drift velocity as a function of the bias voltage can be constructed using

$$\bar{v} = V_0 X_0 \left(\frac{1 + QF}{1 + F} \right)$$

where

- \bar{v} = average carrier drift velocity
- V_0 = product of lower valley mobility and the sample threshold field = $\mu_L E_{peak}$
- X_0 = ratio of the applied electric field to the threshold field, = E/E_{peak}
- Q = ratio of the upper to lower valley mobility = μ_U/μ_L
- F = ratio of the upper to the lower valley carrier density

$$F = \left(\frac{V}{V_{peak}} \right)^B \left(\frac{1}{B - 1} \right)$$

$$B = \frac{1}{1 - \frac{J_p}{\sigma_0 E_{peak}}}$$

J_p being the peak current density and σ_0 the conductivity of the sample.

With equal-area analysis, the low-field voltage, V_L , can be obtained from a plot of the average carrier drive velocity versus bias voltage.

As an example, consider a Texas Instruments Gunn diode (the TI-G) whose typical value of electron upper-valley mobility, μ_U , is 50 cm² per volt-

second, and whose electron lower-valley mobility, μ_L , is $6,200 \text{ cm}^2/\text{volt-sec}$. For this diode, therefore, $Q = 8.06 \times 10^{-3}$.

Now, $E_{\text{peak}} = V_{\text{peak}}/l$, where V_{peak} is the d-c bias voltage that produces the peak current in the volt-ampere characteristic curve and l is the sample length. In the case of the TI-G diode, V_{peak} is 3.8 volts and l is 10^{-3} cm . Therefore, E_{peak} is 3,800 volts/cm and

$$v_0 = \mu_L E_{\text{peak}} = 2.36 \times 10^7 \text{ cm/sec}$$

Also,

$$X_0 = \frac{E}{E_{\text{peak}}} = \frac{V}{3.8}$$

The peak current, I_p , of the TI-G diode is 160 milliamperes. With a cross-sectional area of $34 \times 10^{-6} \text{ cm}^2$, the current density is thus $J_p = I_p/A$, or $0.471 \times 10^4 \text{ amp/cm}^2$.

The low-field conductivity can be calculated from

$$\sigma_0 = ne\mu_L$$

where n is the free carrier concentration and e is the charge of an electron. For the TI-G, n is $2.5 \times 10^{15} \text{ electrons/cm}^3$, and σ_0 is therefore 2.48 mho/cm. Thus, with data for E_{peak} , σ_n , and J_p , B can be calculated to be equal to about 2.

Then,

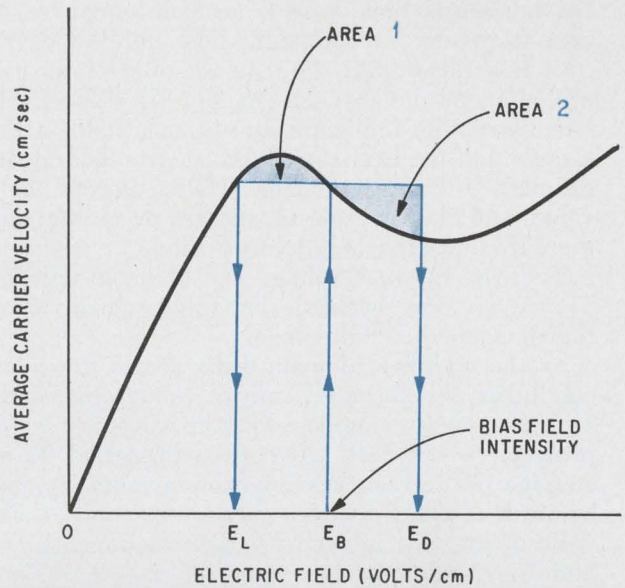
$$F = \left(\frac{V}{V_{\text{peak}}} \right)^2$$

The average carrier drift velocity \bar{v} as a function of the bias voltage V is thus

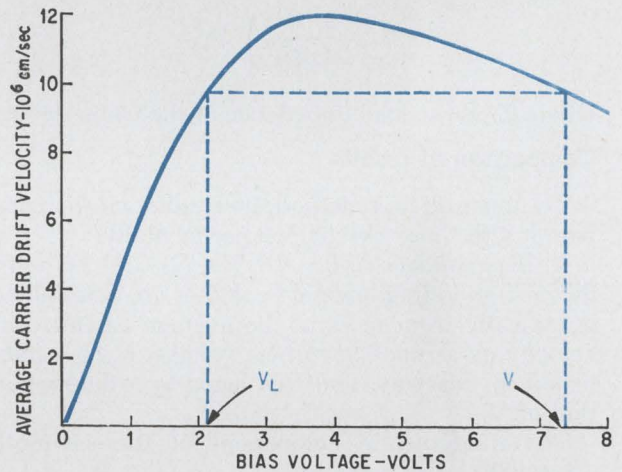
$$\bar{v} = 2.36 \times 10^7 \frac{V}{3.8} \frac{1 + 8.06 \times 10^{-3} \left(\frac{V}{3.8} \right)^2}{1 + \left(\frac{V}{3.8} \right)^2}$$

If this equation is plotted for V ranging from 0 to 8 volts, the curve at the right is obtained.

Once this volt-ampere characteristic curve is plotted, the minimum low-field voltage V_L can be



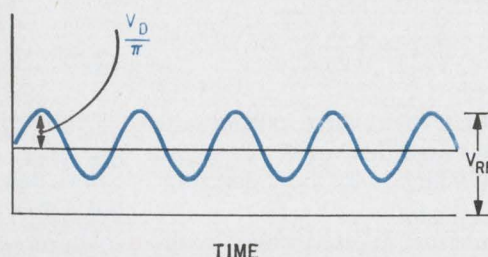
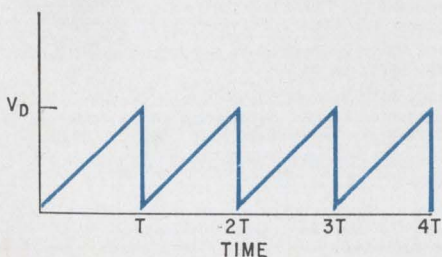
Equal areas. Low- and high-field values are calculated by equating the two areas around the bias point.



Design calculations. For the example in the text, the low-voltage region is figured to be about 2 volts.

obtained using the equal-area analysis, done as follows:

In the average carrier-drift-velocity-versus-sample-electric-field characteristic, a horizontal line is drawn to intersect the curve through a bias field point P_B . If the area surrounded by the curve and



Sawtooth. The voltage across the high-field domain is assumed to rise linearly with time and then drop sharply in sawtooth fashion. Its fundamental sinusoidal component determines the microwave power.

the horizontal line, Area 1, is made equal to the area between the horizontal line and the curve, Area 2, as illustrated, the readings of the intersecting points on the abscissa— E_L and E_D , respectively—represent the minimum low electric field in the sample and the maximum high electric field in the sample's traveling domain. These electric field values can be converted to voltages by multiplying them by the active length of the diode.

Knowing the bias voltage and low-field voltage, V_L , we can now establish the voltage absorbed by the domain—their difference.

As the high-field domain drifts across the semiconductor, the absorbed domain voltage increases. Let's assume for simplicity that its waveform is approximately a linear sawtooth with period T , as on page 149 and reaches a maximum value, V_D , just before it discharges at the anode.

Resolving this into its Fourier components, we find the fundamental component, V_{rf} , to be approximately the generated fundamental microwave signal. The power output, P , of the microwave oscillation is then simply:

$$P = \left(\frac{1}{2Z_L} \right) V_{rf}^2$$

where Z_L is the load impedance of the Gunn device.

Comparison of results

To illustrate this method, its results will be compared with those obtained experimentally.

At bias voltages of 6.8, 6.9, 7.0, 7.3, and 7.5 volts, the corresponding low-field voltages are determined graphically from plots of the average carrier drift velocity as a function of bias voltage. V_D is established in this way, and this leads to a determination of V_{rf} .

The fundamental component of the sawtooth wave with peak value is

$$\frac{V_D}{\pi} \sin \omega t$$

so its maximum value is V_D/π . Therefore,

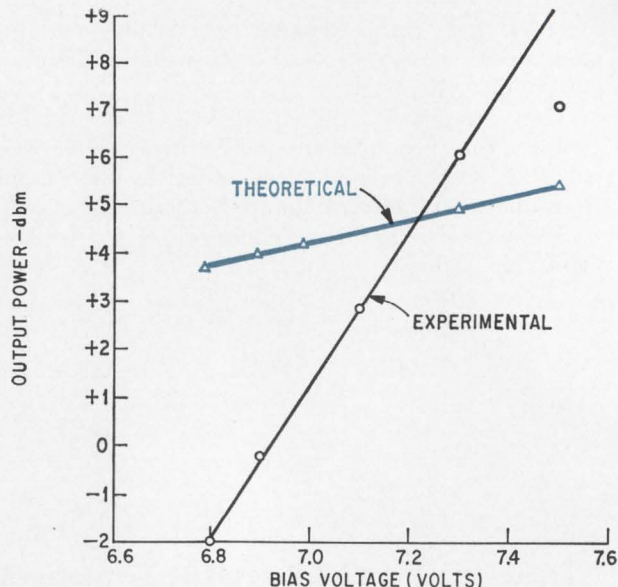
$$V_{rf} = \frac{V_D}{\pi}$$

With V_L and V_{rf} known, and with Z_L equal to the characteristic impedance, Z_0 , of the waveguide where

$$Z_0 = 377 \frac{2b}{a} \frac{1}{\sqrt{1 - \left(\frac{\lambda}{2a} \right)^2}}$$

five values for the diode's microwave output are calculated using a = waveguide width, 0.9 inch; b = waveguide height, 0.4 inch; and λ = operating wavelength, 3 cm ($f_0 = 10$ GHz).

These theoretical values are plotted along with



Close enough. The theoretical and experimental values for a typical Gunn diode are within 6 db of one another.

the experimentally obtained output power measurements, as shown above. The difference between the theoretical and experimental values is well within ± 3 decibels (or 6 db peak to peak). Given the present state of the art in the field, this discrepancy, though not insignificant, is quite acceptable.

The discrepancies between the observed results and theoretical predictions stem from the fact that the shape of the high-field domain absorbed voltage isn't exactly sawtooth, that the circuit interpretation is oversimplified, and that the definition of waveguide characteristic impedance is somewhat ambiguous.

Bibliography

- D.K. Cheng, "Analysis of Linear Systems," Addison Wesley Publishing Co., May 1961, pp. 122-123.
- J.A. Copeland, "Electrostatic Domains in Two-Valley Semiconductors," IEEE Trans. on Electron Devices, January 1966, pp. 190.
- R.W.H. Engelmann and C.F. Quate, "Linear or 'Small-Signal' Theory for the Gunn Effect," *ibid.*, pp. 44-52.
- J.S. Heeks, "Moving High-Field Domain in Gunn-Effect Devices," *ibid.*, p. 72.
- H. Kroemer, "Nonlinear Space-Charge Domain Dynamics in a Semiconductor with Negative Differential Mobility," *ibid.*, pp. 27-40.
- J.B. Gunn, "Effect of Domain and Circuit Properties on Oscillations in GaAs," IBM System Journal, 1966, pp. 310-320.
- J.B. Gunn, "Properties of a Free, Steady Travelling Electrical Domain in GaAs," *ibid.*, pp. 300-309.
- W. Heinle, "Determination of Current Waveform and Efficiency of Gunn Diodes," Electronic Letters, February 1967, pp. 52-54.
- J.A. Copeland, "Bulk Negative-Resistance Semiconductor Devices," IEEE Spectrum, May 1967, pp. 71-77.
- S.V. Jaskolski, "Analysis of Space-Charge Domain Motion in a Bulk-Effect Semiconductor," Ph.D. dissertation, Marquette University Memorial Library, Milwaukee, June 1967, pp. 23-25.
- G.W. Ludwig, "Gunn Effect in CdTe," IEEE Trans. on Electron Devices, September 1967, pp. 547-551.
- M.N. Al-Moufti, "Construction and Evaluation of Bulk-Effect Diode Transmitter," Master's thesis, Marquette University Memorial Library, Milwaukee, April 1968.

MEMO FROM:

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

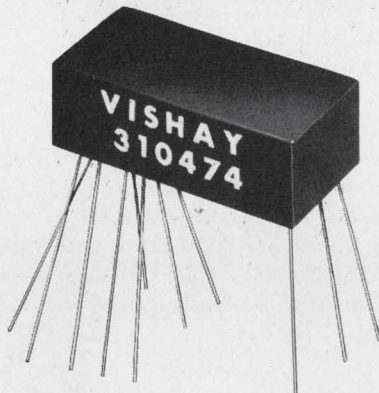
TO All μ A722 users

FOR Optimum μ A722 performance

Vishay Resistance Network
310474 in all A-D and D-A
conversion applications.

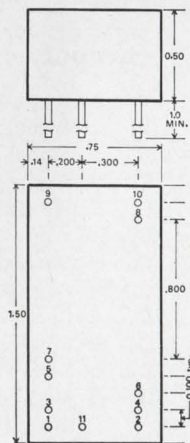
Sam Zivier

WHY...? WHY DOES FAIRCHILD RECOMMEND THIS VISHAY RESISTANCE NETWORK?



Because this network... and only this network... offers this spec combination:

- TC Tracking: $\pm 1.5\text{ppm}/^\circ\text{C}$. (using Vishay Resistors externally)
- Absolute TC: $0\pm 1\text{ppm}/^\circ\text{C}$.
- Shelf Stability: $25\text{ppm}/\text{yr}$.
- Noise: Non-measurable.
- Other specs include— Rise Time: $< 10\text{ ns}$. . . Settling Time: $< 100\text{ ns}$. . . Non-inductive (no ringing.)



Cost, speed, size and reliability of A-D and D-A conversion are all improved dramatically with Fairchild's new μ A722 Converter Current source. And for optimum performance in any of these applications (conversion, function generation, multiplication, division, etc.), Fairchild recommends the Vishay 310474 network. Put the two together in any circuit you're planning . . . for long, low cost, reliable operation.

For full spec data on this network and the complete line of Vishay Precision Resistor Networks, write Vishay today. For μ A722 data, contact Fairchild Semiconductor or any Fairchild distributor.



VISHAY RESISTOR PRODUCTS

a division of Vishay Intertechnology, Inc.

64 Lincoln Highway ■ Malvern, Pa. 19355

(215) 644-1300 ■ TWX: 510-668-8944

MOS multiplexer switches can do well at high frequencies

Signal feedthrough, frequency limitations, and transients can become serious above 1 kilohertz, but mathematical models make it possible to design circuits whose performance isn't marred by these difficulties

By Per Mogensen and Wallace Chan

Fairchild Semiconductor, Mountain View, Calif.

The no-moving-part version of the relay, the metal oxide semiconductor multiplexer switch, is so superior that it has virtually replaced its mechanical counterpart in industrial and military applications. In equipment such as analog-to-digital converters, telemeters, multichannel data transmission and control systems, and computer input-output circuits, it has no peer. However, certain pitfalls can make the MOS switch less useful than the relay.

When MOS multiplexer switches are operated at signal frequencies above 1 kilohertz, capacitance effects become significant and can be serious if they are not allowed for in the design. These effects are:

- **Signal feedthrough.** A signal can feed capacitively through a channel that's off, causing an erroneous reading in another on channel. In a well shielded system, this coupling between input and output is mainly due to the capacitance of the multiplexer switch itself.

- **Frequency limitations.** The maximum signal frequency that the switch can transmit depends on how fast the signal source can charge the capacitance of the channel and external load through the channel on resistance and the source resistance. This maximum is usually expressed as the 3-decibel frequency.

- **Transients.** The capacitive coupling between gate and channel gives rise to a voltage transient on the signal output each time a channel is switched.

Mathematical models are available for each of these effects and can be used to predict high-frequency performance. The models described here are for a simple two-channel switch in an single

package, but they can easily be extended to cover any number of channels in single or multiple packaging schemes.

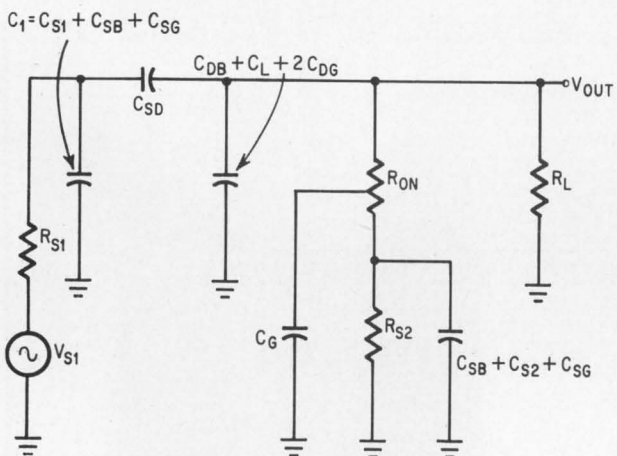
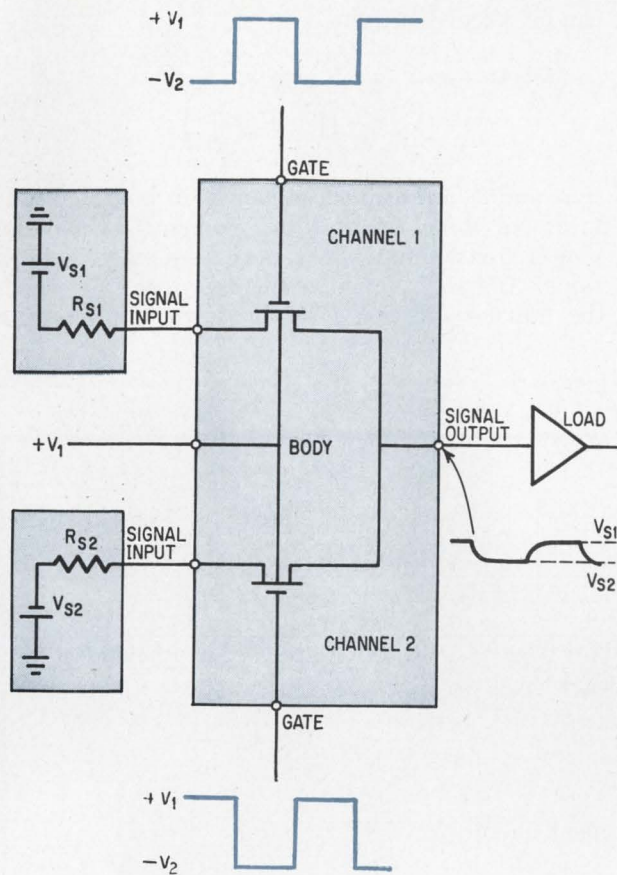
Finding feedthrough

Signal feedthrough—the ratio of output voltage V_{out} to the voltage V_{S1} at the input of the off transistor in the two-channel multiplexer shown on opposite page—is essentially a function of the resistance and capacitance of the combined circuits.

The equivalent circuit shown below the actual circuit applies when $R_{S2} \gg R_{on}$ or $R_{S2} \ll R_{on}$. From

Symbols

V_{S1}	=	Signal voltage in channel 1
V_{S2}	=	Signal voltage in channel 2
R_{S1}	=	Signal resistance in channel 1
R_{S2}	=	Signal resistance in channel 2
C_{S1}	=	Wiring capacitance in channel 1
C_{S2}	=	Wiring capacitance in channel 2
C_{SB}	=	Source-to-bulk capacitance
C_{SG}	=	Source-to-gate capacitance
C_{DB}	=	Common-drain-to-bulk capacitance
C_{DG}	=	Common-drain-to-gate capacitance
C_{SD}	=	Source-to-common-drain capacitance
C_G	=	MOS-channel-to-bulk (and gate metal) capacitance
R_{on}	=	MOS-channel on resistance
R_L	=	Load resistor (generally $\gg R_{on}$)
C_L	=	Load capacitance, including wiring
C_{in}	=	Multiplexer switch input capacitance
C_{out}	=	Multiplexer switch output capacitance



Multiplexer. Voltages on gates switch channels on and off to connect alternate signals to the load. Equivalent circuit at bottom is for feedthrough equations.

this circuit, the signal feedthrough can be calculated from

$$\frac{V_{out}}{V_{S1}} = \frac{j \frac{\omega}{\omega_3}}{\left(1 + j \frac{\omega}{\omega_1}\right) \left(1 + j \frac{\omega}{\omega_2}\right)} \quad (1)$$

if ω_1 , ω_2 , and ω_3 are defined as shown on next page; ω without a subscript represents the radial frequency of V_{S1} . In most multiplexer switches avail-

able today, R_{on} is between 100 and 1,000 ohms, and R_{S1} and R_{S2} range from 0 to 10 kilohms.

Ordinarily, in a well shielded system, C_{SD} is between one and three orders of magnitude smaller than C_1 and C_2 , so the expressions for ω_1 and ω_2 aren't nearly as formidable as they appear. They reduce to an equation in which ω_1 and ω_2 each assumes one of two values

$$\left. \begin{matrix} \omega_1 \\ \omega_2 \end{matrix} \right\} = \left\{ \begin{matrix} \frac{1}{C_1 R_{S1}} \\ \frac{1}{C_2 R_2} \end{matrix} \right.$$

where ω_1 is the smaller of the two quantities on the right.

The maximum signal feedthrough, from equation 1, is

$$\frac{V_{out}}{V_{S1}} = 20 \log \left(\frac{\omega_1}{\omega_3} \right) \text{ decibels}$$

C_1 needs further explanation. It is the input wiring capacitance in parallel with the source-to-bulk capacitance and the source-to-gate capacitance. For practical purposes, C_1 equals the wiring capacitance in parallel with the channel input capacitance (the latter measured with the gate at ground).

For $R_{S2} \ll R_{on}$, C_2 is approximately equal to the multiplexer output capacitance in parallel with the load capacitance

$$C_2 = C_{DB} + C_L + 2C_{DG} + \frac{1}{2}C_G \approx C_{out} + C_L$$

And when $R_{S2} \gg R_{on}$, it's necessary to add the capacitance from the input node of the on channel:

$$C_2 = C_{DB} + C_L + 2C_{DG} + C_G + C_{S2} + C_{SB} + C_{SG} \approx C_{out} + C_L + C_{S2} + C_{in}$$

One needn't use equation 1 to construct a continuous curve of feedthrough versus frequency. A simpler procedure yields fairly accurate results: calculate the maximum V_{out}/V_{S1} from equation 1, construct a line corresponding to this value between ω_1 and ω_2 , then draw lines dropping off at 20 db per decade on both sides.

An example: Fairchild's 3701 six-channel multiplexer switch has $C_1 = 5$ picofarads, $C_2 = 25$ pf, and $C_{SD} = 0.02$ pf. Assume that the system parameters R_{S1} and R_{S2} are 10 kilohms. Then ω_1 , ω_2 , and ω_3 , expressed in cycles per second (hertz) instead of radians per seconds, are 0.64, 3.2 and 800 megahertz, respectively. The maximum V_{out}/V_{S1} is -62 db. Feedthrough can now be plotted as a function of frequency with the simplified construction. The result is acceptably close to the measured curve, as

at top of page 155.

A multiplexer is ordinarily operated below ω_1 . In this range the feedthrough depends on the product $C_{SD}R_2$ —the smaller this product is, the less feedthrough.

The 3-db frequency

To find the maximum signal frequency, the equivalent circuit can be simplified even further, as on page 155. The transfer function—from which the 3-db frequency can be found—for this circuit

can be calculated from

$$\frac{V_{out}}{V_{S2}} = \frac{1}{\left(1 + j \frac{\omega}{\omega_1}\right) \left(1 + j \frac{\omega}{\omega_2}\right)} \quad (2)$$

if ω_1 and ω_2 are defined as shown in box below. It turns out that ω_1 and ω_2 are points at which the plot of transfer function versus frequency changes slope. And ω_1 is, in fact, the frequency at which the transfer function is 3 db down from its low

Feedthrough definitions

$$\omega_1 = \frac{(C_{SD} + C_1)R_{S1} + (C_{SD} + C_2)R_2 - \sqrt{[(C_{SD} + C_1)R_{S1} + (C_{SD} + C_2)R_2]^2 - 4[C_{SD}(C_1 + C_2) + C_1C_2]R_{S1}R_2}}{2[C_{SD}(C_1 + C_2) + C_1C_2]R_{S1}R_2}$$

$$\omega_2 = \frac{(C_{SD} + C_1)R_{S1} + (C_{SD} + C_2)R_2 + \sqrt{[(C_{SD} + C_1)R_{S1} + (C_{SD} + C_2)R_2]^2 - 4[C_{SD}(C_1 + C_2) + C_1C_2]R_{S1}R_2}}{2[C_{SD}(C_1 + C_2) + C_1C_2]R_{S1}R_2}$$

$$\omega_3 = \frac{1}{C_{SD}R_2}$$

The basic equation for feedthrough, from the equivalent circuit, is

$$\frac{V_{out}}{V_{S1}} = \frac{j\omega C_{SD}R_2}{(j\omega)^2 [C_{SD}(C_1 + C_2) + C_1C_2]R_{S1}R_2 + j\omega [(C_{SD} + C_1)R_{S1} + (C_{SD} + C_2)R_2] + 1}$$

which reduces to equation 1 when ω_1 , ω_2 , and ω_3 are defined as shown.

Three-db definitions

$$\omega_1 = \frac{R_{S2}(C_1 + C_2) + R_{on}C_2 - \sqrt{[R_{S2}(C_1 + C_2) + R_{on}C_2]^2 - 4R_{S2}R_{on}C_1C_2}}{2R_{S2}R_{on}C_1C_2}$$

$$\omega_2 = \frac{R_{S2}(C_1 + C_2) + R_{on}C_2 + \sqrt{[R_{S2}(C_1 + C_2) + R_{on}C_2]^2 - 4R_{S2}R_{on}C_1C_2}}{2R_{S2}R_{on}C_1C_2}$$

The transfer function, from the equivalent circuit, is

$$\frac{V_{out}}{V_{S2}} = \frac{1}{(j\omega)^2 R_{S2}R_{on}C_1C_2 + j\omega [R_{S2}(C_1 + C_2) + R_{on}C_2] + 1}$$

This simplifies to equation 2 when ω_1 and ω_2 are defined as shown.

Time constants

$$\tau_1 = \frac{2R_{S1}R_{on}C_1C_2}{R_{S1}(C_1 + C_2) + R_{on}C_2 - \sqrt{[R_{S1}(C_1 + C_2) + R_{on}C_2]^2 - 4R_{S1}R_{on}C_1C_2}}$$

$$\tau_2 = \frac{2R_{S1}R_{on}C_1C_2}{R_{S1}(C_1 + C_2) + R_{on}C_2 + \sqrt{[R_{S1}(C_1 + C_2) + R_{on}C_2]^2 - 4R_{S1}R_{on}C_1C_2}}$$

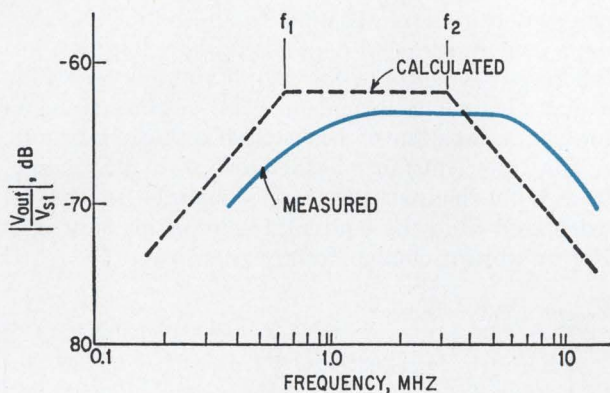
frequency value. As before, the frequency response curve can be approximated by straight lines connected at the critical frequencies, as below left.

If the signal source resistance R_{S2} is smaller than R_{on} , then

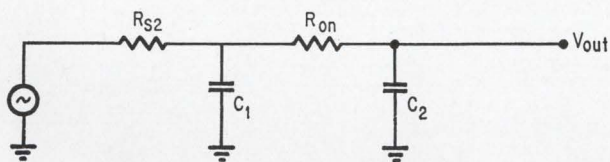
$$\omega_1 = \frac{1}{R_{on} C_2}$$

$$\omega_2 = \infty$$

On the other hand, if R_{S2} is much larger than the on



Close. The dashed line approximates the measured feedthrough well enough for practical purposes.

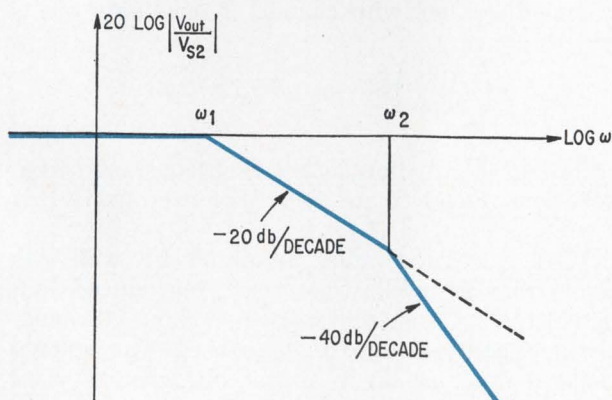


$$C_1 = C_{S2} + C_{SB} + C_{SG} + 1/2 C_G \approx C_{S2} + C_{in}$$

$$C_2 = C_L + C_{DB} + 2C_{DG} + C_{SD} + 1/2 C_G \approx C_L + C_{out}$$

$$R_L \gg R_{on} + R_{S2}$$

Another equivalent. A simplified version of the circuit is used for 3-dB point and transient calculations.



Graphic. A simple construction approximates the attenuation of signal with frequency.

resistance

$$\omega_1 = \frac{1}{R_{S2} (C_1 + C_2)}$$

$$\omega_2 = \frac{1}{R_{on} \left(\frac{C_1 C_2}{C_1 + C_2} \right)}$$

In other words, increasing the signal resistance rapidly degrades switch performance because the 3-dB frequency $[f_{3db} = (1/2\pi) \omega_1]$ is inversely proportional to R_{S2} when $R_{S2} \gg R_{on}$.

In the 3701, for example, R_{on} is 300 ohms. Assume that $C_1 = C_{S2} + C_{in} = 5$ pf and $C_2 = C_L + C_{out} = 20$ pf. If the signal resistance is large, say $R_{S2} = 10$ kilohms

$$f_1 = \frac{1}{2\pi} \cdot \frac{1}{10k (5pf + 20pf)} = 0.64 \text{ Mhz}$$

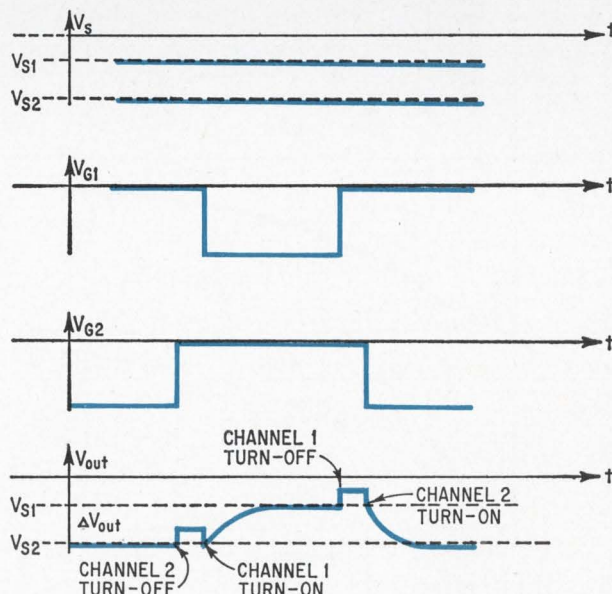
In contrast, when $R_{S2} = 0$

$$f_1 = \frac{1}{2\pi} \cdot \frac{1}{300 \cdot 20pf} = 27 \text{ Mhz}$$

Transient events

When one channel is switched off and another is switched on, the transient voltages at the gates feed through the drain-to-gate capacitance to the output. The sequence of events is shown in figure below; to make things clearer, the control voltages are staggered so that both channels are off simultaneously for a short time.

The drain-gate capacitance and the capacitance between output and ground form a capacitive voltage divider, making the voltage change (i.e., the



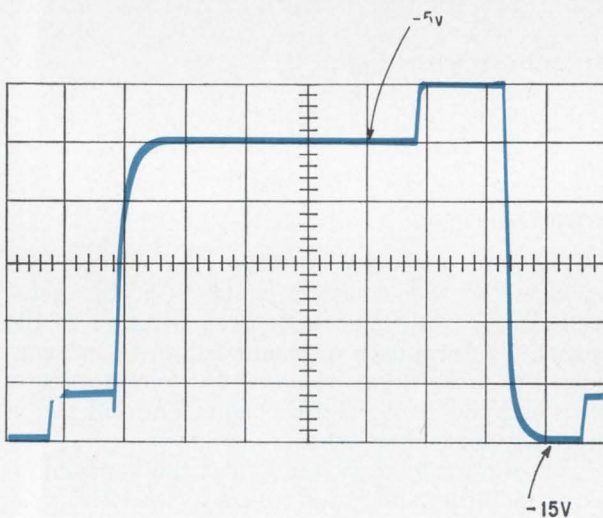
Sequence of events. Transient voltages occur when a channel is turned on while the other is off.

transient) at the output

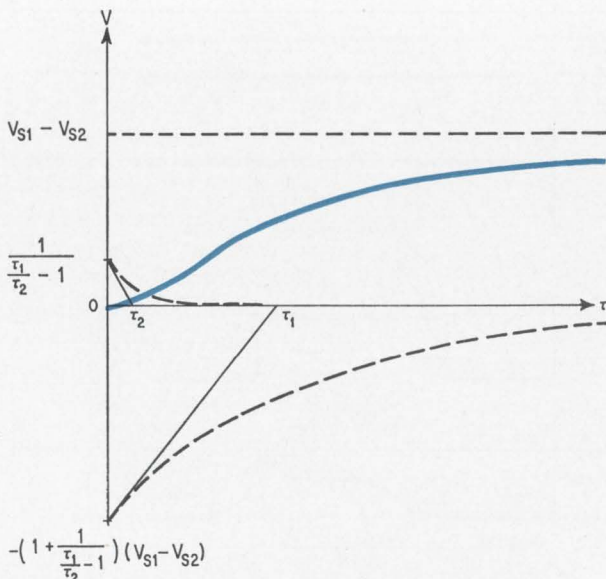
$$\Delta V_{out} = \frac{C_{DG} V_G}{C_{DB} + C_L + 2C_{DG}} \quad (3)$$

$$\approx \frac{C_{DG} V_G}{C_{out} + C_L}$$

In this equation, it's assumed that the capacitors are voltage-independent, just as it was assumed that the capacitors and resistors were constant in the previous equations. This isn't true, of course; all capacitances and the channel resistance in MOS devices are voltage-dependent. But taking the dependency into account would make the analysis too complicated. Fortunately, the equations are accurate enough for practical purposes even if the voltage dependence is ignored.



Trace. Oscilloscope shows switching transients for 3701. Horizontal scale is 2 μ sec per large division.



Turned on. The rise in output voltage after a new channel is turned on is a function of the time constants.

It has also been assumed that the time constants of the control circuits are small compared to the time constants of the multiplexer switch. This is always true when both channels are off; the output voltage is almost constant because the load is large—usually 100 kilohms or more. But as soon as a channel is turned on, the load is charged through the relatively small channel resistance. This reduces the multiplexer-switch time constant, but the time constants in the control circuits still must be much smaller for the ΔV_{out} expression to be correct.

The time constants are important for another reason, too—they indicate how often the multiplexer can switch from one channel to another. This maximum switching speed depends on how long it takes the output to settle to the signal voltage each time a new channel is turned on. The settling time, in turn, is a function of the switch's time constants.

The time constants associated with the change from both channels off to one channel on can be calculated from the equivalent circuit on page 155. For an abrupt change from V_{S2} to V_{S1}

$$V_{out} = (V_{S1} - V_{S2}) \times \left[1 + \frac{1}{\tau_1/\tau_2 - 1} e^{-t/\tau_2} - \left(1 + \frac{1}{\tau_1/\tau_2 - 1} \right) e^{-t/\tau_1} \right]$$

The time constants are defined in the box on page 154. When R_{S1} is much smaller or larger than R_{on} , the time constants reduce to simple expressions.

For $R_{S1} \ll R_{on}$

$$\tau_1 = R_{on} C_2$$

$$\tau_2 = 0$$

and for $R_{S1} \gg R_{on}$

$$\tau_1 = R_{S1} (C_1 + C_2) \quad (4)$$

$$\tau_2 = R_{on} \left(\frac{C_1 C_2}{C_1 + C_2} \right) \quad (5)$$

Imagine 30 volts on the gates of a 3701 multiplexer switch, with $C_{DG} = 1$ pf, $C_2 \approx C_{out} + C_L = 20$ pf, $C_1 \approx C_{S1} + C_{in} = 5$ pf, and $R_{S1} = 5.1$ kilohms. R_{S1} is much larger than the R_{on} of 300 ohms. Then the change in output voltage as channel 1 is switched on, with channel 2 remaining off, is

$$\Delta V_{out} = \left(\frac{1 \text{ pf}}{20 \text{ pf}} \right) 30 \text{ v} = 1.5 \text{ volt}$$

according to equation 3. The time constants, from equations 4 and 5, are $\tau_1 = 124$ nsec and $\tau_2 = 1$ nsec.

These calculated values compare fairly well with those from an oscilloscope trace, reproduced left, in which ΔV_{out} is about 2 volts, τ_1 is about 200 nanoseconds, and τ_2 is too small to read. The voltage changes aren't usually as abrupt, but when they are it's a good idea to allow a brief interval, as shown, between changes of state to prevent a short-circuit between the two signal voltages.

At last, an IC tester that even a company president can use.



It's the new Signetics Model 1100 Integrated Circuit tester series. Never before have such simple-to-use machines performed such complex functions in the hands of a totally unskilled operator (company presidents *do* forget). In fact, the 1100's were designed to be the most compact, comprehensive, inexpensive, easy to use, production-oriented IC testers on the market. And that's just what they are. You simply select and insert a single program board, plug in the IC and punch the test button. Instantly, you get complete "go-no-go" assurance, including AC performance capability. With just

a few minutes training, incoming inspection or production personnel can test 5 to 10,000 IC's per day (that's over 2 million per year). On the other hand, engineers can completely test single IC's in seconds. Prices start at \$3,795. See below for information or a demonstration. And if you're a company president, we'll throw in a box of cigars.

SIGNETICS CORPORATION
MEASUREMENT/DATA
 A subsidiary of Corning Glass Works

For detailed information or a demonstration write Signetics, Measurement/Data, 811 E. Arques Ave., Sunnyvale, Calif. 94086, or contact one of the following:

AUTHORIZED SIGNETICS REPRESENTATIVES (Measurement/Data) □ Alabama and Tennessee Col-Ins.-Co., Inc., Huntsville (205) 539-1771 □ California L and M Engineering, Inc., Inglewood (213) 678-5409; Santa Clara (408) 243-6661 □ Connecticut Datech Associates, Inc., New Haven (203) 624-7291 □ District of Columbia (see Silver Spring, Maryland) □ Florida Col-Ins.-Co., Inc., Orlando (305) 423-7615 □ Georgia Col-Ins.-Co., Inc., Marietta (404) 422-8327 □ Illinois Carter Electronics, Inc., Chicago (312) 776-1601 □ Indiana Carter Electronics, Inc., Indianapolis (317) 293-0696 □ Maryland QED Electronics, Inc., Silver Spring (301) 588-8134 □ Massachusetts Datech Associates, Inc., Newtonville (617) 527-5394 □ Minnesota Carter Electronics, Inc., Minneapolis (612) 869-3261 □ Mississippi/Louisiana Col-Ins.-Co., Inc., St. Louis (504) 833-1116 □ New Jersey QED Electronics, Inc., Camden (215) 925-8711 □ New York QED Electronics, Inc., Mt. Vernon (914) 968-2200 □ J. A. Reagan Co., Inc., Albany (518) 489-4777; Binghamton (607) 723-9661; Newburgh (914) 561-4510; Syracuse (315) 471-7274; Utica (315) 732-3775; Rochester (716) 473-2115 □ North Carolina Col-Ins.-Co., Inc., Winston-Salem (919) 765-3650 □ Ohio WKM Associates, Inc., Cleveland (216) 885-5616; Dayton (573) 434-7500 □ Pennsylvania WKM Associates, Inc., Pittsburgh (412) 892-2953 □ Michigan WKM Associates, Inc., Detroit (313) 892-2500

If you're building any computer except a Computer, you need CT μ L.

CT μ L integrated circuits will give you more speed for less money than any other ICs. They're perfect for process control systems, test instrumentation, central processing units, computer peripheral equipment — just about anything short of an airborne computer.

Keep it in the family.

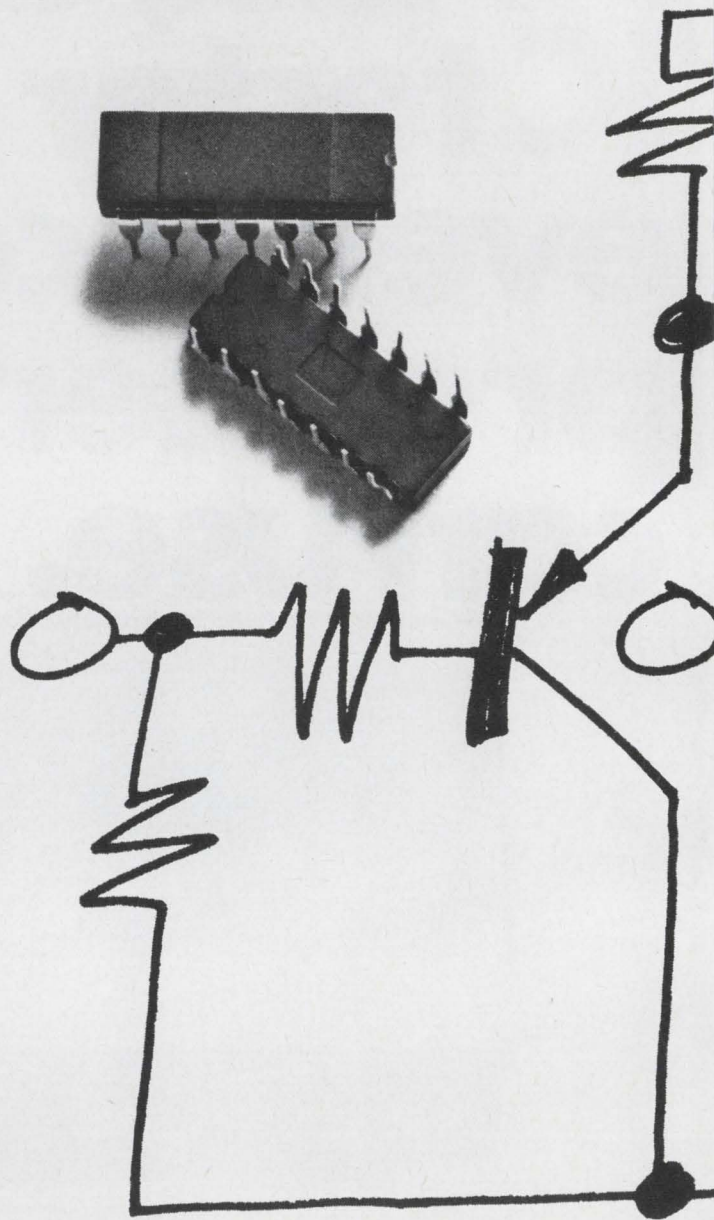
You can build a complete digital logic system with Fairchild's family of CT μ L devices. We have gates, flip-flops, inverters and memory circuits. A dozen different devices that make a computer easy to package. And, you'll need only about 80 percent as many packages as required with TTL.

You get out of it what you put into it.

The key CT μ L characteristic is non-saturating logic. That means you get fast gate propagation delay (typically 3nsec) with slow rise and fall times (typically 6nsec). So, there's no need for transmission lines or complex packaging. You can build an entire computer with normal two-sided circuit boards. Also, CT μ L can handle signal swings as large as 3V. It also provides typical noise immunity of 500mV.

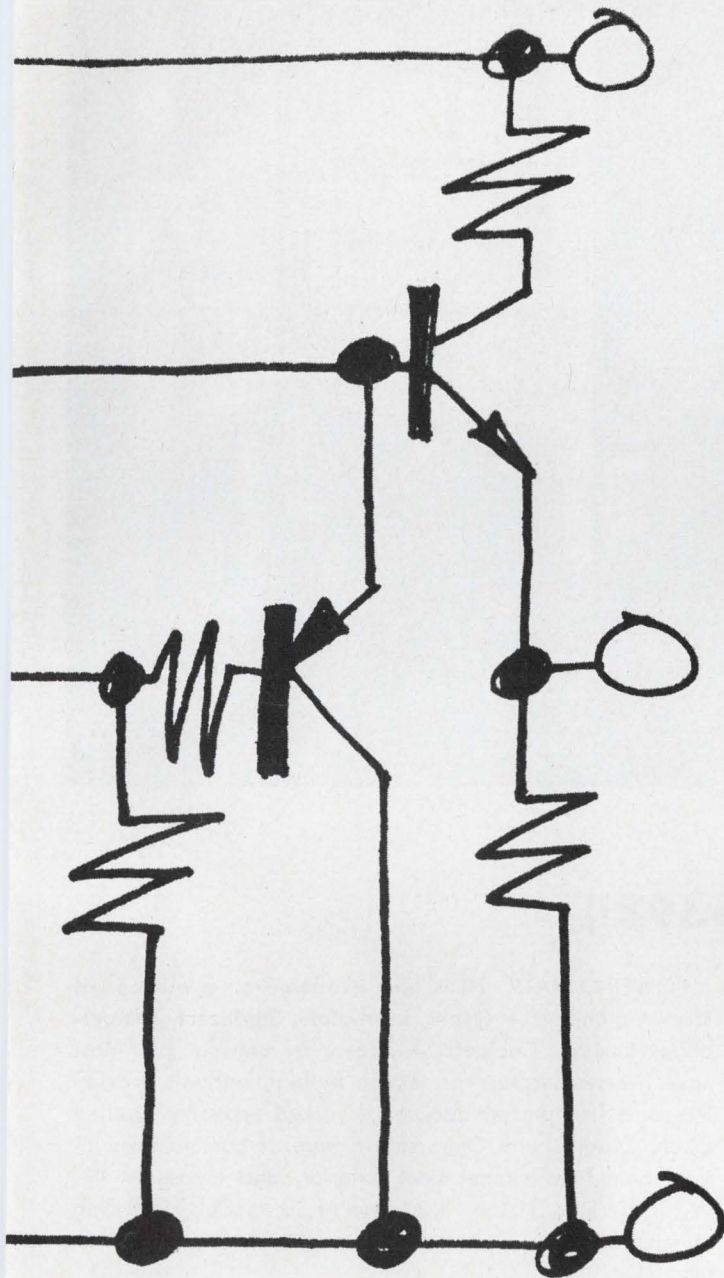
What we'll do for an encore:

MSI CT μ L will be out before the year ends. CT μ L-II will be out even sooner, offering improvements like gate propagation delay of 1.5nsec. (typical, loaded) and a buffer and



The world's largest manufacturer

inverter with propagation delays of 5nsec, compared with 12nsec in standard CT μ L. And, the new MSI and CT μ L-II circuitry will interface beautifully with all these standard CT μ L devices:



Device	Price (100-999)
9952 Dual NOR Gate	\$1.25
9953 Triple AND Gate	1.25
9954 Dual Four-input AND Gate	1.25
9955 Eight-input AND Gate	1.25
9956 Dual Buffer	1.25
9957 Dual-rank Flip-flop	2.00
9964 Dual Three-input and Single-input AND Gates	1.25
9965 Quad Single-input AND Gate	1.25
9966 Quad Two-input AND Gates, one pair with OR-tie	1.25
9967 JK Flip-flop	2.00
9968 Dual Latch	2.00
9971 Quad Two-input AND Gates with OR-tied pairs	1.25
9972 Quad Two-input AND Gates, one pair with OR-tie	1.25

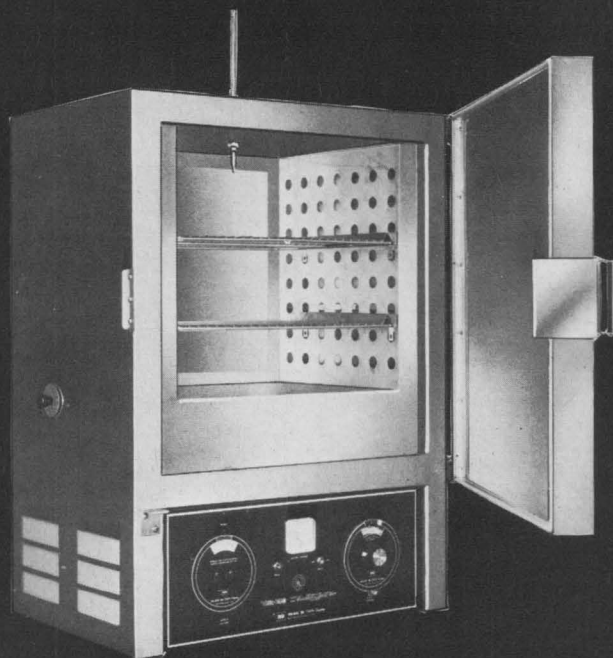
If you want CT μ L-II in sample quantities, call Fairchild. If you want standard CT μ L in production quantities, call a Fairchild distributor. He has everything you need to build any computer. Even a Computer.



Fairchild Semiconductor / A Division of Fairchild Camera and Instrument Corporation / 313 Fairchild Drive, Mountain View, Calif. 94040 (415) 962-5011 / TWX: 910-379-6435

of LSI admits there's another way:

**GUESS HOW
LITTLE
THIS CHAMBER
WITH NEW
PROPORTIONAL
CONTROL
COSTS**



(ONLY \$398!)

That isn't a mis-print. For less than \$400 you can buy a Blue M Stabil-Therm Electric Utility Oven equipped with the new POWER-O-MATIC 70™ Solid-State Proportioning Control System — and get performance that you would expect only from instrumentation costing hundreds of dollars more.

Compact and extremely simple, patented POWER-O-MATIC 70 has an adjustable range to +300°C. (the range of the unit shown is +260°C.). It provides control tolerance of $\pm 0.2^\circ\text{C}$. with extremely fast response to temperature changes. Features such as ambient temperature compensation and line voltage compensation are built in. Now laboratory personnel with limited budgets can select equipment with truly remarkable performance capabilities at a price competitive with inefficient, unreliable on-off controls.

POWER-O-MATIC 70 is now available on a number of Blue M chambers — Ovens, Incubators, Sterilizers, Temperature/Humidity Cabinets — dozens of units in all. Most have overtemperature protection built-in, and all provide the same fine performance and marked economy typified by the Stabil-Therm Oven shown here. It has stainless inside, baked-on enamel steel exterior, and measures 19" W. x 15" D. x 18" H. I.D. One of six models, including all-stainless units. Comes complete with shelves and thermometer.

If you're in the market for a temperature controlled chamber combining quality, performance and economy, it will pay you to investigate the new POWER-O-MATIC 70 chambers. You'll get your money's worth — and more!

SEND FOR FULL INFORMATION



BLUE M *Electric Company*

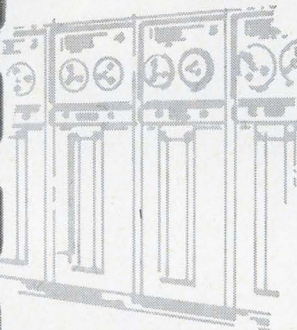
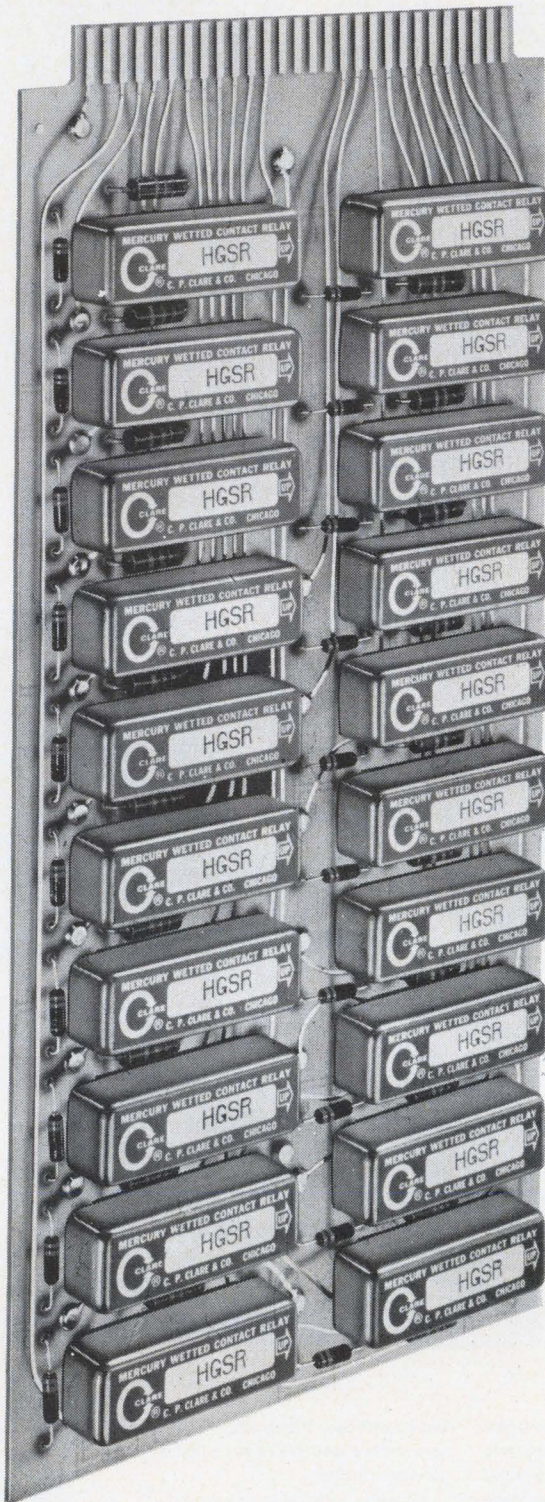
Corporate Headquarters: BLUE ISLAND, ILLINOIS 60406

lowest profile – smallest over-all mercury-wetted contact relay

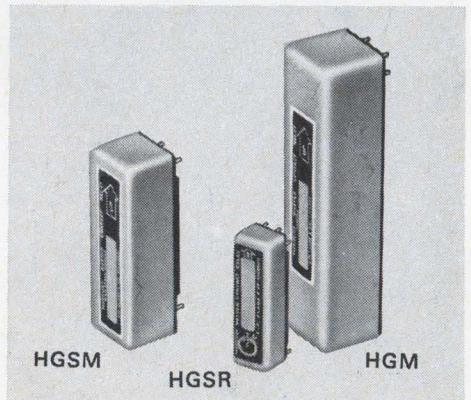
The Clare HGSR (only .33 cu. in.) puts more switching capacity on a board than ever before possible with long life mercury-wetted contacts.

It's fast and tough—serves most process control operations . . . provides over 22 billion operations without fail or falsing. And like the widely recognized Clare HGM and half-size HGSM, it provides a combination of high speed and low contact noise generation . . . the elimination of contact bounce and chatter and resulting false signalling. Advanced circuits can be designed with power gain up to 5000 . . . sensitivities as low as 20 mw. For solid state buffering, you get built-in input/output isolation . . . for measurement circuitry, minimal contact resistance, constant over billions of operations.

For complete information, circle reader service number—ask Clare for Data Sheet 855C . . . Write Group 11N8
C. P. Clare & Co., Chicago, Illinois 60645 . . . and worldwide.



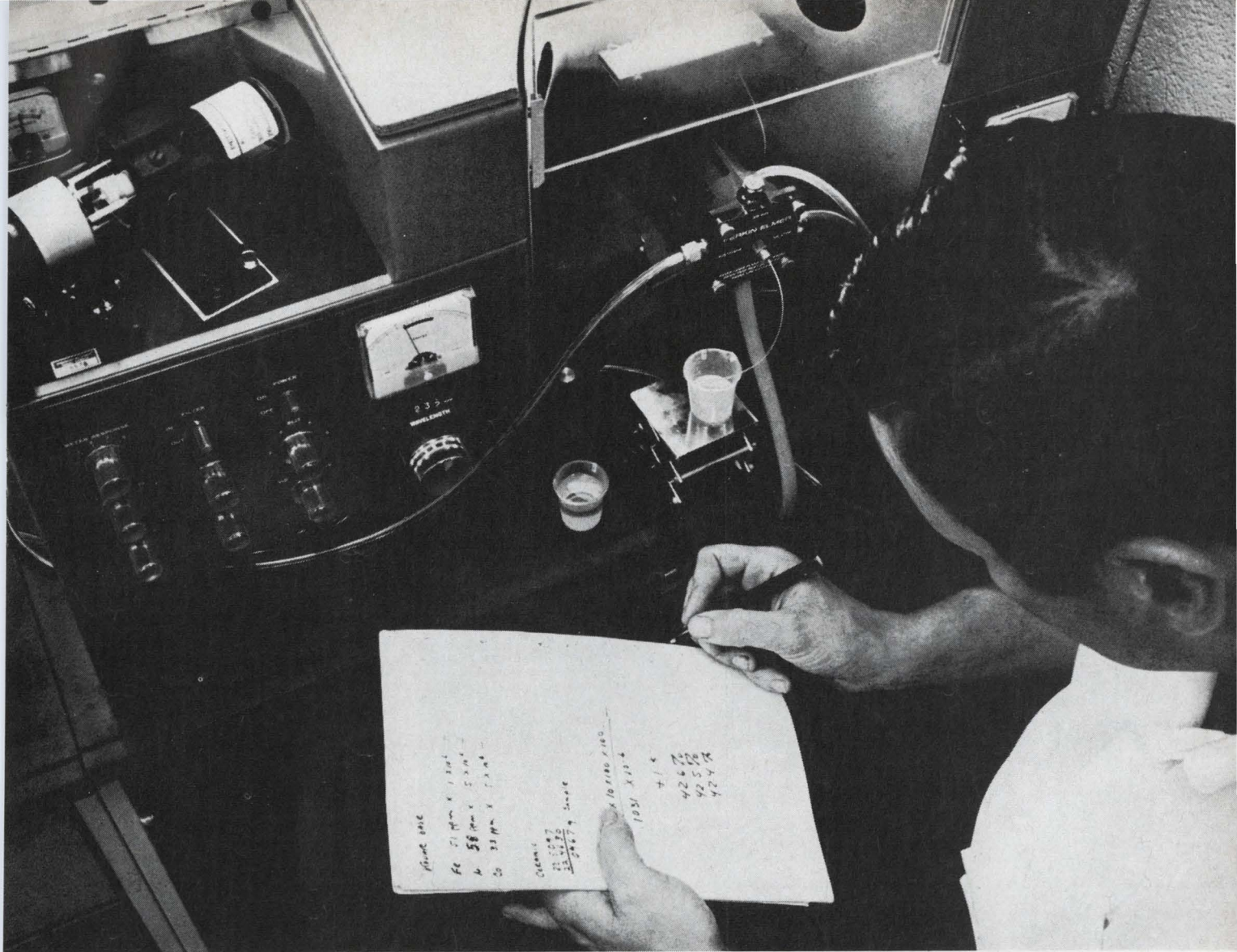
a GENERAL INSTRUMENT company



- Life: 22×10^9 operations—with no maintenance
- Low, constant contact resistance—no mechanical wear or electrical erosion
- No contact bounce
- Switching speeds to 1 ms
- Versatile contact load capabilities—low level to 250 va
- High power gain—to 5000 with no noise sensitivity
- Sensitivities as low as 20 mw

CLARE MERCURY-WETTED CONTACT RELAYS

for input analog switching, output power conversion switching,
solid state input and output buffering



We solve problems you never knew you had.

Any good custom fabricator can solve problems he can see.

It's the ones you can't see that cause all the trouble.

Like parts that stick in the mold.

Or too much flash on the edges.

Or production delays and extra charges for special die changes.

Well, at Sylvania, we don't take chances. When you turn out 50 million precision parts a day, you have to solve problems before they exist.

So the first thing we do is analyze your part's design and its function in the finished product. You'd be surprised at how many

problems we solve here.

Then our diemakers look into it. They know what a tool can and can't do. They solve problems you never knew existed.

Finally, our production engineers get into the act. It's one thing to design a part; it's another to produce it economically. Sometimes, this means designing a whole new piece of equipment. Other times, it calls for modifying your design.

Either way, it means you get the parts you want, the way you want them, when you want them—probably at lower cost than you could do it for yourself.

And we've got nine plants, the most

advanced equipment and the best diemakers and engineers around. We've been doing it for 17 years. On transistor leads, computer memory core frames, connectors, pen caps, aerosol spray tips, razor blade dispensers, integrated circuit frames. You name it.

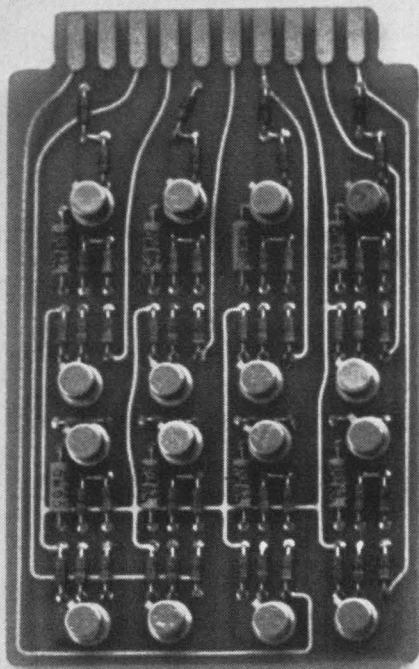
So the next time you need a custom fabricated precision part, let us solve your problems. Especially the ones you don't even know you have.

Sylvania Metals & Chemicals, Parts Div.,
Warren, Pa. 16365.

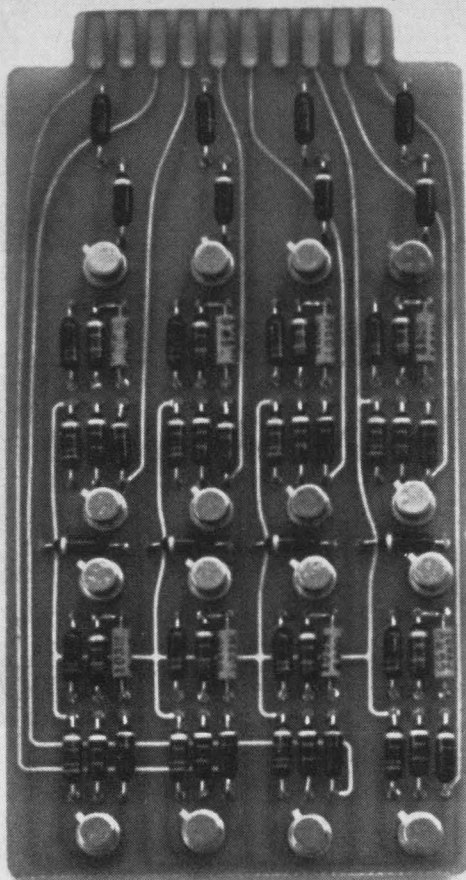
SYLVANIA
A SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS

What is small, has stripes, and shrinks boards?

New CORNING[®]
C3 Resistor.



16 transistors
8 capacitors
52 C3 resistors
Actual size



16 transistors
8 capacitors
52 RL07 resistors
Actual size

Now you can get 1/8 watt in a clean lead length of .150" and diameter of .066" maximum. That means a 35% reduction in board size for these eight Schmitt trigger circuits. Plus the proven stability of glass tin oxide film construction.

Put more circuit in the same space.
Or put the same circuit on a smaller board.

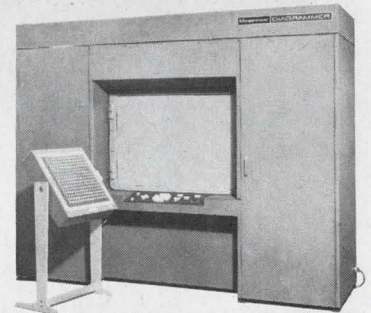
For specs and samples, write to Corning Glass Works,
Electronic Products Division, Corning, N. Y. 14830.

CORNING
ELECTRONICS

Very few capital equipment requests can be accompanied with a 1½ year payback expectation. If your firm constantly strives to reduce its overhead and increase the quality and efficiency of its operation, be sure your drafting department has evaluated the Mergenthaler DIAGRAMMER— an automated push-button drafting system. Users have experienced increased output of better than 4 to 1 over manual methods — 30 to 1 when drawing data is furnished in digitized form — plus receiving superior, “better-than-inked” quality that is geared to the requirements of today and tomorrow’s information storage, retrieval and data transmission systems. For DIAGRAMMER details and user payback testimonials, contact Automated Drafting Systems, Mergenthaler Linotype Co., a Division of ELTRA Corporation, 300 East 42 Street, New York, N.Y. 10017. Tel.: 212-661-5615; TWX 710-581-3385.

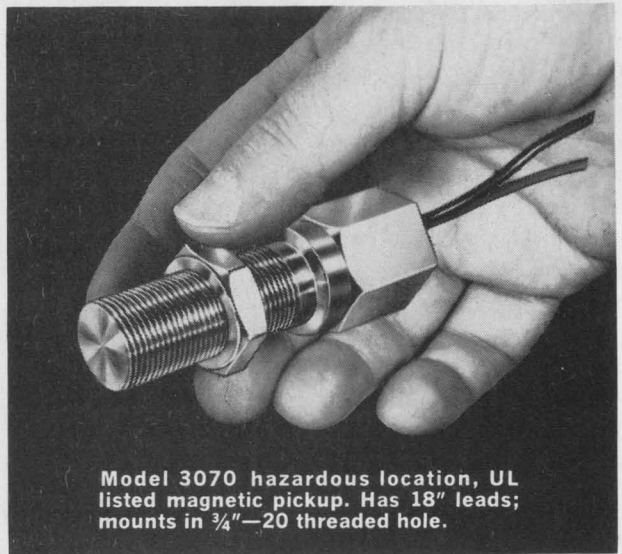
AUTO- MATED DRAFTING PAYBACK IN 1½ YEARS

Please send me DIAGRAMMER details ()
 Please call me soon () Phone No. _____
 Name _____ Title _____
 Firm _____
 Address _____
 City/State/Zip _____
 Mergenthaler Linotype Co., 300 East 42 Street, New York, N.Y. 10017



THE DIAGRAMMER by **Mergenthaler** the total graphic arts company

If you have speed control or detection problems check out these versatile



Model 3070 hazardous location, UL listed magnetic pickup. Has 18" leads; mounts in 3/4"-20 threaded hole.

ELECTRO Magnetic Pickups...

Take a look at the list at the right. It covers just a few of the many applications in which ELECTRO's magnetic pickups are being used. What's your problem? Positioning? Speed detection? Speed control? Timing pulses?

Maybe you can do it better—more economically with a magnetic pickup. Our electronic engineering specialists will help you determine if an ELECTRO magnetic pickup can supply an economical solution.

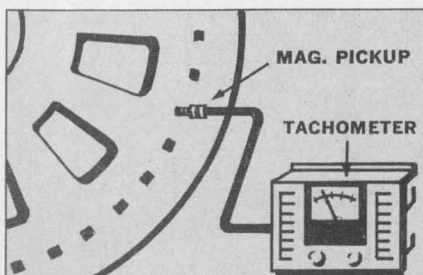
Write for a magnetic pickup data portfolio.

Model 3080 world's smallest standard magnetic pickup. 10-32 thread x 1/2" long, weighs only .05 oz. Up to 10V p-p output.

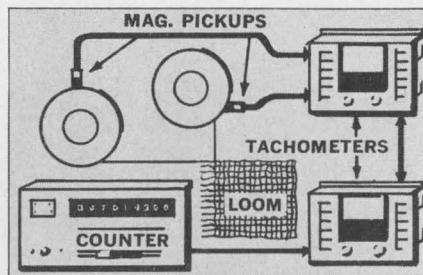


ACTUAL SIZE

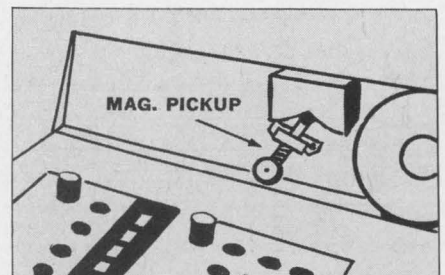
- As a substitute for standard tachometer generator
- High speed printer roll sync and servo control
- Up-to-speed indication for drum memory
- Sector sync signal for disk memory
- Machine gun performance
- Analog electromechanical computer test probe
- Speed control servo for message tape recorder
- Remote water meter indicator and control
- Aircraft generator bearing check
- Diesel engine speed control
- Differential speed measurement
- Tapping machine control
- Molding machine speed indication



Speed Control on Diesel Pumping Engine: Contact tachometers proved inadequate primarily because there are so few places to connect them. A magnetic pickup and Electro-tach (with the addition of a 73.163 Pulse Adaptor) sensing a series of holes on the rim of the flywheel, proved to be the solution.



Differential Speed Detection: Needed was a close check on the speed differential of two sections of a textile machine—to assure the proper stretch to the yarn. Magnetic pickups mounted to sense a gear in each section provided a direct reading of the difference in rpm and a percent of the speed differential.



Precise Position Control: A computer for desk top use demanded exceptional ingenuity in space saving simplification. A magnetic pickup sensing a ferrous set screw on a rotating 20-character print wheel provided a simple logical control of its position and eliminated the need for complex positioning apparatus.

Pioneers in Electronic Sensing and Control.
Electronic Tachometers—
Dynamic Micrometers—
DC Power Supplies—
Magnetic Pickups.
Proximity Switches.



ELECTRO
MAGNETIC PICKUPS

ELECTRO PRODUCTS LABORATORIES, INC.
 6125-Y Howard, Chicago, Illinois 60648 • 312/775-5220

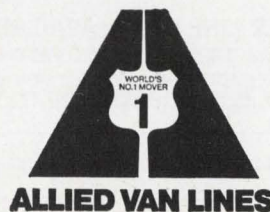
How do most companies move a lightning-fast, long-memory, high-capacity computer?



They choose an on-time, precision-planning, big-capacity van line.

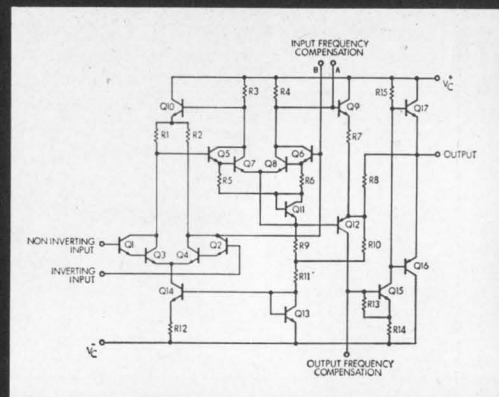
Allied Van Lines safely moves more computers (with long memories) than any other mover.

Call the confident Allied Agent in your area.



Circle 167 on reader service card

10 MEGΩ 709



At last — an IC chip that outperforms many discrete op amps

$Z_{in} = 10$ megohms
 $I_{BIAS} = 10$ nanoamps
 $I_{OFFSET} = 2$ nanoamps
 $V_{OFFSET} = 2$ millivolts

OTHER LINEAR IC's AVAILABLE . . .

Standard 1709, 1710 and 1711 series, plus a sense amplifier series and a high sink current dual output 1711, fully compatible with HLTTTL drive requirements.

*TOA7809 available with Z_{in} guaranteed as high as 50 megohms.

You know the 709-type amplifier. Dependable. Versatile. A regular chip-of-all-trades.

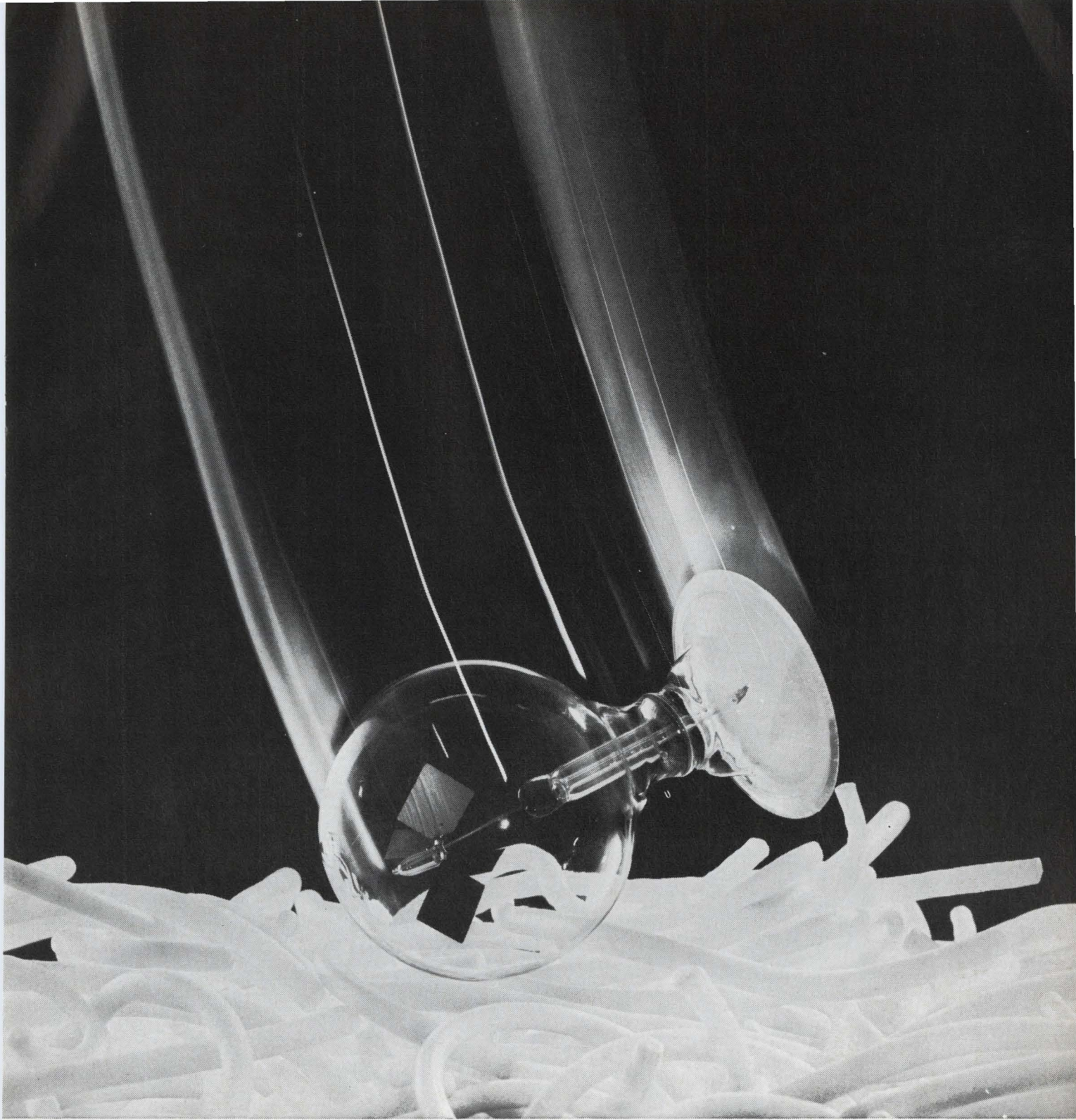
You also know its limitations.

Even while designing it into a circuit, you have probably found yourself thinking, a bit wistfully, of the input characteristics provided by a few of the more expensive discrete op amps on the market.

Now, you can get premium "discrete" performance in a 709-type chip, at a 709-type price. Here . . . today . . . on our shelves is the TOA7709 — eminently suited to direct, plug-in replacement of standard 709-type units — but with unprecedented input characteristics which can greatly simplify new-circuit design. A Darlington-connected input provides an impedance of 10 megohms, and offset and bias currents of 2 and 10 nanoamps respectively.

A commercial version, the TOA8709, provides a 3-megohm impedance, with offset and bias currents of 6 and 30 nanoamps — still a whale of a lot better than any other IC op amp around. Either unit is available in the 8-pin TO-5, 10-lead flat pack or 14-lead dual in-line package.

Transitron
 electronic corporation
 168 Albion Street, Wakefield, Massachusetts 01881



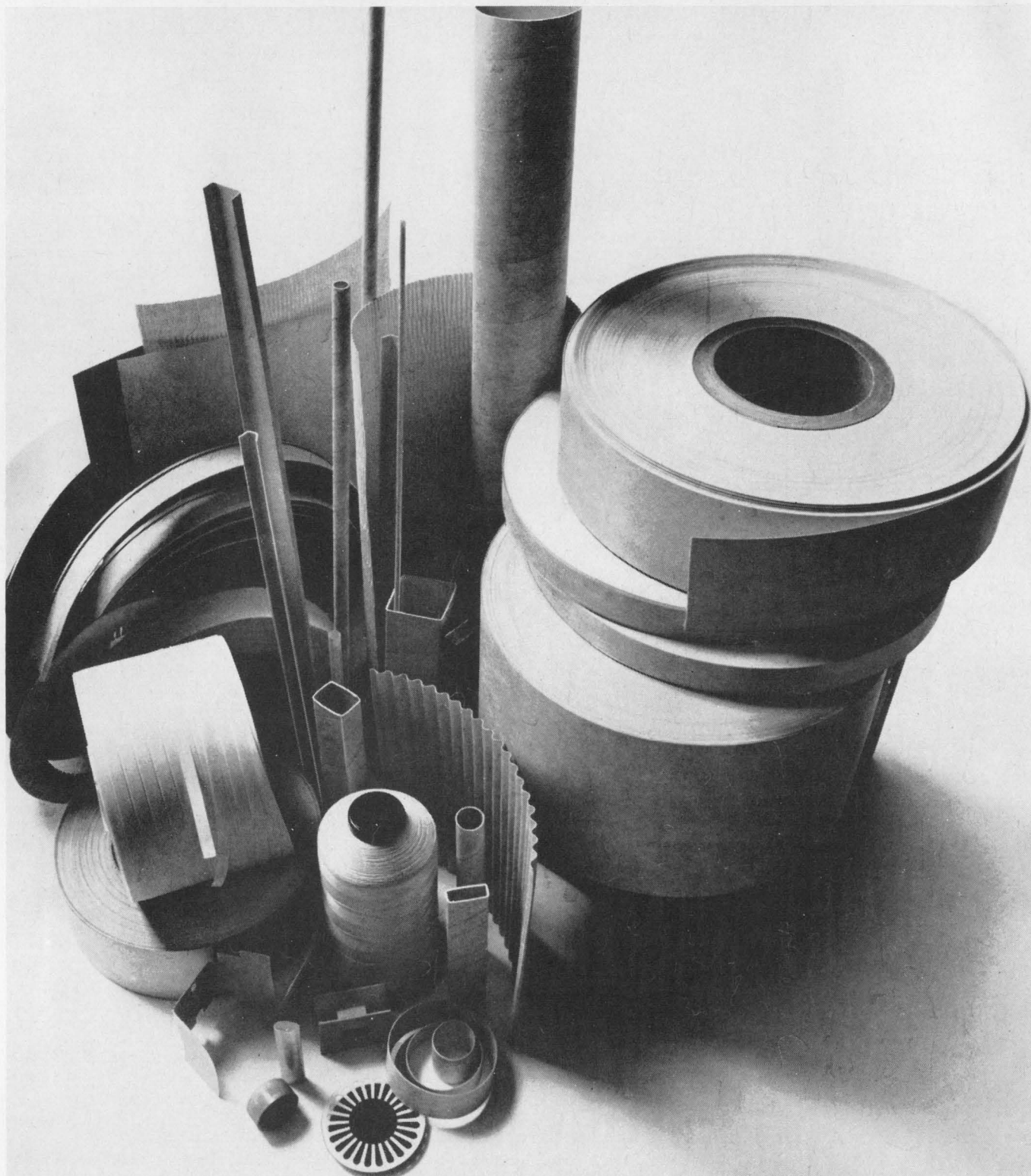
Packaging Sales, The Dow Chemical Company, Midland, Michigan 48640.

Try this on your fragile parts.

Pelaspac[®] loose fill packing. It weighs 3 to 6 times less than most other dunnage. It won't absorb water. It cuts shipping losses. Because it's highly shock-resistant, and it interlocks to prevent settling. It cuts cleanup, too. Because it's clean, nondusting and noncorrosive. Write for details.



Circle 169 on reader service card



Throw away your insulation handbook. All you need is Nomex.[®]

Nomex[®] nylon paper is the one insulation you can use for just about every application. It won't melt or support combustion—it's UL-rated at 220°C. and it complies with MIL-I-24204. Durable "Nomex" paper won't crack when creased or bent and does not flake. It can be easily slit or punched for close tolerance and can be used in automated operations.

*Du Pont registered trademark.

"Nomex" is compatible with all major resins, varnishes and enamels. It is relatively unaffected by moisture, and there are no shelf-life problems.

"Nomex" is available in a wide variety of fabricated forms designed to fit any application. So look to one material—"Nomex"—for all your insulation needs.

To get more information, write:

Du Pont Company, Nomex Marketing,
Room J-10, Wilmington, Delaware
19898. In Canada, write Du Pont of
Canada Ltd. In Europe, Du Pont de
Nemours Int., S.A., 81, Route de l'Aire,
Geneva, Switzerland.

DU PONT
REG. U.S. PAT. OFF.

