

# ELECTRONIC DESIGN

AUGUST 31, 1960

Constant power output from self-adjusting dc supply... p 56



THE LIBRARY OF  
CONGRESS  
SERIAL RECORD  
SEP 6 1960

Designing with Digital Computers  
by ELECTRONIC DESIGN Staff

# HIGHEST ACCURACY

## IN

# PRODUCTION

# QUANTITIES

## PRECISION COMPUTING RESOLVERS



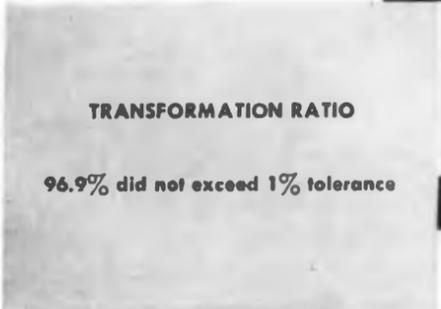
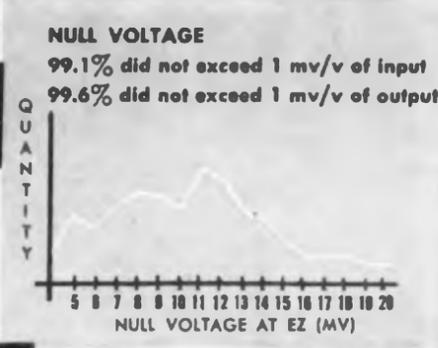
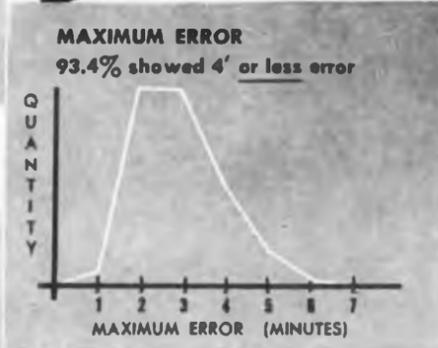
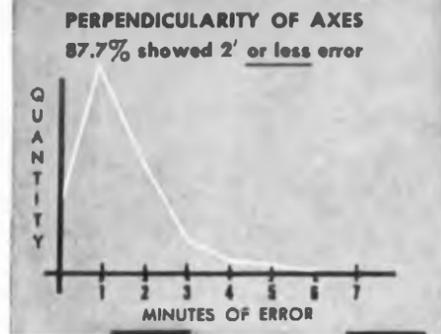
Occasionally we see advertised rotating components of fantastic accuracy. Sure, we make these *hand built* units too. But they are usually very expensive, of a large size, and you get delivery a few units at a time.

CPPC will sell you 1000 (or 10,000) of these Size 11 Precision Computing Resolvers, holding

the very high accuracies shown on this page, and at a price which will surprise you. If you know the rotary components market, you know that we have been able to substantially lower traditional prices in the past.

Two modern rotary components facilities (Clifton Heights, Pa. and Colorado Springs, Colo.) assure deliveries in 45 days on quantity orders. Samples from the shelf immediately. Telephone MAadison 2-1000 or our representatives.

ENGINEERS—Pioneer with a leader in the field. Write David D. Brown, Director of Personnel.

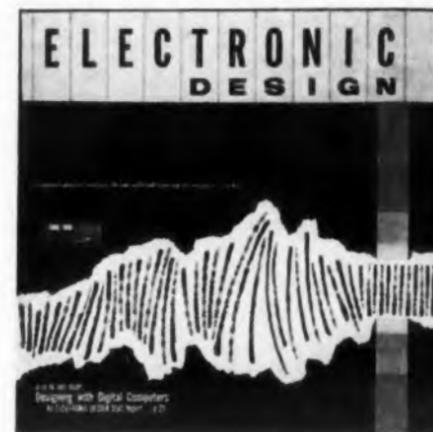


CLIFTON PRECISION PRODUCTS CO., INC.

**cppe**

CLIFTON HEIGHTS, PA.

CIRCLE 1 ON READER-SERVICE CARD



COVER: The irregular lines shown on the left of the cover design symbolize the variations in load demand. These are limited to a maximum value by a "constant-watts" regulating circuit, symbolized by the gray band which protects against overloads by limiting the power dissipated in the output transistor to the maximum value which can safely be tolerated. The regulated lines on the right show that maximum safe value

### Selected Topics In This Issue

- Communications and Radar**  
Engineers Make Use of Project Echo Satellite ..... p 12  
Stripline Technique Produces a Simple 3-Db Directional Coupler ..... p 52
- Components**  
Peltier Cooling Package Used With Gyro Components; Holds Unit Temperature to 110° F. p 16
- Computers**  
Designing With Digital Computers—An *ELECTRONIC DESIGN* Staff Report ..... p 28  
Computed-Prepared Tables Enable Design of Ultra-Flat Networks ..... p 48
- Power Supplies**  
Power-Sensing Circuit Protects New Line of Power Supplies Against Overload ..... p 56
- Semiconductors**  
Flow Graph Speeds Transistor Circuit Analysis ..... p 54

## Sidelights of the Issue

### Read All About It!

For a long period of time now, *ELECTRONIC DESIGN* has been expanding its news coverage to give the reader a wider and better knowledge of the week-by-week happenings in the design field.

We have devoted progressively more space to news; we have published an increasing number of reports in depth on design opportunities in fields such as oceanography and anti-submarine warfare. Our news reports have tried to keep on top of the latest developments and we have tried to show in each story the significance of the event to the design engineer.

Beginning with this issue, we are inaugurating another service. By a special arrangement, we have pushed back the deadline for a number of pages in our News department, so that developments can be reported days later than was previously possible. What this means to the reader is that the copy of *ELECTRONIC DESIGN* which he reads will contain not only fresher news, but that *ED*'s editors will have several more days in which to dig for information and to develop stories. This, we believe, will help make our news coverage more pointed and more informative than any other publication's.

### Dust off that Computer

Too often, in electronic design, have engineers let one of their best tools gather figurative dust. The tool, of course, is the digital computer. To help overcome this oversight, *ED* has gotten together a roundup of digital computer applications by design engineers.

In presenting this roundup, we have tried to depart from the usual method of treating a specific application in depth. Rather, we have gotten together dozens of applications in breadth, in the hope that even those engineers who don't find their particular problems listed to think about—Designing with Digital Computers. The article begins on p 28.

### Folding the WESCON Tent

Now that the WESCON dust has cleared and we have had time to collect our thoughts a bit, we have gotten together two reports on the show. One appears in this issue beginning on p 8; the other will appear in our Sept. 14 issue. To those of you who found time to drop by the *ED* booth in Los Angeles, it was good to see you. To those of you who couldn't make it, see you at the RE Show or next year at WESCON.

CIRCLE 2 ON READER-SERVICE CARD ➤

# WHICH DO YOU NEED?



## HIGH IMPEDANCE

## HIGH GAIN

## LOW DRAIN

## LONG LIFE

## You Get Them All With The Raytheon CK6611 and CK6612

There's no need to compromise when you design Raytheon CK6611 or CK6612 into your RF stages. These fully shielded, subminiature pentodes are specially designed for battery-operated communication applications where high input impedance and maximum gain along with low filament drain are required.

Military specification approval and Raytheon's intensive quality control program assure the ability of both types to meet and surpass vibration, shock, fatigue, and life test requirements. Average life expectancy, for example, is in excess of 5,000 hours. Excellent uniformity of characteristics and availability are the result of Raytheon's special production facilities and long experience in manufacturing these types.

For technical data on the CK6611 and CK6612 please write to: Raytheon, Industrial Components Division, 55 Chapel St., Newton 58, Mass.

*For Small Order or Prototype Requirements See Your Local Franchised Raytheon Distributor*

### CHARACTERISTICS AND TYPICAL OPERATION — CLASS A<sub>1</sub> AMPLIFIER

	Filament Voltage (dc)	Filament Current	Plate Voltage	Grid #2 Voltage	Grid #1 Voltage	Transconductance
CK6611	1.25 volts	20 mA	30 volts	30 volts	0*	1,000 $\mu$ mhos
CK6612	1.25 volts	80 mA	30 volts	30 volts	0**	3,000 $\mu$ mhos

\*Grid Resistor = 5 megohms

\*\*Grid Resistor = 2 megohms

## RAYTHEON COMPANY

INDUSTRIAL COMPONENTS DIVISION

measure

**I**

**AC and DC**

10<sup>-9</sup> to 10 amps ±2% DC, ±3% AC

**R**

10 ohms to 10 megohms  
±5% center scale

**E**

**AC** 1 mv to 1 kv ±3%  
20 cps to 1 mc

**DC** 1 mv to 1 kv ±2%



Model 810 IRE Meter • Price: \$445.00

with the **New**  
**Smith-Florence**  
*Multi-Function* **IRE Meter**

This versatile new instrument combines all the desirable functions of a multimeter, vacuum tube voltmeter, and exceptionally wide range AC and DC ammeter in one space saving, easy-to-use package. Truly the design engineer's answer to bench clutter, the Smith-Florence Model 810 takes the measurements you make most for only 1/3 the cost of comparable instrumentation.

And These Features, Too—Individually illuminated ranges controlled by the positioning of the function switch. Two calibrating output voltages: 1 vdc and 1 vac rms square wave controlled by a zener reference circuit to an accuracy of .1%. Scope and recorder output. 1 mc dbm scale for audio work. Measures two functions simultaneously. Rack mounting at no extra cost.

OTHER SPECIFICATIONS INPUT IMPEDANCE, 10 megohms • POWER REQUIREMENTS, 117 vac ±10%, 50-60 cps • DIMENSIONS, 13" W x 7 1/2" H x 13" D (cabinet) — 19" W x 7" H x 13" D (rack) • WEIGHT, 18 lbs.

For complete technical information, contact your nearby Smith-Florence engineering representative, or write the factory. DEPI 36

**SMITH-FLORENCE, INC.**

4228-36 23RD WEST • SEATTLE 99, WASHINGTON • ATWATER 4-0170  
Another New Instrument For The Sixties From Smith-Florence  
CIRCLE 3 ON READER-SERVICE CARD

CONTENTS FOR AUGUST 31, 1960 VOL. 8 NUMBER

**18**

Consider The Digital Computer ..... 27  
An Editorial

**A Special Section**

Designing With Digital Computers ..... 28  
An ELECTRONIC DESIGN Staff Report with dozens of computer applications by electronic design engineers

Computer-Prepared Tables Enable Design of Ultra-Flat Networks ..... 48  
Practical design data for ultra-flat networks —P. Geffe

Stripline Technique Produces A Simple 3-Db Directional Coupler ..... 52  
Twenty-db isolation achieved over 30 per cent frequency range—J. R. Dent

Flow Graph Speeds Transistor Circuit Analysis ..... 54  
A simple drawing enables the designer to keep track of what's going on electrically in a transistor circuit—T. R. Nisbet

**Coming Next Issue**

In this ever-expanding industry, a new word has begun to be bandied about with ever-increasing frequency. The word: bionics. The specialists at the Wright Air Development Division define it as: "The science of systems which function after the manner of, or in a manner characteristic of or resembling living systems." *ELECTRONIC DESIGN*, in the Sept. 14 issue, will present a full-scale report on this new specialty in electronics. We will show how design engineers are applying the knowledge of biology and biological techniques to the design of electronic devices and systems.

Our report on bionic systems will take the reader into this new electronic area and show him how engineers are working to develop adaptive or self-organizing mechanisms under biological inspiration. Remember the name, then—bionics. And remember to read about it in the Sept. 14 issue of *ELECTRONIC DESIGN*.

27	<b>Power-Sensing Circuit Protects New Line of Power Supplies Against Overload</b> .....	56
	Circuit measures power being dissipated in regulating transistors	
	<b>Solid-State Pressure Transducer</b> .....	58
	Represents a 10-fold increase in the state of the transducer art	
	<b>ELECTRONIC DESIGN News</b> .....	4
28	WESCON Opens in Los Angeles with Parade of Products .....	4
	Reader Described at AIEE Meeting Uses Rotating Rasters .....	10
	Engineers Put Echo Balloon Satellite to Work .....	12
48	Image-Tube Development Aids Astronomers .....	15
	Chicago Traffic Plotter Puts Traffic Data Onto Tube .....	18
	Signal Corps Orders Radios to Replace Three Current Models .....	19
	Fortune Magazine Article Predicts Electronic Industry "Shakeout" .....	25
	<b>Washington Report</b> .....	22
52	<b>New Products</b> .....	60
54	<b>New Literature</b> .....	88
	<b>Ideas for Design</b> .....	92
	<b>Letters</b> .....	94
	<b>Careers</b> .....	98
	<b>Your Career</b> .....	98
	<b>Advertisers' Index</b> .....	103



ELECTRONIC DESIGN is published bi-weekly by Hayden Publishing Company, Inc., 830 Third Avenue, New York 22, N.Y., T. Richard Gascoigne, Chairman of the Board; James S. Mulholland, Jr., President. Printed at Hildreth Press, Bristol, Conn. Accepted as controlled circulation at Bristol, Conn. Additional entry, New York, N. Y. Copyright 1960 Hayden Publishing Company, Inc., 36,657 copies this issue.

## tune the piano all at once...

*The piano tuner hasn't been born who can tune two keys at the same time... and strangely enough, we haven't sold a one of them a Wobbulator. But for electronic tunesmiths, it's a different thing... The Wobbulator, an excellent example of Canoga's R & D originality, literally tunes "the whole piano at once". The Wobbulator is a swept frequency signal generator which affords a new approach to vertical amplification. Best of all, it takes the place of several other instruments.*

*In radar systems... missile range instrumentation... microwave telemetry... microwave components... missile checkout and launch equipment... and test equipment*

**CANOGA**  
CANOGA/A SUBSIDIARY OF THE UNDERWOOD CORPORATION  
VAN NUYS, CALIFORNIA • FORT WALTON BEACH, FLORIDA



CIRCLE 4 ON READER-SERVICE CARD

# Courier Ready for Second Launch Attempt

*Communications Satellite Payload on Hand; Try May Be Made Before End of September*

A SECOND attempt to orbit a Courier communications satellite is likely to be made before the end of September. Failure of the first shot has not materially slowed the project. Philco's Western Development Div., prime contractor for the payload, had readied three complete Courier satellites and has components on hand for a fourth one.

Reliability via the "Put in two of everything" method characterizes the design of Courier's electronic payload and tracking stations. The result is the most heavily instrumented satellite yet attempted, with 38 separate electronic packages crammed into the 51-in. dia. sphere. Courier's insides include:

- Five tape recorders
- Four UHF transmitters
- Four UHF receivers

- Two VHF telemetry transmitters
- Two VHF tracking beacons
- Two VHF telemetry receivers
- Two independent battery-solar cell power supplies.

On the ground, redundancy of components and methods is also specified. The tracking stations, designed by ITT Laboratories, each include four UHF and two VHF receivers. The tracking antennas, supplied by Radiation Inc., can be operated in three different modes—manual, programed scan, and automatic tracking—to maintain contact with the satellite.

#### Real Time Communications Also Planned

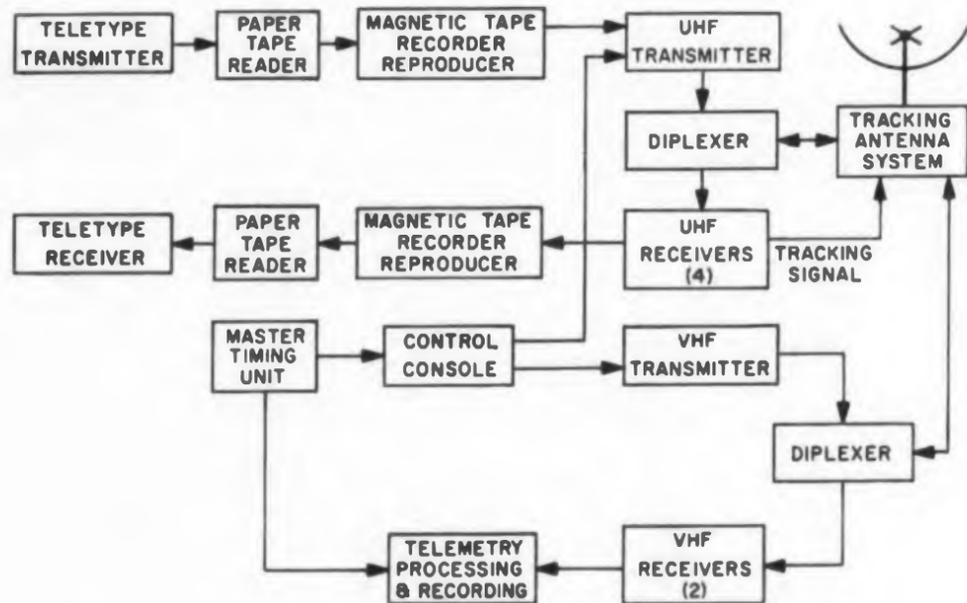
Courier's mission of proving the feasibility of active communication satellites has two aspects. In addition to its much publicized function as a

delayed repeater or "mail" pouch satellite, Courier can also operate as a real time repeater.

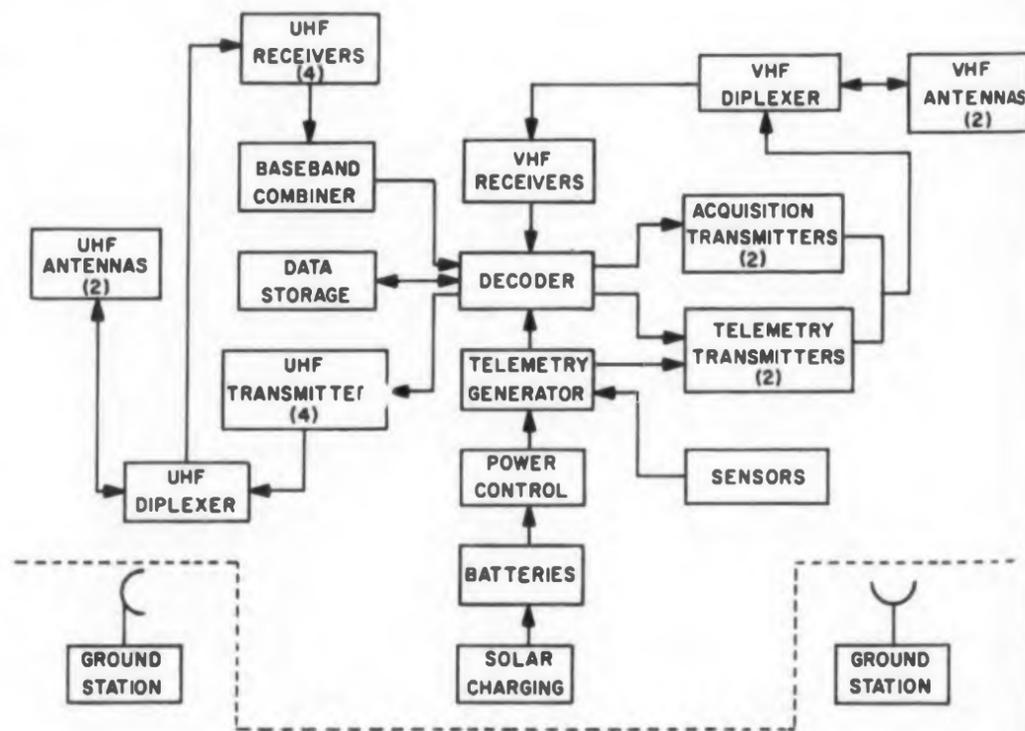
As a delayed repeater, Courier provides the equivalent of twenty 100 wpm teletype channels. The five 30 ips single track tape recorders have a total storage capacity of 15 megabits. Four recorders are equipped to handle NRZ teletype signals at 15 kilobits per sec. The fifth recorder will be used in experimental voice and analog transmissions.

#### Two-Way Transmissions Over UHF And VHF

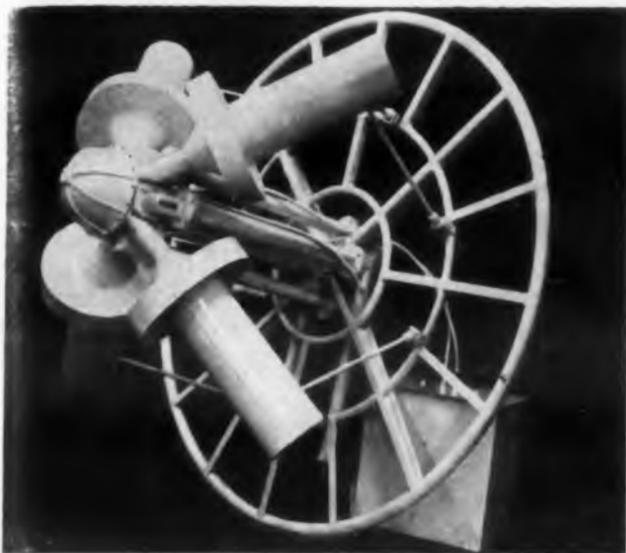
Simultaneous two-way communication between Courier and the tracking station takes place both in the 100 to 150 mc band and in the 1700 to 2300 mc band. The lower frequency band is used for tracking and telemetry; the UHF band carries the actual message transmis-



**Courier ground station** data flow. Message handling is by UHF transmission; telemetry is by VHF using a PAM/FM/FM system. Multiple receivers provide frequency and add redundancy for reliability. Between passes, the entire system can be checked out by aiming antenna at a transponder mounted on a tower some 200 feet distant. Ground station thus "talks to itself" to test all sub-systems in all operating modes.



**Courier payload** is characterized by redundant components for increased reliability. Simplified block diagram includes only a part of the 38 electronic packages in the vehicle. In addition to redundant transmitters and receivers, tape recorders and power supply can also sustain failure of individual units without interrupting communications.



**Feed system** for Courier tracking antenna. Dome at front houses spinning dielectric lens which scans signal to provide error data for automatic tracking. Feed path for VHF is through the four extended arms; UHF is fed through waveguides down center of unit. Antenna and tracking gear is by Radiation, Inc., Melbourne, Fla.

sions and most of the ground-to-satellite commands. VHF transmissions are at approximately 100 w and UHF transmissions are at about 1 kw.

The two VHF receivers at the ground station operate together to provide polarization-diversity reception. The four UHF receivers operate together to provide both polarization and frequency diversity reception.

The UHF receiving system employs a four-fold diversity combining scheme. Polarization diversity is accomplished with two predetection phase combiners; baseband combining is used for frequency diversity.

#### How Courier Is Tracked

Novel design techniques are used to facilitate acquisition and tracking of Courier. The satellite is equipped with two 50 mw VHF beacons which transmit continuously between tracking stations.

The horizon sector at which the satellite is expected to appear is illuminated by the ground station antenna, operating at VHF. When the satellite's beacon signal is detected, a coded

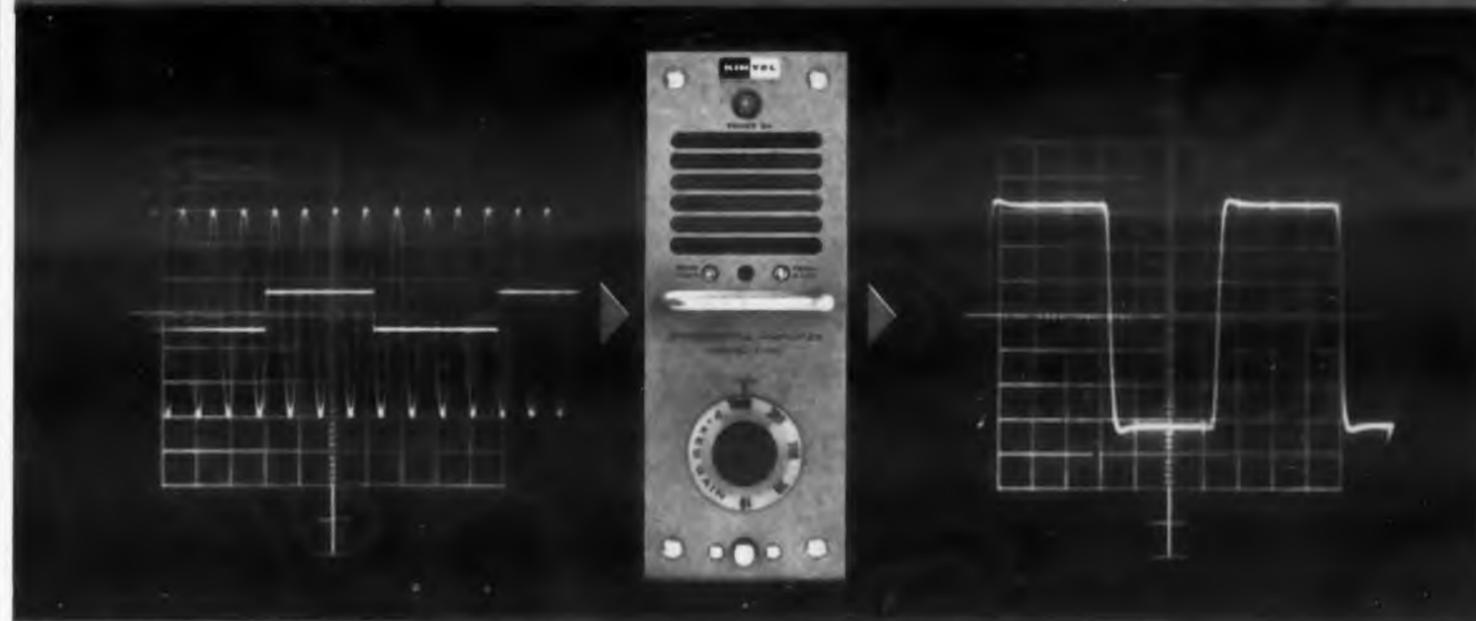
### New Developments Unveiled At WESCON

IN LOS ANGELES' Sports Arena last week, WESCON opened for thousands of exhibitors and visitors. On p 8 of this issue, *ELECTRONIC DESIGN* covers some of the main developments of the big event. Another, and bigger, story will be forthcoming in the Sept. 14 issue.

(picture of a KIN TEL differential amplifier at work)

6 volts of 60 $\nu$  common-mode noise and  
6 millivolts of signal in here

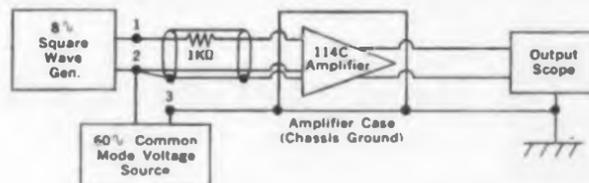
2 microvolts of 60 $\nu$  noise (equivalent input)  
and 6 volts of signal out here



If you measure the output of thermocouples, and the thermocouples are bonded to a rocket engine or almost any other grounded object, and the distance between thermocouples and amplifiers is more than a few feet, you should consider the above illustration carefully. While we'll admit your thermocouples probably aren't producing square waves, nine chances out of ten you *do* have a problem with 60-cycle common-mode noise. Nearly everybody does.

What can be done about it? Well, KIN TEL differential amplifiers reject ruinous 60-cycle common-mode hum and noise by a factor of 3,000,000 to 1 with any unbalance up to 1000 ohms in series with either side of the input, 1,000,000 to 1 with 10,000 ohms unbalance. Rejection for DC is practically infinite and both input and output can be floated up to  $\pm 300$  volts DC or peak AC. The secret of this exceptionally high common-mode rejection in the presence of high input unbalance is isolation. Input signal terminals are isolated from chassis ground by 10,000,000 megohms and 0.6 micromicrofarads. Input and output signal terminals are completely isolated from each other. Output signal terminals are isolated from ground to almost the same extent as the input. With this virtually perfect isolation, you can rescue microvolt level signals from volts of common-mode noise, regardless of whether load and transducer are floating or grounded, balanced or unbalanced.

Before you send us that letter...the input scope photo is a double exposure. The square wave input signal was taken with the scope connected across points 1 and 2 (see drawing below) with 5 mv/division sensitivity. To show the noise, the scope was connected between points 2 and 3, and sensitivity was 1 v/division. The scope on the output was set for 1 v/division sensitivity and, of course, no noise is evident.



Specifications other than common-mode rejection are equally impressive. Linearity is 0.01% of full scale (10 volt) output for either polarity, 0.02% of full scale for plus-to-minus or minus-to-plus polarities. Equivalent input drift is less than  $2\mu\text{v}$ ; noise at full amplifier bandwidth is less than  $6\mu\text{v}$ . Input impedance is 30 megohms, output impedance less than 0.25 ohms. Standard bandwidth is less than 3 db down at 80 cps, and the amplifier settles to within 99.9% of final value within 50 milliseconds for an output change of 5 volts. Plug-in input and output filters allow bandwidth options from 3 cps to 120 cps, transient response as good as 25 milliseconds. Gain is 10 to 1000 in 5 steps. A front panel vernier control provides 1 to greater than 3.3 times continuous adjustment of each gain step. Gain stability is  $\pm 0.05\%$ . Output capability is 10 volts at 10 milliamperes. Amplifiers have integral power supplies. Enclosures include six-amplifier and single-amplifier 19-inch rack modules, and portable single amplifier cabinets.

To meet your exact requirements at minimum cost, two models are now available: the 114A at \$775, and the 114C (described) at \$875. Delivery on both models is currently from stock. Write for detailed technical data or a demonstration. Engineering representatives in all major cities.

**KIN TEL**  
A DIVISION OF  
**COHU**  
ELECTRONICS, INC.

5725 Kearny Villa Road, San Diego 11, California  
Phone: BRowing 7-6700.

CIRCLE 5 ON READER-SERVICE CARD

# HIGH VOLTAGE POWER SUPPLIES NEWS

**designed to  
meet your  
specific  
needs...**

**MODEL 409A** 170-1530V  
0-3 ma

**MODEL 402M** 500-1600V  
0-1 ma

**MODEL 412A** 500-2010V  
0-15 ma

**MODEL 405** 600-3100V  
0-15 ma

**MODEL 408A** 500-6010V  
0-20 ma

**MODEL 410A** 1-10,01KV  
0-10 ma

JOHN FLUKE precision High Voltage Power Supplies offer complete coverage up to 10 KV. In addition to high calibration accuracy, tight line-load regulation, fine voltage resolution, and excellent long term stability; many other plus features are provided the design engineer. For example: difficulties resulting from corona, jitter, bounce or overshoot are non-existent in jf supplies. The capability of the John Fluke Co. to keep pace with industry demand is evidenced by the fact that most of these instruments have been introduced within the past year.



Designed to power photomultiplier tubes and ionization chambers... for research and development of traveling wave tubes and backward wave oscillators.

MODEL	VOLTAGE	CURRENT	REGULATION		STABILITY PER HOUR	MAX. RIPPLE RMS	RESOLUTION	PRICE
			LINE	LOAD				
409A	170-1530V	0-3 ma	0.01%	0.4%	0.02% (Per Day)	0.002%	85V steps	\$335.00
402M	500-1600V	0-1 ma	0.03%	0.03%	0.01%	5mv	100mv	\$320.00
412A	500-2010V	0-15 ma	0.01%	0.01%	0.005%	5mv	10mv	\$455.00
405	600-3100V	0-15 ma	0.01%	0.005%	0.005%	5mv	10mv	\$595.00
408A	500-6010V	0-20 ma	0.01%	0.01%	0.005%	5mv	10mv	\$695.00
410A	1000-10,010V	0-10 ma	0.01%	0.01%	0.005%	5mv	10mv	\$1095.00

All prices quoted, F.O.B., Factory, Seattle. Prices and technical data subject to change without notice.

**JOHN FLUKE**



**MANUFACTURING CO., INC.**

P. O. BOX 7161, SEATTLE 33, WASHINGTON

CIRCLE 6 ON READER-SERVICE CARD

command from the ground station switches Courier from the "standby" to the "active" mode. The satellite's VHF transmitter begins to telemeter, the beacons are shut down, and Courier's UHF transmitters are warmed up.

Upon receipt of VHF signals from the satellite, the ground station places the tracking antenna into a "sector scan" mode. In this mode the dish continuously scans an azimuth sector of about 10 deg, thus maintaining some contact with the satellite at all times. About 40 sec thereafter, Courier's UHF transmitters come on the air; receipt of UHF signals automatically stops sector scanning and places the antenna in an "automatic tracking" mode.

### Spinning Lens for Automatic Tracking

A spinning dielectric lens conically scans the secondary pattern of the antenna. Rotation at 1800 rpm gives a 30 cps amplitude modulated signal which is compared by a phase demodulator against 30 cps signals from a reference generator. Demodulator output provides error signals to the servo system which keep the antenna pointed at the satellite.

The 28-foot dish has a slew speed of 15 deg/sec and an acceleration rate of 12 deg/sec. Pointing accuracy is 0.5 deg. at maximum slew speed and increases to 0.25 deg at slower rates. Beam widths are 18 deg at VHF and 1.3 deg at UHF.

The antenna handles simultaneous two-way transmission between satellite and ground. A four-channel rotary joint in the antenna feed provides continuous signal paths for each of two orthogonally polarized signals for azimuth and elevation movement of the antenna. Transmission from the ground is circularly polarized.

### Tape Recorders Read Out In Reverse

With the satellite acquired and automatically tracked on UHF, message handling begins. The satellite tape recorders, loaded with messages from another station are played back in reverse. Simultaneous two-way digital transmission is thus limited to the capacity of two recorders as two units are recording while two units are read out. There is, however, enough time during a pass to permit separate readout and recording of all four tapes if necessary.

The four UHF satellite receivers feed a base-band diversity combiner which mixes the inputs and essentially accepts the signal from the one receiver having the most favorable signal-to-noise ratio. Individual receiver failure does not interrupt communication.

The four UHF satellite transmitters operate in pairs, with one pair providing redundancy in the

event of failure. Each of the two operating receivers are tuned to slightly different frequencies and are connected to separate antennas. Each transmitter has an output of 8 watts, provided by a planar triode of the 2C39 family. The four UHF transmitting tubes are the only tubes in Courier.

Satellite functions, including real time or delayed message handling, are controlled by 21 different ground commands. The initial command, which prepares the satellite for message handling, is transmitted on VHF as Courier crosses the horizon. The two VHF receivers in Courier are alternately turned on for 1 sec and off for 9 sec. As soon as either unit receives a properly modulated signal, it is locked into the circuit and the switching is discontinued.

#### Telemetry Acknowledges Commands

Commands received on either VHF or UHF are acknowledged by keying of the lowest sub-carrier oscillator in the VHF telemetry system. Six additional IRIG subcarriers, each commutated five times, provide 30 telemetry channels. Battery voltage, tape positions, transmitter power, received signal strength, and temperatures are among the information telemetered. However, four channels are redundant, giving a total of 26 telemetered parameters. Two telemetry transmitters, (one a spare) are installed. Each has an output of 1.5 w. Peak frequency deviation is  $\pm 6$  kc.

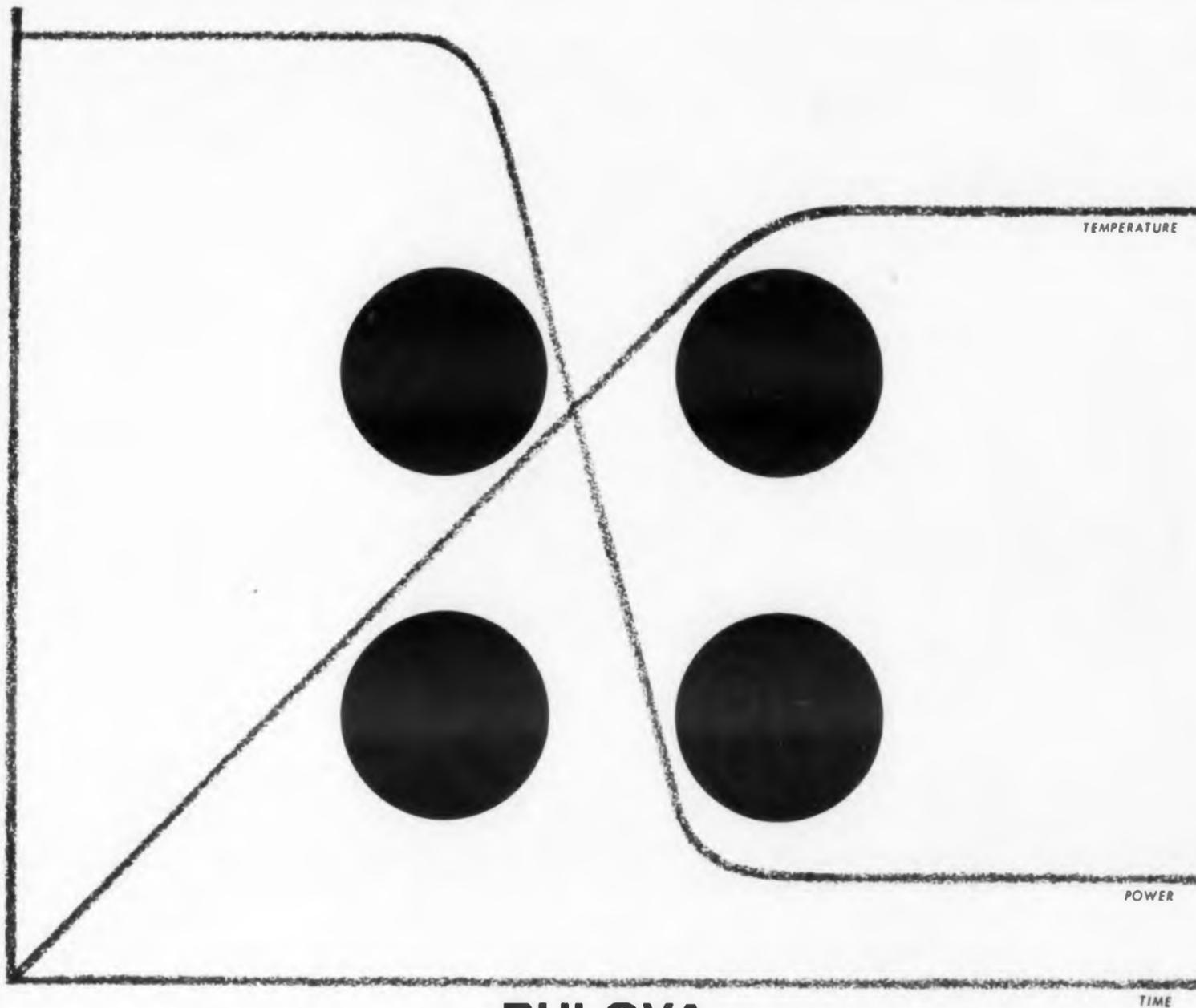
After message handling is completed, a final command shuts down the UHF and VHF transmitters and turns on the beacons. However, if tracking is interrupted at any time during the message, the satellite automatically returns to standby and turns on the beacon transmitters.

#### Power Supply Details

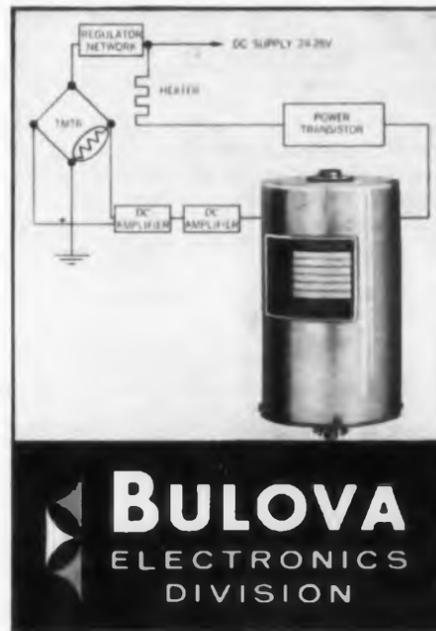
Total power consumption of Courier is 225 watts in the active mode and 10 watts in standby. Power is supplied by 19,152 silicon solar cells which charge two 12 amp-hr 28-v nickel cadmium batteries. Average output of the cells is about 70 w which permits a duty cycle exceeding 10 per cent.

The cells are wired in series strings of 84 cells each. Two independent arrays of cells can be arranged to charge either or both batteries. In the event one battery is disabled, all cells are switched to the surviving battery and satellite operation continues without interruption.

Four VHF antennas consisting of flexible steel probes are mounted around the equator of the satellite. Each antenna is fed by a separate transmitter. UHF antennas are notched fin assemblies mounted at opposite points of the satellite along its equator. ■ ■



## BULOVA PROPORTIONAL SILICON TRANSISTOR CONTROLLED OVEN



Where ever temperature variations affect the "percentage" of heat required to maintain efficient operation, the new Bulova proportional control oven eliminates temperature cycling, RF interference noise, surges of oven power, and the drift of temperature differential due to aging. The oven temperature can be set to an accuracy of  $\pm .5^{\circ}\text{C}$  and has a range of  $+40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

The stepless control of the Bulova proportional system is accomplished by two highly stable Bulova developments: (1) a temperature sensitive bridge, and (2) a transistorized amplifier supplying

power proportional to the output of the bridge. Thus any unbalance created by resistance changes is amplified and conveyed to the heater . . . which receives only enough power to take care of heat loss with a  $.01^{\circ}\text{C}$  stability or better. DC proportional control is employed to eliminate any interference of oven control circuitry with the internal circuitry.

If you'd like more information on how the Bulova proportional control oven can extend the life of your units to equal that of the solid state components used, write

Department 1771, Bulova Electronics, Woodside 77, New York.

CIRCLE 7 ON READER-SERVICE CARD

# NEW

## High Repetition Rate PULSE GENERATOR at same LOW COST



### Rutherford MODEL B-7B

#### HIGH PERFORMANCE and WIDE VERSATILITY

50 volts into 50 ohms at 30% duty factor... rep. rate to 2 mc... widths .05  $\mu$ s to 10,000  $\mu$ s... delays to 10,000  $\mu$ s...

New features for:

#### LONGER LIFE • EASE OF MAINTENANCE and OPERATION

- Printed Circuit Boards with all components clearly identified by schematic symbol numbers
- A new stabilized noise-free repetition rate section
- Variable rise time control
- Rack mountable—new single unit construction
- Dual-purpose fan for more efficient cooling

#### OTHER SPECIFICATIONS:

Rise Time: 15  $\mu$ s • Fall Time: 15  $\mu$ s • Attenuation: 50 db in 10 db steps, 20 db continuous control • External Trigger:  $\pm$  10 volts min. • Syn. Out (Synchronizing pulse): .05  $\mu$ s wide, 25 volts amplitude, lags trigger in by .2  $\mu$ s • Size: 19" wide x 8 $\frac{3}{4}$ " high x 12" deep • Weight: 35 lbs. • Power: 105-125 volts, 50-60 cycles, 350 watts, 5 amps. • Low Budget Price: \$720.00 F.O.B. Culver City, California.

Investigate Rutherford's complete line of Pulse accessories designed to fit all requirements. Write for our catalog sheet.

**ENGINEERS:** If your field is Pulse Circuitry Design, a bright future awaits you at Rutherford Electronics Company. Send resume to Glen Stout, Personnel Director.

# Rutherford

## ELECTRONICS CO.

Dept. ED 831 8944 Lindblade Street • Culver City, California

pulse generators / pulse systems / accurate time delay generators

CIRCLE 8 ON READER-SERVICE CARD

## NEWS

# WESCON Sets A New Tone

A ban against recruiting in the exhibit hall and a conspicuous absence of gimmicks were outstanding characteristics of the largest show yet staged by WESCON.

The 987 exhibit booths in the new Los Angeles Memorial Sports Arena and heavy schedule of provocative technical sessions offered a busy four days for what was estimated would be an engineer attendance in excess of 35,000.

As if to further emphasize the break with the past as evidenced by the ban on recruiting and special efforts to enliven technical sessions, WESCON management dispensed with opening ceremonies.

Although there was no recruiting on the convention floor, it was too early when this story was written to determine the extent to which it would be carried on outside the arena. Some hotel suites had obviously been reserved for recruiting purposes. Still WESCON officials felt that their "gentleman's agreement" ruling out recruiting would establish an important precedent for industry conventions.

Dr. Eberhardt Rehtin, Telecommunication Division Chief at Jet Propulsion Laboratories, was awarded the 1960 Achievement Award of the 7th Region of the IRE. He is currently directing construction of the U.S. deep space tracking net.

A number of technical products



**Microminiature fast-switching transistor** announced by TI was one of the advances shown at WESCON.

not disclosed in pre-convention announcements were unveiled on opening day. Hughes Aircraft created considerable interest by showing a "parametric transistor" in the firm's hotel suite. The developmental model, a pooling of the talents of Lenkurt Electric Co.'s Dr. Vladimir Vodicka for the circuit design and Hughes Semiconductor's Ranier Zuleeg for the transistor, was operating as a mixer-oscillator at four kmc.

Key to the success of the transistor mixer-oscillator was a circuit designed at Lenkurt's advanced development group by Dr. Vodicka last February. Basic circuit is an oscillator with the entire input impedance of the transistor being varied for efficient amplification of the input signal. The input of the transistor is current-tuned.

"This development should help to reduce the size of microwave receivers, lead to pocket radios or handy talkies and has many applications in telemetering, and frequency diversity—with possibilities of simultaneous operation on fundamental and harmonic frequencies," Mr. Zuleeg told ELEC-TRONIC DESIGN.

Four semiconductor manufacturers, by announcing the availability of microtransistors in rapid succession, have started the bandwagon rolling. Pacific Semiconductors, Inc. showed their micro- and pico-transistor versions as at the IRE show in New York last March, where they announced prototypes. Texas Instruments had silicon mesa transistors bearing the company name "Micromesa." From Rheem Semiconductor came the announcement of "Microbloc," another silicon mesa type. Sylvania showed "pencil cake transistors," germanium alloy switching units. According to Sylvania, they chose the germanium alloy type to build because it was the most difficult. Sylvania plans to market the 0.070 in. high by 0.2 in. diameter devices as a standard case size.

Multi-layer circuit boards, a development of Litton Industries, were a major WESCON attraction. (For details, see story on page 20.)

Among other new products on view were Vitramon's minute capacitors which the company claimed were the first capacitors of such small size to be encapsulated in pre-molded cases. Vitramon said the miniature diallyl phthalate plastic cases had passed tests for reliable and superior performance under adverse conditions.

American Optical Co. made its debut in the electronics instrument market with a new recording system. Called the Trace-Master, the system has been under development at the company's Instrument Div. in Buffalo, N.Y., for two years. The system operates at an amplitude of 4 cm. The "band-amplitude" product—bandwidth times amplitude—is nearly six times as high as previously attainable. Each of the eight independent modules can be set up, by means of plug-in modules, for accommodation of a wide variety of input signals.

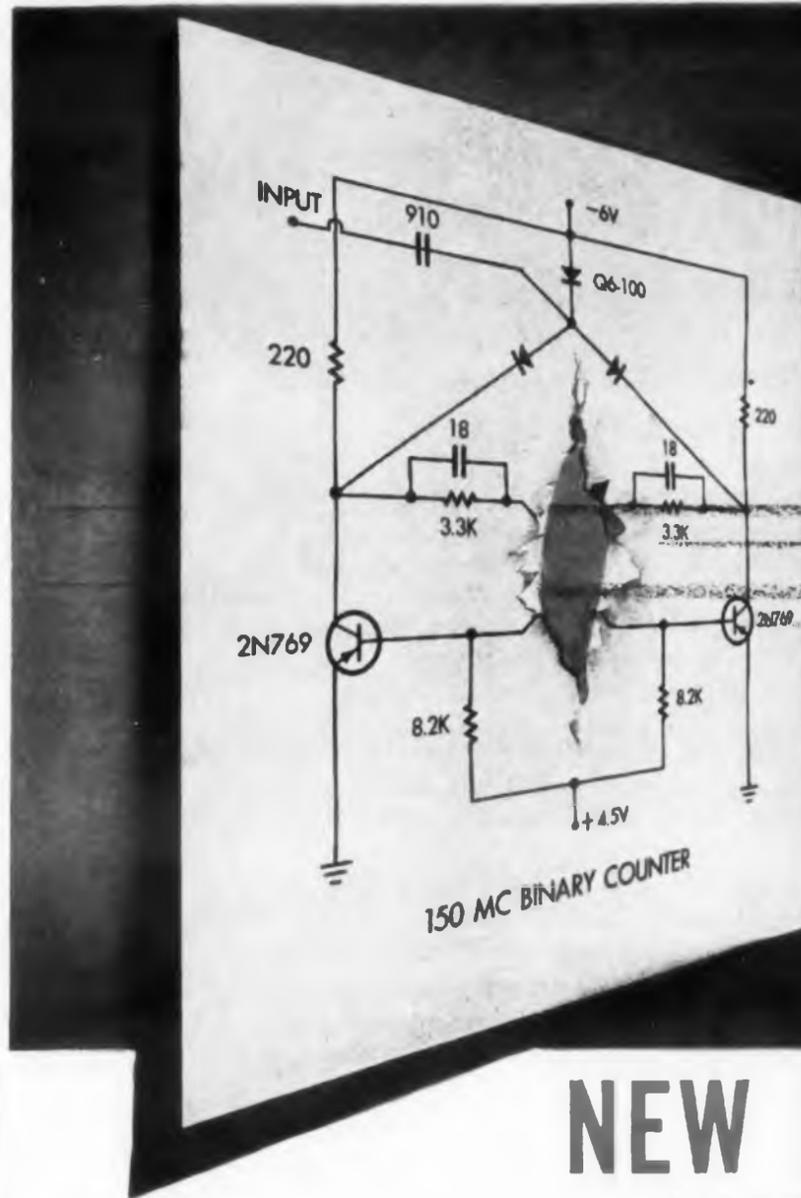
A new line of portable oscilloscopes, completely transistorized, that operate on internal, rechargeable batteries, ac power, or low-voltage dc, were put on view by Electro Instruments, Inc., San Diego. The instruments weigh as little as 2 lb and measure 2-3/4 x 3-1/4 x 5-1/2 in.

Spectrol had hardware samples of its Model 80 subminiature trimming potentiometer line on display. Corning Glass Works' electronic components department at Bradford, Pa., came up with 5 per cent tolerance, 1- and half-watt film resistors, priced at about 6 cents each in lots of 5,000.

The Data Instruments Division of Telecomputing Corp., N. Hollywood, Calif., showed the Tranqualizer, an instrument designed for on-line compensation of transducing systems with previously determined parameters.

This account of WESCON highlights, as noted on the opening day of the show, will be followed by a detailed report in the Sept. 14 issue.

CIRCLE 9 ON READER-SERVICE CARD ➤



### THE TRANSISTOR FOR 100 mc COMPUTER CIRCUITS

Philco's new 2N769 is the world's fastest commercially available switching transistor! This new addition to the Philco line of MADTs features an 800 mc gain bandwidth product, low hole storage factor, and low emitter and collector diode capacities. It is intended for use in saturated switching circuits at switching rates up to 300 mc. For complete information, write Dept. ED83160

Immediately available  
from your Philco  
Industrial Semiconductor  
Distributor.

## NEW PHILCO 2N769 (IN TO-18 CASE)

#### ABSOLUTE MAXIMUM RATINGS

Storage Temperature	100°C
Collector Voltage, $V_{CB0}$	-12 volts
Collector Voltage, $V_{CE0}$	-12 volts
Collector Voltage, $V_{CE0}$	-7 volts
Emitter Voltage, $V_{EB0}$	-2 volts
Collector Current, $I_C$	-100 ma
Device Dissipation @ 25°C	35 mw

#### ELECTRICAL CHARACTERISTICS (T=25°C)

Characteristics	Condition	Min.	Typ.	Max.
Collector Cutoff Current, $I_{CBO}$	$V_{CB} = -5v$			-3 $\mu a$
Current Amplification Factor, $h_{FE}$	$V_{CE} = -0.5v, I_C = -20 ma$	25		
Collector Saturation Voltage, $V_{CE(SAT)}$	$I_C = -10 ma, I_B = -1 ma$			-0.24 volt
Base Input Voltage, $V_{BE}$	$I_C = -10 ma, I_B = -1 ma$	-0.30		-0.45 volt
Output Capacitance, $C_{ob}$	$V_{CB} = -5v, I_E = 0$		1.5	3 $\mu\mu f$
Gain Band-Width Product, $f_T$	$V_{CE} = -5v, I_E = 7 ma$	600	800	mc
Hole Storage Factor, $K's$	$I_B = -2 ma$		15	30 $m\mu sec$
Emitter Transition Capacitance, $C_{TE}$	$V_{EB} = -1v, I_C = 0, f = 4 mc$		5	8 $\mu\mu f$

# PHILCO

Famous for Quality the World Over

LANSDALE DIVISION • LANSDALE, PENNSYLVANIA



## ONLY WESTON VAMISTORS® OFFER SMALLER SIZES, HIGHER RATINGS, EXTENDED RANGES

*1/4-watt and 1/2-watt size resistors give  
double ratings in ambients of 125° C*

Miniaturized Weston VAMISTORS provide the desirable features of wire-wound and film-type resistors, yet offer higher wattages and superior thermal characteristics. For example, standard 1/4-watt size "Missile Line" VAMISTORS are rated at half watt, and 1/2-watt sizes give a full watt at 125° C. Gas-filled "Missile Line" units therefore offer *twice* the wattage ratings of standard VAMISTORS!

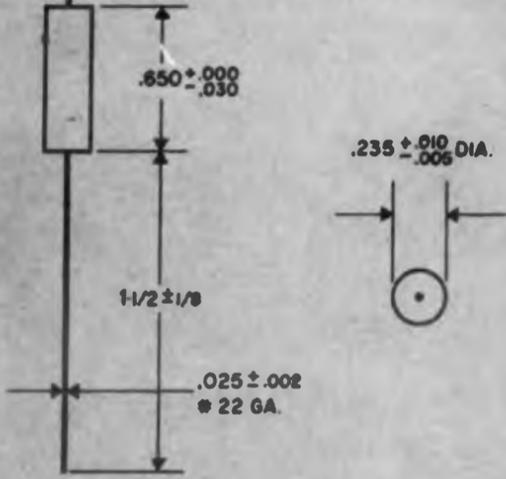
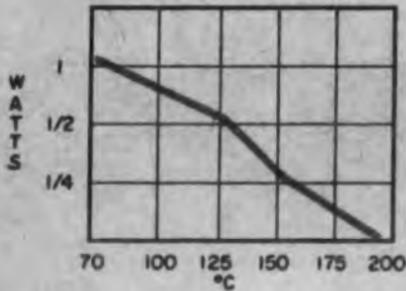
**Design advantages** include high stability, low temperature coefficient, and tolerances of  $\pm 1\%$ ,  $\pm .5\%$ ,  $\pm .25\%$ , and  $.1\%$ . These new precision film resistors are virtually noise free, have extremely low inductances, and are available with resistances up to 5 megohms.