NOMEX[®]
NYLON

**NEED A
SOLENOID
WITH REAL
MUSCLE**



**...OR ONE WITH
VERY LITTLE
PULL?**

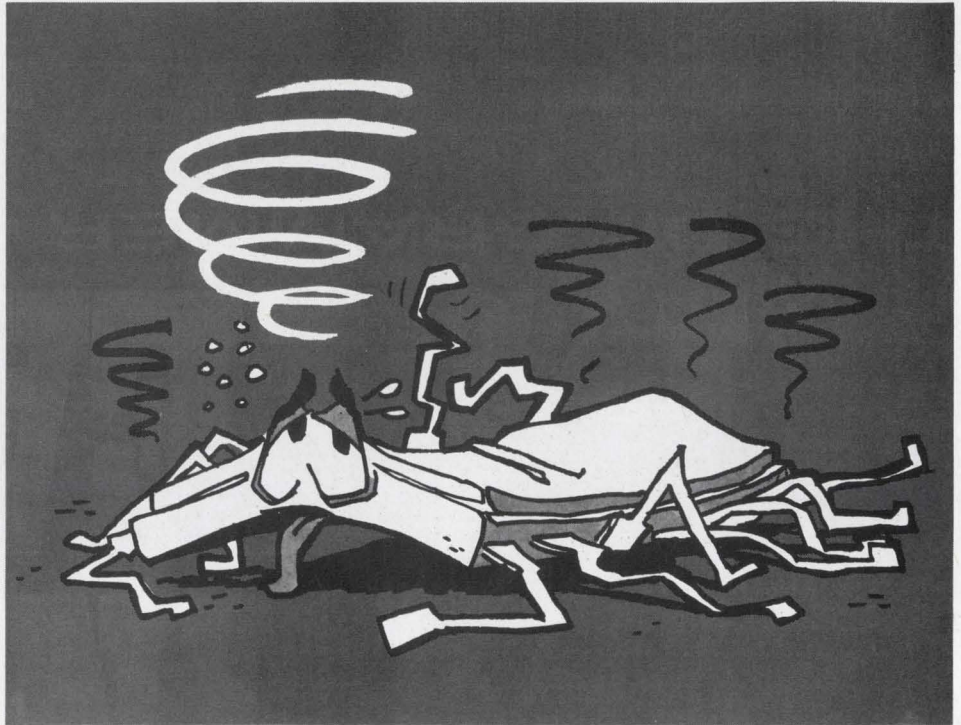
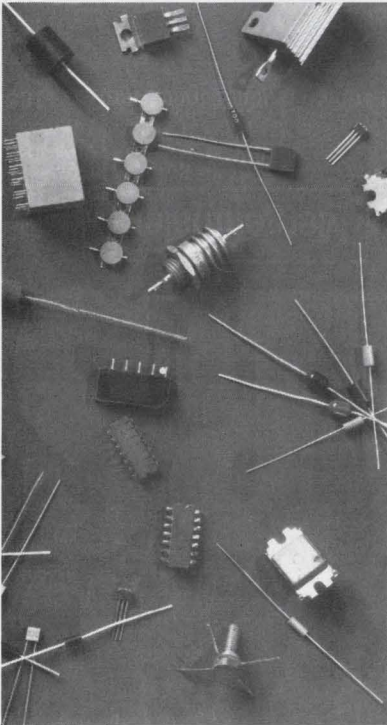
Guardian solenoids come in all shapes and sizes (Guardian had the most complete line even before we added eleven new tubular solenoids) and meet just about every electro-mechanical requirement. Need a pull of 50 pounds or just a fraction of an ounce? We've got them. AC or DC . . . we've got them. Intermittent or continuous duty . . . we've got them. Pull or push . . . we've got them. Write for bulletin G2-TS.

BIG STRONG BRAUNY ONES . . . LITTLE BITTY ONES . . . GUARDIAN'S GOT 'EM ALL

GUARDIAN  **ELECTRIC**
GUARDIAN ELECTRIC MANUFACTURING CO. 1550 W. Carroll Ave., Chicago, Ill. 60607

Circle 171 on reader service card

When your IC bugs out, chances are the heat's on!



Devices packaged in Dow Corning® silicone molding compound are physically and electrically stable—even after long term exposure to both high heat and humidity. Derating, a practice common with organic packaging, is not necessary. In fact, you can design for high device and component density by using silicone molding compound. One manufacturer of glass package power diodes reduced the part to 1/30th of its former volume. Sizes from 1/5th to 1/3rd smaller can be obtained by using silicone molding compound in place of other plastics.

Little moisture absorption. Silicone molding compounds when exposed for 1000 hours to 93% RH at 70 C showed an average weight increase of 0.32% with the greatest increase being 0.5% and the least being 0.17%. Five organic plastics had average weight increases ranging from 1.0 to 2.1%—an average of nearly five times greater than silicone molding compounds under the same test conditions.

No cracking. Unlike other thermal setting plastics, Dow Corning silicone molding compounds are virtually unaffected by thermal shock. For example, a power resistor molded in Dow Corning® 307 compound was cycled repeatedly from -65 to 350 C without damaging the packaging material or the component.

Will not burn. Silicone molding compounds are

inherently nonburning. Thus, components and devices packaged in silicone molding compound do not constitute a fire hazard. No flame snuffers are used—a source of ionic contamination for devices packaged in organic materials.

Corrosion free. These silicone molding compounds are free of ionic contaminants which may contribute to metallic corrosion when operating in high humidity and influenced by voltage bias.

Competitive price. Costing only a fraction of a cent per device, Dow Corning silicone molding compounds enjoy a substantial price advantage over metal cans . . . glass packages.

Manufacturing economies. Transfer molding enables manufacturers to package devices and components with a minimum of manual labor and supervision. Good mold release and minimum flash assure high production rates . . . reduced deflashing costs. These manufacturing advantages make silicone molding compounds totally competitive with organic plastics.

So why be bugged by device failures because of a cheap plastic package? Specify Dow Corning® brand silicone molding compound; and get the best package protection in your electronic equipment . . . lets you keep your cool. For technical data, write: Dept. A-8472, Dow Corning Corporation, Midland, Michigan 48640.

DOW CORNING

DOW CORNING



PLASTICOTE[®] WIRE & CABLE

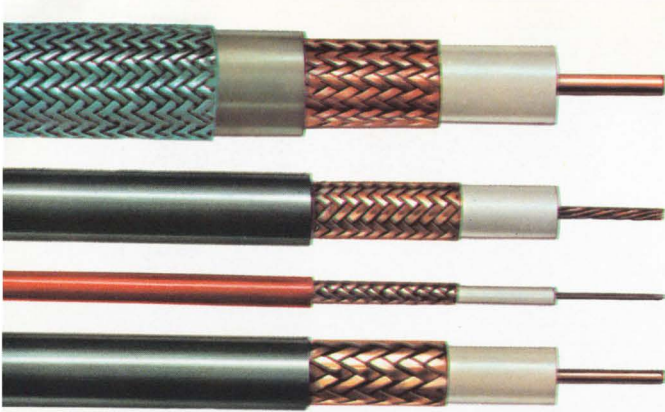
by

CHESTER

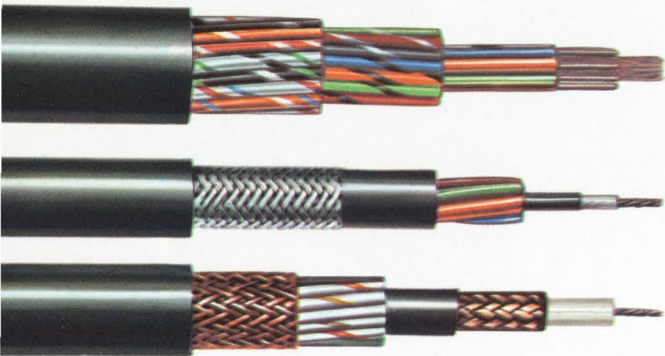
CHESTER CABLE CO.

Division Tennessee Corporation
CHESTER, NEW YORK 10918
A Subsidiary of Cities Service Company

(See reverse side)

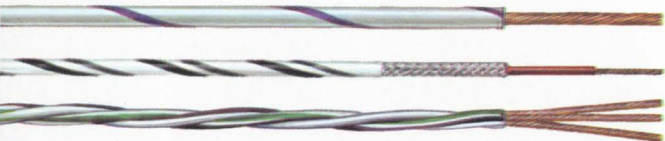


COAXIAL CABLE — Chester Cable Corp. offers a complete line of coaxial cable for military and commercial applications. Manufactured in accordance with MIL-C-17, JAN-C-17 and commercial specifications. Constructions include solid, air-spaced and foam dielectrics with conventional braid shields or flat copper tape shields, having PVC or polyethylene jackets. Custom designed constructions of triaxial cable and high frequency-high voltage cable are also available.

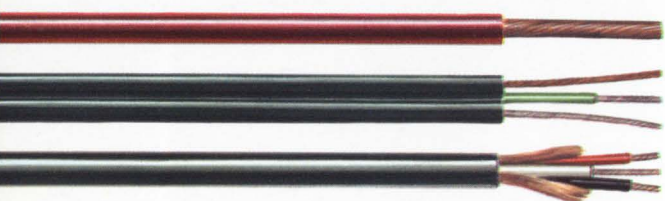


MULTI-CONDUCTOR CABLE — Wide range of custom designs available, manufactured in accordance with such industry standards as MIL specs., U/L, CSA, IPCEA, EIA, IMSA, ASTM, etc.

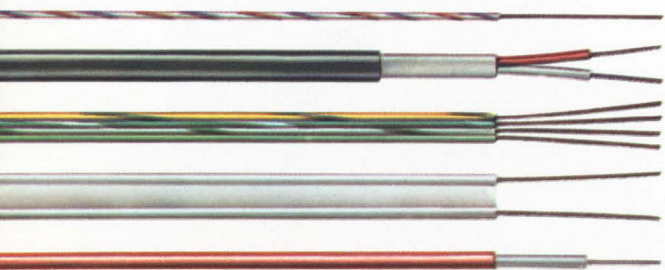
Chester Cable Corp. is a preferred source for quality electronic and electrical cable, insulated and jacketed with thermoplastic materials such as polyvinylchloride, polyethylene and nylon. Custom designs of shielded or unshielded cable include: Control Cable • TV Camera Cable • Missile Cable • Intercom Cable • Computer Cable • Special Hi-Voltage Cable and Parallel Bonded Ribbon Cable.



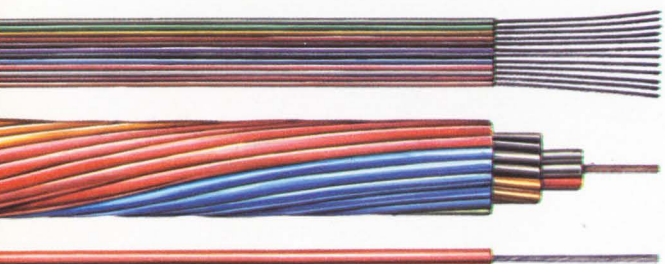
MIL-SPEC WIRE — Made in accordance with specifications MIL-W-16878 (Types B, C & D), MIL-W-76B (Types LW, MW & HW) and MIL-W-5086A for electronic systems. Available in single or multiple constructions, shielded or unshielded, with or without nylon or PVC jackets.



WIRE AND CORD FOR THE APPLIANCE INDUSTRY — U/L and CSA approved, 60°C — 80°C — 90°C — 105°C appliance wiring material — SVT, SJT, ST cord, SJTO & STO oil-resistant cord, SJT & ST oil-proof cord, SPT cord with or without individually insulated ground wire. Used for washers, dryers, refrigerating, air conditioning, vending, heating, X-ray and other electrical and electronic equipment.



RADIO AND TV CIRCUIT WIRE AND CABLE — U/L and CSA approved, 60°C — 80°C — 90°C — 105°C appliance and radio circuit wire, microphone cable, shielded and unshielded audio circuit wire, twin lead antenna wire, phonograph cable, parallel-bonded color convergence ckt. cable, braided hook-up wire, hi-anode wire, hot chassis lead, balun-coil wire, shielded constructions with spiral, braided, aluminum-Mylar tape and conductive materials; all available in Thrif-T-Bond® tinned over-coated conductors.



MISCELLANEOUS WIRE AND CABLE — Machine Tool Wire • Bus Drop Cable • Flexible Test Lead Wire • Municipal Signal Cable • Low Energy Circuit Control Cable • Station Control Cable • Inter-Office Communication and Signaling Cable • Deep-Well Submersible Water Pump Cable • Gas Tube Sign and Oil Burner Ignition Cable • Intercom Cable • Gasoline and Oil Resistant Wire • Computer Cable • Uninsulated Bus Wire • Parallel and Jacketed Cord • Braided Ground Strap, and special custom designed cable for your applications.



Write or phone for further information

CHESTER CABLE CO., Division Tennessee Corporation, **CHESTER, NEW YORK 10918**

A Subsidiary of Cities Service Company

Phone: 914-469-2141 • TWX: 914-469-7011

Printed in U. S. A.

TRW METALLIZED POLYCARBONATES



...good things come in small packages

A 10 mfd 50 volt type X483 capacitor measures a scant .670" x 1⁵/₁₆". It's hermetically sealed and provides outstanding temperature stability and electrical properties. Meets all MIL-C-18312 and MIL-C-19978 requirements.

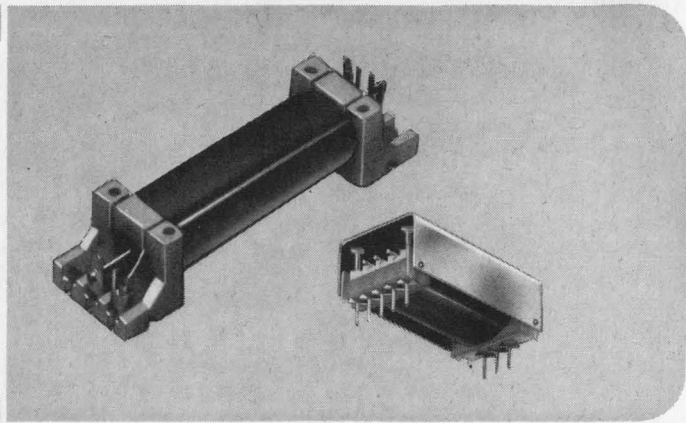
Type X483 are advanced technology capacitors tailor-made for advanced technology applications. Values from .001 to 10 mfd, 50, 100, 200 and 400 volt.

Contact TRW Capacitor Division, Box 1000, Ogallala, Neb.

Phone: (308) 284-3611. TWX: 910-620-0321.

TRW®

Another announcement in the
STRUTHERS-DUNN
YEAR OF RELAY DEVELOPMENTS
 in which we bring you word of
 new Struthers-Dunn relays
 and relay refinements.



Well...well...well!
Struthers-Dunn now has "open" reed relays...
*... and the reason isn't
 what you might think!*

No, we aren't introducing our first "open" reed relays because we couldn't design any before.

Or because no one wanted the sophisticated enclosed reed relays for which we're famous.

It's because many customers for our other relays want open reed relays, too. And since we have the world's largest relay line, we don't intend to have customers pointing out any relays we **don't** have!

So, here are the details. Two types: miniature and standard. "Miniatures" in twelve 1-to-4 pole models with various combinations of Form A, Form B, and Form C miniature dry reed switches. Contacts rated from low level to 12 volt-amperes. 1 1/8" long by 3/8" above the mounting board. Mercury-wetted reed switch available in 1 1/2" wide single-pole package.

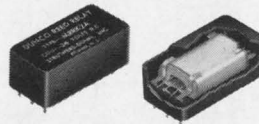
"Standard" sizes in seven 1-to-4 pole contact configurations, rated from low level to 15 volt-amperes. Width varies with number of poles, but other dimensions are standard at 2 1/2" long by 1/4" above P/C board.

Both series have snap-on metal covers for magnetic shielding. Most models in both series interchangeable with many corresponding competitive models.

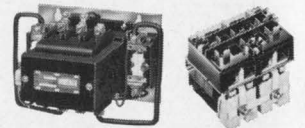
So, Struthers-Dunn customers, here are your open reed relays! New customers, check the low cost, long life, other details.

See data listing at right.

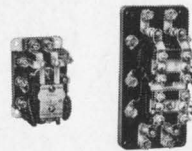
Find your ideal relay faster...in the world's largest line!



New idea in protected reed relays. New plastic sealing technique opens way to completely protected reed relays at just a shade higher than cost of open types. Series MRRK reed relays save time, cut cost of mounting, soldering, cleaning. Nine of the most popular 1 to 3 switch contact combinations available in four coil voltages. See data listing below.



Don't "settle" on a motor control... select from the varied line at Struthers-Dunn! General purpose AC contactors and motor starters for single phase and polyphase service to 600 volts, sizes 0 to 4. Definite-purpose reversing and non-reversing contactors for one to three horsepower applications. New catalog just out. See data listing below.



Zero in on a commercial relay fast! You'll find thousands here. Power, control, sensitive, latch, sequence, instrument-controlled, timers and special purpose relays! Thousands of modifications, too. Yes, even the old standbys that have stood the test of time for dependability and economy... and definitely all the very newest in relay designs for all applications. See listing at right.

**SEND FOR THIS
 REFERENCE DATA!**

Check these numbers on Reader Service Card for any or all reference material listed below.

- #515 New open reed relays
- #516 Sealed reed relays
- #517 Motor controls
- #518 Commercial relays



STRUTHERS-DUNN, INC.

PITMAN, NEW JERSEY 08071

Canada: Struthers-Dunn Relay Div., Renfrew Electric Co., Ltd.



PROGRESS REPORT

ALSiMAG[®]

INJECTION MOLDED CERAMICS

The injection molding process makes it practical to produce certain complex designs in volume and at a practical cost. Some complex designs cannot presently be produced by any other method. The flow of material is controlled so that the injection molded ceramic has exceptional uniformity and density throughout. This offers special advantages for thin walls and edges.

In the past, some complex designs have been made by a combination of dry pressing or extruding and machining. If the machining is complex, it severely limits the quantity which can be produced and is also a costly operation. But the complex precision part sometimes can be produced complete in one stroke by injection molding. This can quickly absorb the die costs, remove the ceiling on quantity and, after the die cost is absorbed, it can result in marked production economies. On especially long runs, multiple cavity dies offer still further savings.

Compound curves and intricate internal detail such as threads are practical by injection molding. Inspection procedures are simplified because statistical sampling normally provides adequate control. Injection molded parts are remarkably uniform from part to part and from one run to the next. "As fired" surface finish can be controlled within reasonable limits.

The typical injection molded ALSiMag ceramic parts shown here are used in electronic, electrical, mechanical, chemical and metal working applications. Special ceramic compositions have been developed for special requirements. Example: precision leachable ceramic cores for investment castings.

If you have a design for a ceramic which has been considered impossible, let our production men check it over and offer suggestions. Or if you could replace two or more parts with one precision ceramic, perhaps it could improve performance and give you lower assembly costs. Our engineers with specialized ceramic experience will be glad to make suggestions. Send your blue print and operating requirements.

CODE IDENT. NO. 70371

American Lava Corporation **3M**

PHONE 615 265-3411, CHATTANOOGA, TENN. 37405

A SUBSIDIARY OF **3M** COMPANY

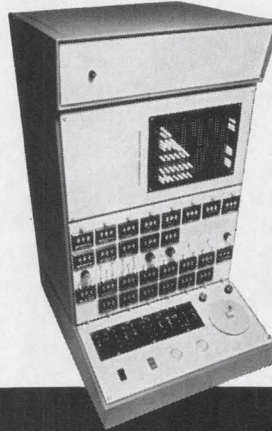
For service, contact American Lava representatives in Offices of Minnesota Mining and Manufacturing Company in these cities (see your local telephone directory): Boston: Needham Heights, Mass. • Chicago: Elmhurst, Ill. • Dallas, Texas • Chagrin Falls, Ohio • Harvard, Mass. • Laurens, S. C. • Los Angeles, Calif. • Metropolitan New York: Ridgefield, N. J. • Up-State New York and Canada: Phoenix, N. Y. • Orange, Conn. • Philadelphia, Penn. • Roanoke, Va. • St. Louis: Lee's Summit, Mo. So. San Francisco, Calif. • 3M International: c/o American Lava Corporation, Chattanooga, Tenn. 37405, U.S.A., 615/265-3411.



Excuse our memory . . . what is it, 5 years now since anyone designed a new device classifier? Seems like only yesterday.


But a lot has changed, hasn't it, especially semiconductors. Mechanical handlers and dice probers have speeded up. QC standards are tighter now.

And we've been busy designing modern classifiers for modern transistors, diodes, rectifiers, and Zeners. The new systems are built to stay ahead of high speed handlers by many milliseconds and ahead of semiconductor developments by many years.



Take speed: 20,000 transistors an hour typical, 10 diode PRV categories in 24 milliseconds. Take versatility: you can change any basic test function in one minute with pluggable modules. Take reliability: solid state switching in all repetitive circuits.

Well, best wishes. After the celebration drop us a line. There's so much news we've had it printed up. Burn's & Towne Inc., Systems Division, 18-36 Granite St., Haverhill, Mass. 01830

 **BURNS & TOWNE INC.**

**Happy Birthday
to Your
Semiconductor Tester**



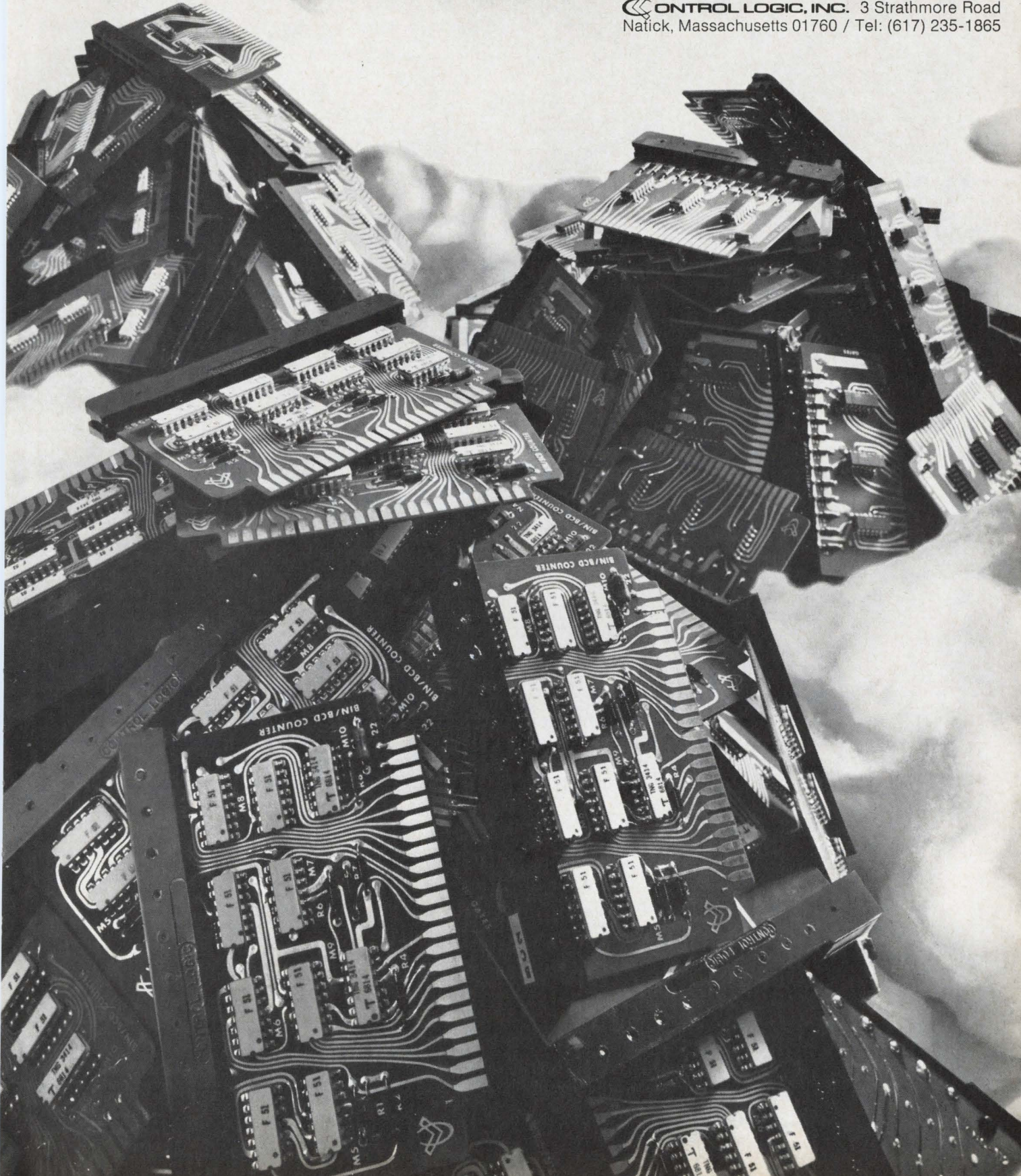
You could build mountains out of our logic cards... if you had to

We've got that many. And you could build different kinds of mountains, too.

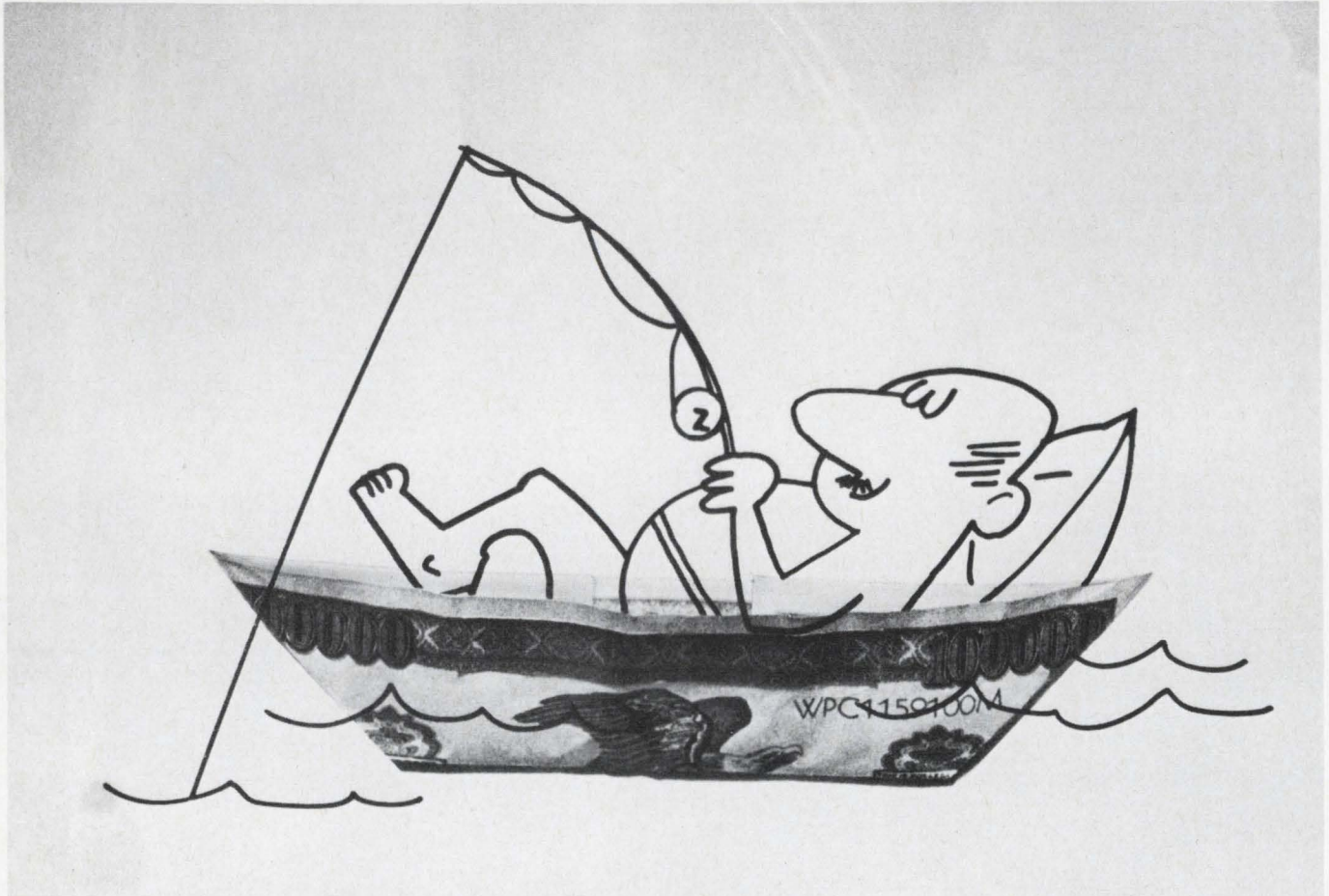
We've got just that product line versatility. Build T²L SUHL I mountains, or T²L SUHL II mountains, or DTL mountains, or 7400 T²L mountains. We can supply enough for you to go as high as you want. And building mountains is a nice way to look at how our micrologic circuit cards are applied. But if you don't want to think in terms of mountains, you can build mole hills, too.

For more information, write or call:

 **CONTROL LOGIC, INC.** 3 Strathmore Road
Natick, Massachusetts 01760 / Tel: (617) 235-1865



It's nice to have enough money to retire on.



It's also nice to be around when it's time to retire.

You want to save a nest egg to retire on? Fine. All we suggest is that you be here to enjoy it. What to do? See your doctor for a thorough health checkup once a year, including a procto. And for women, also a Pap test. In short, the works.

Because most cancers are curable if spotted in time. But your doctor won't be able to spot anything—unless you give him the chance.

If you do, you'll improve your chances of enjoying your retirement. To a ripe old age.



THIS SPACE CONTRIBUTED BY THE PUBLISHER AS A PUBLIC SERVICE

SCIENCE/SCOPE

The world's largest communications satellite -- a two-story-high, 1600-pound experimental giant designed to provide tactical communications among military units in the field, aircraft, and ships at sea -- is being built under direction of the U.S. Air Force for the Department of Defense by Hughes.

Satellite will carry a cluster of antennas whose powerful signals can be picked up by all types of terminals, including those with antennas as small as one foot in diameter. Satellite's communications capacity is comparable to 10,000 two-way telephone channels.

The Army's TOW missile is under consideration by the U.S. Marines as a result of combat-style tests they recently gave the wire-guided antitank weapon. A Marine unit at the Twentynine Palms Marine Base fired 20 TOW missiles, blasting concrete fortifications, sandbag bunkers, tank hulls, and moving targets.

All a TOW gunner has to do is hold the crosshair of the telescopic sight on a target; the missile is automatically steered to impact on that point. After a half-hour of instruction, Marines scored bullseyes on small, distant targets.

A new radar unit to aid ballistic missile defense has been installed on Kwajalein Atoll in the Marshall Islands. The experimental system, designed to help the Defense Department develop technology for protection against ballistic missile and satellite attack, will make high-resolution measurements of various targets, both in outer space and during reentry into the atmosphere. System's 40-foot-diameter parabolic antenna and microwave subsystem were built by Hughes.

Environmental testing is now available to component subcontractors at the six-story, 17,000-square-foot Hughes test center used for Surveyor spacecraft, Intelsat and ATS satellites, and Phoenix and TOW missiles. Eight thermal vacuum chambers, ranging in size from 18x20 inches to 15x36 feet, can duplicate the radiation of sunlight in deep space and the temperatures of lunar day and night. Vibration tests are performed on two 28,000-force-pound shakers, each equipped with a separate control console.

The 30-foot parabolic antenna atop the 12-story Hughes space systems division building adjacent to Los Angeles International Airport is converting signals from two Applications Technology Satellites into pictures of cloud formations and jet streams. Photos are received as part of a research program Hughes is conducting for the Environmental Science Services Administration.

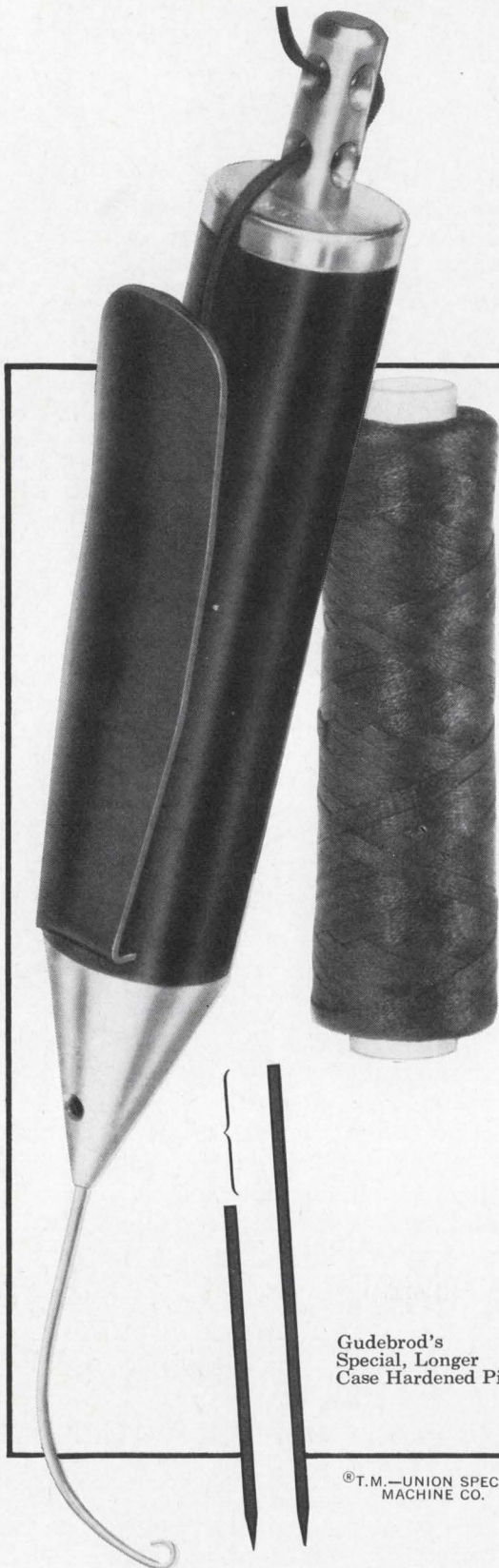
The spin-scan cameras aboard the ATS satellites take a picture of Earth every 20 minutes when weather scientists want to track a storm. Of particular interest to them have been the ATS-3 photos of the Midwest during the 1968 tornado watch. The ATS satellites were built by Hughes, their cameras by Santa Barbara Research Center, a Hughes subsidiary.

Creating a new world with electronics



Circle 181 on reader service card

For high speed harnessing
with continuous lacing...



HERE IS THE WORK SPEEDING - MONEY SAVING -

GUDEBROD SYSTEM "C"

GUDEBROD FLAT TAPE BOBBINS—This special packaging of Gudebrod Flat Braided Lacing Tape is highly popular in the harness shop. Whether used in all hand tying or with the Cable-Lacer (for which it was designed) the bobbin makes conveniently available, high quality Gudebrod Tape in most of its many types—all engineered to lie flat, tie tight.

GUDEBROD CABLE-LACER®—This unique harnessing hand tool has proved a production speeder and harness improver. Makes up to 30 knots per minute. While making firmer harnesses with tighter, more uniform knots, it eliminates wear and tear on operator's hands because special brake takes strain of knot setting. Holds bobbin of Gudebrod Tape in handle.

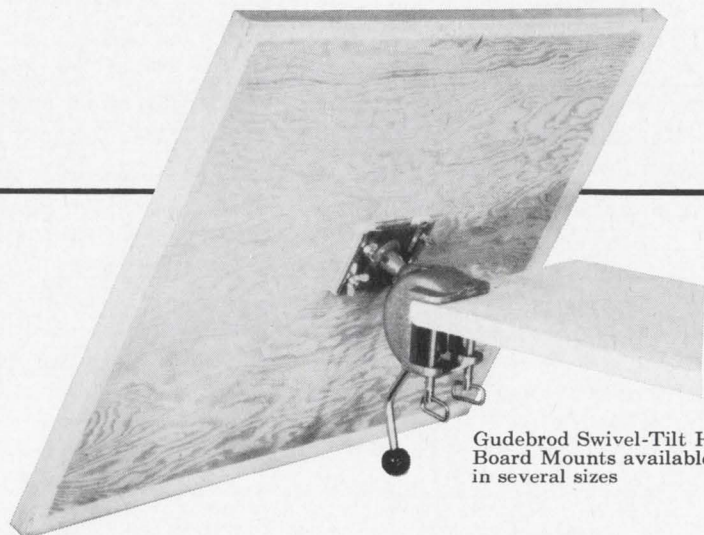
LONGER WIRE HOLDING PINS—They make wire threading much easier, quicker (no repeated wire redressing between pins). In harness tying they preserve the layout while using the Gudebrod Cable-Lacer. Special case hardened pins, nail better, stay straight, no nailheads.

GUDEBROD SWIVEL-TILT HARNESS BOARD MOUNT—Two dimensional balanced mobility puts every section of the cabling within easy, natural reach of the operator. Work done in this unstrained manner goes faster, is better, all day through.

There it is, the Gudebrod System "C" solving the cable making problems in a speedy, economical, profit improving way. Ask about System "C" (If you use intermittent tying, ask about Gudebrod System "S").

Gudebrod's
Special, Longer
Case Hardened Pins

®T.M.—UNION SPECIAL
MACHINE CO.



Gudebrod Swivel-Tilt Harness
Board Mounts available
in several sizes

GUDEBROD
Electronics Division

GUDEBROD BROS. SILK CO., INC. Founded 1870, 12 South 12th Street, Philadelphia, Pa. 19107



product report
digital instruments

Automate Your Measurements . . .

. . . with these NEW Tektronix products.



NEW

NEW

Digital Oscilloscope

The Type 568/230 Digital Oscilloscope System provides digital readout of measurements that are displayed in analog form on the CRT. They enable the engineer, technician or production worker to make dynamic switching-time measurements with greater speed, convenience and repeatability than is possible by making measurements directly from the cathode-ray oscilloscope display. Typical measurements include pulse voltages, risetime, falltime, delay time, storage time, pulse width and many other specific measurements.

With the NEW programmable plug-in units and Sampling Heads, all of the measurement functions of the Type 568/230 can be externally programmed for use in high-speed automated measurement systems. The Type 568/230 can make more than 100 dynamic measurements per second, and data output connectors provide measurement results in convenient BCD code. Programming is easily accomplished with the use of new Tektronix Program Units.

Type 568/230/3T6/3S6/S-1/S-1 \$7340

Automatic Measurements



NEW Type 241

Add the NEW Type 241 Programmer to the Type 568/230 Digital Oscilloscope and obtain up to 15 automatic measurements. The Type 241 will automatically sequence through 15 programs, stopping on out-of-limit measurements. Programs are easy to setup and change, enabling a person having minimum training to program the Type 241.

Type 241 \$1950



NEW Type 240

The NEW Type 240 Program Control Unit and NEW Disc Memory program the Type 568/230 at speeds up to 100 measurements per second and provide local storage of 1600 independent measurements. Sorting, classifying and diagnostic test routines are also obtained using the Disc Memory. A Punched Tape Reader is used with the Type 240 in low-speed systems, providing a maximum of 6 measurements per second.

Type R240 \$3800
Disc Memory \$6600
Punched Tape Reader \$1250



NEW Type R250

The NEW Type R250 Auxiliary Program Unit adds additional programming capabilities to the Type 240 and provides programming and buffering for pulse generators, power supplies and other equipment. System engineering and design is required with the Type R250. The NEW Type R116 MOD 703L and Type R293 MOD 703M Programmable Pulse Generators are designed specifically for use with the Type R250 in automated systems.

Type R250 \$1400
6 Shift-Register Cards \$420
Type R116 MOD 703L \$2775
Type R293 MOD 703M \$1300

U.S. Sales Prices FOB Beaverton, Oregon

Making the Measurement Tektronix Measurement Systems

Tektronix Measurement Systems use Tektronix Catalog products and additional equipment such as programmable power supplies, test stations, equipment racks and other equipment. Tektronix does the systems engineering and supplies a digital measurement system ready to do your measurement job. Your requirements to test integrated circuits, transistors, circuit boards and subassemblies can be met with a Tektronix dynamic measurement system.



NEW

Type S-3120 Switching-Time Measurements

The Type S-3120 is designed to verify the switching-time performance of transistors, diodes and IC's. The Type S-3120 is intended for use where power supply voltages and pulse parameters do not require programming. Program branching with the Type S-3120 permits sorting and classifying of semi-conductors. For example, when making a rise-time measurement, a within-limits measurement will continue the normal measurement sequence; an above-limit measurement (slow risetime) can stop the sequence to reject the component; and a below-limit measurement (fast risetime) can branch to a new measurement sequence for reclassifying the transistor.

Type S-3120 \$28,000

Type S-3110 Pulse Testing

The Type S-3110 provides up to 15 measurement programs and eliminates operator interpretation and error when testing pulse generators and other pulse sources. Programmable measurements provide consistent GO, NO-GO readings with the speed and repeatability required for production testing and QC. Measure pulse period, pulse width, risetime, falltime, pulse amplitude, overshoot, DC offset and many other specific pulse parameters. Sampling Heads provide a choice of system measurement capabilities. Select the measurement performance you need today and update your performance with future Sampling Heads.

Type S-3110 \$11,500



NEW



NEW

Type S-3130 Integrated Circuit Testing

Tektronix Type S-3130 Digital Measurement System makes 100% dynamic testing feasible for incoming inspection of IC's. Dynamic testing now can check the performance of your IC's under simulated operating conditions at a low cost per unit tested. Measurement speeds of 100 measurements per second with local storage of 1600 independent measurements provides the flexibility and versatility required of a dynamic IC tester. Measurement programs change power supply and pulse generator parameters over a wide range; extra program lines from the Type R250 can be used to switch test point and operating and load conditions.

Type S-3130 \$41,000

U.S. Sales Prices FOB Beaverton, Oregon

For a demonstration, call your local Tektronix field engineer or write: Tektronix, Inc., P. O. Box 500, Beaverton, Oregon 97005.



Tektronix, Inc.

committed to progress in waveform measurement

Probing the News

Electronics abroad

Mañana is today in Mexico

An amalgam of local and foreign interests, the nation's electronic industry enjoys excellent prospects in domestic markets and Latin American outlets

By Gerald Parkinson

Mexico City News Bureau

Mexico's electronics industry, with a big assist from Olympics-inspired communications projects, has established an excellent base for future growth. Right now, the field is still small by U.S. standards—1968 factory sales are estimated at \$260 million, against \$224 million last year—and most of its output is consumer goods. But the industry is 90% self-sufficient; television broadcasters have been transmitting in color for almost two years; the Latin American Free Trade Association (Lafta), of which Mexico is a member, has tremendous long-term potential as a market; and by the end of 1970, the country will have probably the best communications network south of the border [Electronics, April 1, p. 95].

The over-all outlook is for annual gains in the 10%-to-12% range during the period ahead as Mexico-based firms exploit not only relatively untapped domestic outlets but Lafta markets. Progress in computers, industrial products, and instrumentation will probably be slower than in other sectors because of the comparatively small local market and the high level of technology involved.

"The new communications and microwave network alone is bound to provide impetus for the electronics industry," says a local source. "There'll be a greater demand for skilled people and replacement parts that will upgrade education at all levels." The net is having other salutary effects. For one thing, a number of contractors,

including Germany's Siemens AG, are studying the possibility of setting up plants in Mexico. For another, hitherto remote sections of the country are being opened up to telephone, television, and related communications services.

Consuming interest. Mexico's consumer electronics concerns, particularly tv set makers, are thriving. This year's output of television sets will probably reach 240,000—a 30% jump from the 1967 figure. Radio production will be around 1.15 million units, a 7% gain from last year's level, and some 125,000 hi-fi stereo sets will be made and sold, for a year-to-year gain of 10%.

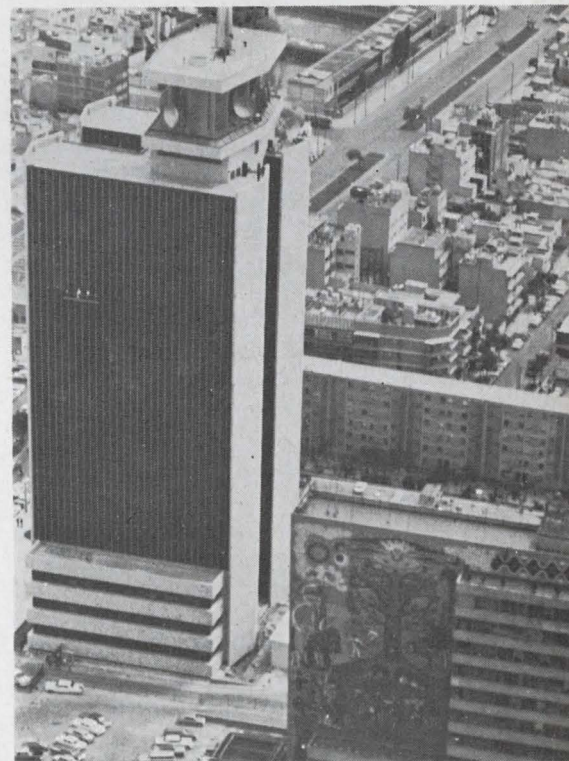
One big reason for the dramatic growth in tv set sales is that customers had deferred purchases until color receivers came to market late in 1967. And Olympic Games broadcasts were also undoubtedly a factor. Finally, Mexico is the only Latin American nation producing color cathode-ray tubes. Sylvania set up shop there more than a year ago, and Electronica S.A., an affiliate of Holland's Philips, got started just recently. RCA and Mexico's Majestic Group also plan to open tube plants.

Their present output represents quite an improvement in set makers' fortunes. As recently as 1960, they were operating at an annual rate of under 100,000. But around that time, the Mexican government began to take an active interest in fostering the industry's development.

The government has several

ways of protecting the interests of fields it would like to see flourish. When, for example, an established firm wants to make, say, a certain component, imports of that item are prohibited by the Ministry of Industry and Commerce. "As soon as someone starts a new operation here, he gets protection whether or not he asks for it," says an experienced local manufacturer of industrial goods.

The ministry also publishes



Cityscape. Microwave antennas top communications tower at Ministry of Communications in Mexico City.

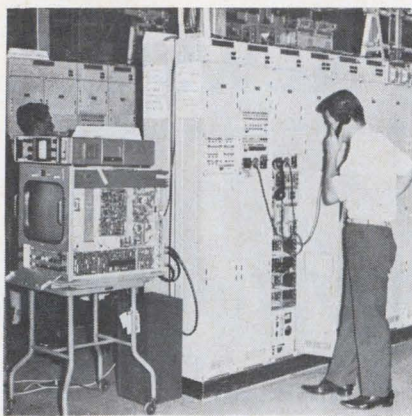
periodic lists of products it feels should be produced in Mexico. The most recent compilation totals 500, including 34 electronic, electric, communications, and instrumentation items. The ministry offers incentives—tax exemptions, for example—to entrepreneurs investing in ventures to produce goods on the list.

In general, the government welcomes foreign investment. Certain industries are state-owned, others are 100% controlled by Mexican interests, and still others are encouraged to have at least majority control of the companies in the hands of nationals. So far, there are no hard-and-fast rules for electronics enterprises; each case is judged on its individual merits. Generally, however, the government enforces the policy of 51% Mexican ownership.

There is, however, no all-embracing Mexicanization law, or even a rigid policy. Most U.S. businessmen prefer it that way because it gives them bargaining room. One observer, familiar with the situation, says, "Mexicanization is a mixture of laws, decrees, and policies—shot through with exceptions—that's administered pragmatically."

Borderline cases. Another way in which the Mexican government encourages foreign investment is through its border industries program. This is not a way to develop industry integral to the economy; it's simply an arrangement whereby U.S. and other foreign companies can establish assembly plants on the Mexican side of the border. Many U.S. electronics firms have taken advantage of this program, under which parts are shipped across the border in bond, put together in the Mexican plant, then shipped out, usually as sub-assemblies. The output of these plants may not be sold in Mexico.

The advantage of this arrangement, from Mexico's viewpoint, is that it provides much-needed employment; for U.S. companies, it offers low-cost hand labor. In general, Mexicans are happy with the program. But Roberto Perez Rodriguez, general manager of the National Chamber of the Electronics and Electrical Communications Industry has some doubts. Perez points out that firms put plants on



Key element. Carrier signal center in communications tower is an integral part of Mexico's new microwave net.

the border largely because labor costs are low. If wages rise or conditions change, he feels, they are likely to move the plant elsewhere—perhaps to Taiwan—leaving the Mexican workers without jobs. "I think it would be more convenient for Mexico if these companies were to integrate more into the economy," he says. "Perhaps they could use some Mexican materials instead of importing everything."

The Burroughs Corp., for one, has already integrated an in-bond operation. At the same time it has built an assembly plant well away from the border in Guadalajara partly because labor costs on the border are now higher.

Burroughs may have started a trend by establishing an in-bond plant in the interior. Motorola Inc., which has one in Nogales, is now setting up another in Guadalajara.

Home cooking

Frontier plants are not exclusively U.S. operations. One all-Mexican group doing a lively components-assembly trade in Mexico is the Majestic Group, one of Mexico's largest and most diversified organizations. Its border operation, Semiconductores California, is making integrated circuits for the Raytheon Co. and the Hughes Aircraft Co., cold cathode display tubes for the Raytheon Co., printed-circuit boards for Anaconda Electronics, and transistors for National Semiconductor.

Semiconductores California supplies these U.S. firms on a piece-work basis. It also makes transistors for Majestic's Mexican plants and exports low-cost elec-

trolytic condensers to the U.S.

Majestic, which started life as a radio assembly plant in 1947, now numbers 57 companies divided into three groups—components, assembly, and distribution. The group accounts for about 60% of Mexico's total radio production and turns out some 6,000 tv sets monthly. The current ratio is five black-and-white units for every color set, but this will narrow to two to one early next year, according to Victor Rivero, president. Annual sales are around \$32 million—comparatively large for a Mexican company. The company's tv production puts it up among the leading producers in Mexico, with Philips, GE, Philco, and Admiral.

Slow start. Majestic exports components to Lafta countries, but the trade association has been slow to get moving as far as the electronics industry is concerned. Representatives failed to ratify two proposed complementary agreements for electronic products at a recent meeting in Montevideo. Complementary agreements provide for tariff reductions on listed products in certain industries. The industries of Colombia, Peru, Chile, and Uruguay suggested a pact on 68 products, while Mexico and Brazil pushed one with 174.

The main reason for the breakdown in negotiations, according to a Mexican official, was that there was no consensus on how to deal with the "national origin" of materials used in listed products. In other words, a country might import all components at a low price from, say, Japan, then export at a low tariff rate to Lafta country where the same item is made and sold at a higher cost because local raw materials are used. The official says this problem is now being studied by member countries so that a formula can be devised.

Nevertheless, some Mexican-based companies are doing good business in Lafta countries through national lists of assorted products. Complementary agreements cover only one industry, but each Lafta country has a national list of allowable imports from other nations at agreed tariff rates. Mexico now is trading in about 60 or 70 "national list" electronics products. In fact, between a quarter and one-

third of Mexico's semiconductor production is now exported to Lafta lands.

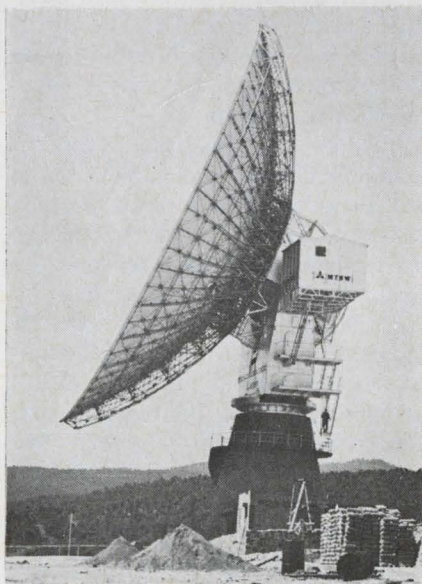
Another Mexican firm doing a brisk trade in the Lafta sphere is Electronica, 40% owned by Philips. The company is Mexico's largest semiconductor producer, making more than a million units a month. Most of this output is sold to companies outside the Philips orbit, but the firm does export to parent-company operations in Brazil and Argentina.

Something borrowed

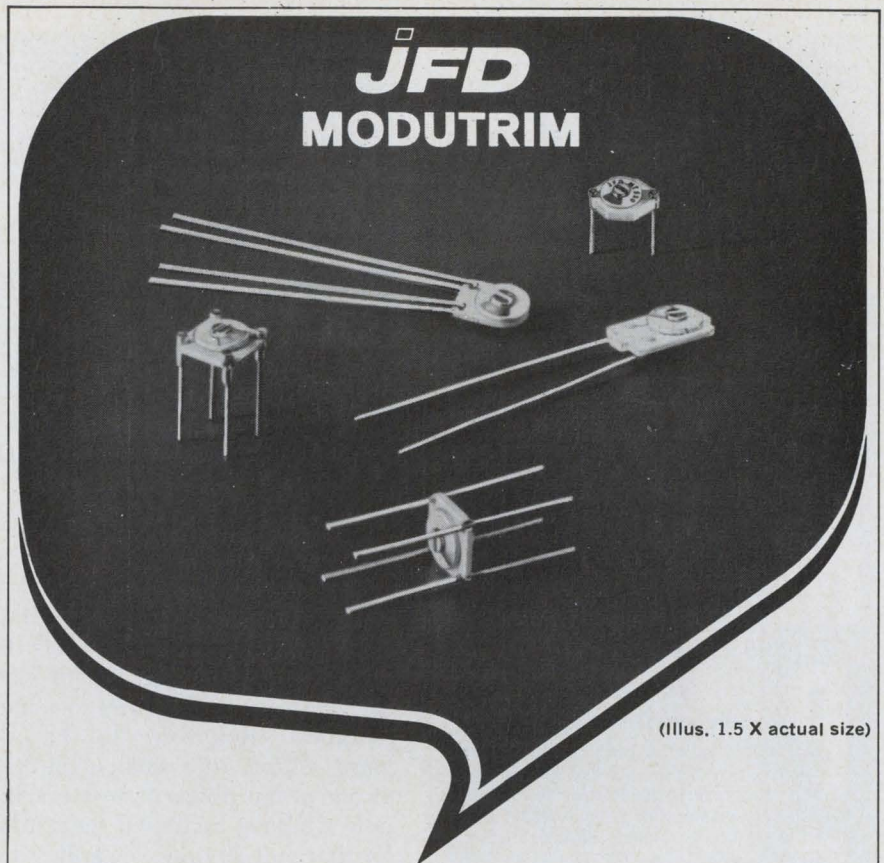
In common with other Mexican electronics firms, Electronica imports most of its technology under licensing agreements—in this case from Philips—and does little or no research and development work. Such activities are largely confined to applications technology.

Juliano Carrillo, technical manager at Electronica, points out that the company can't apply Philips technology directly because Mexican tv set specifications and materials differ from those in Europe. In addition, the effective radiated power of broadcasting stations is much higher there than in Europe—by as much as 100 kilowatts.

Electronica pioneered a practice that other firms have since adopted—an applications laboratory to help develop new products for the market. Originally, the idea was to



Tops. Mexico uses this antenna for satellite communications; it is the largest commercial dish in the world.



(Illus. 1.5 X actual size)

MICROMINIATURE CERAMIC VARIABLE CAPACITORS

Widest Δ Cs, highest stability and smallest size.

Modutrim microminiature ceramic variable capacitors offer micromodule and hybrid circuit designers a choice of wide Δ Cs in extremely small and stable units.

A unique rotor design utilizing a special proprietary ceramic material in a monolithic structure gives excellent stability. Q is in excess of 500 measured at 1 MC for those values under 50.0 pf.

MT 100 Series' design is specifically for channel-mount and cordwood applications, as well as many other micromodule packages.

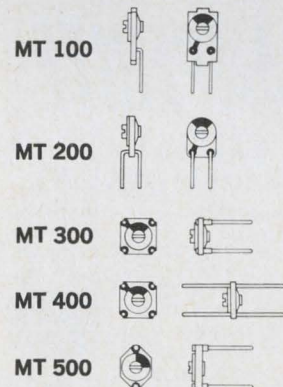
MT 200 Series offers still further miniaturization as an ideal answer to high component density problems and various LC networks packaged in TO-5 cans.

MT 300 Series' 4 terminal lead configuration provides optimum mechanical support and is specifically designed for printed, microminiature

and module circuits.

MT 400 Series is designed for cordwood and module applications. This configuration has 8 terminations for easy connection above and below the capacitor substrate.

MT 500 Series' two terminal lead configuration is designed to fit .100 grid spaced PC Boards.



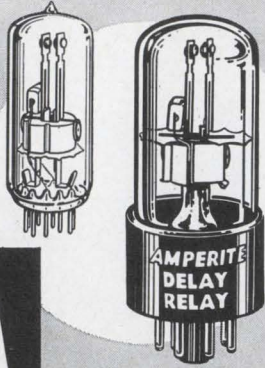
Write for catalogs MT-67-A and MT-500-68.

"TODAY'S COMPONENTS BUILT FOR TOMORROW'S CHALLENGES"

JFD JFD ELECTRONICS CO. / COMPONENTS DIVISION
15th Ave. at 62nd St. • Brooklyn, N.Y. 11219 / Phone 212-331-1000

Offices and subsidiaries in principal cities, world-wide.

"SEE US AT THE NEC SHOW BOOTH #305 and the NEREM SHOW BOOTH #2E22."



**A
M
P
E
R
I
T
E**

GLASS ENCLOSED Thermostatic DELAY RELAYS

Offer true hermetic sealing.
Assure maximum stability
and life.

Delays: 2 to 180 seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current . . . Being hermetically sealed, they are not affected by altitude, moisture, or climate changes . . . SPST only — normally open or normally closed . . . Compensated for ambient temperature changes from -55° to +80°C. . . Heaters consume approximately 2 W. and may be operated continuously. The units are rugged, explosion-proof, long-lived, and inexpensive!

TYPES: Standard Radio Octal and 9-Pin Miniature. . . List Price, \$4.

Amperite Delay Relays are approved for all voltages up to and including 115V under the component regulations of Underwriters' Laboratories, Inc.



PROBLEM? Send for Bulletin No. TR-81.

AMPERITE

BALLAST REGULATORS

Hermetically sealed, they are not affected by changes in altitude, ambient temperature (-50° to +70° C.), or humidity. . . Rugged, light, compact, most inexpensive.

List Price, \$3.00



Write for 4-page Technical
Bulletin No. AB-51

AMPERITE

600 PALISADE AVE., UNION CITY, N.J. 07087

Telephone: 201 UNion 4-9503

In Canada: Atlas Radio Corp., Ltd.,
50 Wingold Ave., Toronto 10



Assembly. Electronics S.A., a Mexican affiliate of M.V. Philips, turns out semiconductor devices at this modern plant in Toluca.

help the components field. Thus, the company fostered outlets for stereos by designing a solid state unit and giving 20 away to manufacturers. "Before we did that, we were selling only small quantities of one of our power transistors, but now we have increased the market for that unit 20 times," Carillo says.

Fairchild Mexicana S.A. is another components firm with an applications lab. "We've had it for about a year," says Manuel Chacon, marketing manager. "It's a big help in sales. We consider ourselves a market-penetration facility as much as a component maker."

Outside outlets. The company, which started production in mid-1966, now makes about 500,000 transistors monthly and perhaps one-third that many diodes, according to Chacon. It expects to double production by the end of next year, with about half that increase going to domestic outlets and the balance to Lafta markets.

Mexican subsidiaries give their U.S. parent concerns an edge in Latin American markets. The tariff advantage for Fairchild in shipping, say, to Brazil is only 5%—a 10% impost on Mexican shipments as opposed to 15% on U.S. exports—but Both Fairchild and Electronica say the edge is sufficient. Carillo of Electronica says his firm's prices are around 10% above international levels on average. In certain cases, however, they are below. "For example, we could beat any price in the world on carbon resistors and profit," he asserts.

Integrated circuits are still used sparingly in Mexico. But Chacon

feels they should start to appear in quantity in a few years—perhaps as i-f strips for tv and radio sets.

Instrumental theme

The market for test and measurement equipment in Mexico is still small—around \$1.5 million to \$2 million a year. But the field was practically nonexistent a few years ago. "I've been here since 1961, and when I started I had to sell components to make my living," says David Fredin, who represents Tektronix Inc. and the General Radio Co. His best prospects now, though, particularly for oscilloscopes, are tv manufacturers, research houses, owners of computer systems, and industrial houses.

The biggest share of the instrument market is held by Hewlett-Packard Mexicana S.A. The firm's largest sales are attributable to the Communications Ministry's new microwave system.

Vicente Garcia Aracil, general manager at H-P Mexicana, feels it will be a long time before the parent company's products can be made in Mexico. The reasons, he says, are a small market and the amount of technology required. At present, the quality of local components is inadequate for precision instruments. And instruments become obsolete about every five years, a situation necessitating large investments in R&D.

Receptions. Despite Garcia's pessimism, a few firms are making a go of it. Perkin-Elmer de Mexico S.A., which started manufacturing inexpensive Coleman meters a few years ago, expects sales of \$150,000

in 1968. The firm has already expanded into ultraviolet spectrometers, power supplies, and flame photometers, and it will be adding more expensive spectrophotometers latter on. Manuel Maya, manager of operations, says his main outlet is Mexico's big and fast-growing chemical industry. Maya expects a 20% sales increase next year and sees a good future.

Local light. Instrumentos Electronicos de Mexico S.A., an independent national firm in Mexico City, turns out iron-core transformers for the radio, tv, and communications industries, power supplies, battery chargers, telephone gear, and specialized electronics for control systems to pinpoint equipment failures. The eight-year-old firm anticipates sales of about \$750,000 this year.

Honeywell S.A. assembles potentiometers and electronic flame-failure safeguards for boilers, among other things. R.J. Holt, the general manager, estimates the industrial market's growth at an annual rate of 20%.

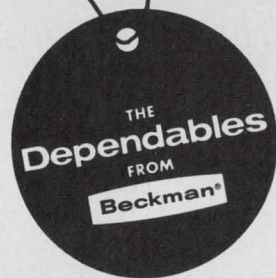
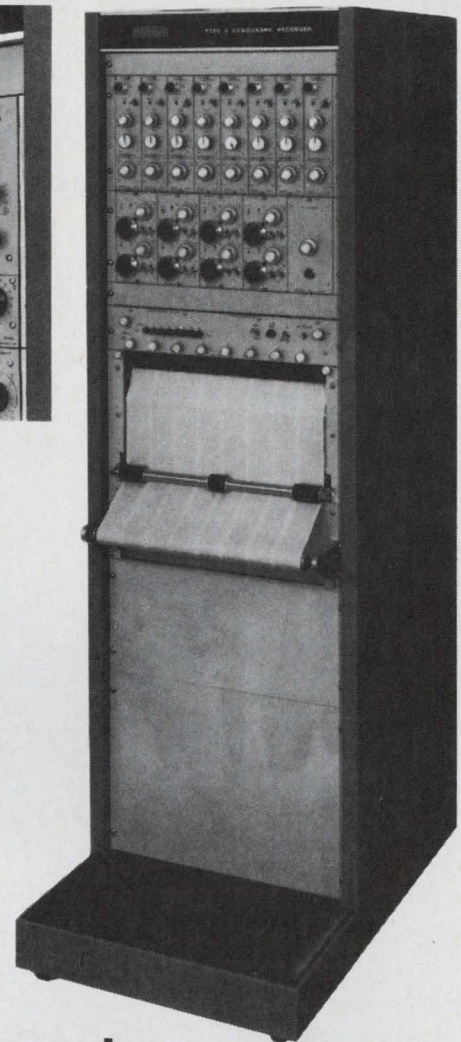
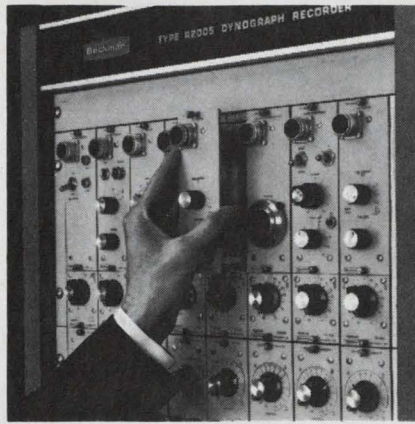
Computer markets

By year-end, as many as 240 computers will have been installed in Mexico, up from 200 in 1967. IBM, which—naturally—has the lion's share of the business, estimates that the market is growing by about 15% a year. Government agencies are the biggest users, says Duncan Howard, the company's promotional programs manager for the Caribbean area. Only about 5% of the installed systems are purchased, Howard says, with the rest being leased. Customers want the latest available equipment.

IBM is now installing what it claims is the first large-scale, direct digital control system in Mexico. This setup at the steel firm of Hojalata y Lamina S.A. in Monterrey will ride herd on the power consumption of blast furnaces.

Schooling. IBM has a training center in Cuernavaca for its own personnel and for customers. The company estimates that more than 1,500 programers, systems analysts, and operators have been trained there in the past three years.

Mexico's National Commission of Outer Space, created in 1962, plans to map Mexico's natural resources from an instrumented DC-6



Beckman recorders solve difficult measurement problems.

From the heartbeat of an insect to the pulse of a nuclear power plant, the measurement is simply a push-in for any of the Beckman input signal conditioners. • Each channel of the standard Dynograph® recorder is tailored to your application by selecting one or more of the many versatile 9800 Series input couplers. No need to purchase expensive preamplifiers; no need for additional complex auxiliary equipment. The standard Dynograph recorder is a *complete* measurement recording system. To change the measurement, simply change the coupler... a matter of a few minutes and only a few dollars. • What is your measurement problem... direct recording of temperature, strain, pressure, flow, force, torque, displacement, velocity, or a more complex measurement involving computation such as rate, integration, or differentiation? • Dynograph recorders write out answers directly, accurately, dependably, and economically. • For complete details, contact your local Beckman office, sales representative or the factory direct.

The Electronic Instruments Division develops and manufactures precision electronic measurement and test instrumentation for science and industry. Major product lines include: electronic counters, IC testers, oscillographic recorders, panel meters, system components, signal sources, time standards, and data acquisition systems.

Beckman

INSTRUMENTS, INC.

ELECTRONIC INSTRUMENTS DIVISION

SCHILLER PARK, ILLINOIS • 60176

INTERNATIONAL SUBSIDIARIES: GENEVA; MUNICH; GLENROTHES, SCOTLAND; TOKYO; PARIS; CAPETOWN; LONDON; MEXICO CITY; STOCKHOLM; VIENNA

aircraft it recently purchased. The work will start about mid-1969 and involve a variety of instruments, including an infrared radiometer, microwave equipment, multispectral cameras, and possibly side-looking radar. All this gear will be imported.

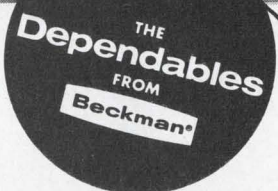
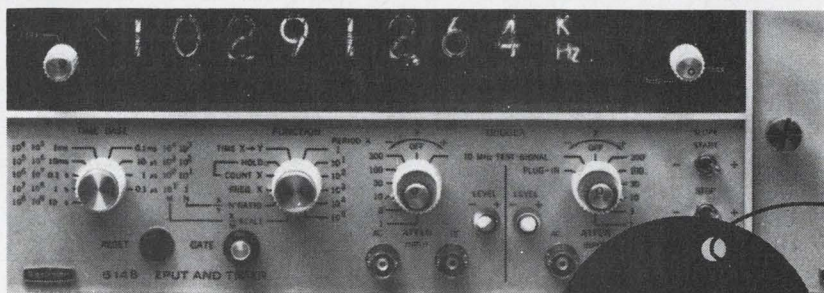
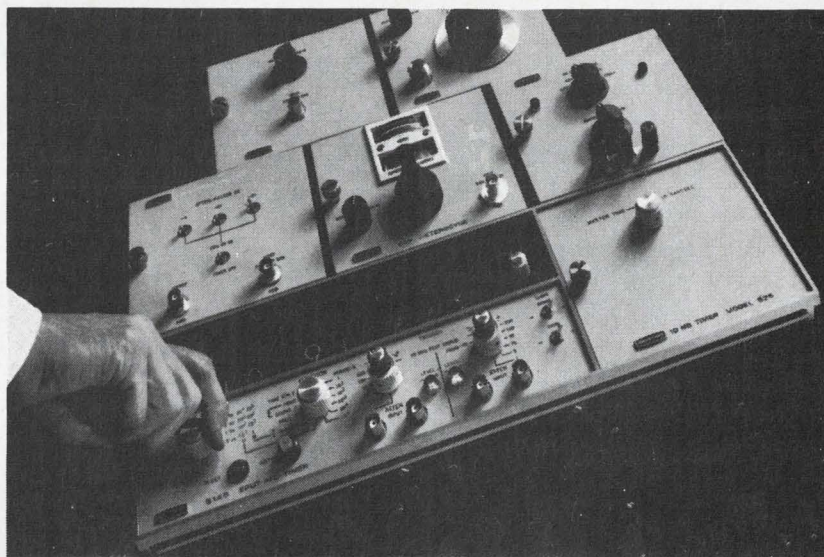
A team of 11 engineers from the commission and other national agencies attended a course in remote sensing techniques at NASA's Manned Space Flight Center in Houston. Under commission auspices, these engineers are now giving a special course to other Mexicans from concerned organizations.

Joint venture

The Mexican commission has also been testing its own rockets, which it will use to take meteorological soundings with NASA and agencies in Argentina and Brazil. Under this program, the four countries will make tests more or less simultaneously, track parachuted payloads by radar as they come down for wind profiles, and pick up temperature readings by telemetry. Each country's data will then be compared. The project is scheduled for the end of 1969. Seven Mexican engineers are now at Wallops Island, Va., training with the radar NASA will lend Mexico for the program.

The Ministry of Communications and Transport's commission for meteorology and telecommunications is installing automatic meteorological stations around the country at a cost of \$5.28 million. Meteorological information will be supplied to airports, the Mexican navy, and anyone who requests it. This data will complement the output of a system currently operated for airports, and will be combined with information supplied by the Ministry of Agriculture, which runs a network of 800 manned stations.

The meteorology commission has ordered equipment for the first 20 automatic stations from a French firm, but plans to subsequently install equipment of its own design. Solid state systems will digitize data from meteorological instruments and convert it to teletype code. The gear will be programmed to transmit automatically every 5 minutes via telephone, telegraph, or the new microwave network.



Can your present counter (without the use of additional test equipment)

- show your operator when he makes mistakes?
- determine the zero crossover of a symmetrical wave form, either ac or dc coupled and with or without a dc bias?
- see if there is an input signal?
- display the *correct* attenuator setting?
- make timing measurements with 10 ns resolution?
- measure the pulse width of a single wave form?
- measure the separation between pulses?
- perform two-channel timing measurements without the aid of a plug-in?
- be used as an error expander with a resolution of 1 part in 10^{10} ?
- be *spared* for less than \$100.00?
- give you reliability—MTBF above 60,000 hours?

BECKMAN'S Model 6148 can...**DEPENDABLY!**...in addition to making all the conventional frequency, period, multiple period, ratio, time interval, scaling measurements.

For complete information on what the Model 6148 can do for you, contact your local Beckman office, sales representative or the factory direct.

The Electronic Instruments Division develops and manufactures precision electronic measurement and test instrumentation for science and industry. Major product lines include: electronic counters, IC testers, oscillographic recorders, panel meters, system components, signal sources, time standards, and data acquisition systems.



INSTRUMENTS, INC.
ELECTRONIC INSTRUMENTS DIVISION
RICHMOND, CALIFORNIA • 94804

INTERNATIONAL SUBSIDIARIES: GENEVA; MUNICH; GLENROTHES, SCOTLAND;
TOKYO; PARIS; CAPE TOWN; LONDON; MEXICO CITY; STOCKHOLM; VIENNA

COAXIAL AND



WAVEGUIDE

BROADBAND ISOLATORS

FEATURES: IMPROVED CHARACTERISTICS • LOW BILATERAL VSWR • MAGNETICALLY SHIELDED • 1, 1-1/2 & 2 OCTAVE BANDWIDTHS • IDEAL FOR PRECISION MICROWAVE MEASUREMENTS • SIGNAL SOURCE STABILITY • HIGH POWER PROTECTION • ALL MODELS AVAILABLE FROM STOCK TO 30 DAYS

BROADBAND WAVEGUIDE ISOLATORS

Frequency Gc	Isolation db Min.	Insertion Loss db Max.	VSWR Max.	Power Kw Peak	W. Ave.	Model Number
2.6 - 3.95	15	1.0	1.15	20	20	S102LI
2.6 - 3.95	20	1.0	1.15	20	20	S103LI
2.6 - 3.95	30	1.7	1.15	20	20	S104LI
3.3 - 4.9	25	1.0	1.15	5	5	CS110LI
3.95- 5.85	30	1.0	1.10*	20	20	C876LI
3.95- 5.85	30	1.2	1.15*	20	20	C110LIA
3.95- 5.85	40	1.0	1.15*	20	20	C111LI
5.85- 8.2	30	1.0	1.10*	20	20	Xb951LI
5.85- 8.2	30	1.0	1.15*	20	20	Xb103LIA
5.85- 8.2	40	1.2	1.15*	20	20	Xb910LI
7.05-10.0	30	1.0	1.10*	10	40	XL920LI
7.05-10.0	30	1.0	1.15*	5	20	XL103LIA
7.05-10.0	35	1.0	1.15*	5	20	XL910LI
7.05-10.0	40	1.2	1.15*	5	20	XL911LI
8.2 -12.4	30	1.0	1.10*	10	40	X956LI
8.2 -12.4	30	1.0	1.10*	5	20	X110LIA
8.2 -12.4	40	1.0	1.10	5	20	X910LI
10.0 -15.0	25	1.0	1.15	10	10	M110LI
10.0 -15.0	30	1.0	1.15*	10	10	M111LI
12.4 -18.0	30	1.0	1.10*	10	20	Ku915LI
12.4 -18.0	30	1.0	1.15*	10	10	Ku110LI
12.4 -18.0	35	1.0	1.15*	10	10	Ku910LI
12.4 -18.0	40	1.2	1.15*	10	10	Ku911LI
18.0 -26.5	25	1.0	1.15	5	5	K110LI
18.0 -26.5	30	1.5	1.15	5	5	K111LI

BROADBAND COAXIAL ISOLATORS

Frequency Gc	Isolation db Min.	Insertion Loss db Max.	VSWR Max.	Model Number
0.5- 1.0	10	1.5	1.25	U10P
1.0- 2.0	10	1.0	1.15	L10P
†1.0- 2.0	15	1.0	1.15	L20PS
1.0- 4.0	12	1.3	1.25	LS10P
2.0- 4.0	12	1.0	1.18	S10P
2.0- 4.0	20	1.0	1.20	S11P
†2.0- 4.0	20	1.0	1.20	S11PS
3.8-11.7	10	1.2	1.30	SCX10P
4.0- 8.0	10	1.0	1.25	C10P
†4.0- 8.0	15	1.0	1.20	C20PS
4.0-11.0	10	1.0	1.25	CX10P
7.0-11.0	15	1.0	1.25	CX11P
7.0-11.0	15	1.0	1.25	CX20PS
8.0-12.0	10	1.0	1.25	X10PS

*Bilaterally matched units.
Specified VSWR is for both forward and reverse directions.
†Magnetically shielded models.

REQUEST SHORT FORM CATALOG LISTING OVER 500 BROADBAND WAVEGUIDE AND COAXIAL ISOLATORS



Division of Sterling Electronics Corporation
7419 Greenbush Avenue, North Hollywood, Calif., 91605
Telephone (213) 875-1484

LABORATORIES

Laser safety issue burning bright

Industry and the military are attempting to establish self-regulatory standards as Federal agencies and state governments come up with more restrictive measures

By Paul A. Dickson and William F. Arnold

Washington regional editors

Safety was the number one topic at the Laser Industries Association's annual meeting in Washington late last month. Everybody's for it, of course, but there's no real consensus among the various interest groups—industrial, military, and medical—about the best way to set up guidelines. To further complicate matters, the Federal Government and the states are getting into the act, passing potentially restrictive legislation.

In general, the industry professes to see no particular problems regarding laser safety. Malcolm L. Stitch, who recently joined the Korad department at the Union Carbide Corp. as assistant general manager, says that during his eight years with the Hughes Aircraft Co. he heard of no laser-connected accidents. "I am not convinced that a need exists for wide-ranging laser regulations so long as systems use is restricted to industrial and military applications," says Stitch, who heads the Electronics Industries Association's laser subdivision.

Similarly, Colin Bowness, manager of microwave devices operations at the Raytheon Co., says: "The dangers of lasers are vastly overrated. There have been rumors about people being badly hurt, but in the eight years since the invention of the ruby laser, I haven't run across any recorded examples. And I've talked to many doctors."

Rebuttal. As it happens, however, the Public Health Service is set to issue a three-state survey of 200 organizations using lasers; seven cases of eye damage were found, five of which were permanent. The report, which covers groups in Massachusetts, New Jersey, and California, will also point

out 20 other laser-associated accidents, including electrical shock and explosions.

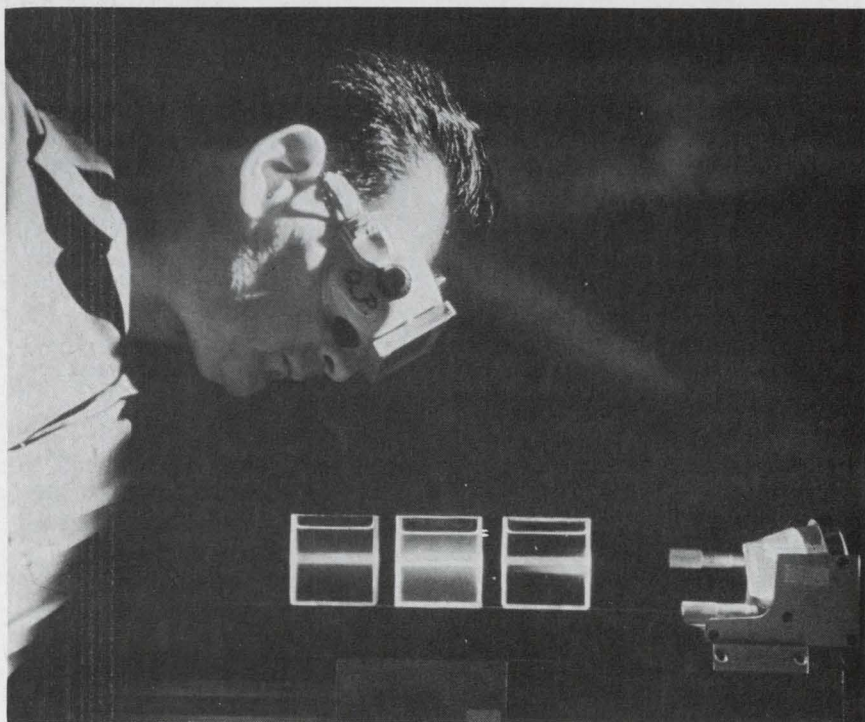
And many scientists and researchers investigating laser hazards warned at the LIA meeting that the dangers could not be minimized until more is known about long-term effects. Moreover, what constitutes "safe" radiation levels is still a very moot point.

Preventive maintenance

If only to protect its best interests, the laser industry is driving hard for self-regulation. Graham W. Flint, who heads the laser devices section at the Martin-Marietta Corp.'s Orlando, Fla., division, says the EIA's laser safety committee, which he heads, is

drafting instructions for various classes and powers of laser systems. "These are designed to take the onus off the industry and manufacturers should an accident occur," Flint says. "A company would be liable only if damage occurred within the confines of the operating instructions."

"We're also trying to develop a closer relationship with Dr. Sam Fine, who heads the LIA's safety committee," Flint says. He hopes the two groups will be able to bring out a single document. "If we get a unified document, we can have some influence on legislation," he says. "And the guy who knows nothing about a laser's safety will have more confidence in proposals approved by both



Ounce of prevention. Upcoming Army-Navy guidelines suggest laser operators wear protective goggles though they're effective only in certain situations.

of our groups."

However, other guidelines are being issued. The American Conference of Governmental Industrial Hygienists, for example, has just published some. Among other things, the report distinguishes between laser radiation and ionizing radiation from gamma and X rays.

Corporate scene. Most companies that use lasers have safety guidelines, but the first to publicize its activities was Martin-Marietta. In 1965, it published a 24-page pamphlet with nine general safety rules for laboratory personnel and formulas for calculating safe operating conditions.

At IBM's Communications and Engineering Sciences Center, Gerald I. Farmer, a staff physicist, says all personnel working with lasers must take certain precautions. Goggles must be worn; periodic checkups with an ophthalmologist are required, and intensive training is given in the safe use of lasers. Farmer says that a guide is now being produced for internal use, which will borrow from the work done by Martin-Marietta and the hygienists.

Military maneuvers

The armed forces, as prospective volume users of laser systems for range-finding, target illumination, station-keeping, and related applications, are also concerned with safety. As it happens, the three services can't agree on just what constitutes hazard-free operation. The main reason for the apparent impasse is similar to that in the civilian world—lack of data. "We know a great deal about the eyes of rabbits and monkeys, but we don't know very much about those of human beings," says Cmdr. Charles F. Tedford, head of the radiation safety branch of the Submarine and Radiation division at the Navy's Bureau of Medicine and Surgery.

In establishing safe thresholds for eyes, the Army is the most cautious, the Air Force the most liberal, the Navy in between. The Air Force measures energy at the cornea, the Army at the retina. Since the eye magnifies light five or six times between the cornea and the retina, the Air Force approves considerably higher levels. The disparity between the two ap-

Further fallout?

While most of the concern about laser hazards centers on damage to the human eyes and skin, there are probably other dangers. For example, Edward Klein, who is investigating laser safety at the Roswell Memorial Institute in Buffalo, N.Y. says the possibilities include "scattering of bacteria and side effects which might increase the virulence of microorganisms." James Terrill, director of the National Center for Radiological Health, is concerned about possible "synergistic effects with other forms of radiation."

Perhaps the longest list has been compiled by William McCullough, a Canadian labor official. At the National Safety Council meeting in Chicago last month he ticked off such potential hazards as: explosions set off by laser beams; atmospheric contamination from vaporized material resulting from laser welding or cutting; contamination from gas lasers or byproducts of laser reaction; ultraviolet radiation from lasers or associated flash tubes; and fire and electrical dangers involved with high-energy voltage.

proaches stems partly from differences in mission; the Air Force rarely has to worry about ground troops in the field.

In addition, the two services use divergent samples. The top Army research organization is the Medical College of Virginia. The Air Force relies largely on the Stanford Research Institute, where "we used monkeys in lieu of rabbits," says Lt. Col. Herbert E. Bell, Biomedical Sciences Corps. "They're far better test animals than rabbits as far as the human eye is concerned. Nothing has shown up on any of the animals." The SRI experiments also included seven staff volunteers, some of whom were exposed to dosages above the thresholds with no damage apparent so far.

But perhaps the biggest factor is an honest difference of medical opinion. "Low levels of radiation exposure previously thought to be safe may be hazardous," says Col. Robert W. Niedlinger, chief of laser biology research for the Army's Medical Research and De-

velopment Command. "The Air Force has set its figures for the extreme circumstances, the exceptions," he says, "but systems may come along for which those values are no good."

Acknowledging that "there is a considerable area of disagreement" and that "we're considerably more liberal than the Army," Col. Alvin M. Burner of the Air Force's Aerospace Medical division replies: "We feel our levels are realistic for our types of operation."

Upshot. There will probably be no triservice laser document for some time. The Army and the Navy will shortly issue a joint guideline [Electronics, Aug. 5, p. 62] treating the laser as if it were a rifle and suggesting that laser operators wear goggles even though they are only effective at certain wavelengths and can shatter at high power levels.

Truly effective eye protection against lasers is a long way off, so the guidelines will also prescribe eye checkups for men about to enter laser work and periodic exams every six months or so. Men believed to have been accidentally exposed to a laser beam would be given immediate exams.

In this respect, the two services are tentatively following what's been standard Air Force practice for almost two years.

Unknowns

For all the interservice controversy, caution marks the military's approach to establishing threshold values. "You can never call a number safe if it damages one rod or cone," says Tedford. "You're born with a certain number and you don't get any more."

With lasers, permanent eye damage is always a threat because the eye is a million times more susceptible to laser burns than the skin. There is no specific treatment for such eye damage. "The only thing we can do is to reduce the inflammation with cortisone-type preparations," says Tedford. And though no one knows for sure, at least one researcher suggests that laser ionization can produce cancerous tissue over an extended period. "Some of us are scared of the long-term effects," he says.

And the Army's values, says Da-

Jack-in-the-box HF antenna. Goes up in 2 hours.

**Transport it by air... or store it for emergency standby.
You'll have reliable performance even after repeated field use.**

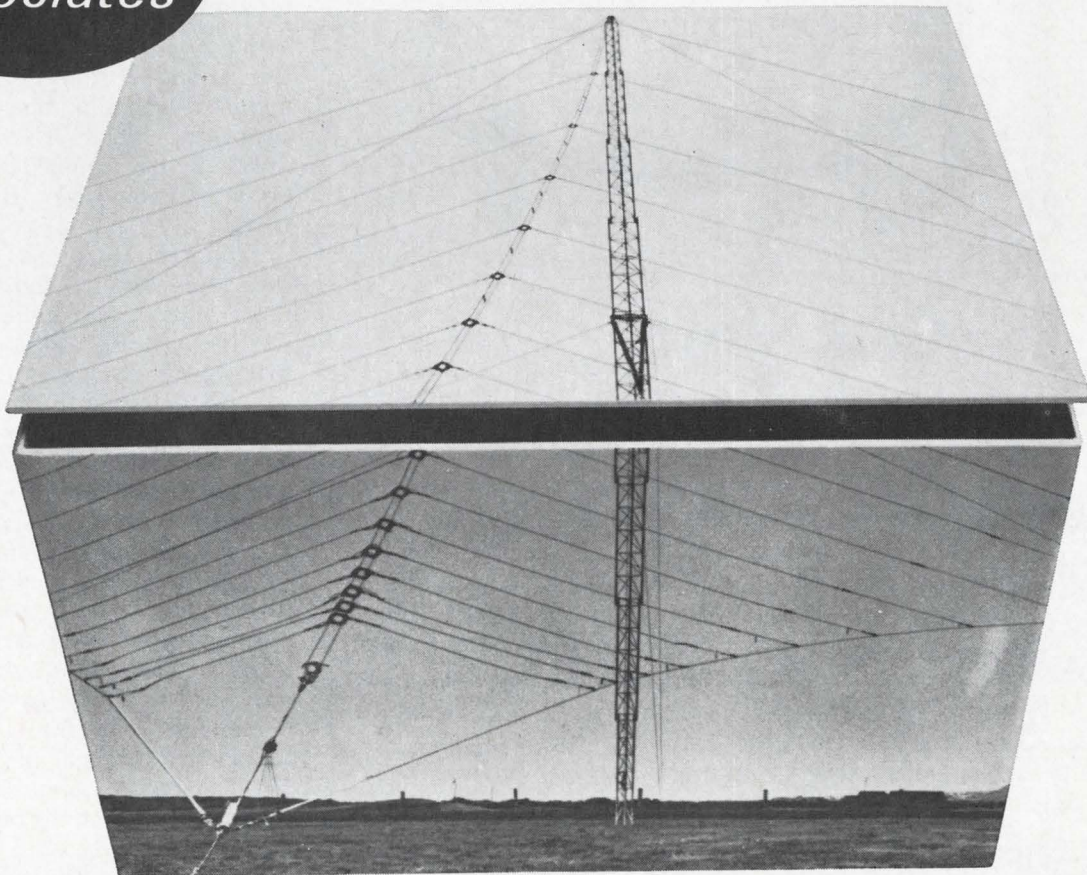
Granger's 747 CA antenna comes out of storage and sets up fast as a 0-to-2000 mile communications back-up if a hurricane knocks out a fixed antenna. Or, move it by air or surface wherever you need quick communications. The 747 CA is a compact package, and five men can set it up in 2 hours. With gain of up to 13 db from 4 to 30 MHz, VSWR under 2.1:1, and no lobe splitting, it performs as well as a permanent installation. A Delta extension kit adds omnidirectional coverage from 2 to 4 MHz for close-in communication.* The 747 CA antenna withstands harsh environments... winds up to 100 mph. Its rigid, nested tower and all materials are corrosion resistant. Available in models from 1 to 20 kw average (2 to 40 kw PEP), this high-performance portable or stowable antenna is a good package deal. Write for complete data.

*The Delta Kit is included with antenna Model 747 CB.
The Kit is also available as a retrofit for 747 CA's.
CA/CB models are available for fixed installation.

Granger

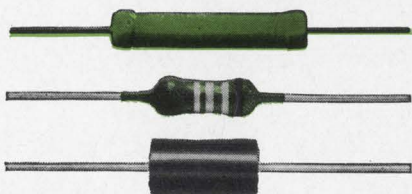
Associates

Circle 195 on reader service card





Our films really get to you



We deliver metal alloy and metal oxide film resistors fast. You get a full range of precision and semi-precision types when you want them. Mallory precision MAF in $\frac{1}{8}W$ and $\frac{1}{4}W$; semi-precision MAL in $\frac{1}{2}W$; metal oxide MOL's in 2W to 7W. Values ranging from 30.1 ohms to 499K. All are 100% inspected. Get prompt delivery from Mallory. For details, write or call Mallory Controls Company.

MALLORY

MALLORY CONTROLS COMPANY

a division of P. R. MALLORY & CO. INC.
Box 231, Frankfort, Indiana 46041

vid H. Sliney, a researcher with the service's Environmental Hygiene Agency, are at least 10 times under dangerous levels. Tedford predicts: "We might be able to relax the figures in time. But getting guidelines to put out to people is more important than the threshold values we're quibbling over." The services may be taking such action none too soon. Says Niedlinger: "We're starting to get proposals for experiments with provisions to expose a human eye directly to a laser. And they're often based on the wrong numbers."

Legislating lasers

Laser safety has in recent months gone beyond the domains of industry and the military to become a public issue. Four states—Illinois, Massachusetts, Pennsylvania, and Louisiana—have laser laws, and the legislatures of New Jersey and California are studying bills. The Federal Radiation Control for Health and Safety Act, passed last month, empowers the Secretary of Health, Education and Welfare to establish a control program that will include performance standards. He'll also conduct research and report back to Congress before January 1970 with a recommendation for stronger legislation. It hasn't been announced officially, but there's no doubt that the job of setting standards will be assigned to the National Center for Radiological Health.

Arthur E. Jones, a Honeywell Inc. laser expert who heads the LIA's legislative committee, says: "At this point it does not appear that the provisions of the Federal act are going to be hard for industry to live with." He points out, however, that some state laws are another question. The recently passed Louisiana law, he contends, may be the hardest, since it's essentially a rewrite of a nuclear radiation law and imposes nuclear reactor strictures on lasers. Jones, who has contacted 49 states to see what is happening in laser legislation, says that quite a few legislatures are thinking of such laws. He is worried about especially stringent bills, like the one defeated in the New York senate that would have made it difficult for anyone without a graduate degree to own

or use a laser.

Best case. According to Jones, the most realistic of the laws is the one in Massachusetts; he considers the Illinois law relatively stiff. The recently passed Massachusetts act allows the state to adopt regulations to protect the public from hazards. Says Ronald C. MacKenzie, the senator who proposed the bill: "I had heard of the Illinois bill, which is very restrictive. The more I learned about lasers, the more I realized that the law should only be regulatory."

The Illinois law calls for the registration of all lasers, mandatory reporting of all accidents, in-plant inspection by the state, and the rejection by the state of the registration of systems it does not deem safe. Illinois officials concede that the law has thus far had little effect—primarily because another bill that was to have provided funds for enforcement was defeated.

The National Center for Radiological Health, the organization which will have the greatest impact on the laser field, was working in the safety field long before the radiation bill was passed. With its new powers, it can be expected to launch a major effort. In the next few weeks the center will issue a publication entitled "Biological Aspects of Laser Radiation," and an official at the center says that there is talk of a possible survey of lasers soon that would be much like the center's controversial check of color tv receivers.

James Terrill, the center's director, indicates that the forthcoming regulations will be tough. Terrill is clearly disturbed by the sale of lasers to schools and their use in industrial displays open to the public. He warns the industry that a black eye now could hamper the long-term success of laser applications.

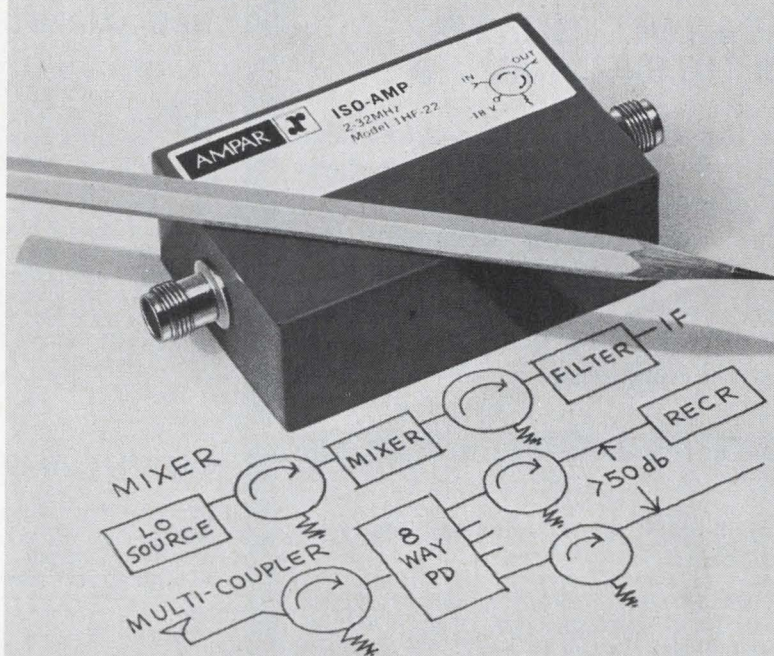
Terrill's strong cautiousness may seem a bit severe to some in the industry, but he does have the backing of experts. A.M. Clark, a member of the team studying laser dangers at the Medical College of Virginia, shares Terrill's views on lasers in the classroom. Clark says, "Students and teachers approach us to check out laser science projects and it's very frightening. Some proposed experiments I have seen are very, very dangerous."

NEW...

now available!

2-32 MHz ISO-AMP

an HF Isolator with over 20 db output to input isolation



The AMPAR ISO-AMP is a compact solid state device specifically designed for high dynamic range systems where high front-to-back isolation and low VSWR are required. Features are:

Broadband Frequency	2-32 MHz
Insertion Loss	0.75 dB
Noise Figure	1.0 dB
Maximum Input Signal	0.5 watts
VSWR	1.2:1, 2 ports
Input Isolation	20 dB

The IHF-22 is available in several connector types and impedances.

Application note available upon request.

For detailed information and assistance in solving your problem, call (617) 899-3145, 39 Green Street, Waltham, Massachusetts.



PACESETTERS IN ADVANCED ACTIVE RF TECHNOLOGY

EUROPE'S STRONGEST GROUP IN SOLID STATE DEVICES CAN DELIVER THESE IC'S RIGHT NOW



LINEAR INTEGRATED CIRCUITS FOR AUDIO

Meet the wide Philips range of linear integrated circuits for audio applications. Designed in the light of all Philips' experience in the audio field, they are being used in tape recorders, pocket radios, car radios, television sets, microphones, hearing-aids, and industrial equipment.

Our application laboratories are ready to assist you

Philips are developing more integrated circuits for audio applications. Why not ask us about the AF integrated circuits you want to use? We may have designed them already!

PHILIPS ADVANCED RANGE OF IC'S FOR TV

The Philips Group also offers the most advanced range of circuits for television, including sound IF, signal processing, synchronous demodulation, and RGB matrix circuits. A number of circuits for communication and instrumentation are also available.

PHILIPS

PHILIPS ELECTRONIC COMPONENTS
AND MATERIALS DIVISION
EINDHOVEN, THE NETHERLANDS

PRE-AMPLIFIERS

TAA263 and TAA293 are two easy-to-use three-stage pre-amplifiers with about 80 dB gain which you can use almost anywhere.

The TAA310 is a pre-amplifier with 100 dB open-loop gain which can be reduced by selective feedback to provide a typical recording and playback amplifier function.

The TAA320 is a circuit combining a MOS FET input transistor with a bi-polar output. Its input impedance is at least 100 G Ω , which makes the circuit ideal for all kinds of industrial sensing functions as well.

The TAA435 is a pre-amplifier capable of driving a 4 W push-pull pair of output transistors. Its supply voltage is 14 V, which makes it particularly useful in car radios and record players.

OUTPUT AMPLIFIER

The TAA300 is a unique 1 W class-B output amplifier, which requires only 10 mV drive for full output. Its current drain is only 8 mA from a 9 V battery, and it works with less than 10 % distortion, even over a battery voltage range of 2 : 1.

HEARING-AID AMPLIFIERS

The OM200, **finest IC in the world**, gives 0.2 mW of audio when powered by a 1.3 V battery. The TAA370, in a 10-lead flat pack, gives 1 mW of audio with the same battery voltage. Both circuits have a typical noise figure of 4 dB.

MICROPHONE AMPLIFIER

The TAA500 is an original audio amplifier with common output and supply line, providing a constant voltage gain of 300 for a power supply current range from 20 to 100 mA. The circuit can be used with ceramic or with dynamic microphones.

distributed and sold in the U.S. by: **AMPEREX ELECTRONIC CORPORATION** Providence Pike, SLATERSVILLE, Rhode Island
230 Duffy Avenue, HICKSVILLE, New York 11802 • 801 E. Charleston Avenue, PALO ALTO, California 94303 • 360 E. North Avenue, NORTHLAKE, Illinois 60164.

Fluidics stays barely above water

Interface problems, cut-and-try designing, and a lack of systems experience and standards are a drag on this field as it struggles to win market acceptance

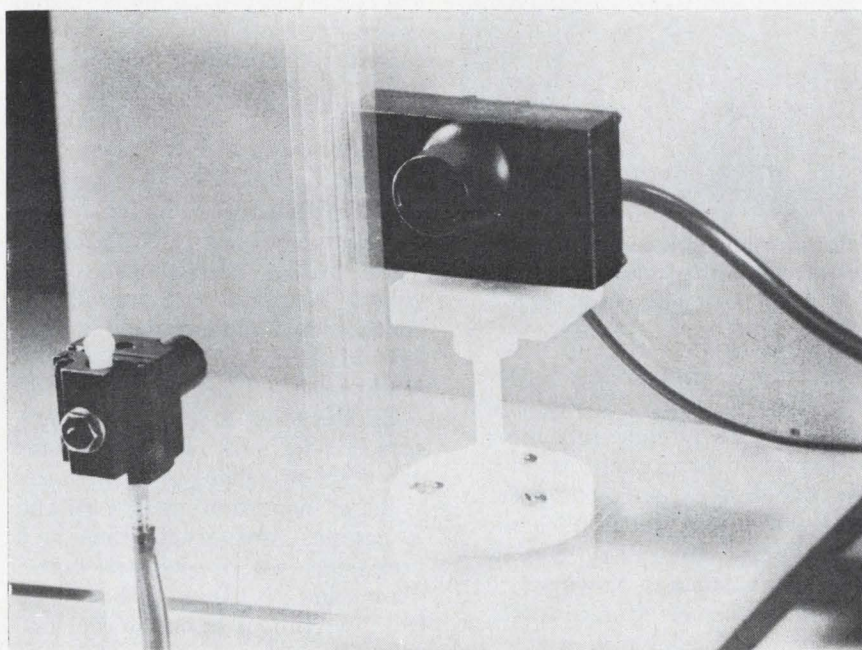
It's beginning to look as if fluidics is another one of those bright ideas that just won't pan out—at least not as a significant technological threat to electronics. Despite the involvement of big-time concerns—Corning, Pitney-Bowes, Bendix, General Electric, Honeywell—the field is still short on accomplishment. As a matter of fact, the gains that have been made during the 10 years or so fluidics has been around are largely promotional in nature.

Drum-beaters have managed to assemble a fat portfolio of press clippings and even gain recognition of sorts. There was, for example, a session on fluidics at Wescon this summer [Electronics, Aug. 5, p. 137], and “the industry” is staging a road show of its own later this month in Chicago.

But a number of problems remain to be overcome if fluidics is ever to secure a foothold in the marketplace. Among them are high costs, a lack of standards and systems experience, customer disinterest, and cut-and-try designs.

Catch phrases. Fluidic devices are built from ceramic material, etched and bonded to provide channels through which a “fluid” power input—usually clean, dry air, though water and process liquids are sometimes used—can flow to perform a function. The general attraction of fluidic systems is ruggedness and reliability. The litany of advantages includes no moving parts; unaffected by temperature extremes, radiation, corrosion, or vibration; spark-free; and operative even in grimy environments.

Richard A. O'Brien, manager of the Corning Glass Works' fluidic products department, likens the technology to a “practical application of a textbook explanation for electricity.” In other words, the



Listening post. Ear arrangement from Pitney-Bowes is fluidic counterpart of an electric eye; company claims it can sense even translucent objects.

passage of fluids through tubing or pipe is often used as an analogy for the flow of electrons through wire. By controlling the direction and velocity of a liquid or gas through interconnected channels, O'Brien says, devices can be made to do almost anything of a control nature that electrical gear does.

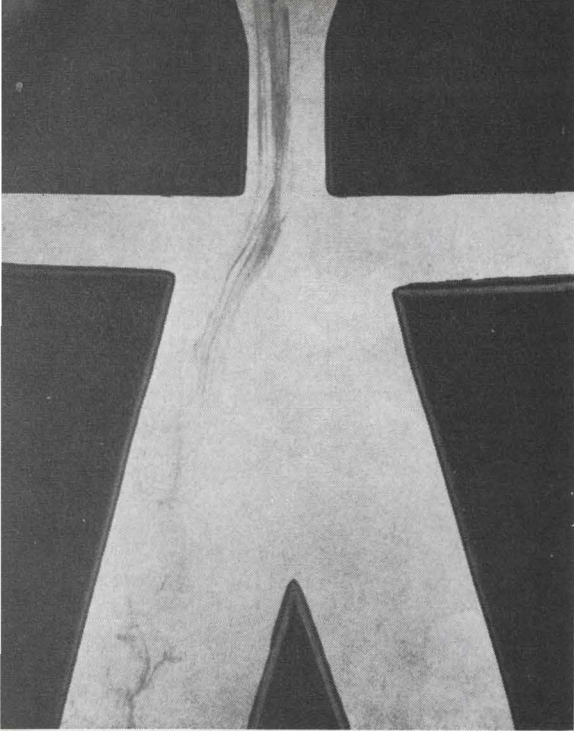
Beyond the fact that both fields use much the same jargon—flip-flops, resistance, AND, NAND, OR, and NOR gates, and the like—fluidics and electronics part company. Fluidic devices work on two basic principles far removed from electronics: the Coanda effect—the tendency of a moving fluid to adhere to an adjacent smooth surface—and momentum transfer, by which fluid mainstreams change course in a controlled manner.

In addition, there's a tremendous

speed differential between the two technologies. Electronic devices are limited only by their size and the speed of light, but fluidic assemblies operate at the slower speed of sound. As a result, such devices can't begin to keep pace in nanosecond computer systems. In theory, however, they can perform decision-making jobs in control setups where speed isn't critical. And this is precisely the area that fluidics enthusiasts have staked out for themselves.

Where it's at

Officials at the Bowles Engineering Corp., one of the relatively few firms making only fluidic devices, identify controls for machine tools as their principal commercial market. “We're after the guy who wants to automate 100 drill presses



Clinging. Warm-table demonstration illustrates wall-attachment tendency of fluid stream in a Bowles flip-flop.

in his shop," says Edwin M. Dexter, vice president for industrial controls. "He already has the air available, so investment costs are low. Electronics can't compete at this volume, and electromechanical devices are clumsy by comparison." Dexter denies, however, that fluidics is after electronics markets as such. "Our competition is with the relay people," he says. "And there's a slight possibility we might infringe on liquid-level controls."

John A. Enright, product manager at the Johnson Service Co., agrees that fluidics' niche is somewhere between electronic and mechanical controls. "But the field is in an evaluation stage," he says. "We're still trying to get our products into users' hands so they can judge what they have to gain."

Among the comparatively few commercially available pieces of equipment incorporating fluidic controls is an air-gaging system used in the machining of automobile blocks. This apparatus is now being marketed in Europe by Imperial-RIV, a joint venture of the I-T-E Imperial Corp.'s Fluidonics division and Italy's RIV-SKF. Another entry, an aerosol-can filler made by the JG Machine Works, incorporates fluidic control modules produced by Corning.

In a more exotic vein, the Howie Corp. of Norristown, Pa., makes a

fluidic sensing device called a turbulence amplifier. Along with interface and input-output hardware, this assembly has been successfully used in control systems for packaging equipment and machine tools. So far, however, the company has come a cropper trying to apply it in a setup that sizes chickens before they're packaged for market. According to Kenneth Howie Jr., a vice president, the pervasive chicken dung in the processing plants hardens to a cement-like consistency, clogging ports and generally fouling up the works.

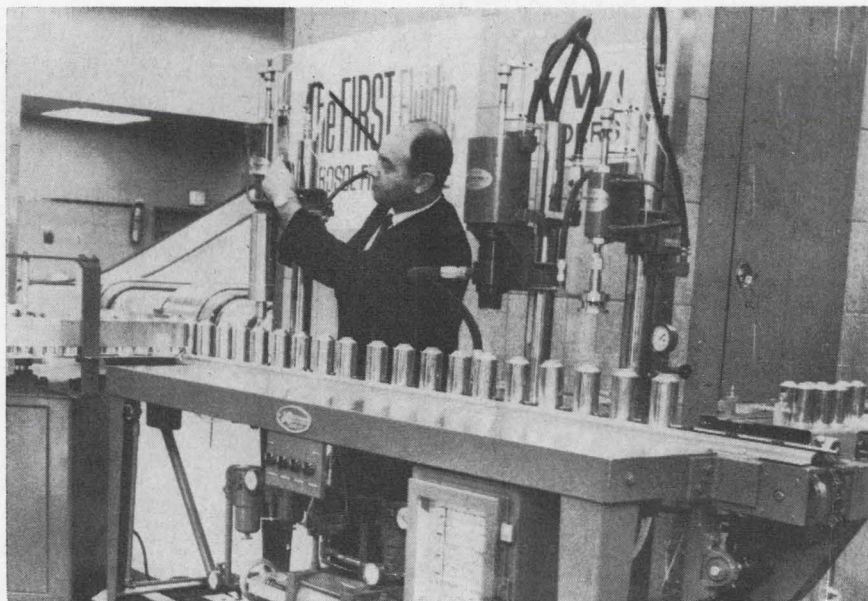
Edge of anxiety. Fluidics proponents agree that their technology has at least a psychological advantage over electronics in industrial outlets. "Among machinists, there's a fear—whether real or imaginary—of electrical shocks and worse when electronics is involved," explains one source. "In addition, maintenance must be considered. It's more expensive with electronics."

On the other side of the ledger, says Howie, is the fact that in some union shops where hybrid control systems incorporating fluidics and electronics are used, there's a problem when breakdowns occur. "You wind up having to have men from two unions in on the repairs." As a result, he claims, most prospects prefer a purely fluidic system—if for no other reason than to avoid labor difficulties.

Aerospace markets follow industrial outlets on fluidics' list of targets. The Bendix Corp.'s research laboratories in Southfield, Mich., for example, have been working on fluidic flight controls for general aviation applications under a contract from the National Aeronautics and Space Administration. Walter F. Datwiler, who heads fluidic research at the labs, notes that most of his organization's military and aerospace efforts involve interfacing with electronics, a situation that poses potential problems.

"Where size isn't critical and pulse-rate requirements don't exceed 100 per second, electropneumatic transducers can be used. But size is critical in spacecraft, and while miniaturization is possible, there are practical limits," says Datwiler. "Where space and response are at a premium, an electromagnetic system with a flapper nozzle in a pneumatic arrangement won't work. A piezoelectric-type driver circuit is necessary." Moreover, he continues, fuel consumption and purification are pretty sticky problems in aerospace applications. If a system requires hundreds of elements, fuel pressure becomes a problem since it must be kept low.

Off the ground. Honeywell Inc.'s Aerospace division has come up with a fluidic flight-control system for helicopters that's now being



Air brush. Fluidic circuit modules from Corning replace pneumatic logic in this aerosol-can filler produced by the JG Machine Works.

tested by the Navy. Powered by bleed air from the craft's jet engine compressor, the system controls the yaw, roll, and pitch axes. The craft's attitude rates are picked up by three fluidic sensors, shaped by fluidic networks, and fed as differential pressures to fluidic amplifiers. According to Walter S. Robinson, the division's director of aircraft flight systems, the pressures are then converted to drive hydrofluidic servos.

Before the system was shipped to the testing site this summer, it was flown aboard a Navy tandem-rotor CH-46A at the Minneapolis-St. Paul International Airport, where its performance was rated by the test pilot as on a par with that of electromechanical systems.

Rx for growth?

Although fluidics' potential appears to lie largely in industrial and aerospace applications, there's increasing interest in the biomedical field. Bendix, for example, is doing research with fluidics for artificial hearts. Another organization that's even more involved in this area is Fluidonics' medical instrumentation department in Salt Lake City.

"We're looking into the full spectrum," says Gale Thorne, who heads the department. "This ranges from basic assist devices through implanted artificial hearts." Some of the research is being funded by the National Heart Institute, but most of the work is financed by the company. "The body itself is a fluid system," says Thorne, "with blood flowing from organ to organ and the heart acting as a pump. What we're attempting to do is wed the electrical operation—the heartbeat—with fluidics."

Thus far, after more than 15 months of intensive research, the marriage has proved far from fruitful. The greatest difficulty still encountered by the fluidonics researchers is in the area of sensors. "The problem is to correctly match circuit functions with the physiological functions of the human body," says Thorne. Also unanswered is the question of how to power assist devices or artificial hearts over a period of, say, 20 years or so. "We're using glucose fuel cells," says Thorne. "But the answer will probably be in nuclear

Crisp Bacon in 90 Seconds

with **INTERNATIONAL'S
MICROWAVE OVEN**



The culinary wonder of space age cooking moves to your kitchen with this new International countertop oven that cooks with radar-spawned microwave power.

People on the go will welcome an oven that makes cooking chores a pleasure. Imagine a "piping hot" TV dinner (frozen) in 3½ minutes* instead of 20 to 50 minutes. Bake a potato in 5 minutes instead of 60 minutes. Warm a chilled baby bottle in 60 seconds. Fry crisp bacon in 90 seconds on a paper plate. Great for those leftovers.

International Microwave Oven is truly remarkable. No more waiting for the oven to reach cooking temperature.

Countertop designed for the home, mobile home, or the galley on your boat. No special wiring required. Works on 115 vac house circuit. Comes in baked vinyl white with attractive trim. **\$545.00**

Available direct from International or through your local appliance dealer.

*Times listed are approximate and vary with size of item.

Write for folder

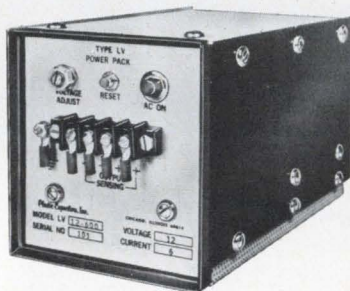


CRYSTAL MFG. CO., INC.

10 NO. LEE • OKLA. CITY, OKLA. 73102

NEW SOLID STATE POWER PACKS

for
regulated
low voltage
applications
from



Plastic Capacitor's new LV Series Power Packs, ranging from 12 to 100 volts DC, offer an improved solution to today's system requirements. Models available with DC output voltages of 12, 24, 28, 36, 48, and 100 volts with power ratings of approximately 25, 50, 100 & 150 watts.

FEATURES INCLUDE:

- 0.01% LINE REGULATION
- 0.05% LOAD REGULATION
- 3MV PEAK TO PEAK RIPPLE AND NOISE
- NEGATIVE 0.015%/°C TEMPERATURE COEFFICIENT
- LESS THAN 0.2 OHMS OUTPUT IMPEDANCE
- TEMPERATURE OPERATING RANGE OF 0°C TO 55°C

For positive proof that good things come in small packages... check your power pack needs with Plastic Capacitors. Write for full engineering data today.

Plastic Capacitors INC.

2620 N. Clybourn Chicago, Ill. 60614
Tel: (312) 348 3735

power. Battery sources are unlikely."

Animation. Fluidionics' medical researchers have developed a small respirator for animals. The fluidic unit helps an animal to absorb oxygen into his system and give off carbon dioxide and water.

Thorne remains optimistic about the long-range potential of fluidics in biomedical applications. Besides respirators and artificial hearts, he predicts inroads in surgical tools and instrumentation as the technology progresses. "Even intravenous feeding as we know it will probably change," says Thorne.

For all this talk of potential market, though, fluidics is still, as Johnson Service's Enright suggests, "little more than a curiosity." And already there's been at least one prominent drop-out—the Conrac Corp. Thomas Harriman, vice president for engineering and marketing there, says: "You might almost say fluidics is too late. Electronic and even mechanical systems have reached a point of refinement and sophistication where there's little left to conquer." Harriman dismisses the industry's bruited digital logic devices as

"nuts and bolts," adding "you can't expect to make a living off them." He does believe a few firms can make out eventually, but says there won't be any bonanza.

Device oriented. One of the principal reasons that fluidics has made so little real headway is the preoccupation of producers with devices rather than systems. "A good 50% of our sales are in breadboarding hardware for prospective customers to try out," says Bowles' Dexter. Not that there aren't extremely interesting assemblies available. Pitney-Bowes Inc., for example, offers a line of digital logic devices, input-output items, and power supplies; only occasionally, though, does the company do systems work. Among the more intriguing items in its catalog is a fluidic ear, a digital output device that's analogous to an electric eye; it transmits a 50-kilohertz sound wave to a sound-sensitive fluidic amplifier, replacing electric eyes in hostile environments.

Similarly, other big-name concerns in the field are long on discrete devices. Corning, which produces Fotoceram, the basic material for much of the industry's output, offers 50 separate items including NOR gates, Schmitt triggers, binary counters, and pulse limiters. Only recently, however, has the company begun packaging systems for prospective customers. Corning is pointing toward an off-the-shelf capability in binary systems, says Thomas Dincher, sales manager for fluidic products.

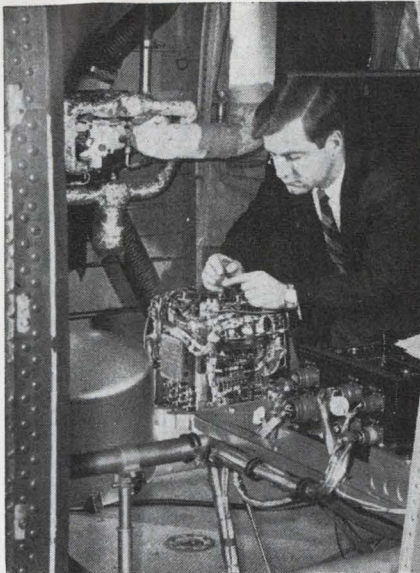
Handicap. In the opinion of many observers, the industry's fascination with devices has impeded progress. "There's no systems approach to circuit design," says one source. "There's not going to be any real gains until producers do this and are able to predict performance, as can be done in electronics." This individual believes that the field's predilection for cut-and-try approaches, particularly in digital fluidics misses the point. "Devices aren't consistent enough for complex circuits," he asserts.

Arthur E. Maine, director of engineering at Aviation Electric Ltd., a Canadian affiliate of Bendix, agrees that output should be applications oriented. "The fluidics field has failed to address itself

A hose by any other name

For a comparatively young technology, fluidics has undergone a number of name changes. Ten years ago, when the first experimental devices were being developed, the Government used the term fluid amplification. The Martin-Marietta Corp. is generally credited with coining the word fluidics to describe work done at its Orlando, Fla., division. In 1965, the National Fluid Power Association put its stamp of approval on the term.

But that same year, the Government's Fluidics Coordinating Group decided another word was necessary to delineate the technology. Thus, fluidics, in Federal parlance at least, covers the field right up through such peripheral equipment as mechanical air pumps. The word fluierics is used to designate actual devices within a system. This distinction is the basis for the new Defense Department standard on fluidics [Electronics, Oct. 28, p. 70].



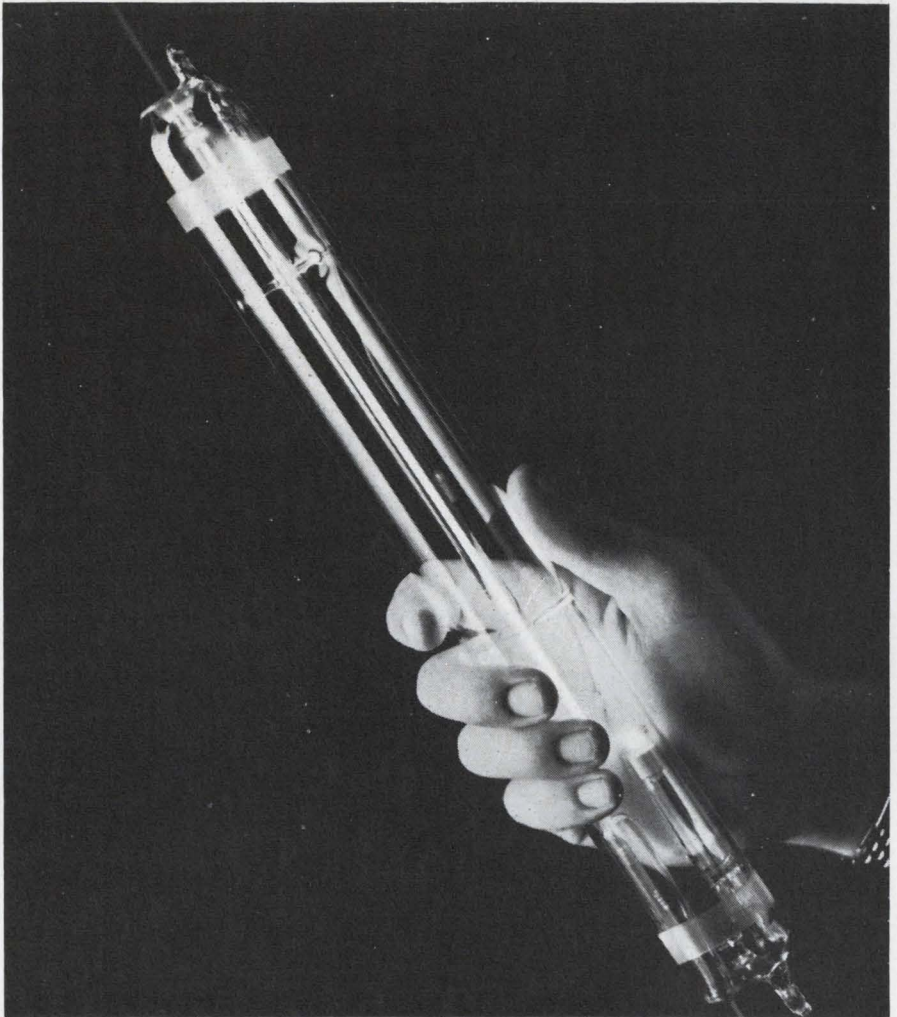
Upbeat. Honeywell developed a fluidic control system for Navy helicopters.

adequately to the applications engineers whose task is to convert the technology into effective and reliable hardware," he says. "All too often a logic diagram defining the required functions has been promptly converted into a breadboard lashup. Once the required circuit operation is obtained, the system is unceremoniously transferred to a box and put on a factory floor to do the job for which it was intended. The rationale for expecting success is that if it works in the lab, why not in the actual application? This enthusiastic but primitive approach has been instrumental in putting fluidics in a poor light."

Incompatibility

Further complicating the problem has been a lack of industry-wide standards, including terms, symbols, operating characteristics, curves, air filters, power supplies and interfaces. As long as a user sticks with a single manufacturer he won't encounter too many difficulties on this score. But the moment he decides to switch vendors or use more than one, he'll have his hands full.

The standardization problem was partially solved earlier this year when the National Fluid Power Association (NFPA) in Thiensville, Wis., published a compilation of recommended symbols and terms. These standards haven't yet been adopted on an industrywide basis,



The coherent lightbulb

A new concept in He-Ne continuous gas lasers for systems and OEM users.

The Lasertron™ He-Ne plasma tube is a lightbulb. A coherent one. Operate it without a housing. Even under water. And it is available as an individual component or as a complete laser instrument with a separate, detachable, low-ripple solid-state power supply.

The Lasertron tube needs no adjustment, alignment, or maintenance. Simply switch it on and off. Nothing more. Its resonator mirrors are permanently aligned inside a rigid coaxial pyrex envelope. Collimation is built in; alignment stability is guaranteed. Dust, humidity, vibration, temperature extremes, and aging will not affect it.

Lasertron tubes are available in a variety of geometries for systems and OEM users. Power outputs range from 10 mW to 0.6 mW in TEM₀₀ mode, at a wavelength of 6328 Angstroms.

Lasertron tubes and complete instruments are guaranteed for one full year, with no restriction on operating hours.

For applications assistance and product literature, please return coupon or contact University Laboratories, 733 Allston Way, Berkeley, California 94710 (415) 848-0491.

University Laboratories

733 ALLSTON WAY, BERKELEY, CALIF. 94710

Please send new brochure with complete specifications on He-Ne laser instruments and accessories.

Please send information on Lasertron™ Plasma Tubes.

My interest is current for future reference.

Name _____

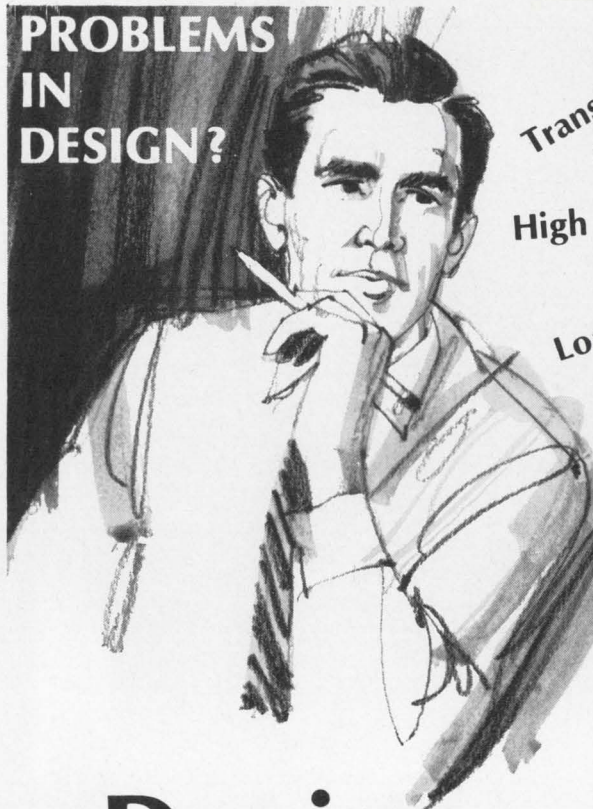
Organization _____

Dept., Mail Station _____

Address _____

City, State, Zip _____

**PROBLEMS
IN
DESIGN?**



**Transient Pulses
and Dips?**

High Supply Voltage?

Load Power Factors?

Close Regulation?

Sine Wave?

Square Wave?

Design . . . with Sola CV Transformers in mind

Sola constant voltage transformers are available in designs with harmonic neutralized (CVS) and normal harmonic (CVN) wave shape outputs. Our CVS transformers contain less than 3% total rms harmonic content in the output and are recommended for all AC applications where harmonics can affect operation. Regulation is $\pm 1\%$ for an input range of $\pm 15\%$ of nominal voltage. CVS transformers are patented by Sola.

CVN transformers provide the same $\pm 1\%$ regulation and contain an average of 20% rms harmonic content. They're recommended for electrical loads not affected by harmonics, such as solenoids, relays and filaments, and where rectification to DC is required.

Sola CV transformers also are available in electronic-power component types providing a regulated source of plate and filament voltages (CVE and CVF).

Give your equipment design the best chance of operating at peak efficiency, without the damaging effects of voltage dips and surges. Contact Sola today for more information on how our transformers can fit your line. SOLA ELECTRIC, 1717 Busse Rd., Elk Grove Village, Illinois.

SUPPLIERS OF CONFIDENCE
TO THE INDUSTRIES
WE SERVE

SOLA ELECTRIC



DIVISION OF SOLA BASIC INDUSTRIES

IN CANADA: SOLA BASIC LTD., 377 EVANS AVENUE, TORONTO 18, ONTARIO
DIVISIONS: ANCHOR ELECTRIC • ENGINEERED CERAMICS • HEVI-DUTY ELECTRIC
LINDBERG HEVI-DUTY • NELSON ELECTRIC • SIERRA ELECTRIC • SOLA ELECTRIC

but Theodore Pearce, the NFPA's executive secretary, is confident they will be. "There's no question as to the need," he says, "if the industry is going to avoid the chaos that the electronics field endured in its early years."

One of the main aims of standardization is to enhance education programs, which play a leading role in sales programs. The market isn't particularly receptive since, according to an estimate by a Corning official, there are less than 200 engineers in all of the U.S., who are skilled in applying fluidics technology. As a result, concerns are hawking their wares vigorously to overcome customers' inexperience and inertia.

Fluidonics and the Brown & Sharp Co.'s Double A Products division, for example, have developed multipurpose kits to familiarize prospective users with fluidic technology and application. Both kits are of the do-it-yourself variety, including technical manuals, circuit blocks, and hardware, as well as the necessary tubing for the assembly of fluidic circuits.

Sales pitch. Besides employing the kits as educational tools, both companies use them as sales aids. The kits are proof-positive, they feel, of the safety involved in fluidics and the ease with which controls can be maintained. Unlike electronics, a wrong connection in fluidics will only result in the system's failure to work—not a short. This, say spokesmen, cashes in on the psychological advantage fluidics holds over electronics.

But the point, as far as Aviation Electric's Maine is concerned, is that fluidics is not a panacea. "Unless we're absolutely positive an application lends itself to fluidics, we won't tackle it." He points out that during the field's formative years, enthusiasts rushed about proclaiming that "pure fluidics" was a cure-all and that other control technologies need not be considered at all. That was, and still is, pure nonsense, he says, "and is the reason why there is so little applications data, even today."

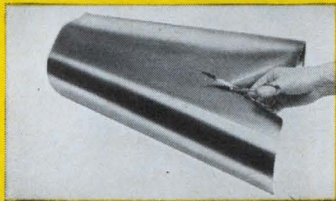
"Fluidics isn't a glamorous new technique to other technologies," he says. "Instead, it is a versatile new tool with which a control engineer can supplement the traditional tools at his command."



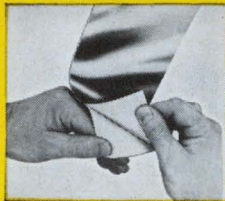
EMC CONTROL

5 SOLUTIONS TO MAGNETIC SHIELDING PROBLEMS

1. Use flexible Netic Co-Netic Foil. It can be cut easily with ordinary scissors and shaped quickly to any desired configuration. One or more layers may be used as needed. Stock delivery in any required length. Widths: 4", 15" and 19 1/4". Other widths available. Several convenient thicknesses.



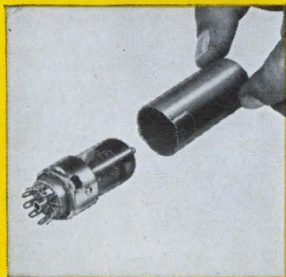
Netic Co-Netic Foil



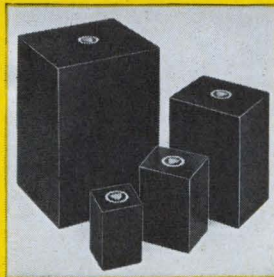
Adhesive-Backed Foil

2. Order Netic Co-Netic Sheet Stock for fabrication in your plant into any desired configuration. Conveniently available in lengths of 15", 30", 60" and 120" in widths of 24", 26" and 30" and in thicknesses from .095 to .014.

3. Specify Netic Co-Netic fabricated component shields made to your exact specification by our magnetic shielding specialists.

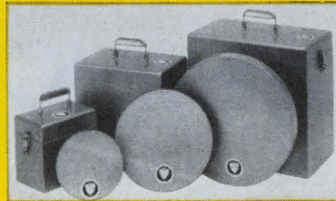


Miniature Component Shielding

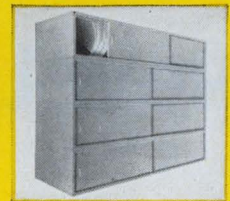


Transformer Cans

4. Protect your vital programming records by storing and transporting them in specially designed rugged Netic containers.

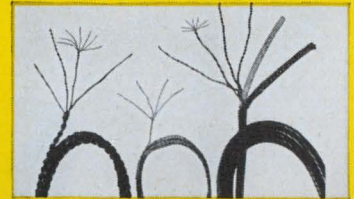


Stock Items



Multiple Stacked Tape Storage Cabinets

5. To reduce magnetic field pickup or radiation in vital wires or cables, select Unique Inter-8 Weave Cables. Available in plain, copper shielded or Co-Netic shielded.



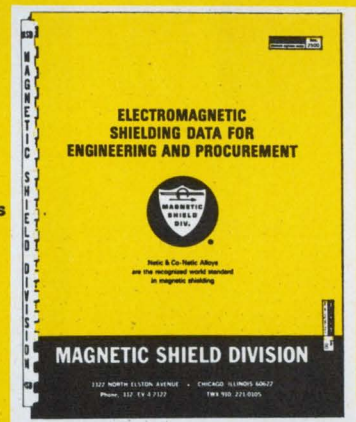
Inter-8 Weave Cable—Plain, Copper Shielded, or Co-Netic Shielded

YOURS FOR THE ASKING:

The most complete literature available on magnetic shielding.

West Coast Stocking Reps
Tech Rep Distributor Co.
10606 W. Pico Blvd.
Los Angeles, Calif. 90064
213, 836-6806
213, 871-0055

Frauman Associates
P.O. Box 969
Menlo Park, Calif. 94026
415, 322-8461



MAGNETIC SHIELD DIVISION

PERFECTION MICA COMPANY

740 THOMAS DRIVE • BENSENVILLE, ILLINOIS 60106
PHONE 312, 766-7800 TWX 910 256-4815

**Dual Differential Amplifiers—
DC to 120 MHz:
RCA - CA3026 @ \$1.25 (1,000 units)**

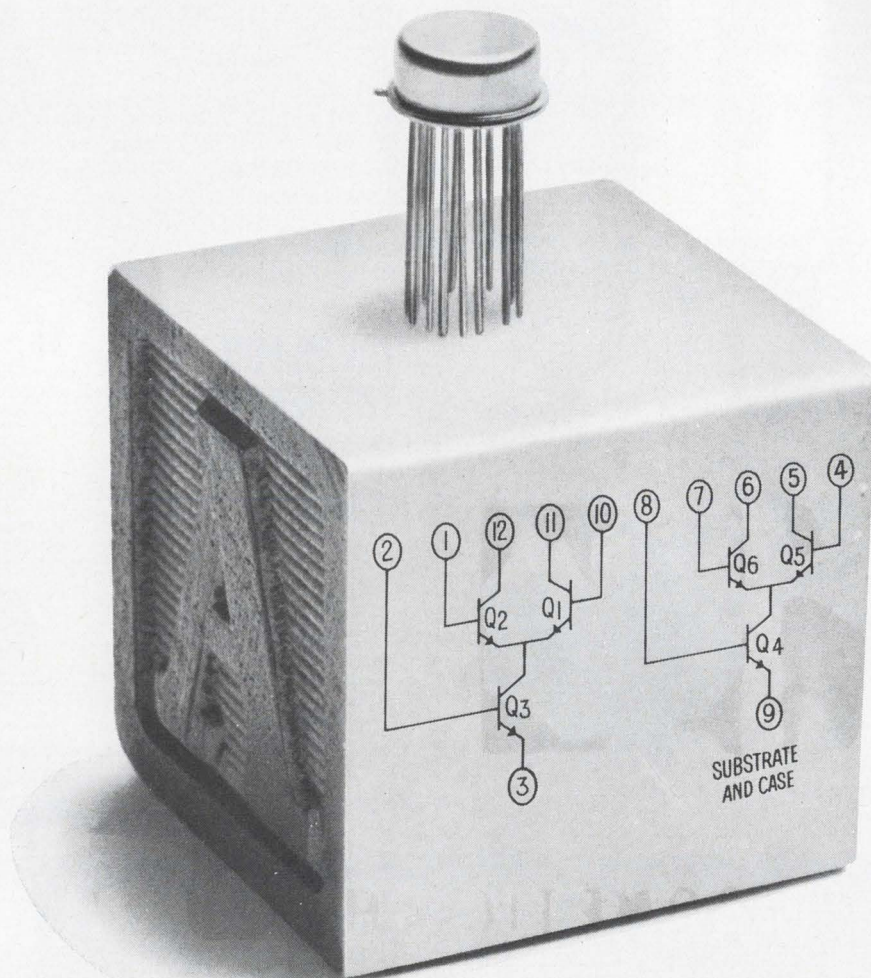
Here—from RCA—is another Integrated Circuit “building block” —two differential amplifiers on a single substrate with uncommitted bases and collectors. Use them as differential and/or cascode amplifiers, IF amplifiers, limiters, video amplifiers, doubly-balanced modulators and demodulators. CA3026 brings the advantages of monolithic IC devices to a more comprehensive range of solid-state circuit applications.

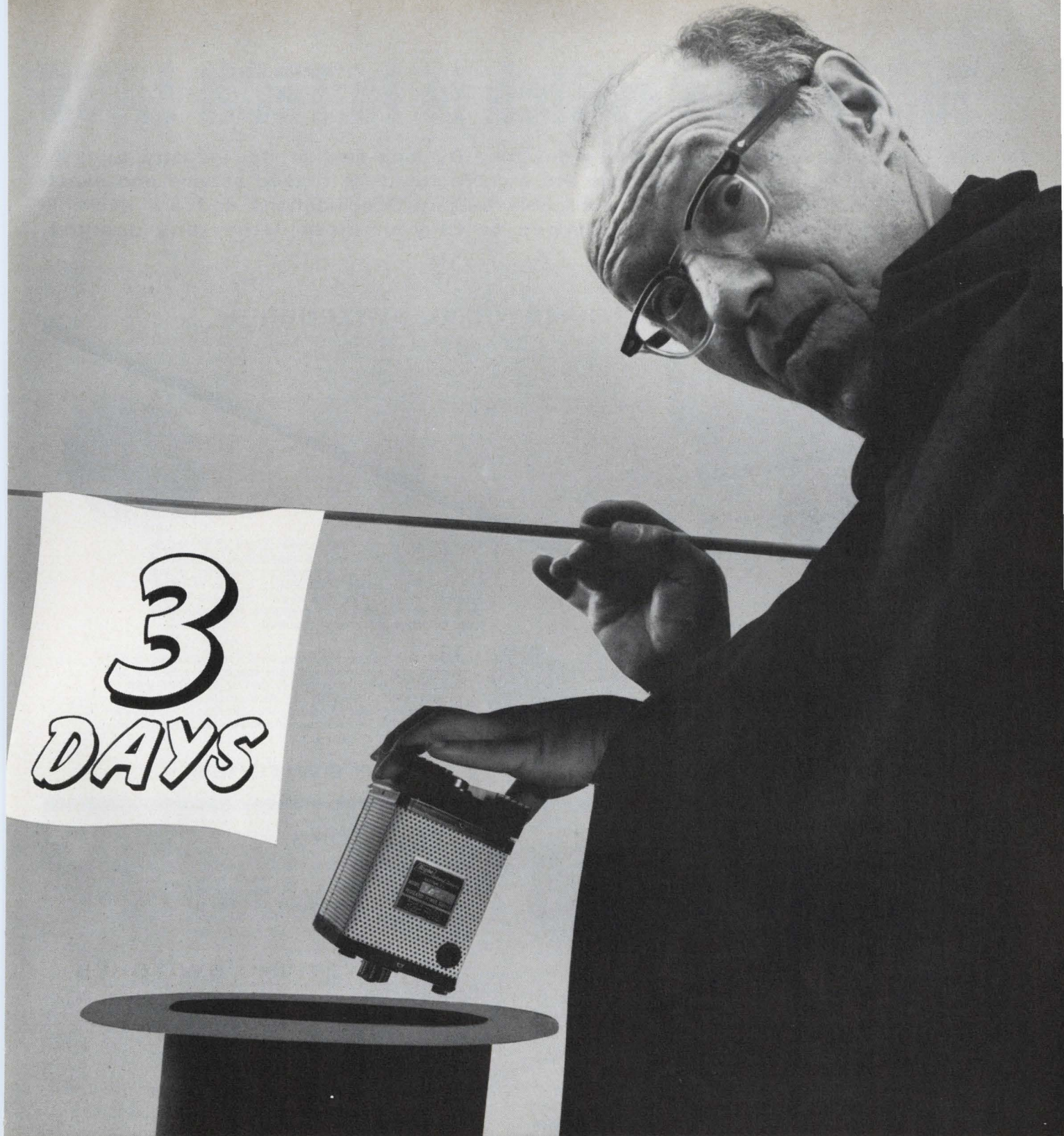
Ask your RCA Representative for details or see your RCA Distributor for his price and delivery. For technical details, write RCA Electronic Components, Commercial Engineering, Section No. IC-N-11-1, Harrison, N.J. 07029.

**Matched differential amplifiers with:
Independent inputs and outputs
Max. input offset voltage ± 5 mV
Max. collector to emitter voltage (V_{CEO}) 15 V
Max. collector current (I_C) 50 mA
Dynamic forward current transfer ratio
(h_{fe}) (typ) 110
Operating temperature range -55°C to $+125^\circ\text{C}$**

RCA Integrated
Circuits

New Linear IC “Building Block”





Magic... Acopian style!

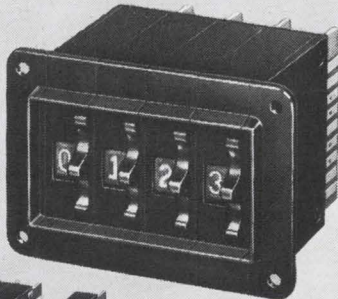
We ship any of our 62,000 different AC to DC plug-in power supplies in just 3 days!

Next time you need power supplies in a hurry, contact Acopian. We offer 62,000 different AC to DC plug-in power supplies, any of which will be shipped to you in **just three days!** Choose the exact DC output you need. Singles or duals. Regulated or unregulated. Whether you need one power supply or several, your order will be shipped in just three days! That's our promise. For your copy of our latest catalog, contact your local Acopian rep, call us at (215) 258-5441, or write to Acopian Corp., Easton, Pa. 18042.

Acopian

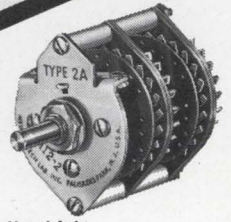
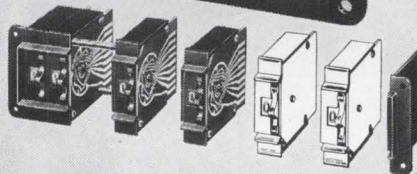
Today...the switch is to TECH LABS

For high quality, precision switches designed for long service life, industry turns to Tech Labs. All Tech Lab switches are manufactured for rugged service and exacting performance. They meet all applicable Military Specifications and are available in a wide range of sizes and types to fit your most demanding designs.

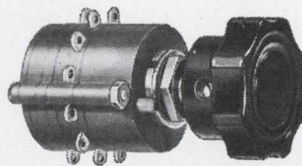


THUMBWHEEL SWITCHES

A compact, molded, printed-circuit wafer switch for limited space and in line readout. Modular type for either front or back of panel mounting: Modules $\frac{1}{2}$ " between center lines, height 2". Single or double pole, 10 position, binary or complementary codes, standard. Other codes available on request. Available with adjustable stops.

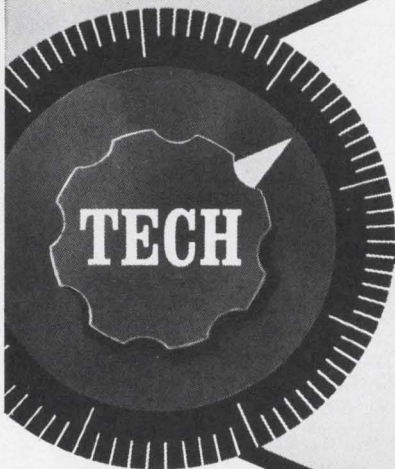


Type 2A: An instrument control switch of the highest quality possible with a reasonable price. This switch is a must for all applications where the rating and requirements are high. Rating 5 amp carrying. Size $1\frac{3}{4}$ " by $2\frac{1}{4}$ ". Available in all combinations with up to 26 decks and 2 to 26 positions. Has adjustable stop. Solenoid operated if required.



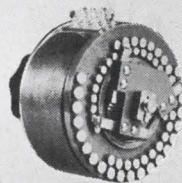
Type 3A: A molded miniature switch used in military and commercial applications where space is a premium and a superior switch is required. Can be furnished with up to 8 decks, 12 positions per deck single pole, or 6 positions double pole, adjustable stop. Rating is 5 amps carrying and it can be solenoid operated and hermetically sealed. Only $1\frac{1}{4}$ " diameter.

TAP SWITCHES



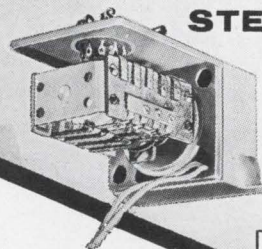
ATTENUATORS

We also manufacture a complete line of attenuators, both audio and RF. These include potentiometers, ladders, T-pads, H-pads, etc., in many varieties of sizes. Our attenuators are approved by the most particular users in this country.



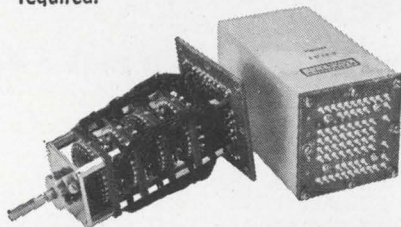
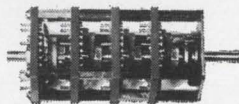
STEPPING SWITCHES

All our switches can be fitted with a stepping mechanism and can be furnished HERMETICALLY SEALED, EXPLOSION PROOF, if desired. We have built stepping switches with 500 positions per deck.



HEAVY DUTY CONTROL SWITCHES

We manufacture a line of heavy duty control switches in various sizes, which are extremely flexible in the combinations available. These switches are particularly useful where a large number of poles are required.



SPECIAL SWITCHES

When standard switches will not meet the requirement, we design and manufacture special switches to order. Send us your specs.

Telephone: 201-944-2221 • TWX: 201-947-4730

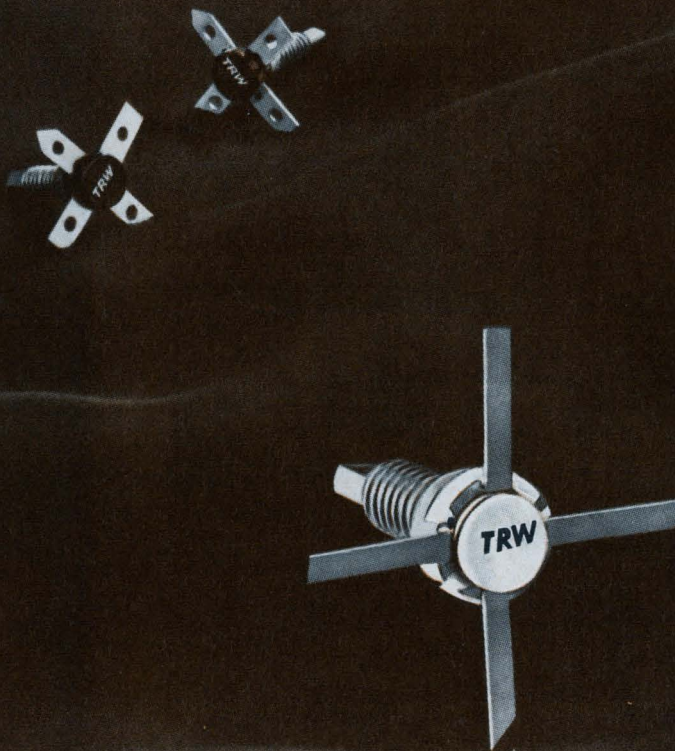


FREE!

Send today for our 24 page Switch Catalog

TECH LABORATORIES, INC., Palisades Park, N. J.

TRW 5-WATT - 2 GIGAHERTZ MICROWAVE TRANSISTOR



28 volts...33% efficiency...stripline design

A 5 watt 2 GHz microwave transistor in a hermetically sealed ultraceramic stripline package!

The new TRW 2N5483 provides 4 db gain at 2 GHz with 33% efficiency in simple, straightforward circuits. Two new companion transistors for input and driver stages deliver 1 watt at 6dB and 2.5 watts

at 5 dB. All operate from a 28V source.

Delivery is immediate... in production quantities. Order from the factory or any TRW distributor.

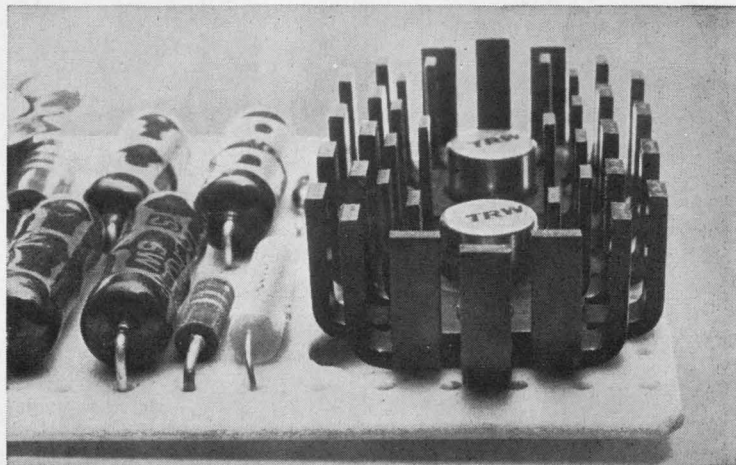
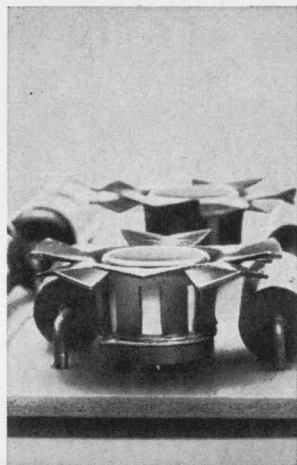
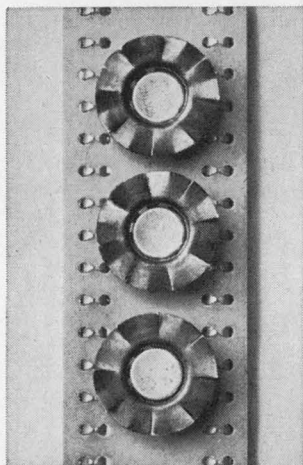
For complete information and applications assistance contact TRW Semiconductors, 14520 Aviation Blvd., Lawndale, California

90260. Phone: (213) 679-4561. TWX: 910-325-6206. TRW Semiconductors Inc. is a subsidiary of TRW INC.

TRW[®]

Tips on cooling off hot transistors

See how circuit designers use IERC heat dissipators to protect semiconductors...improve circuit performance and life.



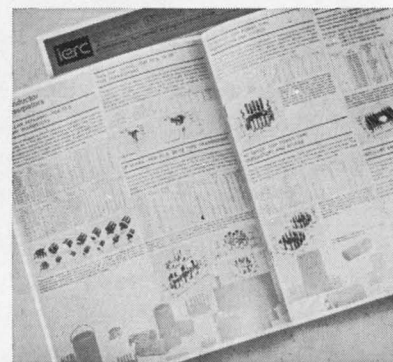
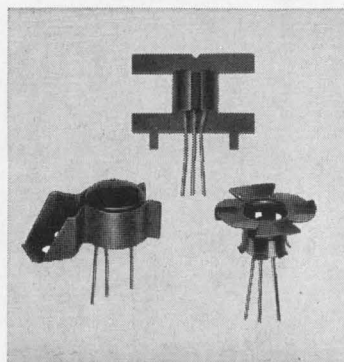
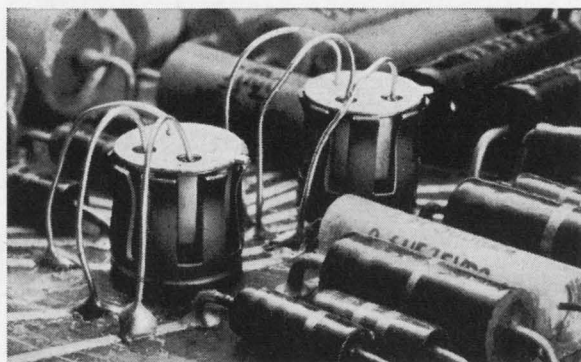
Fan-top dissipators for TO-5 and TO-18 cases drop temperatures dramatically; cost just pennies. T-shape adds almost nothing to board height; allows components to snuggle close to transistors. Spring fingers provide fast, press-on installation.

To cool off low-to-medium power transistors in TO-5 and TO-18 cases, use IERC's efficient LP's. Patented, staggered-finger design maximizes radiation and convection efficiency, radiates heat directly to ambient. Available in single or dual mounting for thermal mating of matched transistors.

IERC Therma-Link Retainers provide efficient thermal links between transistors and chassis or heat sinks. (Also, excellent dissipation when used on p-c boards.) Integral BeO washers reduce capacitance up to 2/3. Fast, no-snap installation; transistors are firmly held.

New! Dissipators and retainers for plastic and epoxy transistors. 3 new series for RO-97A, RO-97 and X-20's. Permit a jump of 10% to 33% in operating power.

Free 8-page short form catalog discusses IERC's complete line of dissipators, retainers and tube shields. Gives specifications, prices, how to order. Send for your copy today.

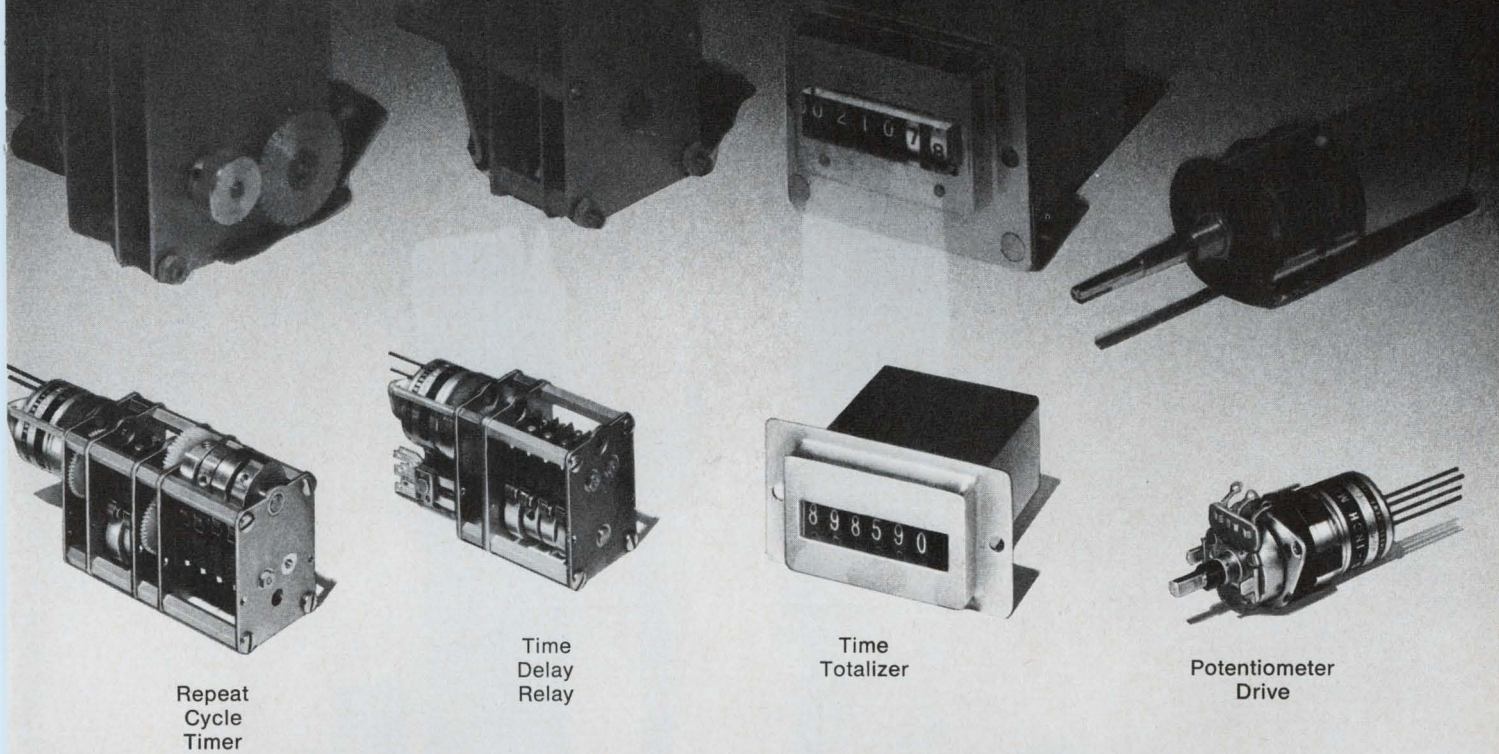


Special insulating coating — Insulube 448, a special non-hygroscopic finish developed by IERC, combines excellent dielectric properties, 50 K megs insulation resistance, and high heat emissivity. Also protects against salt spray, fungus, etc.

Tough heat dissipating problem? IERC engineers welcome your letter-head inquiry for specific information or assistance in selecting heat dissipators.

ierc
SEMICONDUCTOR
HEAT DISSIPATORS

THERE'S A NEW STATE OF THE ART IN MINIATURIZED TIMERS



Repeat
Cycle
Timer

Time
Delay
Relay

Time
Totalizer

Potentiometer
Drive

HSI 3rd Generation Timers

MADE POSSIBLE BY HSI'S MINIATURIZED COMPONENTS:

These new type timers are smaller, lighter in weight and more versatile than other units heretofore available — **without sacrifice in performance or increased cost.**

After years of development, timers like these finally became possible by using HSI's BIG INCH™ motors. No other timing motor has ever been built that is so small yet so precise . . . so powerful . . . so efficient and so low in cost.

HSI's 3rd Generation Timers, which open up a wide new range of applications, will initially be custom-engineered for specific OEM applications. Designers may obtain basic data by writing or calling Mr. G. O. Hoffmann at HSI, Inc. 1500 Meriden Rd., Waterbury, Conn., Tel. (203) 756-7441.

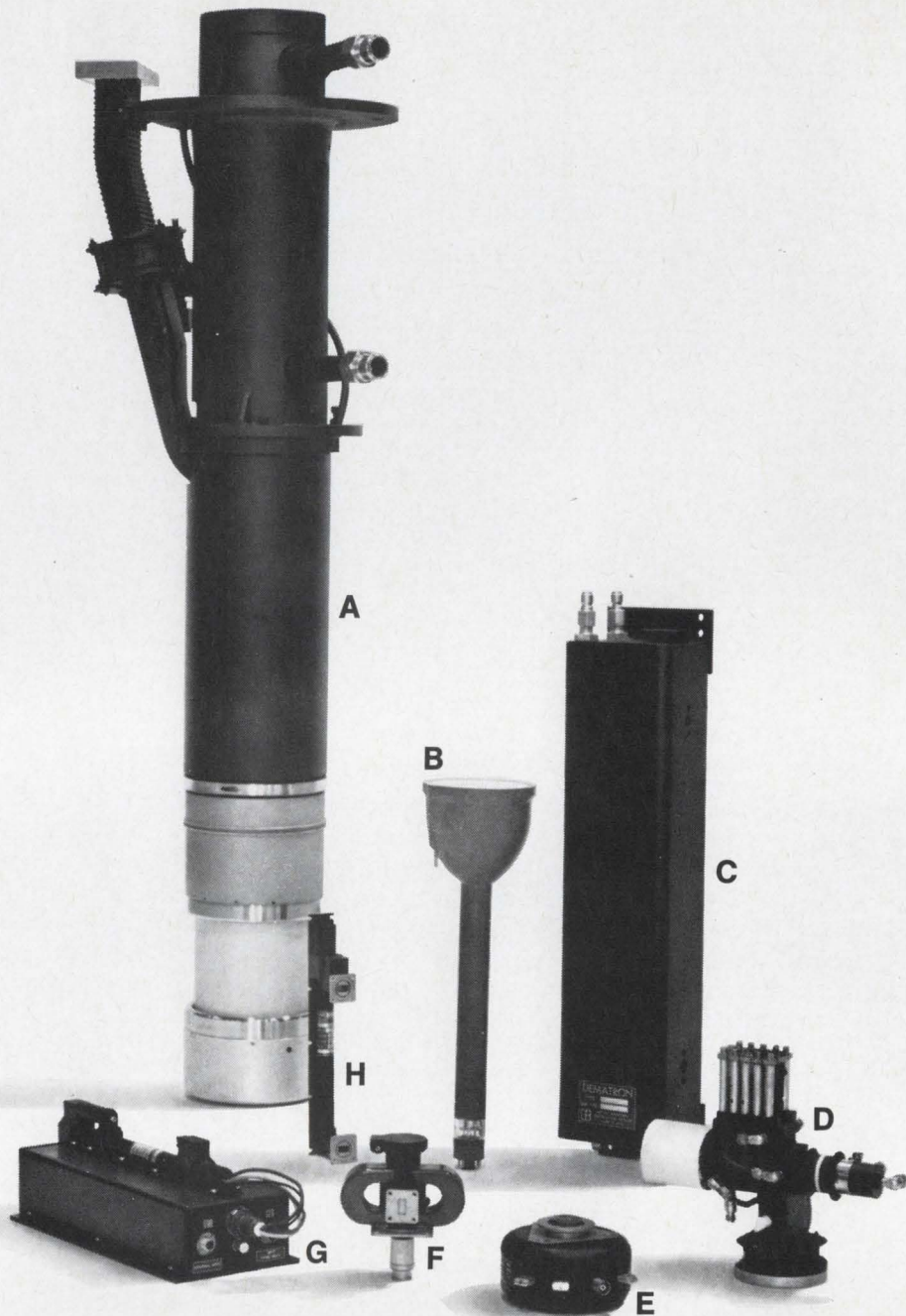
- ... **BIG INCH™ Motors**
- ... **Compact, Interchangeable Gear Trains**
- ... **Advanced Switches and Counters**



HAYDON SWITCH & INSTRUMENT, INC.

The Innovators in 3rd Generation Timers

Circle 211 on reader service card



Litton Electron Tubes

MAGNETRONS for radar, navigation and guidance, fire control, countermeasures, beacons, missile fuzes, transponders, and microwave heating and cooking. From one watt CW to 300 kilowatts pulse; 350 to 34,900 MHz. Frequency agility and dither modes. Vane and strap and coaxial types.

M-TYPE BACKWARD WAVE OSCILLATORS for electronic countermeasures power sources, high power sweep oscillators, and FM or AM transmitters. From 500 to 11,000 MHz; 100 to 500 watts. CW and Pulse modes. Standard and miniature families.

CROSSED FIELD FORWARD WAVE AMPLIFIERS including the self-modulated DEMATRON crossed field amplifier. For electronic countermeasures, CW and Pulse multi-mode radar, phased array radar, and multi-channel wide-band communications.

AMPLIFIER KLYSTRONS for long-range search radar, missile and satellite tracking, particle accelerators, phased array radar and

radar astronomy. From 400 to 11,000 MHz. 20 KW to greater than 30 Mw, pulsed; 5 W to 50kW, CW.

TRAVELING WAVE TUBES as drivers for high power microwave transmitters, missile guidance and control, electronic countermeasures, space communications, telemetry and phased array radar. From L-band through Ku-band; 10 mW CW to 5 kW pulse. Small signal gains from 33 to 70 db. Low noise TWT's.

CATHODE RAY TUBES for airborne radar display, flying spot scanning, infra-red recording and photographic encoding. High resolution and high brightness tubes. Electrostatic printing tubes, fiber optic CRT's and CRT operational accessories.

INTEGRATED SUB-SYSTEMS AND TUBE-RELATED EQUIPMENT to complement our tube line in many of the above applications. Microwave power sources, transitions, sockets, solid state TWT power supplies and flying spot scanners.

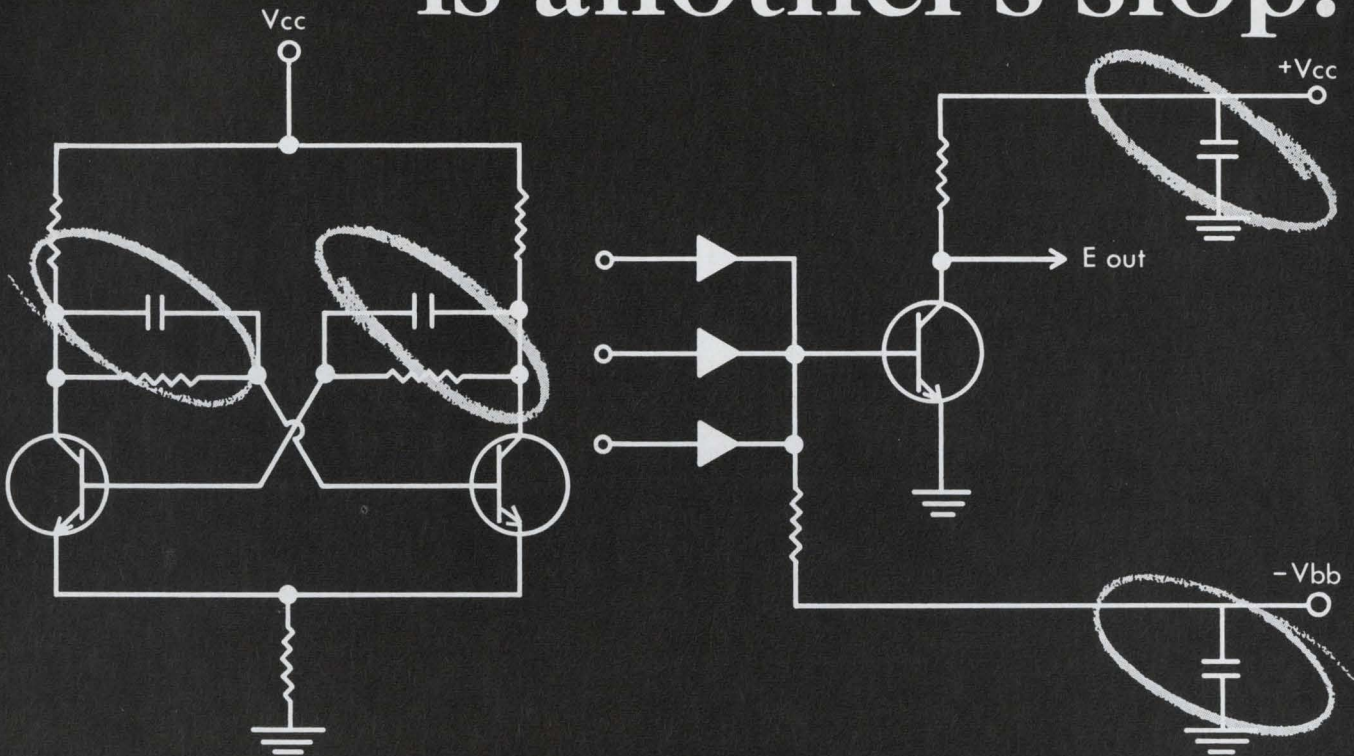
ADVANCED DEVICES. Electrostatically focused klystrons, BIMATRON® injected beam crossed field amplifiers, low noise research, acoustic delay lines, pulse compression filters, low light level camera tubes, etc.

INFORMATION. For information on the entire Electron Tube product line, send for the comprehensive 48-page brochure and catalog. Contact Electron Tube Division, 960 Industrial Road, San Carlos, California 94070.

Products illustrated: (A) L-3989 Particle Accelerator Klystron; (B) L-4238 Ultra-High Resolution CRT; (C) L-5111 DEMATRON Crossed Field Amplifier; (D) L-5182 Electrostatically Focused Klystron; (E) Miniature M-BWO; (F) L-5049 Coaxial Pulse Magnetron; (G) Model 484 Power Supply; (H) L-5117 TWT.

LITTON INDUSTRIES
ELECTRON TUBE DIVISION

One man's stability is another's slop.



CORNING® Glass-K Capacitors provide both.

Needs vary with circuit function.

A filter can stand some slop. You buy for size and plain reliability.

But in timing or tuning, a capacitance change may not only foul up your signal, but the result may be more damaging than a total stop.

CORNING Glass-K answers both needs.

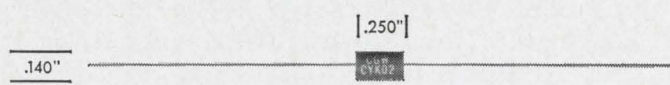
From 270 to 100,000 pf, just .250" long.

Stability? Choose from three characteristics, with ΔC with life as low as 2% max., at 125° C.