**High reliability** is assured, since Weston VAMISTORS are subjected to more rigid quality standards than *any other type* of resistor. They meet or surpass all applicable MIL specifications.

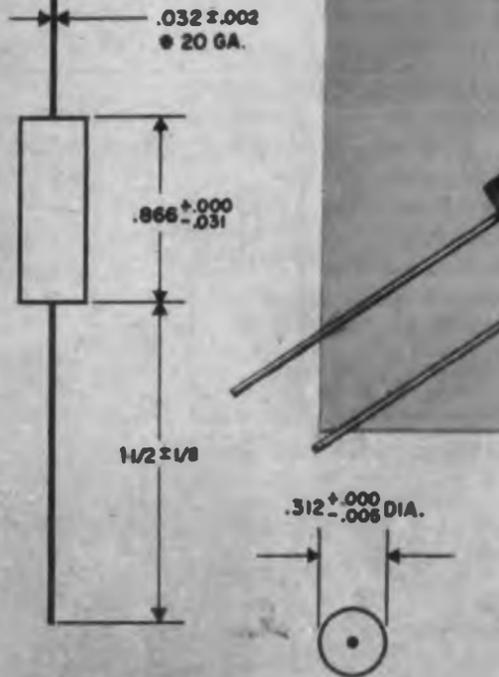
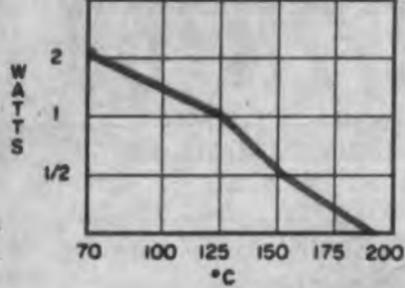
For special applications, pairs or sets of VAMISTORS can be matched to tolerances of  $\pm .025\%$  or temperature coefficients of  $\pm 5$ ppm of each other, or combinations of both tolerance and temperature coefficient.

Call your Weston representative for full information, or write for Catalog 04-101. Daystrom, Incorporated, Weston Instruments Division, Newark 12, New Jersey. *International Sales Division, 100 Empire St., Newark 12, N. J. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ontario.*

DERATING CURVE



DERATING CURVE



Model 9855-4 1/4-watt size VAMISTORS can be used with a maximum of 350 volts. Model 9854 1/2-watt size VAMISTORS have a maximum rating of 500 volts. Resistance ranges: 100 ohms to 5 megohms. Temperature coefficient: 50 and 25 parts per million/°C. Inductance: approximately .007 microhenry.

**DAYSTROM, INCORPORATED**  
WESTON INSTRUMENTS DIVISION

*Reliability by Design*

CIRCLE 10 ON READER-SERVICE CARD

## NEWS

### New IBM Optical Reader Is

*System Uses Rotating Rasters To Recognize Written Characters*

**D**ESCRPTION of a rotating-raster character-recognition system under development for two years by International Business Machines Corp.'s San Jose Products Development Laboratory was one of the high points of the recent Pacific General Meeting of the AIEE in San Diego.

A round-table discussion of radiation effects, a survey of the radiation resistance of many electronic components by two Bendix researchers, and a group of three radiation-effects symposia added emphasis to this topic during the four-day conference. Electronic reactor controls, solid-state devices, radio communication systems, and computing equipment also played major roles during the meeting. Power-source technology, with emphasis on solar converters, was also a major topic.

The IBM rotating-raster system has been used to identify both machine and hand printed numbers according to R. W. Weeks of the Products Development Laboratory.

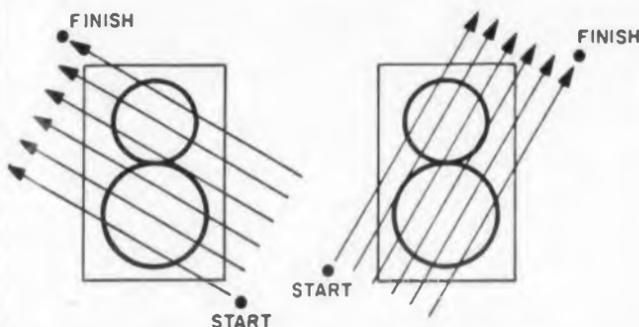
Identification was performed by means of statistical probabilities based on the number of times selected straight lines in an inclined TV-like raster intersected an unknown character. The raster was rotated to different angles so that various distributions of crossings were obtained for making a decision. IBM researchers used six lines in the raster, evenly spaced across a character, with six different inclinations in order to obtain 36 matrices—one for each scan line.

Each matrix consisted of 40 elements, one element for each digit, 0 through 9 for each type of possible crossing—that is zero, one, two or three. For the 36 scan lines this gave a total of 1440 individual statistics for the recognition process. These statistics were gathered by scanning a great number of machine and hand-written characters, and the numbers for each element ranged from zero to the total number of samples used. These data were normalized to a 1,000-sample norm and then converted to logarithms for ease in computation after a one was added to each value to eliminate zeros.

To identify an unknown character a set of 10 accumulators, one for each of the digits 0 to 9, was used to reach a decision. For each of the 36 lines used a single value from the appropriate column of the matrix for that line was stored in each of the accumulators.

For example, referring to the table, if a par-

## Character Described at AIEE



Six scan lines are shown crossing the figure 8 at two different inclinations. Number of crossings for each scan line at six inclinations were used in making identifications. Box around the number is invisible to the scanner.

A particular one of the 36 lines crossed an unknown character two times, then column 2 of the matrix would be selected. This means that 0.98 would be stored in the 0 accumulator, 0.1 would be stored in the 1 accumulator, and so on through the column with 0.5 stored in the 9 accumulator. These logarithmic probability values are summed over the 36 lines, and then the accumulator with the highest total value identifies the character being sensed.

Selection of the six lines in the raster to use at each of the six angles was performed by a logical technique using an IBM 650 computer. The first line to cross a character and the last line to cross the character were determined, and the lines in between these were divided into seven equal groups. The last line in each of the first six groups was used.

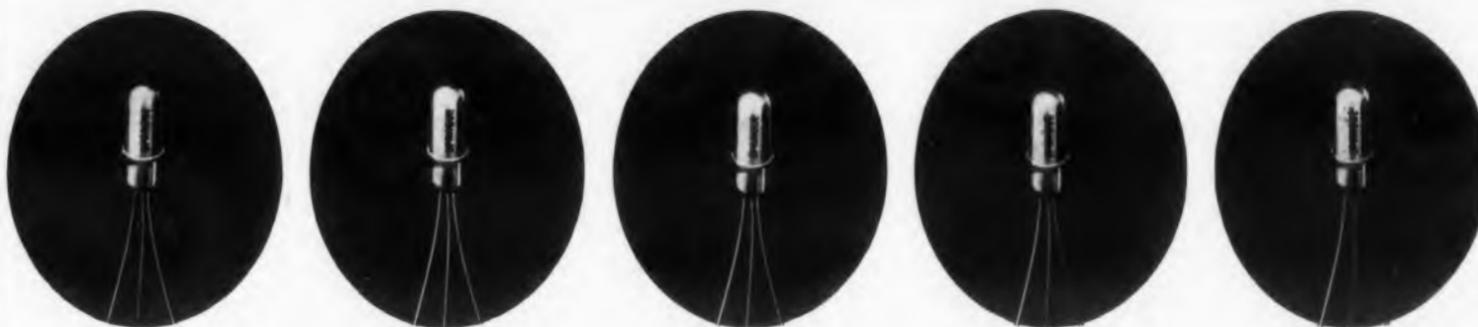
In order to prevent the machine from making false decisions a reject level was set, so that the accumulator with the highest sum had to have a certain amount higher total than the next highest accumulator for a decision to be made.

With machine-printed characters no rejects were encountered, and 100 per cent recognition was obtained.

Hand-written characters were obtained by having a group of college students write numerals inside of small rectangular boxes. The students were instructed to approximately fill the boxes, and an example of the type of character to print was given to them. No rejects were encountered, 92 per cent of characters were identified correctly, and 8 per cent errors resulted. Various techniques for overcoming the high error rate with the hand-written characters were attempted, but little improvement could be obtained.

A machine was designed to accomplish the character recognition process using about 250 transistors, 132 magnetic cores, and about 1500 one per cent tolerance resistors. ■ ■

## MADT<sup>®</sup> transistors from Sprague\*



for the highest r-f operating frequency of all mass-produced transistors

for the fastest switching time of all mass-produced transistors

for storage temperatures up to 100°C

## DESIGN AROUND SPRAGUE MICRO-ALLOY DIFFUSED-BASE TRANSISTORS

*available now at sensible prices you can afford!*

Sprague Germanium Micro-Alloy Diffused-Base Transistors, well-known for their rugged vhf performance, are now priced below other transistors with comparable electrical characteristics. In many areas, this permits designers to improve circuit techniques without necessarily increasing costs. Expanded production facilities enable us to ship quantity orders on short notice. Add to this their ultra-fast switching time, and you have three good reasons why Sprague MADT<sup>®</sup> Transistors have achieved their high level of acceptance.

With Sprague Transistors, circuits in vhf amplifiers and oscillators can now operate with collector currents as high as 50 ma . . . with power dissipation up to 50 mw . . . with collector to base voltages to 15 v. They have been application tested through the entire military electronics vhf spectrum.

The application table may well suggest the use of one or more Micro-Alloy Diffused-Base Transistor types in your latest circuit designs.

\*Sprague micro-alloy, micro-alloy diffused-base, and surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type numbers are manufactured to the same specifications and are fully interchangeable.

### MICRO-ALLOY DIFFUSED-BASE TRANSISTOR APPLICATIONS

Type	Application
2N499	Amplifier, to 100 mcs
2N501	Ultra High Speed Switch (Storage Temperature, 85 C)
2N501A	Ultra High Speed Switch (Storage Temperature, 100 C)
2N504	High Gain IF Amplifier
2N588	Oscillator, Amplifier, to 50 mcs

For complete engineering data on the types in which you are interested, write Technical Literature Section, Sprague Electric Co., 347 Marshall St., North Adams, Massachusetts.

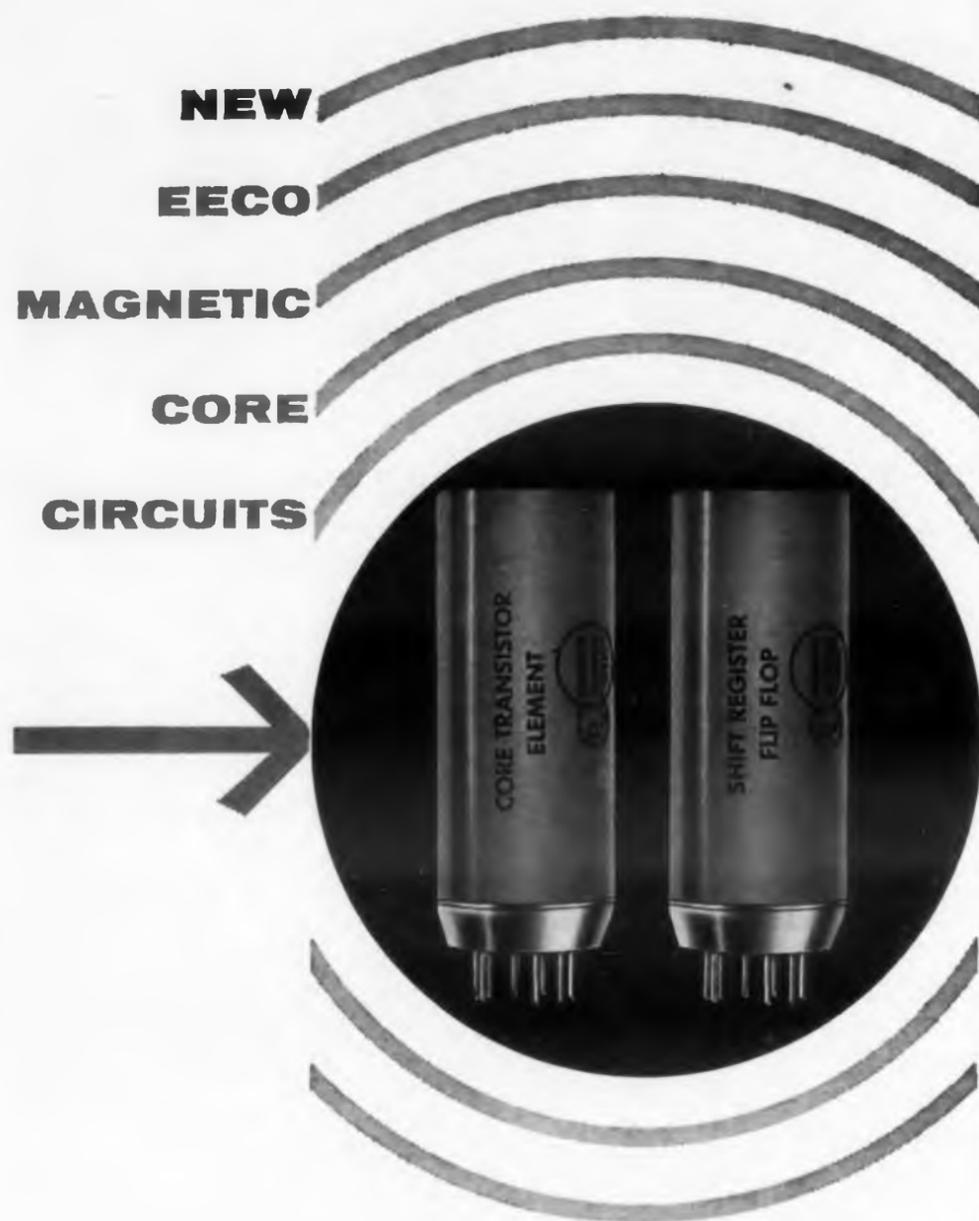
You can get off-the-shelf delivery at factory prices on pilot quantities up to 999 pieces from your local Sprague Industrial Distributor.

**SPRAGUE<sup>®</sup>**  
THE MARK OF RELIABILITY

#### SPRAGUE COMPONENTS:

CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS  
HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

CIRCLE 11 ON READER-SERVICE CARD



## now you can choose

In designing digital systems and equipment employing EECO T-Series Transistor Circuits, you now have an extra choice—EECO Magnetic Core Circuits that are both physically and electrically compatible with the EECO T-Series. This new family of compatible magnetic core circuits for the frequency range 0 to 250 kcs includes a large selection of shift registers (in single or dual units), pulse gates, and core drivers.

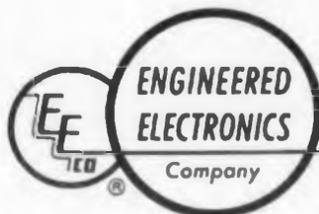
### ADVANTAGES

The ability of magnetic cores to maintain one of two discrete states makes them ideal for shift registers, or counters. A pulse sent through one set of windings will set the core to the "High-Level" state. A pulse sent through another set of windings will reset the core to the "Low-Level" state. Thus you get flip-flop action with a single core. In transistor circuits, on the other hand, it is normally necessary to use two transistors for each flip-flop.

Core circuits are used to good advantage in our line of shift registers. They offer versatility and space saving at a price lower than that of an equivalent transistor circuit.

### COMPATIBILITY WITH T-SERIES

EECO Magnetic Core Circuits are electrically and physically compatible with EECO T-Series Transistor Circuits. They are packaged in T-Series containers, measuring  $\frac{3}{8}$ " diameter x  $2\frac{1}{4}$ " seated height, and they plug into the same miniature tube sockets as the T-Series.



Write, wire, or 'phone today for detailed information on EECO Magnetic Core Circuits.

**ENGINEERED ELECTRONICS COMPANY**

1441 EAST CHESTNUT AVENUE • SANTA ANA, CALIFORNIA  
KImberly 7-5651

## NEWS

# Engineers Putting Echo To Work

*Many Organizations Use Satellite For Complex Communications Tests*

**W**ITH off-again, on-again Project Echo at last in orbit, communications engineers are working overtime to obtain maximum use from the 100-foot balloon during the few weeks that it is expected to remain aloft.

They expressed pleasure at the satellite's performance during its first ten days in orbit. It was said that the slight shifting of orbit due to pressure of the sun's rays would change tracking methods somewhat but would not alter the prognosis on Echo's life expectancy.

At last count, three separate teams were bouncing signals off Echo's aluminumized mylar hide. Bell Telephone Laboratories and Jet Propulsion Laboratories, the official participants in the National Aeronautics and Space Administration project, are exchanging small talk via Echo between Holmdel, N.J. and Goldstone, Calif. Meanwhile, Philco's research division and the Rome Air Development Center have established a communications link from Rome, N.Y., to Trinidad in the Caribbean. Also hitching a free ride on Echo with NASA blessing is

Collins Radio and its Alpha Corp. subsidiary in a hook-up between Cedar Rapids, Iowa, and Dallas.

### Tiros Used in Tracking Tests

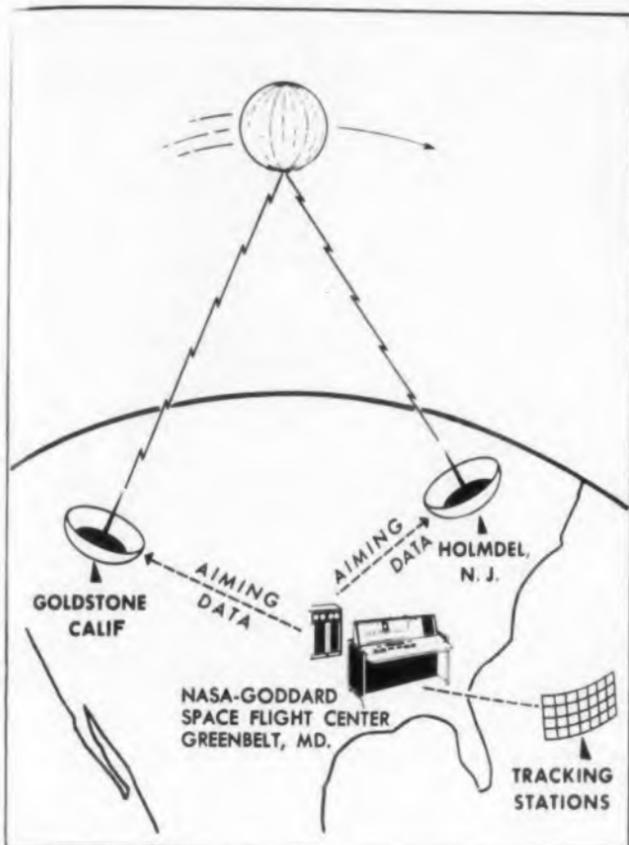
Bell and JPL scientists spent a busy fortnight before Echo was launched. First, tracking accuracy of the parabolic horn antenna and maser receiver sensitivity at Holmdel were tested by transmitting a 2,000-mc cw signal at 10 kw from the Naval Research Laboratory in Washington to Holmdel via the Tiros I weather satellite. Tracking information was supplied by the 709 computer at NASA's Goddard Space Flight Center in Greenbelt, Md. which is now doing the same job in pointing the JPL and Bell Labs antennas at Echo.

About a week later, as a final check, the two organizations staged a two-way live telephone conversation via the moon using Echo equipment and frequencies all along the line. Only the satellite was different.

The JPL-Bell Labs experiments now being conducted with Echo include:



**Control room at Holmdel** during moon bounce experiments preceding Echo launch. Bill Jakes (left), Echo project engineer, and C. C. Cutler, Asst. Director of electronics and radio research at Bell Labs, talk to JPL via moon. Equipment and frequencies during this test are identical to Echo experiment.



Aiming data for Echo transmissions is computed by IBM 709 at Goddard Space Flight Center and relayed to terminals by land line. Tracking is further aided by beacon in satellite, and optical and radar tracking at Goldstone and Holmdel.

- Voice communications, including tests of the  $\pm 30$  kc deviation fm system being used.
- Measurement of reflective properties of the sphere including polarization of reflected signals, faraday rotation and doppler shift.
- Check of propagation theory against measured results.
- Transmission of teletype and other modulation methods.

#### Horn Antenna Cuts Thermal Noise

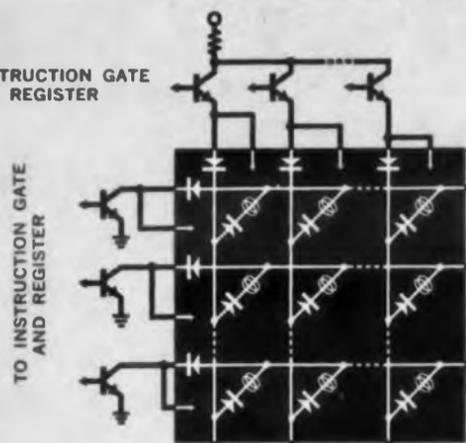
Transmissions from Holmdel to Goldstone are at 960 mc. Simultaneous transmission in the opposite direction is at 2390 mc, with power in each instance 10 kw. Signals are received at Holmdel by a 50-ft long steerable parabolic horn antenna having a 400-ft sq aperture. This design minimizes back and side lobes which pick up thermal noise from the earth. The resultant temperature of the antenna is about 2 K.

The horn feeds into a pair of right-and-left polarized, three-level traveling-wave maser amplifiers. The stronger of the two polarizations is selected for boosting and conversion to 70 mc by parametric amplifier converters.

Holmdel transmissions are via a 60 foot parabolic dish. At Goldstone, twin, 85-ft diam paraboloids are used both for transmission and reception. The JPL receiver employs a varactor diode parametric amplifier instead of a maser amplifier because of the lower frequency of the

# NEW

TO INSTRUCTION GATE AND REGISTER



Typical n-junction matrix for n-stage matrix configuration. Fairchild 2N1613 transistors and FD200 diodes, used throughout, guarantee acceptable leakage, switching speed and conductance values up to 125°C.

# ANSWER

## TO COMPUTER MATRIX PROBLEMS

LOW LEAKAGE TRANSISTORS AND FAST RECOVERY, LOW CAPACITANCE DIODES FROM FAIRCHILD

**Approach to the ideal matrix.** 2N1613 silicon transistors and FD200 silicon diodes from Fairchild are unique in making feasible the ideal matrix. They give you low leakage and low capacitance with high conductance and high speed, even at high ambient temperatures. These characteristics are combined only in Fairchild Planar devices. With them you can now largely ignore stray leakage or capacitance build-up across the matrix. Temperature effects and long-term performance decay are no longer critical. You can eliminate complex circuitry previously necessary in designing around these losses.

**Fairchild's Planar structure** for transistors and diodes features the industry's most advanced diffusion and surface passivation techniques. Current leakage is reduced to 10 m $\mu$ A maximum (2N1613) and 0.1 $\mu$ A maximum (FD200) at 25°C. Maximum values at 150°C are 10 $\mu$ A and 100 $\mu$ A.

Surface passivation also prevents significant degeneration of parameters during circuit life which could introduce error or failure in the matrix. This technique also lends itself to precisely controlled manufacture, assuring excellent product uniformity.

#### 2N1613 ELECTRICAL CHARACTERISTICS (25°C except as noted)

Symbol	Characteristic	Min.	Typical	Max.	Test Conditions
$h_{FE}$	D.C. Current Gain	40		120	$I_C = 150$ mA $V_{CE} = 10$ V
$V_{BE(sat)}$	Base Saturation Voltage			1.3V	$I_C = 150$ mA $I_B = 15$ mA
$V_{CE(sat)}$	Collector Saturation Voltage			1.5V	$I_C = 150$ mA $I_B = 15$ mA
$C_{ob}$	Collector Capacitance	18		25 $\mu$ f	$I_E = 0$ $V_{CB} = 10$ V
$I_{CBO}$	Collector Cutoff Current	0.8m $\mu$ A		10m $\mu$ A	$V_{CB} = 60$ $T = 25^\circ$ C
				1.0 $\mu$ A	$V_{CB} = 60$ $T = 150^\circ$ C

#### FD200 ELECTRICAL SPECIFICATIONS (25°C except as noted)

Symbol	Characteristic	Min.	Typical	Max.	Test Conditions
$V_F$	Forward Voltage			1.0V	$I_F = 100$ mA
$I_R$	Reverse Current			0.1 $\mu$ A	$V_R = -150$ V
$I_{R(150^\circ C)}$	Reverse Current (150°C)			100 $\mu$ A	$V_R = -150$ V
$B_V$	Breakdown Voltage	200 V			$I_R = 100$ $\mu$ A
$t_{rr}$	Reverse Recovery Time			50.0 $\mu$ sec	$I_F = 30$ mA $R_L = 150\Omega$
$C_0$	Capacitance			5.0 $\mu$ f	$I_F = 30$ mA $V_R = 0$ V
RE	Rectification Efficiency	35%			$f = 1$ mc
	Forward Voltage Temperature Coefficient		-1.8 mV/oC		100 mc

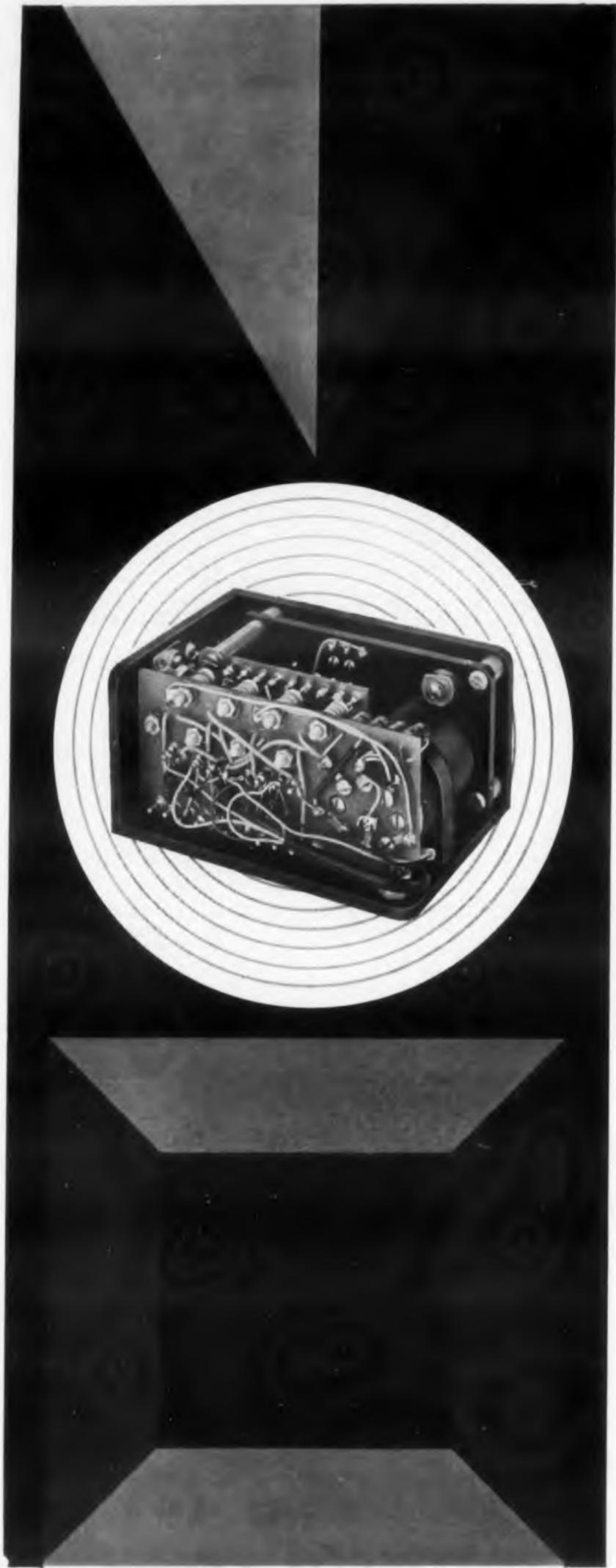


**FAIRCHILD**  
SEMICONDUCTOR CORPORATION

A Wholly Owned Subsidiary of  
Fairchild Camera and Instrument Corporation

545 WHISMAN ROAD, MOUNTAIN VIEW, CALIFORNIA • YORKSHIRE 8-8161 • TWX: MN VW CAL 253

CIRCLE 12 ON READER-SERVICE CARD



## ADVANCING THE ART OF LOGICAL DESIGN

The basic simplicity of subsystems developed by American Electronics is a notable result of Logical Design achievements at the Instrument Division. Maximum reliability and efficiency—at minimum cost—are achieved through advanced circuitry and skilled packaging of components. Another result of this approach has been the substantial reduction in system weight and size while maintaining rigid performance and accuracy standards.