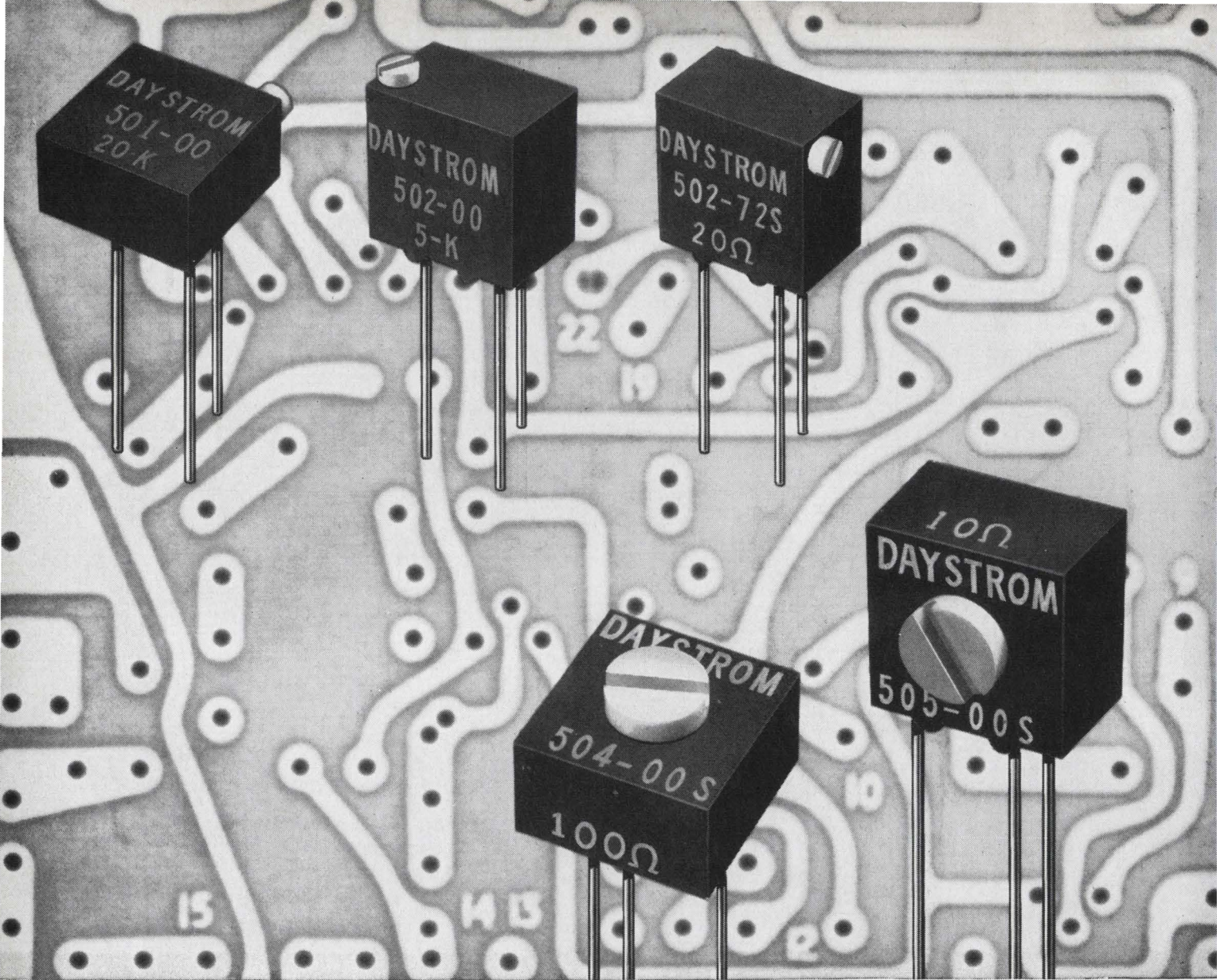
Reliability? Check Apollo, Centaur, Poseidon.

Get size, stability, sureness. Get the figures on Glass-K Capacitors.

Write: Corning Glass Works, Electronic Products Division, Corning, N.Y. 14830



CORNING
ELECTRONICS



Savings across the board just took a new turn

DAYSTROM Commercial Squaretrim® potentiometers now include single-turn types. New models 504 and 505 are fully adjustable with just one turn. Models 501 and 502 are 15-turn types. They all clear up to 80% more PC board space—at no extra cost. But the trim .02 cubic inch size is only one reason why these commercial 500 Series pots are proving so popular. They also feature Weston's exclusive wire-in-the-groove design, and all these performance extras:

Convenience 5 different configurations with adjusting screw on top, side or end • **Tolerance** $\pm 5\%$ • **Adjustability** 15 turns or single turn • **Slip Clutch** eliminates wiper damage, cuts production delays • **Suregard™ Terminations** for better protection against vibration, shock and humidity—no pressure taps • **Superior Resolution** 0.125% or less • **Wide Range** 10Ω to $20K$ (higher values on request) • **High Power** 0.6 watt in still air at $70^\circ C$ • **Wide Temperature Range** $-55^\circ C$ to $150^\circ C$ • **Low Temperature Coefficient** 70 ppm max. • **Low Noise** 100Ω max. ENR • **Small Size** $\frac{5}{16}'' \times \frac{5}{16}'' \times \frac{3}{16}''$ • **Low Cost** \$2.10 each for 501/502 in 500 lot quantity, \$1.95 each for 504/505 in 500 lot quantity.

Daystrom potentiometers are another product of:

Weston Components Division, Weston-Archbald, Archbald, Pennsylvania 18403, a Schlumberger company

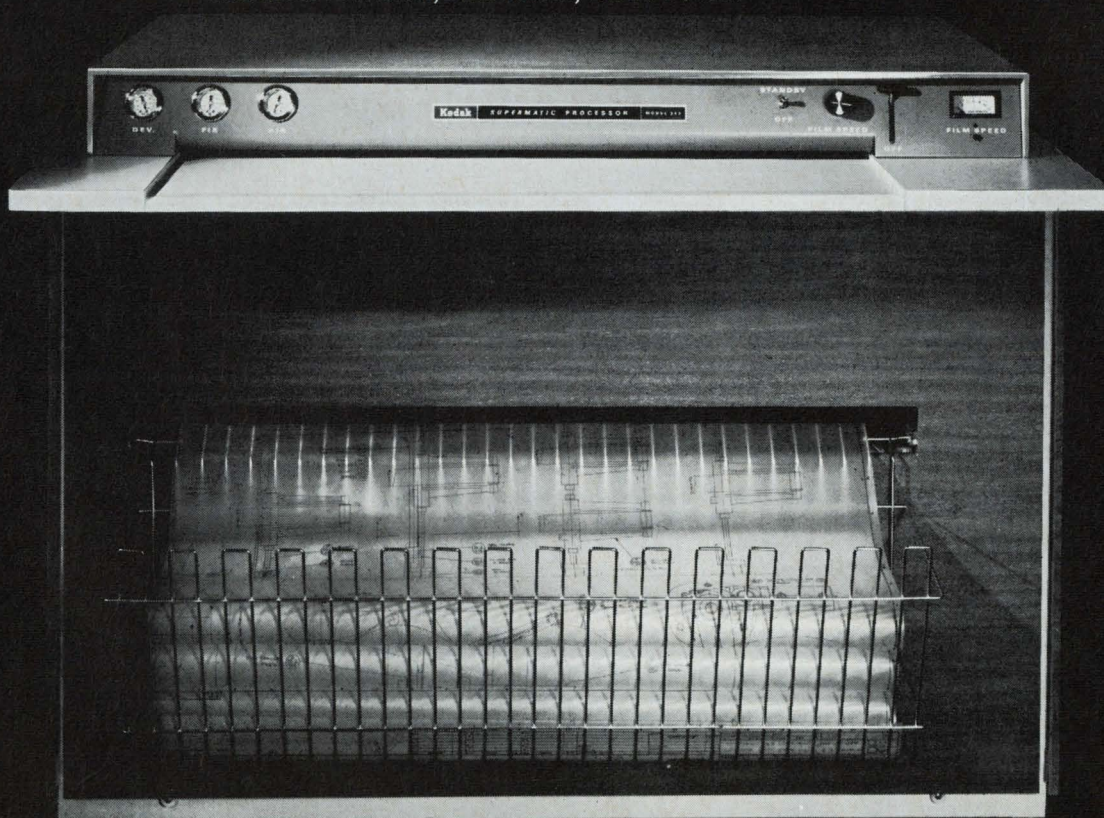
WESTON® prime source for precision . . . since 1888

Kodak beats the clock.

The KODAK SUPERMATIC Processor, Model 242, processes exposed KODAGRAPH ESTAR Base Films up to 60 times faster than manually. And it does it more uniformly, more economically. In a minute you can have a 34" x 44" reproduction. The SUPERMATIC Processor does the developing, fixing, washing, and drying that formerly took skilled technicians an hour.

The SUPERMATIC Processor speeds KODAGRAPH Film processing, frees technicians for more important work, gets prints to draftsmen faster, saves countless hours and dollars. It's versatile, too: processes most ESTAR Base Film in standard A-E drawing sizes—and all the way up to 42" wide and 15 feet long. Ask your Kodak Technical Sales Representative about *super* processing: the KODAK SUPERMATIC Processor system of compatible KODAGRAPH Films, chemicals, and equipment.

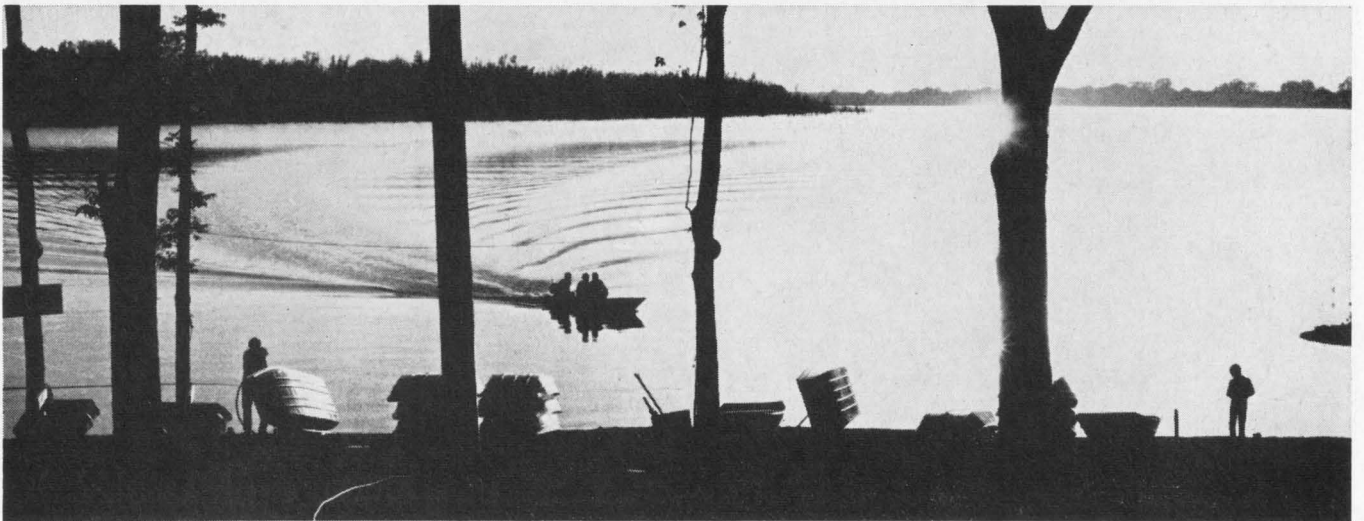
Write: Eastman Kodak Company, Business Systems Markets Division, Rochester, N.Y. 14650.



KODAK SUPERMATIC Processor

Kodak

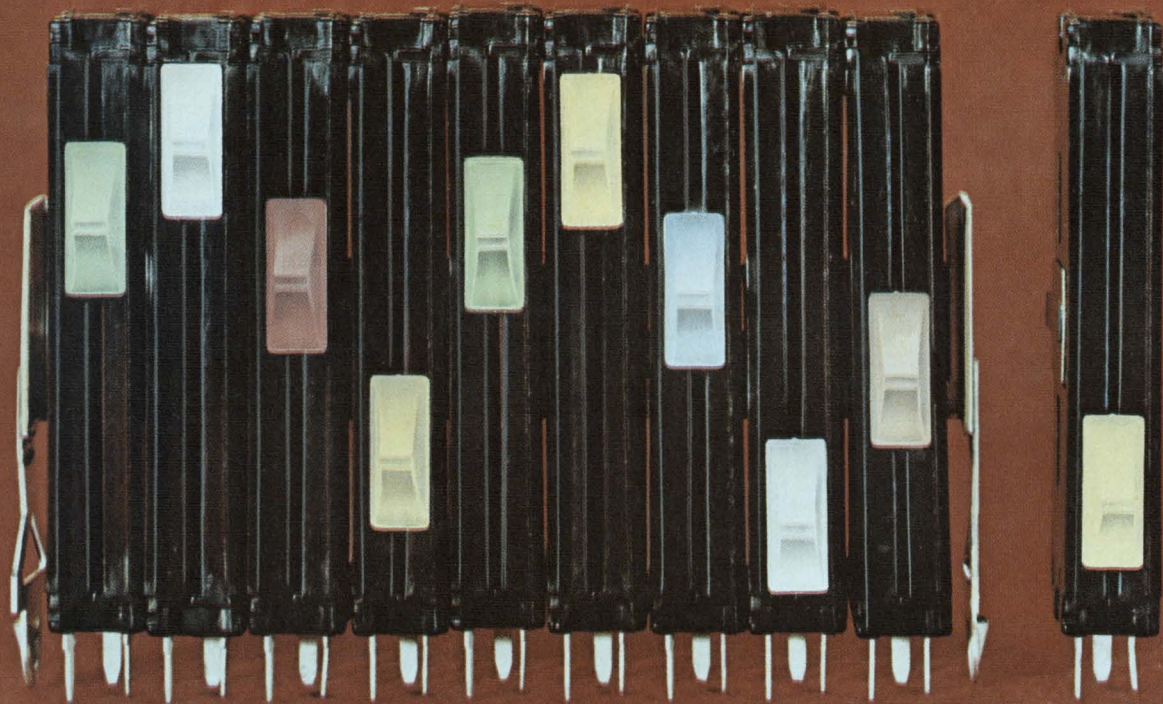
Isn't it great to get paid for working in a year-round vacationland?



Arkansas Industrial Development Commission State Capitol Little Rock 72201 AC 501 376-1961

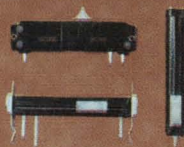


The Straight Line

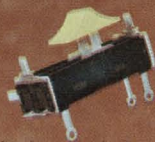


Covered under Patent No. 3,362,004 and others pending.

Functional new concept in Potentiometer design



Horizontal, vertical or side mounting available.



Multiple units lock and actuate with single knob.



Preliminary adjustment with template possible.



Needs only 1/3 mounting area of standard control.



Standard solder lug, wire-wrap or printed circuit terminals supplied.



Forward or rear facing twist-tab mountings. Snap-in mounts also available.

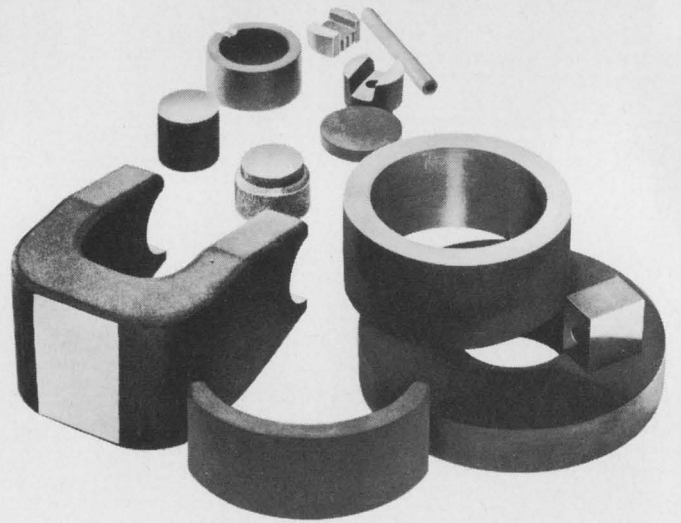
Variable resistors have been going in circles for years. Now Stackpole straightens them out. Using linear motion, Stackpole engineers created a potentiometer that conserves circuit board and panel space and offers a host of design advantages. Stackpole calls it SLIDE-TROL®. You'll call it ingenious! Utter simplicity, yet with all the quality and features of devices costing much more. SLIDE-TROL® is available in values of 40 ohms to 15 meg. ohms and since the element is rectangular and provides more area to dissipate heat, higher wattage ratings are possible. Phenolic housings eliminate shock hazards. Low noise and low contact resistance are assured by a patented 9-point movable spring contact. Only imagination limits the applications for SLIDE-TROL®. If you're looking for performance, economy and appeal in variable resistors, get the facts on SLIDE-TROL®. Write for samples and brochure: Stackpole Components Co., P.O. Box 14466 Raleigh, N. Carolina 27610. PH: 919-828-6201 TWX: 510-928-0520



STACKPOLE
COMPONENTS COMPANY

Also a leading producer of quality slide, rocker and rotary switches.

Permanent magnets up to 13,500 Gauss and 4,400 Oersteds...



...from a production capability of a million magnets a week

Mullard can supply permanent magnets with remanent flux densities up to 13,500 Gauss or intrinsic field strengths up to 4,400 Oersteds, and they can be produced quickly to your specification. Mullard manufactures two main magnetic materials—

Ceramic 'Magnadur' offers exceptionally high coercive force and electrical resistivity (ideal for d.c. motors and generators).

Metal 'Ticonal' is a high efficiency metallic permanent magnet material offering a wide range of performance characteristics.

From these basic materials Mullard produces a range of variants to meet every magnet requirement in applications from meters to motors. Leading automobile manufacturers in the USA, for example, are using Mullard Magnadur segments in d.c. motors. Production capacity at the Mullard magnet factory is around a million magnets a week.

Every designer should obtain the Mullard technical information on permanent magnets. Also ask to be put on

the mailing list of the Mullard Bulletin—a regular publication which gives details of new components and applications . . . the result of extensive research and development programmes in the Mullard laboratories in England. Mullard employs 1,000 qualified scientists and engineers and has six major plants, with over 3 million square feet of floor space.

Write today for information on Mullard permanent magnets and for the name of your local Representative

Mullard Limited, Mullard House, Torrington Place, London WC1, England.

USA enquiries to Mullard Inc., 100 Finn Court, Farmingdale, Long Island, New York 11735, USA. Telephone: (516) 694 8989 Telex: 961455.

Mullard

MOL 52



New, more versatile scribing . . . identical operation

Changes have been made in the new Model "C." Tempress Automatic Scribing Machine, but only where they matter . . . to increase operating flexibility and to incorporate improved components where they will contribute to the efficiency, dependability, or longevity of the machine. Follow the same set-up procedures; press "actuate," and you are scribing any rectangular or triangular pattern from .001" to .399", with incremental resolution to .001". How versatile? Choose a model to scribe either 1½" or 2" wafers, decimal or metric indexing, extended range, 50 or 60 cycle operation, without affecting

price. The only option for which you pay extra is a binocular optical system. Third generation of the machine that brought low-cost, automatic scribing to the semiconductor industry, the new Model "C" meets the Tempress Standard of Excellence, your assurance of precision when you purchase any member of the growing family of Tempress miniature assembly tools and production machines.

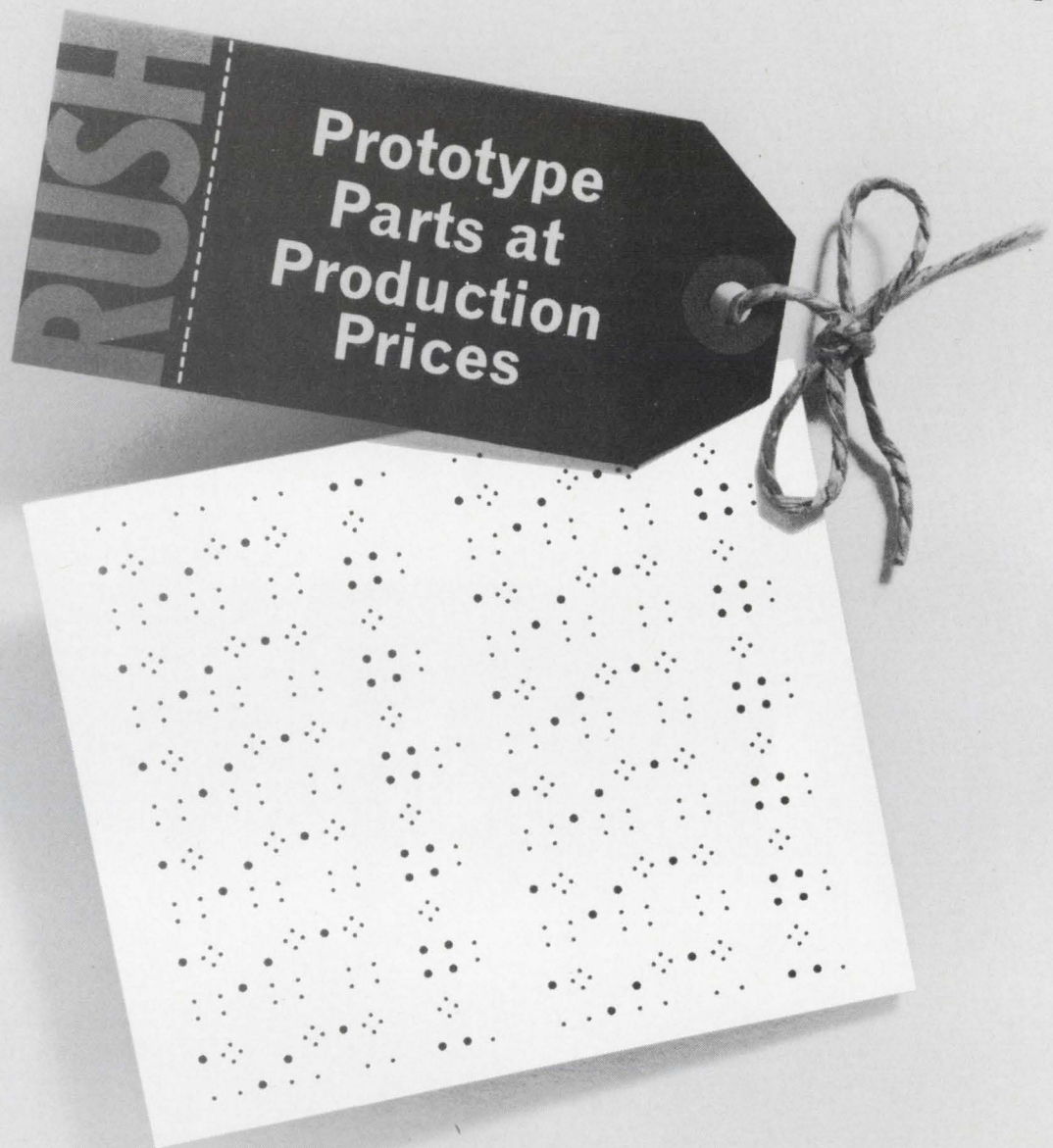


TEMPRESS

Tempress Research Co., 566 San Xavier Ave., Sunnyvale, Calif. 94086

Circle 219 on reader service card

Ceramic substrates in less time, for less money.



Hole-patterned ceramic substrates in quantities up to 250 are now available from Coors at *prices much lower* than ever before.

Parts shipments are faster too — *two weeks maximum* after receipt of order.

Substrates $\frac{1}{4}$ to 17 square inches in size, 10 to 35 mils thick, can be obtained with any practical number of holes in practically any pattern.

Tolerances on hole locations and substrate length and width dimensions can be held to $\pm\frac{1}{2}\%$ (not less than $\pm 0.003''$) if required. Substrate thickness and hole diameters can be kept within $\pm 10\%$.

Materials are Coors famous-quality 96% and 99.5% alumina ceramics.

Turn breadboards into prototypes, prototypes into finished circuits quicker, cheaper.

Mail or phone your substrate specifications to Coors Custom Products Division — today, Coors Porcelain Company, 600 Ninth Street, Golden, Colorado 80401, (303) 279-6565.

Coors / CERAMICS

No other manufacturer offers as large a selection: hundreds of standard types of control knobs, more than 2,000 "specials". Almost every type, style and color combination is promptly available to you from local distributors and large factory stocks.

Turn to color with the new PANELRAMA knobs shown below...mix or match caps and body colors in almost any combination...to harmonize or contrast with every panel decor.

Or, you can choose elegantly-

styled Designer Series knobs with spun-aluminum caps on body colors of black; light, medium, or dark grays; and off-white. When you need a solid color, select from the nine decorative colors in our 400 series.

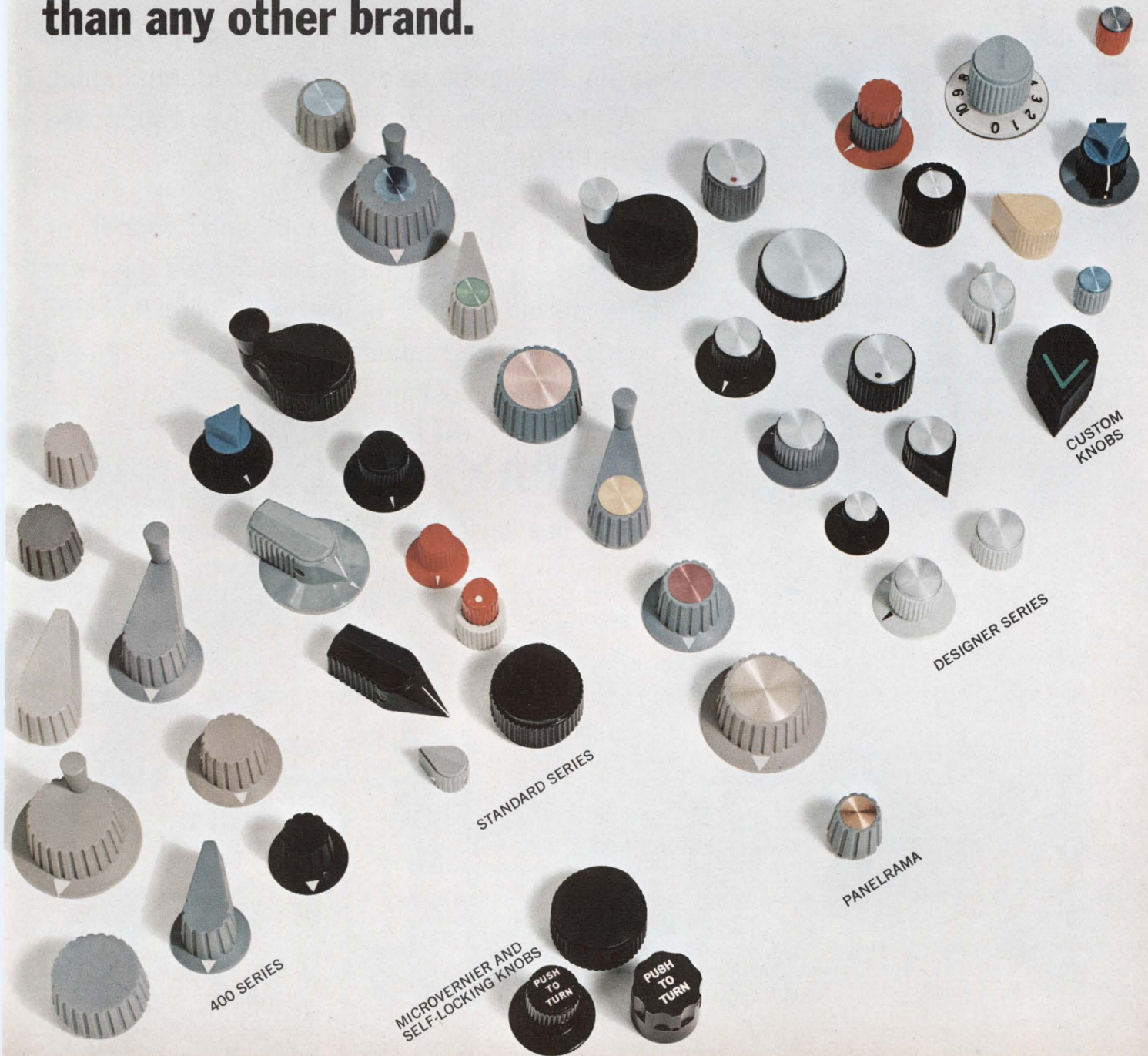
For military applications, specify Standard Series control knobs —thousands of quality knobs that meet MS91528. Or, specify the new self-locking push-to-turn knobs and Microverniers...for accurate, precision control settings. And when you need custom-

made knobs, call Raytheon first ...to get the advantages of Raytheon quality and fast delivery.

For a catalog, call your distributor or nearest Raytheon regional sales office. Or send the reader service card. *Raytheon Company, Industrial Components Operation, Quincy, Massachusetts 02169.*



Here's why Raytheon knobs control more settings than any other brand.



400 SERIES

MICROVERNIER AND SELF-LOCKING KNOBS
PUSH TO TURN

STANDARD SERIES

PANELRAMA

DESIGNER SERIES

CUSTOM KNOBS

GLASS-TO-METAL SEALS

by
AIRPAX

Exacting customer specifications are met by the quality, glass insulated terminals manufactured by Airpax.

A wide variety of terminal designs are producible and glass can be color coded for identification. (We like blue, one reason is that blue is supposed to be difficult.)

Leads can be kovar, or sleeved solid copper, or tubular. A large choice of standardized pins and lugs permits quick delivery to your specific needs. A 90 page catalog giving technical details is yours for the asking.

AIRPAX ELECTRONICS

CAMBRIDGE DIVISION, CAMBRIDGE, MARYLAND 21613

Phone 301-228-4600



New Products

Data handling

TTL enters a numbers game

Digitizer made of these fast IC's is smaller and cheaper than other systems and has much more noise immunity

By Owen Doyle

Assistant editor

Like most fast operators, TTL keeps getting into new things. Its latest venture is a numbers game, but a respectable one.

The game is actually a digitizer that also displays the data and passes it on to a computer or recorder. Called a reversible scaler, the Micrometric Corp. device is built almost entirely with transistor-transistor-logic integrated circuits.

According to Victor Elischer, a consultant who helped design the new scaler, using TTL enabled

Micrometric to build a device that costs less than its older system, has a much higher counting speed—5 megahertz instead of 30 kilohertz—is one-third the size, and has three times the noise immunity.

And, Elischer says, things will be getting even better. "With the multifunction medium-scale-integration logic that's becoming available, we'll be able to reduce the number of components in the circuits by another 30%."

The unit, selling for \$4,500, can take position data from up to three

encoders (x, y, and z axes). The reversible counters can go up to 10^6 , and the three sets of Nixie-tube displays have six digits each. The older scaler handles only two axes, counts up to 10^5 , and costs \$6,000.

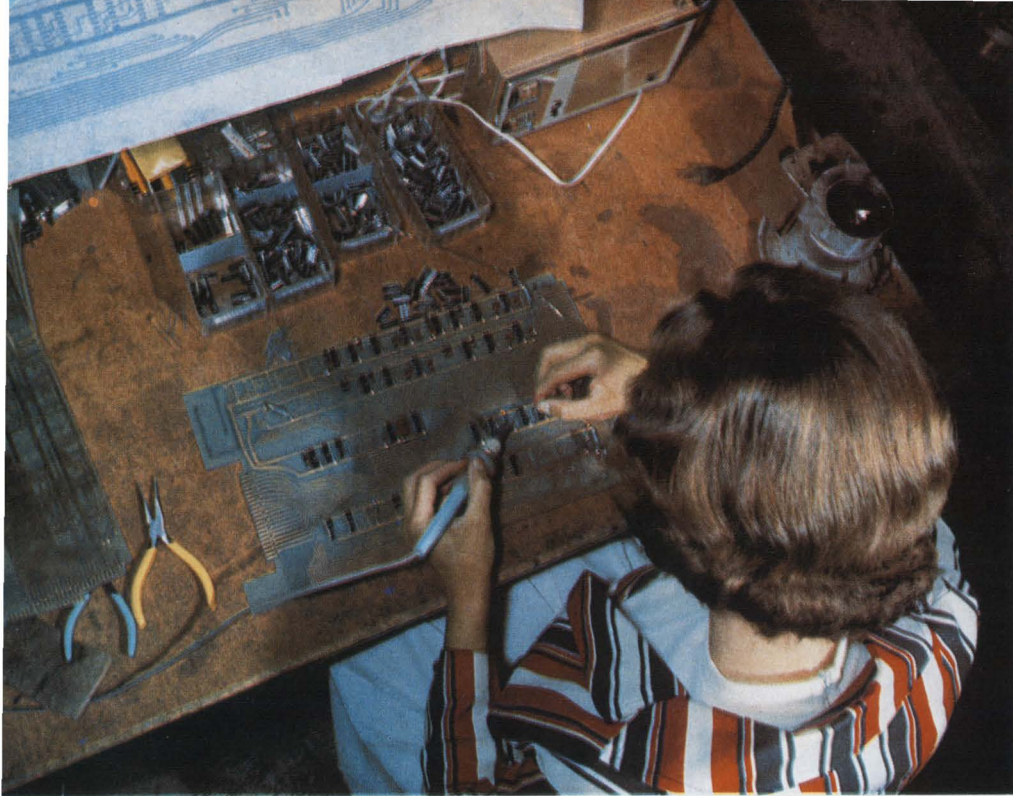
The main parts of the new system are three types of printed-circuit boards, for input, scaling, and display.

Each of the three inputs comes in on two lines containing a quadrature pair of square waves. These waves pass through single-shot



Down the line. A two-axis version of the scaler can be used for laying out the artwork during the design of an integrated circuit. In this application, the system has an accuracy of 2 mils.

Digitized data from the scaler can be fed to the IBM 526 card punch (in picture) or other recorder.



On the board. The system's seven p-c boards—one of which is shown (above) being made—contain a total of 264 IC's.

multivibrators on the input board that fire on both the rising and falling edge of the waves, converting them to pulses. The quadrature waves gate the pulses to produce negative addition or subtraction pulses. These pulses toggle ADD-SUB flip-flops and feed through a gate to supply count pulses to the scaler board.

The rise time of the square waves can't be more than 2 microseconds. The normal pulse amplitude is 6 volts, but the input board can take almost any amplitude as long as the current drawn never exceeds 50 milliamps.

The input board also feeds reset and display pulses to the scaler boards and anode-gating signals to the display board. The scaler boards send cathode-drive signals to the display boards and other signals to the output board which interfaces with a recorder.

Tooling along. The Micrometric scaler can also be used as part of a larger system to control tools. However, the 5-Mhz speed is most important when the system is used as a digitizer, because it allows the instrument to work on the fly.

A user tracing out a curve needn't stop at discrete points to allow the scaler to catch up with the tracing pen, or worry about the scaler catching up when the

pen changes direction.

The digitizer could be used, for example, with an interferometer or to handle topographical or bubble-chamber data.

And Micrometric predicts that designers of IC's will be interested

in the system since it can measure artwork with an accuracy of 2 mils.

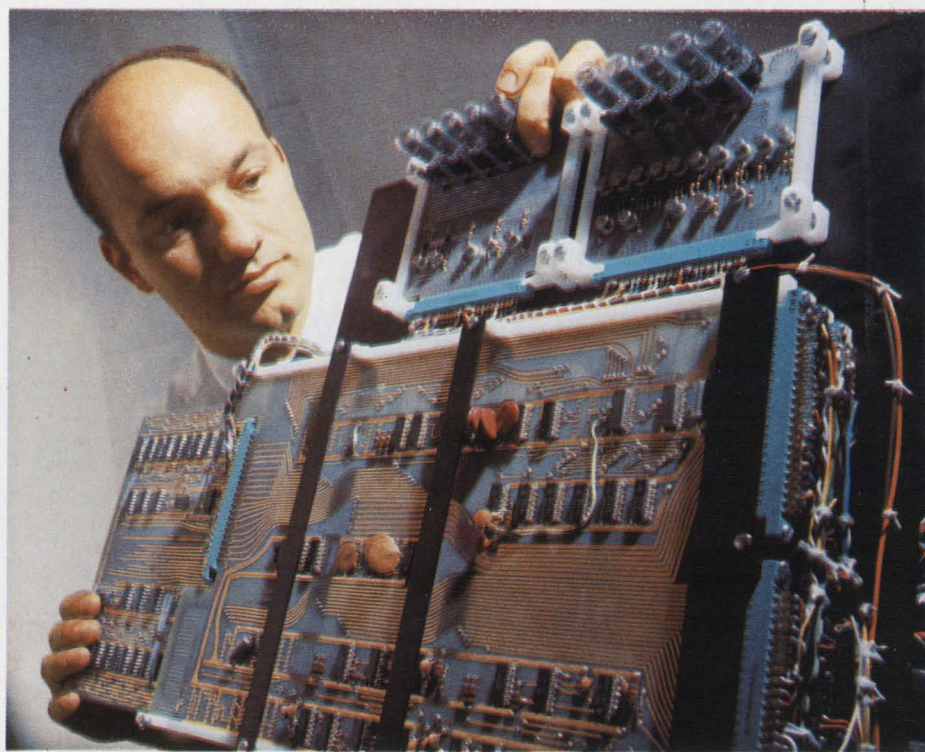
Independent trio

The input board, called the S1001, has three independent sets of logic, for the control of direction, scaler reset, and up to 18 Nixie tubes. This display control is handled by a ring counter and decode logic. The 9-by-16-inch board has 39 Texas Instruments TTL IC's and a few discrete components.

The scaler board, called the S1000, is a one-to-six-decade unit complete with buffer registers. The 9-by-16-inch board has 72 TTL IC's. Separate decimal, binary-coded decimal, octal, and binary outputs are available as options.

Time sharing. Six time-sharing Nixie tubes, six anode drivers, and 10 cathode drivers are mounted on each of the display boards, called S1004's. Micrometric says it's the first to use this type of Nixie tube in a commercial system.

The cathodes of all the tubes are wired in parallel according to digit; all "0" cathodes are tied together, all "1" cathodes are tied together, and so on. The time-sharing control energizes the anode of the first display tube for about a millisecond and simultaneously



With the system. Victor Elischer, who helped design the scaler, examines the display portion, which uses time-shared Nixie tubes.

... different output p-c boards for different recorders ...

strokes the cathodes. All other anodes are held at 0 volts. After the millisecond, the control logic energizes the anode of the second tube and strokes its cathodes. This sequence continues through all tubes and then repeats continuously. To the eye, the tubes seem to be always on.

The time-sharing plan, devised by the Burroughs Corp., reduces the number of circuits and connections in a display.

Each S1004 needs between 200 and 300 volts and draws a maximum of 60 milliamps.

Mating games

Signals from the scaler boards pass through circuit boards specifically designed to interface the system with a particular output device. For example, one board, which Micrometric calls the S1002, links the system with the IBM 526 card punch. Other available boards mate the scaler system with magnetic-tape decks, computers, and paper-tape punches.

Elischer, elaborating on the scaler's advantages, says, "This is the first time anyone has put six-decade 5-Mhz buffered and reversible scalers in such a compact system." The new unit is also lighter—25 pounds against 80 for the old one.

It hurts here. Since the new system has fewer parts and interconnections, it's more reliable. But if something does go wrong, the system itself will often tell the operator where to look for the source of trouble.

If the circuits associated with a decade display go bad, two digits are displayed simultaneously in that decade. Most malfunctions of this type can be pinpointed with a d-c voltmeter; otherwise, the operator just replaces the offending card.

Scaler malfunctions cause the transfer of superimposed data to the recording device, and the resulting gibberish sticks out like a sore digit. Buffer breakdowns turn on front-panel lights.

Micrometric Corp., Box 956, Berkeley, Calif. 94701 [338]

Sensitive and beautifully stable



...our new breed of solid state picoammeters

These pacesetters measure and amplify signals as low as 3×10^{-13} ampere f.s. With stabilities better than 0.5% per week. They're great things to have going for you when measuring semiconductor leakages, photomultiplier outputs, photocell currents and extent or changes in radioactivity. Or when used as amplifiers in monitoring and control systems. Now you can simplify your low level signal search by selecting the picoammeter performance you need . . .

For Sensitivity, Choose Our Model 410A. Twenty ranges span 10^{-3} ampere f.s. to 3×10^{-13} ampere. With stability better than $\frac{1}{2}\%$ /week. It features 1000 volt overload protection, almost instantaneous recovery. Operates with 3 simple controls. And it's yours for \$495.

For Versatility, Use the Model 414S. Sensitive from 10^{-2} ampere

f.s. to 10^{-10} ampere the 414S adds current suppression to the features offered by the 410A. Current suppression up to 100 times full scale lets you observe changes as small as 1% in steady state signals. Buy this performer for only \$425.

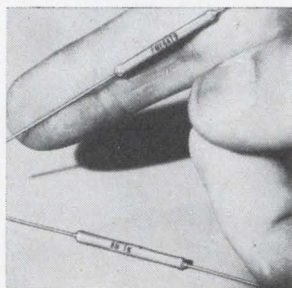
For Economy, Save With Our Model 414A. It's an identical twin to the 414S in all respects but one. Without a current suppression feature, its price is a low \$325.

Extra capability for these picoammeters is offered by our Model 4104 Electronic Trip. Only \$185 installed. And a 300 volt Model 4109 Bias Supply for \$95. Call your Keithley Field Sales Engineer for details. Or contact Keithley Instruments, Inc., 28775 Aurora Road, Cleveland, Ohio 44139. In Europe: 14, Ave. Villardin, 1009 Pully, Suisse. Prices slightly higher outside the U. S. A. and Canada.

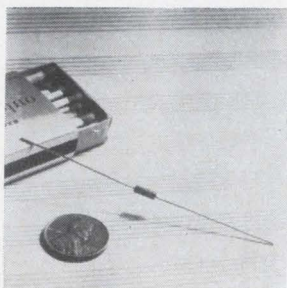


KEITHLEY

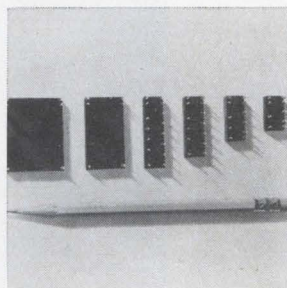
New Components Review



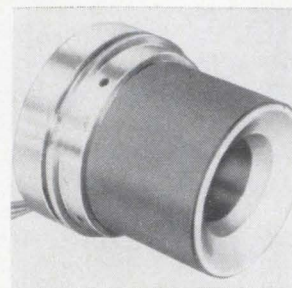
Low-drift metal film resistor is for high-accuracy test probes. The ¼ watt model PME-64 is rated at 2,500 v with a resistance range of 500 ohms minimum to 20 megohms maximum. It measures 0.97 x 0.1 in. Standard temperature coefficients include ± 25 , ± 50 , and ± 100 ppm/°C. This low TC helps eliminate drift. Pyrofilm Resistor Co., Cedar Knolls, N.J. [341]



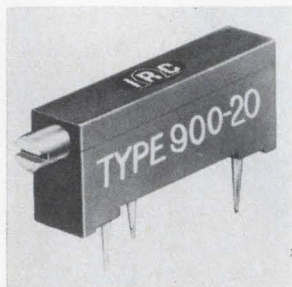
Miniature, high ohm thick film resistor GE10 is a high-stability, molded device for applications such as resistor networks, FET circuits, operational amplifiers and other circuits where a high impedance is characteristic. Maximum voltage rating is 200 v and resistance range is 499 kilohms to 20 megohms. Mepeco Inc., Columbia Rd., Morristown, N.J. [342]



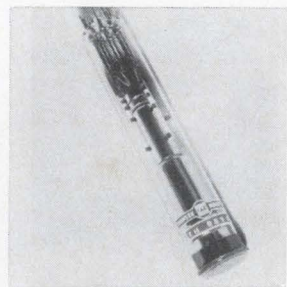
Lumped-constant delay lines series 100 are compatible with dual in-line IC's. Sizes are from 0.385 x 0.700 in. for the 10 nsec line to 1.400 x 1.600 for the 100 nsec line. The units, at 100-ohm impedance, are designed for 125 Mhz cut-off, have typical rise times of 4 to 8 nsec, and taps are each 2.5 nsec. Engineered Components Co., Gardena, Calif. [343]



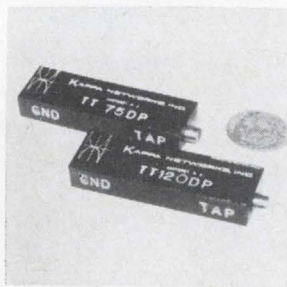
Deflection yokes type YB are designed to fill the need for a high Q yoke with high sensitivity while maintaining reasonable residual magnetism and resolution. The yokes have a d-c to over 4 Mhz bandwidth and a 100 nsec stroke capability. They may be used in direct drive, random positioning alphanumeric applications. Availability is 3 weeks. Celco, Mahwah, N.J. [344]



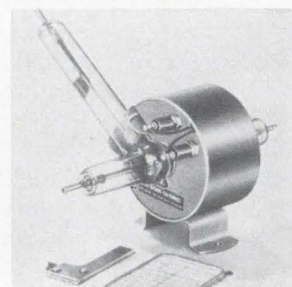
Rectangular trimmer type 900-20 is free from catastrophic termination failures. This is guaranteed by silver-brazed terminations. Unit is available in a resistance range from 10 ohms to 20 kilohms at a tolerance of $\pm 10\%$. It has a power rating of 1 w at 40°C, derated to 0 at 125°C. Trimmer measures ¾ x 0.16 in. IRC, Div. of TRW Inc., 401 N. Broad St., Philadelphia. [345]



Infrared sensitive Vidicon TH9890 differs from similar tube types sensitive in the visible range, only by its photoconductive layer, the threshold spectral sensitivity extending far above 2 microns. Its length is 6.25 in. and its diameter 1 in. Heater consumption is 150 ma under 6.3 v. The high voltage is about 300 v. Thomson Electric Co., 50 Rockefeller Plaza, N.Y. [346]



Screw-driver-adjust TT-75 and TT-120 Tiny Trim delay lines are variable to 75 nsec and 120 nsec and are designed to permit a wide adjustment range in a compact space with a delay resolution of ¼ nsec. Units measure 1.75 x 0.545 x 0.275 in. Price is \$15 or less in quantity; delivery, from stock. Kappa Networks Inc., 165 Roosevelt Ave., Carteret, N.J. 07008. [347]



High-voltage vacuum relay HVS-10/S8, for medical electronic uses, has broad applications in other areas where high reliability, high-voltage switching is required. It can switch up to 500 w-sec of pulse energy. The relay will switch up to 17 kv peak. It operates on a 40-v d-c coil. Price (1-9) is \$65. High Vacuum Electronics Inc., 538 Mission St., S. Pasadena, Calif. [348]

New components

Photomultiplier dynode gives gain of 30

Cesium-doped gallium phosphide is used in first stage of a tube that can distinguish a single-electron event

The leap from invention to production has rarely been as dramatic as in the case of a new photomultiplier tube built by RCA's Industrial Tube division.

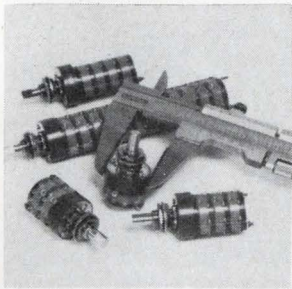
The discovery that properly doped gallium phosphide makes a superior secondary emitter was

made in July; three months later, tubes with first-stage dynodes made of GaP were being produced in evaluation quantities. That dynode has a gain of 30, representing the most significant advance in this type of tube since 1934. The other 11 stages in the tube have beryl-

lium-copper dynodes.

Designated the C31000D, the new tube will be a replacement for the widely used Type 8575, which has a gain of only 5 at its first stage. Gain in this context is the secondary-emission ratio—the number of electrons emitted by the dynode for each electron coming from the photocathode. With an applied field of 600 volts, the new tube's first dynode will emit 30 secondary electrons for each primary electron.

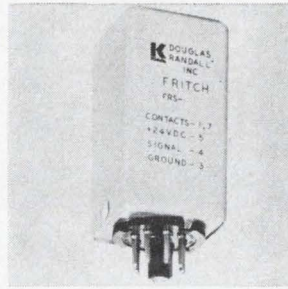
The radically improved tube is designed to detect and measure low light levels, to handle such jobs as photon and low-energy scin-



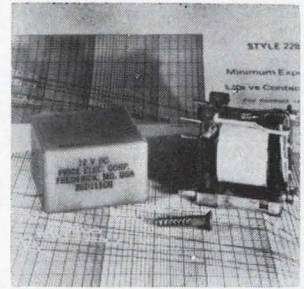
Rotary switches come in 5 series with 30, 36, 45, 60 and 90° angle of throw in 1-in.-diameter totally enclosed construction. Features include 1 to 4 poles/deck, 2 to 12 position/pole, and up to 12 decks per switch. Units are rated to switch 1 to 3 amps 115 v a-c and carry 10 amps. Life expectancy is 25,000 cycles. The ASM Corp., P.O. Box 860, Smithfield, N.C. [349]



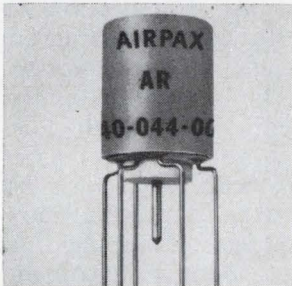
Delay trimmer model DV1446 is designed for p-c board mounting and offers a low profile of 0.31 x 0.62 x 3.5 in. Impedance is 2,000 ohms and ripple is held to 5% or less. Delay is adjustable from 5 to 100 nsec and output rise time is 20 nsec max. Resolution is 100 psec per turn of the adjusting lead screw. Computer Devices Corp., 63 Austin Blvd., Commack, N.Y. [350]



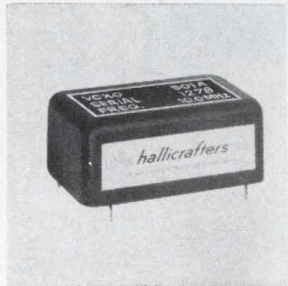
Frequency responsive switch called Fritch is preset to operate at any specified frequency between 40 hz and 50 khz. It must operate within $\pm 2\%$ of the selected frequency and will not operate beyond $\pm 5\%$ of it. Response time is 15 msec. Operating temperature is -40° to $+65^\circ\text{C}$. Units are $1\frac{1}{2} \times 1\frac{1}{2} \times 2\frac{3}{4}$ in. Douglas Randall Inc., 6 Pawcatuck Ave., Westerly, R.I. [351]



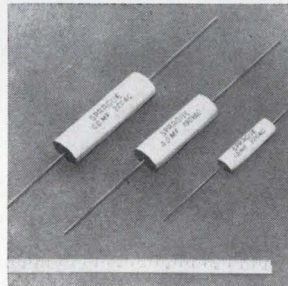
Relay style 228 comes in a wide range of contact and coil options for use in a variety of industrial and commercial control functions. Contact rating is 3 amp resistive at 28 v d-c. Contact resistance is 0.10 ohm max., and contact bounce is 5 msec max. Operate time is 10 msec; release time, 5 msec. Price (1,000 lots) is 90 cents. Price Electric Corp., Frederick, Md. [352]



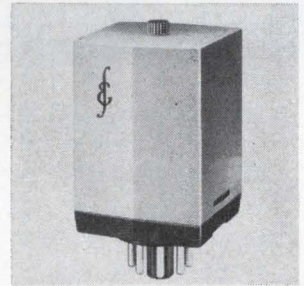
Subminiature relay type AR is a spdt electromagnetic unit for use in applications such as amplifier control, low impedance coaxial switching, integration and h-f/l-f switching. Nominal coil voltage is 6 v d-c. Despite its small size (0.4 x 0.48 in. case length), it accurately switches 0.150 amp resistive at 28 v d-c, 60 or 400 hz. Airpax Electronics Inc., Cambridge, Md. [353]



Voltage controlled crystal oscillator VCO-501A provides $\pm 0.2\%$ deviation at any fixed frequency from 5 to 25 Mhz with better than 2% linearity. Input circuit needs are simplified because the unit's high impedance, direct coupled input accepts a wide band of modulating frequencies. Standard input voltage is 26 v d-c. Hallicrafters Co., 600 Hicks Rd., Rolling Meadows, Ill. [354]



Metalized polyester-film capacitor 439P is for current-limiting or phase correction service in general purpose 60 hz a-c applications. Capacitance ratings are available from 0.047 μf to 15 μf . Typical applications for the capacitors include fan motors, tape recorder drive units, and recharging supplies for nickel cadmium cells. Sprague Electric Co., North Adams, Mass. [355]



Transistorized time delay relays series TDR are of the adjustable type, designed to overcome many of the inherent deficiencies of mechanical, pneumatic, and thermal timers. They delay on pull-in and are available in time ranges from 1 to 60 sec. Repeat accuracy is $\pm 5\%$; reset time, 100 msec. Price is \$8.68. Syracuse Electronics Corp., P.O. Box 566, Syracuse, N.Y. [356]

tillation counting. The high secondary-emission ratio gives a pulse-height resolving capability that permits discrimination of single-and double-electron events.

Big help. RCA says this resolving capability could significantly advance research work in high-energy physics, astronomy, and biochemistry. The tube may help biochemists map the structure of the DNA molecule and astronomers detect light from radio stars, or be used by nuclear physicists to probe more deeply into atomic events. The device, first publicly demonstrated at last month's Nuclear Symposium in Montreal, may also

increase the capability of laser range-finders and improve the performance of receivers in laser communications systems.

Key to the six-fold improvement in first-dynode gain is cesium-doped GaP deposited by vapor phase growth. Work at RCA's David Sarnoff Research Center showed that extremely high gain factors could be obtained with highly doped, p-type single crystals of GaP activated with a surface film of cesium in such a way that "negative electron affinity" is produced. As a result of band bending near the surface, the vacuum level lies below the bottom

of the conduction band in the bulk of the material. Under these conditions, secondary electrons thermalized in the conduction band have enough energy for emission into the vacuum.

Other dynode materials—beryllium-copper, magnesium-silver, and cesium antimonide, for example—apparently present a substantial barrier to secondary electron emission and limit the gain per stage to from 4 to 6.

Less uncertainty. The high ratio of the first dynode in the new tube decreases the noise induced in a signal current by 18%. A photocathode itself produces a certain

If your electronics problems are...

PEOPLE, PRODUCTION, and PROFITS

UTAH has the answers

Utah offers you GUARANTEED BRAINPOWER... an inventory of more than 4000 hard-to-find specialists, experienced people of all kinds, eager to work for you in Utah.

An adequate and stable labor force of women and trainable people with the vocational training facilities to prepare them to meet YOUR needs.

One major electronics firm now in Utah reports:

Increased productivity 2.5 to 3 times.

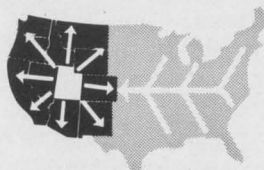
Decreased labor turnover $\frac{2}{3}$ to $\frac{3}{4}$.

... and that spells PROFITS...

That is why such firms as Univac, Litton, Sperry, General Instrument, Signetics, and others are sold on the fact that "This Is the Place" for profitable electronics operations.

In addition to an unlimited source of low cost raw materials, Utah offers you:

- Many trained people in the electronics field.
- An outstanding and stable labor supply at reasonable wages.
- Training aid and research help.
- Low-cost plant sites.
- Favorable freight rates.
- Freeport-Export Exemption laws.
- An ideal distribution location in the middle of a market of 30 million.
- Recreation, culture, scenery... a wonderful place to live and work.



Win the WEST.. from
UTAH!

For information write:
UTAH INDUSTRIAL PROMOTION BOARD
167 Social Hall Avenue,
Salt Lake City, Utah 84111 Dept. 119

Name.....

Company.....

Type of Business.....

Address.....

City.....

State..... Zip.....



Sharp-eyed. Photomultiplier can detect a light-producing nuclear event that generates only a single electron.

amount of noise, or statistical uncertainty about the occurrence of an electron event. Conventional tubes add to this uncertainty because their low secondary-emission ratios make it impossible to distinguish signals representing the emission of one or two photoelectrons from the photocathode. But the resolving capability of the new tube is such that a pulse-height analyzer can easily distinguish the electron-event peaks from the noise peaks, which occur even when no light impinges on the photocathode. The old tubes peak at a secondary-emission ratio of 7, and the curve rolls off with an increase of applied voltage. RCA engineers say the performance of the new tube is linear with increasing voltage.

There are 10 to 12 dynodes in a standard photomultiplier. But RCA is beginning work on multistage tubes with all dynodes made of gallium phosphide, and the resulting high gains may make it possible to reduce the number of stages. This would mean a shorter path for the electrons to traverse in the amplification process, which in turn would result in a shorter rise time. Rise time in the C31000D is 2 nanoseconds, but this might be reduced to around 0.5 nsec in a tube with all stages made of GaP.

Evaluation quantities of the C31000D are available, with the tubes priced at \$600 each, about $2\frac{1}{2}$ times the cost of conventional devices. RCA predicts that this type tube will account for a big share of the \$10-million-per-year photomultiplier market.

RCA Industrial Tube Division, Lancaster, Pa. [357]

Corning introduces the 2½ cent bit.

In the newest CORNING® Low Cost Digital Memory Modules for serial storage.

Each bit costs 2½ cents, for 4096 bits @ 16 MHz, in the 1000-module bracket.

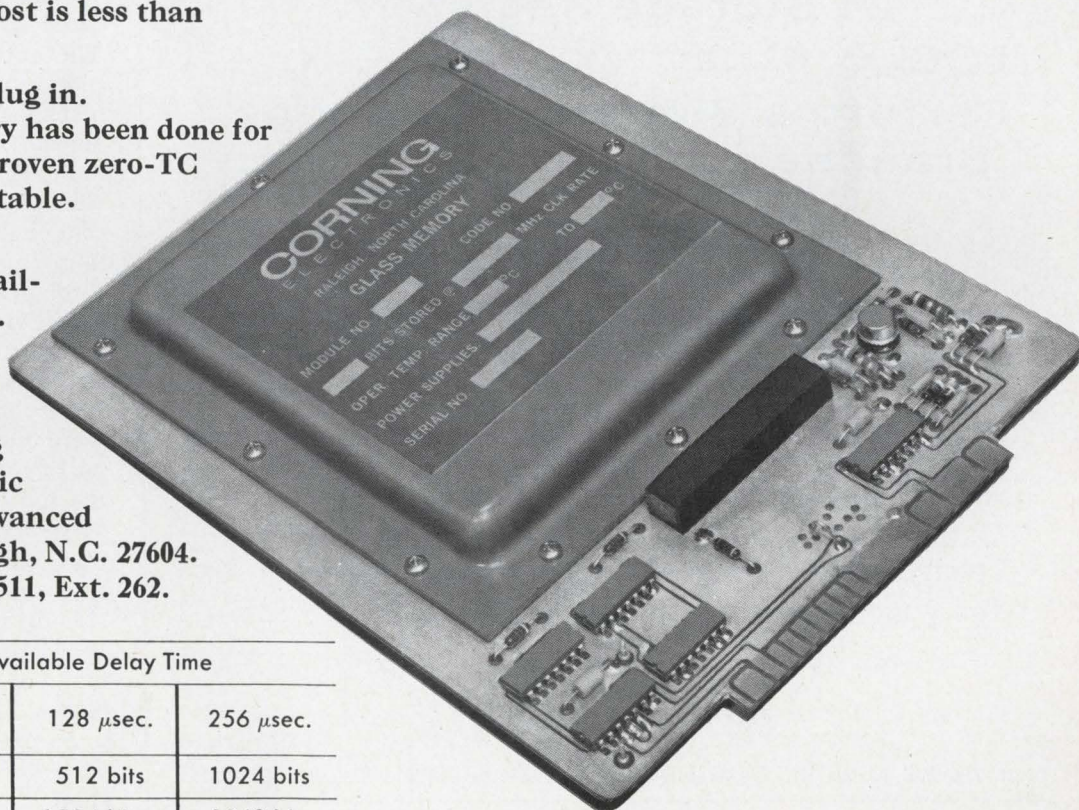
More modules—less cost. And even for 100 units, your total cost is less than a nickel per bit.

CORNING modules plug in. TTL interface circuitry has been done for you. The medium is proven zero-TC glass from Corning. Stable. Rugged.

These modules are available now, off the shelf.

Specials on request.

For specs and to see a sample, write Corning Glass Works, Electronic Products Division, Advanced Products Dept., Raleigh, N.C. 27604. Telephone (919) 828-0511, Ext. 262.



Available Frequencies	Available Delay Time		
	64 μ sec.	128 μ sec.	256 μ sec.
4 MHz	256 bits	512 bits	1024 bits
8 MHz	512 bits	1024 bits	2048 bits
16 MHz	1024 bits	2048 bits	4096 bits

CORNING
ELECTRONICS

Computer Performance; Calculator Price.



WANG 380

640 Program Steps

24 Storage Registers

$\text{LOG}_e X$, e^x , X^2 , \sqrt{X} , $\frac{1}{x}$, $+$, $-$, X , \div
Performs Subroutines, Loops,
Branches, Makes Decisions.

\$3795.

No special programming language needed. The Wang 380 learns programs directly from keyboard operations and stores them on plug-in magnetic tape cartridges.

You can tailor system capability to your exact needs with compatible accessories including:

Output Writer, CRT Display, additional Data Storage, Teletype, Trig Pack, and On-line Interface.

There is nothing comparable, anywhere.



Dept. 7H, 836 North St., Tewksbury, Massachusetts 01876 • Tel. 617 851-7311

Call today for immediate trial:

(201) 241-0250	(216) 333-6611	(313) 278-4744	(416) 364-0327	(604) 685-2835	(703) 931-7878
(203) 223-7588	(301) 588-3711	(314) 727-0256	(504) 729-6858	(612) 881-5324	(713) 668-0275
(205) 595-0694	(301) 821-8212	(317) 631-0909	(505) 255-9042	(613) 224-4554	(716) 234-5651
(206) 622-2466	(303) 364-7361	(403) 266-1804	(512) 454-4324	(614) 488-9753	(717) 381-5440
(212) 682-5921	(304) 344-9431	(404) 457-6441	(513) 531-2729	(615) 588-5731	(805) 962-6112
(213) 278-3232	(305) 564-3785	(405) 842-7882	(514) 482-0737	(617) 851-7311	(901) 272-7488
(214) 361-4351	(305) 841-3691	(412) 366-1906	(518) 463-8877	(702) 322-4692	(916) 489-7326
(215) 642-4321	(312) 889-2254	(415) 454-4140	(602) 265-8747	(703) 877-5535	(919) 288-1695

New components

Graphite coatings are hard and porous

They won't out-gas or flake when used on inner surface of color television tubes

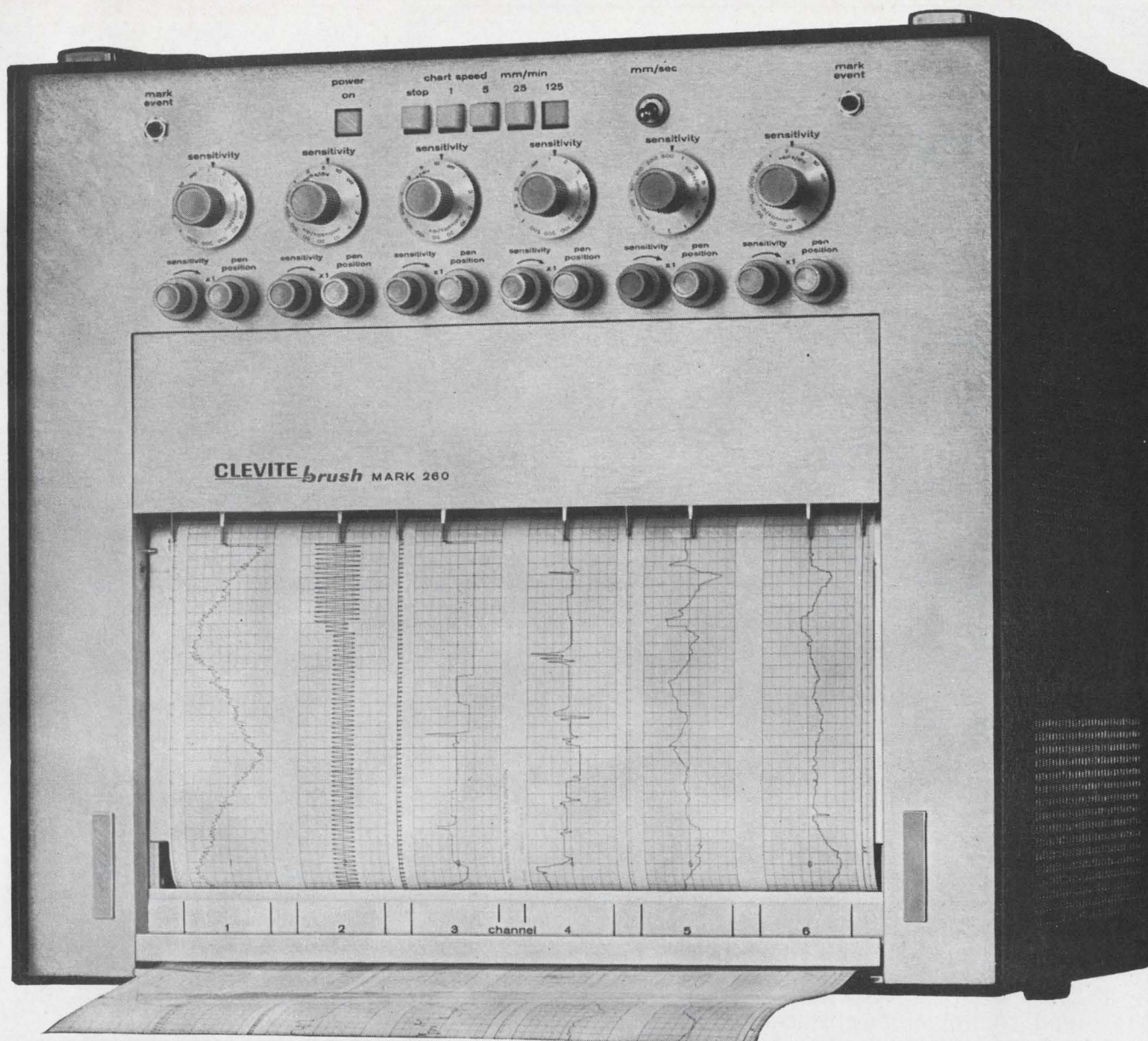
"Conductors" and "wire" have become almost synonymous, but other things besides strips of metal can carry electrons from one point to another. For example, there are the conductive coatings made by the Acheson Colloids Co. These suspensions of graphite or precious metal can be applied by brushing, dipping, spraying or screening.

The newest coatings developed by Acheson go on the insides of cathode-ray tubes, particularly the picture tubes of color television sets. The company says these coatings improve both performance and reliability.

Heat caused by electron bombardment is a problem in all crt's. The outside of a black-and-white picture tube is usually coated with a suspension of graphite in sodium silicate, and the inside with aluminum. The electrons striking the inside of the tube generate a current that flows through the aluminum to an anode button, and through the anode on out to the graphite, where heat is dissipated.

But a color tube runs so hot, that heat must be dissipated inside it. Color-tube makers first attempted to cool things off by putting a graphite coating inside the tube. This does keep the heat down and prevents a lot of the electron reflection, but the graphite suspension developed for the outside is too soft for inside work. When the electron gun is inserted into the neck of the tube during final assembly, part of the coating is chipped away, and these loose particles can get into the gun and short it.

Without additives, a hardened version of the standard coating doesn't work either because it isn't porous enough, according to Acheson. Water vapor and gas accumulated during assembly can't be



The Mark 260 tells it like it is.

That's because we've taken the fooling out of recording. This high-performance six-channel portable delivers more fact and less fiction than any other make you can buy.

The Mark 260 eliminates the things that can fool you. First, it's accurate — better than 99.5% accurate. It's the only recorder of its type with a foolproof *position feedback* system that enforces accuracy regardless of the pen's position on the chart. Second, its resolution is fully equal to its accuracy. The Brush patented pressure-fluid writing system produces thin, sharply defined traces that cannot smudge and cannot be misread. No fooling about exact reading of point-to-point values; no fooling about even the most complex wave-forms.

And no fooling with recalibration every time you change a setting. Calibration is factory fixed, drift free and constant — no matter how often you change your mode of recording. You can be certain your data is valid . . . you save time and

chart paper. Just plug it in, set it up, and you're in business. No fooling.

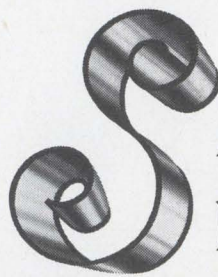
Six analog channels and four event channels in a package you can carry and use anywhere. Performance that's better than many recorders twice its size . . . and twice as expensive. That's what the Mark 260 delivers.

More fact and less fooling.

We'd like to send you sample charts that "tell it like it is"—or better yet, demonstrate the Mark 260 right in your plant. Write Clevite Corporation, Brush Instruments Division, 37th and Perkins, Cleveland, Ohio 44114.

CLEVITE BRUSH





**SAVE
PRODUCTION
TIME BY USING
HAMILTON
PRECISION
STRIP
AND FOIL**

Because you get superior surface finish, the tightest dimensional tolerances and exactly the physical properties you specify, production time in your plant is cut to the bare minimum. The parts you make will perform as expected and your total product will be improved.

Every lot of Hamilton strip and foil is produced under rigid control of mechanical properties through alloy analysis, annealing and heat-treating; the closest dimensional control by means of X-Ray and Beta-Ray gages; superior surface finish through the use of diamond lapped work rolls and process cleanliness.

This same technical "know-how" goes into the processing of every one of our 7 proprietary metals, 12 pure metals and 112 commercial alloys rolled in thicknesses from 0.060" down to 0.000070" in widths up to 12" and continuous coils to 1000 lbs.

Write, wire or phone giving us the material you desire and the properties you need. We'll tell you how fast we can get it to you—in quantity! Or, write for our latest catalog containing our capabilities and engineering data on all our materials.



HAMILTON PRECISION METALS

Division of Hamilton Watch Company, Lancaster, Pa. 17604
Telephone 717-394-7161 TWX 717-560-4417

driven out before the tube is sealed, so tubes with these coatings often out-gas during operation. And when the pockets of gas crack open, large chips break away from the surface, again posing a danger to the gun.

One of the company's two new coatings, a graphite-silicate suspension, has an additive that increases porosity. Acheson says that though this coating is very hard, it can be completely out-gassed before the tube is sealed.

And the increased porosity means the coating can absorb gases when electrons bombard the tube face.

The other new suspension, graphite in lithium polysilicate, also gives a hard and porous coat. But it has the added advantage of being moisture resistant, and so eliminates the need for constant protection of the inner surfaces of partly assembled tubes.

Acheson Colloids Co., Box 288, Port Huron, Mich. 48060 [358]

New components

A weight saver for jumbo jets

Remote circuit breaker
controlled from cockpit
lightens power-cable load

As airplanes get larger, part of their extra weight comes from the electrical wiring needed to get information or energy from one end to the other.

In some new aircraft, data and communications are multiplexed and transmitted over coaxial cables to cut the weight of redundant small-gage wiring. But, until recently, no company had done much about expensive, heavy avionic power cable.

No one has yet found out how to multiplex power circuits, but Texas Instruments' Precision Circuit Breaker department has figured out how to eliminate many of the long runs of cable connecting the flight engineer's console

WE GOT 'EM, YOU GET 'EM.

You've heard by now about the new Dumont. Now we'll tell you about the great Dumont products you can order **today**. Like our 700 series 'scopes, including the great 766H, our 'scope cameras, signal generators and... well, more. All ready now for shipment within twenty-four hours after we get your order. So just turn a peeled eye below and see what you need, want, are curious about, don't believe or would like to know more about. Then call our rep,

call us, write or mail the coupon below and you'll get yours... fast.

DUMONT OSCILLOSCOPE LABORATORIES, INC.
40 Fairfield Place West Caldwell, New Jersey 07006
(201) 228-3665/TWX (710)-734-4308

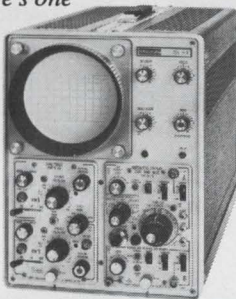
DUMONT

OSCILLOSCOPE LABORATORIES, INC.

Oscilloscopes:

Beautiful. We now have in stock and are ready to ship these complete lines of 'scopes, many of which have the highest writing rate, 13 Kv acceleration and high light output, frequency range DC to 100 MHz, rise time to 3.5 ns., 5 sec/div to 5 ns/div.

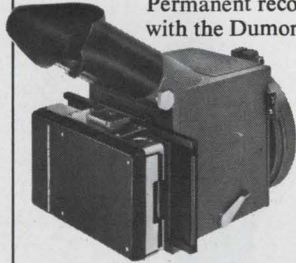
Here's one



DUMONT 766H with silicon solid state circuitry, no-fan 200 watts power consumption, greater display area, fully interchangeable X and Y plug-ins, internal graticule, and... well, what more could you want?

Oscilloscope Camera Systems:

Permanent records of your readings with the Dumont 'scope camera. Can be equipped with a Polaroid Back for instantaneous recording and reading or comparing. Fits any 5" 'scope. 35 mm, anyone?



More Oscilloscopes:

DUMONT 704A.

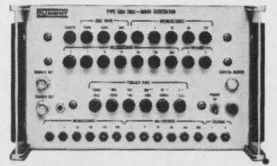
Complete line of rack or bench low frequency, high sensitivity, low cost 'scopes.



Pulse, Square Wave and Time Mark Generators

DUMONT 781A Time Mark Generator

Extremely precise and accurate time markers. Provides 14 time markers, 6 trigger rates and 3 sine wave outputs. This time mark generator is among the smallest and lightest available and has very low power consumption.

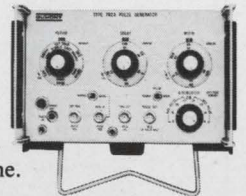


DUMONT 791 Square Wave Generator

Gives nanosecond rise and fall times, extremely wide operational frequency range, from 7 Hz to 10 MHz.

DUMONT 792A Pulse Generator

50 Hz to 10 MHz rep rate, double or single pulse, single shot operation. Gives nanosecond rise and fall time.

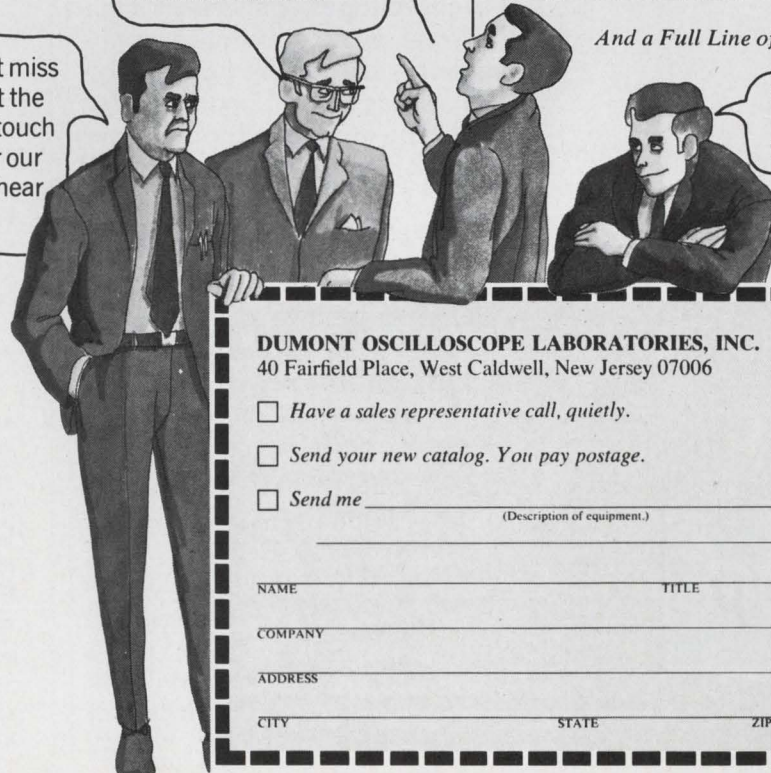


And a Full Line of 'Scope Accessories

Think anyone'll believe 13 KV is standard in our high frequency lines?

And how about 100 MHz and sweep switching in one instrument?

I hope you guys didn't miss anything. Let's repeat the part about getting in touch with us and asking for our **new catalog**. I like to hear my phone ring.



My wife says we should give trading stamps.

DUMONT OSCILLOSCOPE LABORATORIES, INC.
40 Fairfield Place, West Caldwell, New Jersey 07006

Have a sales representative call, quietly.

Send your new catalog. You pay postage.

Send me _____
(Description of equipment.)

NAME _____ TITLE _____

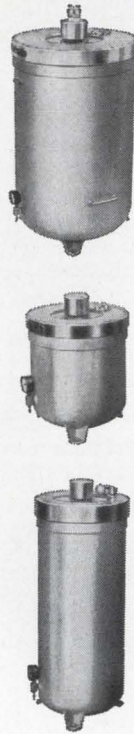
COMPANY _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

E

Lapp Gas-filled Capacitors



Specially designed for a broad range
of high voltage operating conditions.

High voltages, as well as high current and capacitance applications, are easily handled by Lapp Gas Filled Capacitors. For this type of service Lapp Capacitors offer small size and low cost.

Lapp precision-builds these capacitors to give years and years of accurate trouble-free operation. They are made in either fixed or variable models. All are equipped with external safety gap to protect against internal flashover.

Current ratings are available up to 400 amps at 1 mc., capacitance to 30,000 mmf, and safety gap settings to 85 kv peak. These characteristics fill a broad range of needs. May we send you more information? Ask for Bulletin 302. Lapp Insulator Co., Inc., LeRoy, N.Y. 14482.

Lapp

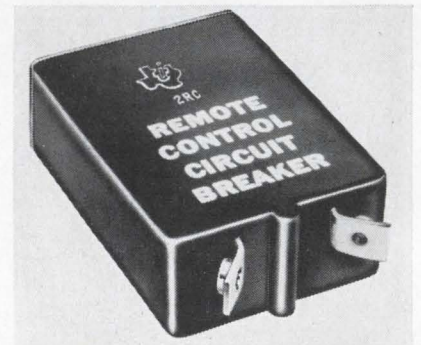
with power-generation gear.

Long loop. In today's aircraft, power leads run from generator to radar and other systems by way of a large circuit-breaker panel in the cockpit, and this additional loop might be as long as 300 feet in a plane like the Boeing 747 jumbo jet. TI would eliminate this 300 feet of heavy and costly cable by using a remote-control circuit breaker near the generator and controlling the breaker by a small low-voltage switch in the cockpit.

In a 75-amp circuit, such an installation could save tens of pounds of 6-gage wire. Substituted for it would be light, inexpensive 22-gage control wiring. The control wire would cost about 18 cents per foot, against about \$1 per foot for the conventional wire, according to a TI spokesman.

Weight savings also reduce the cost of the airframe. This varies among manufacturers, but the range is from \$100 to \$200 per pound saved.

According to Harold R. Damberg, senior product specialist for



Sensor. The 2RC circuit breaker (above) fits into a power line and is actuated by a cockpit switch.

circuit breakers, TI foresaw the need for such a remote-control circuit breaker about two years ago.

"A jumbo jet might contain from 1,000 to 1,200 circuit breakers," says Damberg. "Of these, about 75% would be in circuits where remoting could be profitable." Damberg adds that the new breakers are expected to sell for about \$75 each and will be competing with manually controlled breakers costing only about a tenth that amount. "Even so, the amount saved in heavy cable alone would offset the higher price of the re-

New Mil-Standard 883 specifies "Fluorinert"TM brand electronic liquids for gross leak testing

New Mil-Standard 883, designed specifically for microelectronics, specifies "FLUORINERT" Brand Electronic Liquids for the gross leak testing of microcircuits.

No wonder.

They're compatible with sensitive electronic materials and can be used over a wide temperature range. They drain clean, dry fast and leave no messy residue.

Bring your tests up to "standard". Write today for a copy of Mil-Standard 883, test method 1014.



3M Company, 3M Center Dept. KAX 11-68
St. Paul, Minn. 55101

Please send me a copy of Mil-Standard 883, test method 1014, and more information on "FLUORINERT" Brand Electronic Liquids.

Name _____

Company _____ Title _____

Address _____

City _____ State _____ Zip _____

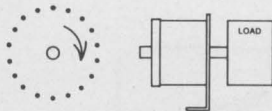
Chemical Division **3M**
CORPORATION

New Ledex stepping motor has 160 ounce-inches breakaway torque

Our new 18 position Series 50 Stepping Motor has more working torque than any stepping motor we've ever built. Its breakaway torque is 160 ounce-inches . . . and it drives a constant friction load of 64 ounce-inches through a full 20° stroke, accurate to $\pm 1^\circ$ non-accumulative.

An exclusive new tooth clutch, with positive grip-action drive makes this extra torque possible.

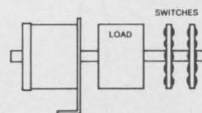
With a **unidirectional** Series 50 you can . . .



drive your load remotely through a series of short steps and stop at any one of 18 positions



or add a knob for manual reset in either direction . . .

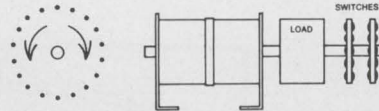


or add rotary switches for a combination power positioning drive and a step or program switch



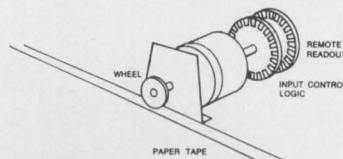
or use shaft extensions on each end to direct-couple two loads and drive them in the same direction at the same time.

With a **bidirectional** Series 50 you can do all this . . . plus *remotely position* loads CW or CCW.



All working parts are completely enclosed. Minimum life is 3 million steps. For bidirectional, 3 million in each direction. And, the Series 50 works on simple square wave input pulses . . . so you don't need expensive logic circuitry.

Here's one of the many ways you can use the Series 50.



The price gives you a lot of positioning power for your money.

UNIDIRECTIONAL	
1-9 from stock	1000 lots
\$25 to 30	\$10 to 15
BIDIRECTIONAL	
1-9 from stock	1000 lots
\$40 to 45	\$20 to 25

This new stepping motor is ready to solve your remote positioning problems now. For more information, write or call for a copy of our Bulletin 468. Or, send us a description of your application and we'll recommend a solution.

. . . a bending bimetallic strip trips breaker . . .

mote breaker," he says. And then there's that \$100 a pound.

On the buses? Early in 1968, Boeing gave TI a development contract for a remote breaker, having found that wire runs would be a weighty design problem in its 747. Damberg says that McDonnell Douglas is considering such breakers for its DC-10. Lockheed is said to be considering them for its own airbus, and it may retrofit them to the C-5A transport.

Each breaker, part of TI's Klixon line, consists of a 7274 series trip-set switch and a 2RC series circuit breaker. With the switch, the flight engineer can either open circuits at the breaker or reset breakers which have already been opened because of overload.

The 2RC is a thermally operated breaker; overload heats a bimetallic strip that releases a latched set of contacts. To reset the breaker, a 28-volt signal is sent to a solenoid in the breaker package. Another solenoid opens the power circuit with a push of the same button on the trip-set switch.

Damberg says TI will offer the remote circuit breakers in amperage ratings from less than 2.5 to 100 amperes. They would each be capable of handling either 30 volts d-c or 120 volts a-c, 60 or 400 hertz, without any sort of modification.

The new breakers might replace contactors in some applications, according to Damberg. Contactors are very high-amperage circuit breakers without current-sensing elements like the Klixon's bimetallic strip; they're usually controlled by another circuit breaker.

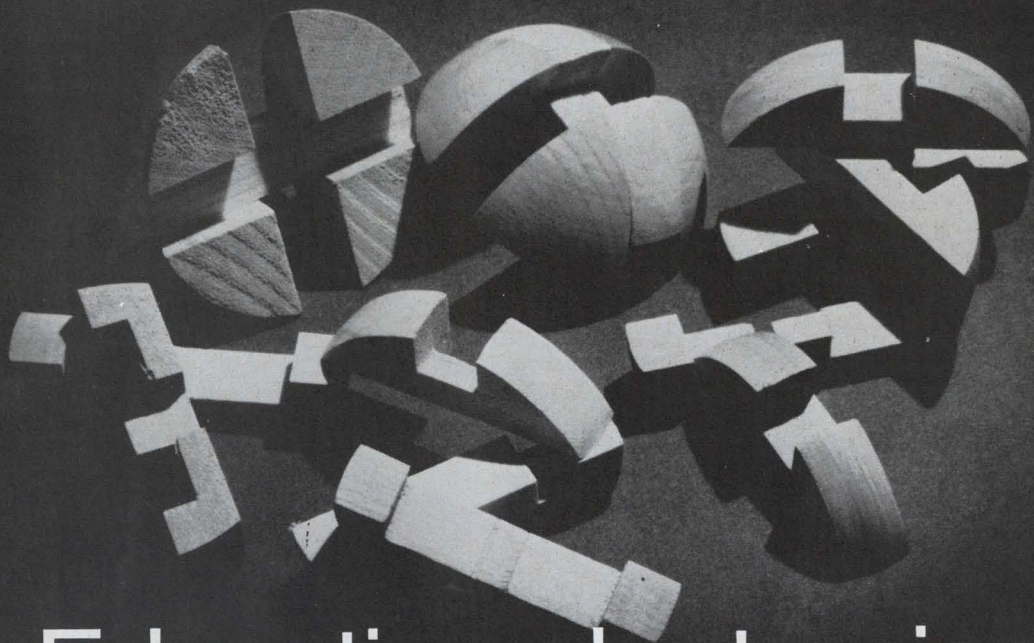
In its new series, TI will combine the heavy-duty contact assembly of the contactor with its thermal sensing elements in a single package.

TI plans to announce the line early in 1969 and will begin deliveries in the first quarter of the year. A delivery time of four to six weeks is scheduled after next March.

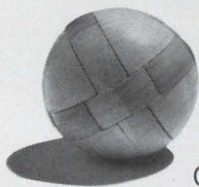
Texas Instruments Incorporated, Precision Circuit Breaker Department, 34 Forest St., Attleboro, Mass. [359]



LEDEX DIVISION, LEDEX INC.
123 Webster Street, Dayton, Ohio 45402 • phone (513) 224-9891



Educating electronics personnel is too big a problem to have only one solution.



Of course, you're sold on the importance of providing continuing education for your electronics personnel. So rapidly do new developments take place in electronics that knowledge begins to lose its value almost as soon as it is acquired. Valuable men can become outmoded and unproductive almost overnight. And the shortage of technical manpower at both the professional and supporting levels makes it imperative that you utilize fully every man you have.

Perhaps your company conducts in-plant programs of instruction. Or pays all or part of the cost

of evening classes in nearby technical institutes, colleges and universities. Whatever your educational program, we believe it will be more flexible and more effective if you supplement it with CREI Home Study Programs in Electronics.

We've prepared a brochure that tells how CREI Programs can help you update, upgrade and reorient electronics personnel. Use coupon below to send for a copy today.

Founded 1927



Accredited Member of the National Home Study Council



CREI, Home Study Division, McGraw-Hill Book Company
 Dept. WTC-02, 3224 Sixteenth Street, N.W.
 Washington, D.C. 20010

I want more information on CREI Programs in Electronics and how they can supplement our educational program for electronics personnel. Please send me, without obligation, your descriptive brochure.

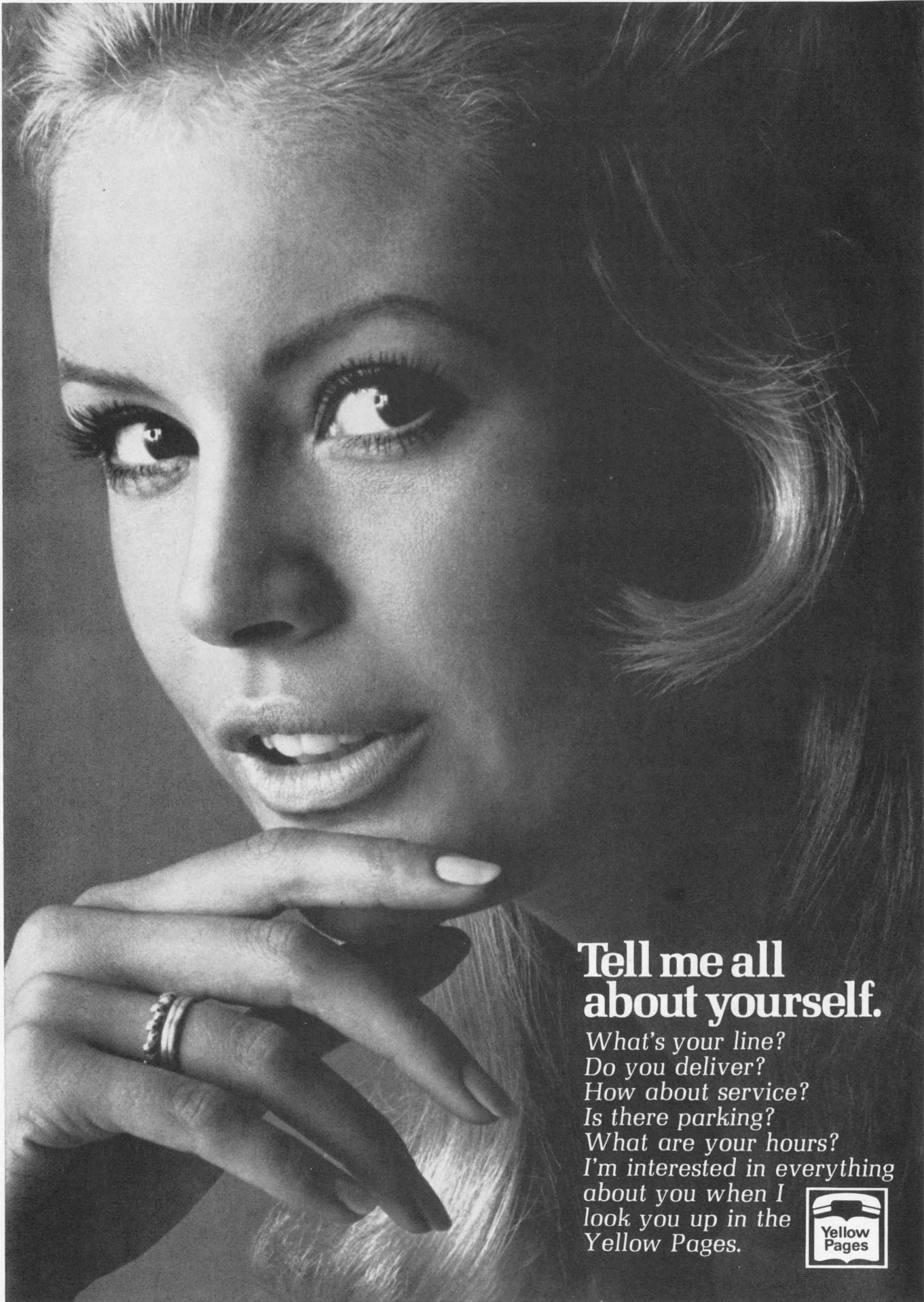
Name _____

Title _____

Firm Name _____

Address _____

City _____ State _____ Zip _____

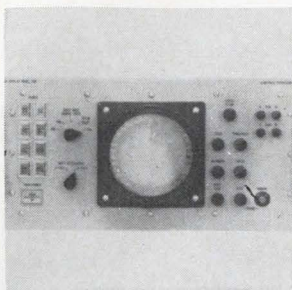


**Tell me all
about yourself.**

*What's your line?
Do you deliver?
How about service?
Is there parking?
What are your hours?
I'm interested in everything
about you when I
look you up in the
Yellow Pages.*



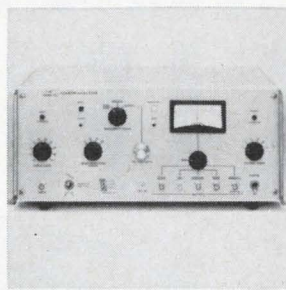
New Instruments Review



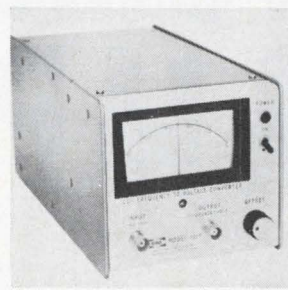
Signals detected by any 360° azimuth scan receiving system can be observed simultaneously on direction finder polar display indicator 1701. The unit is compatible with receiving systems that can supply ± 1 v d-c into 680 kilohms, or 1 v d-c to 10 Mhz video into 50, 90, or 300 ohms and 60 hz synchro position data. Symetrics Engineering Corp., Satellite Beach, Fla. [361]



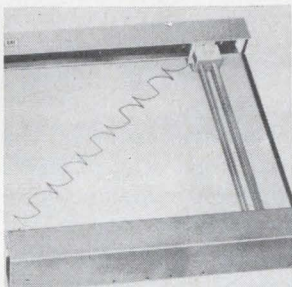
Pulse generator 9054 is for IC logic level compatibility. It has a frequency range of 1 hz to 10 Mhz, with controllable pulse duration. Pulse widths from 50 nsec to 50 msec are provided. The unit has two continuously adjustable signal outputs, one delivering 5-v and the other 2.5-v pulses to a 50-ohm load. Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif. [362]



Fourier analyzer model 102 is for spectrum analysis of complex or noisy signals. It provides either the power spectrum, which is the Fourier transform of the autocorrelation or the cross power spectrum, which is the Fourier transform of the crosscorrelation. Frequency range is from 0.25 hz to 4.95 khz. Price is \$12,950. Princeton Applied Research Corp., Box 565, Princeton, N.J. [363]



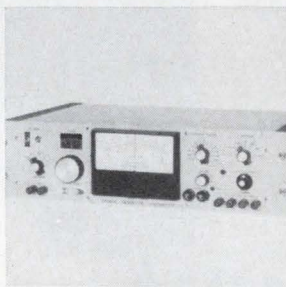
Six-decade log frequency to voltage converter model 1017 has an output that is a d-c voltage proportional to the logarithm of the input frequency. Output is precisely 1 v/decade and may be set to zero at any frequency. Frequency range is 10 hz to 10 Mhz with conversion accuracy of 0.5%. Price is \$680. Pacific Measurements Inc., 940 Industrial Ave., Palo Alto, Calif. [364]



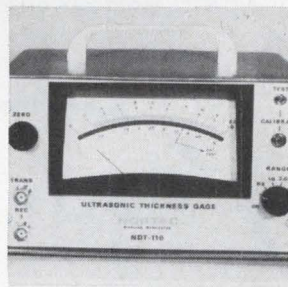
X-Y recorder OEM-17 employs a low cost design using a d-c servo system. It offers flexibility in size and interface to accommodate various system requirements. Features include a 17 x 17 in. plotting surface, a magnetic paper-hold system, and static accuracy of $\pm 0.2\%$ of full scale. Price is under \$700. Electronic Associates Inc., Long Branch, N.J. [365]



Solid state amplifier RF-805 is a broadband instrument from 0.05 to 80 Mhz. Ten watts are produced with better than -30 db harmonic and intermodulation distortion. No bandswitching is necessary. Gain is 47 db minimum, constant within 1 db, and full output is produced with less than 0.1 v. at 50-ohm input. RF Communications Inc., University Ave., Rochester, N.Y. [366]



Phase sensitive voltmeter model 250 will measure phase angle, in-phase and quadrature voltages, and total voltage while sweeping frequency. For total voltage measurements, the frequency range from 10 hz to 100 khz is covered; for phase sensitive measurements, the frequency range from 30 hz to 20 khz is covered. Dytronics Co., 4800 Evanswood Drive, Columbus, Ohio. [367]



Portable ultrasonic gage NDT-110 measures thickness of metals and plastics. Using the dual-element, contact transducer, thicknesses from 0.050 in. to 2.0 in. can be read directly on the calibrated $\pm 1\%$ meter. Pipe or tubing as small as $\frac{5}{8}$ inch in diameter can be measured with the gage. Northwest Technical Industries, George Washington Way, Richland, Wash. [368]

New instruments

A new 'scope—and a wider scope

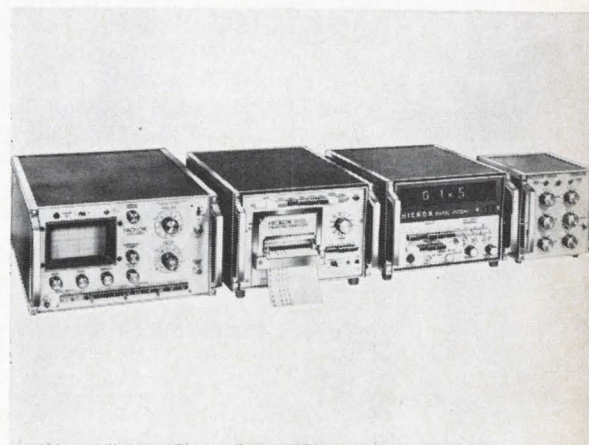
Old-line instrument company introduces 25-Mhz crt display, and adds six plug-ins to its digital measuring system

Its introduction three years ago of a digital system capable of both counting and voltage-measuring marked the Hickok Electrical Instrument Co.'s entry into the field of laboratory and industrial test equipment.

The firm is now taking another

diversification step, tackling the market for high-frequency oscilloscopes with a medium-priced unit having a bandwidth of d-c to 25 megahertz. At the same time, it's expanding its digital system, the DMS 3200, with six new plug-ins.

The compact, \$650 oscilloscope



Test line. 25 Mhz scope, left, is shown with one grouping of digital system.

TOMORROW'S AMPLIFIER

- $\pm 0.005\%$ linearity
- 100 kHz bandwidth
- 30 usec settling to $\pm 0.01\%$
 - $0.2 \mu\text{V}/^\circ\text{C}$ drift
- 150 dB CMR, 350 V CMV
- 30 usec overload recovery to $\pm 0.01\%$ from 20V on any range



THE
8300-XWB
HERE NOW!

UNIQUE FERROMAGNETIC ISOLATOR enables combining all these parameters in the new 8300-XWB Wideband Floating Differential Amplifier... and gives complete freedom from modulation spikes and signal folding!

You also get 10-position 1:1000 gain span... $\pm 0.01\%$ 6-months-stable accuracy...under $7 \mu\text{V}$ rms noise at a full 100 kHz...integral d-c power supply...choice of 5 or 10V output. Price \$550 in 1-9 quantities.

Options include variable gain, mux-switch, switch-selectable bandwidth filter.

To get tomorrow's amplifier today—write, wire or phone:

PRESTON



SCIENTIFIC INCORPORATED

805 EAST CERRITOS AVENUE
ANAHEIM, CALIFORNIA 92805
(714) 776-6400

... plug-in extends
tests to a-c voltages

"has all the important basic measurement capabilities but omits many of the more exotic and seldom-used functions often found in higher-priced models," says Kenneth F. Petersen, marketing vice president.

In the CRO 5000, response above 25 Mhz is essentially Gaussian. The scope is usable to around 50 Mhz, and trigger capability and sweep-speed ranges are consistent with this response, assuring stable displays with adequate horizontal expansion.

Display delay. A built-in vertical delay line provides nearly 50 nanoseconds of baseline prior to start of the pulse display, so the full leading edge of pulses can be viewed. Vertical sensitivity is 10 millivolts per division, with 12 calibrated steps from 10 millivolts per division through 50 volts/division. Hickok says a user can overdrive the vertical section to five times the screen height without distorting the waveshape.

The displayed waveform on the CRO 5000 can be continuously delayed up to 40 divisions by means of a multiturn horizontal position control allowing full-screen presentation of small portions of the input waveform. Sweep linearity is unaffected by this positioning. There are 24 calibrated sweep ranges, from 50 nsec per division to 2 seconds.

The scope is 11 $\frac{1}{4}$ inches wide, 6 $\frac{7}{8}$ inches high, and 19 inches deep, and weighs 24 pounds. Delivery is from stock.

Sensitive. One of Hickok's new plug-ins for its DMS 3200, the DP110 digital microvoltmeter, provides digital display of d-c measurements from as low as 1 microvolt up to 1,000 volts when used with any of the DMS main frames. Accuracy is $\pm 0.05\%$ of reading ± 1 digit. Push-button overranging provides full four-digit resolution for all measurements and, within the overrange capability, five-digit resolution. The price is \$450.

Another plug-in extends DMS 3200 measurements to a-c voltages. The DP 130 will make a-c measurements down to 10 micro-

From The Millimeter Men at TRG...



...the widest choice of components and instruments for millimeter systems anywhere

Getting the millimeter components you need for R&D systems can be time-consuming business. Especially if you are forced into do-it-yourself solutions. The Millimeter Men at TRG can spare you all this. They offer today's most comprehensive line of standard millimeter components. Variable and precision attenuators, wavemeters, slotted lines, phase shifters, terminations, antennas — whatever your system requires in the 12.4 to 220GHz range, Control Data Corporation can supply it. We are also uniquely qualified to design special components, or assemble systems to your specifications. For widest choice and uncompromising quality — look to Control Data Corporation. Write for new short-form catalog to The Millimeter Men, Boston Space and Defense Systems Operation, Control Data Corporation, 404 Border Street, East Boston, Massachusetts 02128. Telephone 617-569-2110.



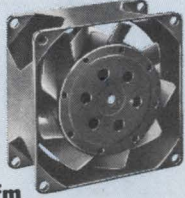
TRG Series 510 Precision Direct Reading Attenuator, a rotary vane type attenuator, covers the full wave-guide band with precise, repeatable, attenuation values independent of operating frequency.

CONTROL DATA
CORPORATION
SPACE AND DEFENSE SYSTEMS

Keep your equipment cool. Here are a few of our 23 all-metal fans that will do the job...economically.

COMPACT MODEL 8500

1/8" thinner
than other
3 1/8" fans ... 45 cfm

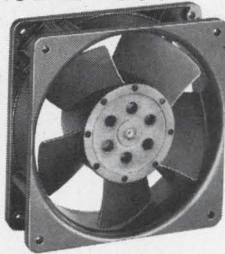


- Unmatched noise level of 28.8 dB
- Ideal for tight dimensional applications where performance and cost are prime considerations.
- Only 3 1/8" x 3 1/8" x 1 1/2" deep.
- Standard mounting dimensions for EIA 3 1/2" rack panels.
- UL recognition number E41168.

ON READER-SERVICE CARD CIRCLE 510

LOW-NOISE 4 1/2" MODEL 4500

115 cfm with
less than
37.5 dB SIL

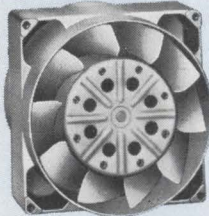


- Operates continuously at room temperature (25°C) for over 100,000 hours—even at 55°C, operates 20,000 hours, continuous duty.
- Powerful shaded-pole motor.
- Interchangeable with similar, less reliable 4 1/2" fans.
- UL recognition number E41168.
- New Model 4800 has unmatched noise level of 17.9 dB SIL.

ON READER-SERVICE CARD CIRCLE 512

ULTRA-RELIABLE INDUCTION MODELS

8 models
available
with ratings
from 130 to
65 cfm

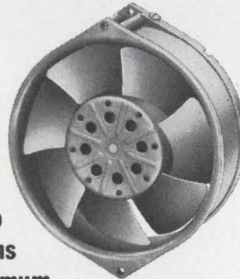


- Models 1000A, 1110, 1300, 2000, 2050, 2110 are 4 7/16" square x 1 3/32".
- Models 3000 and 3050 are 3 1/2" square x 1 3/32".
- UL recognition number E41168.

ON READER-SERVICE CARD CIRCLE 514

6" MODEL 7500

Use one to
replace two
or more fans
where maximum
total air movement is required
with extremely low noise level

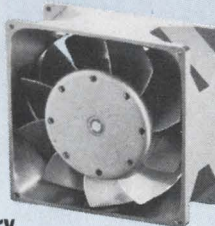


- Moves up to a whopping 265 cfm
- Ideal for cooling large electronic enclosures with excessive resistance to air flow.
- With new aerodynamic design of pressure type blades, sustains delivery as high as 225 cfm at .2 inches of water back pressure.
- Low noise 40.5 dB SIL at 265 cfm.
- UL recognition number E41168.

ON READER-SERVICE CARD CIRCLE 511

LOW-COST MODEL 2500

high air delivery
at higher back pressures



- 4 1/2" fan moves 115 cfm.
- Standard mounting dimensions.
- 50-60Hz operation at 117 or 230 VAC.
- UL recognition number E41168.

ON READER-SERVICE CARD CIRCLE 513

In addition to giving you a wide choice of sizes and performance characteristics in all-metal fans with shaded-pole or induction type motors, we can give you a special fan to solve your particular cooling problem. We can deliver fans with low, low noise levels, economical "bracket" models, and ball bearing fans for 85°C ambient temperature operation. Extend the life of your equipment ... cool it and call us now at (415) 863-5440. Or TWX 910-372-6127. Or write for data to 312 Seventh St., San Francisco, California 94103.

PAMOTOR, INC.

... set-point controller
added to test line ...

volts. The unit, priced at \$375, operates over a range of 22 hertz to 1 Mhz. Its accuracy up to 100 kilohertz is 0.1%.

Scalable. The DP 160 counter plug-in gives the DMS the ability to count and measure frequencies up to 80 Mhz. The functions are performed directly; heterodyning isn't needed. The plug-in, which is priced at \$395 and can be used with the basic system's three-digit readout, includes scaling pushbuttons to give reading resolution up to seven digits.

A meter plug-in, the DP 210, provides digital displays of either time-interval or period measurements from 10 microseconds to 999 seconds with an accuracy of ±0.0005% of reading ± one digit. The instrument, which sells for \$230, has separate start and stop inputs, each with independent adjustments of trigger level, attenuation, and slope.

Trim silhouette. The only adapter in Hickok's new line of plug-ins adds d-c current measurement to the system's capabilities. The D310, which will sell for \$90, permits the DMS to measure d-c currents from 0.1 nanoampere to 10 amperes when a d-c microvoltmeter is in the main frame. Accuracy is 0.15%, and Hickok says that insertion loss is low because of the high sensitivity of the measurement plug-in. A 3,000-volt isolation from ground means the D310 can be used for in-circuit tests. And because of its thin silhouette, it can be inserted beneath the DMS main frame.

A digital set-point controller, the model 1050, can start and/or stop the operation of any peripheral function at measurement values selected by the operator. When it's used with the DMS main frame, digital values of voltage, frequency, or other measurements will activate external mechanical feeds, printouts, or feed motors. External control will be activated when a reading exceeds an upper set-point number or drops below a lower set-point.

Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 44108 [369]

ONE MILLION OHMS PER VOLT

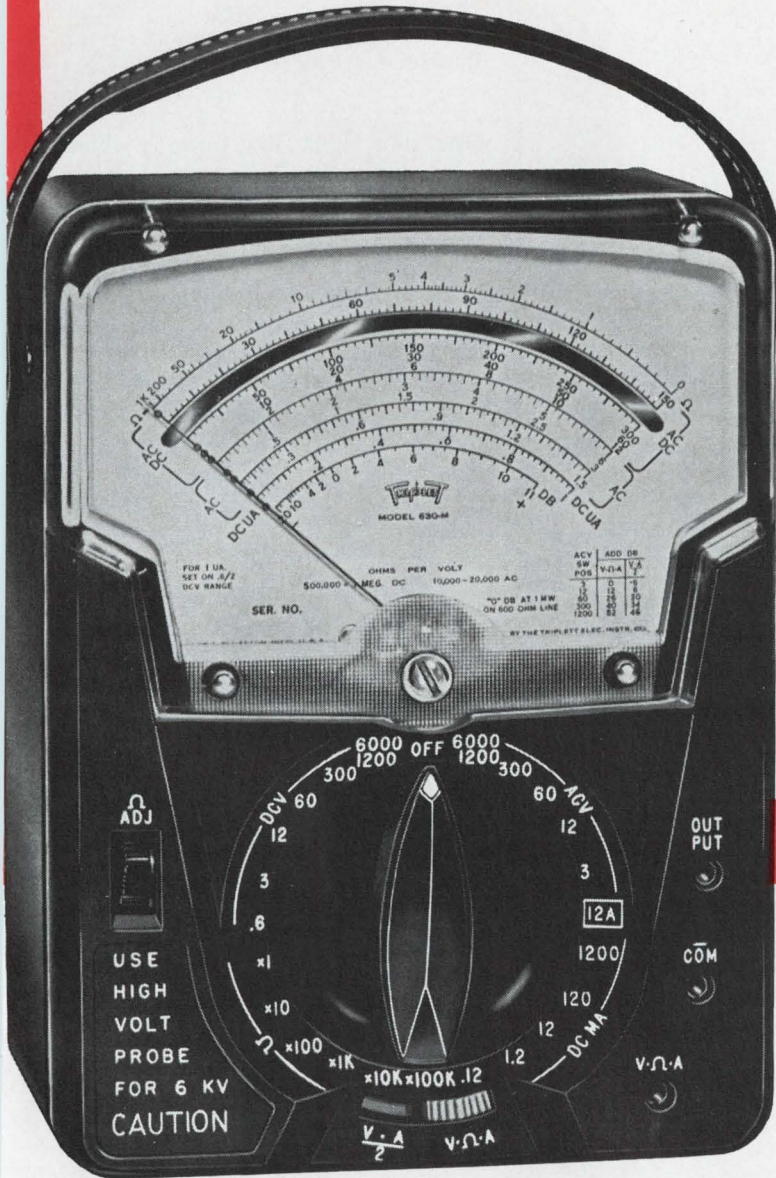


V-O-M

Model 630-M
VOLT-OHM-MICROAMMETER

\$220.00

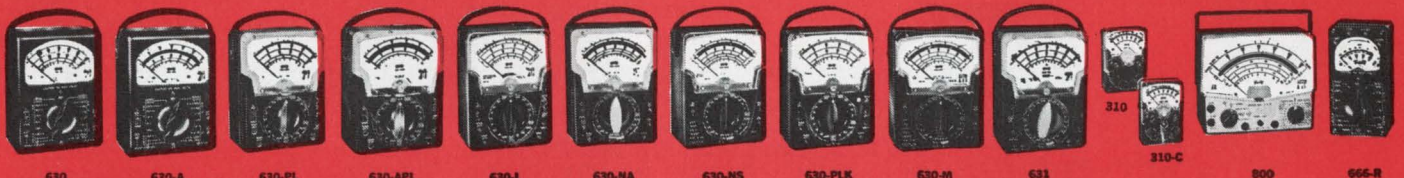
Suggested U.S.A. user net



Triplet Model 630-M features the input impedance of a VTVM with the convenience of a V-O-M. The 630-M's sensitivity is derived from the singular achievement of its basic 0-1 D.C. microampere movement. The 630-M incorporates no amplifiers, no warm-up, and no power requirements. Model 630-M is a true V-O-M whose engineering excellence is based on 60 years of instrument manufacturing, and contains the top quality associated only with Triplet.

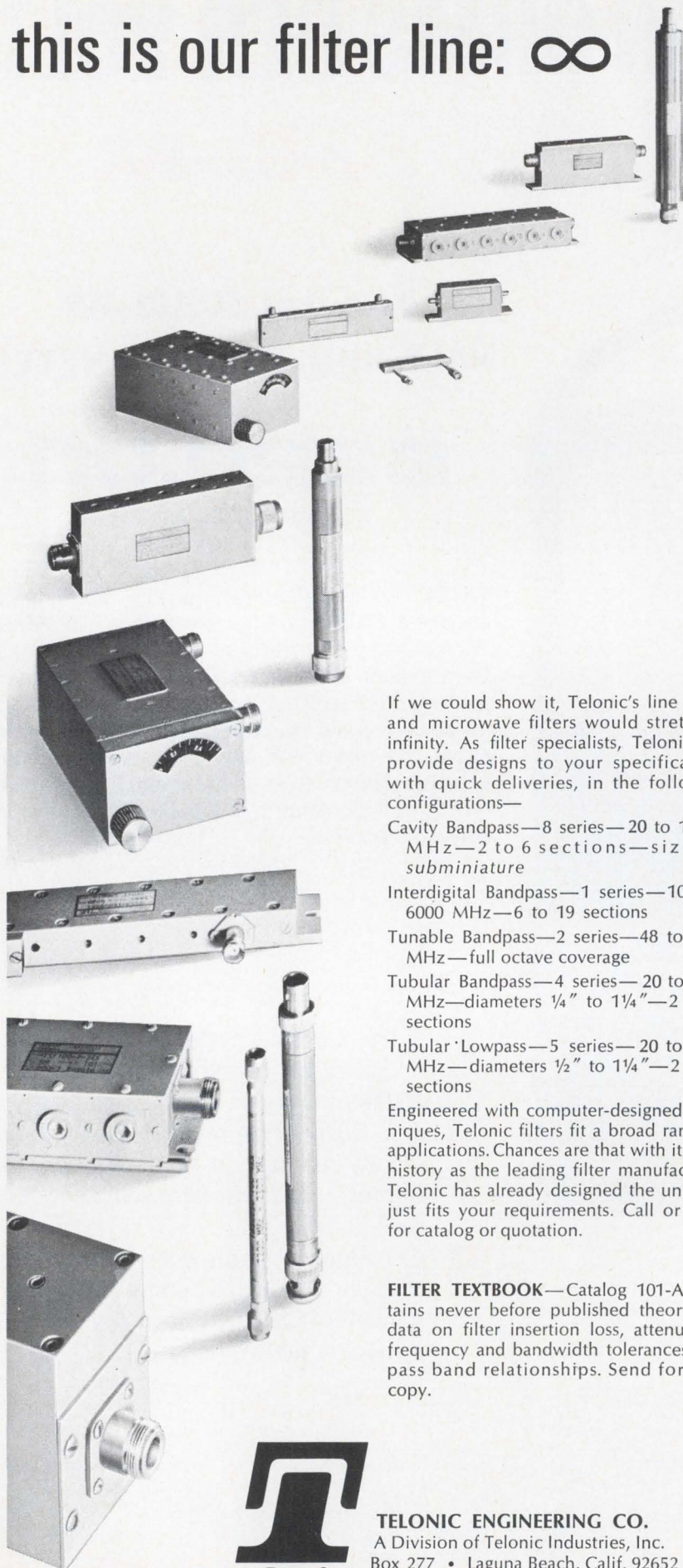
- 1** 1,000,000 ohms per volt D.C. for greater accuracy on high resistance circuits. 20,000 ohms per volt A.C.
- 2** 1 ua Suspension Meter Movement. No pivots, bearings, or rolling friction. Extremely rugged. Greater sensitivity and repeatability.
- 3** 61 ranges, usable with frequencies through 100 kHz. Temperature compensated. 1½% D.C. accuracy, 3% A.C. in horizontal position.

TRIPLETT ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO



MANUFACTURERS OF PANEL AND PORTABLE INSTRUMENTS; ELECTRICAL AND ELECTRONIC TEST EQUIPMENT

this is our filter line: ∞



If we could show it, Telonic's line of RF and microwave filters would stretch to infinity. As filter specialists, Telonic can provide designs to your specifications with quick deliveries, in the following configurations—

Cavity Bandpass—8 series—20 to 12,000 MHz—2 to 6 sections—sizes to subminiature

Interdigital Bandpass—1 series—1000 to 6000 MHz—6 to 19 sections

Tunable Bandpass—2 series—48 to 4000 MHz—full octave coverage

Tubular Bandpass—4 series—20 to 2700 MHz—diameters 1/4" to 1 1/4"—2 to 12 sections

Tubular Lowpass—5 series—20 to 3000 MHz—diameters 1/2" to 1 1/4"—2 to 12 sections

Engineered with computer-designed techniques, Telonic filters fit a broad range of applications. Chances are that with its long history as the leading filter manufacturer, Telonic has already designed the unit that just fits your requirements. Call or write for catalog or quotation.

FILTER TEXTBOOK—Catalog 101-A contains never before published theory and data on filter insertion loss, attenuation, frequency and bandwidth tolerances, and pass band relationships. Send for your copy.



TELONIC ENGINEERING CO.

A Division of Telonic Industries, Inc.

Box 277 • Laguna Beach, Calif. 92652

Phone—(714) 494-9401 • TWX-910-596-1320

New instruments

Devices meter auto pollutants

Portable analyzers use resistance changes to measure amounts

One new idea that auto makers have had recently is to put pollution-control devices on cars and trucks. They got this idea from reading both recently enacted and proposed laws that taken together say: "Clean up automotive exhaust."

The Bacharach Instrument Corp., anticipating a demand for instruments to test these devices, has developed two: one measures the carbon-monoxide content of car exhaust; the other, the opacity of diesel engine exhaust.

Double take. As pollution legislation gets tougher, two things are going to happen, says William Milon, chief engineer in Bacharach's diesel division. First, government control agencies will need an instrument for vehicle inspection stations and roadside check points that an inspector can hook up to an exhaust pipe to get a direct reading of pollution concentration.

Failing such an inspection could mean a heavy fine for the driver. So, says Milon, garages are also going to need these instruments to calibrate, repair, or adjust the control devices.

So any instruments of this type have to be simple to both hook up and operate. They also should be portable and capable of running off a battery.

But they don't need the accuracy of a laboratory instrument.

Milon says both of Bacharach's instruments are rugged, easy to use, and low-cost.

The CO analyzer, called the model 7414, works on the principle of selective catalytic combustion. Exhaust gas, mostly CO and hydrogen, is pumped into a chamber that contains a catalyst-coated platinum wire. A power source outside the chamber continuously



This multiple pair, Beldfoil shielded cable is typical of the types of Belden cable used in recording critical measurements on the Goldstone tracking antenna.

BELDFOIL* SHIELDED CABLE

SOLVED

CRITICAL NASA INSTRUMENTATION PROBLEM!

The unique insulating properties of Belden's exclusive Beldfoil shielding provides 100% protection against "cross-talk" and spurious signal impulses in highly sensitive circuit applications. That's why NASA used Beldfoil cable for its Goldstone Tracking Station. ■ In this massive 210 foot

diameter antenna, built to track lunar and planetary probes, Belden Beldfoil shielded cables carry instrumentation signals from sensitive structural detectors to an instrumentation facility nearby.

Every measurement of critical structure deflection, angular position, structure temperatures, and bearing pressures are recorded and analyzed prior to tracking operations.

■ Get the same precision analyzation in your critical instrumentation. Specify Belden Beldfoil shielded cable —the only cable providing 100% isolation.

*Belden Trademark Reg. U.S. Pat. Off.



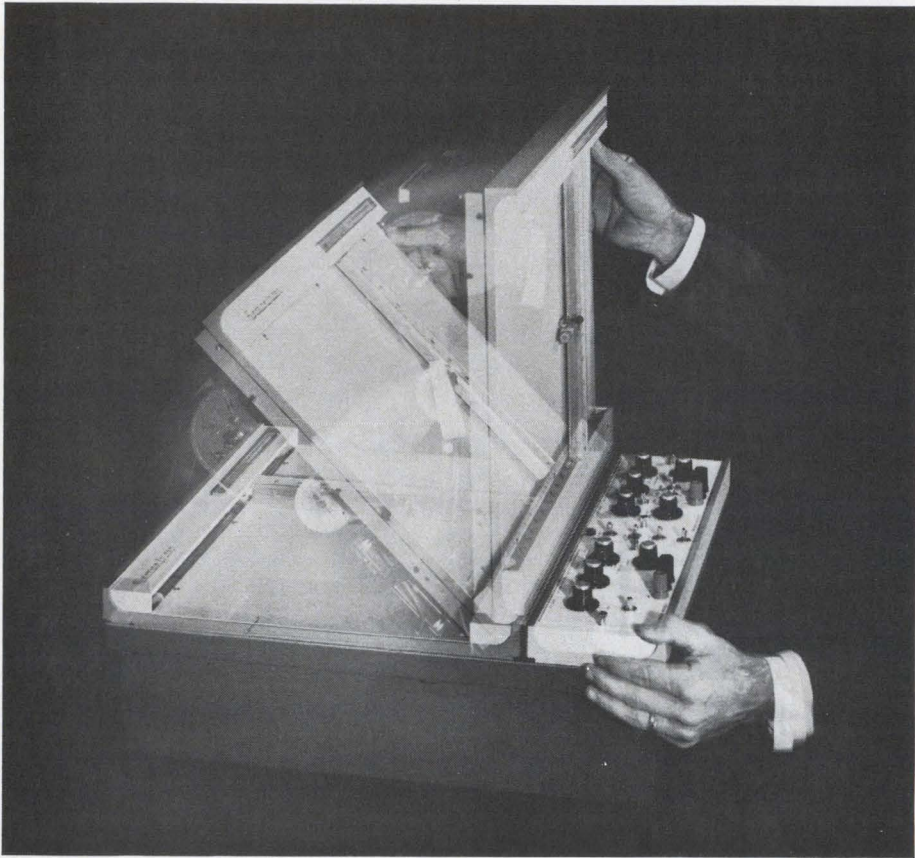
FOR COMPLETE INFORMATION
CONTACT YOUR BELDEN
DISTRIBUTOR.



8-1-6A,

BELDEN CORPORATION • P.O. Box 5070-A • Chicago, Illinois 60680 • Phone 312-378-1000

A New X-Y Recorder...



That's Easier To Operate

Easier to operate . . . easier to position . . . and meets top performance requirements. The *function/riter** recorder is more convenient than other X-Y plotters. You can operate this new TI recorder in five different positions to suit any application. Mount it in a 19-inch rack without adapters, stand it upright on a benchtop or position it flat with the writing surface horizontal, at a 45° or 90° tilt angle so you see the plot, even when you're sitting.

It's easy to change applications too. Three types of plug-in "function modules" allow you to plot inputs from 100 μ v to 50v, with time sweeps from 0.1 second/inch to 100 seconds/inch. All modules are interchangeable between X and Y axes. *Signal Input* module permits single-range millivolt recording. *Signal Control*

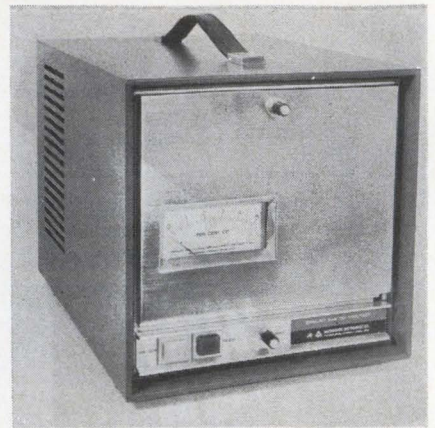
module offers 16 calibrated scale factors. *Time Base* module gives 10 time or voltage factors.

For more than four years, the servo system of the *function/riter* recorder has been use-proved in thousands of other TI instruments. Quieter operation of the vacuum hold down (for either 8½ x 11-inch or 11 x 17-inch paper), solid-state electronics, 20 inches/second slewing speed and accuracy of 0.2% of full scale are some of the other features that make this X-Y recorder an outstanding instrument to solve your plotting problems.

There's more to the story too. Find out by asking for complete data or a demonstration from your TI representative or the Industrial Products Division, P. O. Box 66027, Houston, Texas 77006 (713-349-2171).

*Trademark of Texas Instruments

TEXAS INSTRUMENTS
INCORPORATED

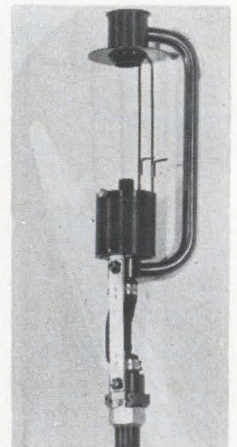


Hot . . . Exhaust is pumped into test chamber and ignited. The temperature is proportional to CO concentration.

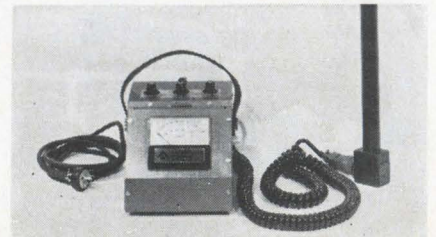
drives current through the wire, generating enough heat to ignite the CO and the hydrogen in the presence of the catalyst.

When the exhaust ignites, the temperature in the chamber rises, increasing the wire resistance. Since the ratio of hydrogen to carbon monoxide concentrations is fairly constant, the resistance change is proportional to the amount of CO in the exhaust.

Tests in Detroit. The 7414 is accurate to within $\pm 5\%$. Its meter and controls are in a 4-by-4-by-2-inch package, and the test chamber is in an 8-by-9-by-12-inch case. Packed along with the chamber is a condenser that takes hydrocarbons out of the exhaust so they



. . . and cloudy. As density of diesel exhaust increases, the amount of light reaching the photocell decreases.



Only Magnetics Inc. gives you all three of these advantages in photo-etched parts:

1. Metals processed to your specification
2. Guaranteed magnetic performance properties
3. Total quality control, raw metal to finished part

There is nothing new about chemically milling small, thin metal parts. Dozens of companies can photo-etch any part that can be drawn. What sets Magnetics Inc. apart in photo-etching is our capability of processing the metal to close tolerances.

Magnetics' completely integrated

production system for Photofab® parts is all-inclusive. We can custom blend basic metals into special alloys, or we can start with stock metal. We follow through with whatever it takes to match your specifications—precision rolling or flattening or strip annealing. As long-time specialists in magnetic materials, we have the facilities and the expertise needed to provide the ultimate in dimensional accuracies, at the same time guaranteeing the magnetic properties of your parts.

We augment our production capa-

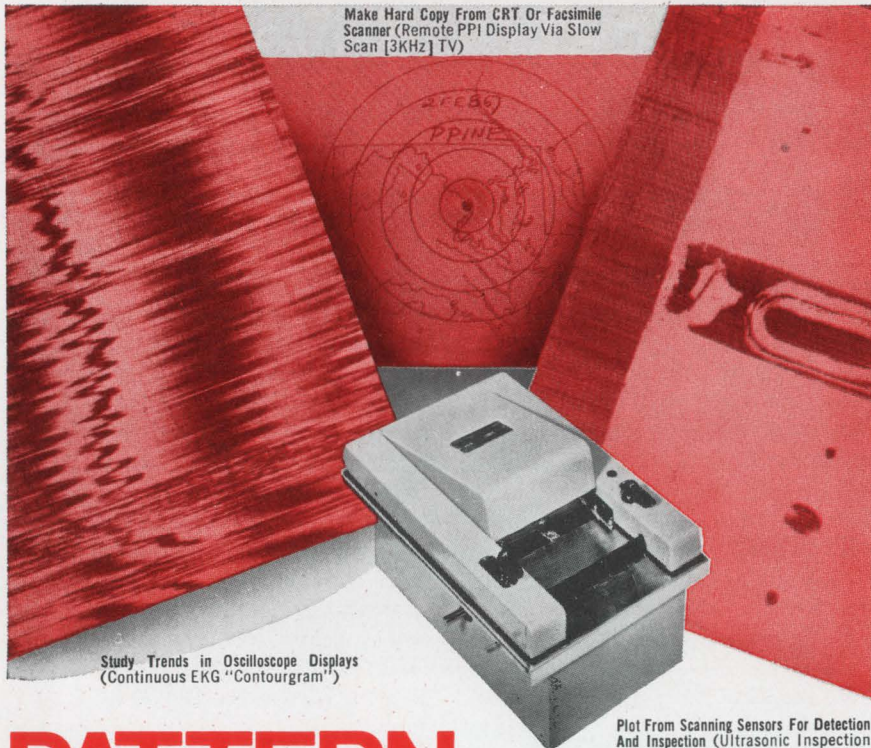
bilities with uptight quality control. This means the most advanced laboratory and test equipment, manned by a staff of nit-picking experts. When you take delivery on Photofab parts, you can be sure that they've passed our constant surveillance, from basic metal through shipment in custom-designed packaging.

If you've been looking for a supplier who can offer single-source responsibility on photo-etched parts, you've found us. For more information, write Magnetics Inc., Dept. EL-104, Butler, Pa. 16001.



Photofab example— words photo-etched in a sheet of .001 beryllium copper.

Make Hard Copy From CRT Or Facsimile Scanner (Remote PPI Display Via Slow Scan [3KHz] TV)



Study Trends in Oscilloscope Displays (Continuous EKG "Contourgram")

Plot From Scanning Sensors For Detection And Inspection (Ultrasonic Inspection For Bond Flaws)

PATTERN, PLOT OR PICTURE

Now . . . with a simple instrument . . . you can reproduce electrical phenomena as permanent records in pattern, plot, or picture form where otherwise the data is presented as transient oscilloscope or CRT displays.

The versatile Alden "Flying-Spot" Helix Recorder, used with Alfax Type A electro-sensitive paper, produces permanent graphic images of repetitive or sequential signals with a wealth of detail and information content not approached by other display and recording techniques.

It is a simple matter to synchronize the Alden Recorder with scanning sensor or transducer (sonar, radar, ultrasonic, infra-red detectors, etc.) to provide a continuous "plot" of the information obtained. The recorder sweep speed (horizontal output) can be varied to provide almost any desired rate of presentation. Paper advance rates can readily be changed to provide time expansion or compression for increased detail, or clearer representation of long-term data trends and improved signal-to-noise ratio.

The Alden Recorder can be used with a broad variety of systems (computers, television, medical instrumentation, facsimile, scanning radiometers, etc.) which produce sequential signals on a constant time base, to provide accurate and instantly visible "picture" or "pattern" information. Images are produced with a dynamic, tonal shading directly proportional to signal strength, providing a "third dimension" of information recording.

To satisfy your exact requirements, Alden "Flying-Spot" Component Recorders, in various printing widths from 4" to 48", along with a wide selection of plug-in drives, recording configurations, signal amplifiers, phasing circuits, and synchronizing accessories are available, designed to provide a simple, economical adaptation of Alden instant recording techniques to your instrumentation.

ALDEN

ELECTRONICS & IMPULSE RECORDING EQUIPMENT CO., INC., WASHINGTON STREET, WESTBORO, MASSACHUSETTS 01581 — TELEPHONE: (617) 366-8851

For more information on the most versatile data recorders available, write today for complete details.

Dept. E-11

ALDEN ELECTRONICS & IMPULSE RECORDING EQUIPMENT CO., INC., WASHINGTON STREET, WESTBORO, MASSACHUSETTS 01581

GENTLEMEN: I am interested in Alden "Flying-Spot" recording techniques.

I would like to investigate Alden Equipment for use in the following application:

I would like data for possible future reference.

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____ ZIP CODE _____

. . . lens needs no tanks to keep itself clean . . .

aren't burned with the CO and hydrogen.

Although intended for quick checking, the 7414 can run continuously and has a 5-second response time. The range is 0 to 5% concentration, and the instrument draws 30 watts from a 115-volt, 60-hertz input.

Milon says the 7414 is in the "advanced prototype" stage. This means Bacharach has a working instrument but is waiting for a big order before going into full production. According to Milon, the unit is now being tested by Detroit's Big Three and by the State of California.

The price isn't set, but Milon says it will be about \$350.

Smoke signal. The opacity meter uses a standard technique. A sensor containing a lamp and a photocell is placed at the end of the diesel engine's exhaust pipe. As the opacity of the exhaust changes, so does the amount of light reaching the cell, and the change in cell resistance is read out on a meter scaled in opacity units. The opacity is proportional to pollutant concentration.

One improvement over similar devices, says Milon, is that the Bacharach unit doesn't need compressed air to clean the lenses that focus light on the photocell, so a user doesn't have to lug air tanks around with him. Bacharach engineers built the device with the idea of selling it to New Jersey, one of the tougher states when it comes to pollution laws. Trenton hasn't decided whose meter to buy, but Milon says the Bacharach unit fills all the state's requirements.

The lenses are arranged so that the cell sees only light from the lamp; a truck won't fail a roadside inspection because a cloud passes in front of the sun.

The instrument runs off a rechargeable battery pack, has ranges of either 0 to 50% or 0 to 100% opacity, is accurate to within ± 2 opacity units, and costs about \$400.

Bacharach Instrument Co., RIDC Industrial Park, Pittsburgh 15238 [370]



Engineers and Scientists: Diversified opportunities now available on Hughes AGM's

Increasing Air-to-Ground Missile activity at Hughes Aerospace Divisions has created many diversified growth opportunities for qualified Engineers and Scientists. Immediate openings exist at all levels on a variety of interesting projects such as: MAVERICK, Anti-Radiation Missiles, Radar-Guided Missiles and new advanced missile technologies.

Areas of interest include:

Laser	Trajectory Analysis
Radar	Operational Analysis
Infrared	Warheads & Fuzing
Television	Structural Design
Guidance & Control	Thermodynamics
Signal Processing	Aerodynamics
Digital Computer Simulation Studies	

All assignments require accredited, applicable degrees, U.S. citizenship and a minimum of 3 years of related, professional experience.

Please airmail your resume to:

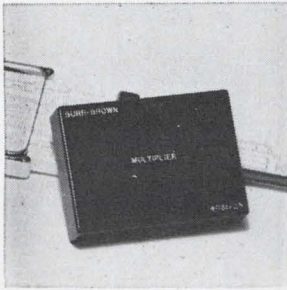
Mr. Robert A. Martin
Head of Employment, Dept. 65
Hughes Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City, Calif. 90230

HUGHES

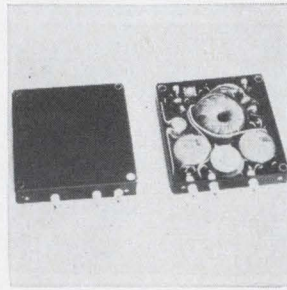
HUGHES AIRCRAFT COMPANY
AEROSPACE DIVISIONS

An equal opportunity employer

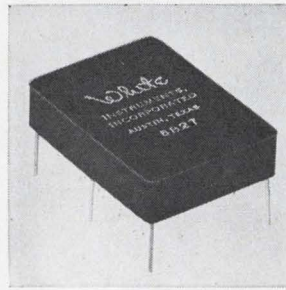
New Subassemblies Review



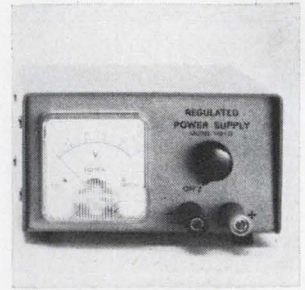
Modular triangle-averaging multiplier model 4031/25 may be used for 2-quadrant division, squaring, and square-rooting, as well as 4-quadrant multiplication with $\pm 0.5\%$ accuracy. Both inputs and the output are rated to ± 10 v, and the module operates on standard ± 15 v d-c power supplies. Unit price is \$145. Burr-Brown Research Corp., 6730 S. Tucson Blvd., Tucson 85706. [381]



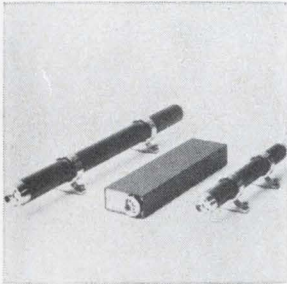
D-c/d-c converter type IT-322 is designed to supply accelerating voltage for a wide variety of post accelerator type crt's. Outputs of $\pm 2,200$ v at $40 \mu\text{a}$ and -850 v at 2 ma are available with 1% line regulation and 3% load regulation in a 5 cu in. module. Input is 28 v d-c $\pm 10\%$. Price in lots of 100 is \$125. ITI Electronics Inc., 369 Lexington Ave., Clifton, N.J. [382]



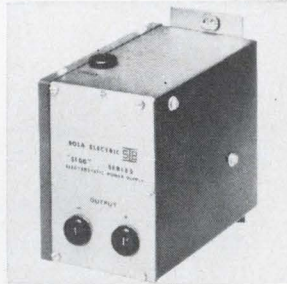
Low pass transister active filter type 714 provides a 3-pole Butterworth response to attenuate undesired frequencies at a rate of 60 db per decade. Operating temperature range is 0° to 70°C . Units with -3 db cutoff frequencies in the range of 10 hz to 10 khz are offered at \$45, and units down to 0.005 hz will be quoted. White Instruments Inc., Box 698, Austin, Texas. [383]



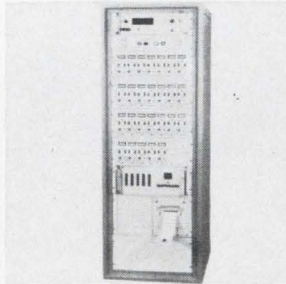
Power supply model TRP-25-0.25 is a solid state unit operating from 115 v 60 hz, delivering continuously adjustable d-c from 0.5 to 25 v at currents up to 250 ma. Housed in a cabinet $4\frac{3}{4} \times 4\frac{1}{2} \times 4\frac{1}{2}$ in. including direct reading voltmeter, it has an output regulated to $\pm 0.1\%$ against line variations of $\pm 10\%$. Canadian Research Institute, 85 Curlew Drive, Don Mills, Ontario. [384]



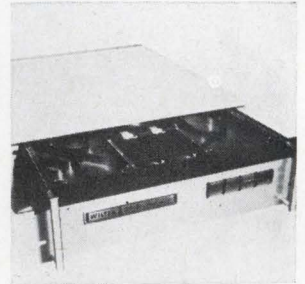
Helium neon lasers models 195, 210 and 230 feature a coaxial plasma tube design and have a guaranteed output in excess of 2 mw, 4 mw and 7 mw respectively. They come in a variety of modular configurations, and can operate at wavelengths of 6,328 angstroms, 1.15 and 3.39 microns. Optics Technology Inc., 901 California Ave., Palo Alto, Calif. [385]



Power supplies series 5100 are for electrostatic applications. They are ferroresonant-transformer regulated using basic voltage multiplying circuits to attain high voltage outputs from lower voltages on the transformer. Typical output voltages would be 12.5 at 1 ma; or 6 kv at 2 to 4 ma. Sola Electric Div., Sola Basic Industries, 1717 Busse Rd., Elk Grove Village, Ill. [386]



Digital data acquisition systems of the SD-500 series are for industrial processes, laboratory, aerospace and aircraft tests. They are designed to accept d-c or a-c signals in the range from 0 to 10 khz. Full scale input ranges 2.5 v rms and 25 v rms are standard. Prices start at \$25,000. Columbia Research Laboratories Inc., McDade Blvd. & Bullens Lane, Woodlyn, Pa. [387]



Magnetic tape buffer store DS-3 is for fast, accurate reception, storage and transmission of binary coded data. The basic machine provides independent read and write tape drives with associated electronics operating on a single closed loop of tape. Input and output are in 8-bit parallel format. Unit measures $5\frac{1}{4} \times 19 \times 22$ in. Wiltek Inc., 59 Danbury Road, Wilton, Conn. [388]

New subassemblies

Tape memory price and package trimmed

Skew is minimized in a low-speed recording system developed for small computers and peripheral equipment

Small-computer makers and peripheral-equipment houses usually have to buy the components and make their own memory subsystems. The price tags on off-the-shelf equipment have been just too high. Ampex Corporation says it will change that situation with a

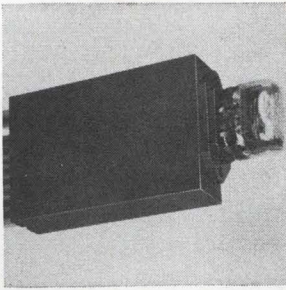
tape memory system in which substantially lower costs are achieved by use of integrated circuits, simplification of mechanical features, and elimination of waste space.

The unit will be demonstrated at the Fall Joint Computer Conference in San Francisco, Dec. 9-11.

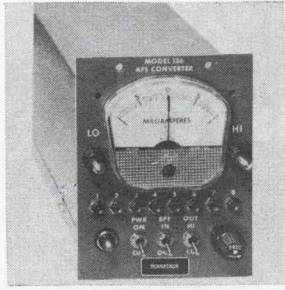
The model TM-Z, which is compatible with IBM computer systems, will sell for \$3500, a figure Ampex says is 20% to 40% lower than the prices on complete tape memories of comparable size and performance.

"The emphasis is on the word 'complete,'" says Eugene E. Prince, Ampex vice president and general manager of the Computer Products division. "Tape memory prices often include only the transport. Such equipment as record/reproduce heads and electronics are available at extra cost."

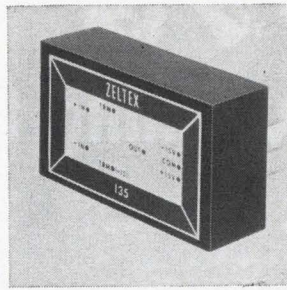
The TM-Z will be available in December and will be sold in mini-



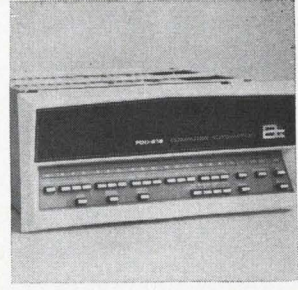
Decode/display memory module series DS-100 is designed to drive a Datecon cold-cathode tube directly from low level natural binary coded decimal input. The input count is stored in a quad latch memory and displayed on a readout tube. The display is updated upon application of a gating signal to the quad latch. Integrated Circuit Electronics Inc., Box 647, Waltham, Mass. [389]



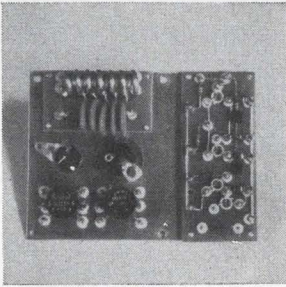
Converter model 136 is fed audio-frequency-shift signals as received by a compatible radio receiver, or from line signals, and converts them into amplitude modulated signals suitable for photo-facsimile or teletypewriter reproduction. The converter will accept input frequencies 1,500 to 2,300 hz. International Scanatron Systems Corp., 1623 Straight Path, Wyandanch, N.Y. [390]



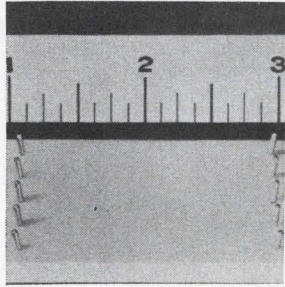
FET differential amplifier model 135 is for use in sample and hold circuits, integrators and buffers. Key specs include: common mode rejection ratio of 300,000 v/v, gain bandwidth product of 5 Mhz, and slew rate of 100 v/μsec, minimum. The unit measures 1.135 x 1.135 x 0.640 in. Price is \$89 in evaluation quantities. Zeltex Inc., 1000 Chalomar Road, Concord, Calif. [391]



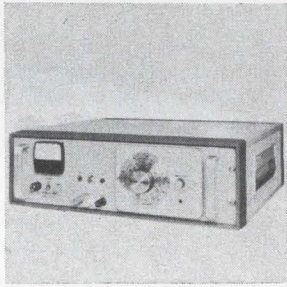
Programed digital controller model 816, with a 4,096 word 16-bit memory and over 140 basic instructions, is for a variety of control, monitoring, data logging, data communication and calculation tasks. Many standard peripherals are available including teletypewriter, magnetic and paper tape, disk, and modems. Computer Automation Inc., Newport Beach, Calif. [392]



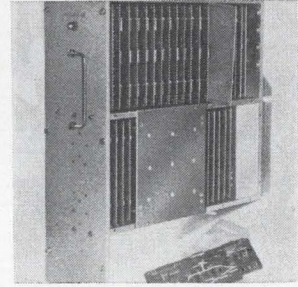
Diode laser pulser P-110 has a pulse length adjustable over 10 nsec to 210 nsec in 25 nsec steps, permitting flexibility in choice of signal characteristics. Pulse repetition rate is variable from 1 pulse every 2 sec to 30,000 hz. Pulse amplitude is continuously variable from 0 to 100 amps at any prr up to 30 khz. Seed Electronics Corp., 9 Cypress Drive, Burlington, Mass. [393]



Hybrid IC audio amplifier BHA-0002 is capable of a sustained 15 w output. Distortion is 1% or less while operating into conventional speaker loads. Frequency response is 25 hz to 20 khz. Operating case temperature is -30° to +100°C. Price is \$5.60 each in lots from 100 to 999; \$9.40 each in lots from 1 to 24. Delivery is 2 weeks. Bendix Corp., South St., Holmdel, N.J. [394]



A solid state family of a-c power sources are modularly constructed and supply 130 va to 2,000 va using 19 plug-in oscillator options. Model 200-S shown features full power from 45 hz to 10 khz, regulated output settable to zero low distortion (typically 0.5%), and is short circuit proof. Price is \$580. Vector Engineering Inc., 58 Brown Ave., Springfield, N.J. [395]



Compact, rugged core memory model CR-95 is available in capacities of 4,096 and 8,192 words with word lengths variable in 4 bit increments from 8 to 36 bits. Full cycle time is 1 μsec with access time less than 500 nsec. The unit is designed for application as a memory or buffer in small computers. Lockheed Electronics Co., 6201 E. Randolph St., Los Angeles. [396]

num quantities of 100. The company says that with this system, it will be more economical for manufacturers of small computers and peripheral equipment to purchase complete tape memories than to buy components and build their own.

The unit operates in both seven- and nine-track modes. Tape speeds run up to 24 inches per second and packing densities up to 800 bits per inch.

All in one. Both the transport unit and the memory electronics are in a single 100-pound package that takes up only 24 inches in a standard 19-inch equipment rack. The

system, 19 inches deep, consists of three mechanical and electronic modules; replacement of the mechanical modules can be done by semiskilled technicians. The capstan head assembly is prealigned.

The single-capstan tape drive uses 80% fewer parts than pinch-roller machines, and this reduces maintenance, eliminates tape path adjustments, and makes for gentler tape handling, according to Ampex.

Integrated circuits are used extensively in the unit. All the read-write electronics are on a single 8-by 12-inch card, and all the mode control and servo control electronics are on another. The two fit



Compact. Tape memory system occupies 24 inches in standard rack.

NATIONAL®
Regenerative Gate* SCR

lowest switching losses

Operates to 20 KHz with switching losses lower than any other high power SCR available. Ideal for inverters, choppers, DC to DC converters, cycloconverters. Only the Regenerative Gate* SCR gives 600 amperes/ μ sec. di/dt with low power gate drive. 110 ampere rating available with 200 volts/ μ sec. minimum dv/dt and 10 μ sec. maximum turn-off time.

*A NATIONAL® exclusive,
Patent Pending.

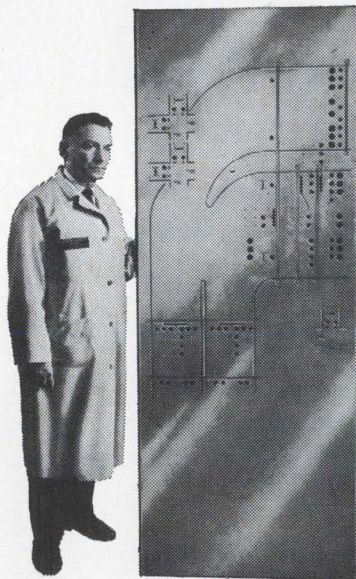
NATIONAL
ELECTRONICS, INC.
a varian subsidiary

PHONE: (312) 232-4300 • GENEVA, ILLINOIS 60134

REQUEST BULLETIN

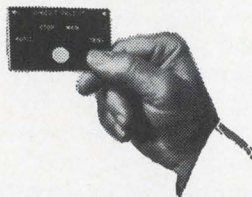


Circle 332 on reader service card



think
BIG

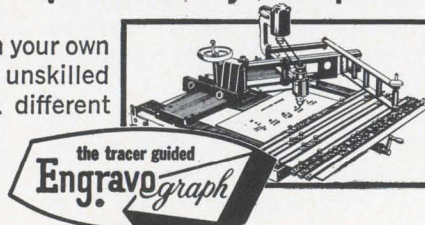
(also small)



Now engrave anything from 6 ft. panels to tiny nameplates

Engravograph tackles them all. Right in your own shop, effortlessly, speedily — ideal for unskilled workers. Adjustable ratio engraves 21 different sizes.

Write for illustrated catalog # 114



new hermes engraving machine corp.

... tape drive capstan
is servocontrolled ...

in what would otherwise be waste space in the machine.

Doubleheader. The read-write head is in two individually adjustable pieces, each having its own gap. One of the gaps is used for writing and the other for reading; the tape first passes over the write gap and then over the read, so that the computer has a chance to read what it has just written and thus check for errors. The head sections are on the short ends of long levers with adjusting screws for very fine control—in microinches—and this control serves to reduce skew.

Most important in controlling skew—time displacement of nominally simultaneous pulses—is a technique employing special checkout and testing equipment to precisely align the gaps.

Minimum gap scatter plus separately adjustable read and write head sections hold down skew to the point that individual adjustments on the data channels aren't needed. Therefore, replacing a circuit card is simply a matter of unplugging and plugging. In some other systems, the replacement card has to be "tuned" to the skew characteristics of the particular drive into which it is being plugged.

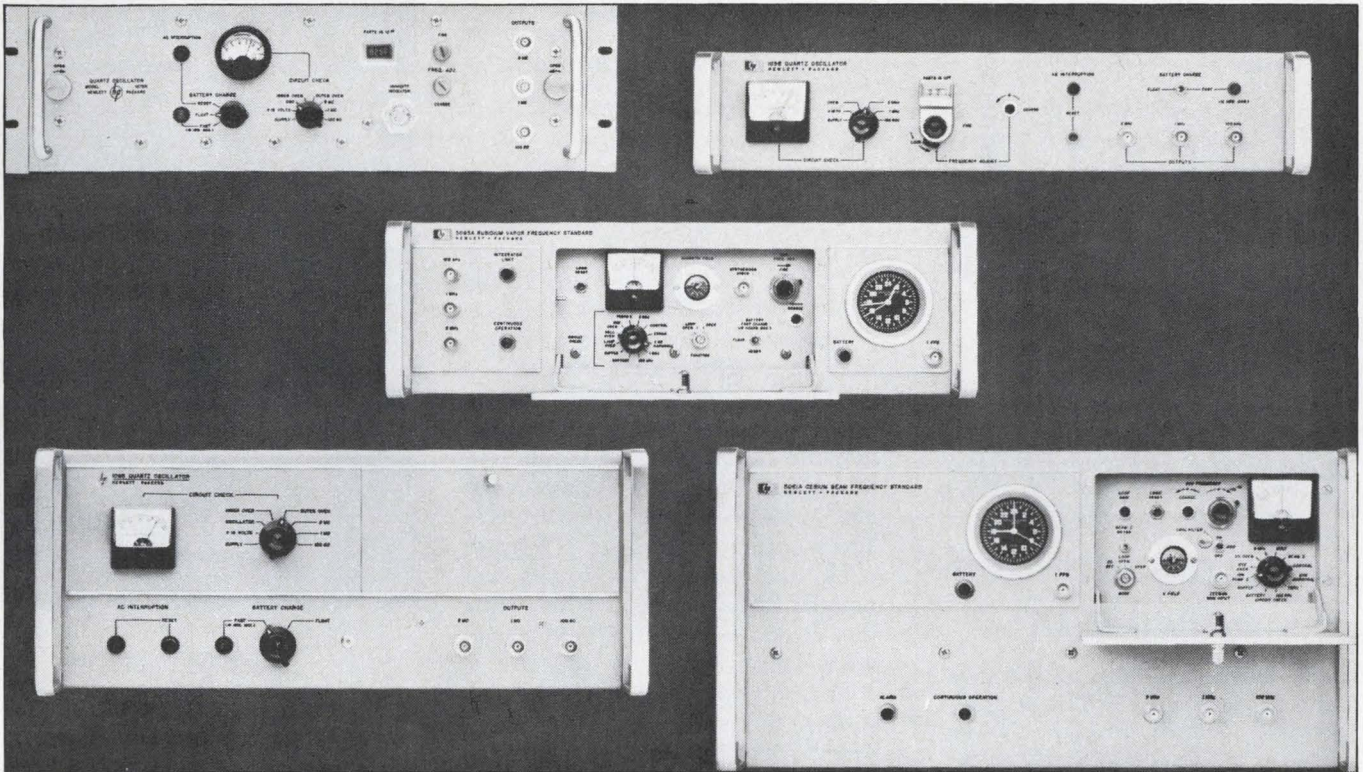
The TM-Z's relatively low tape speed contributes to its low cost, and also helps reduce skew; tape moving slowly is less inclined to flap as it moves across the head. The speed also permits the use of follower arms instead of vacuum columns to control servomotors on reels—another cost shaver.

The capstan is also servocontrolled and has a tachometer and a d-c generator whose output is proportional to speed. A variable potentiometer on it permits tape speed to be varied from 10 to 24 inches per second, depending on the application.

Servo control is usually preferred to synchronous motor drives. The latter run at fixed speed, but the speed is locked to a primary power frequency and is more susceptible to line power and frequency surges than are servocontrol devices.

Computer Products Division, Ampex Corp., Culver City, Calif. 90230 [397]

No matter which HP frequency/time standard you buy....



you're getting the best of its kind.

Hewlett-Packard Frequency & Time standards are known throughout the world for their ability to meet specific frequency and timekeeping requirements. Each type gives outstanding performance in its particular class; accuracy, precision, stability and rugged dependability.

—The HP 5061A Cesium Beam Frequency Standard has been flown around the world to coordinate international timekeeping stations within 1 microsecond. It has no long-term drift and an absolute accuracy of ± 1 part in 10^{11} for the life of its cesium beam tube. That's the equivalent of losing only one second in more than 3000 years. It costs \$14,800 as a frequency standard, \$16,900 as a time standard with internal standby power.

—The HP 5065A Rubidium Frequency Standard offers you superior electrical quietness over short periods of time, with short-term stability of 7×10^{-13} rms, 100 s. avg.; 7×10^{-12} rms, 1 s. avg. It's highly portable, yet rugged enough to take tough field operation. It costs \$7500 as a frequency standard, \$9300 as a time standard with internal standby power.

—The HP 105A Quartz Oscillator offers you the best stability available for the price. Aging rate less than 5 parts in 10^9 per day; short-term stability $< 1 \times 10^{-11}$ rms (1 s. averaging); S-N ratio > 90 dB; rapid warm-

up. It costs only \$1500. The 105B has built-in standby power, \$1800.

—The 106A is HP's most stable quartz oscillator: aging rate $< 5 \times 10^{-11}$ per day. Price: \$3750. The 106B, with built-in standby power, is \$4200.

—The 107AR is HP's most rugged quartz oscillator, and is hermetically sealed. Aging rate $< 5 \times 10^{-10}$ per day. Price: \$2600. The 107BR, with built-in standby power, is \$2950.

Also available from HP are the 117A VLF Comparator, for comparing frequency against NBS 60 kHz standard frequency broadcasts, \$1400 (incl. loop antenna); the 115BR Digital Clock and Frequency Divider, \$3000; and the highly versatile KO2-5060A Standby Power Supply, \$2850.

For information about all HP frequency & time standards and their various options, call your HP field engineer. Or write Hewlett-Packard, Palo Alto, California 94304; Europe: 54 Route des Acacias, Geneva.

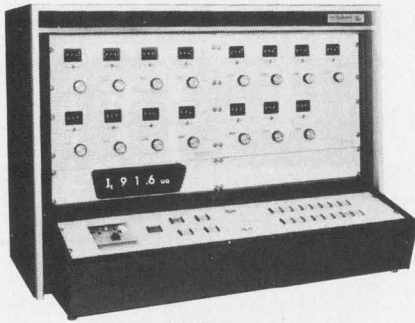
HEWLETT  **PACKARD**

FREQUENCY STANDARDS

02821



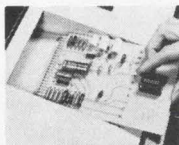
Model 79 Linear IC Tester



New automatic Linear IC Tester offers simple, preprogrammed operation

The simple operation of the new automatic Model 79 Linear Integrated Circuit (LIC) Tester from Test Equipment Corporation virtually eliminates costly operator training. This savings, combined with its low initial cost, makes the Model 79 an excellent buy for production, engineering and quality control applications.

TEC's Model 79 "LIC" Tester is completely automatic with the



exception of test limits and range selections and is preprogrammed on performance boards (inset)

for up to 15 different test measurements. It provides five dc and eight dynamic tests. In addition, two auxiliary positions are available for customer-specified tests.

The Model 79 features low current measurements to 99.9 pa full scale, low voltage measurements to 99.9 μ V full scale, and high speed typically 100 ms or less per test. It accepts all IC package configurations.

Write today for full technical and pricing information on the new TEC Model 79 "LIC" Tester.

Test Equipment

CORPORATION
P.O. BOX 20215, DALLAS, TEXAS 75220 • 214/357-6271

New subassemblies

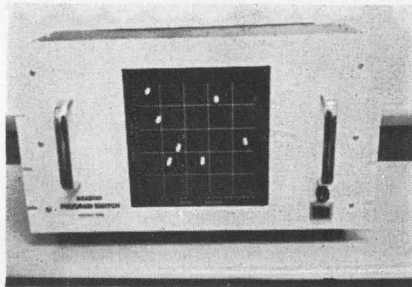
Electronic switch is a random thing

Device with 25 inputs,
25 outputs is programed
through its front panel

Attracted by the reliability and compactness of solid state systems, a textile manufacturer recently asked the Agastat division of the Amerace-Esna Corp. to build a replacement for the banks of relays used to control a dye process.

"They wanted to know if we could make an electronic switch capable of handling 25 inputs and 25 outputs on a purely random basis," recalls William Ward, Agastat's sales manager. Agastat could and did, and the textile firm bought 100 of these switches. Now the device is being offered as an off-the-shelf item.

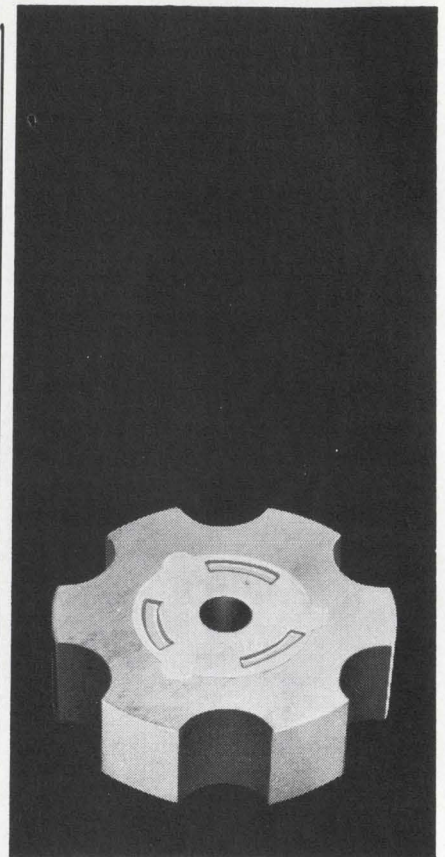
"I don't know of anybody else selling a switch like this," says Ward. "It's completely programable and its program can be



Pinpoint program. Each pin plugged into a socket connects a specific input to a specific output.

changed easily at any time. And notice I'm not calling this a stepping switch; that connotes some kind of sequential operation. This is completely random."

Plug-in program. On the switch's front panel is a square pegboard with 25 sockets on each side. Each row is associated with one of the 25 inputs, and each of the columns with one of the outputs. To program the switch, the user plugs shorting pins into specific sockets. For example, if he wants input



For Extra Meter Precision and Consistency Specify Hitachi Magnets

To create these extremely stable magnets Hitachi developed its own processes for the compounding and heat-treatment of fine alloys. The result is a range of cast magnets for metering that are precisely finished to unusually close tolerances, are more compact, and yet retain magnetic stability and uniformity. You can get a fast supply of Hitachi meter magnets with properties to suit your particular application. Each one has guaranteed characteristics. Full information on types for your application can be quickly mailed.

Products:

Meter Magnets:

For Speedometer, Tachometer,
Amperemeter

Motor Magnets:

For Micro Motor, Hysteresis Motor,
Wiper Motor, Blower Motor

Generator Magnets:

For A.C. Generator, Flywheel



Head Office
Chiyoda Bldg., Marunouchi, Tokyo, Japan
Hitachi Metals America, Ltd.
Magnet Materials Sect.
437, Madison Ave., New York, N.Y. 10022,
U.S.A. Tel. 212-758-5255

NEW 5/16" TRIMMER PACKS TIGHTER

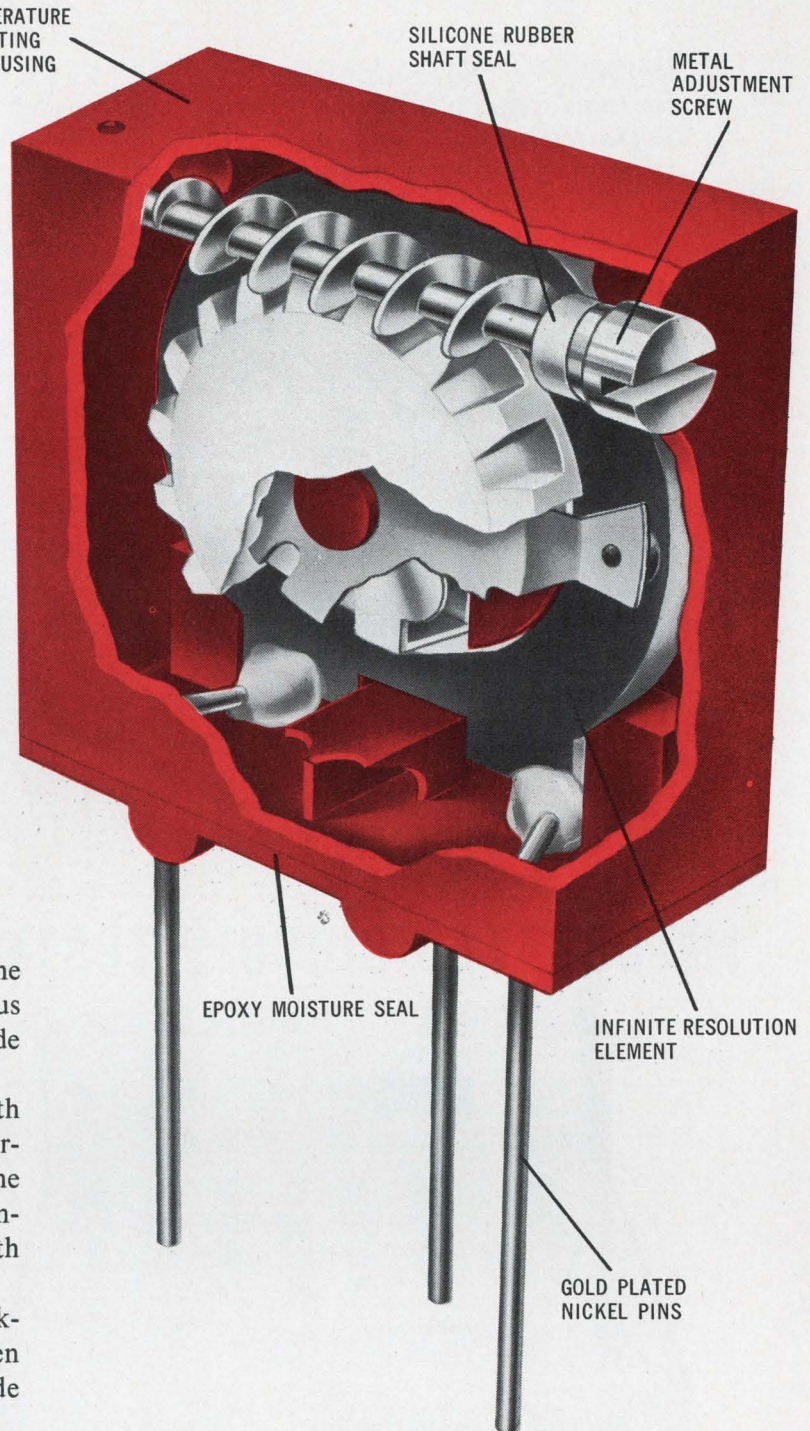
Saves space without sacrificing performance

IRC's new 5/16" square trimmer gives you the performance and stability of larger units plus the opportunity to save board area and provide greater packaging density.

Two types are now available. The 850, with infinite resolution, is designed to meet the environmental requirements of MIL-R-22097. The 800, a precision wirewound trimmer, is designed to meet MIL-R-27208 environments. Both are priced significantly less than MIL styles.

The metal adjustment screw eliminates breakage or distortion of the screwdriver slot even after repeated use. Staggered pins provide strength and mounting stability.

Both types are fully sealed and impervious to common industrial solvents because of a silicone rubber shaft seal and epoxy bonding at all seams. They exceed MIL humidity cycling tests. For complete data and prices see your IRC Qualified Industrial Distributor. Or, write IRC, 401 N. Broad St., Philadelphia, Pa. 19108.



Actual size
Infinite Resolution
Circuitrim 850



Actual size
Precision Wirewound
Circuitrim 800

CAPSULE SPECIFICATIONS

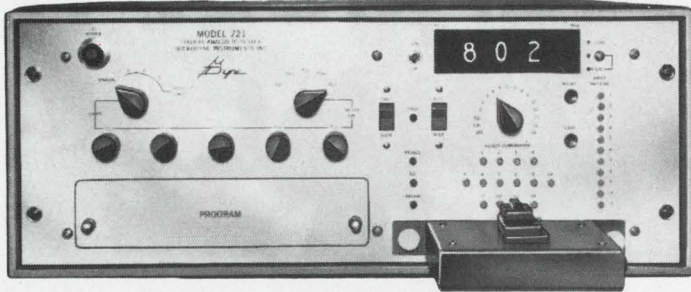
POWER	0.3 Watt @ 70°C (300V max.)	0.6 Watt @ 70°C
TOLERANCE	±10% or ±20%	±5%
RESISTANCE	100Ω to 1 meg.	10Ω to 20K
TEMP. RANGE	-65°C to +125°C	-65°C to +150°C
INSULATION RESISTANCE	1000 megohms @ 500V DC	1000 megohms @ 500V DC
DIELECTRIC STRENGTH	900V AC	900V AC



DIVISION OF TRW INC.

MODEL 721 Fully Automatic for high speed production testing. Performs both **PARAMETRIC** and **FUNCTIONAL** tests simultaneously

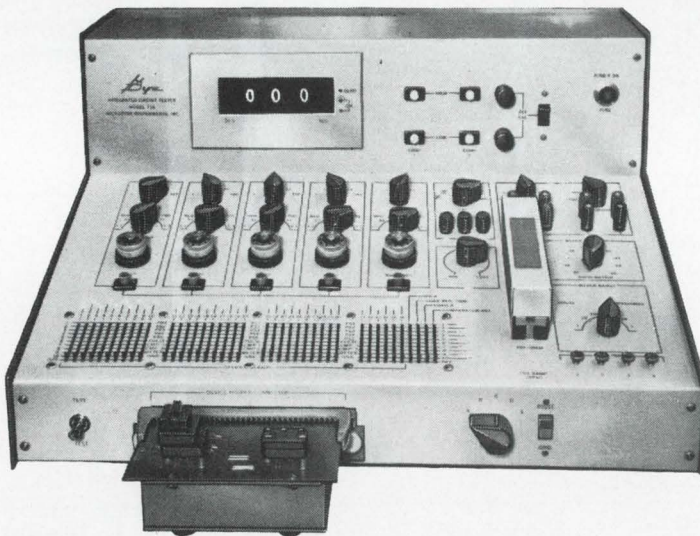
priced from **\$3490**



MICRODYNE MODELS 721 & 716

VERSATILES

INTEGRATED CIRCUIT TESTERS



MODEL 716 Manual/Semi-Automatic for engineering evaluation. Quality control and small quantity production testing. Capable of testing both **LINEAR** and **DIGITAL** circuits.

priced from **\$1890**

Microdyne

MICRODYNE INSTRUMENTS, INC.