Combining years of experience in precision component manufacturing with creative subsystem engineering, American Electronics offers a record of proven capability, serving many of the nation's leaders in space and flight control.

Shown left is an AEI Digital Servo System used by a leading missile manufacturer to tune a radar klystron to a precise frequency. This compact system embodies an error-sensing device, an amplifier-logic circuit and a pulse motor with special design features offering exceptionally long life and high reliability.

American Electronics subsystem engineers have applied Logical Design principles to solve many space age problems. Analysis of your problems is invited. Please write for detailed information.



**AMERICAN ELECTRONICS, INC.**

INSTRUMENT DIVISION

9503 WEST JEFFERSON BLVD., CULVER CITY, CALIF.  
UPTON 0-5581

CIRCLE 13 ON READER-SERVICE CARD

## NEWS



**Parabolic horn antenna** at Holmdel tracks Echo with minimum thermal noise. "There seems to be little room for improvement insofar as noise is concerned," said one Bell Labs engineer of the big horn. Maser amplifier and other receiving gear are housed in cab at the small end of the horn.

east-to-west transmission. Over-all system noise of the JPL antenna-receiver combination is about 300 K in contrast with approximately 6 K of noise for the horn-maser combination at Bell Laboratories.

### Miniature Beacons Aid Tracking

Tracking of the balloon has been greatly facilitated by the mounting of two miniature radio beacons onto the satellite. Last April, at the time of the first attempt to orbit Echo, considerable difficulty in tracking the balloon was expected. "About 80 per cent of our effort in terms of manpower and equipment involves tracking," a JPL scientist said. An engineer at Bell Labs noted that "A beacon on the satellite would make our job a darn sight easier."

The delay in a second launching attempt permitted the development of suitable beacons for the purpose by RCA. The beacons are mounted on opposite sides of the balloon and linked together by thin, printed circuit cables. Each unit consists of a 0.5-oz transistorized transmitter, a miniature storage battery and an array of 70 solar cells. The components are encased in a molded foam plastic disc weighing 11 oz and 10 in. across. The beacons fit snugly against the side of the balloon and contain spring loaded whip antennas which unfold upon ejection of the balloon from its container.

Each of the solar cell arrays is sufficient to power both units. The transmitters radiate about 5 mw at 107.94 and 107.97 mc. ■ ■

ELECTRONIC DESIGN • August 31, 1960

## Image-Tube Development Provides Important Aids To Astronomers

Photoelectric image intensifiers or image tubes have already increased telescope speeds by as much as 30 times, and have the potential of increasing them by a factor of 100.

Three recent investigations using image tubes, as well as development of the tubes used in two of these three projects, were sponsored by the National Science Foundation.

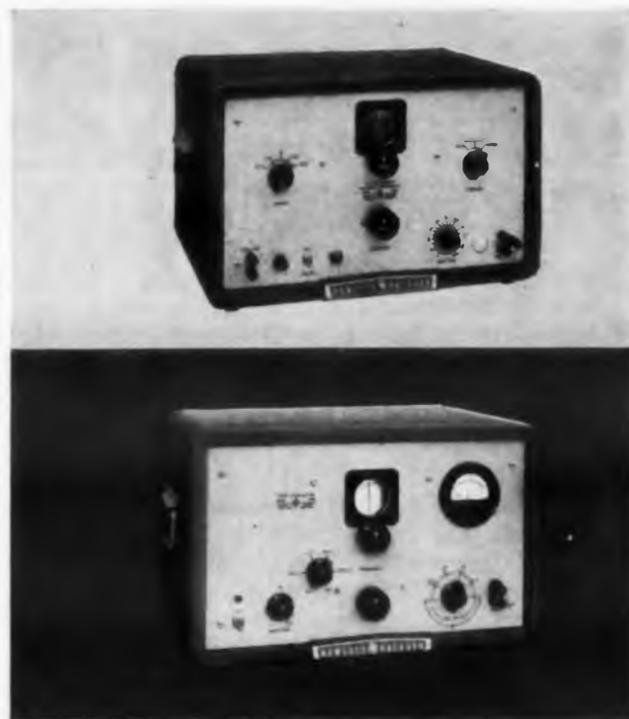
Development of image tubes has been carried on by the Carnegie Institution of Washington through the Carnegie Committee on Image Tubes for Telescopes, initially with funds provided by the Carnegie Corp. and more recently under NSF grants totaling \$385,000.

One investigation used an image tube called an "electronic camera" developed with French Government funds by A. Lallemand and M. Duchesne of the Paris Observatory. Lallemand is a pioneer in image-tube development and was one of the first to point out the potential advantages of such a device. In the Lallemand-Duchesne tube, the electrons are focused directly on a photographic plate, rather than on a phosphor screen.

## Mobile Electronic Laboratory



One of two mobile electronic laboratories developed by the Boulder Laboratories, National Bureau of Standards, for conducting radio propagation studies in isolated areas. Equipment in the trailers is designed to study time variations in refractivity at one or more points along a radio propagation path and the corresponding variations in the phase of arrival of a microwave signal transmitted over the path. Initially developed for a study at Cape Canaveral, the 35-ft trailers contain—in addition to their electronic instrumentation—office, sleeping, and kitchen facilities for two men.

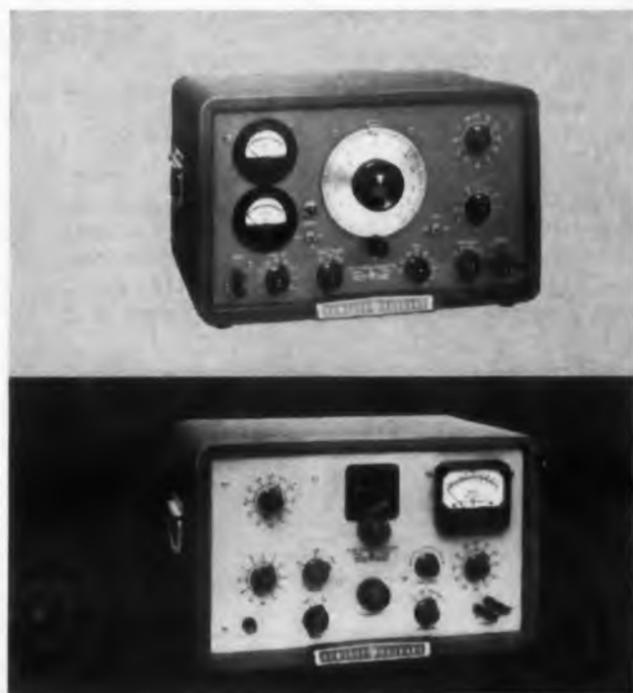


**Easy to operate,  
highly stable,  
wide range**



# PRECISION OSCILLATORS

precision oscillators perform a wide variety of audio, video, and low frequency tests. They offer the outstanding advantages of flexibility and broad usefulness at moderate cost. Employing the pioneered RC resistance capacity circuit, the units combine accuracy and reliability with ease of operation and minimum adjustment.



### 202A FUNCTION GENERATOR—Down to 0.008 cps; transient-free!

**Uses:** Electrical simulation of mechanical phenomena, vibration studies, servo research and testing, medical research, geophysical problems, subsonic and audio testing.

**Advantages:** No switching transients, continuously variable 0.008 to 1,200 cps range, 30 v output peak-to-peak constant, hum less than 0.05%, square, triangular or electronically synthesized sine waves, 1% stability, 0.2 db response, less than 1% distortion (sine waves) on all but x 100 range.

**Price:** \$525.00 (cabinet model), \$510.00 (rack mount).

### 650A TEST OSCILLATOR—Flat within 1 db, 10 cps to 10 MC!

**Uses:** Testing TV amplifiers or wide-band systems, measuring filter transmission characteristics and tuned circuit response, determining receiver alignment, making telephone carrier and bridge measurements.

**Advantages:** No zero set, no adjustments during operation, output voltage range 30  $\mu$ v to 3 v, less than 1% distortion, 20 cps to 100 KC; less than 2%, 100 KC to 1 MC; approx. 5% at 10 MC. Hum less than 0.5%, output voltage attenuator, self-contained voltmeter, 2% to 3% stability.

**Price:** \$490.00 (cabinet model), \$475.00 (rack mount).

### 205AG AUDIO SIGNAL GENERATOR—Six instruments in one; 20 cps to 20 KC!

**Uses:** Measure amplifier gain and network frequency response, measure broadcast transmitter audio and loudspeaker response, drive bridges, use in production testing or as precision source for voltages. Monitors oscillator output, measures output of device under test.

**Advantages:** Self-contained instrument, no auxiliary equipment needed. 5 watts output,  $\pm$  1 db response, less than 1% distortion, hum more than 60 db down, no zero setting, output and input meters read v and dbm; four output impedances.

**Price:** \$500.00 (cabinet model), \$485.00 (rack mount).

### 206A AUDIO SIGNAL GENERATOR—Less than 0.1% distortion; 20 cps to 20 KC!

**Uses:** Convenient, precision audio voltage source; checks FM transmitter response, makes high quality, high fidelity amplifier tests, transmission measurements.

**Advantages:** Continuously variable audio frequency voltage, (output 15 dbm) 0.2 db response, hum 75 db down, 2% frequency accuracy, less than 0.1% distortion. 111 db attenuator with 0.1 db steps.

**Price:** \$750.00 (cabinet model), \$735.00 (rack mount).

*Data subject to change without notice. Prices f.o.b. factory.*



pioneered the world-famous  
resistance-capacity  
oscillator circuit

## HEWLETT-PACKARD COMPANY

1031K Page Mill Road Palo Alto, California, U.S.A.  
Cable "HEWPACK" Davenport 6-7000

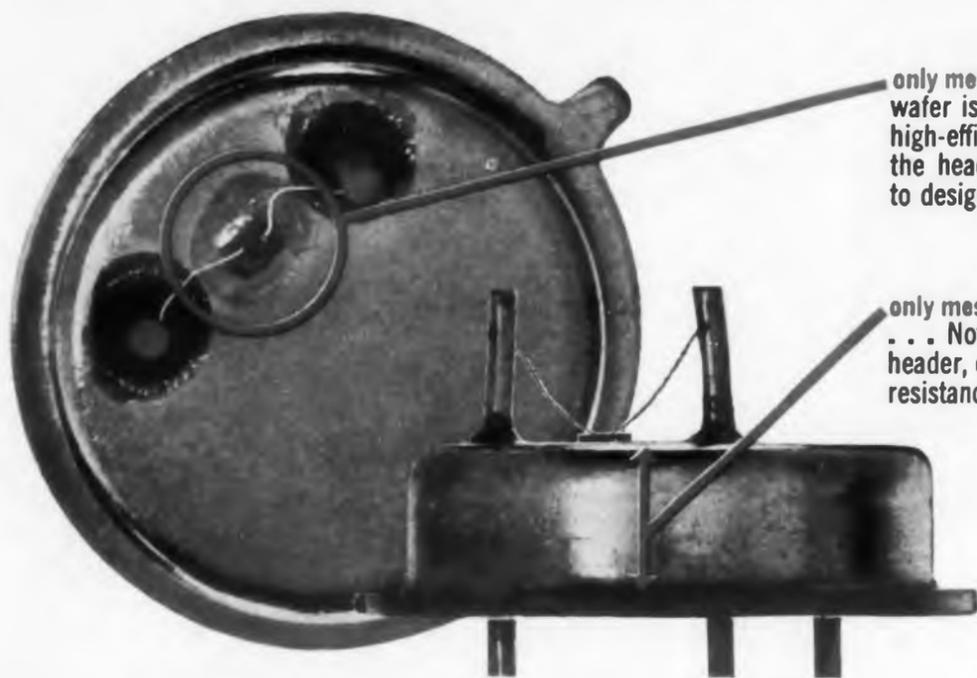
HEWLETT-PACKARD S.A.

Rue du Vieux Billard No. 1, Geneva, Switzerland  
Cable "HEWPACKSA" Tel. No. (022) 26. 43. 36

*Field representatives in all principal areas*

CIRCLE 14 ON READER-SERVICE CARD

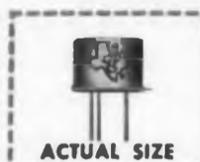
# NEW TI GENERAL-PURPOSE SILICON MESA TRANSISTORS



only mesas give you maximum dissipation... Note how wafer is bonded directly to header, forming a direct, high-efficiency metal-to-metal thermal path through the header. High dissipation capabilities permit you to design conservatively for maximum reliability!

only mesas give you maximum mechanical ruggedness... Note how active element is bonded directly to header, close to unit's center of gravity—for maximum resistance to vibration and shock.

## TI 2N1564 series GUARANTEES -55°C beta, 600-mw dissipation and gain at 30mc



Design now with industry's first small-signal silicon mesa transistors... the new TI 2N1564-series! Take advantage of guaranteed -55°C betas of 12, 20 and 40... guaranteed 600-mw free-air dissipation... guaranteed current gain at 30 mc. Apply the design flexibility of 1 to 50 ma collector current operating range; 20-50, 40-100 and 80-200 beta spreads at 25°C and 60-v collector-emitter breakdown voltage to your audio, medium-power and higher frequency amplifier and switching designs... Specify the new TI 2N1564-series.

Available TODAY in production quantities through all TI Sales Offices and Authorized TI Distributors.

absolute maximum ratings at 25°C ambient (unless otherwise noted)	
Collector-Emitter Voltage (see note 1)	60 v
Emitter-Base Voltage	5 v
Total Device Dissipation at 25°C Case Temperature (see note 2)	1.2 w
Total Device Dissipation at 25°C Ambient Temperature (see note 3)	0.6 w
Collector Junction Temperature	175°C
Storage Temperature Range	-65°C to +200°C

Note 1: The voltage at which  $h_{FE}$  approaches one when the emitter-base diode is open circuited. This value can be exceeded in applications where the dc circuit resistance ( $R_{BE}$ ) between base and emitter is a finite value.  
 Note 2: Derate linearly to 175°C case temperature at the rate of 8.0 mw/°C.  
 Note 3: Derate linearly to 175°C ambient temperature at the rate of 4.0 mw/°C.

Parameter	Test Conditions	2N1564			2N1565			2N1566			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
$I_{CBO}$ Collector Reverse Current	$V_{CB} = 40\text{ v}$ $I_E = 0$			1			1			1	$\mu\text{a}$
$BV_{CBO}$ Collector-Base Breakdown Voltage	$I_C = 10\ \mu\text{a}$ $I_E = 0$	80			80			80			volt
$BV_{CEO}^*$ Collector-Emitter Breakdown Voltage	$I_C = 10\ \text{ma}$ $I_E = 0$	60			60			60		200	volt
$h_{fe}$ A-C Common-Emitter Forward Current Transfer Ratio	$V_{CE} = 5\ \text{v}$ $f = 1\ \text{kc}$ $I_E = -5\ \text{ma}$	20	50		40	100		80	200		
	$V_{CE} = 5\ \text{v}$ $T_A = -55^\circ\text{C}$ $f = 1\ \text{kc}$	12			20			40			
	$V_{CE} = 5\ \text{v}$ $f = 30\ \text{mc}$ $I_E = -5\ \text{ma}$	1	4		2	4.5		2	5.0		



**TEXAS INSTRUMENTS**  
 INCORPORATED  
 SEMICONDUCTOR-COMPONENTS DIVISION  
 13500 N. CENTRAL EXPRESSWAY  
 POST OFFICE BOX 312 · DALLAS, TEXAS

CIRCLE 15 ON READER-SERVICE CARD

## NEWS

### Peltier Cooling Used With

#### Holds Unit Temperature to 110 F; 64 Thermocouples in Cooling Plate

**P**ELTIER cooling is employed in a new package designed to dissipate heat generated by gyro servo components. The manufacturer claims the development can get rid of 65.3 w of heat to ambient air at 140 F.

The component holds the gyro unit temperature to 110 F. Heat is transferred via internal air to the case, from the case by conduction to a stable-platform aluminum housing, which, in turn is cooled by the new unit.

Manufactured by Airesearch Manufacturing Div. of the Garrett Corp., Los Angeles, the heat pump uses 64 thermoelectric couples formed into a cooling plate. Heat in the gyro platform housing is drawn out by the thermoelectric couples and vented overboard by a fan through a plate and fin heat exchanger.

A total of 20 amp, 5.5 v dc—110 w power input—is needed for the Peltier unit. According to Alfred L. Johnson, Jr., senior project engineer, and William Ferris, project design engineer, the new gyro platform cooler is first in a line of Peltier heat pumps. A more complex unit using two fans and more complex heat exchanging construction is currently on the drawing boards. "Gyro platforms must exist in a 140 C environment according to specifications," Mr. Johnson says, "but they're usually built to withstand only 140 C. No margin for error." Another unit being designed will cool down to -125 C, according to Mr. Johnson. New materials are expected to



Designers Ferris and Johnson (right) show their new cooling package using Peltier technique. Heat in gyro platform is drawn out by thermoelectric couples and vented overboard by a fan through a plate and fin heat exchanger.

ELECTRONIC DESIGN • August 31, 1960

## sed With Gyro Components

permit a 50 per cent increase in efficiency of Peltier coolers within about two months, and, Mr. Johnson says, there is no reason Airesearch couldn't get down to liquid nitrogen temperatures with this efficiency increase. This would provide a refrigerator system for cryogenic gyros, among other applications.

Peltier cooling uses electrons as an energy transport fluid. As electrons pass from one leg of a thermocouple to another they pass from one energy level to another. "So far as the math is concerned," Mr. Johnson says, "the system is identical to a standard Freon system. At a lower energy level, the electrons are close together like the molecules in the liquid Freon state. At the higher energy level, the electrons are farther apart, corresponding to the gaseous Freon state."

The difference in electron energy is made up by absorbing or rejecting thermal energy, pumping it from a cool source to the heat sink. Advantages of Peltier cooling include good reliability, higher heat sink temperatures, and the ease with which a given static temperature may be maintained. ■ ■

## TWT's Used in Program For Space Temperature Research

The radio telescope at Bonn University Observatory in Germany will be used for an intensive investigation into the temperatures prevailing in interstellar gas.

Special dual channel amplifying equipment, using two low noise type N1017 Traveling Wave Tubes in cascade in each channel, has been supplied to the university by Marconi's Wireless Telegraph Co., Ltd.

The radio telescope, an 83-ft diam parabolic mirror mounted on a pyramidal tower about 60 ft high, scans the sky picking up the cosmic continuum radiation emanating from galactic and extragalactic radio sources. The signals in the neighborhood of the hydrogen line frequency (1420 mc) are amplified by one pair of traveling wave tubes, the other amplifying reference noise signals from a resistor at a known temperature.

The outputs from the two amplifying channels are detected, integrated and compared and the effective cosmic temperature determined; from these, data contour maps are prepared. So accurate has the system proved in initial tests that a discrimination of 0.1 K has been achieved.

# Tung-Sol/Chatham CROWBAR Thyratrons

## PROTECT HIGH-POWER CIRCUITS AGAINST DESTRUCTIVE ARCS

Any one of a host of causes can trigger internal arcs in high-power tubes with little or no warning . . . even if the tubes are well designed, operate in well-engineered circuits, and have conservative demands placed upon them. Cosmic rays, line-voltage transients, parasitic oscillations, spurious primary and secondary electrons and material whiskers are just a few of the potential sources of these highly destructive arcs.

But by engineering Tung-Sol/Chatham high reliability crowbar hydrogen thyratrons into your design, you can safeguard against costly arc-generated breakdowns. By short-circuiting destructive currents, these zero bias "arc-busters" extinguish the arcs before circuit elements can be damaged.

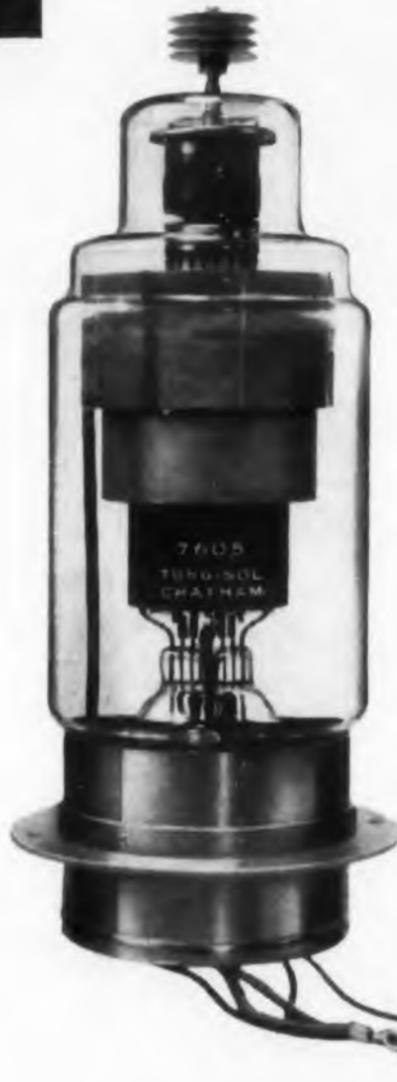
Instantaneous response and the ability to carry extremely large currents make these rugged thyratrons ideally suited for this purpose. Moreover, they are able to conduct these heavy surge currents even after having been idle for long periods. Each tube contains a hydrogen reservoir which promotes long life and permits optimum gas pressure adjustment for various operating conditions. Write for full technical details. Tung-Sol Electric Inc., Newark 4, N. J. TWX: NK193

Technical assistance is available through the following sales offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. Canada: Toronto, Ont.



**Typical application:** A crowbar thyatron is connected in series with a suitable impedance across the filter of the high voltage power supply for a high frequency amplifier tube. Whenever an arc occurs in the power

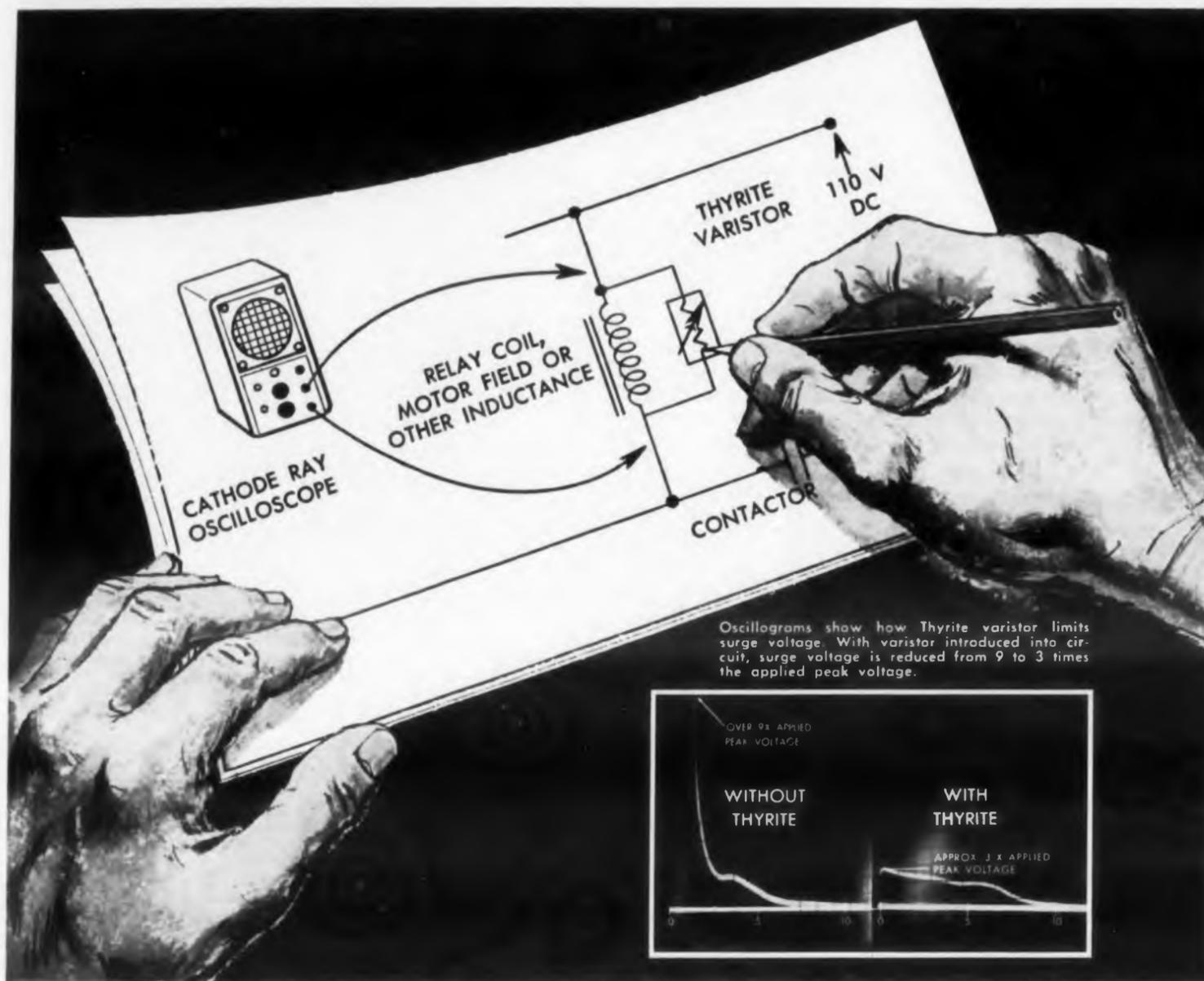
tube, the rising current is used to deliver a suitable signal to the grid of the thyatron. The thyatron immediately conducts to short circuit the power supply, until the protective circuit breaker opens 0.1 second later.