203 MIDDLESEX TURNPIKE • BURLINGTON • MASSACHUSETTS 01803 • (617) 272-5691

**... if an output goes bad,
just replace one card ...**

seven to trigger output 16, he plugs a pin into the socket located where row seven intersects column 16.

Any number of pins up to 625 can be plugged into the board in any arrangement.

The outputs are silicon controlled rectifiers that close when a signal is applied to an appropriate input and open when the input is removed. Each SCR can continuously handle 4 amps at 115 or 220 volts and can take surges as high as 60 amps.

The input can be almost any waveform from a d-c voltage to a pulse that's 10 milliseconds wide.

In the original model, if voltages appeared at more than one input at the same time, the output switches associated with the energized inputs closed simultaneously. However, Agastat engineers can build in logic circuits that assign priorities to the inputs.

Searching. Inside the switch, input signals cycle through a matrix of AND gates looking for paths through shorting pins to the outputs. Inside each of the inch-long, plastic-covered pins is a single diode that prevents feedback to the input circuits.

All the switch's circuitry is on printed-circuit boards. Behind the pegboard is a large p-c board with input circuits, power supplies, and interconnections mounted on one side; on the other side, output cards are stacked perpendicular to the large board. If one output circuit goes bad, the card it's on is replaced.

The original units had five of these output boards with five output circuits per board. But Ward says the new units will have 10 or 15 output cards to handle the 25 output circuits. The fewer circuits per card, the cheaper it is to replace a card when a circuit goes bad, he notes.

Replacing an output card takes but seconds, and if the main board goes bad, it only takes a few minutes to pull the whole switch out of the control system since the switch only has three cable connections—inputs, outputs, and power.

Ward expects anyone in the process-control business to be in-

These new SAMPLE/HOLD MODULES from BURR-BROWN



actual size

will help you build accurate A/D conversion systems in less time...at lower cost

Of the six Sample and Hold (or Track and Store) modules supplied by Burr-Brown, these two new units are proving to be the most popular. Why? Because they provide the type of precise, non-inverting performance that is ideally suited for highly-accurate A to D conversion systems. And, the price is reasonable. Only \$110.00 for the 4034/25 . . . \$125.00 for the 4035/15 . . . in single unit quantity.

Both units have excellent gain accuracy ($\pm 0.01\%$), low drift in the HOLD mode and a $10M\Omega$ input impedance. Size is a convenient 1.80" x 2.40" x .60" for the Model 4034/25 . . . only 1.20" x 1.80" x .60" for the Model 4035/15. Rack mount versions are also available.

FOR DETAILED INFORMATION

on the complete line of Burr-Brown Sample/Hold Modules,

simply contact your Burr-Brown Engineering Representative or use this publication's reader service card.

HIGHLIGHT SPECIFICATIONS

	4034/25	4035/15
Accuracy (0 to 60°C, 1% of f.s.)	$\pm 0.01\%$	$\pm 0.01\%$
Input Impedance	10 M Ω	10 M Ω
Aperture Time	0.05 μ s	0.05 μ s
Acquisition Time		
Settling to 0.01%	1000 μ s	100 μ s
HOLD Decay (at 25°C)	± 0.1 mV/s	± 0.25 mV/s
Power Requirements	± 15 V	± 15 V
Price, single unit quantity	\$110.00	\$125.00

BURR-BROWN

RESEARCH CORPORATION

International Airport Industrial Park • Tucson, Arizona 85706
TELEPHONE: 602-294-1431 • TWX: 910-952-1111 • CABLE: BBRCORP



Operational Amplifiers
Instrumentation Amplifiers
Function Modules
Active Filters
Power Supplies

ENGINEERING REPRESENTATIVES: ALABAMA, HUNTSVILLE (205) 534-1648 / ARIZONA, PHOENIX (602) 254-6085 / CALIF., LOS ANGELES (213) 665-5181, SAN DIEGO (714) 232-2017, SAN FRANCISCO (408) 244-1505 / COLO., DENVER (303) 399-4391 / CONN., EAST HARTFORD (203) 874-9222 / D.C., WASHINGTON (SEE MARYLAND) / FLORIDA, ORLANDO (305) 425-2764 / ILLINOIS, CHICAGO (312) 286-6824 / LA., NEW ORLEANS (504) 888-2266 / MD., SILVER SPRING (301) 588-8134 / MASS., BOSTON (617) 245-4870 / MICH., DETROIT (313) 358-3333 / MINN., MINNEAPOLIS (612) 781-1611 / MO., ST. LOUIS (314) 524-4800 / N.C., GREENSBORO (919) 273-1918 / N.J., CAMDEN (215) 925-8711 / N.M., ALBUQUERQUE (505) 255-1638 / N.Y., ALBANY

(518) 489-4777, BINGHAMTON (607) 723-9661, MT. VERNON (914) 968-2200, NEWBURGH (914) 561-4510, NEW HARTFORD (315) 732-3775, ROCHESTER (716) 473-2115 / OHIO, CINCINNATI (513) 761-5432, CLEVELAND (216) 237-9145, DAYTON (513) 277-8911 / PENN., PHILADELPHIA (SEE CAMDEN, N.J.), PITTSBURGH (412) 243-6655 / TEXAS, DALLAS (214) 357-6451, HOUSTON (713) 774-2568 / UTAH, SALT LAKE CITY (801) 466-8709 / VIRGINIA, (SEE MARYLAND) / WASH., SEATTLE (206) 767-4260 / CANADA, DOWNSVIEW, ONT. (416) 636-4910, MONTREAL, QUE. (514) 739-6776, OTTAWA, ONT. (613) 725-1288, VANCOUVER B.C. (604) 291-7161

Custom Magnetic Processing with Standard Components

RFL Automagnetic® Systems — New Concept in Magnetic Processing

The RFL Automagnetic System now makes it possible to completely automate your production permanent magnet processing operation at a minimum cost. This new concept affords maximum flexibility for manual, automatic and programmable operations. Complete processing of magnets, meter movements, magnetic assemblies and a wide range of relative applications can all be achieved automatically by using *standard* RFL magnetizing, treating, and measurement equipment. Each instrument can be used individually for production, field and laboratory applications.

BASIC COMPONENTS

A typical Automagnetic System would consist of a Model 3260 Magnet Charger, a Model 990 Magnetreater®, a Model 750 Gaussmeter, and a Model 3356 Automatic Module Enclosure. The configuration of a system will vary according to specific customer requirements.



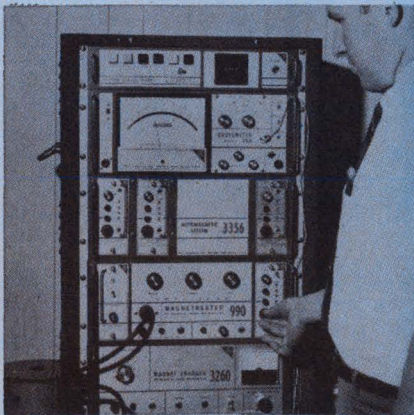
OPERATION OF THE SYSTEM

The magnet material to be processed is placed in the magnetizing/treating and measuring fixture which is interconnected to the Model 3260 Magnet Charger and Model 990 Magnetreater. The magnet is then charged to saturation. The Model 750 Gaussmeter, will indicate the magnet saturation flux density. Simultaneously, the gaussmeter output is fed to the input of the control circuitry of the Model 990 Magnetreater. When the information is received, the treating cycle will automatically begin. (In some instances other sensing apparatus may be used for a means of control.) A series of continuously increasing amplitude pulses treat the magnet to a preset level and the process is automatically terminated. During this entire operation, the value of the magnet's flux density may be monitored on the gaussmeter. A System Status Panel, using indicators will show that the operation is complete and is ready for another process. Other conditions such as Calibrate, Operate, Non Saturate, Overtreat and Incomplete can be incorporated on this status panel. Failure to reach the pre-Circle 258 on reader service card

set level results in the operation of an Incomplete signal indicating the possibility of a flaw in the material or improper control settings.

APPLICATIONS

The RFL Automagnetic System is primarily used for production processing of magnets and magnetic assemblies. Typical production assembly processing includes TWT magnets, Bar and C shaped magnets and other basic magnet configurations. The Automagnetic System is particularly suited for processing magnets in assemblies that require field strength adjustments. Typical of these applications are: precision adjustment of D-C meters, torque motors, accelerometers, permanent magnet field motors and other designs embodying permanent magnets. Basically any magnet or magnet assembly requiring magnetic adjustment can be processed with the RFL Automagnetic System.



RFL's Magnetic Applications Engineering Staff will design at no cost, the necessary fixturing interconnection wiring and any additional apparatus for specific customer requirements. For detailed information on Automagnetic Systems contact:



RFL Industries, Inc.
Instrumentation Div. • Boonton, N. J. 07005
Tel: 201-334-3100 / TWX: 710-987-8352 / CABLE: RADAIRCO, N.J.

terested in the switch. "We'll be going after people like Foxboro and Leeds & Northrup," he says.

Packaging is decided by the customer; in a rack mount, for instance, the unit measures 18 by 10 by 12 inches. The customer also tells Agastat what the input voltage levels will be.

Delivery time is two months and price is around \$1,000.

Agastat Division, Amerace-Esna Corp., Elizabeth, N.J. [398]

New subassemblies

Modulator works with hangers-on

Unit for laser Q-switching easily fitted with prisms, windows, and mirrors

"In a way, it's like an oscilloscope because it's built to take different types of plug-ins without too much adjustment," says Robert Goldstein, president of Crystalab Products Corp., describing a new light modulator for laser Q-switching.

Prisms and Brewster windows, optical devices used for high-power work, can be attached to the model 3051. So can bleachable dye cells, which are used for mode-locking work and for reducing the rise time of switching pulses.

The 3051 can also be fitted with a second-harmonic crystal generator and with a totally reflective mirror. When the mirror is attached, the 3051 can be put right into one end of a laser cavity.

The 3051 is a Pockels-effect modulator—the electric field inside the device is parallel to the optical path.

Choices. Available in eight models, the price of the modulator ranges from \$925 to \$1,775. For all models, the optical power-density capability is 250 megawatts per square centimeter, the rise time of the switching pulse is one nanosecond, and the maximum transmission is 96%.

The bandwidth of some models is 0.25 to 1.10 microns, while others

communications engineers

needed now

Here at MITRE we're involved in many highly complex (and urgent) projects requiring the special skills of Communications Engineers and Specialists. We're working on Air Force and

Defense Communications Agency programs in Bedford, Massachusetts, and Washington, D.C.

MITRE is responsible for planning and designing new systems for transmission and reception of voice, digital, and pictorial information over global distances — sometimes involving communications satellites. We're also responsible for integrating these new systems with existing ones. The need for technical innovation is great.

We need EE's (from BS to Ph.D.) who qualify for Technical Staff positions in any one of the following areas:

Communications Systems

- Systems engineering from planning to final evaluation of common-user communications networks in survivable command and control, tactical air control, and space and weapons systems.
- Analytical studies of modulation and filtering processes associated with wireline digital data transmission devices.
- Design analysis, system planning and laboratory studies in secure voice communications.
- Data processing techniques and digital terminal equipment.
- Conceptual design, acquisition and check-out of line-of-sight digital and analog links for radio surveillance systems.

Communications Techniques

- Theoretical analysis, advanced development test and evaluation of advanced digital data transmission techniques.
- Advanced modulation theory and system design.
- Coding theory applications to system design.
- Sequential decoding.
- Pseudo-noise communications and ranging.
- Digital filtering analysis, synthesis and computer modulation and evaluation.
- Airborne data communications, AJ and ECM techniques.
- Logic design and special purpose computer architecture.
- Theory and design of digital data multiplexing.
- System design and integration of complex avionics, and/or shipborne digital communications systems.
- Airborne communications systems, electromagnetic interference, automated system control and performance monitoring.

Communications Satellite Systems

- Design and application of simulators, both computer-based and man/machine laboratory, for satellite communications systems.
- Preparation of operational and technical test plans for tactical satellite communications program.
- Design and analysis of advanced operational communications satellite systems.
- Analysis of user requirements.
- Equipment engineering for tactical satellite communications program.
- Field testing experimental tactical communications systems.
- Analytical and experimental work in modulation and multiple access techniques, signal processing frequency allocation, net control and modems for communications satellite systems.

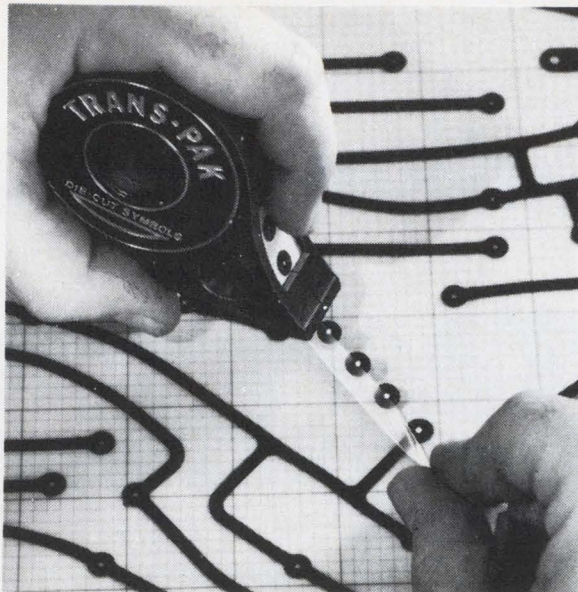
Communications Systems Planning

- VLF propagation and modulation techniques.
- Microwave communications system design, test and implementation.
- Aircraft communications and navigation systems design with an analysis base in electronic systems.
- Communications system and network planning, design and implementation.
- A key program requiring the above capabilities involves the systems engineering for the CNI (Integrated Communication, Navigation and Identification) project.

THE
MITRE
CORPORATION

Address Mr. Richard Seamans, The MITRE Corporation, 3911 Middlesex Turnpike, Bedford, Mass. 01730
In Washington, Mr. Robert Knotts, The MITRE Corporation, P.O. Box 1202BC, Bailey's Crossroads, Va. 22041

Chart-Pak® short cuts get printed circuit masters off the board fast!



- Trans-Pak die-cut symbols and Chart-Pak pressure sensitive tapes cut time, cut cost.
 - Trans-Pak's unique patented "position, press and peel" method permits fast application of distortion-free symbols.
 - Chart-Pak crepe paper tapes precision-slit guaranteed to $\pm .002$ " accuracy.
 - Finished masters reproduce with maximum sharpness . . . require minimum opaquing.
 - Chart-Pak's Precision Grids guarantee master accuracy.
- Using is believing . . . write for free catalog showing complete line of printed circuit materials.

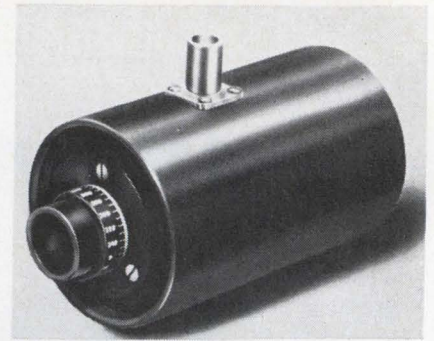


CHARTPAK ROTEX

A Division of Avery Products Corp.
146K River Road, Leeds, Mass. 01053

Look In The Yellow Pages under Charts/Business, Drafting Supplies, Tapes or Art Supplies for your dealer's name.

Circle 334 on reader service card



Same road. The electric field generated by the 3051 travels parallel to the light from the laser.

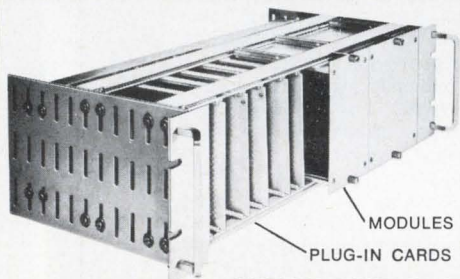
work up to 1.30 microns. Depending on model, angle aperture is 0.5° , 0.6° , 0.75° , or 1.0° , and aperture diameter is 6.35, 10, 12.5, or 16 millimeters.

The crystal can be either potassium dihydrogen phosphate (KDP) or potassium dideuterium phosphate (KD*P). Multiple-crystal units, which have lower operating voltages, are also available.

The least expensive unit, the 3051-6, has a KDP crystal, 6.35-mm aperture diameter, and 1.0° angular aperture, while the \$1,775 model's crystal is KD*P, aperture is 16 mm, and angular aperture is 0.5° .

Crystalab says the 3051 can resist shock and vibration. "We don't have any numbers because we don't know of any standard shock and vibration tests for lasers," says Goldstein. "But we've dropped the modulator, and thrown it against the wall, and it still worked."

Crystalab Products Corp., 19 Legion Place, Rochelle Park, N.J. [399]



Vector-strut Cages Have Universal Adjustability

- STRENGTH
- HANDSOME APPEARANCE
- QUICK ASSEMBLY
- LOW COST

CHECK THE SPECS AND SEE:

THE VECTOR-STRUT CAGE provides an adjustable aluminum frame which through customer test has proven to be more versatile than other competitive units on the market.

- Mountable on 10", 19" or 24" racks.
- Three standard heights - $3\frac{1}{2}$ ", $7\frac{1}{2}$ ", $8\frac{3}{4}$ ".
- Three standard depths - 8.975", 11.975", 15.725".

• Prototype quantities shipped from stock. Production quantities in minimum time.

• Vertically slotted side walls and adjustable cross member end brackets allow universal height and depth adjustability for cards and module cases.

• Infinite adjacent positioning capability for modules, cards and connectors with extruded fastener holding ducts.

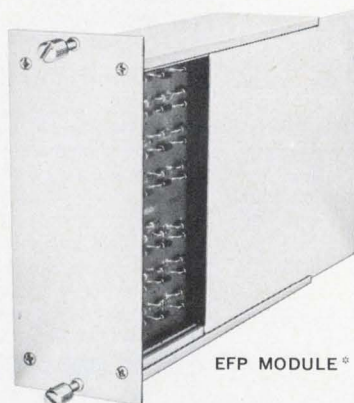
"EFP" ALUMINUM MODULE CASES® to fit Vector-Strut Cages

• Sixty (60) standard sizes for circuit cards, featuring $\frac{1}{16}$ " extruded grooves on .150" centers across case width for easy card mounting — no holes required in circuit board.

• Slide out side covers for quick access to cards.

• Front panels with captive thumb screws and rear panels either slotted or closed for user's connector design.

FOR HIGH FREQUENCY Vector Pak plug-in cases provide 90 to 100 DB of shielding with optional side panel gasketing.



EFP MODULE®

® Patented Features

Write the factory for specification data and prices.



Vector ELECTRONIC COMPANY, INC.

12460 Gladstone Ave., Sylmar, Calif. 91342

New subassemblies

Data recorder has light touch

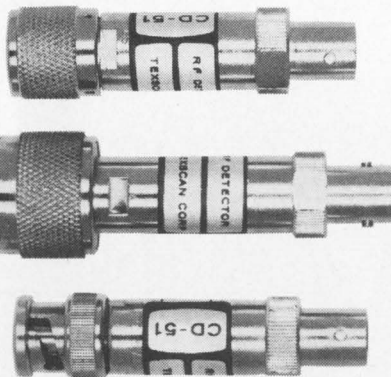
Keyboard-to-tape unit
uses single-capstan drive;
left-zero fill is standard

One of the truisms of the computer business is that computers themselves are becoming too fast too soon for peripheral equipment.

RF Detectors

Texscan crystal detectors are broadband devices designed for use in 50 or 75 ohm coaxial systems. Featuring low VSWR and excellent flatness, these detectors are ideal for use with sweep generators, reflectometers, and other general purpose applications.

- CD-50 0.1 MHz to 1 GHz
- CD-51 1 MHz to 4 GHz
- CD-75 0.1 MHz to 1 GHz



TEXSCAN CORPORATION
 2446 N. Shadeland Avenue
 Indianapolis, Indiana 46219
 Telephone (317) 357-8781
 TWX: 810 - 341 - 3184

It's usually put his way: "What good is it making computers that hum along in nanoseconds if the machinery that feeds them can only chug along in milliseconds?" The obvious answer to the lag is to design faster peripherals; another, and perhaps simpler remedy, is to eliminate steps in data-handling operations.

The punched card has long been considered one of the worst slow-pokes [Electronics, April 15, p. 193]. Equipment that enters information on magnetic tape directly from a keyboard, bypassing the punched card, is made by the Mohawk Data Sciences Corp., Honeywell Inc. and others. Now there's a new entry in that race; the KDR 3100 key data recorder manufactured by the Potter Instrument Co.

It comes naturally. Stephen J. Keane, the company's marketing vice president, says that the 3100



Talking to the tape. The keyboard can generate codes that have densities as high as 800 bits per inch.

is a logical extension of Potter's line of single-capstan magnetic tape drives.

The company says that the single-capstan design makes the 3100 gentler with tape than competitive devices, so breaks should be held to a minimum. All the improvements in the new machine are on that order—not necessarily advances in the state of the art, but subtle changes that enable the user to get more data on tape in less



At General Electric's Industry Control Department plant, Salem, Virginia, Di-Acro's adjustable stroke and fast die change has reduced overall production time 20%.

CONTINUOUS FORMING CONTROL

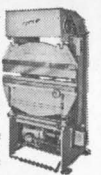
pronounced die-ack-ro



25 TON HYDRAULIC PRESS BRAKE

It takes less than 15 seconds to pre-set the length of stroke for most efficient operation and maximum safety. The rapid, dual speed work cycle provides fast approach, slow work and fast return—or a stroke as slow as 6 operations per minute. It's easy to "inch" the ram or reverse it at any point in the stroke. Dangerous sheet whipping with resultant costly kinking can be virtually eliminated. This dependable 25 ton hydraulic press brake is available in 6 and 8 foot bed sizes.

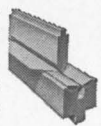
Designed for high speed, economical forming and fabricating of small parts. The 12 Ton series uses standard press dies and is practical for short run production and sample work. Available with 3 or 4 foot bed.



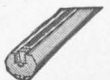
A complete selection of press brake dies for bending, blanking, box forming, corrugating, curling, hemming, punching and flattening. Fits all standard press brakes.



Di-Acro Rol-Form Dies eliminate work marking of highly polished or painted materials. Saves time and reduces die costs—one die does the job of many.



A new Di-Acro True Form Die contains an adiprene insert which "gives" under forming pressure. It forms the finest finishes without marking but requires more pressure than the Rol-Form Die.



See your Di-Acro distributor or write us.

Di-Acro manufactures a complete line of benders, rod parters, brakes, press brakes, press brake dies, shears, notchers, rollers, punch presses, layout machines, spring winders and punches and dies. Write for catalog.

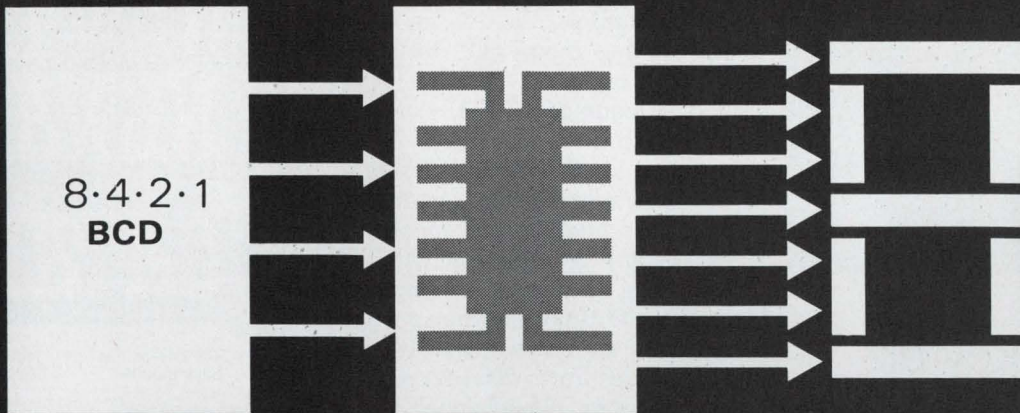


DI-ACRO

A Division of Houdaille Industries, Inc.
 4311 Eighth Avenue • Lake City, Minnesota

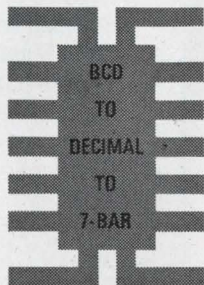
Pick the
BEST IC
for the job

Problem: 80 milliamps minimum per bar is required to drive a 15 volt seven segment display. One integrated circuit package is to be used. Input to the package is BCD. Pick the best Custom IC capability for the job.



the **BEST** Solution:

**THE CUSTOM MSI SEVEN SEGMENT
DECODER/DRIVER**

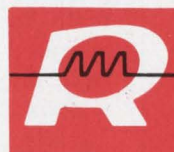


One of our customers had the exact problem stated above. Radiation solved the problem reliably and economically with dielectric isolation and medium scale integration. BCD to decimal to seven-bar with built-in drivers... three hundred elements on a single chip! And an 80 MA per bar minimum drive current. The best IC solution for the job.

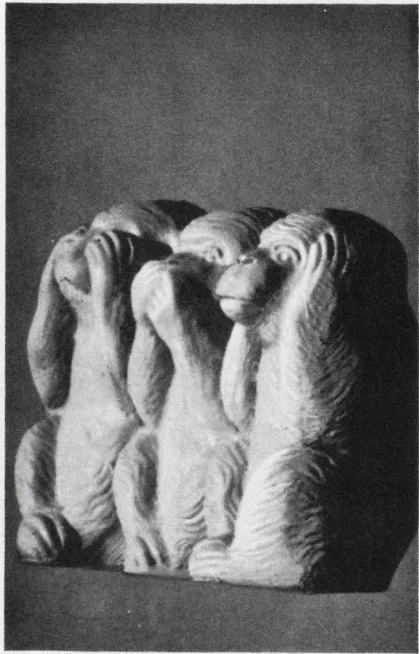
Radiation has mastered dielectrically isolated MSI. We would like to work with you on your particular application. Medium scale integration is the best solution to the packaging density problem. Dielectric isolation is the best approach.

Contact your nearest Radiation sales office. State your problem. Let us help you pick the Best IC for the job.

WE MAKE THE **BEST IC** FOR THE JOB



RADIATION
INCORPORATED
SUBSIDIARY OF HARRIS-INTERTYPE CORPORATION
MICROELECTRONICS DIVISION



No monkey biz when you buy Security Filters from Captor

Captor Corporation is a specialist in the manufacture of communications, security and shielded room filters. Our goal is to satisfy the industry's long-standing needs: the need for a supplier who makes on-time deliveries... whose sales promises are fulfilled... whose products meet all applicable specifications... who gives good overall service. Captor offers one of the industry's most complete line of security filters, including units capable of carrying very large power line loads. Our security filters meet even more rigorous specifications than EMC filters, including DCA and FED-STD-222. If your requirements are unusual or unique, Captor engineers are available to evolve special filter designs. Now that you have an alternative, let Captor bid on your next security filter requirement!

Captor Corporation manufactures miniature filters... communications and security filters... custom-design filters, and other electronic components.

CAPTOR CORPORATION
APPLICATION ENGINEERING DEPT.
5040 Dixie Highway, Tipp City, Ohio 45371

... there's no destruction
of the displayed data ...

time and with less effort. As Keane puts it, "We paid a great deal of attention to such intangibles as work area, comfort and compactness. These features might not make engineers drool, but for the user they can mean money in the bank."

For example, there is more than enough leg room and work room for the operator; speedier operation is made possible by keyboard and console layout, color coding, and key sensitivity and design.

The single-capstan feature also simplifies loading and ensures accuracy and reliability of data. The recording head is a single-gap read/write type; the transport also contains an erase head. It generates codes up to 800 bits per inch in seven- or nine-channel format. Conventional half-inch computer tape is used.

Under the hood. The memory, says the company, has advantages over those in card-punch and other entry machines. Among the advantages are fast duplication, and skip and release functions. The memory also displays contents without destroying the data and allows character-error correction within any field of data. It stores its programs, holds 48 to 160 characters, and permits operation of the machine in five different modes: entry, verify, search, display, and record/read.

One feature offered as standard on the 3100 is optional on competitors' machines. That's what Potter calls the unlimited left-zero fill, which automatically fills in zeros if a two- or three-digit number should come up in a series of five-digit numbers.

The company is confident that there's a good market for its 3100. Says Keane: "While our marketing plans in this country are to sell directly to end users, we've already accepted an order for 1,000 units from one of the largest computer makers in Europe." He wouldn't identify the firm, but European sources indicated that it's Britain's International Computers Ltd.

Potter Instrument Co., E. Bethpage Rd., Plainview, N.Y. 11803 [400]

YOUR FREE COPY IS READY!

NEW 1969 NEWARK INDUSTRIAL ELECTRONICS CATALOG

- ★ The one-source buying guide
- ★ Over 70,000 items—500 major brand lines
- ★ 700 pages
- ★ Over \$7,000,000 industrial electronic inventory

NEWARK HAS IT NOW, THE COMPLETE LINE OF
**ALL
GENEAL ELECTRIC
COMPONENTS**



and
EQUIPMENT

- Integrated Circuits
- Semiconductors
- Photoconductive Cells
- Soldering Equipment
- Dry Reed Switches
- Transformers
- Batteries
- Pilot Lamps
- Silicones
- Tubes
- Switches

*Immediate delivery from stock—factory OEM prices
—fast efficient service from 11 Newark warehouses.*



New Main Office & Warehouse

NEWARK ELECTRONICS CORPORATION

500 North Pulaski Chicago, Illinois 60624
(312) 638-4411

WAREHOUSES IN

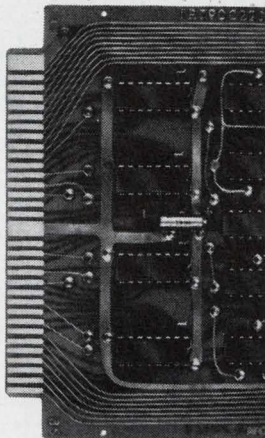
- | | | |
|--|--|---|
| ★ Minneapolis, Minn.
(612) 331-6350 | ★ Los Angeles Area
(213) 678-0441 | ★ |
| ★ Cincinnati, Ohio
(513) 421-5282 | ★ Grand Rapids, Michigan
(616) 452-1411 | ★ |
| ★ Denver, Colorado
(303) 757-3351 | ★ New Orleans, Louisiana
(504) 834-9470 | ★ |
| ★ Detroit, Michigan
(313) 548-0250 | ★ Dallas, Texas
(214) 271-2511 | ★ |
| ★ New York City
(212) 255-4600 | ★ Houston, Texas
(713) 782-4800 | ★ |

We have something for no-nonsense design engineers

who want to make
the best investment
in IC logic assemblies.

Design with CAMBION® IC Logic Assemblies. You get more for your money . . . more functions on every logic card . . . an exclusive 70-pin input/output that lets you bring more functions through to the outside world.

With this unique connector capability, we've developed both standard and those hard-to-find cards . . . grey code logic, arithmetic logic, counters, decoders, registers, comparators . . . all the odd-ball assemblies you need.



BCD counters with decoder/Nixie drivers

Look at these advantages:

SPEED — IC logic assemblies with speeds to 25 MHz.

NOISE — Exact component location with precision etched interconnections achieve "short-leads" and prevent signal cross-coupling. BCD counters with decoder/Nixie* drivers all on a single card are but one example.

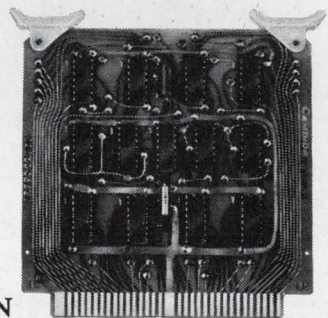
PACKAGE DENSITIES — 70-pin input/output, plus a great array of complex functions and you've got what it takes for highest density packages. (You use fewer cards this way, too.)

VARIETY — Over 250 card types for difficult applications.

DELIVERY — Immediate . . . from stock . . . honestly.

DOCUMENTATION — CAMBION's new logic manual has the data, including application and helpful reference formulas.

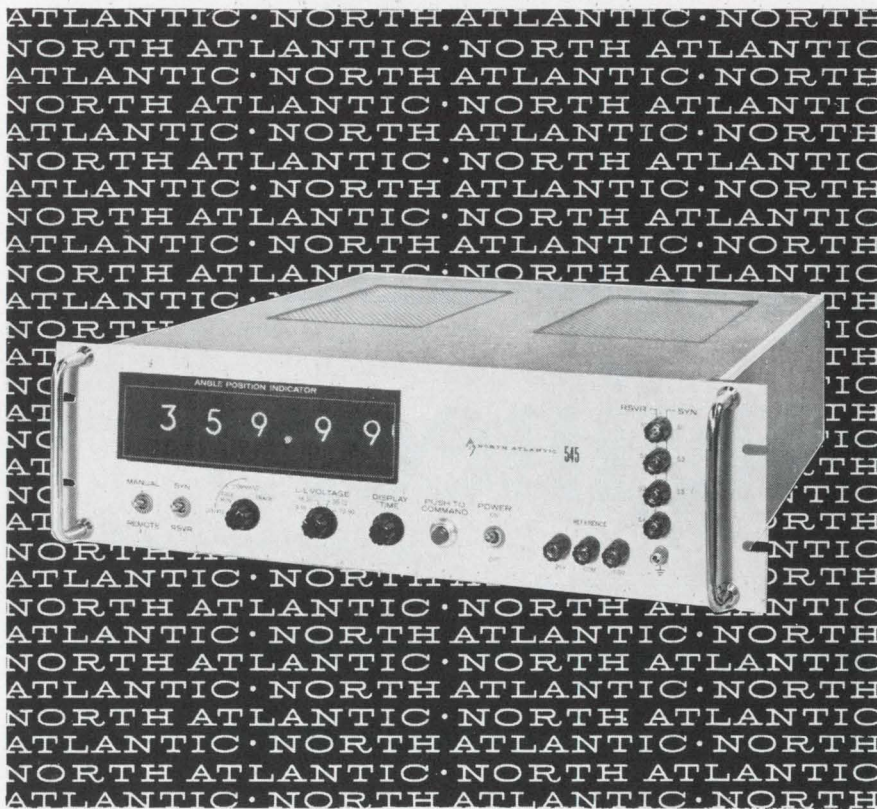
NO-NONSENSE — Make the best investment in IC logic assemblies. Send for new manual. Cambridge Thermionic Corporation, 447 Concord Ave., Cambridge, Mass. 02138. Phone: (617) 491-5400. In Los Angeles, 8703 La Tijera Boulevard. Phone: (213) 776-0472.



®Reg. U.S. Pat. Off.
*Trademark, Burroughs Corp.

CAMBRIDGE THERMIONIC CORPORATION
CAMBION®

Standardize on CAMBION . . . the guaranteed logic assemblies



resolver/synchro to digital conversion

~~20,000~~... **.01° accuracy**
~~2000~~°/sec. tracking

North Atlantic now brings you a new generation of solid-state analog-to-digital converters for resolver and synchro data. They offer major advances in high-speed precision tracking as required in modern antenna readout, ground support, simulation, and measurement systems.

For example, the Model ~~20,000~~ 545 provides conversion of both resolver and synchro data at rates to ~~2000~~ 2000°/second, and accommodates 11.8v to 90v 400Hz line-line signals. For multiplexed applications, acquisition time is less than 50ms. Digital output data is visually displayed and simultaneously available on rear connectors. All modes are programmable as well as manually controlled. Optional features include .001° resolution with 10 arc second accuracy, data frequencies from 60Hz to 4.8KHz, data freeze command for digital readout at a critical instant, and programmed mode where difference angle computation is required.

Your North Atlantic representative (see EEM) has complete specifications and application information. He'll be glad to show you how these converters can answer critical interface problems in your system.



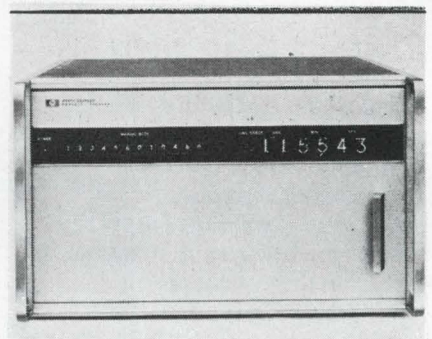
NORTH ATLANTIC industries, inc.
TERMINAL DRIVE, PLAINVIEW, NEW YORK 11803 • 516-681-8600

New subassemblies

Coupler makes many matches

Device gets digital data
and sends it to variety
of recording devices

One of the wider and more persistent communications gaps is the one between measuring and recording devices. Only rarely can a meter be plugged right into a recorder. The engineer usually has to go looking for a coupler, and his problems don't end even when he finds one; these devices have a



Half-dozen hookups. The coupler can handle as many as six inputs.

tendency to work with only one type of meter and recorder.

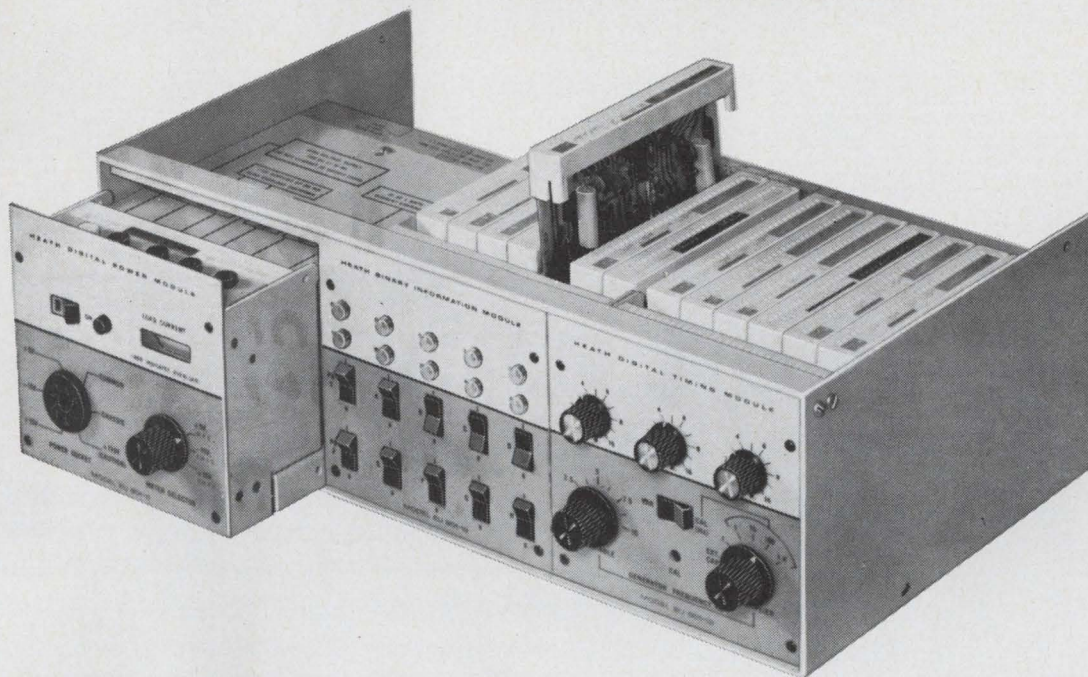
A new coupler from the Hewlett-Packard Co. takes some of the trouble out of interfacing.

Called the model 2547, the device accepts digital data, translates it from parallel-entry code to serial form, and then transfers it to any one of eight recording devices: —a Kennedy 1406 incremental recorder, an H-P 2780A junction panel, an H-P 5050A digital recorder, a modified IBM model B output writer, an H-P 2752A teleprinter, or a Friden 2303. The coupler can be adapted to other recorders by changing logic cards.

The price depends on the recorder supplied with the coupler. A coupler and teleprinter, for example, costs \$4,150.

Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. 94304 [480]

Move from the problem to the solution



with Heath Analog Digital Designer
only . . . \$435

Achieve virtually anything you wish in digital and analog circuitry: design your own Counters, Frequency Meters, DVM, Precision Timers, Frequency Standards, Digital Interfaces . . . and hundreds of other digital instruments. You can also investigate Counter, Scaling and DVM circuits, Adders, Subtractors, Digital Analog Interfaces and special circuits of your own. All you have to do is plug-in a few circuit cards and connect them . . .

The Heath/Malmstadt-Enke Analog Digital Designer (ADD) EU-801A is a unique method of systems and circuit "bread-boarding" for experimentation. The ADD includes three factory-assembled modules (power supply, binary information and digital timing) and 13 factory-assembled cards. Each module may be used individually or connected to the others in the system cabinet. Cards plug into each module . . . power supply connections are automatically made.

High value cards with TTL ICs feature "wire-patch" solderless connector boards to accept ordinary hookup wire and component leads for simple and rapid assembly of your circuit designs. A color schematic of inputs and outputs is provided on the board.

The ADD may easily be expanded as new modules and new cards are available following the improvement of technology. The ADD with its Analog Digital Interfaces is able to accept and process external information, thus opening it to the outside world. 10 lamp binary readout is built-in . . . digital readout will be available shortly.

Multiple nand gate, Dual J-K Flip-flop, Dual monostable, Relay, Comparator/Voltage to Frequency, Dual inline IC socket, Multiple connector/Blank PC and Operational Amplifier cards are supplied. Just plug-in your design in the ADD . . . optimize it and use the solution directly . . . for only \$435 (circuit cards and modules also may be purchased separately).

The ADD'S Logical Companion



Many cards from the Heath EU-805 Universal Digital Instrument (UDI) may be used in the ADD increasing its capabilities. The UDI combines in one package a 12.5 MHz Multi-Purpose Counter/Timer and a 0.05% accuracy Integrating Digital Voltmeter to measure frequency, period, time interval, ratio, count events and perform as a DVM and voltage integrator with unmatched versatility.

For more information send for
the NEW
HEATH
Scientific
Instrumentation
Catalog



HEATH COMPANY, Dept. 580-04
Benton Harbor, Michigan 49022

- Please Send Free EU-805 UDI Spec. Sheet
- Please Send Free EU-801 ADD Spec. Sheet
- Please Send Free New Scientific Instrumentation Catalog

Name _____

Company _____

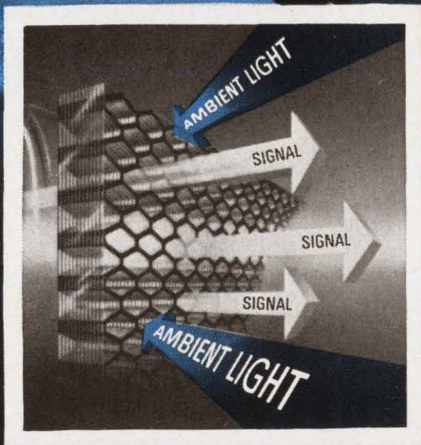
City _____ State _____ Zip _____

(prices & specifications subject to change without notice) EK-255

**PILOTS,
NAVIGATORS,
CONTROL TOWER
OPERATORS**

*If you have trouble reading CRT displays in the cockpit, control tower, or on the ship's bridge, the **HYCONTRAST_{tm}** Image Enhancer makes signals readable under worst glare conditions — without operator fatigue!*

*Tell your systems engineer to write today for details on our **HYCONTRAST** Image Enhancer . . .*

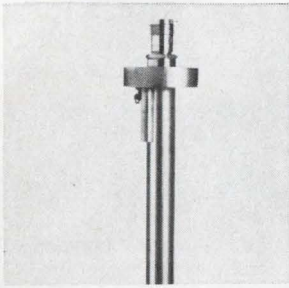


This new filter traps ambient light with 4,000 cells per square inch, and is only .125" thick. It really works and is inexpensive.

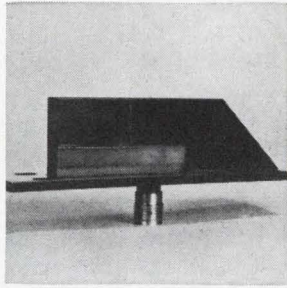
hycon

700 ROYAL OAKS DRIVE
MONROVIA, CALIFORNIA 91016
(213) 359-8216

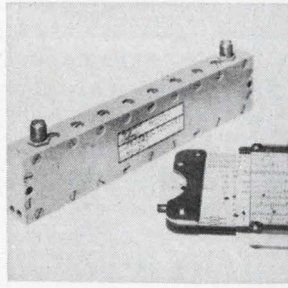
New Microwave Review



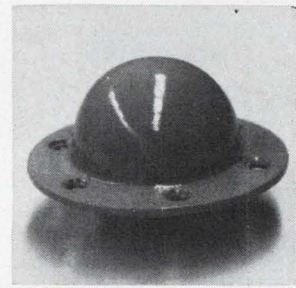
Solid state local oscillator series 6001 has afc capability and covers octave frequencies ranging from 100 Mhz to 2 Ghz. With single screw tuning it can also be used as a multiplier pump, low power transmitter and the signal source for broad-tuning-range test equipment. Power output ranges from 20 mw to 100 mw. Trak Microwave Corp., Tampa, Fla. 33614. [401]



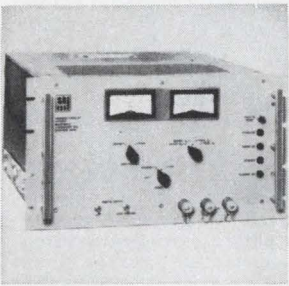
Slotted blade, linearly polarized antenna model 803L was developed as part of an L-band radar transponder system for use in drone application. The antenna's stainless steel body construction offers high dependability in missile environments. Linear radiation coverage is provided with minimum aerodynamic drag. Vega Precision Labs, Vienna, Va. [402]



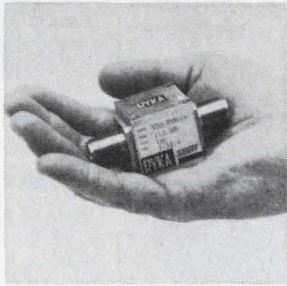
Bandpass filter TSJ2250-100-8SS for use from 2.2 to 2.3 Ghz is designed for airborne telemetry applications. A typical unit measures 5 in. long with a cross section of 1 1/8 x 1/2 in., and weighs less than 4 oz. Insertion loss is 1.5 db max. at center frequency. Average power rating is 60 w. Price is \$380. Telonic Engineering Co., Laguna Beach, Calif. [403]



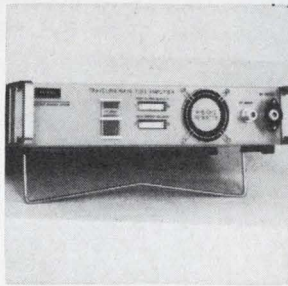
Broad band stub antenna 01-24-03444 covers 2 to 10 Ghz. Vertically polarized with a quarter-wave monopole pattern, the radome-enclosed antenna has a vswr of under 2 to 1 over 96% of the band. It has a 90% efficiency and can handle 100 w average power. It weighs 3 oz. Temperature range is -65° to +250° F. Electronic Specialty Co., Los Angeles. [404]



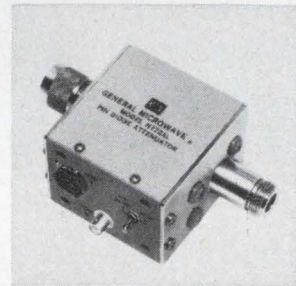
Two-stage r-f power amplifier model 03-63-00 provides greater than 17 db of gain from 1.725 to 1.775 Ghz. It is a completely self-contained instrument including all necessary power supplies and control circuitry. R-f input is 1 watt; impedance (input and output), 50 ohms; vswr (input and output), 1.5:1. Applied Microwave Laboratory Inc., Andover St., Andover, Mass. [405]



Multi-octave YIG filter model 212MS, available with OSM or N-type connectors, shows a high performance, two-stage bandpass from 1.0 to 12.4 Ghz. Tuning power required is less than 6 w at 12.4 Ghz. The unit has application as a test component for lab measurements. Size is 1.4 in. cube. Price is \$880. Ryka Scientific, North Pastoria Ave., Sunnyvale, Calif. [406]



TWT amplifier 1177H covers 2 to 18 Ghz with a minimum power output of 10 w c-w. Each amplifier consists of a ppm traveling-wave tube, an all solid state regulated power supply and a complete air cooling system. Units are suited for applications in rfi testing, antenna measurements and general laboratory use. Hughes Aircraft Co., Torrance, Calif. [407]



P-i-n diode attenuator/modulator model N172AL incorporates a driver module with a logarithmic transfer function which permits the attenuation level to be controlled with a single d-c voltage at the rate of 10 db/v. The unit operates over the frequency range from 0.05 to 8.0 Ghz. Price is \$525. General Microwave Corp., 155 Marine St., Farmingdale, N.Y. [408]

New microwave

Double cavity widens Gunn range

Two-resonator design combats mode jumping in oscillator; initial X- and K-band units put out 32 to 87 milliwatts

Complexity can sometimes be a good way to simplify things. The Nippon Electric Co. added a second cavity in its new Gunn oscillators, and it says the double-cavity models give a tuning range of about 10% of the center frequency by a simple adjustment of a sin-

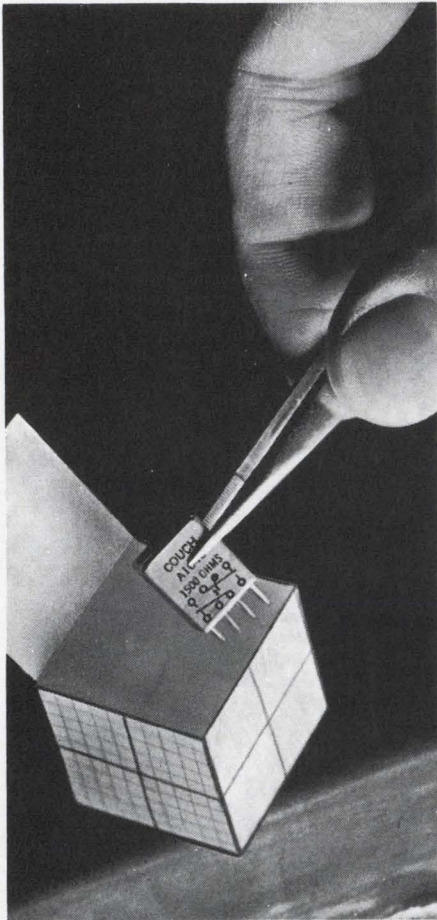
gle screw; one needn't change the applied voltage. The power output over the tuning range varies by less than a decibel from the maximum.

By changing the iris between the cavities and adjusting the applied voltage, the same oscillator can be

set to operate at any frequency over a range of an octave.

One reason for the wider tuning, Nippon Electric says, is the absence of unwanted modes and mode jumping within the tuning range. Mode jumping refers to sudden changes in frequency and power output of the oscillator because of changes in the pattern of electric and magnetic fields in a single cavity, usually tuned with a variable-position plunger.

Sizing it up. At lower frequencies, the Japanese company says, a tunable single-cavity oscillator operating in the fundamental mode is not greatly susceptible to mode



Couch 2X 1/7-size relays meet MIL-R-5757D/19 in 1/25th of a cubic inch

The new, third generation Couch 2X relays solve switching problems where space and weight are critical. Thoroughly field-proven in electronic and space applications. Relays are delivered *fully tested*. Additional screening tests available at your option.

	2X (DPDT)	1X (SPDT)
Size	0.2" x 0.4" x 0.5"	same
Weight	0.1 oz. max.	same
Contacts	0.5 amp @ 30 VDC	same
Coil		
Operating Power	100 mw 150 mw	70 mw 100 mw
Resistance	60 to 4000 ohms	125 to 4000 ohms
Temperature	-65°C to 125°C	same
Vibration	20 G to 2000 Hz	same
Shock	75 G, 11 Ms	same

Broad choice of terminals, coil resistances, mounting styles. Write for detailed data sheets.

RUGGED ROTARY RELAYS  Dynamically and Statically Balanced

Couch
1894

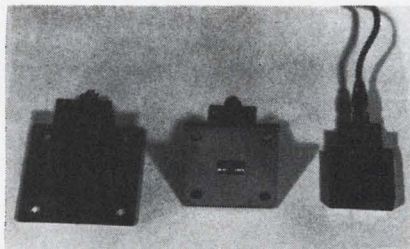
COUCH ORDNANCE INC.

3 Arlington St., North Quincy, Mass. 02171
Area Code 617 Cypress 8-4147
A subsidiary of S. H. COUCH COMPANY, INC.

jumping. But at X and K bands, where the new oscillators work, a fundamental-mode cavity becomes too small for convenient fabrication of a tunable cavity, so the designer has to go to a larger cavity and operate it in a higher-order mode. This increases the probability that it will jump to neighboring modes.

With the double-cavity configuration, there is no tuning in the diode oscillator cavity, which thus can be made small enough to operate in the fundamental mode. Adjustment of the capacitance at the iris and the coupling between the two cavities make the double-cavity circuit lossy at neighboring modes, effectively suppressing them.

The smaller cavity contains the Gunn diode. The supplementary cavity is tuned by a plunger attached to a screw. The two cavities, with the iris between them,



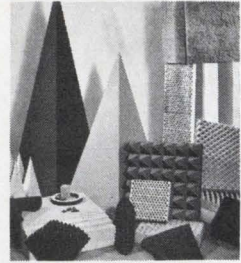
Band trio. Gunn oscillators, left to right, operate at 10, 15, and 22 Ghz. Flanges fit standard waveguides.

can be considered a resonator consisting of a transmission line shorted at both ends and having capacitive loading.

Nippon Electric points out that it borrowed an idea from the designers of reflex klystrons—the tubes, which, it is hoped, will be replaced by solid state sources. In some of the latest klystrons, a supplementary cavity is electrically coupled to the internal cavity but is itself outside the evacuated portion of the tube for mechanical convenience and superior electrical performance.

Power play. Standard units of the double-cavity Gunn oscillators are available for the 10, 15, and 22-gigahertz ranges. The 10- and 15-Ghz devices can be tuned over a range of more than 10%, and the 22-Ghz units are tunable over a range of about 1.9 Ghz. The maxi-

NEW, COMPLETE DATA ON ECCOSORB® "FREE-SPACE" MICROWAVE ABSORBERS



Physically/electrically-tapered "building blocks" for anechoic chambers; conformable, flexible foams to reduce radar cross-section. 12 different high-performance types are described in new bulletin.

Circle 307 on reader service card

ECCOMAX HI-Q LOW-LOSS DIELECTRICS



18 low loss systems are described in new folder and chart. Casting resins, impregnants, coatings, adhesives, rod & sheet — some foams — some Hi K — all with dissipation factors below 0.001. For RF, UHF, VHF and microwaves — capacitors, coils, etc.

Circle 308 on reader service card

NEW, COMPLETE DATA ON ECCOSORB® "HIGH-LOSS" DIELECTRICS



Microwave absorbers for waveguide and coax terminations, attenuators, etc. Suppress surface waves; reduce reflectivity. Machineable rod & sheet, casting resins, flexible sheets, high-temp ceramics described in new bulletin with application selector and fold-out properties chart. Send for free copy.

Circle 309 on reader service card

Emerson & Cuming, Inc.



CANTON, MASS.
GARDENA, CALIF.
NORTHBROOK, ILL.
Sales Offices
in Principal Cities

EMERSON & CUMING EUROPE N.V., Oevel, Belgium



E-Cell* Integrator/Readout System Measures, Stores, and Retrieves the "Area Under the Curve"

"Area under the curve" is a phrase that first enters an engineer's working vocabulary in high school calculus and stays with him throughout his career. Yet, even with today's sophisticated technologies, actually *measuring* the area under the curve has until now been a lot easier said than done.

So we see good engineers and scientists resorting to the old brute force method of doing it — plotting the curve and calculating the area under it.

In a field use situation, even if basic engineering sense points to building an on-line, real time integration function into the problem solution, the researcher or designer is likely to seek another alternative approach. Why? Simply because the only tools previously available to do the job were bulky, complicated, and expensive.

But as every engineer knows intuitively, there's always got to be a "better way." Our "better way" is...

The E-CELL Integrator

Bissett-Berman's E-CELL integrator looks like a simple circuit element but does the work of a complex assembly. It can be simply connected across the output leads of a sensor unit responsive to the phenomenon to be integrated. Examples: a photoelectric cell sensing the accumulated sunlight falling on a satellite during a several months' mission; or the accumulation of RF energy output of several radars to give a warning when the total becomes dangerous to humans.

Physically, an E-CELL integrator is the size of a discrete electronic component. Inside the cell is a center electrode, which is surrounded by an electrolyte, with the case itself serving as the second electrode.

When connected in a circuit, the E-CELL integrator plates silver atoms onto either the center electrode or the case electrode, depending on the polarity of the integrator in the circuit and the operational mode.

The E-CELL Transform

The simple beauty of this arrangement lies in the fact that the plating process is perfectly precise. For every electron impressed on one of the electrodes, exactly one atom is plated onto the other.

The information stored in the E-CELL integrator as atoms is non-volatile, and doesn't have to be retrieved in the same way or at the same rate that it was generated in the E-CELL integrator. This means that the *input* curve can be highly irregular, have simultaneous multiple sources, and extend over a very long time period, but the transformed integrator *output* can be represented as a convenient flat curve at any chosen level of time or current.

The E-CELL integrator action is reversible, i.e. you can count up from zero or count from a predetermined total down to zero. In the "Countup" mode you start with a bare center electrode on the integrator and accumulate a charge on it as the action proceeds. In the "Countdown" mode you start with an E-CELL integrator whose center electrode is plated with an amount of silver representing the integral in your problem solution. Then you let the integrator run until all of the silver has been transferred from the center electrode to the case. When this has occurred, the E-CELL integrator delivers a sharp voltage rise which can trigger a solid state-actuated light, alarm, or switch.

The Integrator/Readout System

Bissett-Berman has just completed development of the Model 300 EDR E-CELL Digital Readout. An E-CELL

integrator together with a Model 300 EDR Readout comprise a *data collection system* capable of measuring the "area under the curve" on-line in real time, and over periods from seconds to months.

The Model 300 EDR Readout is specifically designed to measure and digitally display total charge accumulated on the center electrode of an E-CELL integrator used in the "Countup" mode. In addition, the Model 300 EDR provides for manually pre-setting an E-CELL integrator with a precise amount of plating for operation in the "Countdown" mode.

The E-CELL Integrator/Readout system is ideally suited for: physical, medical, and agricultural research; product field testing; collection of use data, and evaluation; process monitoring and control; warranty validation — or wherever an analyst desires to measure a phenomenon that can be represented by the "area under the curve."

*Patents applied for.



For technical information on Bissett-Berman E-CELL integrators and our new Model 300 EDR Digital Readout, please send in the coupon below.

**BISSETT
BERMAN**

COMPONENTS DIVISION
Los Angeles, California

The Bissett-Berman Corporation

Components Division
3860 Centinela Ave.
Los Angeles, Calif. 90066

- LITERATURE ONLY
 HAVE REPRESENTATIVE CALL

APPLICATION _____

NAME _____

COMPANY _____

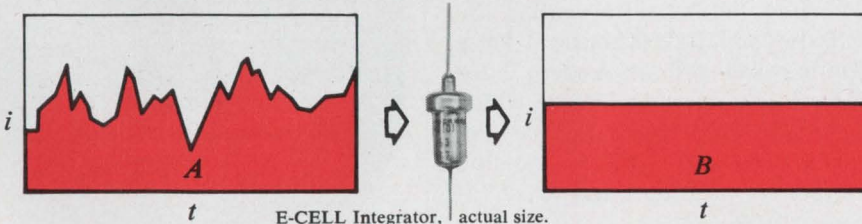
DEPT. _____

STREET _____

CITY _____

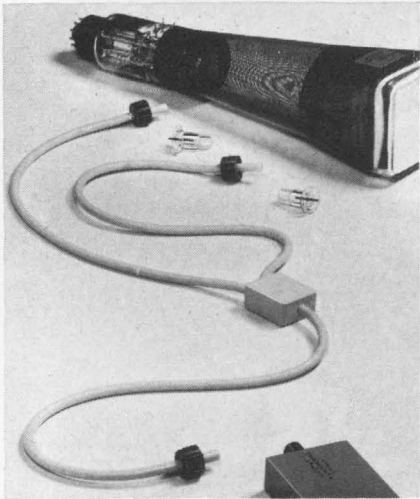
STATE _____ ZIP _____

CI168-BS



E-CELL integrator transforms irregular input signal into average integral. Area under curve A equals curve B area. Countup Mode → measures unknown input integral. Countdown Mode ← gives signal when unknown input equals pre-set value.

Never use less than the safest High- Voltage leads



For example: a quick connect/disconnect 20 KVDC connector feeding two CRT tubes from a single terminal 20 feet away. It's a compact lead assembly with glass and epoxy receptacles and silicone insulated leads that can be mated safely by hand, yet it's rated 25 KVDC at 70,000 feet!

- Lightweight, flexible assembly
- Meets applicable MIL specifications
- RFI shielding available
- Rated at 10 amps
- No exposed high-voltage
- Corona and radiation resistant
- Foolproof assembly

Let us design an assembly that meets or exceeds your requirements. We're the leading maker of high-voltage, high-altitude custom lead assemblies. Whatever your connection problem, write or call today.

AMP INCORPORATED

CAPITRON DIVISION

155 Park Street • Elizabethtown, Pa.
717-367-1105 • TWX: 510-675-4561

... 100 mw Gunn units
now being planned ...

mum power outputs are 56 milliwatts for the 10-Ghz units, 87 mw for the 15-Ghz, and 32 mw for the 22-Ghz models. The devices sell for about \$550 in Japan.

The company expects to design oscillators with outputs of more than 100 mw soon. It will not try to go much above this because its engineers expect that Gunn oscillators will be solid state sources for low-power, low-noise applications and that avalanche-diode oscillators will be more suitable for higher-power jobs. In the avalanche field, Nippon Electric expects to offer an X-band unit for transmitter applications that will put out more than a watt.

The Gunn diodes for the oscillators now available have an n^+ , n^{++} structure, formed by epitaxial growth of n and then n^{++} material on the original n^+ substrate. The diodes are given a mesa etch so that only the substrate remains large and the diameter of the active epitaxial portion is greatly reduced. The diode is mounted with the n^{++} region bonded to the heat sink, for the most efficient heat removal. The other end is attached by a bonded gold ribbon. The diode for the 10-Ghz oscillator is in a pill case, and those for the higher-frequency units are directly mounted to the cavity interior.

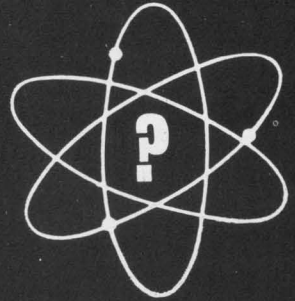
Nippon Electric expects the devices to be used in receiver local oscillators, test equipment and signal generators.

In portable equipment, the oscillators can operate from the same low-voltage power supplies needed for transistor equipment, without a voltage converter. They are also suitable for use in telephone repeaters.

The company says that some of the Gunn diodes selected at random have withstood operating life tests beyond 10,000 hours. A large number selected at random have passed environmental tests which included temperature cycling between -65 and $+150^\circ\text{C}$, variable frequency vibration, and acceleration to 2,000 g 's.

Nippon Electric Co., 33-7, Shiba
5-chome, Minato-ku, Tokyo [409]

why Maryland



Proximity to federal agencies in Washington, D.C. affords the unique advantage of constant personal contact with government officials working with science-oriented industry. Such contact is an increasingly important locational criterion.

No other state is as convenient to as many Federal agencies as Maryland. For example, Maryland's major government scientific installations include NASA, AEC, NIH, the National Bureau of Standards, plus some 20 others.

Are there other reasons
why R&D and science-
oriented industries
should locate
in MARYLAND?

Yes... emphatically!

There are almost 30,000 scientists and over 25,000 engineers living and working in Maryland and the District of Columbia. Graduate and post-doctoral programs considered most significant to research and science industry are available.

Locate in a big state like Maryland

We could write a book about why you should locate in Maryland... and we did. Send for it.

Contact:

Maryland Department of
Economic Development
DIVISION E-8

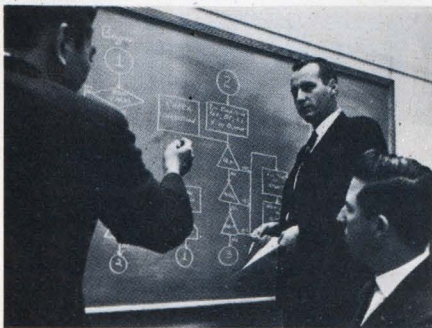
State Office Bldg.
Annapolis, Md. 21404

NCR Los Angeles invites you to join the fast moving Century Series team

NCR, creator of the sophisticated and fast-selling Century Series computer systems, offers you immediate opportunity to work in new-generation technology. Join the men responsible for the industry's most advanced developments in high-speed thin-film memories, monolithic integrated circuitry, disc memory innovation, and automated production techniques. NCR Electronics Division is the largest commercial computer manufacturing facility in Southern California and one of the most advanced in the world. Benefits include a thoroughly professional environment, an excellent salary, non-defense stability, and fully paid life, hospital and medical plans for you and your dependents. Look into NCR now and accelerate your career.

SOFTWARE DEVELOPMENT SYSTEMS ANALYSIS ENGINEERS

Analysis and development of advanced systems specifications; consultation on systems design, hardware configuration, software trade-offs; analysis of competitive systems. Prefer applicants with BS degrees and 3-5 years' experience and ability to write and test functional specifications in such areas as very-high-speed memories, disc files, drum files, central processors employing large-scale integration, communications and time-sharing systems.



SOFTWARE SYSTEMS DESIGN

Develop operating, executive, utility and on-line systems for third- and fourth-generation advanced systems. Positions require a business or science degree and large-scale file computer or software development experience.

ENGINEERS

ELECTRONIC DEVELOPMENT ENGINEERS

Specification, design, checkout and documentation of digital and digital/analog equipment for use with on-line data processing and data communications systems. Requires BSEE and five years' related experience.

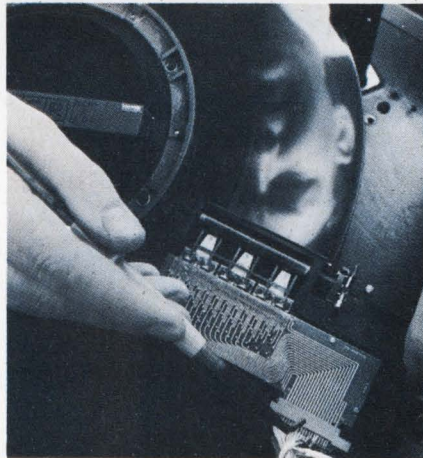


CIRCUIT DESIGN ENGINEERS

Will design and develop digital and analog semiconductor circuits, including discrete, integrated and hybrid types. Requires a BS/MSEE and two years' related experience.

MAGNETIC HEAD DESIGN ENGINEER

Will design and develop flying magnetic recording heads and the required prototype tooling. Requires BS or MS in EE, ME or physics plus three years' applicable experience. Knowledge of ferrite machining technology and ferrite heads desirable.



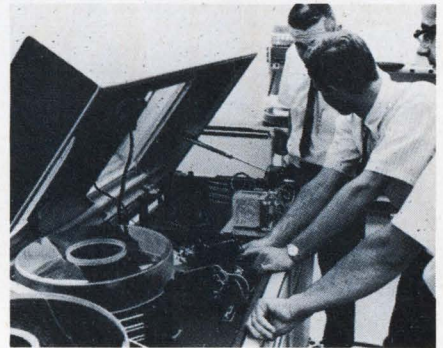
INDUSTRIAL ENGINEERS

Will develop manufacturing machining processes for various projects. Will be responsible for capital equipment analysis, fabrication tooling and initial production. Positions require BSIE and heavy mechanical/industrial engineering experience.



MATERIALS & PROCESS ENGINEERS

Will evaluate and select metallic or non-metallic materials, develop chemical or metallurgical processes, or prepare specifications for computer equipment. Requires BS or MS and 2 years' applicable experience.



CHEMICAL ENGINEERS

Positions are available for college trained engineers to assume responsibility for film plating, organic finish analysis, and production plating process functions. Successful candidates will possess a BS degree in chemical engineering, a knowledge of organic coatings, the ability to develop and direct a process laboratory, and 3 to 5 years' experience in electroplating of magnetic thin film materials or chemical process analysis.

RESEARCH ENGINEERS

Will be engaged in feasibility model development, or integrated circuit memory or high speed magnetic memory circuit design.

Requires scientific and/or engineering degree and adaptability to a multiplicity of applied research projects.

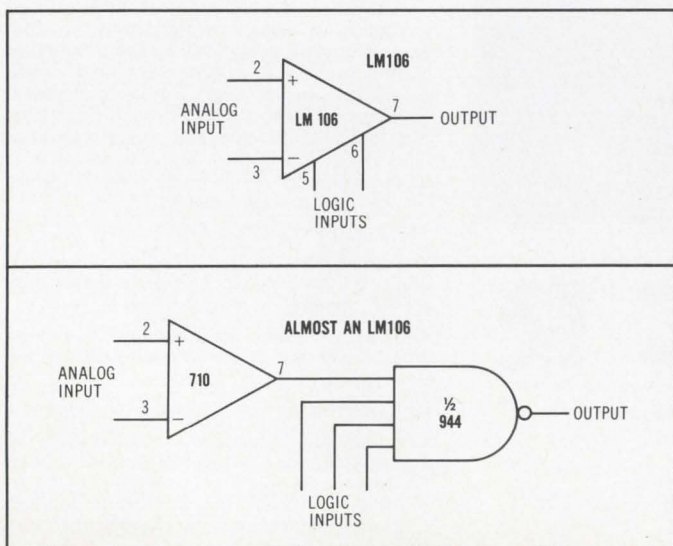
ARRANGE NOW FOR INTERVIEW AT FJCC

Confidential interviews will be held at the St. Francis Hotel during the Fall Joint Computer Conference in San Francisco, Dec. 9-11. To schedule an appointment, submit detailed resume including salary history to Steve Williams at the Division.



The National Cash Register Company
ELECTRONICS DIVISION
2816 W. El Segundo Blvd.
Hawthorne, California 90250
An equal-opportunity employer

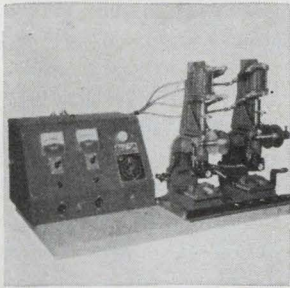
Our new LM 106 is the 710 and then some.



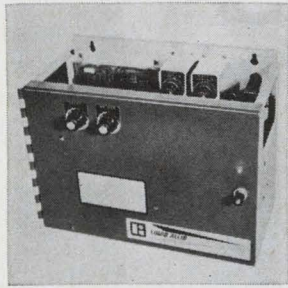
Our LM106 is a clever brute. It's a high-speed voltage comparator that is a direct plug-in replacement for the 710 in practically every application. What's more, on two pins the 710 doesn't even use, the LM106 accepts logic signals to strobe an output that drives up to 10 DTL or TTL loads. Or it switches up to 18V at 100mA to drive relays or lamps directly. The 25,000 gain makes gain error insignificant compared to the 2mV maximum offset. And it operates over a wide range of supply voltages even with symmetrical supplies. In quantities of 100 to 999, the military version LM-106 is \$18.00, the LM206 for instrumentation (-25 to +85°C) is \$11.50, and the LM306 for industrial uses (0 to +70°C) is \$6.80. Write us for other clever things about the LM106. National Semiconductor, 2975 San Ysidro Way, Santa Clara, California 95051. (408) 245-4320.

National Semiconductor

New Production Equipment Review



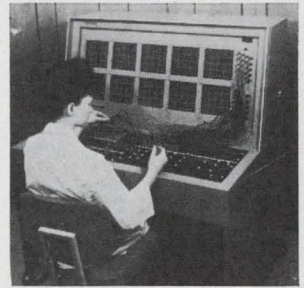
Roll leaf wire-marking machine model 2A2 has individually heated, twin imprint heads. One section is adjustable so that spacing between each marking can range from 5 to 10 inches. Roll leaf is fed into the marking machine automatically on spools where a hot type then imprints and marks the wire. Ackerman-Gould Co., 10 Neil Court, Oceanside, N.Y. 11572. [421]



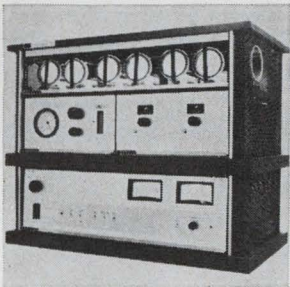
Dancer winder tension controller DLC-100 is applicable to any type of dancer mechanism and is adaptable to new or existing winders. It offers constant and adjustable taper tension capability. By utilizing this capability, winder horsepower can be reduced by a factor equal to the taper ratio. Lower horsepower reduces costs. Louis Allis Co., 427 E. Stewart St., Milwaukee. [422]



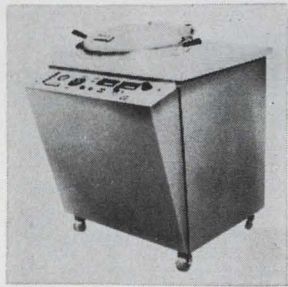
Leak detector MS-90UFT is for fast, high-sensitivity, low memory production leak testing of hermetically sealed IC's, semiconductors and components. Capable of detecting leaks as small as 1×10^{-10} atm cc/sec at slower speeds, it still detects leaks as small as 6×10^{-10} atm cc/sec at its full rated production speed. Veeco Instruments Inc., Terminal Dr., Plainview, N.Y. [423]



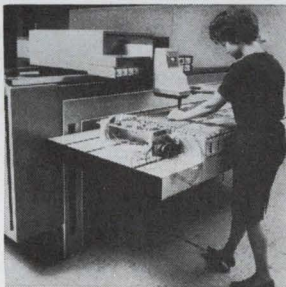
Console type machine tests and calibrates large scale integrated arrays, including universal LSI devices. It is for use where different arrays will be tested, and solves the problem encountered with short runs of different circuits, each requiring special word drivers. It incorporates a large programable word generator. North American Electronic Systems, Sicklerville, N.J. [424]



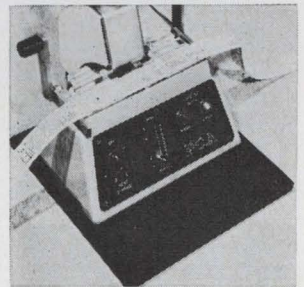
Plasma machines models 1101 and 2101 use the electrodeless plasma dry chemical process to remove photoresist and clean semiconductor substrates. They require less than 5 minutes to remove photoresist from 100 wafers. The machines generate 1,000 w output of r-f power at a frequency of 13.56 Mhz. International Plasma Corp., 25222 Cypress Ave., Hayward, Calif. [425]



Production centrifuge meets all requirements of MIL-STD-883 for both destruct and screen testing of semiconductors and IC's. A fast cycle time for screening 14-lead devices allows testing of approximately 800 pieces every 4 minutes. The machine will complete a 4-minute cycle to 25,000 g's. Trio-Tech Inc. of California, 2435 North Naomi St., Burbank, Calif. 91504 [426]



Wire locating and terminating machine called Wirecenter W/C1 blends numerical control and manual techniques. It is designed to handle a wide variety of wire types and gauges, and can accommodate any size panel up to 30 x 72 in. The table operates at a traverse speed of 360 ipm with a resolution of 0.001 in. Hughes Aircraft Co., 5261 W. Imperial Highway, Los Angeles. [427]



Paper-tape slicer called Thermo-press offers 4-sec average splicing time and strong bonds. Individual controls for heat, pressure, and timing allows 5-, 7-, or 8-channel tape to be spliced accurately, quickly and economically, with a minimal overlap and increase of thickness. A "winking eye" timer blinks at 1-sec intervals. Jay Smith Inc., 292 State St. East, Westport, Conn. [428]

New production equipment

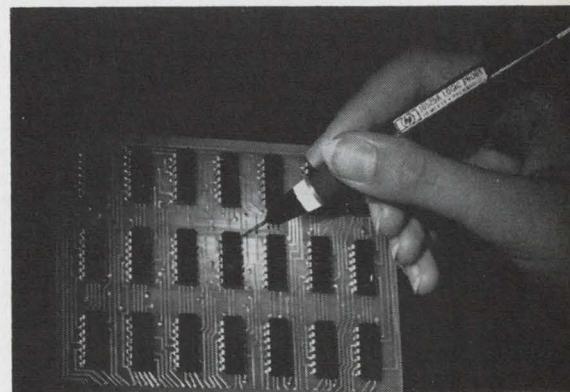
Probe lights up to verify IC logic state

Hand-held instrument detects DTL or TTL pulses, eliminates need to monitor oscilloscope or voltmeter

Techniques for verifying the logic states of integrated circuits mounted on printed-circuit boards have been extremely cumbersome, usually requiring the use of an oscilloscope—often with a viewing hood—or a voltmeter. In either case, the engineer has to move his eyes

from the workpiece, slowing the operation and increasing the probability of error.

A hand-held probe being announced this month by the Hewlett-Packard Co. detects the steady-state logic level, checks repetitive pulses and fast nonrepetitive



Visual aid. Presence of logic pulse is indicated by lighted band near tip.

HOT RODS!

**SPEED PRODUCTION WITH
BARNES MSI/LSI FLAT-PACK
CARRIERS/CONTACTORS
AND SOCKETS**



I.C. production bogged down? Barnes Hot Rods keep it moving at top speed. The 039 Series Carriers protect flat-packs through handling, environmental and ambient testing, branding and shipping... increasing speed and yields in every process step by eliminating handling damage. MD-100 Sockets and 039 Series Contactors feature fast one-hand loading and unloading—for individual devices or those in carriers. Write or call collect for details on the Hot Rods.

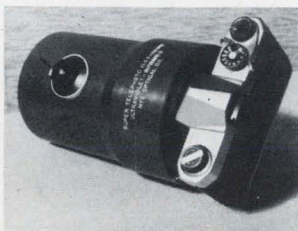


Lansdowne, Pa. 19050 • 215/MA2-1525

barnes / THE FIRST WORD IN CARRIERS, CONTACTORS AND SOCKETS FOR I.C.'S

Circle 115 on reader service card

**FAR U.V.
TO
INTERMED. I.R.
150 MM F/1.4**



New, Ultra High Speed, lightweight, mirror lens. For low light level photography over a very broad spectral range from .2 microns in the far ultra-violet to 4.5 microns in the intermediate infrared.

Highly efficient light transmission yields an image about 16 times brighter than most telephoto lenses. Fits 35 mm single lens reflex cameras, or use with adapter on movie or T.V. cameras. Long working distance of 1.78" makes use with image intensifiers or photo detectors quite easy.

Excellent for photography under very adverse lighting conditions or ultra high speed shots. We have taken pictures by moonlight and candlelight on ordinary color film. Continuously variable light control from F/1.4 down to complete extinction. Weighs 40 ozs.; 6 1/2 inches long.

NYE OPTICAL COMPANY

8781 Troy Street
Spring Valley, Calif. 92077
Phone: (714) 466-2200



actual size
Model A1-21

Mite-size miniature 7/16" indicator

These tiny indicators are compact, rugged, versatile and easy to read. They feature a microminiature moving coil core magnet mechanism. A1-21 Indicators operate in -55°C to +85°C environments and are sealed against dirt and dust. Choice of pointer or flag display in a wide variety of electrical sensitivities and functions. Size: 7/16" in diameter, 31/32" in length. Weight: 11.5 grams. Write today for complete information.

AMMON

AMMON INSTRUMENTS, INC.
345 Kelley St., Manchester, N.H. 03105

Circle 116 on reader service card

... works with positive
or negative logic ...

pulses, and displays these variables.

The designer, Gary Gordon, says he and other H-P engineers got tired of looking for traces on an oscilloscope or fooling around with analog voltmeters to determine logic states. "The engineer," he says, "needs to be free to think about what the circuit should be doing and not about how to read a signal."

The 10525A logic probe emits a bright circle of light from a translucent band about an inch from the probe tip; the light goes on or off to indicate the presence or absence of logical highs or lows for conventional diode-transistor or transistor-transistor logic levels. The indicator, unlike other rudimentary probes on the market, operates equally well for either positive or negative logic. And it responds to pulses as brief as 30 nanoseconds and stretches the duration of the illuminated indicator to 0.1 second for easy viewing. For pulse trains, the indicator light glows at half intensity.

The following table shows how the probe indicates various test conditions:

Condition	Indicator
Positive reference	
No pulse	Bright
Pulse	Out momentarily
Repetitive pulse	Partial brightness
Negative reference	
No pulse	Out
Pulse	Bright momentarily
Repetitive pulse	Partial brightness

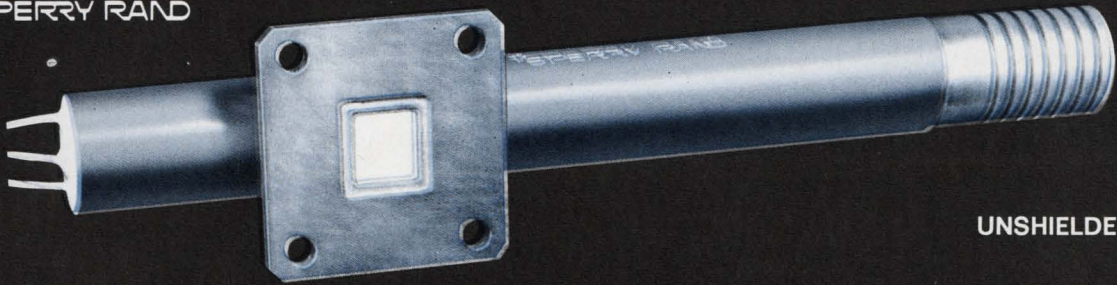
Linger a little. The probe's incandescent lamp, says Gordon, will indicate any change in voltage level out to its overload limit as long as the on-off voltage spans a ± 0.4 -volt swing through the preset 1.4-volt triggering point of the probe input. This threshold-level discriminator and amplifier activates a quad NAND gate, especially designed for H-P by Texas Instruments, which stretches a short pulse into a lingering illumination of the probe.