Type	DC. Anode Forward Voltage	Peak Cathode Current
7559	18KV	1500A
7568	25KV	800A
7605	25KV	2500A

 **TUNG-SOL®**

CIRCLE 16 ON READER-SERVICE CARD



Oscillograms show how Thyrite varistor limits surge voltage. With varistor introduced into circuit, surge voltage is reduced from 9 to 3 times the applied peak voltage.

## He'll get surge protection results with G-E Thyrite® varistors

TRY IT YOURSELF  
SEND FOR GENERAL ELECTRIC  
ENGINEERING APPRAISAL KITS



Kit #1 (illus.) contains 12 miniature disc varistors, color-coded and with connecting leads. Price: \$5.00. Also, Kit #2 containing 10 color-coded rod varistors with connecting leads. Price: \$5.00. Test their properties; see how they can help you. Send for yours today.

... and so can you with the assistance of a G-E engineer in your circuit planning

Sudden interruption of an inductive current produces high surge voltages which must be limited to a safe value. The engineer who plans his circuit to include a General Electric Thyrite varistor is "buying" the best and lowest cost surge protection available.

Thyrite varistors are voltage-sensitive resistors which limit voltage surges and stabilize current. Available in rods, discs, or washers — with or without leads, and as assemblies ready for installation — Thyrite varistors are made with a wide variety of volt-ampere characteristics for components rated from 6 to 10,000 volts.

For more information on Thyrite varistors — or for the assistance of a G-E engineer to help you with a specific problem — write: Magnetic Materials Section, General Electric Company, 7820 N. Neff Street, Edmore, Michigan.

MAGNETIC MATERIALS SECTION

GENERAL  ELECTRIC

CARBOLOY® CEMENTED CARBIDES • MAN-MADE DIAMONDS • MAGNETIC MATERIALS • THERMISTORS • THYRITE® • VACUUM-MELTED ALLOYS  
CIRCLE 17 ON READER-SERVICE CARD

## News

### Chicago Traffic Plotter Put

Map of Auto Density Results From Data Fed Into Computer

A PHOTOGRAPHIC data plotter for rapid and convenient display of automobile traffic distribution has been developed at the Illinois Institute of Technology, Chicago. Called the Cartographatron, the instrument records on film the thousands of trips made by Chicago motorists who answered questionnaires in a recent transportation survey.

Time, origin, destination, and other trip data derived from the questionnaires are stored in digital form on magnetic tape. The Cartographatron plots trip lines from the tape and displays them on a cathode-ray tube whose image is focused on a photographic plate. Since any number of trips can be plotted on the tube during a single exposure, the result is a map showing traffic density. Tape data can be selected to generate traffic maps for a variety of conditions such as rush hours, truck trips only, or city-bound traffic only. The entire trip, or merely the origin and destination points can be plotted as required.

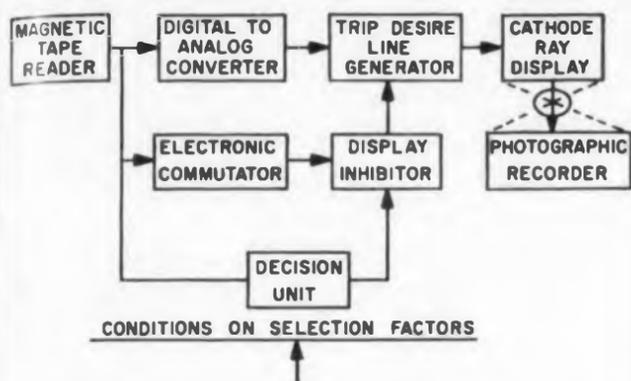
Information from about 370,000 questionnaires gathered by the Chicago Area Transportation



Automobile traffic density in Chicago area as plotted by the Cartographatron. Each trip made by a vehicle is represented by a trace from its point of origin to its destination. Together, the thousands of traces provide a visual display of traffic density.

ELECTRONIC DESIGN • August 31, 1960

## puts Theory Onto Tube



**Cartographatron processes traffic data** from magnetic tape to give visual display of traffic density. Decision unit is programmed to select only those trips required for a particular study. Origin and destination of each trip is then plotted on the cathode-ray tube. If required, the two points can be connected by a trace.

Study is contained in 21 reels of tape which can be processed in about 3-1/2 hours. Trip records are read and displayed at a rate of approximately 48 per sec.

Only one Cartographatron has been built to date—this at a cost of \$68,500. Having completed its work in Chicago, the device will next be used for transportation studies in Pittsburgh and for air traffic studies by the Federal Aviation Agency. ■ ■

## Signal Corps Orders Radios To Replace 3 Current Models

The Signal Corps has authorized the Speciality Electronics Development Corp., Syosset, N.Y., to produce a radio receiver to replace three existing models.

The FM receivers, which will be part of communications sets that cover the range 19.9 to 70.1 mc, were termed "interim" models by the Signal Corps. Depending on the design of the transmitter to be used in conjunction with the receivers, they ultimately may be modified or rejected.

The receivers produced under the \$600,000 negotiated contract use transistors and tubes in circuits designed and developed by the Signal Corps. The units use modular construction and have the dimensions 5 x 7 x 9 in.

Designated as R745, the receivers will be part of the pack and vehicular communications apparatus PRC-12 or VRC-25. The receivers replace R108, R109 and R110, each covering a third of the band to be covered by one unit.

ONE-FOURTH  
THE SIZE  
OF TO-18!

# NEW SUBMIN RELIABLE SILICON MESAS



For switching and computer applications in missiles, satellites, and airborne equipment . . . where considerations of space, weight, temperature and reliability combine to create an acute problem of transistor selection . . . turn to these Raytheon subminiature silicon mesas. All embody top Raytheon quality, hermetically sealed in the industry's *only* welded submin package, for utmost shelf life and reliability under extreme conditions.

**2N745 and 2N746.** Subminiature versions of the popular 2N337 and 2N338, with *no* decrease in power dissipation, plus over 5 times the speed of conventional types.

**2N747, 2N748, 2N749, 2N750, 2N751.** Subminiature versions of the popular Raytheon types 2N1386, 2N1387, 2N1388, 2N1389 and 2N1340; high speed switches and high frequency amplifiers for your most critical circuits.

**2N789, 2N790, 2N791, 2N792, 2N793.** Subminiature versions of the popular 2N332, 2N333, 2N334, 2N335 and 2N336; with lower leakage current, higher breakdown voltages and higher alpha cutoffs.

### Raytheon Silicon Submin with Mesa Construction

†	Type	I <sub>EO</sub> μA	I <sub>CO</sub> μA	V <sub>CE</sub> Max. Volts	f <sub>RE</sub>	V <sub>SAT</sub> Volts	C <sub>ob</sub> f = 100KC μμf	f <sub>cb</sub> Mc
NPN	2N745	0.05	0.05	45	35	1.5	2.0	10
Temp.	2N746	0.05	0.05	45	60	1.5	2.0	20
Range	2N747	0.006	0.006	25	60	0.6	4.0	25
-65°C to	2N748	0.006	0.006	30	30	0.6	4.0	25
+175°C	2N749	0.01	0.01	45	10*	—	4.0	80
	2N750	0.01	0.01	50	7*	—	4.0	25
	2N751	0.01	0.05	20	4*	—	4.0	12
	2N789	0.05	0.05	45	15	1.0	7.0	6
	2N790	0.05	0.05	45	25	1.0	7.0	8
	2N791	0.05	0.05	45	40	1.0	7.0	11
	2N792	0.05	0.05	45	60	1.0	7.0	8
	2N793	0.05	0.05	45	150	1.0	7.0	13

\*h<sub>fe</sub> @ 6mc

†Values are average parameter measurements. For individual test conditions refer to respective technical specifications.



*Off-the-shelf delivery! Contact your local authorized Raytheon distributor!*

## SEMICONDUCTOR DIVISION

RAYTHEON COMPANY • Silicon and Germanium Diodes and Transistors • Silicon Rectifiers • Circuit-Paks

ENGLEWOOD CLIFFS, N. J., LOwell 7-4911 (Manhattan Phone, WISconsin 7-6400) • BOSTON, MASS., Hillcrest 4-6700 • CHICAGO, Ill., National 5-4000  
LOS ANGELES, CAL., PLYmouth 7-3151 • ORLANDO, FLA., GARDen 3-0618 • SYRACUSE, N. Y., GRANite 2-7751 • BALTIMORE, MD., SOUTHfield 1-0450  
CLEVELAND, O., WINTon 1-7716 • DETROIT, MICH., TRinity 1-1710 • SAN FRANCISCO, CAL. (Redwood City), EMerson 9-5566  
CANADA: Waterloo, Ont., SHerwood 5-6831 • GOVERNMENT RELATIONS: Washington, D.C., METropolitan 8-5205

CIRCLE 18 ON READER-SERVICE CARD

## NEWS

### Multi-layer Printed Circuits Are Announced at WESCON

Commercially available multi-layer printed circuit boards were announced by Litton Industries, Beverly Hills, Calif. at WESCON.

Development of the multi-layered etched laminates was described at the Electronic Circuit Packaging Symposium at the University of Colorado a few days before WESCON opened. Norman J. Schuster, Litton design engineer, disclosed that the multi-layer boards are now being included in a Litton airborne digital computer which has 70,000 to 80,000 parts. The use of four-layer rather than conventional single-layer boards reduced size by over 50 per cent for regular cards and 70 per cent for the logic section of the computer, including coiling and other equipment but not power supplies or memories. Cards are now available commercially.

Getting required dimensional stability to match up thousands of contacts could not be achieved using a thermoplastic teflon base, Mr. Schuster reported. Excellent results were achieved, however, when Litton shifted to a thermosetting material.

High interbus capacitance, where bus strips must parallel each other along the cards, was one of the problems encountered. In one application, this factor was found to be an advantage because shunt capacitance to ground was added to a circuit for better filtering action.

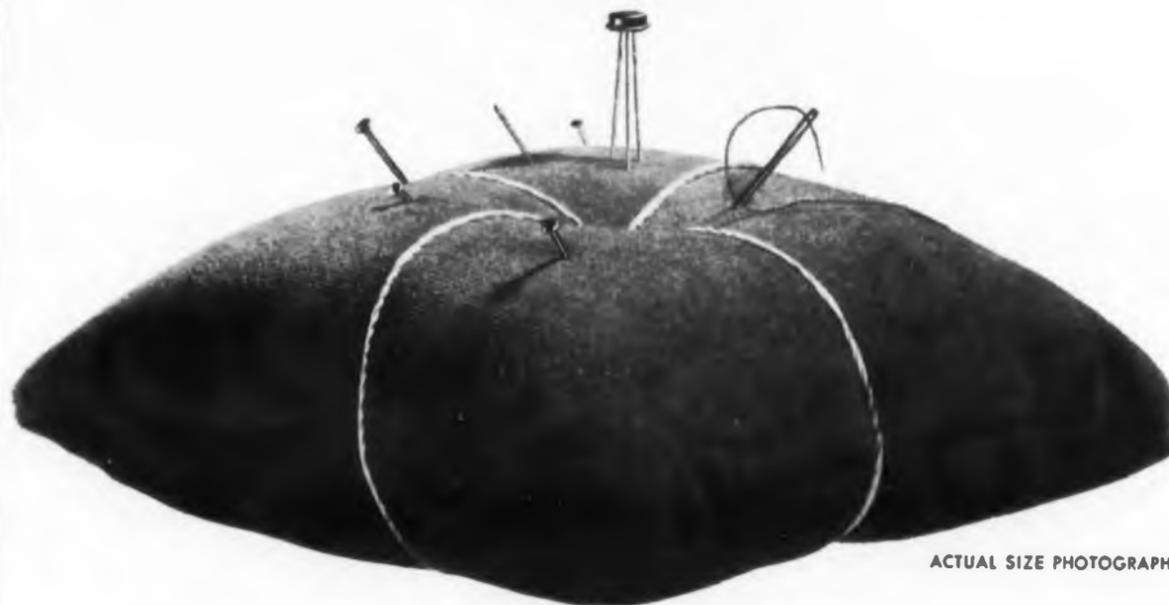
Several boards are printed, plated and etched in the Litton process, and then bonded together. Pin-type connectors are brought off the end of the boards. Experiments showed that plated-through holes could be used, although this has not yet been found necessary in Litton designs.

### Microfilmed Missile Documents



All of the engineering documents for the entire guided missile program are stored in the cabinets above. Small space is all that is required at Redstone Arsenal, Ala., to maintain this active file of 850,000 documents on microfilm in aperture cards.

# NOW... AN IMPROVED 2N697 IN A WELDED MICRO-PACKAGE THIS SMALL!



ACTUAL SIZE PHOTOGRAPH

# MICROBLOC RT697M

## Rheem's new solid-design silicon mesa transistor!

### WELDED HERMETIC SEAL

The MICROBLOC RT697M is the first micro-miniature silicon mesa transistor with a guaranteed welded hermetic seal. The glass sealing and welding techniques used in MICROBLOC production are the same techniques the industry has tested and perfected over the years, in the manufacture of millions of transistors. Each MICROBLOC is subjected to two hermetic seal—a helium leak test and a Joy bomb test—to ensure a vacuum-tight seal.

### MINI SIZE

MICROBLOC RT697M is .063 inches flat, .211 inches in diameter, weighs only 1/4 gram, and occupies 1/7th the volume of the standard 2N697.

### IMPROVED ELECTRICAL CHARACTERISTICS

The new Rheem transistor has a three watt power capability—50% more than the standard 2N697. It features cooler running junctions to assure wider safety margins and greater reliability. The MICROBLOC RT697M also has a 35 volt guaranteed minimum switchback voltage with base open, controlled signal parameters and meets or exceeds every specification of the 2N697.

### MODERN DESIGN

As its name suggests, MICROBLOC is virtually a block—a silicon crystal embedded in an optimum

dimensioned, gas tight, hermetically sealed, welded block that is essentially all heat sink. There are no fragile suspended internal leads or non-integrated elements, and the crystal is protected from welding flash. Thus, the MICROBLOC RT697M design is mechanically more stable, more resistant to shock and vibration than any previous transistor. It will withstand at least 1,500 G shock and 20,000 G acceleration, and is guaranteed to survive thermal shock and temperature cycling per MIL-S-19500B. (Additional data will be published as more stringent tests are completed.)

### APPLICATION

The MICROBLOC RT697M is tailored for high-density applications, such as micro modules and miniature circuit boards. In addition, because of its cooler running junctions, it is an ideal improvement/replacement for standard size transistors in applications where wider safety margins and great reliability are required. (Rheem will also continue to offer its standard 2N697, TO-5 package, per MIL-S-19500/99A.)

### OTHER MICROBLOC TYPES

Rheem is now producing a complete new series of MICROBLOC silicon mesa transistors. There is a MICROBLOC type for every electrical function that can be performed by transistors up to a 1 amp. current level. For full details, see your Rheem representative.

### AVAILABLE IMMEDIATELY

### MAXIMUM RATINGS AT 25°C AMBIENT (unless otherwise noted)

Collector--Base Voltage	60 V
Collector--Emitter Voltage (Base Open Circuit)	35 V
Emitter--Base Voltage	5 V
Total Device Dissipation at case temperature 25°C	3 W
Operating Temperature Range	-65°C to +175°C

All units are stabilized before testing at 300°C



ENLARGED MICROBLOC  
OUTLINE  
DIMENSIONS IN INCHES

### ELECTRICAL CHARACTERISTICS AT 25°C AMBIENT

PARAMETERS	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Collector Reverse Current	$V_{CB} = 30v$ $I_E = 0$	—	.005	1.0	$\mu A$
D-C Forward Current Transfer Ratio	$I_C = 150ma$ $V_{CE} = 10v$	40	75	120	—
Collector-Emitter Saturation Voltage	$I_C = 150ma$ $I_B = 15ma$	—	0.7	1.5	v
A-C Common-Emitter Forward Current Transfer Ratio	$I_C = 50ma$ $V_{CE} = 10v$ $f = 20mc$	2.5	5	—	—
Collector Capacitance	$I_E = 0$ $V_{CB} = 10v$ $f = 1mc$	—	20	35	$\mu\mu f$
<b>SMALL SIGNAL PARAMETERS</b>					
Small Signal Forward Transfer Ratio	$I_C = 1mA$ $V_C = 5v$	30	70	—	—
Common Base Input Impedance	$f = 1KC$	20	26	30	ohms
Common Base Voltage Feedback Ratio		—	$160 \times 10^{-6}$	$250 \times 10^{-6}$	$\mu mhos$
Common Base Output Admittance			.2	1.0	$\mu mhos$

## RHEEM SEMICONDUCTOR CORPORATION

A SUBSIDIARY OF RHEEM MANUFACTURING COMPANY  
Dept. G1, P.O. Box 1327, Mountain View, California • YORKSHIRE 8-9211



CIRCLE 19 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 31, 1960

## Discoverer XIV Carrying Gear For Optical Tracking Experiment

Discover XIV, whose instrument capsule was snared in mid air by a U.S. Air Force plane as it came down over the Pacific, carried an additional payload for comparative tracking tests in connection with the Navy's Transit 2-A navigation satellite.

The mid air catch, widely regarded as a noteworthy achievement, was overshadowed, however, by the recovery in the Soviet Union of a five-ton space vehicle carrying two dogs and other life.

A doppler transmitter package and a flashing light beacon are along for the ride and tracking stations are comparing results obtained with both doppler and optical tracking. The experiment is continuing beyond the usual lifetime of Discoverer satellites, whose value terminates with ejection of the capsule shortly after launching.

The Applied Physics Laboratory of Johns Hopkins, designers of the Transit system supplied the payload for Discoverer XIV and is manning tracking stations in Florida, New Mexico and Hawaii.

The flashing lights are seen on earth with a brightness equivalent to an eighth-magnitude star and must be observed through a telescope. If optical tracking proves feasible, Transit's future value to navigation may extend to vessels unable to afford receiving and computing equipment required to make use of the system.

## Project Mercury Consoles Completed



Project Mercury display console is checked over before shipment from Stromberg-Carlson-San Diego, Div. of General Dynamics Corp., to Cape Canaveral. Several control center consoles built under subcontract to Bell Telephone Labs have been delivered to the Cape and Bermuda, where another control station will be located. A Project Mercury flight controller team will monitor data about an astronaut, the capsule and the flight.

# DRAFTING TRENDS



## Helpful new booklet suggests drafting, engineering shortcuts

Just published—"DRAFTING SHORTCUTS" is a completely new booklet of helpful ideas and aids for engineers, draftsmen and students. It is well illustrated, clearly and logically written. It contains a wealth of time-saving tips to speed both routine and specialized tasks.

The ideas selected were submitted by professionals and judged by an impartial panel of widely recognized authorities on the various topics covered.

As an example, the section covering *Calculating Ideas* includes a simple means of locating stress points on cantilevered beams, also a simple method for retaining fundamental trigonometric relations.

In the section on *Drafting Shortcuts*, our editors have come up with topics like a simplified, fast and easy method for drawing gear teeth profiles and a rapid means of showing twisted wire elements.

The *Engineering Data* section covers new, easy-to-use shortcuts to formulas and engineering data.

There's a special section devoted to time-saving techniques on the drawing board, too. One of the suggestions on how to make life easier for the draftsman tells how to use a bent paper clip as a variable guide for making section lines.



For your free copy of "Drafting Shortcuts" contact your POST dealer or write today to the Frederick Post Company, 3644 N. Avondale Avenue, Chicago 18, Illinois.



SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES  
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

CIRCLE 20 ON READER-SERVICE CARD

## WASHINGTON REPORT



Ephraim Kahn

MORE CONTROLLED AIRSPACE is proposed by the Federal Aviation Agency. It would drop to 14,500 ft (from the present 24,000 ft) the floor above which exists the "continental control area." Comments on the agency's proposal will be accepted from industry and other interested parties until Oct. 13. The increase in traffic control has been made possible because of electronic communications and improved control systems.

COMPETITION IN NEGOTIATED BUYING, a sore point with the Defense Department since it is under intermittent fire from Congressmen for letting contracts by methods other than competitive bidding, is being given careful study. To bolster its contention that negotiated contracts are often placed only after a number of firms have had a crack at meeting the military's requirements, the Defense Department has instituted a new system of reporting on new contracts. It will show the volume of negotiated pacts—but it will also indicate the extent to which design competition, price competition, technical competition, or sole-source negotiation have figured in the deal. This breakdown will be given for "follow-on" contracts as well, which have been regarded as sole-source purchases.

DEFENSE CONTRACTING RATE WILL RISE during the rest of this year and on into 1961. The Administration and the Pentagon have agreed that some of the extra \$703 million voted by Congress to the military will be spent, not saved. Furthermore, it is apparent that the military is making plans that are based on the idea that more money will be coming their way next year, no matter which candidate wins the Presidency. There are, of course, substantial amounts that have not yet been committed. In addition, cancellations of contracts will result in a turn-back of funds which can be re-apportioned to projects that seem promising.

U.S.—CANADIAN COORDINATION of military R&D as well as purchasing has been ordered by the Defense Department. Efforts to have the U.S. buy more in Canada, or at least to give Canadian firms (including subsidiaries of U.S. companies) a "fair opportunity" will be increased, and the Defense Department will keep closer tabs on military contracts placed there. Heretofore, much U.S. military buying in Canada has been related to the electronic early-warning systems that are located there. To help balance international accounts, the suggestion has been made that Canada's CL-44 transport airplanes be swapped for the two squadrons of Bomarc missiles Canada plans to acquire.

NEW MAINTENANCE POLICY for military weapons and equipment will work changes in the type of work now being done by commercial firms, but probably will not have a significant effect on total volume. The new policy requires the military to do its own tactical maintenance work, but directs the use of contractors whenever feasible at higher echelons. Objective is to assure the military has "the minimum capacity necessary to insure a ready and controlled source of technical competence and resources to meet military contingencies." Recurring and predictable maintenance workloads will clearly be the most fruitful source of work for contractors, as a general rule. But it would appear as though new weapons systems will also provide opportunities, at least until they have become thoroughly familiar to troops. The Defense Department notes that consideration to contract maintenance is to be given "when it is desirable to augment military maintenance capability for an interim period to attain an earlier operational status for new military material being introduced."

INDUSTRIAL SECURITY PROCEDURES of the Defense Department have been modified in line with a Supreme Court decision. Employees of contractors now can, in most situations, confront and cross-examine persons who accuse them of things which might result in suspension, or denial, of the employee's right of access to classified information. Documents involved may be examined, as well. Exceptions to the right of confrontation will be made if the head of the government agency involved says there is "good and sufficient reason" to refrain from disclosing the informant's identity, and if the informant is a bona fide intelligence operative or is physically unable to appear. Hearings are held before boards which have no power to subpoena. This is expected to make it more difficult for the government to substantiate allegations since witnesses in security risk cases often are reluctant to appear voluntarily.

NEED FOR SHORTER LEAD-TIME has again been stressed by General Trudeau, chief of Army R&D. He wants "more rapid and intensive exchanges of information between industry and the Army at every stage of development . . . new procedures for expedited development such as overlapping and telescoping phases of the R&D cycle . . . conducting user and engineering testing concurrently or on a combined basis, and starting production engineering and tooling as early in the development cycle as possible."

ARMY'S RESEARCH NEEDS for aircraft over the next decade involve substantial problems in electronics and design. Major job for design engineers in the electronics field would be instrument packages for manned deep-penetration surveillance aircraft, as well as for drones. In addition, extensive work will have to be done on the development and testing of sensors for target acquisition, equipment for processing and interpreting the data returned by the aircraft, and avionics equipment that will meet the high standards of performance and reliability that will have to be built into future manned aircraft if they are to be sufficiently effective under combat conditions.



## Miniaturized POWER SUPPLIES FOR WIDE LOAD AND LINE VARIATIONS

Designed and manufactured to operate from an auxiliary power source such as an unmanned microwave station, these power supplies provide a wide input frequency range, offer transient and short-term short-circuit protection, and are complete with terminals for external output fusing.

### SPECIFICATIONS Model No. PAI-040

#### ELECTRICAL CHARACTERISTICS:

INPUT: 108 to 132 V, 47 to 420 cycles  
 OUTPUT: 200V<sub>DC</sub> ± 1% at any load  
 between 100 to 200 MA and at any  
 input between 108 to 132 V, 47 to  
 420 cycles  
 RIPPLE: (Max) 300MV<sub>RMS</sub> @ 47 cycle  
 —200MV<sub>RMS</sub> @ 60 cycle —10MV<sub>RMS</sub>  
 @ 400 cycle

#### ENVIRONMENT CONDITIONS:

AMBIENT TEMPERATURE: Operating  
 —40°C to +30°C  
 —30°C to +55°C with forced  
 air cooling  
 ALTITUDE: Operating 10,000 ft.  
 Non-Operating 40,000 ft.  
 HUMIDITY: 95% RH 40°C 240 HR  
 (Mil-Std-202 Method 103)  
 SHOCK: 30 g's (Mil-S-4456)  
 VIBRATION: .060" Total Excursion 10-  
 55 cycles (Mil-Std-202 Method 201A)

#### MECHANICAL CHARACTERISTICS:

SIZE: 4¼" x 5" x 4¾" WEIGHT: Less than 13 lbs. MOUNTING: Four # ¼-20 Studs

WRITE FOR BULLETIN NPB-104

HST Special Products Division specializes in the design and production of power supplies for radar range circuits, tracking circuits, computers, and built-in control or evaluator portions of equipment. Comparable supplies are available in commercial counterparts. Please invite us to quote on your next special production requirements.

		<b>DRESSER INDUSTRIES INC.</b>
		ELECTRONIC OIL • GAS CHEMICAL INDUSTRIAL
MAGNETIC IRON-CORE COMPONENTS ENVIRONMENTAL TESTING POWER SUPPLIES—SERVO AMPLIFIERS		

### SPECIAL PRODUCTS DIVISION

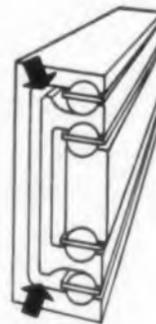
2925 Merrell Road Dallas 29, Texas Phone Fleetwood 7-4348

CIRCLE 21 ON READER-SERVICE CARD



**ONLY  
GRANT  
SELF-  
ALIGNING  
SLIDES  
PUT  
SHIMS  
WHERE  
THEY  
BELONG**

*Slide automatically adjusts to fit misaligned chassis or cabinet.  
Write for complete descriptive data.*



## GRANT INDUSTRIAL SLIDES



**GRANT PULLEY & HARDWARE CORPORATION**  
Eastern Division / 21 High Street, West Nyack, N.Y.  
Western Division / 944 Long Beach Ave., Los Angeles 21, Calif.

CIRCLE 22 ON READER-SERVICE CARD

## NEWS

### Transitron Plans Research Into Passive Component Field

Transitron Electronics Corp. plans to begin research on passive electronic components in a 400,000-sq ft facility now being occupied in Boston.

The company has up to now been known for its work in semiconductors, and it has not produced passive components.

Much Transitron research effort is also being directed at the thermoelectricity field. Lead telluride elements are now being sampled. Silicones are also being investigated, according to a company spokesman.

Transitron will begin marketing tunnel diodes and microtransistors later this year.

### CHANGES IN PRICE & AVAILABILITY

**ELECTROLYTIC CAPACITORS** have been increased 5 per cent in price by Astron Corp. of East Newark, N.J. and General Electric Co. of Hudson Falls, N.Y.