In operation, the logic probe is moved from point to point on a circuit run at normal speed; this process detects the presence of pulses such as clock, reset, start, shift, and transfer. The circuit can also be stepped one pulse at a time

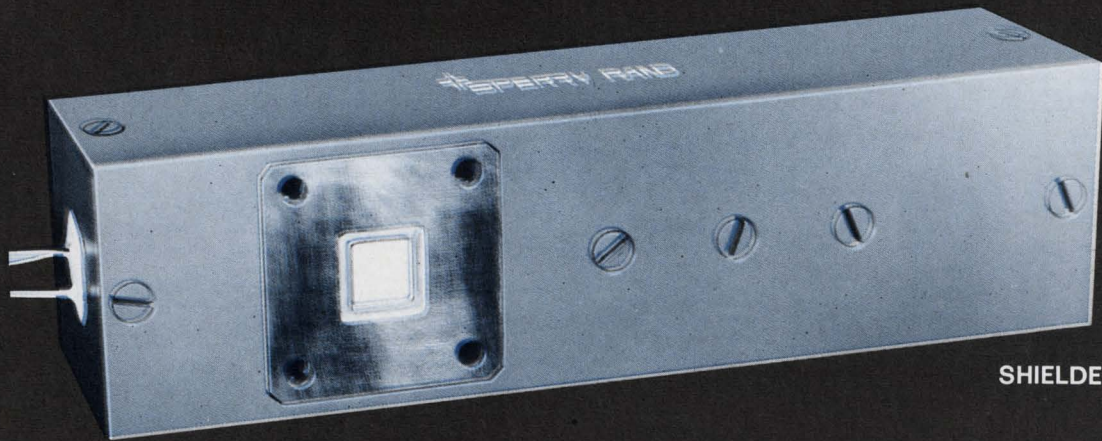
Electronics | November 11, 1968

276 Circle 276 on reader service card

 SPERRY RAND



UNSHIELDED



SHIELDED

Who needs Sperry's new 5 ounce Ku band backward wave oscillator?

You do, if you're working on radar systems, ECM systems or test equipment with a premium on size and weight.

Sperry's remarkable new device, the SBU-4531 will give you 20 mW or more of output from 14 to 16 GHz. In the 14.5 to 15.5 GHz area, it produces 60 mW.

The SBU-4531 also features a modulating electrode that permits flexible programming of the BWO output.

The tube is PPM focused and forced air or conduction cooled. It is available with or

without an integral power supply. In its unshielded version, it weighs only 5 ounces and is approximately 6 inches long. Its low external magnetic field makes it suitable for many applications that formerly demanded shielded tubes. It is also available, as the SBU-4532, in a magnetically shielded package which weighs only 12 ounces.

Find out how the SBU-4531 and SBU-4532 can help you cut size and weight out of your Ku band system — contact your Cain & Co. representative or write Sperry Electronic Tube Division, Gainesville, Florida.

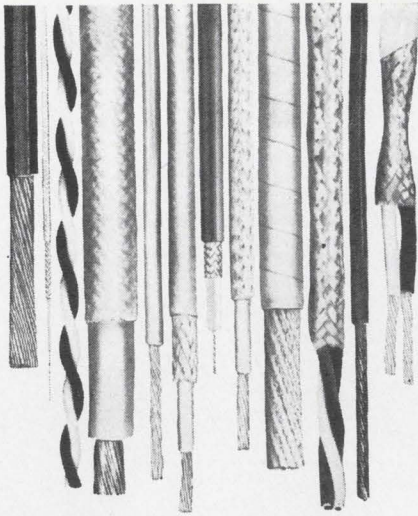


MICROWAVE PROS!



SPERRY
ELECTRONIC TUBE DIVISION
GAINESVILLE, FLORIDA

Tell us about your engineering degree(s) and your five or more years of microwave tube experience. Let us tell you about exciting work, educational opportunity and pleasant living in one of America's most attractive university cities. Resume, please, to Walt Thomas, Director of Industrial Relations. (An equal opportunity employer, M&F.)



if we haven't
made it . . .
nobody has
asked for it

We make not only a wide variety of standard cable constructions, including all the standard RG/U Coaxial cables, but also a tremendous number of special constructions to customers' specifications. These special *Flexlead* cables are precisely engineered to meet the exacting requirements of high and low temperatures, corrosive atmospheres, repeated flexure, abrasion, excessive corona, weathering, and many other severe conditions. Whatever your requirements, Markel will make a cable to meet them. In fact, the chances are good that we've already made one like it . . . and that could save you both time and money! Your letterhead request will bring a copy of our complete *Flexlead* catalog.



L. FRANK MARKEL & SONS, INC.
Norristown, Pa. 19404 • Phone: 215/272-8960
INSULATING TUBINGS AND SLEEVINGS
HIGH TEMPERATURE WIRE AND CABLE

and a comparison made between the logic levels of the IC package and corresponding truth tables. Using several logic probes simultaneously, timing pulses and following state transitions can be detected to identify function operations.

In addition to simple troubleshooting and maintenance checks, the probe can be used for analysis of breadboard designs; complete digital systems and data acquisition systems can also be analyzed and checked.

The probe operates from any positive 5-volt source and is supplied with a BNC bulkhead connector to be plugged into the power bus of the unit under test, a BNC-to-banana adapter for use with a laboratory power supply, a BNC-to-miniature-alligator connector to clip onto p-c boards, and a ground cable assembly.

The price will be \$95 each, with quantity discounts available.

Specifications

Impedance	10 kohm
Trigger threshold	+1.4 v, nominal
Pulse-width sensitivity	30 nsec for ± 2 v referenced symmetrically about ± 1.4 v
Overload protection	-50 v to +200 v continuous -200 v to +200 v transient 120 v a-c for 10 sec
Power requirements	5 v $\pm 10\%$ at 75 ma, BNC power connector. Internal overload protection to ± 7 v supply 0 to 55°C
Temperature	

Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94303 [429]

New production equipment

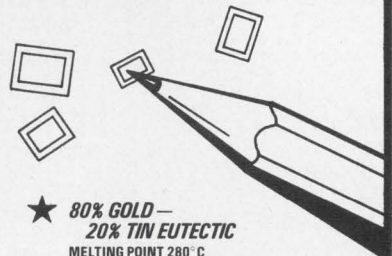
Climate for growth
is inside cathode

System for making crystals
has a hollow electron gun
and handles many materials

Crystal growing systems are usually specialized; they handle three or four materials and that's it. But a unit built by engineers at the Materials Research Corp. makes

IC SEALING PROBLEMS SOLVED

WITH WILLIAMS' IMPROVED
ALLOYS FOR
MICROELECTRONIC DESIGN.



- ★ **80% GOLD — 20% TIN EUTECTIC**
MELTING POINT 280°C
- ★ **88% GOLD — 12% GERMANIUM EUTECTIC**
MELTING POINT 356°C
- ★ **SOLDER PREFORMS FOR SEALING INTEGRATED CIRCUIT PACKAGES**
- ★ **TOOLING AVAILABLE ON MOST STANDARD SIZES**
4 to 6 Weeks Delivery on New Tooling

PARTIAL LIST OF AVAILABLE ALLOYS & SOLDER PREFORMS

88% Gold 12% Germanium (Eutectic Alloy)
Strip and solder preforms in all sizes
80% Gold 20% Tin (Eutectic Alloy)
Strip, wire and solder preforms in all sizes
Gold with .1 to 1.2% Antimony
Wire, strip and solder preforms all sizes
Gold — .05% Min. Phosphorous
Wire, strip and solder preforms all sizes
95% Gold 5% Nickel
Wire, strip and solder preforms all sizes
Gold and up to .5% Arsenic
Strip and solder preforms all sizes
Silver with .1 to 1.2% Antimony
Wire, strip and solder preforms all sizes
Silver — .1% Min. Phosphorous
Wire, strip and solder preforms all sizes
95% Silver 5% Nickel
Wire, strip and solder preforms all sizes
Silver and up to .5% Arsenic
Strip and solder preforms all sizes
Special alloys produced on request at minimum charge.
Precious Metals in 99.9% Pure, 99.99% Pure, and 99.999% Pure.

Modern, up-to-date refining of precious metals and complete spectrographic facilities available.

HIGH PURITY METALS USED ON ALL ALLOYS

WRITE FOR COMPLETE PRECIOUS METALS CATALOG AND SPECIFICATION SHEETS. PHONE 716-834-7204

OVER 50 YEARS OF PRECIOUS METALS EXPERIENCE

**WILLIAMS
PRECIOUS
METALS**



2978 MAIN ST. BUFFALO, NEW YORK 14214
Division of Williams Gold Refining Co., Inc.

Florida opportunities

*for a special breed of
communication engineer*

If you're going to enjoy your job, you might as well enjoy where you're living! At Electronic Communications, Inc., you can have both: professional challenge and career opportunity plus the advantages of living in St. Petersburg on Florida's subtropical Gulf Coast.

We don't offer comfortable grooves where you can get lost . . . and your work overlooked. At ECI you'll work on projects that push the state-of-the-art in satellite communications, multiplexing, electronic switching and advanced radio communications to supply systems advanced and equipment for many of the nation's key military and space programs. You'll work on projects beginning with applied research and advance development through prototype and product design. In fact, two-thirds of all advanced development at ECI is done in regular engineering development areas.

CHECK THESE OPPORTUNITIES IN ENGINEERING AT ECI

RF Circuit Engineers
Systems Analysis Engineers
Systems Integration Engineers
Industrial Engineers
Digital Engineers
Reliability Engineers

CHALLENGE, GROWTH . . . AND LOCATION TOO!

If you'd like a challenging engineering position, growth instead of a groove, and stimulating, comfortable living in sunny St. Petersburg, send your resume — in confidence — to K. E. Nipper, Supervisor of Professional Placement, Electronic Communications, Inc., Box 12248, St. Petersburg, Florida 33733.

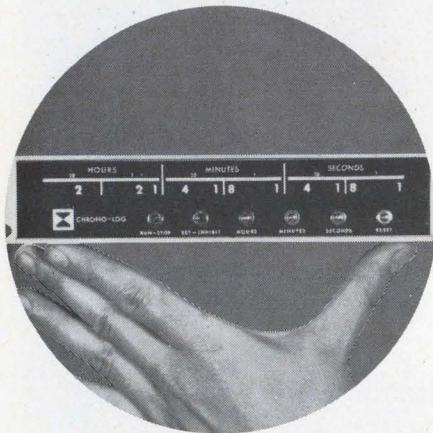
(An equal opportunity employer, M/F.)



**ELECTRONIC COMMUNICATIONS, INC.
ST. PETERSBURG DIVISION**



This new digital clock is systems oriented



For systems requiring a digital output of time and date, Chrono-log offers the Series 30,000 Integrated Circuit Digital Clock, systems oriented because . . .

IT MEETS EXACT SYSTEM NEEDS — choose from standardized options such as BCD or NIXIE display, outputs of hours-minutes-seconds or other time formats, addition of month-and-day or day-of-year calendars, parallel or serial (or both) output gating, standard or expanded operating temperature range . . . and many more.

IT SAVES SYSTEM SPACE — measures only 1¾ in. high, 8¾ deep and half-rack wide.

IT CUTS SYSTEM COST—basic clock costs less than electromechanical or discrete-component models. Also, use of standardized options assures the features you want (over 7,500 combinations available) at off-the-shelf prices.

Uses for Chrono-log Digital Clocks include real time and elapsed time inputs for data logging, data transmission, data processing, time display, telemetry and digital printout systems.

For complete information write Chrono-log Corp., 2583 West Chester Pike, Broomall, Pa. 19008 or call (215) 356-6771.



. . . method may produce new laser materials . . .

single crystals out of almost anything—yag, Y_2O_3 , $YAlO_3$, Er_2O_3 , $ErAlO_3$, $NiAl$, Cu , Si , Ge . The company says the system, called the PBZ-99, handles most dielectrics, metals, and rare-earth oxides.

The PBZ-99's versatility can be traced to use of a plasma-beam technique for transferring energy to the source material. Materials Research's approach was developed by Walter Class, manager of the Ceramic Products division.

Key to this method is the heat source, a hollow-cathode gun, which makes it possible to melt float zones on highly reactive and refractive materials. Application of a high d-c voltage to low-pressure gas in a bell jar causes glow discharge. Electrons come off the surface of the cathode and converge at its center, producing a high energy-density heat source.

According to Class, the plasma-beam technique lets the operator choose from a wide variety of gases and run the system over a broad temperature range.

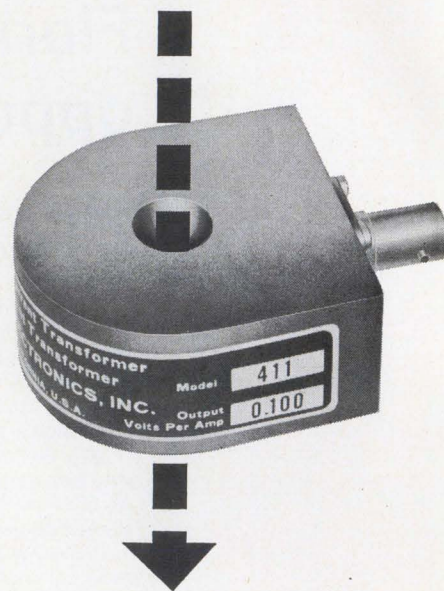
Amateur growers. Class notes that the beam can be given a much sharper focus than is possible with radio-frequency growers. "There are a few people around, real pros, who can grow copper crystal with a radio-frequency system. But we brought technicians and even sales engineers into the lab and taught them to grow copper crystals without any problems."

Another use for the system is purification. Most rare-earth oxides come with a high-purity tag, says Class, but these percentages are calculated relative to the purity of other rare-earth oxides. In all these oxides there are metallic contaminants whose presence isn't indicated by the purity figures and which are very difficult to get out. "But our system will get rid of a lot of these metals," Class declares.

Materials Research expects the system to find use of research and production laboratories.

Priced at \$21,000, the PBZ-99 has a delivery time of eight weeks.

Materials Research Corp., Orangeburg, N.Y. 10962 [430]



Wide Band, Precision CURRENT MONITOR

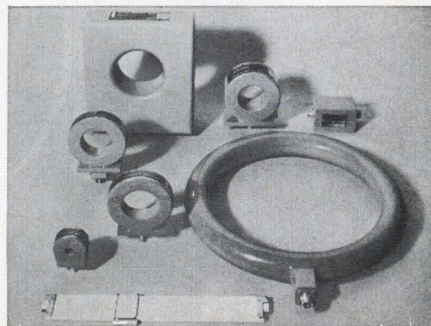
With a Pearson current monitor and an oscilloscope, you can measure pulse or ac currents from milliamperes to kiloamperes, in any conductor or beam of charged particles, at any voltage level up to a million volts, at frequencies up to 35 MHz or down to 1 Hz.

The monitor is physically isolated from the circuit. It is a current transformer capable of highly precise measurement of pulse amplitude and waveshape. The one shown above, for example, offers pulse-amplitude accuracy of +1%, -0% (typical of all Pearson current monitors), 10 nanosecond rise time, and droop of only 0.5% per millisecond. Three db bandwidth is 1 Hz to 35 MHz.

Whether you wish to measure current in a conductor, a klystron, or a particle accelerator, it's likely that one of our off-the-shelf models (ranging from ½" to 10¾" ID) will do the job. Contact us and we will send you engineering data.

PEARSON ELECTRONICS INC

4007 Transport St., Palo Alto, California 94303
Telephone (415) 326-7285





FASTENER KNOW-HOW

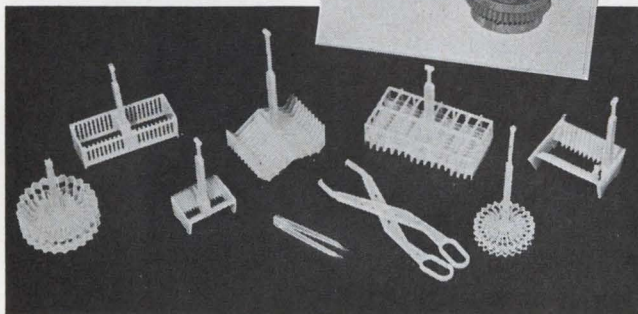
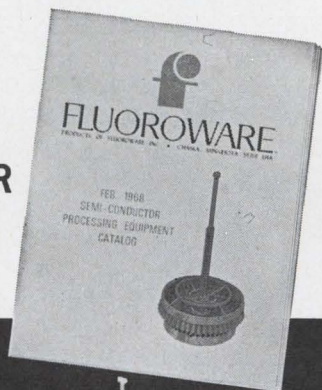
Here's complete design and application data on precision GROOV-PINS . . . the solid cylindrical fastener pins with longitudinal grooves. Now! Combine economy, versatility, reliability with positive locking action. Get your copy of this helpful 12-page catalog by writing: Groov-Pin Corporation, 1121 Hendricks Causeway, Ridgefield, N.J. 07657, WH-5-6780.

FASTENER DIVISION

GROOV-PIN CORP.

Circle 119 on reader service card

FREE!
CATALOG ON
SEMI-CONDUCTOR
PROCESSING
EQUIPMENT



Get full information on a wide variety of products for handling substrates, wafers, and crystals. Fluoroware carriers, baskets, and trays are precision-molded from FEP Teflon*, a material that is almost 100% inert and useable at extreme temperatures.

Write for the "Semi-conductor Processing Equipment Catalog," including information on the new Fluoroware spin dryer.

*DuPont Trademark

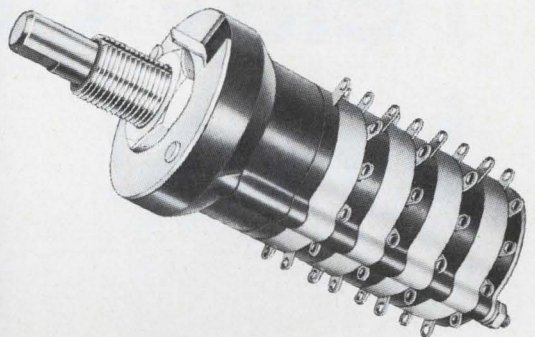
FLUOROWARE.

Chaska, Minnesota 55318 • Phone 612-448-3131

Circle 120 on reader service card

When Only Excellent is Adequate TURN to Grayhill

WHAT'S NEW ABOUT THIS SWITCH?



It's NOT Because It

- 1) is explosion proof.
- 2) has up to 12 positions/deck.
- 3) could have up to 6 poles/deck.
- 4) comes in shorting or non-shorting versions.
- 5) is available in sealed, military or standard versions.

NO... These are Standard Grayhill Rotary Switch features.

IT'S NEW BECAUSE

one or more positions may be ISOLATED from normal shaft turning techniques. It has its own built-in shaft turning SAFETY feature.

For details on this
 and other Switches
 Ask for Catalog G-304-A



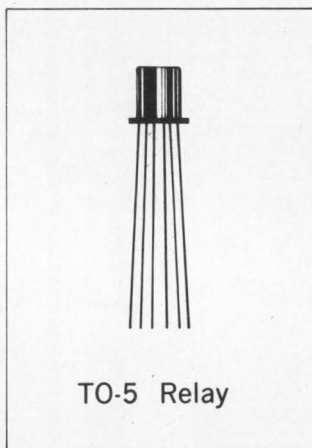
523 Hillgrove Avenue
 LaGrange, Illinois 60525
 Area Code 312, Phone 354-1040

The Difference Between Excellent and Adequate

Circle 281 on reader service card

281

Leave the relay driving to us!

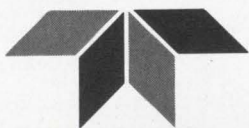


Teledyne Relays has put the Driver where it belongs — in the Driver's Seat. Neatly enclosed in the relay package, it: • suppresses coil transients • increases reliability • reduces design time • reduces relay package size more than 50% • cuts production costs. Don't wait! Our new T Series TO-5 Relays, with



Driver enclosed, are in full production—available off-the-shelf. Driver cost? Less than \$3. Learn how Teledyne is qualified to meet your specific relay requirements — current or future.

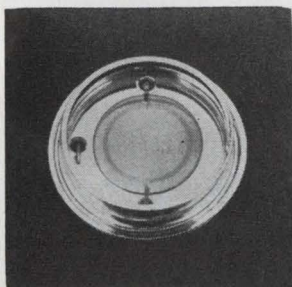
Send for complete data on our T Series TO-5 Relays:



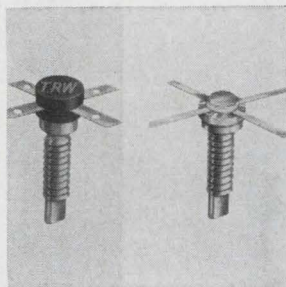
TELEDYNE RELAYS A TELEDYNE COMPANY

3155 West El Segundo Boulevard • Hawthorne, California
90250 Telephone: (213) 679-2205

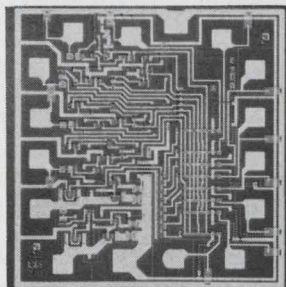
New Semiconductors Review



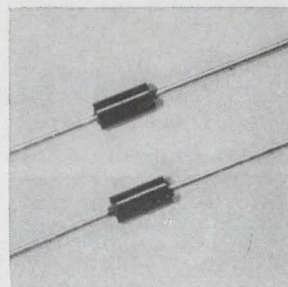
Silicon diffused photodiodes 671 and 663 feature low leakage current. They offer high quantum efficiency and/or sensitivity, and high detectivity throughout the visible range and to 1.1 microns. Active areas measure 10 mm diameter for the 671 and 5 mm for the 663. Units are surface passivated. Electro-Nuclear Laboratories Inc., 115 Independence Dr., Menlo Park, Calif. [436]



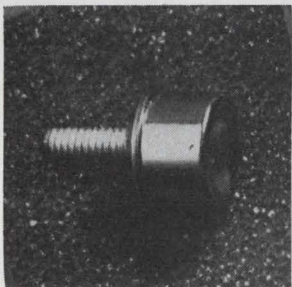
High power 2 GHz microwave transistors come in a hermetically sealed ultrac ceramic stripline package. Type 2N5483 provides 5 w output from a 28 v source with 4 db gain. Type 2N5482 furnishes 2.5 w r-f output from a 28 v source with 5 db gain; and the 2N5481 delivers 1 w from a 28 v source with 6 db gain. TRW Semiconductors Inc., Aviation Blvd. Lawndale, Calif. [437]



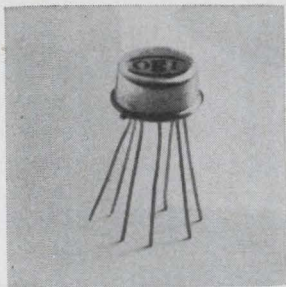
Eight-input digital multiplexer 9312 is a medium scale integration circuit featuring on-chip select decoding and input enabling, with fully buffered complementary pull-up outputs. A 25-nsec through delay allows this monolithic device to be used in a wide variety of multiplexing and switching uses. Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. [438]



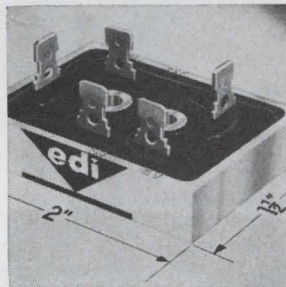
Miniature molded zener diodes feature internally the Amerseal process for protection against vibration and shock. They are for use on compact p-c boards in commercial applications. They are offered in ratings up to 200 v. Standard tolerance is 20%, but tolerances of 10%, 5% and closer are available. American Semiconductor Corp., 4 N. Hickory Ave., Arlington Heights, Ill. [439]



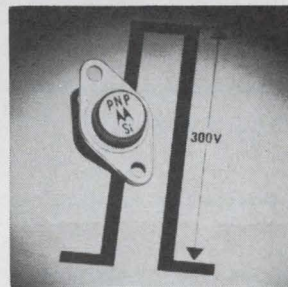
Gallium-arsenide laser diode arrays LD200 are for room temperature operation. Emitting coherent, infrared radiation at 9040 angstroms when pulsed in the forward biased region, the magnitude of their light output is a function of the magnitude of the forward current in the array. Prices are \$78 to \$207 in 1,000 lots. Laser Diode Laboratories Inc., Metuchen, N.J. [440]



Monolithic operational amplifier model 9308 provides full output swing of ± 10 v from d-c to 500 khz minimum. Features include: 80 db minimum open loop gain, ± 30 v/ μ sec minimum slewing rate, 80 Mhz minimum gain bandwidth product, and 150 nsec settling time to 0.01%. Price in lots of 100 to 299 is \$25 each. Optical Electronics Inc., P.O. Box 11140, Tucson 8576. [441]



Three-phase silicon rectifier bridge PBT 05 is a 50 piv device that carries 30 amps at 100° case temperature. Dimensions are 2 x 1½ x 1 in. including terminal. Units are suitable for motor controls, computer power supplies, transistor circuitry and instrumentation. Price is \$3.70 each in quantities of 1,000. Electronic Devices Inc., 21 Gray Oakes Ave., Yonkers, N.Y. 10710. [442]



Two PNP, high-voltage silicon transistors are for power switching applications. The 2N5345 is a 1 amp device that can handle 300 v, while the 2N5344 is rated at 250 v. Both have a maximum total run-on time of 200 nsec at 500 ma and 100 v. Price (100-999) of the 2N5344 is \$12 and the 2N5345 is \$15. Motorola Semiconductor Products Inc., Box 20924, Phoenix. [443]

New semiconductors

Added terminal lets SCR turn on a crowd

Rectifier has a lead connected to its regenerative gate, which puts out enough voltage to fire parallel devices

As far as specs go, the NL-F silicon controlled rectifier National Electronics, Inc. developed last spring [Electronics, June 10, p. 207] and the NL-H, the company's new SCR, are identical. Voltage and current ranges, anode current change (di/dt), size, weight, and

other parameters have the same value for both rectifiers.

The difference is that the NL-H is more of a team player than its older brother. Besides the normal cathode, anode and initiating-gate leads, the NL-H has a fourth terminal whose signal can be used to

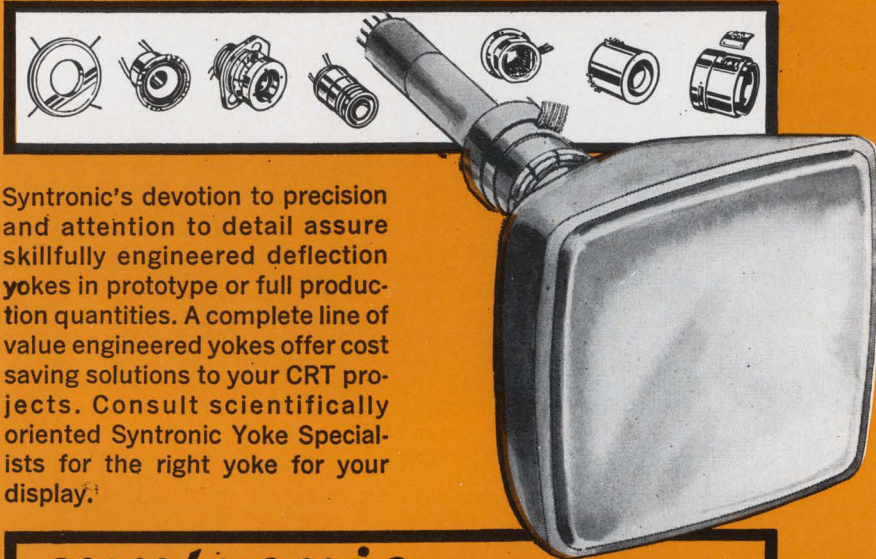
trigger other rectifiers. So in high-power work where it's necessary to run SCR's in parallel, using an NL-H as one of those SCR's enables a single driving circuit to turn on all the rectifiers.

When National—a subsidiary of Varian Associates—introduced the NL-F, it stressed the device's high di/dt, 600 amps per microsecond. National got this quick current change by putting conductive spokes into the rectifier. Called a regenerative gate, these spokes are bedded in the emitter lip, that part of the n-layer cathode not under the metal terminal.

The signal from the driving cir-

YOKE SPECIALISTS

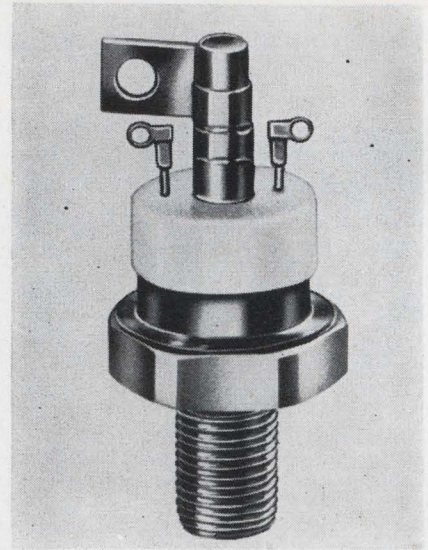
FOR INFORMATION DISPLAYS



Syntronic's devotion to precision and attention to detail assure skillfully engineered deflection yokes in prototype or full production quantities. A complete line of value engineered yokes offer cost saving solutions to your CRT projects. Consult scientifically oriented Syntronic Yoke Specialists for the right yoke for your display.

Syntronic INSTRUMENTS, INC.
100 Industrial Road, Addison, Ill.
Phone: Area 312, 543-6444

Circle 121 on reader service card



Spiked. The output of the regenerative gate is a voltage spike that can turn on other rectifiers or sync a circuit

cuit comes in through the initiating gate, then travels across the cathode to the regenerative gate and out along the spokes. The entire region near the spokes thus turns on right away. The added gate lets more of the cathode see the turn-on signal faster, resulting in a high di/dt and less chance of inrush current burning out the center of the cathode.

Getting the gate. Discussing regenerative-gate SCR's, National design engineer Donald I. Gray has said, "Paralleling these devices is a simple matter; the regenerative signal of one device can be used to trigger others" [Electronics, Sept. 30, p. 100].

National engineers took care of this simple matter in the NL-H by connecting the fourth lead internally to the regenerative gate. The regenerative signal—the potential between the regenerative gate and the center of the cathode—appears when the SCR starts to turn on. It's a spike whose amplitude can go as high as 50 volts.

When SCR's are paralleled, the drive circuit is connected to the NL-H's initiating gate, and the initiating gates of all the other SCR's are tied to the NL-H's regenerative gate. The NL-H can drive as many as five NL-F's.

The price depends mainly on the voltage rating, up to 1,000 volts, and ranges from \$120 to \$275. Delivery is from stock.

National Electronics Inc., Geneva, Ill. 60134 [444]

TYPE FEP

**ZIPPERTUBING®
TEFLON* JACKETING**

for extreme temperature variations —
minus 425° to plus 400° F!

FEP TEFLON provides low installation cost, and abrasive-resistant jacketing for extreme temperature environments. In 3 types: Shrinkable, regular and shielded for R.F.I. protection with grounding braid. Sizes 1/2" to 4" (or larger) in 1/8" increments. *Reg. T.M. of Dupont

For full information on specialized, high-performance jacketing, contact

THE ZIPPERTUBING® CO.

CORPORATE HEADQUARTERS
13000 S. BROADWAY
LOS ANGELES, CALIF. 90061
Phone (213) 321-3901
TWX 910-346-6713

BALTIMORE • BOSTON • CHICAGO • DALLAS • NEW YORK
PHOENIX • SAN FRANCISCO • WEST GERMANY

284 Circle 284 on reader service card

DIFFERENTIAL TRANSFORMERS
For measurement and control use

Capable of obtaining output voltages exactly proportional to any kind of mechanical variation.

More than 500 types are available.

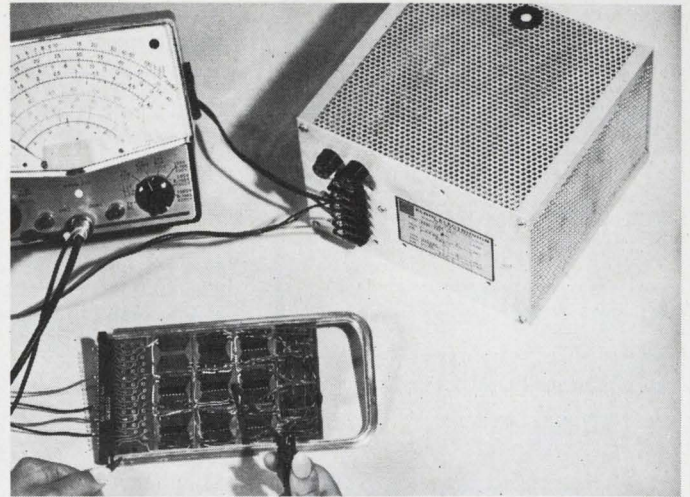
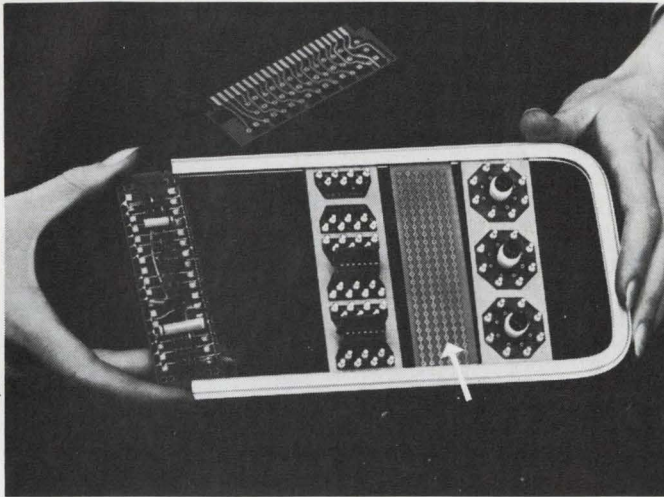
Features:

- *Outstanding interchangeability
- *Quite free from outer magnetic field
- *Insensitive to ordinary shock, water and heat

Manufacturers of Differential Transformers

NIPPON COIL CO., LTD.
Amakawa Bldg. 1, 1-chome, Hommachi, Higashi-ku, Osaka, Japan.

Circle 122 on reader service card



PICK A CARD...THEN POWER UP

with Elgin's New Integrid® Cards and Low Voltage Power Supplies

"Mix and match" with Elgin's Integrid Cards. Couple 8 and 10-pin T.O. 5's with 14 and 16-pin dual-in-line I.C.'s. Then add Elgin's patented "strip pack" to link I.C.'s with discrete components, and Econo-Grid® for additional bussing.

Finally, complete the cycle with one of Elgin's nine new, off-the-shelf Low Voltage (5V) Power Supplies for precision sources. They feature exclusive over-current and over-voltage protection (patents pending). Elgin's solid state units are available in three basic sizes, with three standard output currents of 4, 8 and 16 amps—at a *fraction* of the cost you'd

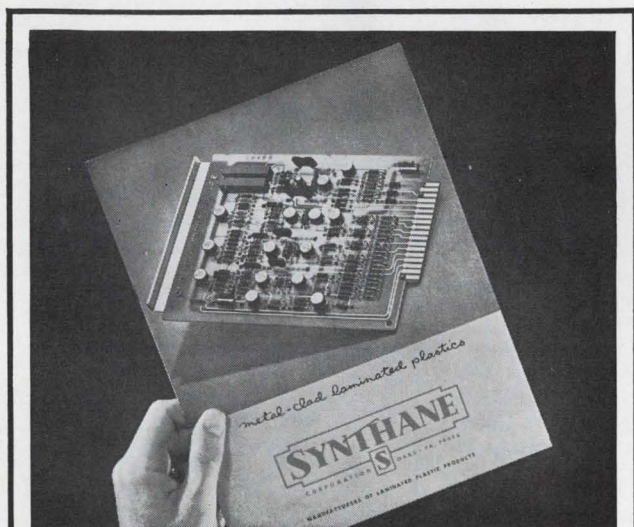
expect. Regulation—less than 0.05%, load regulation—less than 0.1% for 0-100% load change. Combined regulation—less than $\pm 0.25\%$!

AND YOU GET AN ELGIN BONUS—**GUARANTEED PROMPT DELIVERY.**

For literature and prices on Integrid Cards or Power Supplies, write Elgin Electronics Incorporated, P. O. Box 1318, Erie, Pennsylvania 16512, or phone 814-452-6773.

ELGIN ELECTRONICS INCORPORATED
Subsidiary of Basic Incorporated.

Circle 283 on reader service card



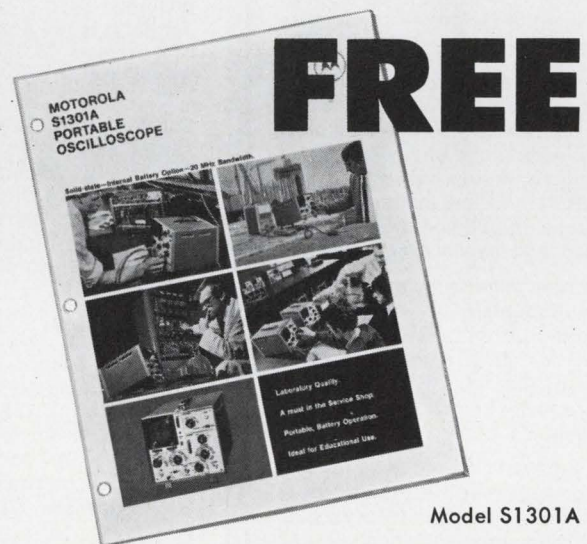
The booklet every electronic designer should have

The supply of this recent Synthane Metal-clad Laminate folder is going fast because it is packed with new information on Synthane high-quality metal-clad laminates. Grades, sizes, types of foils, trademark identification, property values, a section on thin laminates and prepreg materials. Be sure of your copy by writing us or circling our inquiry number in this publication. Synthane Corporation 36 River Road, Oaks, Pa. 19456.

SYNTHANE
CORPORATION **S** OAKS, PA. 19456

Laminated Plastic Sheets, Rods, Tubes and Fabricated Parts

Circle 123 on reader service card



Model S1301A

Get technical literature on the only *totally* portable, solid state oscilloscope. Operates from optional internal battery or from 110/220 vac, 50 to 400 Hz line voltage. Features include: 20 MHz bandwidth; 17 nsec rise time; 18 ranges of calibrated sweep speeds; internal voltage calibrator; and triggering stability in excess of 30 MHz.

Write for Bulletin TIC 3316 to Motorola Communications & Electronics Inc., 4501 W. Augusta Blvd., Chicago, Ill. 60651



MOTOROLA
Precision Instrument Products



Circle 285 on reader service card

285




**miniature
DC-18 GHz motorized
programmable
step attenuators
0-129 dB**



New  Miniature Motorized Programmable Step attenuators come with values as high as 129 dB in 1 and 10 dB steps. These 50 ohm  series 96, 97 and 98 Step attenuators come in a choice of 8 standard RF connector options (coaxial or waveguide); 5 standard frequency ranges; 17 standard insertion loss ranges; and single, double or triple drum assemblies internally connected in series with low reflection adapters to minimize mismatch errors.

They feature switching life exceeding 1,000,000 steps excellent repeatability high stability under wide range of environmental conditions low leakage low VSWR and low minimum insertion loss. In addition, they are motorized and easily programmable.

Switching time is typically 2 seconds. Repeatability exceeds ± 0.01 dB/drum up to 10 GHz. Maximum VSWR for all  series 96 units is held to less than 1.50 and to 18 GHz and to below 1.15 for lower frequencies.

The ease with which these models are programmable makes them especially useful in systems employing automatically controlled levels. These step attenuators can be switched more than one million times without deterioration and without in-between maintenance.

Designers and
Manufacturers of Precision
Microwave Equipment

**WEINSCHEL
ENGINEERING**

Gaithersburg, Md. 20760
Tel: (301) 948-3434
TWX: 710-828-9705

Meetings

(Continued from p. 26)

Short courses

Modern small digital computers, University of Wisconsin's Department of Engineering, Madison, Wis., Nov. 14-15; \$70 fee.

Maintainability—engineering and management, George Washington University's School of Engineering and Applied Science, Washington, Dec. 2-6; \$275 fee.

Computer Systems: applications, University of Wisconsin's Department of Engineering, Madison, Wis., Dec. 6-7; \$70 fee.

Standards and calibration laboratories, George Washington University's School of Engineering and Applied Science, Washington, Dec. 9-13; \$275 fee.

Reliability—failure analysis, George Washington University's School of Engineering and Applied Science, Washington, Dec. 9-13; \$275 fee.

Call for papers

G-MTT International Microwave Symposium, IEEE; Dallas, Texas, May 5-8. **January 10** is deadline for submission of abstracts to IEEE at 345 East 47th Street, New York, N.Y. 10017

Southwestern Convention & Exhibition (Swieeco), IEEE; San Antonio, Texas, April 23-25. **December 1** is deadline for submission of abstracts to Dr. William H. Hartwig, Department of Electrical Engineering, Engineering Science Building 439, University of Texas, Austin, Texas 78712

International Joint Conference on Artificial Intelligence, Association for Computing Machinery; Statler-Hilton Hotel, Washington, D.C., May 7-9. **January 15** is deadline for submission of manuscripts to Dr. Donald E. Walker, IJCAI program chairman, The Mitre Corp., Bedford, Mass. 01730

Biennial Joint Materials Handling Conference, IEEE; Portland, Ore., October 26-29. **May 1** is deadline for submission for abstracts to Max Frey, conference program chairman, project engineer, Cascade Corp., P.O. Box 7587, Portland, Ore. 97220

International Symposium on Man-Machine Systems, IEEE; Cambridge, England, September 8-12. Information will be circulated to individuals who request it from Robert C. McLane, G-MMS meetings chairman, Honeywell Inc. 2345 Walnut Street, St. Paul, Minn. 55113

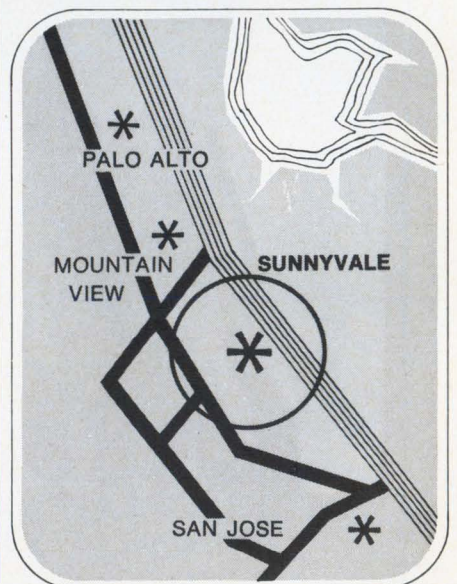
If you supply, serve or compete within the instrumentation field, you can benefit from locating your plant in the Western core of the industry. Here, in Santa Clara County, 57 instrument manufacturers prosper — two to 30 minutes apart.

Join the synergistic action sparked by top educational facilities, a business climate that welcomes innovation, plus the constant challenge of new breakthrough to be measured. The \$6 billion Western electronics market is at your doorstep! Send for your free copy of a census, "Instrument Manufacturers in Santa Clara County", plus eye-opening facts on this technically-oriented industrial center. Write Ed Beaty, Chamber of Commerce, 499 South Murphy Avenue, Sunnyvale, California 94086.



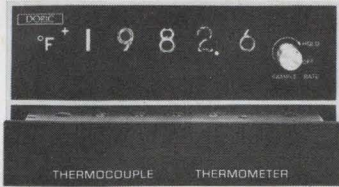
this is

INSTRUMENT TERRITORY...



*a good place
to locate your
business*

SUNNYVALE CALIFORNIA



**need
repeatable
temperature
measurements?**

DORIC'S REVOLUTIONARY THERMOCOUPLE TEMPERATURE METER OUTCLASSES ALL SIMILAR DEVICES . . . AND GIVES YOU ROCK SOLID .005% REPEATABILITY.

READS IN °F OR °C with up to 20000 active counts of resolution. Plug-in program cards for ISA types J, K, T, Y, E, R and S. Dual curve models. Auto polarity on bipolar ranges. Optional compensation.

DIGITAL LINEARIZATION computing techniques eliminate severe short and long term errors due to conventional analog curve approximation methods. Digital programming simplifies conversion to other curves. **AUTOMATIC ZERO DRIFT CORRECTION** totally eliminates the troublesome zero drift problems common to all other instruments—requires no attention—no adjustment.

GUARDED DIFFERENTIAL MEASUREMENTS and true integration allows floating or grounded thermocouples, allows differential temperature measurements, puts an end to ground loops and other noise problems typical to industrial plant environments.

INPUT/OUTPUT CONDITIONING PLUG-INS for pressure, position, load, force, torque, horsepower, flow, microvolts/millivolts, DVM, plus digital outputs for data logging, alarm, programming, etc.

CALL US COLLECT NOW for questions and answers. 8-page catalog. Reps and demonstrators in all areas. Prices range from \$790 to \$1,490.

**DORIC
SCIENTIFIC
CORPORATION**

DORIC SCIENTIFIC CORP.
7969 Engineer Road
San Diego, California 92111
PHONE: (714) 277-8421

Circle 125 on reader service card

**COMPACT • PORTABLE
HIGH SENSITIVITY**



**1.5MHz
20mV/cm**

**MODEL
536A**

Model 536A is a compact, portable, general purpose oscilloscope employing a 3 inch cathode ray tube and possessing superior electric characteristics and easy to operate.

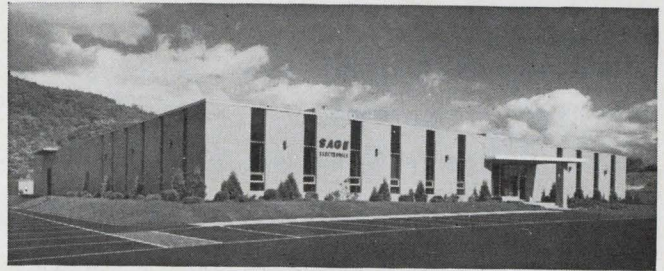
This oscilloscope is a highly usable instrument, because the vertical axis is provided with a push-pull type DC amplifier of high sensitivity, wide band and good stability and phase characteristics, together with a time base oscillator of good linearity variable over a wide range.

kikusui
KIKUSUI ELECTRONICS CORP.

3-1175, SHINMARUKO-HIGASHI, KAWASAKI-CITY, KANAGAWA-PREF., JAPAN.
CABLE ADDRESS: "KIKUSUIDE" KAWASAKI.

Circle 126 on reader service card

SMALL COMPANY



BIG PERFORMANCE



Why knock yourself out when your customer keeps scoring your performance at zero? It makes sense at Sage Electronics, especially when that score is another Zero Defects citation, as evidenced by the examples above.

We are specialists in **MINIATURE POWER RESISTOR** products. Accordingly SAGE pursues active programs second to none in respect to:

1. Zero Defects
2. High Reliability
3. MIL spec production and test
4. High volume commercial production

Look us over, first by exploring SAGE Catalog R-66. A phone or letter request will promptly bring your copy.



SAGE

SEE OUR SPECIFICATIONS IN
VSMF
THE MICROFILM CATALOG FILE

SAGE ELECTRONICS CORP.

Subsidiary of Gulton Industries, Inc.

BOX 3926 ROCHESTER, N. Y. 14610
Phone: (716) 586-8010

Circle 287 on reader service card

287

Maxwell meets Einstein

Electromagnetic Waves and Radiating Systems
Edward C. Jordan and Keith G. Balmain
Prentice Hall Inc.
753 pp., \$14.95

Advances in electromagnetic technology over the past 18 years have prompted Prof. Jordan of the University of Illinois to revise his popular textbook, originally published in 1950. The new edition, prepared with the help of Balmain of the University of Toronto, is as clear and comprehensive in its treatment of today's technology as its predecessor was in its day. And though intended primarily for undergraduate honors students, the book will profit many design engineers with its chapters on waveguides and antennas.

Practical engineering examples are interspersed throughout, but the text is aimed at comprehension of the subject and is not meant to be a designer's reference book.

Disappointingly, though, the bibliography isn't as updated as the subject matter.

The book begins with the usual approach—vector analysis, electrostatics, magnetic fields, Maxwell's equations, and configurations of waves reflected off surfaces or transmitted through various waveguides. But then the authors, believing that engineers nowadays should know how materials behave, devote a lengthy chapter to the interaction of fields and matter. Covered are such subjects as oscillations of hot, gaseous plasma, the interaction of a wave with a plasma, and the frequency response in a dielectric material.

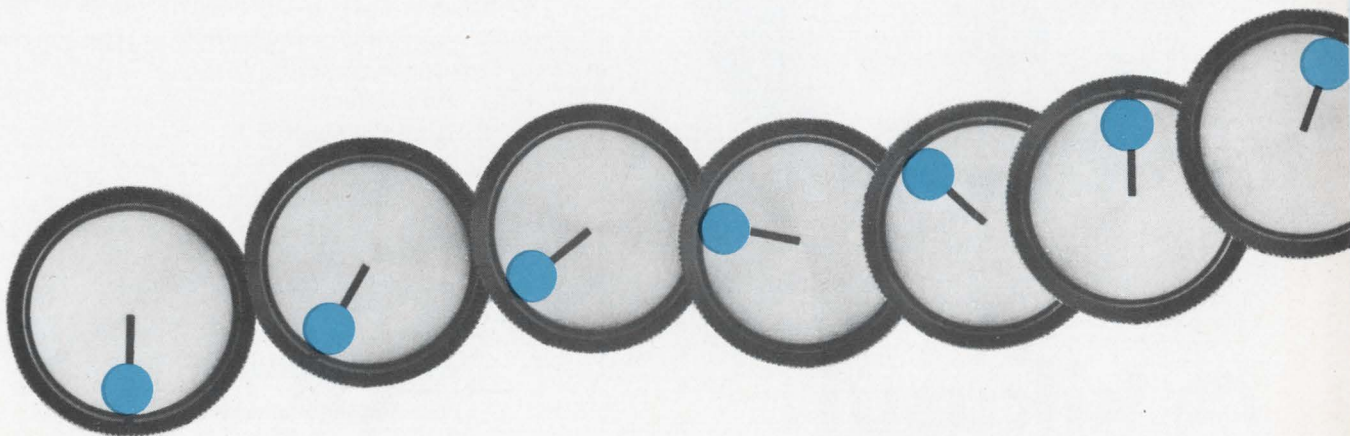
Coverage of developments in space communications, radio astronomy, and holography bring the text into the 1960's; major innovations in antenna design, particularly the frequency-independent and log-periodic structures, are also discussed.

Another addition is a chapter on the relation of Maxwell's electromagnetic theory to Einstein's special theory of relativity. The authors speculate that "there may come a time when electromagnetic theory is introduced to the electrical engineer using Coulomb's law and special relativity as a starting point."

Linking two worlds

Analog-to-Digital/
Digital-to-Analog
Conversion Techniques
David F. Hoeschele Jr.
John Wiley & Sons Inc.
455 pp., \$15.95

Engineering is full of ideal laws, but their application often suffers from errors introduced by the equipment itself and by how it works. A classic example is the conversion of signals from analog to digital form and vice versa. Even with precise construction of a con-



verter, the discrete nature of its conversion technique usually generates errors.

This volume acknowledges that conversion error can be tolerated in some systems. As usual, the smaller the tolerable error, the more the converter costs. The reader is given an understanding of the conversion methods and their relative performance.

The author comprehensively discusses the design and operation of all major methods of conversion, from shaft-position converters to successive-approximation ladder networks. A review of conversion logic is also included. Other major parts of the book include detailed discussions of reference voltages, analog voltage comparators, and the switching of analog voltages.

Bipolar transistor switches and field effect transistor comparators also get complete treatment.

The text is excellently complemented by lists of symbols and by

appendices. Among the latter are a table of binary-decimal equivalents and a review of the network theorems that form the bases of the design and operation of many types of converters.

Winning the pot

Computer Process Control
Modeling and Optimization
T.H. Lee, G.E. Adams, and W.M. Gaines
John Wiley & Sons Inc.
386 pp., \$14.95

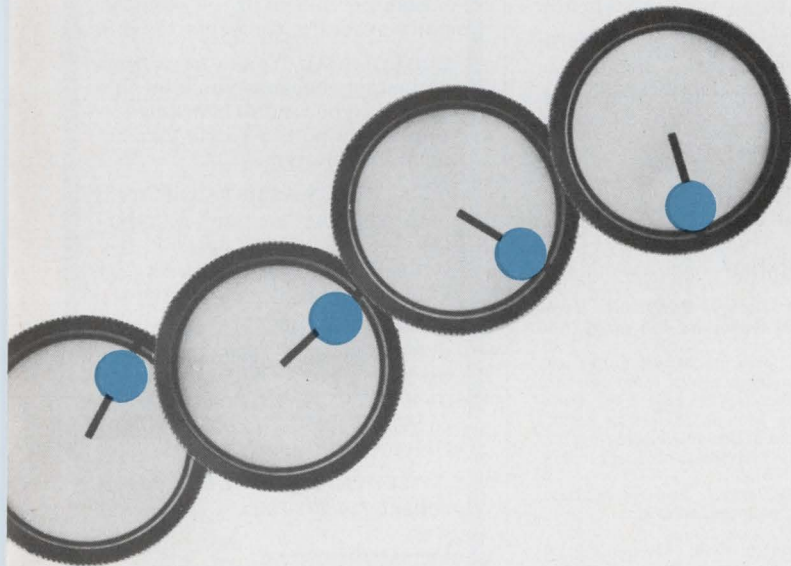
Taking on a computer control project is like playing high-stakes poker. The smartest players make money and become confident enough to sit down for more rounds. Winning means a continuing return of hundreds of thousands of dollars—perhaps more. Losing means a sterile investment of several hundred thousand dollars, with more going into the pot to get the system to work—just like trying to fill an inside straight.

In computer control, as in poker, it's brains and experience that win. This excellent book is bound to become the "How to win in computer control." It's packed with clear, valuable knowledge.

Computer control differs from conventional closed-loop control in many ways, but an essential distinction is that while conventional control is concerned mainly with plant regulation, computer control can continually adjust the plant to meet stated production demands. Key phases in computer control are defining the objectives, modeling the controlled operation, and implementing an optimization procedure. The book handles these extremely complex subjects with exceptional skill and clarity.

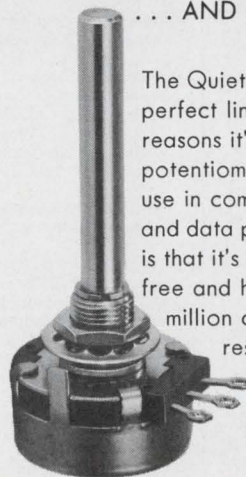
Each of the many broad subjects is segmented to let the reader grasp the over-all subject piece by piece and make him aware of how these pieces fit into a total project.

Model is a word usually tossed



THE QUIET ONE HAS TWICE THE LINEARITY
OF THE ALLEN-BRADLEY J SERIES POT

... AND ITS PRICE IS COMPETITIVE

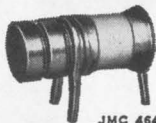
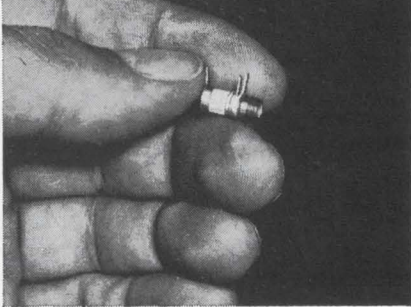


The Quiet One is within 5% of perfect linearity. That's one of the reasons it's the one low cost potentiometer that's a natural for use in computers, test equipment and data processors. Another reason is that it's almost perfectly noise-free and has been field tested 2 million cycles with less than a 5% resistance change.

Write for full information. Dept. 101, Dover, N.H. 03820

CLAROSTAT

HIGH Q LOW TC



JMC 4642



JMC 4640

New Miniature Series Variable Air Capacitors

High capacity in a small package — exclusive round nut permits installation in tight places or miniaturized packaging. Ultra-rugged construction.

Specifications

- **Small Size:** .220" dia. 15/32" length
- **Q @ 100 mc:** > 5000
- **Capacity Range:** .4 pF — 6 pF (> 8 Turns)
- **Working Voltage:** 250 VDC (Test Voltage 500 VDC)
- **Insulation Resistance:** > 10⁶ Megohms
- **Temperature Coefficient:** 50 ±50 ppm/°C
- **Temperature Range:** -65°C to +125°C

Features 570° Solder. Prevents distortion. Not affected by conventional soldering temperatures.

Call or write for complete information.

Johanson

**MANUFACTURING
CORPORATION**

400 Rockaway Valley Road
Boonton, N. J. 07005 • (201) 334-2676
Electronic Accuracy Through Mechanical Precision

New Books

around rather glibly in industry, sometimes to the point that real projects go awry because the engineer didn't realize which kind of a model he needed. The authors settle this matter nicely. They distinguish between functional, physical, and economic models, and spend several chapters detailing each type. For example, the authors point out that there is a difference between an economic model for planning the computer control project and an economic model for operating the controlled process. A realistic numerical example is worked out for many kinds of models.

The book also discusses the optimization problem, a subject that must be accompanied by advanced mathematics to be comprehensible. The authors don't shy away from the math, but skillfully blend ideas and equations—and examples—to let the reader learn without getting bogged down in mathematical obfuscation. The book thus very ably presents chapters on steady-state and dynamic optimization for processes that can be properly defined, and on evolutionary operation for poorly defined processes.

If you're going into the computer-control game, read this book of instruction first.

Recently published

Algebraic Coding Theory, Edwyn R. Berlekamp, McGraw-Hill Book Co., 466 pp., \$17.50

Discusses the best error-correcting codes proposed to date, stressing topics most relevant to the design of decoders. It covers the structure of finite fields and presents new results likely to have applications in discrete system theory. For graduate students and engineers.

Optimum Systems Control, Andrew P. Sage, Prentice-Hall Inc., 562 pp., \$14.50

Covers optimal control with deterministic inputs, state estimation, combined estimation and control, sensitivity analysis, and computational techniques. Included are deterministic control and stochastic problems. Aimed at graduate students and systems engineers, it emphasizes basic concepts.

High-Voltage Technology, Edited by L.L. Alston, Oxford University Press, 408 pp., \$14.40

Aimed at graduate engineers and scientists, this text covers the basic concepts of electric stress and strength, and surveys associated phenomena and techniques. It also comprehensively discusses electrical breakdown in gases, vacuums, liquids, and solids under laboratory and practical conditions. In covering high-voltage equipment it emphasizes practical application of basic principles.

Analyze light sources

There's an easier way to measure radiance and irradiance, luminance and illuminance. Use one of Gamma Scientific's light analysis systems. You'll get top performance, and you'll eliminate all the headaches of one-of-a-kind instrumentation.

VERSATILE. All our photometric and spectroradiometric systems are compatible with a full line of plug-in heads and accessories. Microscopes. Telescopes. Grating monochromators. Cosine receptors. Filters. Etcetera. You can change from one configuration to another in moments.

ACCURATE, RELIABLE. Gamma Scientific's fully transistorized systems are assembled, tested, calibrated . . . guaranteed from input to output. Add one of our calibrated sources and your measurements will be consistently accurate, traceable to NBS.

ECONOMICAL. You'll save time and money because you'll be able to meet your total instrumentation needs with a single Gamma Scientific system.

APPLICATION ASSISTANCE. We'll help you whether you're analyzing light sources, optical systems, photo detectors or the optical properties of materials.

MORE INFORMATION. Get all the details and our latest catalogue by writing to Systems Manager, Dept. 221, Gamma Scientific, Incorporated, 2165 Kurtz Street, San Diego, California 92110.

IMMEDIATE PROBLEMS? Call collect 714/291-2230.



**GAMMA
SCIENTIFIC
Incorporated**

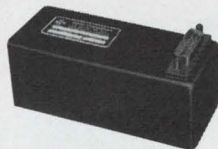
CEDAR Servo Packages



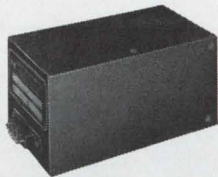
DATA CONVERTER



IN-LINE SERVO



SYNCHRONIZER



FOLLOW-UP SERVO

...like getting a Servo Engineer free

On your next make-or-buy decision, give careful consideration to the benefits of putting Cedar's servo experience to work for you in engineering your servo package. It's like getting the services of a highly experienced servo design engineer free.

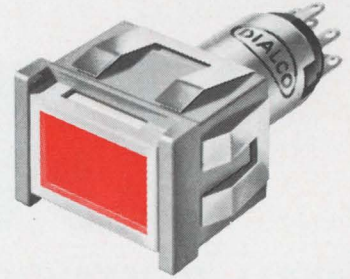
Cedar servo packages have been successfully used on leading missiles and aircraft, ranging from the LTVA7A autopilot synchronizer to the Polaris A3 pulse sum-to-analog converter. Write or give us a call on your next servo package problem. You'll be glad you did.

CEDAR CONTROL DATA
ENGINEERING DIVISION CORPORATION

5806 W. 36th St., Minneapolis, Minn. 55416 • Phone (612) 929-1681

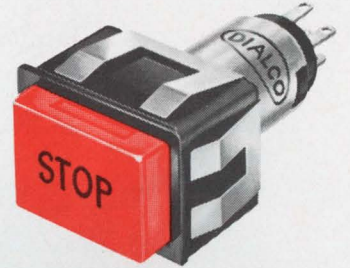
You say you want a

low-profile snap-in-mounting push button switch or matching indicator that is interchangeable with most 4-lamp displays... available in a full range of cap colors... with a choice of bezels with or without barriers in black, gray, dark gray or white.



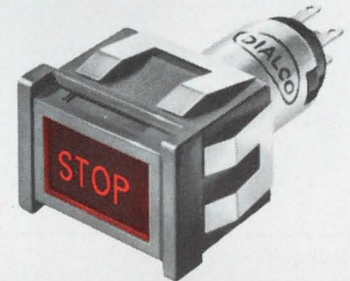
and a

legend presentation that's positive (like this one) or negative (like the one below) or just plain (like the one above)... one that's white when "off" and red, green, yellow (amber), blue or light yellow when "on"... or colored both "on" and "off."



and a

highly reliable switch proven in thousands of installations... available in momentary or alternate action... N.O., N.C. or two circuit (one N.O., one N.C.)... that accommodates a T-1 3/4 bulb with midget flanged base, incandescent, in a range of voltages from 6-28V.



*etc.
etc.
etc.*

*Now, for the first time
Dialight gives you
custom panel designing
with a standard line of
push-button switches and
matching indicators*

Dialight offers a broader range of switch and indicator possibilities than you'll find anywhere in a standard single-lamp line. Sizes: 3/4" x 1", 5/8" square and round. Send today for our new full-color catalog L-209.

DIALIGHT

Dialight Corporation, 60 Stewart Ave., Brooklyn, N.Y. 11237

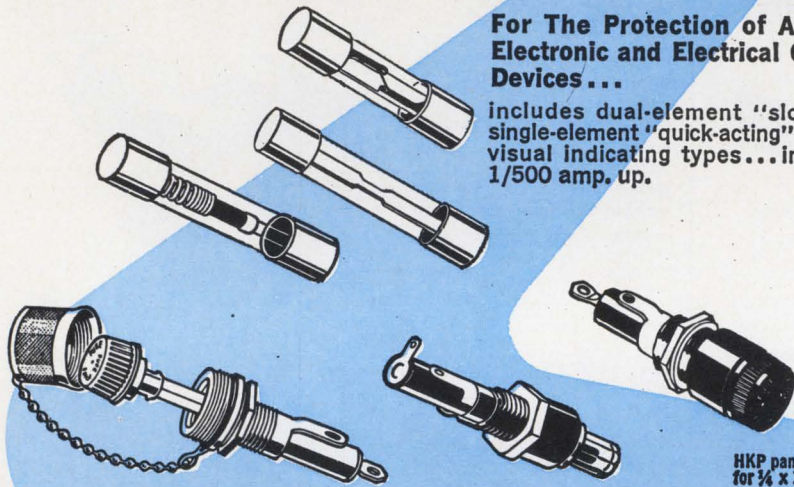
DT-125

BUSS QUALITY

SMALL DIMENSION FUSES AND FUSEHOLDERS

For The Protection of All Types of Electronic and Electrical Circuits and Devices...

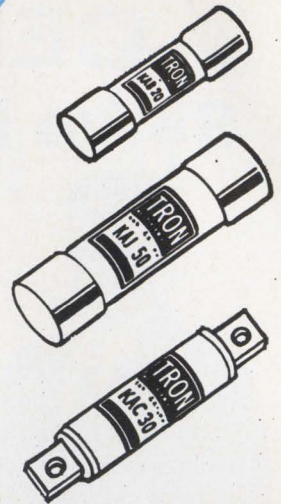
includes dual-element "slow-blowing", single-element "quick-acting" and signal or visual indicating types...in sizes from 1/500 amp. up.



HMR-RF shielded holder for 1/4 x 1 1/4 in. fuses.

HKA lamp-indicating, signal activating holder.

HKP panel mounted holder for 1/4 x 1 1/4 in. fuses.

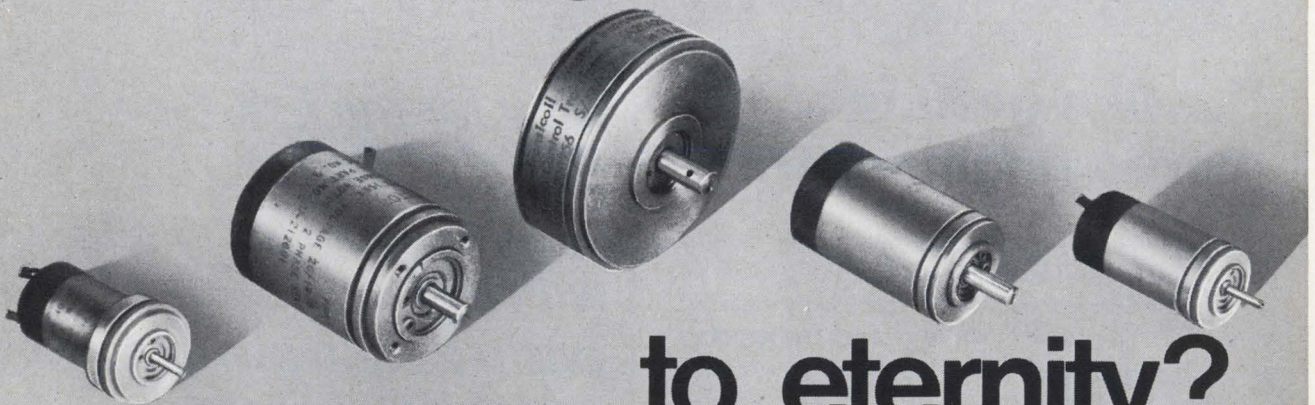


TRON Rectifier Fuses
For the Safe Protection of Solid State Devices

Provide extremely fast opening on overload and fault currents, with a high degree of restriction of let-thru current. Many types and sizes available. Ampere ratings from 1/2 to 1000 in voltage ratings up to 1500.

Circle 129 on reader service card

From here



to eternity?

That may be the life of these new synchros but, frankly, we doubt it.

We do know that none of these brushless synchros have failed in service... and that some of them have functioned for well over a million cycles.

Moreover, these synchros are not limited in electrical specifications because of their long life. They are made to the same specs as our standard synchros... and to the same dimensions as our regular Size 8, 10, 11, 15 and 23 units.

Unlike all other Weston-Transicoil components, which

have a minimum warranty of two years or two thousand hours of operating life, these units are warranted for 10,000 hours.

In view of the already proven performance of these synchros, this could be the understatement of all warranties. For further information write to: WESTON-TRANSCICOLL, Components Division of Weston Instruments, Inc., Worcester, Pa. 19490, a Schlumberger company

WESTON®

Circle 292 on reader service card

Film puzzlers

Thin-film microwave components
Martin Caulton
RCA Laboratories, Princeton, N.J.

What are microwave integrated circuits? Just metal put on top of a dielectric substrate and etched? Many manufacturers wish they were that simple.

The job of fabricating precise and reproducible thin-film microwave components, either lumped or distributed, on ceramic substrates involves a host of considerations. These include the value of the dielectric constant of the substrate and its surface finish; the adherence of the metal to the substrate and the kind of r-f conductor it will make; and the thickness of the conductor. In addition, there's the question of how compatible the substrate will be with the metal conductor.

Regardless of the type of microwave integrated circuitry to be

fabricated, materials are judged as much on their compatibility as on their electrical parameters. The thermal expansion coefficients of the dielectric and conductor and the etchants that can be used are part of the picture, as is the possibility that troublesome alloys may develop.

Thin-film microwave IC's have been built with distributed or lumped elements for use at the lower frequencies, but microstrip is used for circuits operating at X band and higher. The same basic metal and dielectric deposition techniques are used in making either type of IC, but there are differences.

If a lumped-constant high-frequency inductor is to have a high Q, for example, the thickness of the conductor must be equal to several skin depths at the operating frequency. Also, the surface finish must be smooth and only the

better conductors such as gold, silver, and copper should be used.

Presented at Nerem, Boston, Nov. 6-8.

Simple setup

The gyrator—a miniature ferrite device
R.W. Roberts
Microwave Associates (West) Inc.
Sunnyvale, Calif.

The microwave gyrator is a passive, nonreciprocal ferrite device that can be used as a circulator, isolator, or impedance inverter. It consists of the same basic ferrite element found in a circulator, but it comes without the impedance-matching networks, transmission lines, and connectors usually associated with a circulator.

The gyrator is smaller, cheaper, and easier to put into integrated circuits than the circulator. The disadvantage of the gyrator is its generally complex characteristic

The Complete Line of Signal-Indicating Alarm-Activating Fuses

For use on computers, microwave units, communication equipment, all electronic circuitry.



BUSS GLD- $\frac{1}{4}$ x $1\frac{1}{4}$ in. Visual-Indicating, Alarm-Activating.

BUSS GBA- $\frac{1}{4}$ x $1\frac{1}{4}$ in. Visual-Indicating.



BUSS MIC-13/32 x $1\frac{1}{2}$ in. Visual-Indicating, Alarm-Activating.

BUSS MIN-13/32 x $1\frac{1}{2}$ in. Visual-Indicating.



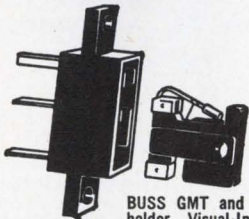
FNA FUSETRON Fuse 13/32 x $1\frac{1}{2}$ in. slow-blowing, Visual-Indicating, Alarm-Activating. (Also useful for protection of small motors, solenoids, transformers in machine tool industry.)



BUSS Grasshopper Fuse, Visual-Indicating, Alarm-Activating.



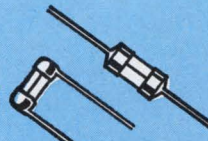
BUSS ACH Aircraft Limiter, Visual-Indicating.



BUSS GMT and HLT holder, Visual-Indicating, Alarm-Activating.

SUB-MINIATURE FUSES

Ideal for space tight applications, light weight, vibration and shock resistant. For use as part of miniaturized integrated circuit, large multi-circuit electronic systems, computers, printed circuit boards, all electronic circuitry.



TRON Sub-Miniature Pigtail

Fuses—Body size only .145 x .300 inches. Glass tube construction permits visual inspection of element. Hermetically sealed. Twenty-three ampere sizes from 1/100 thru 15.



BUSS Sub-Miniature GMW

Fuse and HWA Fuseholder
Fuse size only .270 x .250 inches. Fuse has window for visual inspection of element. Fuse may be used with or without holder. 1/200 to 5 amp. Fuses and holders meet Military Specifications.

Write for **BUSS Form SFB**

BUSSMANN MFG. DIVISION, McGraw-Edison Co. St. Louis, Mo. 63107

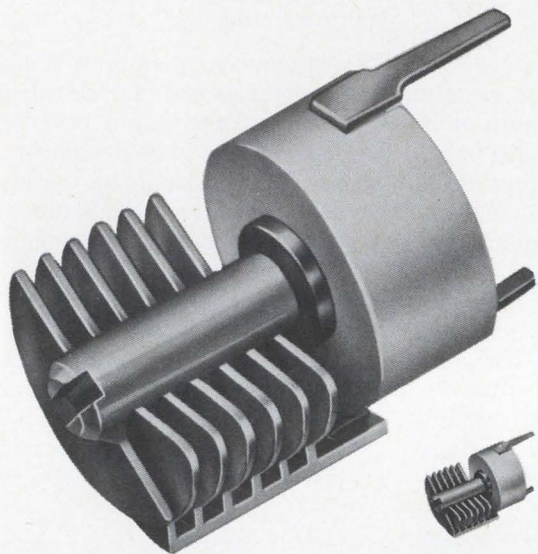
SUPPLIED THE ECONOMICAL WAY...
THRU DISTRIBUTORS

BUSS QUALITY

FUSES

For fuses and fuseholders of unquestioned high quality
for every protection need...

New, smaller air variable capacitor



ACTUAL SIZE

**1.7 to 11 pf machined plate capacitor
for PC mounting is only .310" in diameter**

This new, sub-miniature Type "T" air dielectric trimmer capacitor from E. F. Johnson fits the limited space requirements of modern design. It is designed for VHF and UHF applications where small size (.310" diameter), high Q (greater than 1500 at 1 MHz), low TC and low cost are important considerations.

The Type "T" mounts interchangeably with widely used 3/8" printed-circuit-type ceramic disc trimmers in two .050" diameter holes on .300" centers.

Nominal capacity is 1.7 pf minimum, 11.0 pf maximum. Peak voltage breakdown is 250 VDC. End frame is 95% alumina, grade L624 or better, DC200 treated. Metal parts are silver plated and Iridited.

Johnson machined plate construction provides exceptional stability, including minimum drift over extremes of temperature and humidity.

MAY WE TELL YOU MORE? Write for detailed specs and prices on Type "T" capacitors. And ask for Components Catalog 701 covering the entire E. F. Johnson component line.



E. F. JOHNSON COMPANY

3078 Tenth Ave. S.W., Waseca, Minnesota 56093

Providing nearly a half-century of communications leadership

WANTED: ELECTRONICS MANUFACTURER

who desires to fill a
dependable supply of
government contracts

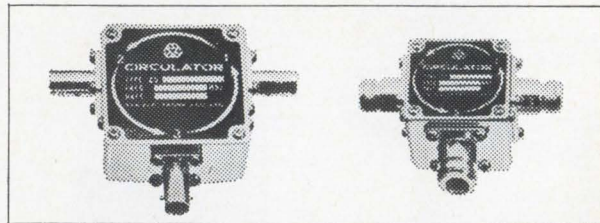
Excellent opportunity for growth-minded electronics manufacturer to locate in Texas and help meet the needs of the government and the third fastest-growing state. Stable, productive labor. Incomparable tax advantages. Lowest living costs. For 1968 Texas Fact Book, write or call the:

TEXAS INDUSTRIAL COMMISSION
Central Information Source for all of Texas
Box JJ-E, Capitol Station
Austin, Texas 78711
Telephone 512/475-4331

Circle 130 on reader service card

TDK CIRCULATOR

The 200-series Circulators and Isolators are designed for VHF and UHF application up to 1,000MHz. They are compact, high-performance, and low cost, circulators developed by TDK under the guidance of the NHK Technical Research Laboratory.



Write to MH&W for full technical data and information on applications



Representative in U.S.A. & Canada for Ferrite Core for communications

MH&W INTERNATIONAL CORPORATION

280 Midland Avenue Saddle Brook, N.J.: 07662
phone: N.J.: 201-791-6277 N.Y.: 212-244-0695



TDK

TDK ELECTRONICS CO., LTD.
2-14-6 Uchikanda, Chiyoda-ku, Tokyo Japan

Circle 131 on reader service card

Technical Abstracts

impedance, which requires fairly sophisticated matching networks.

A typical junction circulator for conventional microwave applications may be roughly 2½ inches square and an inch thick. Connectors may extend out for another inch or so. In a typical IC application, most of the networks and connectors aren't needed.

For example, there is no need to use a 50-ohm transmission line in an IC, because the components are so close together. Also, connectors aren't needed, and impedance-matching networks can be absorbed within other components of the IC.

Thus, if all these parts are stripped away from a typical junction circulator, the central ferrite element alone is left. This is roughly only 0.4 inch in diameter and 0.125 inch thick.

A gyrator consists of this single ferrite disk with three windings wound around it and returned to

ground. The windings are coupled to each other both through a reciprocal leakage term and through a nonreciprocal off-diagonal susceptibility term. A bias field is supplied by a permanent magnet. This field is chosen as the best compromise between low loss, which requires a high field, and maximum nonreciprocity, which requires a lower field. Leakage inductance is a primary bandwidth-limiting element and must be considered in designing the impedance-matching network. Bandwidths may range from 4 to 20%, depending on the network's complexity.

A typical gyrator for the uhf band is about 5/8 inch in diameter and 5/8 inch thick. In S band, projections show that the size could be reduced to ¼ inch in diameter and ¼ inch in thickness. These dimensions are much smaller than those possible even with circulators built on microstrip. They're

quite compatible with the size of other components used in IC's.

Presented at Nerem, Boston, Nov. 6-8.

Print hints

Printed thick-film microwave integrated circuits

Charles Greenwald and
R.K. Barcklow Jr
ITT Defense Communications Inc.,
Nutley, N.J.
Edwin Zaratkiewicz
ITT Avionics Inc., Nutley, N.J.

Studies of nonmicrowave microcircuits have shown thick-film types to be 20% to 40% cheaper than the thin-film versions. Similar cost savings may apply to microwave circuits, especially when they're printed.

A high-resolution screen-printing process yields acceptable pattern resolution for most microwave integrated-circuit geometries. Resolution is now 100 to 150 lines per inch—with equal line width and spacing, and with line-edge varia-

CERMET TRIMMERS



Series 340 Top Adjust 1/4" x 1/4" x .220"
Cermet Trimmer

NEW FROM CTS

\$1.25 ea. in 1,000 lots down to
93c ea. in 50,000 lots.



Series 360 Side Adjust 7/16" x 17/64" x 25/64"
Snap-in Type Cermet Trimmer

NEW FROM CTS

\$1.04 ea. in 1,000 lots down to
80c ea. in 50,000 lots.

50 Ω through 500K Ω.

±20% tolerance.

3/4 watt @ 25°C; 1/2 watt @ 85°C, derated to no load @ 150°C.

Single turn.

Prototype Quantities From Stock.

Production Quantities: 4-6 weeks.

Order from: CTS of Berne, Inc., Berne, Indiana 46711.
(219) 589-3111.

 **CTS CORPORATION**
Founded 1896

50 Ω through 1 megohm.

±20% tolerance.

1 watt @ 25°C; 1/2 watt @ 85°C, derated to no load @ 125°C.

Single turn.

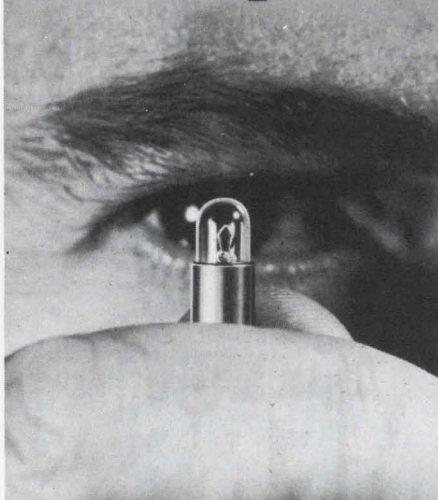
Prototype Quantities From Stock.

Production Quantities: 4-6 weeks.

Order from: CTS of Berne, Inc., Berne, Indiana 46711.
(219) 589-3111.

 **CTS CORPORATION**
Founded 1896

looking
for
a
low
price
quality
lamp?



IEE has 'em!

Search no more for quality high performing subminiature lamps. We have them in stock at 1/2 the price of competitive lamps.

All our lamps are aged and selected, possessing hand placed filaments, stabilized to assure uniform brightness. They meet all standard Mil-Specs, and you can count on 40,000 to over 100,000 hours life.

For as low as 29 cents per lamp we can supply your needs on T-1 lamps. Search no farther than your local IEE representative.



Industrial Electronic Engineers, Inc.
7720 Lemona Avenue, Van Nuys, California 91405

296 Circle 296 on reader service card

Technical Abstracts

tions less than 20% of line width. Process refinements can, however, improve resolution.

A finer mesh stainless-steel screen is required. A 325 mesh was used in the present system. High-viscosity inks will minimize pattern settling after screening. Du Pont 8115 thixotropic gold ink, with a 1,000-poise viscosity, was found to print better than higher-conductivity silver-based inks.

Indirect screen-pattern preparation, where the emulsion pattern is photo-formed on a Mylar carrier sheet and then adhesively transferred to the screen, is recommended. Substrates should be very flat, with a 1-mil maximum camber. Patterns should be air-dried before firing because rapid drying with a heat lamp will distort the pattern.

One component that's been printed is a 50-ohm termination that dissipates 50 milliwatts (less than 1/50 wavelength) and has a vswr of less than 1.2:1 over a 16% bandwidth at 4 gigahertz. A 100-ohm-per-square palladium-silver resistor ink is used, printed to a 1-mil thickness.

A microwave transistor oscillator was printed on a 1-by-1.5-by-0.25-inch alumina substrate. It develops a 10-milliwatt fundamental at 4 Ghz. The circuit includes a 10-decibel directional coupler (with a 5-mil gap) to provide an auxiliary output to feed an external phase detector. Three d-c bias resistors are printed, as are three 100-pico-farad bypass capacitors, which provide low-frequency stability. These two components are decoupled from the r-f circuitry by series-choke/shunt-stub microstrip sections.

Another component is a printed thick-film mixer-preamplifier with an X-band balanced mixer and a 70-megahertz i-f preamplifier. It fits on a 1-by-3-by-.025-inch alumina substrate. Microstrip lines, d-c bias and i-f pad resistors, and i-f bypass and coupling capacitors are printed as well. Schottky mixer diodes, a leadless, inverted, device-mounted (LID) i-f input transistor, a flatpack monolithic IC, and a toroidal transformer are applied.

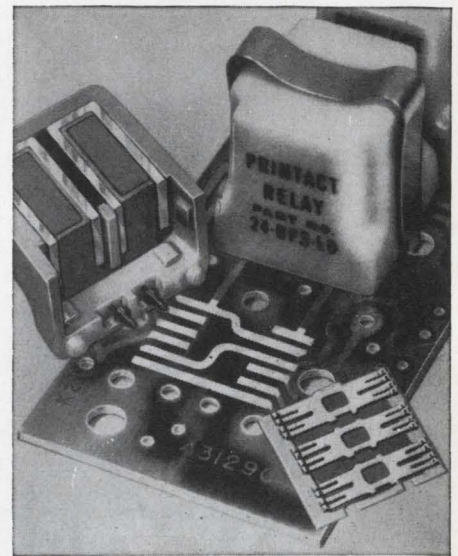
Presented at Nerem, Boston, Nov. 6-8.