**POWER SUPPLY**, Model 3225, has been reduced in price by Power Instruments Corp. of El Segundo, Calif. This unit, originally costing \$198, is now available from stock at \$160.

**CRYSTAL SILICON** has been reduced 6 to 28 per cent in price by Merck & Co., Inc. of Rahway, N.J. The 1-50 ohm-cm P types, were cut from \$1.55 to \$1.39 a gram. Polycrystalline billets, with a boron content of less than one part in 6-million, dropped from 61 to 44 cents a gram.

**TIPERSUL**, a fibrous potassium titanate insulation material for 2,000 F applications has been reduced in price by E. I. du Pont de Nemours & Co., Inc. of Wilmington, Dela. The loose-fibre form of the material is reduced from \$16.50 to \$5.10 lb. The price for lumps and cut lumps is now \$4.25 and \$4.50 lb respectively.

### Accuracy Is Our Policy . . .

On p 24 of the June 8 issue, General Instrument Corp. was incorrectly identified as being located in Elizabeth, N.J. Its correct address is Newark, N.J.

## Fortune Predicts 'Shakeout' For Electronics Industry

A slowdown over the next 10 years in the rate of growth of the electronics industry, resulting in a "shakeout" of vulnerable companies, is anticipated in an article in Fortune magazine.

"It is clear," says Fortune, "that the industry cannot continue to expand at the rate of the past decade, almost 15 per cent a year compounded, or three and one-half times as fast as all industrial production. On the highest projections now being made by serious economists and market researchers the industry's growth in the 1960's will not exceed 9 per cent a year. On the most conservative projections, the industry will expand by 4 per cent a year, or slightly less than the rate Fortune has projected for all industrial production."

Estimates contained in the article picture the industry growing from about \$10 billion in factory sales this year to \$13-18 billion by 1965, and to \$15.2-19.8 billion by 1970.

These values are based on a growth rate of the "crucial" government market estimated in the article at 3.5 to 8.7 per cent per year for the 10-year period. The five-year average for 1955-1960 is reported to be 15 per cent.

Sales of industrial equipment, which Fortune rates as the most hopeful area of growth for the industry, are predicted to rise from about \$1.8 billion this year to \$5.75 billion by 1970.

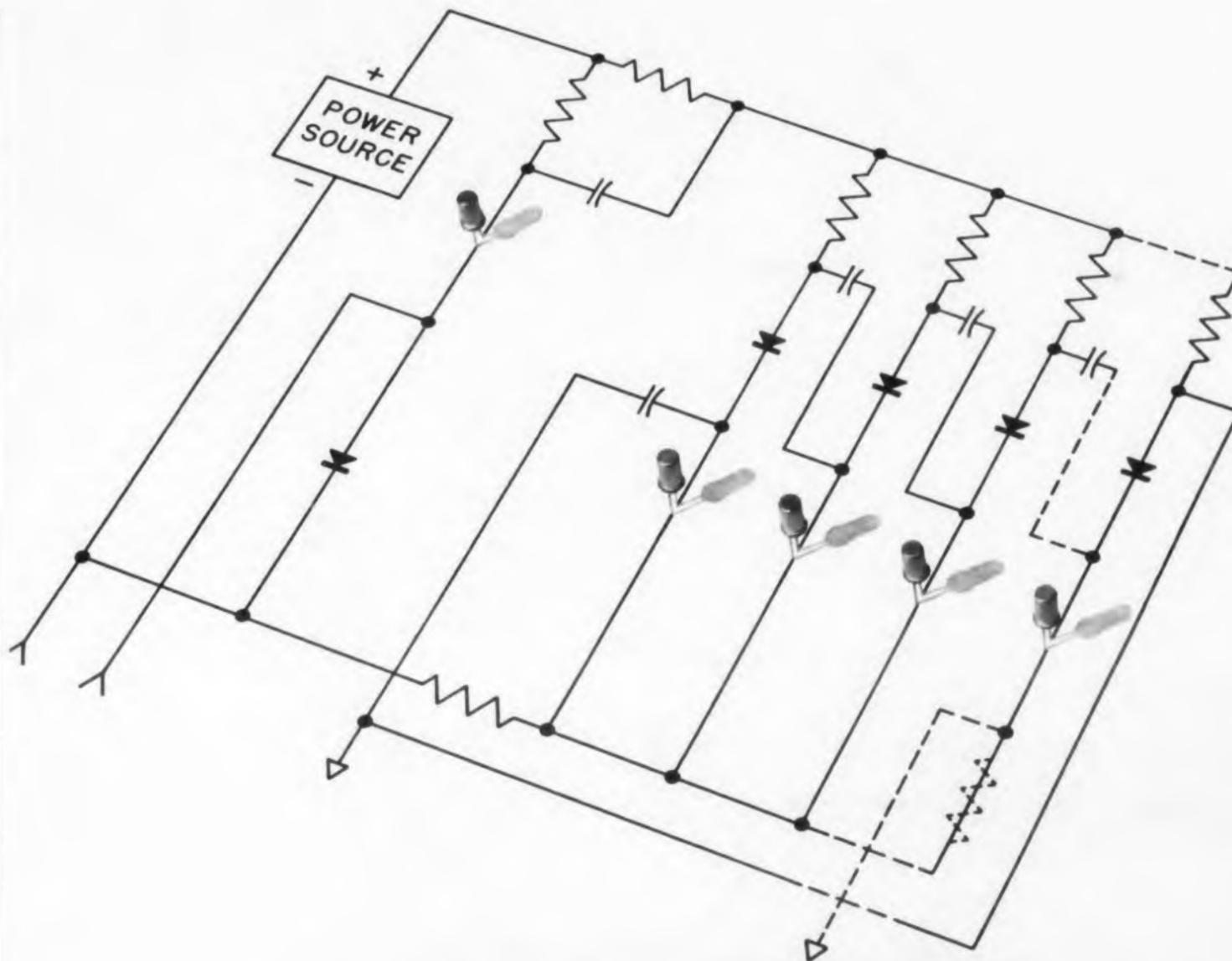
Because of the leveling off of the industry's growth rate and the fact that "survival requires a much broader range of attributes" than being able to develop a single innovation and riding it successfully for a while, Fortune concludes that "many companies now in the industry won't be around five or 10 years hence."

## No Need to Handle Goods In Electronic Supermarket

An electronic supermarket where the customer never handles the goods, has been demonstrated in model form to retail trade experts in London.

The full-scale model incorporates an automatic method of warehousing coupled with an electronic system of order-taking. The customer has no loaded wire basket to steer around the store. She simply makes her choice, which is recorded on a card pushed into a processing machine at the cashier's desk.

While the customer pays for the goods, the cashier presses a button to set in motion the automatic dispensing from the warehouse. By the time the customer walks to the delivery counter, the goods are ready to collect.



\*SHOCKLEY 4-LAYER DIODES used in typical multiple-stage ring counter circuit.

# YOU CAN COUNT ON 4-LAYER DIODES

For counting pulses...for timing...for digital read-out. The diagram shows one of several simplified ring counter circuits using Shockley 4-layer diodes. This silicon semiconductor switch is the key to circuit versatility. Apply appropriate resistors and capacitors, and speeds from less than one pulse per second to several hundred thousand per second may be obtained. At each stage enough power can be handled to operate signal lamps, enough voltage can be supplied to operate Nixie Tubes.

When broad temperature ranges and tough en-

vironmental conditions must be met, the MIL-LINE diode is available. Standard commercial 4-layer diode is available. Standard commercial 4-layer diodes are suggested for low cost, non-military applications. If your circuits involve ring counters, consider Shockley 4-layer diodes for faster, more dependable operation. For application notes on ring counters, how to make flip-flops, drive relays, convert DC to AC, pulse magnetrons, or for suggestions about the use of 4-layer diodes in the circuit you are developing now...call or write your local Shockley representative or write Dept. 12-2.

## Shockley TRANSISTOR

UNIT OF CLEVITE TRANSISTOR

STANFORD INDUSTRIAL PARK, PALO ALTO, CALIF.

CIRCLE 24 ON READER-SERVICE CARD

CLEVITE CORPORATION



**Design  
engineer  
with a  
problem:**

## "Small size is not enough!"

"Nothing fits . . . components too bulky . . . have to save space . . . have to trim size . . . maybe eliminate tubes . . . maybe brackets, too . . . maybe smaller relays. Yes, relays . . . if there's a smaller one that's fast enough, strong enough, tough enough. Better be careful though . . . can't sacrifice performance . . . or reliability. Now, where are those sealed relay catalogs?"

We at General Electric appreciate this respect for relay performance. Relay tasks are normally too critical to risk compromising reliability no matter what the gain—small size not excepted.

That's why performance always comes first in General Electric sealed relays.

But we haven't forgotten the importance of miniaturization either. In fact, General Electric designers have pioneered in miniaturized relays four times in the past ten years—Miniature (1951), Micro-miniature (1955), and 4-pole and Unimite (1959). Each relay represents an advance in *performance*, as well as a reduction in size.

Superior performance is no accident with General Electric sealed relays. It is the product of General Electric's advanced technology, ever improving

manufacturing processes, relentless testing, and stringent quality control.

For relays that offer top performance and reliability in the smallest available packages, turn first to your G-E Sealed Relay Catalog. As always, more information is available from your nearby General Electric Sales Engineer. General Electric Co., Specialty Control Dept., Waynesboro, Virginia.

*Progress Is Our Most Important Product*  
**GENERAL  ELECTRIC**

**GENERAL ELECTRIC SEALED RELAYS—UNMATCHED FOR RELIABILITY**

CIRCLE 25 ON READER-SERVICE CARD

### General Electric sealed relays for the '60's



#### **4-POLE MICRO- MINIATURE**

New grid-space, 4-pole double-throw micro-miniature relay features all-welded construction to eliminate flux contaminants. Knife-edge armature bearing and other design features provide structure capable of mechanical life in excess of 10 million operations. Rated 2 amps at 28 volts DC, or 115 volts AC resistive; requires only 100 milliwatts per pole. Other specifications are:

**Operating sensitivity:** 400 milliwatts at pickup voltages; continuous duty.

**Vibration:** 55 to 2000 cps at 30G's with 0.195" max. excursion 10 to 55 cps.

**Shock:** 50G's for 11 ms operating.

**Temperature range:** 125 C to -65 C.

**Operating time:** 6 milliseconds max. including bounce.

**Insulation resistance:** 1000 megohms min.

**Dielectric strength:** 1000 volts rms except 600 volts across contact gap.

**Contact resistance:** 0.050 ohms maximum (0.1 ohms max. after life).

**Release time:** 5 milliseconds maximum including bounce.



**MINIATURE:** Long-life type; rated 5 amps at 28 volts DC; in 2- or 4-pole double-throw and 6PNO forms. Ideal for ground jobs.



**MICRO-MINIATURE:** Crystal can type, all popular coils and mounting forms; 2 amps, 28 v DC or 115 v AC. Grid-spaced terminals available.



**UNIMITE:** World's smallest 1-amp sealed relay! Operates in 1.5 millisecond, releases in 3.5 milliseconds. Isolated contact chamber; all-welded construction.

General Electric Company  
Section 8792-18  
Schenectady, New York

Please send me a free copy of the  
1959-60 Sealed Relay Catalog.

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_

State \_\_\_\_\_

**GENERAL  ELECTRIC**

CIRCLE 26 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 31, 1960

# EDITORIAL

## Consider the Digital Computer

Despite the vital role they've played and the important contributions they've made to the computer art, electronic design engineers haven't taken advantage of the digital computer as a tool. The growth of the digital computer as a mighty tool for business and industry can be attributed, in large measure, to electronics designers.

Yes, with the very important exception of those who design computers, the number of electronics engineers who use a digital computer in design is surprisingly small. There are many "reasons" for their reluctance to investigate this powerful tool, but in general, the "reasons" are faulty, as shown in this issue's staff report.

The "literature" hasn't helped the engineer; it certainly hasn't stimulated him to consider using a computer. Almost every article on applying digital computers in design work has stressed a single application. Thus, an article might explore the details of a specific application of a computer in the design of pulse transformers.

Of course, such an article can have tremendous value to pulse-transformer designers. But its value to other engineers is quite limited. More often than not, others are left with the feeling that computers are useful in pulse-transformer design, ". . . but I can't use a computer in my job."

To help offset this attitude, and to encourage designers to investigate the potential of digital computers, ELECTRONIC DESIGN presents in this issue a completely different approach. Here are listed dozens of applications of digital computers by forward-looking electronic design engineers. None of the applications is explored in depth. Rather, all are presented in breadth with the hope that they will stimulate other electronic designers to—Consider the Digital Computer.

*George H. Roatky*

### TRY THE SMALL ECONOMY

**SIZE** . . . when you're pinched for pennies and panel space! This miniature precision pot is priced at \$10.75 and down; the dial at \$7.75 and down!

Here's togetherness that makes sense . . . when an application cries out for a low-price pot & dial in  $\frac{7}{8}$ " of panel space!

Pencil your way out of this design dilemma by simply specifying Helipot's new economy pair: the  $\frac{7}{8}$ " diameter, 10-turn 7216 pot and 2600 series dial. We've restricted the size (and price) . . . not the designer!

The bushing mount 7216 gives you  $\pm 0.5\%$  standard linearity, 10 to 125,000-ohm resistance ranges, and plenty of environmental strength. In short, all the virtues of a precision pot at a price near that of a tolerable trimmer!

The dial is a miniature version of the RB DUODIAL® that counts up to 15 full turns and hundredths of each! It accommodates  $\frac{1}{4}$ " shaft and  $\frac{3}{8}$ "-32 bushing or  $\frac{1}{8}$ " shaft and  $\frac{1}{4}$ "-32 bushing with shafts extending as much as  $\frac{43}{64}$ " from the panel!

Whenever your thoughts turn to pots (or dials) . . . turn to Helipot. We've got a full line of single- and multi-turn pots, linear or non-linear models, with temperature ranges to 85°C, 125°C, and 150°C.

There's much more to tell, so help us. So help yourself and ask for Data File P-10 today.



Beckman / Helipot®

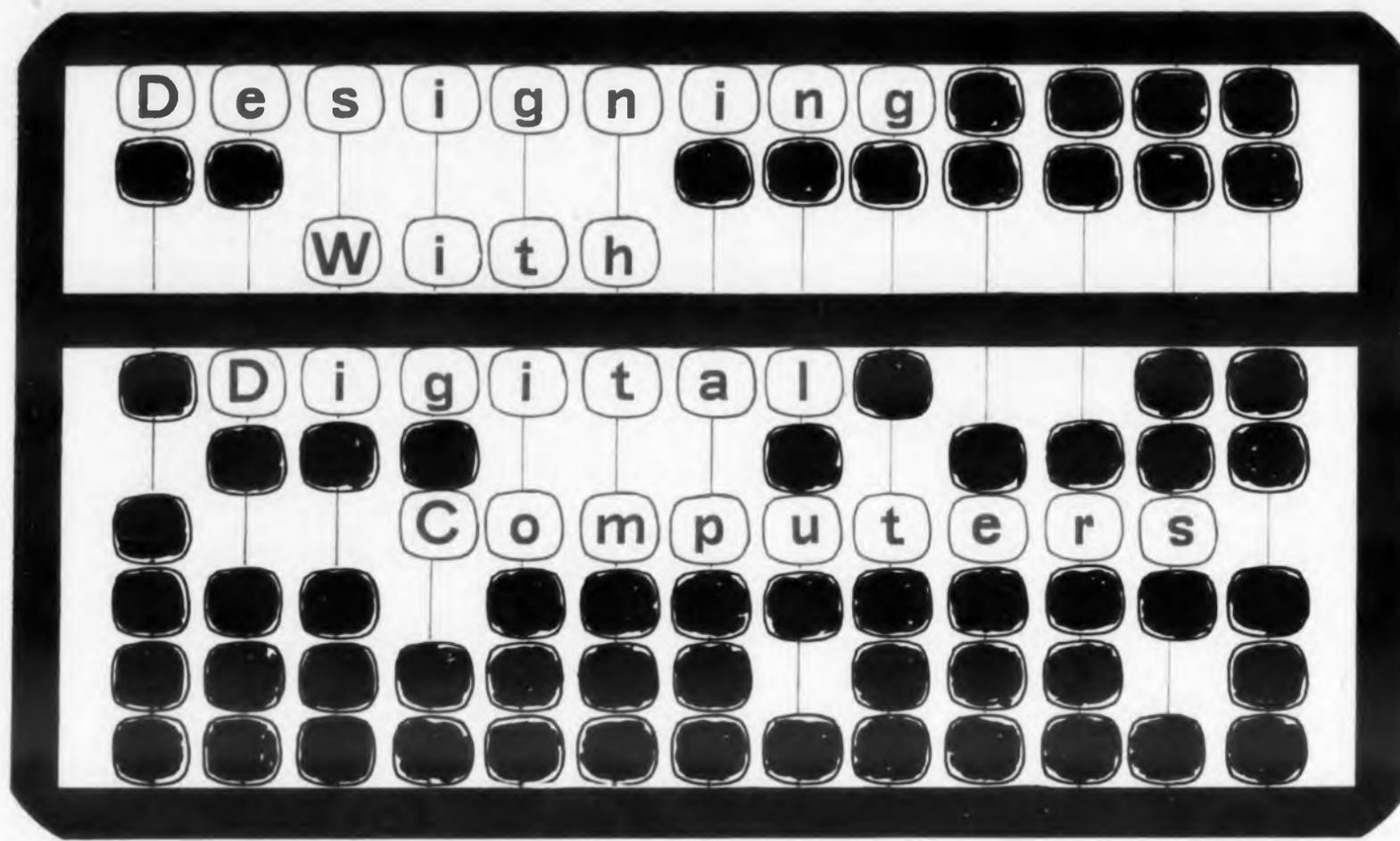
POTS : MOTORS : METERS

Helipot Division of  
Beckman Instruments, Inc.  
Fullerton, California



©1960 B.I.I. 81022

CIRCLE 27 ON READER-SERVICE CARD



**George Rostky**  
Associate Editor

**P**ARADOXICAL as it may seem, electronics designers, by and large, are not using digital computers. Electronics designers have raised the digital computer from its "electronic curiosity" status a decade ago to its current status of an indispensable tool for business and industry.

These men have sold the world on the advantages of using digital computers. But they have not sold themselves.

They have seen the computer industry grow from a sideline of major business-machine companies (like International Business Machines and Remington-Rand) to a vast, dynamic industry with a whole train of peripheral industries manufacturing input-output equipment, logic modules, core memories, external storage devices, and a variety of supporting products.

In a period of two or three years, they have seen small, relatively unheard-of-companies (like Control Data Corp.) become important forces in the industry with machines that rival some of the most powerful computers built. In recent months they've heard some of the country's major industrial giants (like Radio Corp. of America and General Electric) proclaim that they're out to capture a sizable chunk of the computer market.

Yet, by and large, electronics engineers do not use computers in their work.

#### **Computer Accomplishments Do Not Stir Engineers**

They seem unmoved by reports of the monumental accounting, operational, statistical, and other specialized problems which computers have solved for business, industry and government. They may learn, for example, that Remington-Rand's Solid State 80 is keeping track of some 4 million publications issued by the Navy. Or they may learn how Remington-Rand's 1105's are helping the 1960 census.

Questioned on this score, an electronic design engineer is likely to answer: "A computer is great for paperwork. But I do creative work. A computer can't help me."

Here and there in the literature, they have seen how computers have helped civil engineers, mechanical engineers, thermodynamics engineers, optics engineers, and electrical engineers. They may have noticed that Massachusetts Institute of Technology has established a computer laboratory (with the IBM 650) for civil engineering students.

They may have read that the National Broach & Machine Co. is using a Bendix G-15 to help design gear-shaving cutters, gear-honing tools, master gears, and broaching tools. Or they may learn that Kollmorgen Optical Corp. is using

Librascope's LGP-30 to help design lenses for precision optical systems.

Occasionally, they read about a rewarding application of digital computers by electronic design engineers. They may learn that Westinghouse is using an IBM 704 to design power transformers—or that Arma is using a Burroughs 203 to design pulse transformers.

Even these dramatic examples do not seem to inspire the average electronic design engineer. "Sure, they can use computers to design transformers," he's likely to say, "but I design audio amplifiers. I can't use a computer."

#### **Why Electronics Engineers Do Not Use Digital Computers**

Though several hypotheses have been offered, nobody knows for certain why so few electronics engineers have taken advantage of digital computers. The leading "reasons" engineers give include:

1. "Computers are too darned expensive."
2. "It takes too long to program a computer. By the time I write a program, I could have solved the problem."
3. "We have a computer but it's only good for payrolls."
4. "We have too few major design problems to justify renting a computer. Computers are only useful to large companies with large engineering departments."

## Engineers Do Not Know How Quickly They Can Learn

Of course, in many cases, engineers don't know how quickly they can learn to use a computer. Using compilers like IBM's *Fortran* or Remington-Rand's *Mathmatic*, engineers have learned to use even large computers in two days. To a usable extent, these compilers translate English into computer language.

Dr. J. J. Sopka, mathematics consultant at the National Bureau of Standards in Boulder, offers still another explanation of why electronics engineers don't use computers. "They don't think their problems all the way through," he says.

"They like to formulate a problem in stages. They'll breadboard the first stage of a problem and wait for the answers to that before they start working on the next stage."

For small-equipment designs, Dr. Sopka points out, this can be a satisfactory approach. But it would be an awful way to do a job with a computer. To use a computer to best advantage, it is necessary to think a problem all the way through. As much as possible, one should give the computer alternative courses based on expected results at each stage.

## Why Electronics Engineers Should Consider The Computer

Dr. Sopka's hypothesis on why electronics engineers do not use computers is certainly plausible and its solution is rather obvious. The other objections are answered almost as easily.

1. It is certainly true that computers are expensive, but once installed, they often seem to find jobs for themselves, and just as often they can pay for themselves very quickly.

2. For short, "one-shot" designs, it may not be worth while to use a computer—especially if set-up time is long compared with the manual design time. But even for short jobs, the optimized results which a computer can yield can make it worth while.

Further, there are many computer-users' organizations which have programs available to solve many specific design problems. These groups include: *POOL*, an association of Royal-McBee computer users; *EXCHANGE*, the Bendix computer-users' group; Remington-Rand's *Univac Scientific Exchange*; and IBM's *SHARE*.

3. No computers are good "only for payrolls." Even machines which are best-suited to payroll and large record-keeping jobs can be used by electronics engineers. Most forward-looking company managements are eager to have their engineers use available machine time. (Unfortunately, this time is, in many cases, available only after 10 am on a Sunday.)

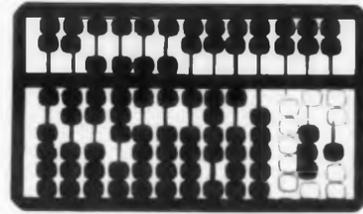
4. Even the organization with few design problems can use computers. Where it may not

be economical to rent a computer, it may be wise to take advantage of some of the computer service organizations. Companies like C-E-I-R (Arlington, Va.), Computer Services Inc. (Englewood, N.J.), Marc Shiowitz and Associates (Hawthorne, Calif.), William M. Wolf Co. (Boston), and General Kinetics Inc. (Arlington, Va.) provide a variety of useful services.

They will rent time on their computers; they will make available the services and advice of expert programmers and other computer personnel; or they will simply take over a problem and try to solve it for a fee.

There are many, many cases where an engineer will find it well worth while to discuss his design problems with a computer manufacturer or a computer service organization.

The survey which follows illustrates how many electronics engineers have reaped the benefits of computers. It is hoped that this survey will stimulate others to consider the digital computer.



## Component Design

Most applications of digital computers to component design are rather new. Probably, the oldest applications—dating back four or five years—are in motor and transformer design.

### Power-Transformer Design

The Recomp computer, manufactured by the Autonetics Div. of North American Aviation in Los Angeles, is one of the machines which has been applied to power-transformer design. In this application, the computer is fed information on transformer input-voltage, frequency, output-voltage and power.

Recomp types out information on the required number of primary turns, the number of secondary turns, and the core area. The computation minimizes copper and iron losses.

### Power-Inductor Design

One of the most extensive applications to inductor design can be credited to David Wildfeuer, a senior engineer at American Bosch Arma Corp.'s Arma Div. in Garden City, N.Y. Mr. Wildfeuer reports that he turned to a computer "as a matter of desperation." His Components Section just couldn't cope with its staggering

workload. A Burroughs 203 solved Mr. Wildfeuer's problem.

This computer, manufactured by the Electrodata Div. of Burroughs Corp. in Pasadena, has cut design time from 30 hours per transformer or filter choke to 3 hours. Of the 3 hours, only 6 to 10 minutes are computer time; the balance of the time is spent preparing drawings.

The 203 helps Arma design power transformers for frequencies of 60 cps to 10 kc with up to four secondaries, each capable of having any kind of resistive or reactive loading. These transformers handle power levels of up to 2,500 w at 400 cps. The computer helps design filter chokes just as thoroughly.

### Pulse-Transformer Design

In applying the Burroughs 203 to the design of miniature pulse transformers, Arma realizes impressive savings. Using the 203 cuts the cost of designing pulse transformers from about \$400 per transformer to a dollar. It cuts the time from 40 hours to about 45 seconds.

Input to the computer, on five punched cards, includes all the design requirements. The memory stores data on magnet-wire and core-material characteristics.

Typewritten output from the computer includes: core type and size, winding schedule (order of winding primary and secondary turns), insulation type, wire size and power rating for each winding, rise and fall times, overshoot, various losses, turns ratios, as well as voltages and resistances.

### Vacuum-Tube Design

The Red Bank Div. of Bendix Aviation Corp. in Eatontown, N.J., uses the technique of polynomial curve fitting in designing vacuum tubes with the Bendix G-15. The company estimates that it saves 10 engineering man-hours in computing a tenth-order polynomial and 50 sets of data.

### Potentiometer Tap Selection

Nonlinear-potentiometer design is another fruitful application of digital computers. In one application of Librascope's LGP-30, the Link Div. of General Precision Inc. in Binghamton, N.Y., determines tap points for a linear potentiometer and shunting resistances necessary to provide straight-line approximations of nonlinear functions.

Before the potentiometer-tapping program is inserted in the computer, a nonlinear function is graphically approximated with a set of straight-line segments. The coordinates of the points of intersection of the straight lines are entered into the computer as raw data.

The LGP-30 calculates the tap points of the

## LAMINATED PLASTICS *What they are, where they can be used*

Taylor laminated plastics, also known as reinforced plastics, are thermosetting-type materials formed by impregnating paper, cotton cloth, asbestos, glass cloth, nylon or other base materials with synthetic resins and fusing them into sheets, rods, tubes and special shapes under heat and pressure. These materials exhibit a valuable combination of characteristics, including high electrical insulation resistance, structural strength, strength-to-weight ratio, and resistance to chemical reaction; also adaptability to fabricating operations.

### Types of laminated plastics made by Taylor

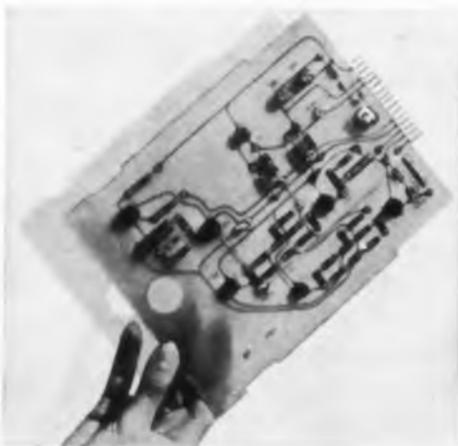
There are four basic types of Taylor laminated plastics commonly specified and used throughout industry today. They are as follows:



**Phenolic Laminates.** Paper, cotton fabric or mat, asbestos, glass cloth or nylon bases impregnated with phenol formaldehyde resins. These provide strength and rigidity, dimensional stability, resistance to heat, chemical resistance, and good dielectric characteristics. Some Taylor grades are excellent basic materials for gears, cams, pinions, bearings and other mechanical applications. Others are widely used in terminal boards, switchgear, circuit breakers, switches, electrical appliances and motors. Also in radios, television equipment and other electronic devices; and in missiles as nose cones, exhaust nozzles, and combustion chamber liners.



**Melamine Laminates.** Glass cloth or cotton fabric impregnated with melamine formaldehyde resin. Taylor melamine laminates have superior mechanical strength and are especially desirable for their arc-resistant qualities. Good flame and heat resistance, good resistance to the corrosive effects of alkalis and most other common solvents, besides other favorable characteristics. Typical applications include arc barriers, switchboard panels, and circuit-breaker parts in electrical installations.



**Silicone Laminates.** Continuous-filament woven glass fabric impregnated with a silicone resin. These laminates combine high heat resistance (up to 500°F. continuous) with excellent electrical and mechanical properties. They are primarily used in high-temperature electrical applications and high-frequency radio equipment.

**Epoxy Laminates.** Continuous-filament woven glass fabric or paper impregnated with epoxy resin. Glass-fabric grades are designed for use in applications requiring high humidity-resistance, good chemical resistance,

CIRCLE 28 ON READER-SERVICE CARD



and strength retention at elevated temperatures. Paper grades are used under high-humidity conditions where resistance to acids and alkalis is required. Both grades are characterized by good dielectric strength, low dielectric losses, and high insulation resistance even following severe humidity conditions.

Recent technical advances in the bonding of various metallic and nonmetallic materials to laminated plastics have opened up new design opportunities. It is now possible to bond virtually any compatible material with a laminated plastic to form a composite which combines the advantages of both. One of the first composite materials was a copper-clad laminate used for printed circuits. More recent composite laminates, usually manufactured to customer specification, include the following: Taylorite® vulcanized fibre-clad, rubber-clad, asbestos-clad, aluminum-clad, beryllium-copper-clad, stainless-steel-clad, magnesium-clad, and silver-and gold-clad. Any one of these materials can be sandwiched between sheets of laminates, too, and can be molded to fit specific requirements.

Send for complete information about any or all of these Taylor laminates. And remember Taylor's new selection guide will simplify your problems in choosing the right laminate for your specific application. Taylor Fibre Co., Norristown 48, Pa.

# Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

## Designing With Digital Computers

linear potentiometer in terms of degrees of wiper rotation as well as shunt and padder resistances necessary for the straight-line approximation of the original nonlinear function.

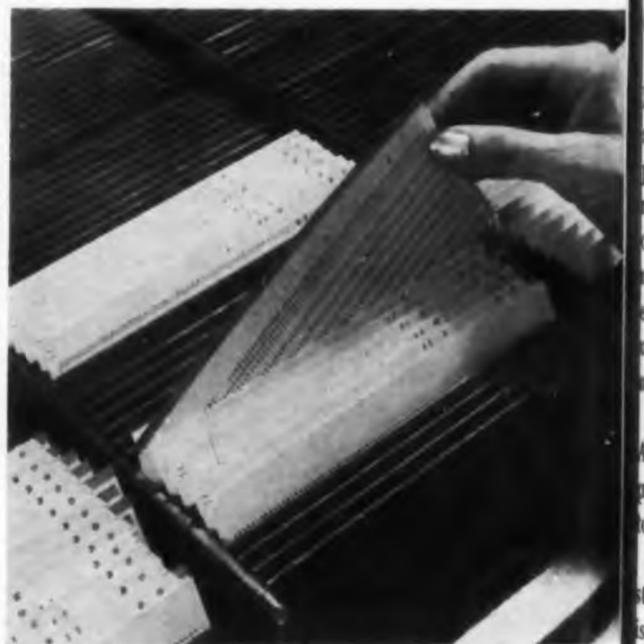
### Nonlinear-Potentiometer Design

Spectrol Electronics Corp. of San Gabriel, Calif., uses an IBM 610 to design nonlinear potentiometers. For both single and multiturn potentiometers, Spectrol engineers prepare input information in the form of  $x$  and  $y$  coordinates or equations describing the parameters of a given nonlinear function. With the help of previously programmed general equations, the 610 computes manufacturing directions in terms of winding-equipment settings, cam angles, and radii.

The manufacturing directions are automatically printed on a form which is sent to production. At the same time, punched tape is prepared to store information for repeat requirements. Using the 610 reduces quote time for complex potentiometers from weeks to days, and in emergencies, to a few hours. Computations that formerly took four to six days now require only minutes.

### Solenoid Design

Royal McBee Corp. of Port Chester, N.Y., uses the LGP-30 (which it markets for Librascope Corp.) to evaluate solenoid designs. Information fed to the computer on punched paper tape in-

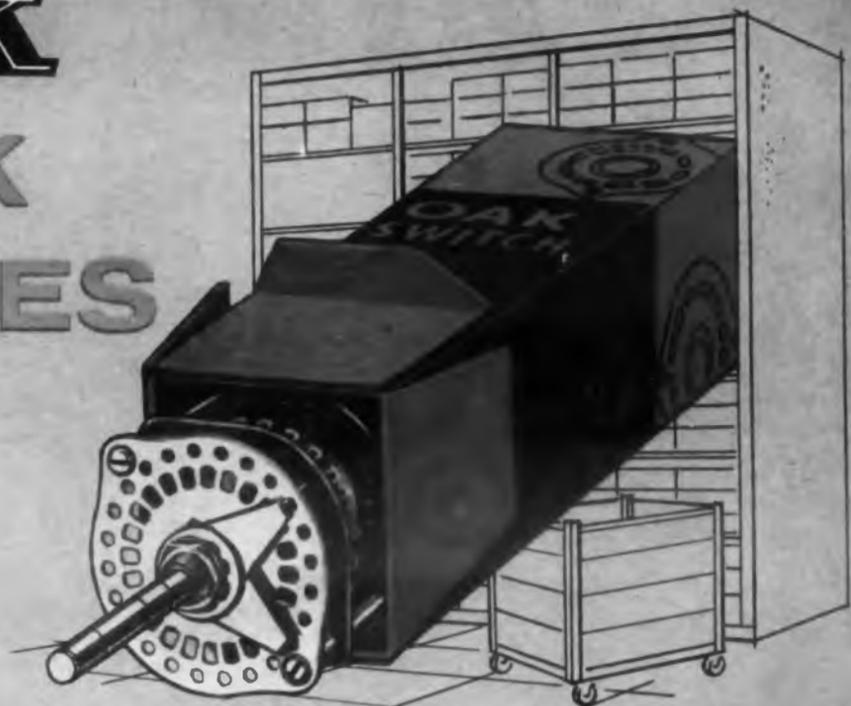


Punched cards show Litton engineers which circuit-board and computer-frame locations are available for new circuits.

# Now Stock as well as Custom!

## OAK STOCK SWITCHES

### ROTARY LOW-POWER TYPE



*48-Hour Order Handling Procedures and  
Fast Transportation Methods Assure Quick Delivery*



- 124 Different Sizes and Types
- Supplied Fully Assembled or as Subassemblies
- Subassemblies: Sections, Shafts with Index, Strut Screws, Spacers, Miscellaneous Hardware
- Phenolic and Steatite Grade Insulations
- 1 to 4 Sections—2 to 23 Positions
- Shorting and Nonshorting

Now you can get *fast delivery from stock* of popular Oak rotary switches.

Order them as completely assembled units or as sub-assemblies in quantities from 1 to 249. All stock switches have one fixed and one adjustable stop; grooved shafts for "break-off" to desired length; double-wiping contacts of silver-plated brass (shorting and nonshorting types). Finishes withstand the 50-hour salt spray test, enabling the switches to be used in most military as well as commercial applications.

These are the same, quality OEM switches which have formerly been available only as custom units in large production quantities. For years they have been the industry's standard in all types of electronic equipment.

Don't wait, call your Oak representative or the factory for complete details today.

*Send For Catalog 399 Showing Complete  
Stock Line and Prices. Quantities  
Available on Letterhead Request.*



## OAK

MANUFACTURING CO.

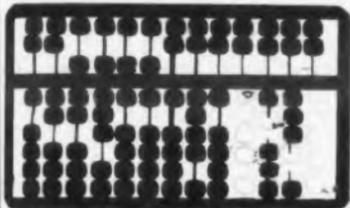
1260 Clyburn Ave., Dept. D, Chicago 10, Ill. Phone: MOhawk 4-2227

SWITCHES CHOPPERS VIBRATORS  
ROTARY SOLENOIDS TUNERS TIMERS  
ELECTRONIC SUBASSEMBLIES

West Coast: Oak Electronics Corp., 11252 Playa Court  
Culver City, Calif. Phone: EXmont 1-6367

cludes: the gap at the pole piece when open, a time increment to be used, mass of the armature, gap at the pole piece at closure, mechanical damping factor, a constant to indicate no current change, the initial armature hold-back force, the spring constant, the initial current and applied emf, the pole-face area, number of turns, average length of a turn, wire resistance, length of the iron, and  $\mu$  of the air and iron.

The LGP-30 delivers information on the steady-state operation of the solenoid in terms of the total resistance, steady-state current, steady-state flux, generated force, inductance and time constant. The entire program shows the chronological operation of the solenoid through closure and opening. When 0.1-msec time increments are used over a closure time of about 10 msec, the entire computation on the LGP-30 requires only about 90 min.



Network  
Design

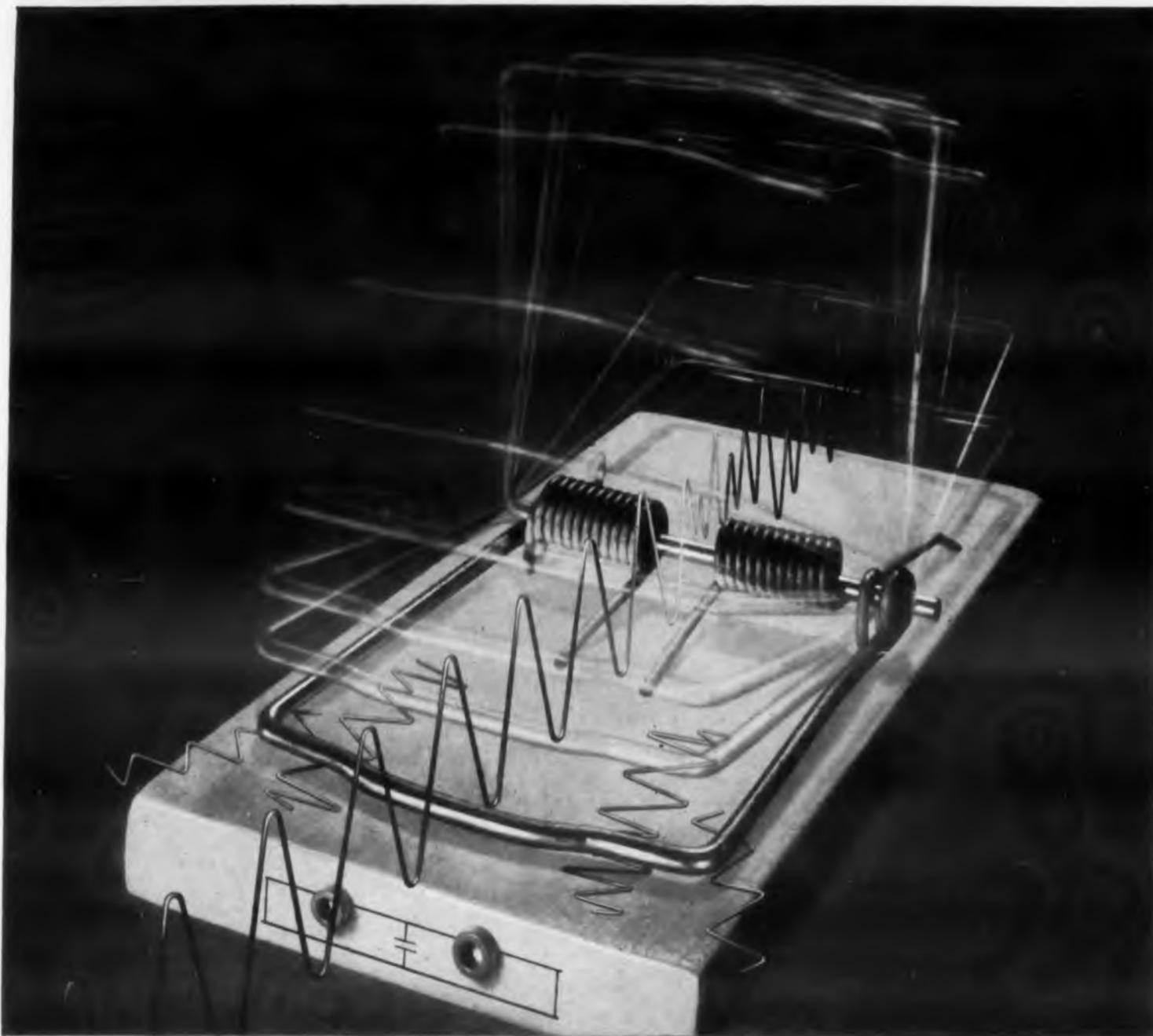
There are few areas where digital computers are used more fruitfully than in network design and analysis and, more specifically, in filter design. Here, at least, there is a significant trend away from manual computation. The valuable paperwork which even small machines can deliver in a relatively short time can often save thousands of engineering hours.

#### Passive-Network Design

At North Hills Electric Co. of Mineola, N.Y., Philip R. Geffe used an IBM 650 to analyze and synthesize a variety of passive networks. Using punched-card input, he inserted network formulas and likely element values. The output, also on punched cards, yielded information including network element values, attenuation in db and envelope delay. One year of part-time computer usage yielded at least 10 years worth of engineering hand-calculated data.

Engineering consultants Marc Schiowitz and Associates of Hawthorne, Calif., have a computer program for National Cash Register's NCR-304 to analyze steady-state linear passive networks. The program uses an iterative technique instead of the usual equation-solving methods. It is supposed to cut down computing time for many types of networks.

Magnavox Co. of Fort Wayne, Ind., uses a Bendix G-15 for filter design. Magnavox engi-



## How to build a better (audio signal) trap!

Magnetics Inc. permalloy powder cores give filter designers new attenuation and stability standards—and miniaturization to boot!

The art of trapping unwanted frequencies has been advanced during the past year with a succession of improvements in molybdenum permalloy powder cores by Magnetics Inc. Most audio filter designers now work with smaller cores, more stable cores and cores whose attenuation characteristics are ultra-sharp. Do you?

Do you, for example, specify our 160-mu cores when space is a problem? With this higher inductance, you need at least 10 percent fewer turns for a given inductance than with the 125-mu core. What's more, you can use heavier wire, and thus cut down d-c resistance.

What about temperature stability? Our linear cores are used with polystyrene capacitors, cutting costs in half compared to temperature stabilized moly-permalloy cores with silvered mica capacitors. Yet frequency stability over a wide swing in ambient temperatures is increased!

And what do you specify when you must rigidly define channel cut-offs, with sharp, permanent attenuation at channel crossovers? Our moly-permalloy cores have virtually no resistive component, so there is almost no core loss. The resultant high Q means sharp attenuation of blocked frequencies in high and low band pass ranges.

Why not write for complete information? Like all of our components, molybdenum permalloy powder cores are performance-guaranteed to standards unsurpassed in the industry. *Magnetics Inc., Dept. ED-82, Butler, Pa.*



CIRCLE 30 ON READER-SERVICE CARD

## Designing With Digital Computers

neers feed the computer information on a filter's load and its various attenuation frequencies. The machine gives the attenuation frequencies and values of all the elements in the filters.

### Filter Design

In one of the most extensive applications to filter design, Kenneth Smith of Lenkurt Electric Co. in San Carlos, Calif., uses an IBM 650 for a whole series of designs. Though Lenkurt's 650 is devoted principally to factory accounting, the engineering department has used it to great advantage in designing bandpass filters for telephone and telegraph carrier systems.

Before the computer was installed at Lenkurt all filter calculations were performed on a desk calculator. Solving equations for a single bandpass filter required about 20 man-hours. Now, the same equations, involving roughly 10,000 computations are worked in five minutes by the IBM 650. In peak periods, when a design group may be developing as many as 12 filters a week the saving can amount to 239 engineering man-hours a week. Lenkurt's use of the 650 is well illustrated in the following typical problems.

**Problem 1.** Estimate the attenuation of an image-parameter filter prior to design. Computer input includes: (1) cutoff frequencies, (2) infinite-point frequencies, (3) filter half-sections to be considered, (4) frequencies of the desired estimate of attenuation.

Computer output includes: (1) frequencies of desired estimate of attenuation, (2) corresponding estimate of attenuation. Average machine time—18 minutes. Time required by a desk calculator to do the same job—4 hours.

**Problem 2.** Design an image parameter filter from the best estimate in problem 1. Computer input: (1) cutoff frequencies, (2) infinite-point frequencies, (3) filter half-sections in proper order.

Computer output: element values of each filter half-section. Machine time—6 minutes. Desk calculator time would have been 20 hours including a double check for accuracy.

**Problem 3.** Combine the half-section element values and write an analysis program for the next step. Computer input: element values of each filter half-section from problem 2, and element losses.

Computer output: element values of the combined composite filter and an input program for

the Bell Telephone Laboratories analysis deck BL-2002. Average 650 time—3 minutes. Desk calculator to do the same job—4 hours.

**Problem 4.** Analyze response of the filters of problem 3 with lossy elements using the analysis deck BL-2002. Computer input: the program from problem 3 and the frequencies of desired response.

Computer output: (1) attenuation in db, (2) phase angle in degrees, (3) insertion loss ratio as a complex number, (4) input impedance and admittance. Computer time—30 minutes. Problem is not practical with a desk calculator. It would have been necessary to build a model and test (about 20 hours).

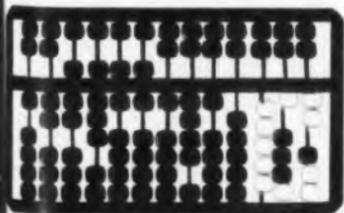
**Problem 5.** Prepare a table for frequency-difference tuning of all meshes of a filter. Computer input: (1) design-center frequency of each mesh, (2) frequency tolerance of each mesh, (3) design capacity of each mesh.

Computer output: (1) upper frequency limit and upper padder-capacity value for each internal frequency difference from design center, (2) lower frequency limit and lower padder values for each internal frequency difference. Average machine time—24 minutes. Desk-calculator time would have been 20 hours.

Mr. Smith comments that Lenkurt's engineers used 396 hours of 650 time during 1959. He estimates that the same job by desk calculator would have required 20,160 man-hours.

Other companies using computer in filter-network design have realized similar savings.

Vitro Laboratories of West Orange, N.J., saved three man-months on two problems. Vitro engineers used the Bendix G-15 whose input included measured gains and outputs and values for assumed design parameters. The G-15 provided information for plotting slopes, intercepts, and additional design parameters resulting from the solutions of simultaneous equations.



Circuit Design

One of the broadest areas of application for digital computers lies in circuit design and analysis. Yet even here, the computer scarcely sees full exploitation. Relatively few circuit designers have taken even partial advantage of this powerful tool. Where the computers have been used,

ALL UNITS ACTUAL SIZE



## HYREL® FB DEPOSITED CARBON RESISTORS ARE UNMATCHED FOR PERFORMANCE



HYREL® FB DEPOSITED CARBON RESISTORS

are hermetically sealed in ceramic jackets against moisture and vapor... safely protected against mechanical abuse.

The Hyrel FB series is intended for applications in military, commercial and telephone equipment where long life under high humidity, small size, and stability of electrical characteristics are important.

WRITE FOR ENGINEERING BULLETIN 7010B  
SPRAGUE ELECTRIC COMPANY  
307 MARSHALL STREET • NORTH ADAMS, MASS.

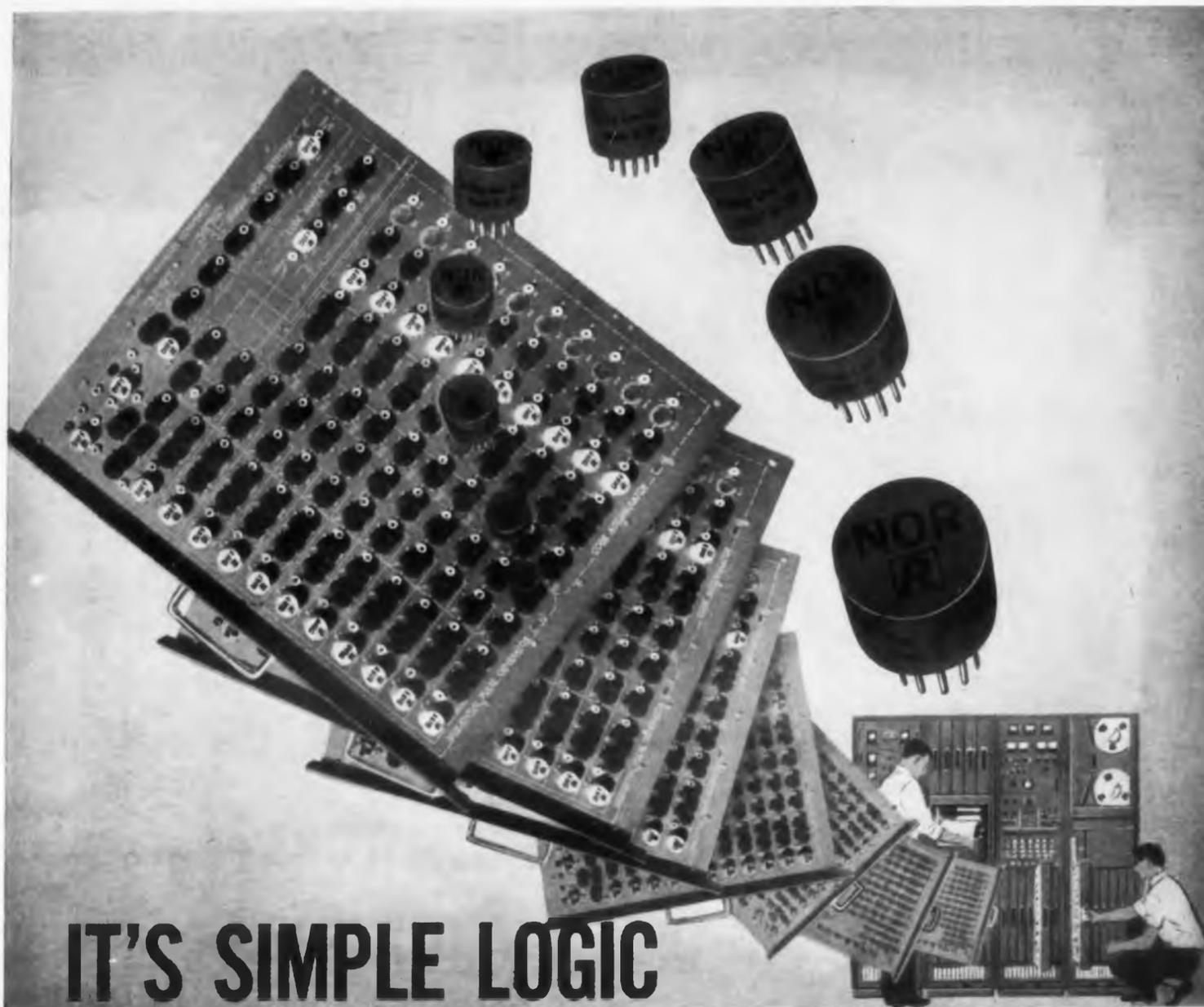


Made to far exceed MIL-R-10509C Specifications

SPRAGUE COMPONENTS:

CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS  
HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

CIRCLE 31 ON READER-SERVICE CARD



## IT'S SIMPLE LOGIC

...to standardize digital systems...and simplify maintenance with **RADILOGS**

"Radilogs" are small plug-in logic modules that make possible entire digital systems, using a repetition of as few as two basic circuits. Maintenance involves consideration of only two parameters, saturation and cut-off. Simple rearrangement of a group of "Radilogs" produces entirely new configurations of logic networks. Thus, many a costly system that has served its original purpose is saved from obsolescence. New systems can be designed for greater simplicity and versatility at lower cost.

Radiation developed and presently offers "Radilogs" in three circuit configurations: NOR, Differentiator and Power Driver. Each of these is available in three speed ranges: low, medium and high. Encapsulated and color-coded, they plug into standard 9-pin miniature tube sockets.

For technical information and prices, write to Radiation Inc., Dept. ED-8, Melbourne, Fla.

### THE ELECTRONICS FIELD ALSO RELIES ON RADIATION FOR...

**TDMS**—Telegraph Distortion Monitoring System pin-points type and source of trouble on teletype, data processing and similar communications links without interrupting traffic. Ultra-compact TDMS can replace most test equipment now required for teletype maintenance and monitoring.

**RADIPLEX**—48-channel low-level multiplexer with broad data processing applications. Features rugged solid-state circuitry, almost unlimited programming flexibility, unique modular construction for compactness and exceptional ease of operation and maintenance.

**TELEMETRY TRANSMITTER**—Model 3115 is a ruggedized 215-260 MC unit with extremely linear FM output under the most severe environmental conditions. With its record of outstanding performance in many missile programs, Model 3115 is specified by leading missile manufacturers.



**RADIATION**  
INCORPORATED

CIRCLE 32 ON READER-SERVICE CARD

## Designing With Digital Computers

designers have realized substantial advantages in circuit performance, as well as engineering time and costs.

### Impedance Calculations

The Recomp computer has been used for calculating complex impedances. In such applications, the machine receives as input, values of resistance, capacitance and inductance of a complex network and the input frequency. Recomp calculates the total impedance, equivalent series and parallel resistance, and reactance and phase angle at a given frequency, as well as other resonant frequencies.

### Equivalent Circuit Analysis

At Bell Telephone Laboratories, V. R. Saari uses an IBM 650 and an IBM 704 in a variety of circuit design and analysis applications. In one application, he found equivalent circuits to fit measured black-box data. He fed the computer an analysis program based on the type of circuit whose characteristics could reasonably approximate those of the black box. He also inserted several sets of likely element and parameter values as well as measured data on the black box to be characterized.

The computer listed electrical characteristics to approximate the circuit in the black box and reorganized the measured data into a form more suitable for examination and comparison with the computed characteristics. The set of element and parameter values which resulted in circuit characteristics most closely approximating the measured data was chosen as the best one to describe the black box.