NEW MAGNETIC RELAY plugs into your PC board!

NO Springs, NO Wiring,
NO Sockets, NO Soldering,
NO Mechanical Linkage

Printact®

Standard Series G
Latching Series LS/LD



(actual size)

Plated Conductors on Your PC Board are the Fixed Contacts

Save SPACE, MONEY and MANHOURS with these new small, lightweight, highly reliable Standard and Latching PRINTACT Relays.

Available with Bifurcated Palladium or Gold Alloy contacts for more than 10 million cycle 2 to 4* pole switching. Handles up to 2 amp. res. loads. Coils for 6, 12, 24 and 48 vdc at 500 mw. Operating temperature -30°C to +95°C. Operate time 7 ms. The little gem is an 0.8 oz. 7/8" cube.

Quality features include: double-break contacts; balanced armature, enclosed housing, plug-in application; encapsulated coil; self-wiping contacts and inherent snap-action — saves sockets soldering, and wiring and the cost is lower than you think!

*Switches up to 4 form A plus B, or 4 form C.

For data and prices write or call:
212-EX2-4800

Executone

PRINTACT RELAY DIVISION

47-37 Austell Place
Long Island City, N.Y. 11101

Circle 133 on reader service card

New Literature

Control, telemetry, conversion. Raven Electronics Inc., 101 W. Alameda Ave., Burbank, Calif. 91502, has published an eight-page catalog on its control, telemetry and power conversion components.

Circle 446 on reader service card.

Digital spectrogram recorder. Conrac Corp., 1600 S. Mountain Ave., Duarte, Calif. 91010. An eight-page brochure describes a system for converting analog data from potentiometric recorders into digital form for computer analysis. [447]

Digital data monitors. Lear Siegler Inc., 1152 Morena Blvd., San Diego, Calif. 92110, offers a two-page data sheet describing a new generation of digital data monitors. [448]

Power supply modules. Power/Mate Corp., 163 Clay St., Hackensack, N.J. 07601, has released a 16-page general catalog covering a broad line of regulated power supply modules. [449]

Vacuum components. Granville-Phillips Co., 5675 E. Arapahoe Ave., Boulder, Colo. 80302. A 12-page brochure describes more than 200 standard com-

ponents to assist in building or modifying vacuum systems. [450]

Solid state relays. Ohmite Mfg. Co., 3601 Howard St., Skokie, Ill. 60076. Catalog 750 describes features of the SSA solid state relays, such as inherent contact isolation and universal operating voltage range. [451]

Laser trimming system. Spacerays Inc., Northwest Industrial Park, Burlington, Mass. 01803. A four-page data sheet covers the factors involved in mass producing precision-trimmed cermet resistors with an automatic laser trimming system. [452]

Polycarbonate capacitors. San Fernando Electric Mfg. Co., 1501 First St., San Fernando, Calif. 91341. A 12-page brochure details operating characteristics of West-Cap polycarbonate capacitors for application in precision RC circuits, high-Q tuned circuits, ac circuitry, or capacitance standards. [453]

Pulse instrumentation. Datapulse Inc., 10150 W. Jefferson Blvd., Culver City, Calif. 90230, offers a condensed catalog describing its complete line of

general purpose pulse generators and digital data generators. [454]

Ultrasonic degreasers. Westinghouse Electric Corp., P.O. Box 868, Pittsburgh 15230. Ultrasonic degreasers for rapidly cleaning delicate components and pieces with difficult-to-reach crevices are described and illustrated in a four-page bulletin. [455]

Stepping motors. Heinemann Electric Co., 252 Magnetic Dr., Trenton, N.J. 08602. Bulletin 702 covers the Roto-Netic line of inexpensive stepping motors. [456]

Frequency response tracer. B&K Instruments Inc., 5111 W. 164th St., Cleveland 44142. Model 4712 frequency response tracer is described in a product data bulletin. [457]

Transducer/strain indicator. Strainsert Co., 24 Summit Grove Ave., Bryn Mawr, Pa. 19010, offers bulletin 102 describing a portable transducer/strain indicator, which permits reading of eight separate strain sensors. [458]

Strain gage pressure transducers. Astra Corp., 2428 Wyandotte Road, Willow

CERMET TRIMMERS



Series 165-3/8" x 3/8" x 13/64" Cermet Trimmer

NEW FROM CTS

\$3.25 ea. in 1,000 lots down to
\$2.56 ea. in 50,000 lots.

50 Ω through 1 megohm.

$\pm 20\%$ tolerance.

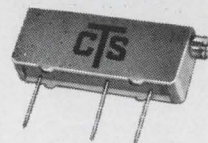
1/2 watt @ 85°C derated to no load @ 150°C.

25 turns.

Prototype Quantities From Stock.
Production Quantities: 4-6 weeks.

Order from: CTS of Berne, Inc., Berne, Indiana 46711.
(219) 589-3111.

 **CTS CORPORATION**
Founded 1896



Series 190-3/4" x .160" x .310" Cermet Trimmer

NEW FROM CTS

\$1.24 ea. in 1,000 lots down to
98c ea. in 50,000 lots.

50 Ω through 500K Ω .

$\pm 20\%$ tolerance.

1/2 watt @ 85°C derated to no load @ 125°C.

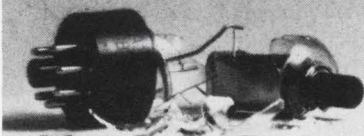
20 turns.

Prototype Quantities From Stock.
Production Quantities: 4-6 weeks.

Order from: CTS of Berne, Inc., Berne, Indiana 46711.
(219) 589-3111.

 **CTS CORPORATION**
Founded 1896

The vacuum-tube rectifier is dead.



Now Varo has developed a new series of High Voltage Fast Recovery Diffused Silicon Rectifiers economically competitive with both vacuum tubes and selenium. And they mean improved reliability in color and monochrome receiver applications.

Peak reverse voltage rating for the series is from 5,000 Volts to 45,000 Volts, with rated output current to 25 milliAmps. And we can supply you with any shape you need. In sizes from .250" square and 1.00" long. Diode-capacitor voltage multiplier assemblies are also available.

This new series is the result of Varo's continuing R & D leadership in high-voltage rectifiers.

Varo is the same company that introduced miniature, low-cost high-voltage diodes for night vision applications; the Integrated Bridge Rectifier (IBR®) and the Epoxy Integrated Bridge Rectifier (EBR).

If you'd like to give your customers all the advantages of totally solid state TV circuitry, now you can.

In the meantime, don't feel bad if you're still using vacuum-tube rectifiers.

Up until now, it was the only choice you had.

For complete details, applications, and price list write or call.



SEMICONDUCTOR DIVISION
2203 WALNUT STREET,
GARLAND, TEXAS 75040
(214) 272-3561

New Literature

Grove, Pa. 19090. A line of patented strain gage pressure transducers is described in technical bulletin 60-5. [459]

Microwave test lab system. Genesys Systems Inc., 1479 Plymouth St., Mountain View, Calif. 94040, has available a data sheet on the model 4030 microwave test lab system. [460]

Analog building blocks. Dana Laboratories Inc., 2401 Campus Dr., Irvine, Calif. 92664. Series 2600 analog building blocks for high-performance instrumentation and data-processing systems are described in bulletin 894. [461]

Microwave tube stabilization. Micro-Now Instrument Co., 6124 N. Pulaski Rd., Chicago 60646. Stabilization of microwave oscillators in the 40- to 100-gigahertz region is described in engineering application bulletin No. 3. [462]

Serial character generator. National Semiconductor Corp., 2950 San Ysidro Way, Santa Clara, Calif. 95051. Application Note 14 describes the MM420/MM520, a 256-bit serial character generator. [463]

Assured reliability relays. Hi-G Inc., Spring St. and Route 75, Windsor Locks, Conn. 06096, has available a brochure for relay specifiers and buyers requiring exceptional reliability in crystal can relays. [464]

Microwave loadings. Solitron-Microwave, 37-11 47th Ave., Long Island City, N.Y. 11101. A six-page brochure provides a reference source to design-in terminations, attenuations, and other loadings as required in a particular system. [465]

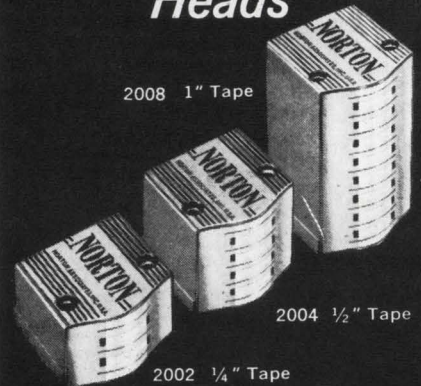
Count-display module. Integrated Circuit Electronics Inc., P.O. Box 647, Waltham, Mass. 02154. A data sheet describes the C-101 count-display module that accepts 4-line or 8-line BCD for display with decimal point on a cold-cathode tube. [466]

Automated instrumentation. Julie Research Laboratories Inc., 211 W. 61st St., New York 10023. Catalog CC-6 highlights automated instrumentation and precise components for production, test, and calibration. [467]

Hybrid IC's. WEMS Inc., 4650 W. Rosecrans Ave., Hawthorne, Calif. 90251, offers a brochure outlining the manufacturing process of a hybrid IC from the engineer's drawing to the finished package. [468]

Rack-and-panel connectors. Elco Corp., Willow Grove, Pa. 19090. A 28-page guide describes a wide range of low-cost rack-and-panel connectors. [469]

NORTON Magnetic Tape Heads



SERIES 2000

Crosstalk—60 DB
+75°C Temperature Operation

Send now for complete technical literature.

NORTON

ASSOCIATES, INC.

10 Di Tomas Court, Copiague, N.Y. 11726
Phone: 516 598-1600

Circle 134 on reader service card

FOR Chemicals

Think

GC

Solve all electronic chemical needs quickly and economically... simply specify GC!

GC manufacturers and stocks cleaners, solvents, cements, lubricants, lacquers and varnishes for in-plant servicing and maintenance needs on all office and production equipment. Packaged, or in bulk, all are available for immediate shipment.



FREE!



Write today for the big GC Electronic Chemical Handbook — \$1.50 value — yours FREE when applied for on your Company letterhead. It's your solution to all chemical problems.

GC Electronics

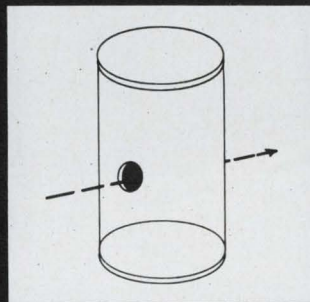
400 South Wymar Street
Rockford, Ill. 61101

A Division of
GC Hydrometals, Inc.
Shipping warehouses in:
Hicksville, L.I., N.Y.
Los Angeles, California



Circle 135 on reader service card

Plink!



continental can is looking for innovative engineers to shoot holes through today's packaging concepts.

Are you quick on the trigger with new ideas, new approaches, new solutions? There's a great big, beautiful career waiting for you at the Technical Center of Continental Can, world leader in packaging.

The Technical Center is our private "think tank." It provides the creative services for our 180-plus manufacturing plants.

Here, engineers of diverse disciplines undertake basic and applied research in every avenue of packaging, from concept through production. They explore new forms of packaging consumer and industrial goods. Experiment with better and bigger uses of metals, paper, plastics, and composites. Create new systems and methods of production. Solve problems that a lot of people didn't even know existed.

The Technical Center, in reality, is the "Action Environment" for the right engineer. What do we mean by "right engineer"? A man who is happiest when he obsoletes today's standards.

What do we mean by the "Action Environment"? Unparalleled creative latitude. Enormous opportunity for individual effort. The full backing of virtually limitless resources, both in terms of talent and equipment. A top-level salary. Substantial fringe benefits. An open door to rapid advancement. And, above all, the chance to enjoy your work.

For further information and an appointment, write Mr. J. G. Mikota, Recruitment Supervisor, Chicago Technical Center.

Mechanical Engineering

High speed equipment design. Analytical functions providing service to all development areas. Dynamic stress, and vibrations. Evaluation of metal fabrication processes. Recommendations for new manufacturing methods and tool development.

Electrical/Electronic Engineering

Digital logic, high power solid state circuits, fluidics, electro-statics. Energy conversion. Electrical power to laser, infra-red, ultrasonic, X-ray and electron beam. Field engineers for new equipment installations.

Chemistry and Chemical Engineering

Analytical chemistry with emphasis on instrumental analysis. Ink formulation, graphic arts, rheology instrumentation related to applications in offset, flexographic, rotogravure and letter press. Coil coatings. Packaging performance evaluation. Establishment of new and novel plastic processes, including injection and blow molding, PVC formulation, etc. Material evaluation to include metals, papers, plastic resins and composites.

Electronic Data Processing

Equipment Manufacturing Planning Control for packaging machinery. Computer systems for purchasing, machine tool and assembly scheduling, inventory control and distribution, using third generation computer hardware.



Continental
Can Company

1200 West 76th Street, Chicago, Illinois 60620
An Equal Opportunity Employer

Our 40 years of RF Systems Engineering:

Your opportunity for tomorrow



Motorola was founded on RF systems engineering. In 1928 we pioneered the first successful mobile radio broadcast receiving systems — and for four decades have steadily added to our list of significant technological “firsts.” Our past achievements and present programs at Motorola Government Electronics Division include space communications, multi-sensor data transmission, worldwide space tracking systems, side-looking radar sensor and all-weather surveillance/mapping, perimeter security, and oceanography systems. We are also engaged in monitoring and control system concepts for offshore oil production applications — and extensive highway safety programs. To qualified RF engineers, our 40 years of leadership in electronic systems engineering — and our unmatched technical facilities — offer an excellent opportunity for accelerated career fulfillment.

Specific opportunities are:

Space Communications ■ Radar Systems ■ Tracking & Telemetry ■ Fuzing Digital Data Transmission ■ Guidance & Navigation ■ Radar Transponders ECM & Elint ■ Coherent Transponders ■ Integrated Electronics ■ Antennas & Propagation ■ Advanced RF & Microwave Techniques ■ Ground Support Equipment ■ UHF/VHF Communications Equipment ■ Display ■ Digital Multiplex ■ Troposcatter ■ Readout ■ Undersea ■ Mechanical Design

in PHOENIX  MOTOROLA

Government Electronics Division

Write: Paul Ahler, Recruitment Mgr., Dept. 65, Box 1417, Scottsdale, Arizona

AN EQUAL OPPORTUNITY EMPLOYER

*"Put Yourself
in the Other
Fellow's Place"*

TO EMPLOYERS

TO EMPLOYEES

Letters written offering Employment or applying for same are written with the hope of satisfying a current need. An answer, regardless of whether it is favorable or not, is usually expected.

MR. EMPLOYER, won't you remove the mystery about the status of an employee's application by acknowledging all applicants and not just the promising candidates.

MR. EMPLOYEE you, too, can help by acknowledging applications and job offers. This would encourage more companies to answer position wanted ads in this section.

We make this suggestion in a spirit of helpful cooperation between employers and employees.

This section will be the more useful to all as a result of this consideration.

Classified Advertising Dept.

McGRAW-HILL, INC.

330 West 42nd St., N. Y., N. Y. 10036

ADDRESS BOX NO. REPLIES TO: Box No.
Classified Ad. Dept. of this publication.
Send to office nearest you.
NEW YORK, N. Y. 10036: P. O. Box 12
CHICAGO, Ill. 60611: 645 N. Michigan Ave.
SAN FRANCISCO, Cal. 94111: 255 California St.

CIRCLE 967 ON READER SERVICE CARD

SURPLUS BARGAINS!

0.01% SORENSEN Line Voltage Regulator

#1001 regul. against load changes 95-130 v. 1 ph. 55/65 cy; adj. output 110-120 v. holds to 0.01%. Distortion max. 3%. Response 0.1 sec. Regularly \$570.00. From us, OK



grtd. only \$275.00

#2501 is same but 0-2.5 kva. . . . \$375.00

#500S is same, 0.5 kva, 0.1% . . . \$89.50

#1000S is same, 1 kva, 0.1% \$99.50

#2000S is same, 2 kva, 0.1% \$179.50

Sup. Electric #IE-5102 is same spec. electronic regul., but 2½ kva, 0.1% . . . \$199.50

Sup. Elect. IE-20060: 3 kva. Same specs as above but MIL-spec built, all potted xfmrs. etc. Behind rack panel 21" h. 14½" dp; no cabinet. Regular \$960. NEW export boxed, 330# job Utica, N.Y. (Cabinet for above \$30 job Utica.) . . . \$279.50

Sorensen R5010 all-solid-state, zener reference, 0-5 kva, 90% efficient. . . . \$450.00

Sup. Elect. IE-5105: Same specs as Sorensen "S" series, 0-5 kva \$349.50

Sorensen 10,000S: Same specs as above but 0-10 kva \$695.00

ALL ABOVE are 1 ph 95-130 v. Here are 1 ph 190-250 v in, 220-240v out, 0-5 kva. Choose Sorensen 5000-2S or Sup. IE-5205P. . . . \$349.50

Above are electronic. Following are electromech.:

Gen. Radio #1570AL: 0-6 kva. . . . \$199.50

Sup. Elect. EM-4106: 0-6 kva. . . . \$199.50

Sup. Elect. EM-4115: 1 ph 0-15 kva. . . \$295.00

Above are all 95-130 v; 190-260 v follows:

Sup. Elect. EM-4228, 1 ph, 0-27½ kva. . \$495.00

EMT 6220Y (transistorized) 3 ph 20 kva \$450.00

L&N #4725, .05% Wheatstone Bridge, 1's thru K's, X.0001 thru X10K. . . . \$227.50

WE PROBABLY HAVE THE BEST INVENTORY OF GOOD LAB TEST EQUIPMENT IN THE COUNTRY, BUT PLEASE DO NOT ASK FOR CATALOG! ASK FOR SPECIFIC ITEMS OR KINDS OF ITEMS YOU NEED! WE ALSO BUY! WHAT DO YOU HAVE?

R. E. GOODHEART CO. INC.
Box 1220-E, Beverly Hills, Calif. 90213
Phones: Area 213, office 272-5707, messages 275-5342

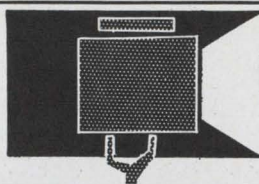
CIRCLE 968 ON READER SERVICE CARD

FOR SALE



When you have used electronics equipment to sell, advertise in Electronics Searchlight Section for fastest results.

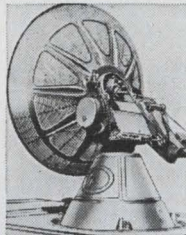
For information:
Searchlight Section
Classified Advertising Department
Post Office Box 12
New York 10036



SEARCHLIGHT SECTION

- CLASSIFIED ADVERTISING • BUSINESS OPPORTUNITIES
- USED OR SURPLUS EQUIPMENT

AUTOTRACK MOUNT



360 degree azimuth, 210 degree elevation sweep with better than 1 mil. accuracy. Missile velocity acceleration and slewing rates. Amplidyne and servo control. Will handle up to 20 ft. dish. Supplied complete with control chassis. In stock—immediate delivery. Used work over by NASA, USAF, MP-61-B. Type SCR-584. Nike Ajax mounts also in stock.

PULSE MODULATORS

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. G.E. 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 VAG 60 cycle. Mfr. G.E. Complete with high voltage power supply.

250 KW HARD TUBE PULSER

Output 16 kv 16 amp. Duty cycle .002. Pulses can be coded. Uses 5D21, 715C or 4PR60A. Input 115 v 60 cy. AC \$1200 ea.

18 MEGAWATT PULSER

Output 150KV at 120 amps. Rep rate: 50-500 PPS. Pulse length: 5 msec. 15KV 120 amp. Into pulse transformer. Rise time 1.5 msec. Filament supply 5V 80 amp. incl. 17.5KV 1.5 amp DC power supply. Input: 220V 60 cy AC.

INDICATOR CONSOLES

AN/SPA-4A, PPI 10", range to 300 mi.

VL-1 PPI 12". Range to 200 mi.

VL-1 RH1 12" to 200 mi. 60K ft.

HIGH VOLTAGE POWER SUPPLIES

100 KV, 200MA, DC, \$3500; 27 KV, 100MA, DC, \$2200; 15KV, 2 amp. DC, \$3800; 12KV, 1200MA, DC, \$1400; 8KV, 800MA, DC, \$975.

SCR 584 AUTOTRACK RADARS

Our 584s in like new condition ready to go, and in stock for immediate delivery. Ideal for telemetry research and development, missile tracking, satellite tracking. Fully Desc. MIT Rad. Lab. Series, Vol. 1, pps. 207-210, 228, 284-286. Comp. Inst. Bk available \$25.00 each.

Minifluid DISPENSER

for miniature potting and encapsulating

Available in 3 sizes
6cc - 12cc - 30cc



\$34.00 UP

PHILIP FISHMAN COMPANY
7 CAMERON ST., WELLESLEY, MASSACHUSETTS 02181

CIRCLE 970 ON READER SERVICE CARD

SONAR SYSTEMS IN STOCK

AN/FQS-1A, AN/UQS-1B, QHBa scanning sonars. Rochelle salt hydrophones 6 ft.

MICROWAVE SYSTEMS

200-2400 mc. RF PKG

Continuous coverage, 30 Watts Cw nominal output. Uses 2C39A. Price \$575.

L BAND RF PKG.

20 KW peak 990 to 1040 MC. Pulse width .7 to 1.2 micro sec. Rep. rate 180 to 420 pps. Input 115 vac incl. Receiver \$1200.

200-225 mc RADAR SYSTEM

1 Megawatt output, 200 nautical mile range for long range detection of medium and high altitude jet aircraft as well as general search. AN/TPS-28.

SURVEILLANCE DRONE RADAR SYSTEM

X-Band tracking system with plotting boards. Type AN/MPQ-29. Drone also in stock.

5 MEGAWATT C-BAND

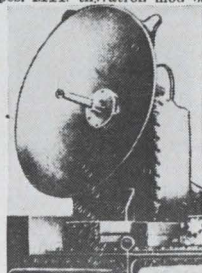
Klystron RF package delivering nominal 5 megawatt pulse RF. Complete with pulser and power supply.

500 KW L BAND RADAR

500 kw 1220-1350 msc. 160 nautical mile search range P.R.I. and A scopes. MTI thrvatron mod 5J28 magnetron. Complete system.

AN/GPG-1 SKY-SWEEP TRACKER

3 cm. automatic tracking radar system. Complete package with indicator system. Full target acquisition and automatic tracking. Input 115 volts 60 cycle New. In stock for immediate delivery. Entire System 6' long, 3' wide, 10" high. Ideal for Infrared Tracker, Drone Tracker, Missile Tracker, R. & D.



500KW S BAND RADAR

250 miles search 115V 60 cy. AC. Mfg. G.E.

RADAR SYSTEMS GROUND AND AIRBORNE. AUTOMATIC TRACKING ANTENNA SYSTEMS NIKE AJAX. NIKE HERCULES M-33 MSQ-1A MPS-19 MPS-9 SCR 584 TPS-1D TPS-28 FAA ASR-2 AIRBORNE SYSTEMS APN-84 APN-102 APS-23 APS-27 APS-45 DPN-19. DIGITAL COMPUTERS IBM 650 IBM 704

LARGEST INVENTORY OF RADAR AND MICROWAVE EQUIPMENT IN THE WORLD
RADIO RESEARCH INSTRUMENT CO.
45 WEST 45TH ST N. Y. 10036 212-JU 6-4691

CIRCLE 969 ON READER SERVICE CARD

ELECTRON TUBES

KLYSTRONS • ATR & TR • MAGNETRONS
SUBMINIATURES • C.R.T. • T.W.T. • 5000-
6000 SERIES

• SEND FOR NEW CATALOG A2 •

A & A ELECTRONICS CORP.
1063 PERRY ANNEX
WHITTIER, CALIF.
696-7544

CIRCLE 971 ON READER SERVICE CARD

Mr. Used Equipment Dealer:

When you advertise in the Searchlight Section . . . You have hired your most persuasive salesman:

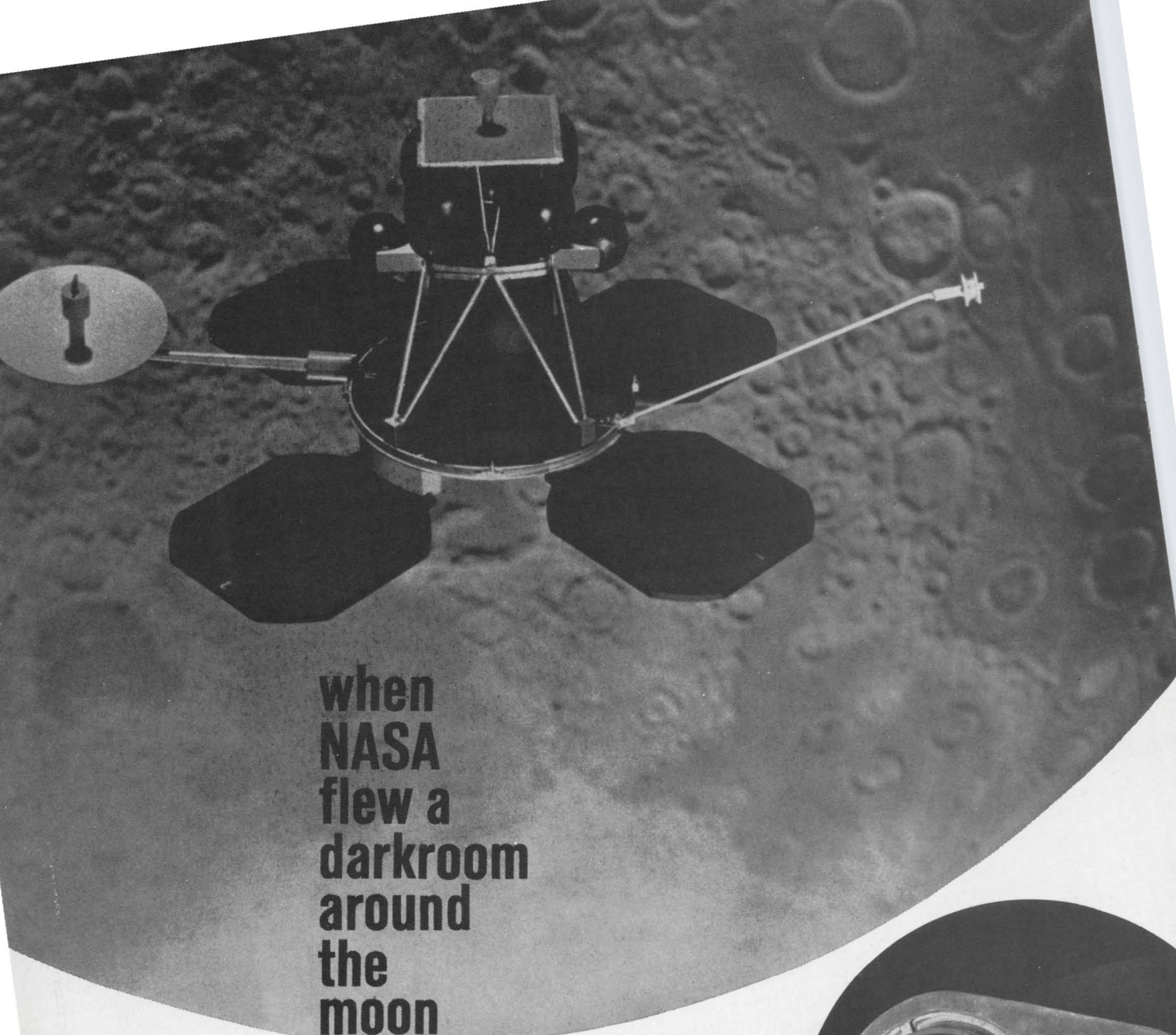
He's efficient . . . He thrives on long hours . . . His territory is the entire nation . . . and overseas . . . He doesn't see buyers of used and new surplus equipment: They see him—regularly. They depend on him.

He is Searchlight—the section of this publication where wise dealers advertise and list their stocks for sale.

SEARCHLIGHT SECTION

Classified Advertising Dept.

Post Office Box 12 • New York, N. Y. 10036



when
NASA
flew a
darkroom
around
the
moon

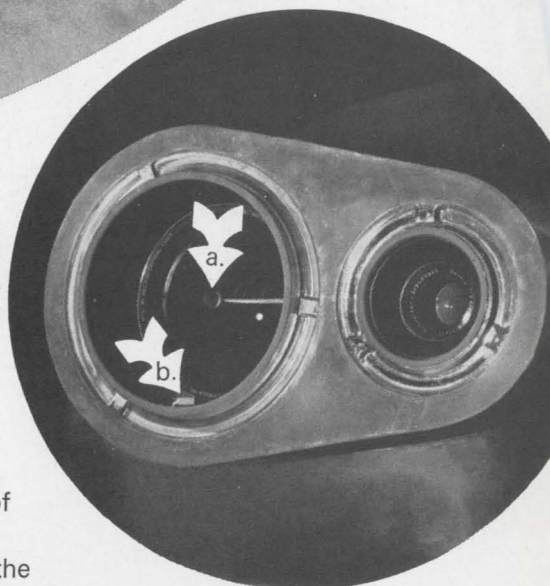
Keystone thermistors kept thermal controls on the beam!

On Lunar Orbiter's historic photographic mission encircling the moon, Keystone thermistors were on the job—sensing and controlling temperatures of lenses and film processing laboratory.

With outer temperatures ranging from -200°C . in the moon's shadow to $+200^{\circ}\text{C}$. in full sunlight, Orbiter's temperature balancing systems performed beautifully . . . holding temperatures in the spacecraft to within $\pm 4^{\circ}\text{C}$. of required figures.

A dramatic instance of Keystone thermistor ability to perform as specified on very tough applications. Is yours a problem? Write us.

KEYSTONE CARBON COMPANY, St. Marys, Pa. 15857



Uniform temperature is a must for stable lens focus. a. Keystone thermistor monitors temperature at lens center. b. Another is placed between lens and outer cover.

Keystone
leads

in versatile thermistor design

Circle 331 on reader service card

International Newsletter

November 11, 1968

French claim NASA will agree to launch Symphonie satellite

French space sources are jubilantly passing the word that NASA will soon agree to launch the Franco-German Symphonie communications satellite. NASA officials refuse to confirm or deny the report. **Though the U.S. has refused in the past to launch satellites that could compete with Intelsat, it apparently has decided to accept the argument that Symphonie is an experimental project, not a commercial system.** The French point out, though, that Early Bird was launched as an experiment but has since become a useful communications link.

NASA's acquiescence could be a fatal blow to the financially troubled European Launcher Development Organization, which had hoped to get the Symphonie job for its Europa 2 rocket [Electronics, Oct. 28, p. 201].

Britain's withdrawal from the project has left ELDO's members with the prospect of chipping in an extra \$49 million to keep Europa 2 on schedule—an outlay that will receive a lot of study **this week from European space ministers meeting in Bonn.**

Nippon Telegraph developing repeater

A solid state microwave repeater, using a high-power impatt diode and a low-noise Gunn oscillator, is being developed at the Electrical Communication laboratory of the Nippon Telegraph and Telephone Public Corp. **It features an 11-gigahertz transmitter and puts out an f-m signal.**

Nippon's researchers say that the signal-to-noise ratio is about 70 decibels, slightly lower than a klystron's but more than enough for the 960-channel telephone repeater the equipment is being developed for. For longer range, though, an impatt avalanche diode with higher output power will be used. For short-haul systems, the diodes are presently available off the shelf.

Grundig: more time for the consumer

Behind the \$50 million sale of the Grundig Group's six office-equipment manufacturing and distributing subsidiaries to Litton Industries is Max Grundig's belief that his firm has no future in that business. **The West German magnate is convinced that the problems of software supply—even for small computers—will become increasingly knotty and that they're better left to the giants in the field.** The six firms involved make typewriters, small accounting machines, and desktop calculators.

Instead, Grundig plans to concentrate on consumer electronics. **Most of his profit from the Litton deal will be used to expand his company's already far-flung consumer operations.** For example, \$40 million is earmarked for additional facilities in Ireland, Portugal, France, Italy, and at home.

What Grundig isn't saying, though, is that he must lay out that kind of money to meet increasingly stiff competition from European companies controlled by U.S. firms that have introduced streamlined mass-production techniques. Among them are Saba GmbH, controlled by General Telephone and Electronics, and Kuba-Imperial, with General Electric. **Also, Grundig must take into account the surging demand for color television sets in West Germany and elsewhere in Europe.**

As for Litton's plans for the former Grundig properties, the American firm will combine their small-computer operations and continue to produce typewriters.

International Newsletter

British firm delays IC amplifier's debut

Britain's Sinclair Radionics Ltd., the first company to announce a 5-watt monolithic integrated-circuit audio amplifier, won't be the first to sell one. General Electric is getting set to unveil its PA246 [see p. 33], but Sinclair says its already-advertised IC-10 is "several months" away from production. Designers, Sinclair concedes, have not solved all the technical problems. Sinclair says the IC-10 will have ± 1 -decibel response from 5 hertz to 100 kilohertz, 1% distortion at full output, 110-db gain, and 5-millivolt sensitivity.

U.S. nears decision on dumping charges against Japanese

The Bureau of Customs, winding up its year-long inquiry into charges of Japanese dumping of receiving tubes and resistors, will make its recommendations to the Treasury by the end of the year. The bureau isn't giving any hints as to its recommendations.

If Customs finds evidence of dumping, and the Treasury agrees, the Tariff Commission must then determine if U.S. industry has been hurt. If so, a dumping duty can be applied to these products. The bureau's findings in this case might be a clue to what it will conclude from investigations, started within the past few months, covering a broad range of electronic components and products from Japan. Investigations were begun after complaints from the parts division of the Electronic Industries Association.

Dutch plan to buy 400 German tanks

West Germany may be considered Europe's biggest importer of arms, but when it comes to tanks she's quite an exporter. Now that Belgium has received the first 100 of the 334 Leopard tanks ordered last year [Electronics, July 24, 1967, p. 224], the Dutch government is dickering with the Germans about a similar deal, with the stipulation that electronics be installed in the Netherlands. The Dutch have decided to buy about 400 Leopards worth about \$125 million. Details on the manner of payment are still being worked out with Krauss-Maffei AG, producer of the tank. Krauss-Maffei says deliveries would start during the second half of next year.

The order will be part of a compensation deal calling for Germans to order products worth about the same amount from the Netherlands. The Dutch will probably also insist on putting some hardware other than electronics into the tanks.

Also, negotiations with Norway for 75 Leopards worth about \$25 million dollars are still in progress [Electronics, May 27, p. 236]. Contracts might be signed at any time.

Nippon Electric mulls U.S. prospects for 1240 computer

The Nippon Electric Co. may take a fling at the U.S. computer market. The company, which has a close working arrangement with Honeywell Inc., is gauging the U.S. prospects for its NEAC 1240, a machine in much the same class as the Digital Equipment Corp.'s PDP-8, a small-sized computer.

The Japanese firm plans to put the 1240 through its paces for Honeywell's computer people in Boston soon. If their reaction is favorable, Nippon Electric will presumably begin setting up an American sales network. Although the mainstays of the company's computer line are Honeywell designs built under license, the 1240 is a Nippon Electric development and has been selling well in Japan since its introduction there three years ago.

Electronics International

Japan

Put it on the line

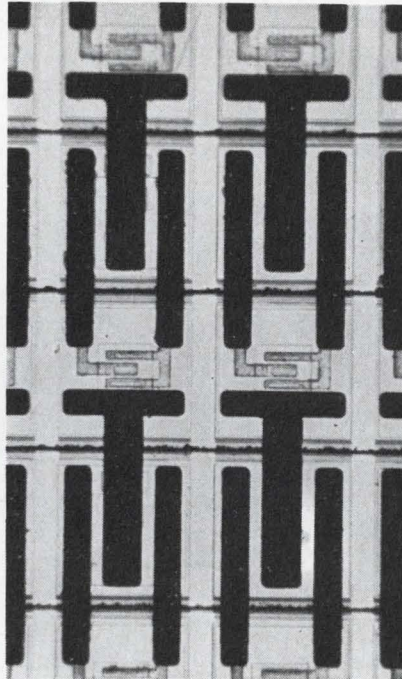
The beam-lead technique offers economies in packaging integrated circuits—and packaging can cost more than the chip itself. Still, it's a difficult way to make IC's, because of the ticklish etching required to provide separated chips with cantilevered leads.

A small Japanese company, Kyodo Electronic Laboratories, has developed what it calls a scribe fabrication technique that eliminates the need for etching after electrochemical formation of the beam leads and prevents the accompanying loss of silicon. And because there is no concern over the corrosive action of silicon etchants, limitations on the selection of metals are relaxed. What's more, say the three engineers who perfected the process—Heishichi Ikeda, Yoshio Enosawa, and Takoshi Yamaoka—the method yields the same number of devices per wafer as wire bonding.

More than 1,000 hours of life tests promise reliability exceeding that of conventional devices. Bonded wire leads, says the company, can be peeled away from the chip by a 3-gram force; the figures for the Kyodo beam-lead diode, for example, are 12 grams for a wide lead and 8 grams for a narrower version. For the new Kyodo IC's, peel strength is 10 grams.

Do it first. The major innovation is to scribe wafers before beam leads are formed; this permits easy separation. Portions of the beams are fabricated over, but not attached to, the neighboring chip. Polycrystalline isolation keeps beam lead-to-substrate capacitance low. The final result is cantilevered beam leads extending beyond the edge of the chip.

After the completed wafer is etched to remove silicon dioxide



Together. Beam-lead transistors, shown before dicing, made by the Kyodo scribe fabrication technique. Final etch step is eliminated.

over the contact areas and photoresist is stripped away, the wafer is scribed. Then another photoresist coating is applied over the entire wafer, exposed through a mask, and developed. This gives a coating over the area between the contact and the edge of the chip where the beam lead will be anchored to the silicon dioxide passivation layer. Also, the scribed line is filled with photoresist material to provide a smooth surface.

Aluminum film 0.8 micron thick and nickel film 0.1 micron thick are vacuum-evaporated onto the wafer. Then a second photoresist coating is applied above the nickel film, exposed, and developed. The nickel is now completely covered except for the regions where beam leads are to be formed by electrically plating gold onto the uncovered portions of the nickel surface to a thickness of 10 to 15 microns.

Take it off. All excess material is then stripped, starting with the second photoresist layer, which is the uppermost layer surrounding the beam leads. Next, using the gold beams as a mask, the unneeded nickel and aluminum layers that don't lie under the beams are stripped. This leaves the beam leads firmly attached to contacts and anchor points beside the contacts, freeing them and leaving them cantilevered over the wafer where they cross the boundary between chips and extend over the adjacent chip.

Finally, the wafer is diced in a manner identical to that used for transistors: the wafer is attached to adhesive-backed flexible material and bent to break at the scribed lines.

Even with its new development, the company is reluctant to compete head-on with larger firms for a share of the standard monolithic IC business. Instead, it will use the process for its line of hybrids, where higher unit prices make competition more attractive.

But because portions of the hybrids are similar to standard monolithics, Kyodo hasn't ruled out eventual entry into that area. For example, a core driver might consist of a standard transistor-transistor-logic gate chip, followed by an amplifier consisting of a power transistor chip and cermet resistors, in a single assembly.

LSI calculator

Backed by a government subsidy, the Hayakawa Electric Co. has put together a small experimental electronic desk calculator incorporating large-scale integration. The machine contains 11 MOS integrated circuits with 300 to 400 elements, three bipolar hybrid IC's, four bipolar transistors, four display tubes, a six-layer p-c board, and assorted hardware. The proj-

ect was undertaken to show that the Japanese industry could accomplish such miniaturization; a commercial prototype is due next March.

The machine is 2.8 inches high, 6.3 wide, and 8.7 deep. It has an average calculation time of 0.6 second and uses 4.5 watts of power from an a-c line.

The Hayakawa approach was to place all logic circuits in a small number of LSI packages, which were designed as functional blocks; it's thus possible to change the calculator's design by adding or subtracting a block or two. Application of LSI—plus the use of custom-made components—adds reliability.

Also, the LSI circuits and multi-layer board mean fewer manufacturing operations and simpler servicing.

But there are several obstacles between laboratory and market, as Hayakawa has discovered with some other experimental calculators. For one thing, the machine displayed in Japan is designed for only four operations—addition, subtraction, multiplication, and division—and provides no roots or other complex functions. There are just eight digits and a floating decimal point.

The project has been expensive. Hayakawa received \$42,000 for R&D, and will get another \$130,000 to design a commercial version. Component makers such as Mitsubishi, which is developing the MOS IC's, claim they're spending more than the subcontracts are bringing in. Hayakawa must still come up with a design that's commercially viable.

West Germany

A sad Red Baron

West Germany's troubled aircraft and avionics industries, stunned by the government's decision to fill the Luftwaffe's reconnaissance gap with McDonnell Douglas RF-4E Phantoms, expect things to get even worse.

For the reasons, it's necessary to go back about a year to the beginning of a debate over which of two aircraft to buy—the Phantom or Lockheed's RTF-104, which is a beefed-up version of the F-104C Starfighter the Luftwaffe already flies. The 104 would have been built under license in Germany, giving the ailing industries a shot in the arm. But the generals wanted the Phantom, and Bonn's defense committee went along to the tune of 88 planes at a cost of \$500 million.

A little balm. Even the belief that the U.S. has promised to get McDonnell Douglas to invite German bids on \$100 million worth of subcontracts has failed to dispel the clouds. The German aircraft industry association figures its members are in a poor competitive position on price and know-how, because the Americans have been supplying Phantom parts right along. And it's unlikely that the American firms would step aside in favor of the Germans.

Furthermore, a spokesman for a large U.S. company in Germany points out that "because of the so-called Buy American regulation, it'll be tough for foreign firms to compete in the U.S." Even if the ruling is waived, he says, it will be difficult for German firms to meet prices.

What it all boils down to is that there isn't much work left in the German aircraft houses. Since the end of the big licensing deals for Lockheed and Fiat fighters three years ago, the outlook has been bleak. True, the industry has been reasonably busy lately with the Transall, a Franco-German transport, and with some helicopter license deals. But these can't begin to fill the vacuum left when the 700 F-104's and 400 Fiat G-91's were completed. And unless more big contracts are signed soon—the British-German-French airbus is a possibility—the industry faces harder times in the early 1970's.

The industry also fears that the half-billion-dollar outlay might hurt NKF, the proposed Starfighter replacement. The government could delay action or be less inclined to commit as much money as the industry wants. And a decision to

buy the Lockheed reconnaissance plane would have given the industry further design, production, and system-management know-how that could have been applied to the NKF.

Quick recovery

When the West German electronics industry slumped in 1967—sales up only 3% from the previous year after a 7% growth in 1966—it was feared that the industry might be sick. However, the current version of *Electronica*, the big biannual components show at Munich that ends this week, indicates that those fears were groundless.

Judging from experts' comments at the show, 1968 industry sales growth will bounce back to 7%. Not only that, they say, but 1969 may see an increase of 10%.

Coming up rosy. The industry-wide optimism has generated a lot of bullishness in the components sector. The 900 exhibitors at *Electronica* (there were 780 in 1966) are predicting an \$800 million components market next year, up almost 20% from the estimated total of \$670 million for this year. That would be the biggest leap for components in recent years.

The major impetus for the quick comeback has come from the rising production of color and monochrome television sets, the opening of markets, and stable prices. For example, predictions are that next year 450,000 color receivers will be turned out, up from 280,000 this year. And with each cathode-ray tube costing an average of \$125, crt's alone will account for a sizable chunk of the components market. Add to that the expected 2.2 million black-and-white sets and the result is a lot of business for device makers.

Also contributing to the upsurge in component sales is the automobile industry. For example, a big break was made last year when Volkswagen put an electronic fuel injection system into its 1968 beetle exported to the U.S.; other companies may soon follow suit. One large firm, Robert Bosch GmbH, has come out with a line of acces-

sories—windshield wiper systems, regulators, signaling equipment—using passive and active devices.

Hold the line. Still another factor is that prices for most components have stopped tumbling. “With many electronics firms now beginning to hit bottlenecks in production, ours has become a seller’s market,” one large component manufacturer says. “We can pretty much ask for what we want.” The production difficulties, especially in consumer electronics, will probably get worse next year as a result of rising demand and the continuing shortage of labor. Integrated-circuit prices will keep falling, however, but not as drastically as in the past. Says Fritz Hoehne of Texas Instruments Deutschland GmbH, “Electronica-goers are interested in IC applications. Price has become a secondary consideration.” IC exhibitors report that radio and tv manufacturers are increasingly turning to IC’s.

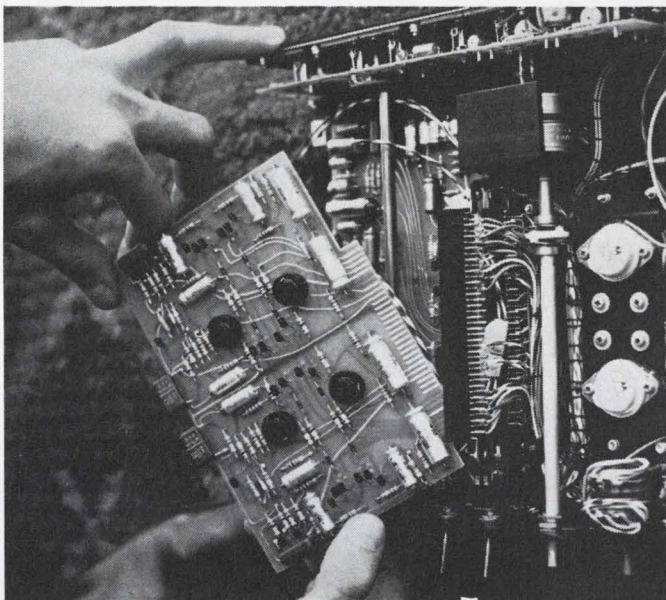
The consumer sector alone will account for about a third of the 1969 IC market, estimated at \$105 million to \$110 million, up about 10%. Even so, the move toward IC’s in consumer goods is just beginning, and it will be another year or two before all of West Germany’s tv producers put IC’s in their sets.

Great Britain

Sound thought

If a hi-fi enthusiast wants to heighten the fi of his equipment, one of the things he might tend to do is plug in a high-gain cartridge, right? Wrong. Because if the cartridge’s gain is too high for the input preamplifier, it will overload the amplifier and distort the sound.

To avoid the overload, an operational-amplifier circuit between the cartridge and the hi-fi set’s amplifier can adjust the gain. In the U.S., H.H. Scott has built an op amp into an f-m stereo music system [Electronics, Dec 11, 1967, p. 50]. Now a British company—Cam-



Innards. The p-c boards of Cambridge Audio’s new preamplifier carry an op-amp circuit that prevents amplifier overload.

bridge Audio Laboratories, a subsidiary of Cambridge Consultants—has turned the trick.

Sweet and low. Cambridge has used an essentially grounded, low-noise op amp operated by the gain control to optimize preamp performance the way an op amp handles input for an analog computer. So long as the gain is set so that the total volume doesn’t exceed the rated power of the amplifier, the preamp will be able to handle without distortion any signal level likely to be fed into it from the cartridge pickup. If the selected gain level and the top end of the record’s dynamic range result in overload distortion from the speakers, the gain control is tuned down. This simultaneously increases the signal level the preamp can handle until the distortion is eliminated.

With this technique, says Cambridge, the input stage can handle 3 volts through a 3-millivolt input, or an overload of 1,000 times—10 times the overload claimed for any other equipment known to the company.

Cambridge has made two models. The smaller gives 40 watts rms output and 80 watts peak into 8 ohms, the larger 80 watts rms and 60 watts peak into 8 ohms. Prices in Britain are \$155 for the smaller model and approximately \$222 for the larger version.

Indonesia

East is east—and cheaper

Gordon Ness bristles at the suggestion that he’s running a country club in the Far East. But try as they may, neither he nor Frank Bailey, president of the new subsidiary that Ness Industries Inc. has formed to manufacture electronic subassemblies in Indonesia, can come up with a more descriptive phrase for the operation.

Ness Industries is a conglomerate whose component companies offer a variety of marketing, manufacturing, and consulting services. P.T. IndoNess (the initials stand for “Perseroan Terbatas,” the Indonesian equivalent of “societe anonyme,” or “persons undisclosed”) is the country club; for a fee of \$50,000, its members will be permitted to exploit the agreement that IndoNess has negotiated with the Suharto regime in Djarkata.

Key to the door. That agreement has given IndoNess practically exclusive access, so far as small manufacturers are concerned, to the cheap labor pool in Indonesia—where unemployment is at the 15% level and where the basic rate for unskilled workers is 3 cents an hour (5 cents with fringe benefits). IndoNess and its members will enjoy a three-year tax holiday (four

years, if they sign up during 1968), will be exempt from duties on imported materials that are to be made into articles for export, and will be given a guaranteed exchange rate for reconverting Indonesian rupiahs into dollars.

Most important, IndoNess has been given exclusive rights to its type of operation in Indonesia for three years. Other companies may manufacture subassemblies; but no other consortium (the way IndoNess describes itself when it's not using "country club") may be formed to do so. Since the research and capital investments needed to start a manufacturing facility in the Far East are considerable, IndoNess figures it has a head start on the competition. Phillips Gloeilampenfabrieken of the Netherlands does have a radio manufacturing plant in the country; but it's the small- and medium-sized manufacturer that IndoNess hopes to attract.

For his \$50,000, IndoNess will provide the investor with a plant and a labor force, and will generally smooth his way in Indonesia.

John I. Hermann, who for a time ran Philco-Ford's Taiwan semiconductor assembly plant, will be the resident manager, though members can send over their own managers. IndoNess can also keep air-freight costs down to approximately 65 cents a pound by pooling freight operations.

A membership runs for four years, and it may be sold like a seat on the stock exchange or a taxi medallion.

Dealer's choice. By no coincidence, the first member of IndoNess is the Pacific Assemblers Co. (Pasco), a Ness subsidiary that manufactures subassemblies on a contract basis in Hong Kong. Last year's Hong Kong riots scared off some of Pasco's customers. Ness, pursuing cheap labor and stable political conditions, began dicker-ing with Indonesia, where the military has maintained iron control since the bloody anti-Communist revolt.

Then as now, Indonesia required foreign investors to commit \$2.5 million to an Indonesian manufacturing venture. However, Ness was

able to get this requirement reduced to \$50,000—provided that the investor did not manufacture finished products. That's why IndoNess is limited to the manufacture of subassemblies, though neither Ness nor the Indonesians are anxious to define just what a subassembly is. The first product—printed circuit boards—qualifies no matter what the definition.

Regarding other members, Bailey says that "we're looking for medium-sized electronics companies—perhaps 200 to 500 employees—that are beginning to feel the competitive pinch from larger companies already having offshore assembly operations." The club needs two members besides Pasco to begin operations, Bailey says; he expects to sign them up within a month. IndoNess wants five to 10 members eventually.

Soviet Union

Getting a rouble's worth

Soviet scientists and engineers are about to find out that Lenin wasn't just playing with platitudes when he wrote: "Political institutions are a superstructure resting on an economic foundation." Those words must have been echoing through the corridors of the Kremlin late last month when the Central Committee of the Communist Party and the Council of Ministers decreed that all the money being poured into pure research had better generate some results pretty fast. Apparently, Russian officials, like their American counterparts, have been finding it more and more difficult to justify expenditures that lead only to more expenditures.

Shape up. The double imprimatur on the decree, and the fact that it was spread over the front page of Pravda, is evidence enough that the government means business. But in case there was a lingering doubt, a system of periodic evaluations of the work of individuals and research organizations has been instituted with punishment specified for malefac-

tors. Also, certain programs have been given high-priority tags.

Visiting Western scientists have long noted that the gulf between research and production men is often wider in the Soviet Union than in their own countries. The prevailing Russian attitude is expressed by a researcher in the intellectual hothouse of Akademgorod: "We have our problems and the factories have theirs." This division isn't universal, though. One large electronics research institute outside Moscow has its own instrument-making department turning out equipment that is patented and sold elsewhere.

The reforms were probably spurred principally by dissatisfaction with the nation's recent growth in productivity. Just published economic statistics for the third quarter of 1968 show a production increase of only 5%, a rate sufficient to please some countries but disappointing when compared with Russia's past performance and its long-range goals. The decree also reflects the findings of the State Committee of Science and Technology, which has been assessing the country's research efforts over the past two years.

The inspection and penalty system calls for at least one evaluation every three years based on five criteria:

- Novelty of the research.
- The promise of an application.
- The number of scientific and technological proposals generated.
- Their over-all economic effect.
- Fulfillment of contracted research obligations—not only to Soviet enterprises but those of all other East-bloc countries.

Or ship out. These appraisals, says the decree, "will be taken as the basis for the decisions on material incentives to staff members and the further development of the institutes." In other words, they will affect employee bonuses and fringe benefits, capital investments, and outlays for new equipment, housing, recreational facilities, and the like. Finally, an accreditation system has been established to determine whether individuals should be promoted, demoted, or even fired.

Electronics advertisers

November 11, 1968

■ Acopian Corp. Mort Barish Associates	207	■ Chester Cable Corp. Lewis Adv. Agcy.	173, 174	Electro Fiberoptics Corp. Davis Adv. Inc.	14
Airco Speer Electronic Components Hazard Adv. Co., Inc.	77	Chrono-Log Corp. Mort Barish Assoc., Inc.	280	Electronic Communications, Inc. Neals & Hickok, Inc.	279
Airpax Electronics, Inc. Welch, Mirabile & Co., Inc.	222	Cimron Division of Lear Siegler, Inc. Phillips-Ramsey, Inc.	50	Electro Products Laboratories, Inc. Transducer Div.	166
■ Alden Electronics Larcom Randall Adv., Inc.	248	■ Cinch Mfg. Co. Stral Adv. Co., Inc.	99	Grant, Schwenck & Baker, Inc.	
Allen-Bradley Co. Fensholt Adv. Agcy.	83, 85	■ Clairex Corp. Michel-Cather, Inc.	69	E & M Laboratories Brewer, Betancourt & Moisselle, Inc.	192
Allied Van Lines, Inc. Young & Rubicam, Inc.	167	Clare & Co., C.P. Reincke, Meyer & Finn Adv., Inc.	162	Emerson & Cuming, Inc. Edwin F. Hall	270
American Cyanamid Co., Plastics & Resins Div.	80	Clarostat Mfg. Co. Horton, Church & Goff, Inc.	288, 289	Erie Technological Products Co., Inc. Altman-Hall Associates	61
American Lava Corp., Sub. of Minnesota Mining & Mfg. Co.	177	CMC, A Division of Pacific Industries Jones, Maher, Roberts, Inc.	43	Executone, Inc., Printact Relay Div. J.A. Richards	296
American Telephone & Telegraph Co. Cunningham & Walsh, Inc. Adv.	238	Connecticut Hard Rubber Co. Chirurg & Cairns, Inc.	26		
■ Ammon Instruments, Inc. Culver Adv., Inc.	276	Control Data Corp., Boston Space and Defense Systems Operation	241		
■ AMP, Inc.	28, 29, 272	Control-Logic, Inc. Van Christo Assoc., Inc.	179	Fairchild Instrumentation Faust/Day, Inc.	30
Garceau, Hallahan & McCullough, Inc.		Coors Porcelain Co. Tallant/Yates Adv., Inc.	220	■ Fairchild Semiconductor, Inc.	18, 19, 90, 91, 158, 159
AMPAR, Div. of Adams-Russell Marchal Associates	197	■ Cornell-Dubilier Electronics Daniel & Charles, Inc.	161	Faust/Day, Inc.	
Amperite Co. H.J. Gold Co.	188	Corning Glass Works Electronics Division—Capacitors	213	Fluoroware Colle & McVoy Adv. Agcy., Inc.	281
□ AOIP	3E, 4E	Corning Glass Works Electronics Division—Glass Memories	229		
Dumesnil Publicite		Corning Glass Works Electronics Division—Resistors	164	■ Gamma Scientific, Inc.	290
Arkansas Industrial Development Commission	216	Corning Glass Works Electronics Division—Resistors	164	Barnes-Champ/Advertising	
Cranford/Johnson & Associates		■ Couch Ordnance, Inc., Couch Co. Div. Culver Adv., Inc.	270	G-C Electronics Co., Industrial Div. Sander Rodkin Adv. Agcy., Ltd.	298
Arnold Engineering Co. Buchen Adv., Inc.	20, 21	CREI, Home Study Division of the McGraw-Hill Book Co.	237	■ General Electric Co., Electronic Components Sales Operation	10, 11
Automatic Electric Co., Sub. of General Telephone & Electronics Corp.	48, 49	Henry J. Kaufman & Associates		Robert S. Cragin, Inc.	
Marsteller, Inc.		■ CTS Corp.	295, 297	General Radio Co. Horton, Church & Goff, Inc.	6
		Burton Browne Advertising		Gordon Company Merrill, McEnroe & Assoc., Inc.	22
				Granger Associates West Associates	195
Bank of New York, The Special Industries Group	84			■ Grayhill, Inc. Merchandising Adv., Inc.	281
Evans Marketing Communications, Inc.				Groov-Pin Corp. Feeley & Wheeler, Inc.	281
Barnes Corp. Industrial Public Relations, Inc.	276	■ Dale Electronics, Inc., Sub. of Lionel Corp.	3rd Cover	■ Guardian Electric Mfg. Co. K & A Advertising	171
Basic, Inc., Elgin Electronics Div. Carr Liggett Adv., Inc.	285	Swanson, Sinkey, Ellis, Inc.		■ Gudebrod Brothers Silk Co., Electronics Div.	182
Beckman Instruments, Inc., Electronic Instrument Div.	189, 191	Dana Laboratories, Inc. Smith-Klitten, Inc.	44, 45	Ramsdell-Buckley & Co.	
Hixson & Jorgensen, Inc.		Data General Corp.	12, 13		
Belden Corporation Fensholt Adv., Inc.	245	Hill, Holliday, Connors, Cosmopolos, Inc.		Hamilton Watch Co. Beaumont, Heller & Sperling, Inc.	232
Bissett-Berman Corp. S F Associates	271	Di-Acro Corp. Div. of Houdaille Industries, Inc.	262	Charles E. Brown Adv. Agcy.	
■ Blue M Electric Co. South Suburban Advertising	160	Dialight Corp. Michel, Cather, Inc.	291	Haydon Switch & Instrument, Inc. Reynolds & Foster, Inc.	211
Bourns, Inc., Trimpot Div. Lester Co., The	17	Doric Scientific Corp. Professional Adv. Agcy.	287	■ Heath Co., Sub. of Schlumberger, Ltd. Advance Advertising Service	267
Brush Instruments Division of Clevite Corp.	231	Dow Chemical Co., The MacManus, John & Adams, Inc.	169	■ Hewlett Packard, Frequency & Time Div.	253
Carr Liggett Adv., Inc.		Dow Corning Corp., Engineering Products Div.	172	Lennen & Newell, Inc.	
■ Burndy Corp. Don Kemper Co., Inc.	92, 93	Church & Guisewite Advertising		■ Hewlett Packard, Palo Alto Div. Lennen & Newell, Inc.	1
Burns & Towne Kalb & Schneider, Inc.	178	Dumont Oscilloscope Laboratories, Inc. Keyes, Martin & Co.	233	Hitachi Metals, Ltd. Standard Adv., Inc.	254
■ Burr Brown Research Corp. N.A. Winter Adv. Agcy.	257	Duncan Electronics, Inc., Sub. of Systron Donner Corp.	62	■ Honeywell, PMD Div. Batten, Barton, Durstine & Osborn, Inc.	101
■ Burroughs Corp., Electronic Components Div.	110	Enyart & Rose Adv., Inc.		Hughes Aircraft Co.	181, 249
Conti Adv. Agcy., Inc.		DuPont de Nemours Co., Industrial Fibers Nomex	170	Foote, Cone & Belding	
■ Bussmann Mfg. Div. of McGraw Edison Co.	292, 293	Batten, Barton, Durstine & Osborn, Inc.		Hugle Industries, Inc. Tom Jones Advertising	75
Henderson Adv. Co.		DuPont de Nemours Co., Mylar Div.	59	Hycon	268
		Batten, Barton, Durstine & Osborn, Inc.			
Captor Corp.	264	DuPont de Nemours Co., Teflon Div.	104		
Weber, Geiber & Kalat, Inc.		Batten, Barton, Durstine & Osborn, Inc.			
Cambridge Thermionic Corp. Chirurg & Cairns, Inc.	265				
Cedar Engineering Div., Control Data Corp.	291	■ Eagle Signal Division of E.W. Bliss Co.	66, 68, 70	■ Indiana General Corp., Ferrites Div.	32
Colle & McVoy Adv. Agcy., Inc.		Feeley & Wheeler, Inc.		Griswold & Eshleman	
Centralab Div. of Globe-Union, Inc. The Brady Co.	81	Eastman Kodak Co., Business Systems Markets Div.	219	Industrial Electronic Engineers Van Der Boom, McCarron, Inc. Adv.	296
Chartpak Rotex Hoag & Provandie, Inc.	260	J. Walter Thompson Co.		■ International Crystal Mfg. Co. Robert V. Freeland & Associates	201
		Elco Corp. Fien and Schwerin, Inc.	314		

International Electronic Research Corp.	210	National Cash Register	273	Stackpole Carbon Co., Electronic Components Division	217
Van Der Boom, McCarron, Inc. Adv.		Allen Dorsey & Hatfield		Meek & Thomas Inc.	
I R C, Inc.	255	National Electronics, Inc.	252	Struthers-Dunn Incorporated	176
Gray & Rogers, Inc.		Connor-Gager Associates		Harry P. Bridge Co.	
ITT Cannon Electric	82	National Semiconductor Corp.	73, 274	Sunnyvale Chamber of Commerce, Industrial Development Div.	286
MacManus, John & Adams, Inc.		Jay Chiat & Associates		Giulie, Smith & Beal Inc.	
		Newark Electronics Corp.	264	Superior Electric Co., The	76
		Stral Adv. Co.		K.C. Shenton Co.	
		New Hermes Engraving Machine Corp.	252	Sylvania Electric Products, Inc. Electronic Components Group	35 to 42
		Lester Harrison Adv., Inc.		Doyle, Dane, Bernbach, Inc.	
		Nippon Coil Co., Ltd.	284	Sylvania Electric Products, Inc. Parts Division	163
		Dai-Ichi International, Inc.		Doyle, Dane, Bernbach, Inc.	
J F D Electronics Co., Components Div.	187	North American Electronics Systems, Div. Educational Computer Corp.	141	Synthane Corporation	285
Delphi Adv., Inc.		George Moll Adv., Inc.		Arndt, Preston, Chapin, Lamb & Keen Inc.	
Johanson Mfg. Co.	290	North Atlantic Industries, Inc.	266	Syntronic Instruments, Inc.	284
Josephson, Cuffari & Co.		Ross Roy of New York, Inc.		Burton Browne Advertising	
Johnson Co., E.F.	294	Norton Assoc., Inc.	298	Systemation Inc.	102
Midland Associates		J.J. Coppo Co.		Barlow/Johnson Inc.	
		Nye Optical Co.	276	Systron-Donner Corporation	25
				Bonfield Associates, Inc.	
Keithley Instruments, Inc.	225				
Bayless-Kerr Co.		Pamotor, Inc.	242		
Keystone Carbon Co.	304	Harry P. Bridge Co.		TDK Electronics Co. Ltd.	294
Downing Industrial Adv., Inc.		Pearson Electronics	280	Fuji Agency	
Kikusui Electronics Corp.	287	William E. Clayton & Assoc., Inc.		Tech Laboratories Inc.	208
General Adv. Agcy., Inc.		Philbrick/Nexus Research	46, 47	Lewis Advertising Agency	
Kings Electronics Co., Inc.	24	Culver Adv., Inc.		Tektronix Inc.	183, 184
Caroe Marketing, Inc.		Phillips Eindhoven, Nederland	198	Dawson, Turner & Jenkins Inc.	
Krohn-Hite Corp.	74	Media International		Teledyne Relays Co.	282
L.K. Frank Co., Inc.		Plastic Capacitors, Inc.	202	S. Michelson Advertising	
		Sander Rodkin Adv. Agcy., Ltd.		Telonic Engineering Co.	244
		Polaroid Corp.	190	Jansen Associates Inc.	
		Doyle, Dane, Bernbach, Inc.		Tempress Research Co., Inc.	219
		Preston Scientific	240	Hal Lawrence Inc.	
		Donald S. Smith Associates		Test Equipment Corporation	254
Lapp Insulator Co.	234	Princeton Applied Research Corp.	52	Dean & Bain Advertising Inc.	
Wolff Associates		Mort Barish Assoc., Inc.		Texas Industrial Commission	294
Leach Corp.	67			The Pitluk Group	
Jay Chiat & Associates		Radiation, Inc.	263	Texas Instruments Incorporated Components Group	78
Ledex, Inc.	236	W.M. Zemp & Assoc., Inc.		Don L. Baxter Div. of Albert, Frank-Guenther-Law Inc.	
Yeck & Yeck, Inc.		Radio Corporation of America	4th Cover, 65, 206	Texas Instruments Incorporated Industrial Products Group	246
Litton Industries, Inc., Electron Tube Div.	212	Al Paul Lefton Co.		Robinson-Gerrard	
MacManus, John & Adams, Inc.		Raytheon Company, Components Division	221	Texas Instruments Incorporated Advanced Circuit Board Dept.	94, 95
		Fuller & Smith & Ross Inc.		Management Communication Consultants Inc.	
		RFL Industries Inc., Instrumentation Division	258	Texscan Corporation	262
		Josephson, Cuffari & Company		Burton Browne Advertising	
Machlett Laboratories, Div. of Raytheon Co.	15	Sage Electronics Corporation	287	Torrington Mfg. Co., Air Moving Division	79
Fuller & Smith & Ross, Inc.		Mathison Adv. Inc.		Wilson, Haight & Welch Inc.	
Magnetics, Inc.	247	Sel-Rex Corporation	105 to 108	Transitron Electronic Corporation	168
Lando Adv. Agcy., Inc.		O.S. Tyson & Company Inc.		Larcom Randall Advertising Inc.	
Magnetic Shield Div., Perfection Mica Co.	205	Semtech Corporation	57	Triplett Electrical Instrument Co.	243
Burton Browne Adv.		Burress Advertising		Burton Browne Advertising	
Mallory & Co., P.R., Mfg. Div.	196	Siemens America	98	TRW Electronics, Capacitors Division	175
Aitkin-Kynett Co.		Clinton E. Frank Inc.		Fuller & Smith & Ross Inc.	
Markel & Sons, L. Frank	278	Signetics Corp.	157	TRW Semiconductors Inc.	209
George Moll Adv., Inc.		Sub. Corning Glass Works		Fuller & Smith & Ross Inc.	
Markem Corp.	261	Cunningham & Walsh Inc.		Trygon Electronics Inc.	64
Creamer Trowbridge Case & Basford, Inc.		Siliconix Inc.	7	Kameny Associates Inc.	
Maryland Dept. of Economic Development	272	Graphics West		Tung-Sol Division, Wagner Electric Corporation	313
The Robert Goodman Agcy., Inc.		Sola Basic Industries	204	Feeley & Wheeler Inc.	
Mergenthaler Linotype Co.	165	The Brady Company			
Merlin Advertising		Sollitron Devices Inc., Transistor Division	109	Union Carbide Electronics Semiconductor Products	27
Metal Removal Co., The	16	Haselmir Pearson Advertising Inc.		Hal Lawrence Inc.	
Advertising Producers Associates		Sorenson Operation, Raytheon Company	89	United Systems Corporation	71
Microdyne Instruments, Inc.	256	Urrutia & Hayes Inc.		Advertising & Merchandising Inc.	
Studio 6, Inc.		Sperry Rand Corporation, Sperry Electronic Tube Division	277	United Transformer Co., Division of TRW Inc.	2nd Cover
Minnesota Mining & Mfg. Co., Chemicals Div.	235	Neals & Hickok Inc.		Fuller & Smith & Ross Inc.	
Young & Rubicam, Inc.		Sperry Rand Corporation, Sperry Microwave Electronics Division	86	Unitrode Corporation	63
Minnesota Mining & Mfg. Co., Scotchpar Div.	96	Neals & Hickok Inc.		Siltan Brothers, Inc.	
Young & Rubicam, Inc.		Sprague Electric Company, The	5, 9	University Laboratories Inc.	203
Mitre Corp.	259	Harry P. Bridge Company		West Associates	
The Bresnick Co.				Utah Industrial Promotion Commission	228
Monsanto Co.	97			David W. Evans & Associates	
Michel-Cather, Inc.					
Motorola Communications & Electronics Inc.	285				
The Griswold-Eshleman Co.					
Motorola Semiconductor Products, Inc.	51, 60				
Lane & Bird Adv., Inc.					
Mullard, Ltd.	218				
Parker-Rumrill International, Inc.					



Advertising Sales Staff

Frank E. LeBeau [212] 971-6464
Advertising Sales Manager

Wallis Clarke [212] 971-2187
Assistant to sales manager

Donald J. Austermann [212] 971-3139
Promotion Manager

Warren H. Gardner [215] LO 8-6161
Eastern Advertising Sales Manager

Atlanta, Ga. 30309: Michael H. Miller, 1375 Peachtree St., N.E. [404] 892-2868

Boston, Mass. 02116: William S. Hodgkinson McGraw-Hill Building, Copley Square [617] CO 2-1160

Cleveland, Ohio 44113: William J. Boyle, 55 Public Square, [216] SU 1-7000

New York, N.Y. 10036
500 Fifth Avenue
James R. Pierce [212] 971-3616
John A. Garland [212] 971-3617
Michael J. Stoller [212] 971-3615

Philadelphia, Pa. 19103:
Jeffrey M. Preston
Warren H. Gardner,
6 Penn Center Plaza,
[215] LO 8-6161

Pittsburgh, Pa. 15222: Warren H. Gardner,
4 Gateway Center, [412] 391-1314

Rochester, N.Y. 14534: William J. Boyle,
9 Greylock Ridge, Pittsford, N.Y.
[716] 586-5040

Donald R. Furth (312) MO 4-5800
Midwest Advertising Sales Manager

Chicago, Ill. 60611: Kenneth E. Nicklas
Ralph Hanning, 645 North Michigan Avenue,
[312] MO 4-5800

Dallas, Texas 75201: Richard P. Poole, 1800 Republic National Bank Tower,
[214] RI 7-9721

Houston, Texas 77002: Robert Wallin,
2270 Humble Bldg. [713] CA 4-8381

Detroit, Michigan 48226: Ralph Hanning,
856 Penobscot Building
[313] 962-1793

Minneapolis, Minn. 55402: 1104 Northstar Center [612] 332-7425

St. Louis, Mo. 63105: Kenneth E. Nicklas,
The Clayton Tower, 7751 Carondelet Ave.
[314] PA 5-7285

James T. Hauptli [415] DO 2-4600
Western Advertising Sales Manager

Denver, Colo. 80202: Joseph C. Page, David M. Watson, Tower Bldg., 1700 Broadway [303] 255-5484

Los Angeles, Calif. 90017: Ian C. Hill, John G. Zisch, 1125 W. 6th St., [213] HU 2-5450

Portland, Ore. 97204: James T. Hauptli, Thomas McElhinny, 218 Mohawk Building, 222 S.W. Morrison Street, Phone [503] 223-5118

San Francisco, Calif. 94111: James T. Hauptli, Thomas McElhinny, 255 California Street, [415] DO 2-4600

Pierre Braude Tel: 225 85 88: Paris
European Director

Paris: Denis Jacob
88-90 Avenue Des Champs-Elysees, Paris 8

United Kingdom and Scandinavia
London: Oliver Ball, Tel: Hyde Park 1451
34 Dover Street, London W1

Milan: Robert Saidel
1 via Baracchini Phone 86-90-656

Brussels: F.I.H. Huntjens
27 Rue Ducale Tel: 136503

Frankfurt/Main: Hans Haller
Elsa-Brandstroem Str. 2
Phone 72 01 81

Geneva: Denis Jacob
1, rue du Temple Phone: 31 95 60

Tokyo: Takeji Kinoshita 1 Kotohiracho Shiba, Minato-Ku Tokyo [502] 0656

Osaka: Ryoji Kobayashi 163, Umegae-cho Kita-ku [362] 8771

Business Department

Wallace C. Carmichael, Manager
[212] 971-3191

Stephen R. Weiss, Production Manager
[212] 971-2044

Thomas M. Egan, Assistant Production Manager [212] 971-3140

Dorothy Carmesin, Contracts and Billings [212] 971-2908

Frances Vallone, Reader Service Manager [212] 971-2865

- **Vactec Inc.** 72
Coleman & Associates Advertising
- Varo Inc.** 298
Tracy-Locke Co., Inc.
- Vector Electronic Co., Inc.** 260
Packard Advertising Inc.
- Vishay Resistor Products** 151
Alpern Communications
- **Wang Laboratories** 230
Impact Advertising Inc.
- **Weinschel Engineering Co.** 286
E.G. White Advertising Inc.
- Westinghouse/MED** 103
Pritchard Wood Associates, Inc.
- **Weston Instruments Inc., Archbald Division** 214
Arndt, Preston, Chapin, Lamp & Keen Inc.
- **Weston Instruments Inc., Transicoil Division** 292
Arndt, Preston, Chapin, Lamp & Keen Inc.
- White Company, S.S.** 100
W.L. Towne Company Inc.
- Williams Gold Refining Co., Inc. Precious Metal Div.** 278
Stahlka, Faller & Klenk Inc.
- Zippertubing Company** 284
Edward S. Kellogg Company

Classified Advertising

F. J. Eberle, Manager

EMPLOYMENT OPPORTUNITIES

- Continental Can Co.** 301
- Motorola** 302

EQUIPMENT (Used or Surplus New) For Sale

- A & A Electronics Corp.** 303
- Fishman, P. Co.** 303
- R. G. Goodheart Co. Inc.** 303
- Radio Research Instrument Co.** 303

■ For more information on complete product line see advertisement in the latest Electronics Buyer's Guide

□ Advertisers in Electronics International

Electronics Buyers' Guide

George F. Werner, General Manager
[212] 971-2310

Robert M. Denmead, Midwest Regional Manager
[312] MO 4-5800

Regina Hera, Directory Manager
[212] 971-2544

Thomas M. Egan, Production Manager
[212] 971-3140

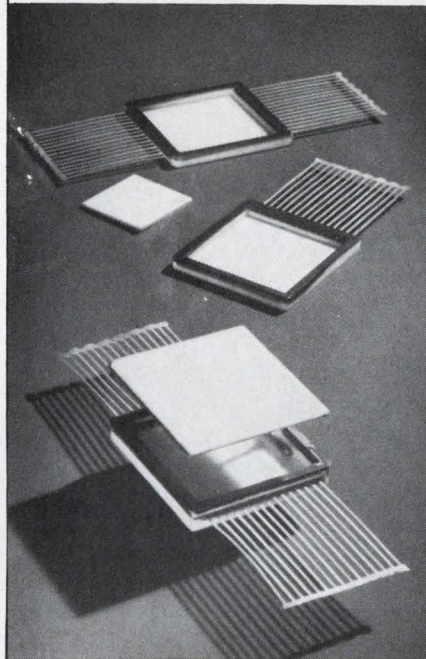
Circulation Department

Isaaca Siegel, Manager [212] 971-6057

Research Department

David Strassler, Manager [212] 971-6058

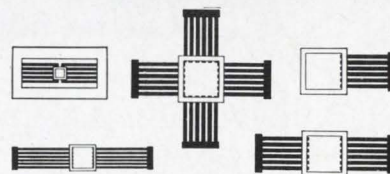
TUNG-SOL[®] FLAT PACKS



High mechanical strength, excellent thermal dissipation and precise dimensional accuracy provide microcircuit packaging that assures maximum performance and utmost reliability with widest latitude of design freedom.

TYPICAL CONFIGURATIONS

Available in closed and "see-through" types.



WRITE FOR "MICROCIRCUIT PACKAGES"



This brochure is eight pages of detailed information about Tung-Sol Flat Packs. No charge.

TUNG-SOL DIVISION

Wagner Electric Corporation
One Summer Avenue, Newark, N. J. 07104

© REG. T.M. WAGNER ELECTRIC CORPORATION



'We don't know any better.'

"... ANY BETTER THAN ELCO RACK-AND-PANEL CONNECTORS."

So says Bill McKay, our Director of Sales, whom you'd expect to be prejudiced. But listen to his reasons. "Miniature size and design give you greater density in less space. From 6 to 140 contacts. Our patented Elco Varicon contacts (stamped, not screw-machined) with tails for 6 kinds of wiring terminations—including wire wrap and crimp. Also polarizing guide pins and sockets. Actuating screws. Locking nuts. Cable clamps. We'll even install the contacts." Then Bill finishes with this clincher. "With so much going for you, and our track record of proven reliability, you'd expect prices to be yea-high. Instead, we're lower. Much lower." You'd better believe Bill — and write, wire, phone or TWX us for the facts. Elco Corporation, Willow Grove, Pa. 19090; 215-659-7000; TWX 510-665-5573.

P.S.—FREE SAMPLE? Let us know after you read our literature. We'll be delighted to send you one.





The counterpart.

Dale's new 8100 film T-Pots offer RJ-11 advantages at industrial prices

Dale's new 8100 Series makes it easy to approach RJ-11 performance at highly competitive industrial prices. Buy it sealed or unsealed—you're the boss. Get essentially infinite resolution...a broad 10 ohm to 2 Megohm resistance range...plus ability to dissipate $\frac{3}{4}$ watt at 70°C. The 8100 is part of a wide range of film element and wirewound T-Pots now available from Dale for industrial and commercial use. Common parameters: Low price, quick delivery. See your Dale distributor or call us at 402-564-3131 for complete details.

8100 FILM-T-POT SPECIFICATIONS

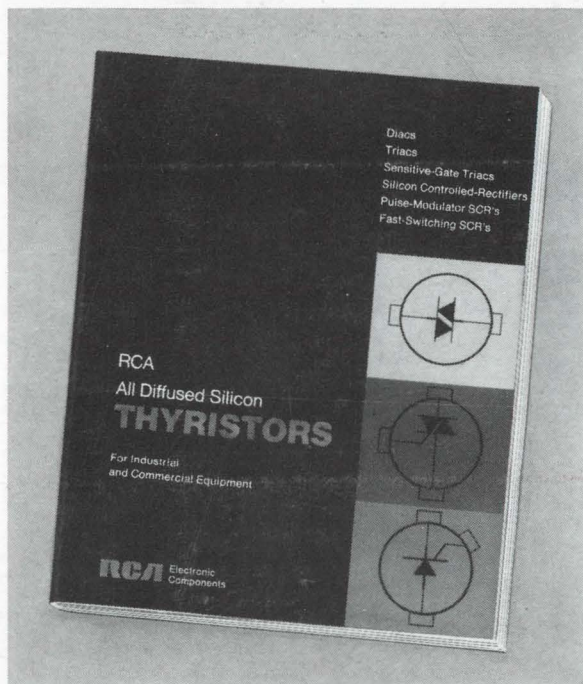
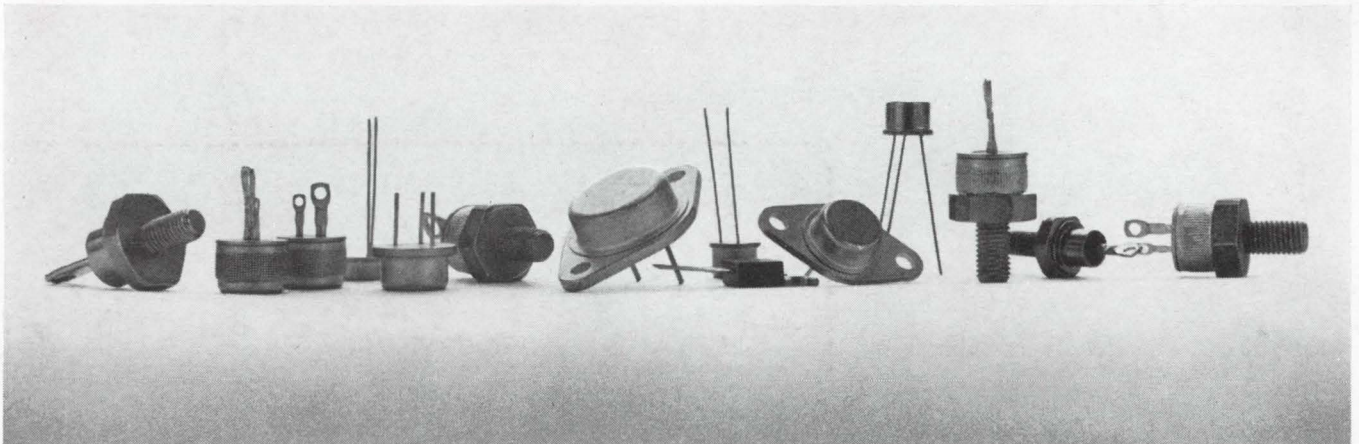
- Standard Resistance Range:** 10 ohms to 2 Megohms
- Resistance Tolerance:** $\pm 10\%$ 100 ohms through 500K ohms; $\pm 20\%$ all other values
- Resolution:** Essentially infinite
- Power Rating:** .75 watt at 70°C, derating to 0 at 125°C
- Operating Temperature Range:** -65°C to +125°C
- Mechanical Adjustment:** 25 ± 2 turns. Clutch prevents overtravel damage
- Dimensions:** .28" H x .31" W x 1.25" L
- Models:** 8187, printed circuit pins; 8188, stranded vinyl leads; 8189, solder hook; 8184, panel mount version of 8189; 8186, panel mount version of 8188



DALE ELECTRONICS, INC.
 1300 28th Avenue, Columbus, Nebr. 68601
 In Canada: Dale Electronics Canada, Ltd.

Circle 901 on reader service card

From 2 A to 40 A



Send for our latest full-line Thyristor catalog today!

RCA Thyristors are the greatest for appliances, power tools, heating controls, photocopiers, air conditioning, radar, alarm systems, welders, vending machines, and many control and switching applications.

Triacs, Diacs, SCR's: in package styles and current ratings to fit most applications. Packages: 2-lead; 3-lead; press fit; stud; plastic; Jedec TO-66, TO-8, TO-3. Current ratings: for Triacs from 2.5 A to 40 A, for SCR's from 2 A to 35 A. Our new full-line Thyristor catalog tells the story... including quick-reference data for all RCA types, package outlines and typical applications. It's hot off the press.

RCA

RCA Electronic Components
Commercial Engineering, Department No. RN-11-1
415 South 5th Street, Harrison, N. J. 07029

Okay, RCA Thyristors are the greatest. But just so I can check for myself, send me my FREE copy of catalog SCR-500B, "RCA Thyristors for Commercial, Industrial, and Military Applications".

Name _____
Title _____
Company _____
Address _____
City _____ State _____ Zip _____