Mr. Saari also used these computers in analyzing networks of various types. As input, he used measured data tabulated against frequency for active devices and other components for which valid equivalent circuits were not available. He also inputted values for lumped-constant networks and other parameter values such as characteristic impedance and length of transmission lines and operating temperature.

The computer yielded information on: (1) forward and reverse currents, voltage- and power-transfer ratios of a cascade of active devices (or lumped-constant networks, or transmission lines); (2) input and output impedances of such cascades; (3) derivatives with respect to the various

element and parameter values, hence reasonable tolerances; and (4) total current or power drain by the network.

#### Amplifier Analysis

In still another application, Mr. Saari used the 650 or the 704 to determine whether or not parasitics were under control in an amplifier. He programmed the computer to yield the electrical characteristics of an amplifier circuit or a cascade of amplifiers.

Mr. Saari also used the 650 or 704 to check the final design of an amplifier and calculate its sensitivity to changes in circuit-element or transistor parameters.

#### Microwave Circuit Design

At the high-frequency end of the spectrum, Leo Young of Westinghouse Electric Corp. in Baltimore teamed up a Smith chart and an IBM 650. Using the Smith chart, he first estimated the parameters of a microwave bandpass filter. He then used the 650 to analyze the preliminary design. He varied the parameters till the computer showed the new performance to be acceptable. This was his first approach to the design.

Finally, however, he programmed the 650 to vary the circuit parameters till the optimum design was reached. The computer made trial and error adjustments, interpolations, and extrapolations automatically. The 650 calculated vswr, reflection coefficient, insertion loss, maximum voltage and phase difference as a function of frequency. It also made calculations for component tolerances and circuit losses.

#### Transistorized-Inverter Design

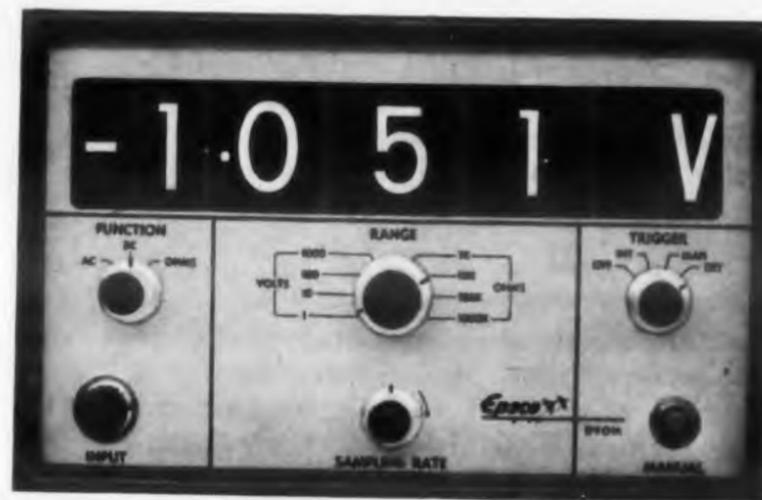
Bendix Aviation Corp.'s Computer Div. in Los Angeles used the Bendix G-15 to design transistorized inverters for the Bendix G-20 computer. Information fed to the G-15 included end-of-life transistor parameter values, maximum expected temperature (with a safety factor), input voltage and tolerance, special bias, maximum collector currents, and calculated resistor values and tolerances. The G-15 typed out values of resistor couplings for the transistor inverters and listed the driving currents required.

After the initial program was set up, the G-15 required about two minutes to provide a curve. Previously, using a desk calculator, 45 to 60 minutes were required.

#### Blocking-Oscillator Design

The Bendix G-15 was also used to design transistorized blocking oscillators and inductive integrators for the Bendix G-20. In the blocking-oscillator program input to the machine included measured values of transistor and transformer

## IN ADVANCED DIGITAL INSTRUMENTS EPSCO DELIVERS ITS SPECIFICATION



# EPSCO DVOM<sup>®</sup> COMBINES 9 FEATURES IN 8<sup>3</sup>/<sub>4</sub>" x 5<sup>1</sup>/<sub>4</sub>" x 13<sup>3</sup>/<sub>4</sub>"



QUICK SPEC CHECK—compare with your needs:

- AC and DC voltages from 0 to 1000 (four ranges)
- Resistance: 1K to 1000K (four ranges)
- Accuracy: DC - 0.1% AC - 0.25% Ohms - 0.25%
- 3 decimal digits plus over-ranging

For complete specifications, call or write today for Bulletin 26002.

#### HERE ARE THE 9 FEATURES:

1. Measures AC volts, DC volts and ohms.
2. Parallel decimal and 4221 BCD output.
3. 4 milliseconds per conversion.
4. All solid state circuitry.
5. Modular, plug-in construction.
6. In-line, in-plane display.
7. 100 independent measurements per second.
8. Internal and external conversion command.
9. Mount two, side by side, in a RETMA rack.

**EpSCO**  **INSTRUMENTS**

A division of EpSCO, Incorporated, 275 Massachusetts Ave., Cambridge 39, Mass. Telephone UNIVERSITY 4-4950  
CIRCLE 33 ON READER-SERVICE CARD

## Designing With Digital Computers

parameters. The input bias voltage was used as the running parameter.

The G-15 calculated the output pulse width of the oscillator and provided 70 curves in three quarters of an hour. It used to take a design engineer and a desk calculator an hour and a half for a single curve.

In designing inductive integrators, Bendix engineers fed the G-15 measured values of transistor parameters and the required timing resistance. They used clamp voltage as the running parameter. The computer provided a time delay curve in five minutes. A desk-calculator design-engineer team used to require an hour and a half per curve.

### Power-Supply Design

One of the popular computer applications is power-supply design and analysis. IBM has a program which treats selected polyphase and single-phase circuits. It operates not only on passive parameters but also on overlapping diode currents and non-sinusoidal input voltages. Including laboratory test and redesign, the program can help an engineer design as many as five complete power supplies in a month.

### Flip-Flop Design

At the Ramo-Wooldridge Div. of Thompson Ramo Wooldridge in Los Angeles, three engineers, Tom Connolly, Bob Mellott, and Mel Gillies, used an IBM 704 to design the flip-flops for the RW-31, RW-400, and RW-41 computers. They wrote Kirchhoff equations describing the flip-flops and used these to find the optimum value of the components which were critical to the dc stability of the circuits. They made approximations for transistor parameters, component variation, and voltage variation. The 704 gave optimum component values for various voltage levels, for leakage-current levels, and for standard resistor values (about 1,000 different cases).

Hand computation, Schmo plots, and trial-and-error methods for flip-flop design used to require several weeks to a month. Using the 704 to compute and print out the solutions for more thorough analysis required only 20 minutes.

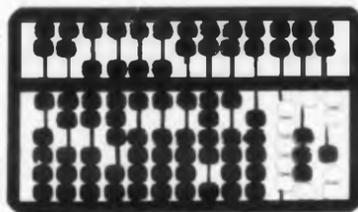
### Nonlinear-Circuit Analysis

At the University of Illinois, L. D. Fosdick used a computer to calculate equilibrium node



**Nonlinear potentiometers** are designed faster and better by Spectrol Electronics Corp. with the IBM-610.

voltages and branch currents in circuits with nonlinear elements. The circuits included resistors, diodes and transistors.



### Computer Design

Few areas of design seem more appropriate for the digital computer than that of designing digital computers. The cynics of a decade ago who quipped that the "giant electronic brains" would soon be fathering "baby electronic brains" were not far off. An ironical twist, however, lies in the fact that the progeny is often more powerful than the parent.

One example of this comes from the Datamatic Div. of Minneapolis-Honeywell Regulator Co. in Newton Highlands, Mass., where engineers used the Datamatic 1000 to design the new Honeywell 800. Using the Datamatic 1000 obviated about 10,000 circuit diagrams that otherwise would have been required in manufacturing the Honeywell 800.

The Datamatic 1000 prepared wiring lists fixing the origin and termination for each of 60,000 wires, as well as the route each was to follow. In addition, tables of wire position, recorded on

magnetic tape, helped engineers check for noise pickup. The computer also checked the new machine's logic for timing errors.

### Wiring-List Preparation

At IBM in Poughkeepsie, N.Y., many programs written for the IBM 704 and 705 have been used to help design new computers. With one program, a computer prepares back-panel wiring lists which describe how the components are to be interconnected in the new machine to implement the logic and to minimize interwire noise and the amount of wire used.

In a paper presented at the AIEE Winter General Meeting early this year, IBM's G. W. Altman, L. A. DeCampo, and C. R. Warburton indicated that minimizing interwire noise, a monotonous and error-prone job, used to require two engineering man-weeks. Judgment, rather than computation, was the criterion.

Now, the average time for the first run of a panel is six hours from the start of key punching to the delivery of a completed panel-wiring list. The list printed out by the computer contains information about wire types, wire connections, lengths and routing.

The back-panel wiring program has produced almost 3,000 panels for IBM's Poughkeepsie Product Development Group.

In a similar application, Marc Shiowitz and Associates of Hawthorne, Calif., use the Alvac III-E to generate detailed and complete wiring lists from logical design. In this service offered

by MSA, wiring lists can be generated within a day after a logical design is completed. When design changes are required the wiring lists can be updated immediately.

MSA's program, using Boolean equations for input, can mechanize multi-level diode or transistor logic. It allows for the use of any standardized set of digital building blocks. The service fee for computer-generated wiring lists is less than the cost of schematics or the cost of a manually prepared list.

#### Automatic Logic Design

Eugen I. Bosch of Litton Industries in Beverly Hills, Calif., used—not a computer—but inexpensive peripheral equipment to design large-scale computers at Litton's Tactical Systems Laboratory. Automating the logic was accomplished with off-line equipment like sorters, collators and tabulators.

An actual computer was used only to simulate the operation of the new computer before the logic was actually wired up as final hardware. Using the off-line equipment, Mr. Bosch had the handwritten logic punched on cards, then tabulated in two versions: (1) logical equations representing the inputs to active circuits, (2) a list showing all places where the output of each circuit must go.

When the logic was ready for wiring, another card deck was prepared from a logic deck. It contained one card for each circuit required to mechanize the logic. Circuit and space allocation was accomplished by manually merging this deck with pre-punched cards which represented the available circuit boards and computer-frame locations.

The merged deck was used to generate wiring lists automatically. Final printout included a logic listing (a neat alphabetized copy of the handwritten logic), and a tabulation showing the total current each signal was to supply.

#### Circuit-Loading Calculation

A large general-purpose computer helped engineers at Ramo-Wooldridge design the large RW-400 computer as well as other RW computers. From logical equations the computer prepared wiring lists for chassis and logic card assembly. It determined loading of each flip-flop and of other circuits and advised the logical designer of required changes in logic. In addition to this, the computer produced necessary check-out and maintenance information for the finished equipment.

In a paper delivered before the Association for Computing Machinery, Ramo-Wooldridge engineers John P. Malbrain and Anthony V. Banes reported that using the computer to de-

## DESIGN WITH ARNOLD 6T CORES . . . SAME-DAY SHIPMENT OF STANDARD DELTAMAX CORE SIZES

Arnold 6T tape cores (aluminum-cased and hermetically-sealed) offer you three very important design advantages. *One:* Maximum compactness, comparable to or exceeding that previously offered only by plastic-cased cores. *Two:* Maximum built-in protection against environmental hazards. *Three:* Require no supplementary insulation prior to winding and can be vacuum impregnated after winding.

Now we've added a fourth vital advantage: Maximum availability. An initial stock of approximately

20,000 Deltamax 1, 2 and 4-mil tape cores in the proposed EIA standard sizes (See AIEE Publication No. 430) is ready on warehouse shelves for your convenience. From this revolving stock, you can get immediate shipment (*the same day order is received*) on cores in quantities from prototype lots to regular production requirements.

Use Arnold 6T cores in your designs for improved performance and reduced cost. They're guaranteed against 1000-volt breakdown . . . guaranteed to meet military

test specifications for resistance to vibration and shock . . . guaranteed also to meet military specifications for operating temperatures. The 6T hermetic casing method is extra rigid to protect against strains.

Let us supply *your* requirements. Full data (Bulletin TC-101A and Supplements) on request. • Write *The Arnold Engineering Company, Main Office and Plant, Marengo, Ill.*

ADDRESS DEPT. ED-8-2



# ARNOLD

SPECIALISTS IN MAGNETIC MATERIALS

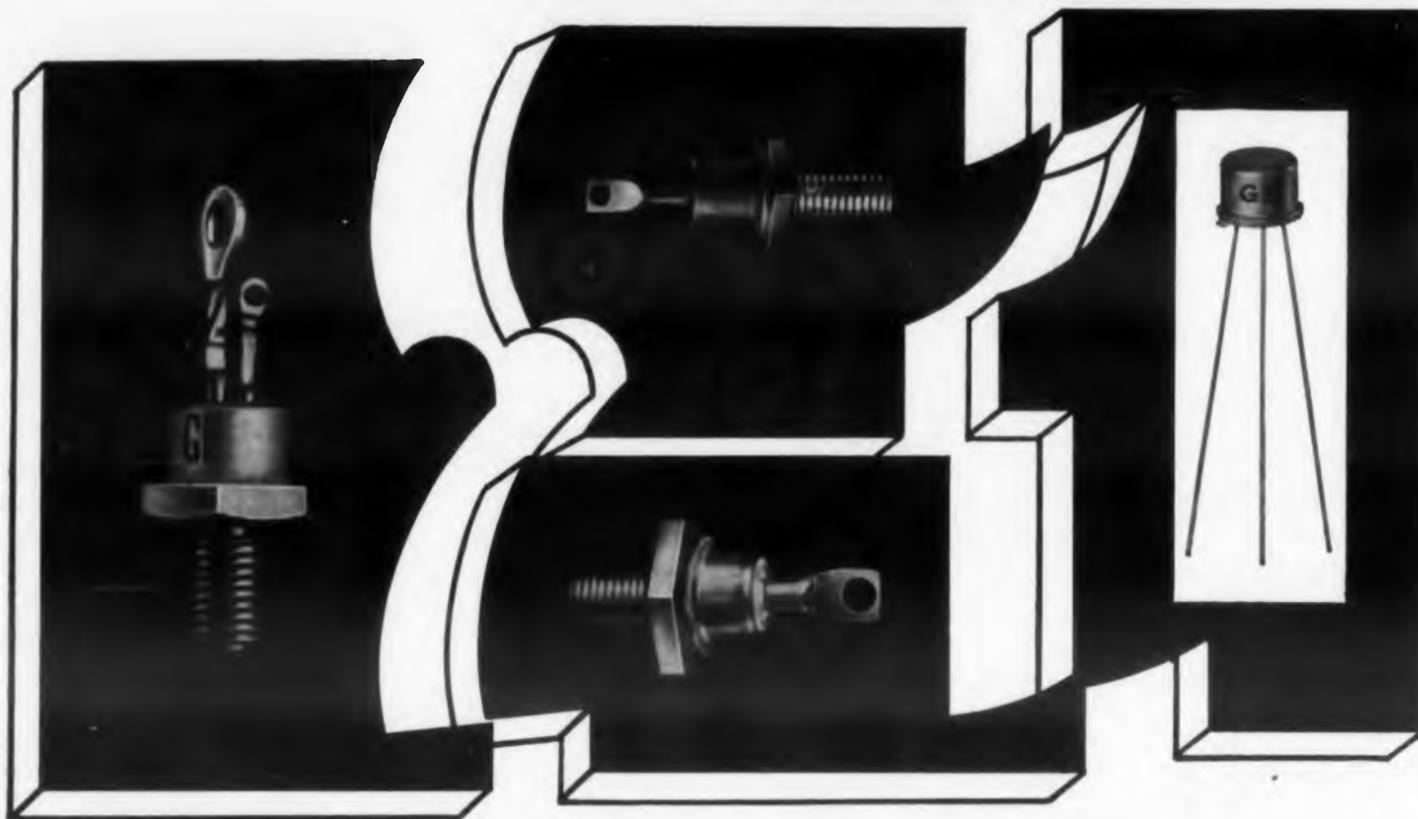
BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES • Find them FAST In the YELLOW PAGES



**READY  
TO ROLL!  
RIGHT  
FROM  
STOCK**

CIRCLE 34 ON READER-SERVICE CARD

# How to fit proved



## components into your SCR circuits

Hundreds of circuits have successfully proved out the General Electric semiconductors listed here as companions to the silicon controlled rectifier. In fact, General Electric used these very same components in developing and perfecting the revolutionary SCR. You capitalize on G.E.'s three years of unequalled SCR experience when you choose compatible G-E components. Together they form a seasoned, smooth-running team that will enhance the performance and reliability of your designs.

And remember, *only* G-E medium current rectifiers give you freedom from thermal fatigue (only hard solders are used); *transient* PRV ratings that save you money; reverse polarity for common heat sink mounting; and very low reverse leakage current for operation in series with SCR's.

For detailed information on SCR theory, ratings and applications, send \$1.00 for General Electric's new *Controlled Rectifier Manual*. Also at many G-E Distributors.

CIRCUIT COMPATIBILITY CHART					
If using G-E SCR Type	Use G-E Rectifier Type	Max. Cont. Current @ Stud Temp.	Peak 1 Cycle Surge	Max. Trans. PRV	Stud Hex. Size
C10	1N1341A-1N1348A	7A @ 140C	150A	800V	7/16"
C11	1N1341A-1N1348A	7A @ 140C	150A	800V	7/16"
C35	1N1199A-1N1206A* 1N2154-1N2160*	12A @ 150C 25A @ 145C	240A 300A	800V 800V	7/16" 11/16"
C36	1N1341A-1N1348A 1N1199A-1N1206A*	7A @ 140C 12A @ 150C	150A 240A	800V 800V	7/16" 7/16"
C40	1N1199A-1N1348A 1N2154-1N2160*	12A @ 150C	240A	800V	7/16"
C50	4JA60*	50A @ 160C	900A	500V	1-19/32" Dia. Housing
ZJ50L	4JA62*	50A @ 110C	900A	500V	1-19/32" Dia. Housing

Compatible Unijunction Firing Transistor: 2N1671A

\* Stack Assemblies Available

**GENERAL  ELECTRIC**

Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

CIRCLE 35 ON READER-SERVICE CARD

## Designing With Digital Computers

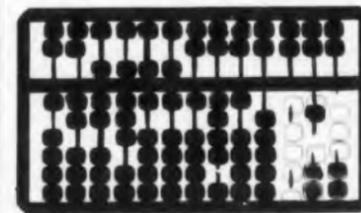
sign new ones cut the calendar time to produce a large data processor by a year or more.

Final output from the computer gave all parts locations, wire routing, and component values. After more than a year of experience, RW engineers have found that maintenance personnel prefer computer-prepared wiring lists even when drawings exist.

The National Bureau of Standards, also, has used a computer to help design new ones. Approximately 20,000 punched cards contained information from which logical design was converted into detailed wiring plans.

Boolean equations were first checked for internal consistency, then, using additional data describing the physical location of the principal building blocks in the system, the computer automatically assigned minor components to optimum physical locations. The computer calculated optimum wire routing and prepared the topological diagram of the wiring tree showing the location of each node and its connection with other nodes in the tree.

Finally, the computer calculated the exact lengths of all wires, specifying terminal types, pin-to-pin connections, text for wire labels, and a detailed inventory of components and materials to be used. Final output data included 15,000 printed pages.



ropagation  
Studies

In propagation studies and in antenna design, the digital computer has not only saved time and money, it has performed tasks which would not have even been attempted without its aid.

### Ionospheric-Scatter Analysis

At the National Bureau of Standards in Boulder, Gregg Merrill of the Central Radio Propagation Laboratory used an IBM 650 for a problem which could not have been approached by manual methods. He used the computer to analyze antenna radiation patterns in the lower ionosphere and fresnel zones for antennas elevated over spherical earth. The fresnel zone had



**Translating Russian** to English at NBS is the job of Mrs. Ida Rhodes who is developing automatic translation techniques to allow a computer to do the job.

never before been calculated over spherical earth.

Card input to the 650 represented tropospheric refraction, spherical divergence, parallax, surface refractivity, linear lapse rate, antenna height and frequency.

Output from the 650 gave the ground-voltage interference pattern between the direct wave and ground-reflected wave. Matching the direct wave and reflected wave gave the smooth pattern needed (to within 3 mm in 1200 km), over the frequency range of 30 to 55 mc. With help from the 650, Mr. Merrill established a theoretical pattern which helped him set up experiments.

He was able to determine optimum antenna height, size of the fresnel zone, near and far edges, near and far quarter-wave contours, angles of illumination through the fresnel zone, and the elevation of the zero-phase surface of the earth. Machine time on the 650 was about 400 hours.

#### Lightning-Flash Analysis

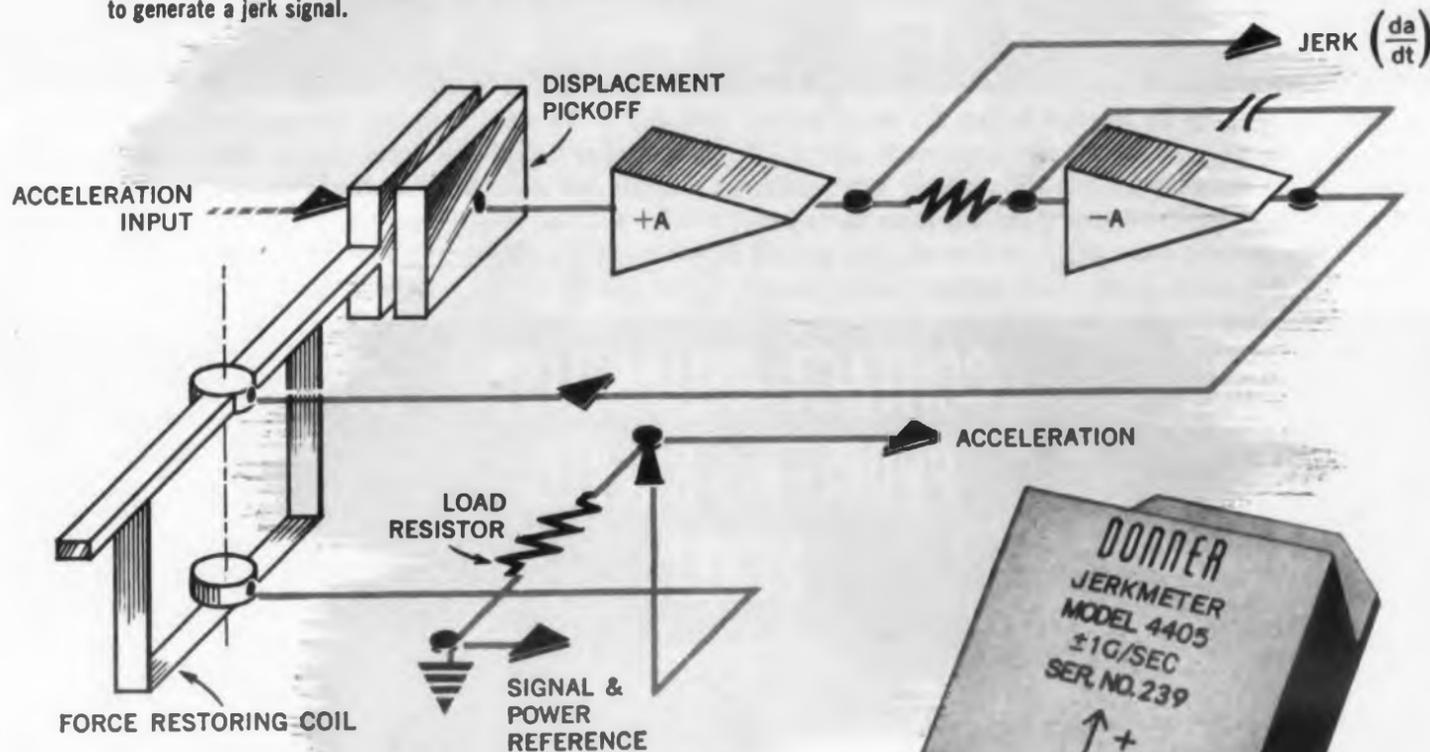
Using the same 650, John Kemper of the NBS Central Radio Propagation Laboratory analyzed the attenuation and phase delay due to propagation. He used the 650 to perform Fourier analyses of pulses from lightning flashes 1,000 and 2,000 km away.

Scope waveforms of the pulses were filmed, then transferred to a curve tracer which yielded the  $x$  and  $y$  coordinates of the waveform envelope. Mr. Kemper punched these coordinates on cards. Output from the computer represented the frequency spectrum, phase, and amplitude of the lightning pulses. These were plotted directly.

Subtracting the pulse of the near lightning flash from that of the far one showed the attenuation and phase change due to propagation. About an hour was required to trace one waveform and enter it into the 650. Eight hours of computation would have been required with a desk calculator.

NBS has used digital computers in other areas

Functional diagram of Donner Linear Jerkmeter. This unique instrument operates as a subminiature servo-system of the force-balance type which is responsive to jerk along the sensitivity axis of the linear unit and about the sensitive axis of the angular unit. Basically, the system consists of a transistorized accelerometer with an integrator inserted into the servo-loop to generate a jerk signal.



## HOW TO MEASURE $\frac{da}{dt}$

*New Donner precision Jerkmeters measure linear and angular jerk to  $\pm 0.5\%$  or better.*

If your measurement and control problem requires accurate measurement of jerk or the rate of change of acceleration, Donner Scientific's new line of precision angular and linear jerkmeters can help.

These new instruments are the only truly accurate device of this type ever made. They are designed to meet the most demanding applications. Both angular and linear jerkmeters provide an output voltage proportional to jerk which in turn can be used to

instigate compensatory control forces or other actions. An acceleration analog output voltage is also available.

Typically, a jerkmeter installed in a jet aircraft will provide an instantaneous output proportional to the rate of change of g's. This signal can be used to predict impending disaster conditions.

Other applications include use wherever constant acceleration is required. Here, the Donner jerkmeter provides a "velocity-damping" term. The jerkmeter also provides a third order term for stabilizing displacement devices. It can also be used as an inertial indicator of first motion.

#### KEY SPECIFICATIONS for Model 4405 Linear Jerkmeter

#### RANGES

Acceleration:  $\pm 1$  g full range to  $\pm 30$  g full range  
Jerk:  $\pm 0.5$  g/sec full range to  $\pm 20$  g/sec full range

#### OUTPUT FULL SCALE

Accelerometer:  $\pm 7.5$  v dc  
Jerk:  $\pm 7.5$  v dc

#### RESOLUTION

0.1% full scale or better

#### LINEARITY

0.1% full scale or better

**WANT MORE INFORMATION?** The new Donner Jerkmeter is another product from a firm specializing in the manufacture of accurate fixed and general purpose analog systems designed to analyze, measure, and control inputs interlocking time, acceleration, jerk, velocity, and other dynamic inputs. Complete technical information can be obtained by calling your nearby Donner engineering sales representative or writing Dept. 36.

#### HYSTERESIS

Less than 0.1%

#### POWER

+15 v dc at 10 ma and -15v dc at 10 ma

#### SIZE

3" long, 1½" wide, 1½" high

#### WEIGHT

7.5 ounces

**DONNER SCIENTIFIC  
COMPANY**  
CONCORD, CALIFORNIA

CIRCLE 36 ON READER-SERVICE CARD



We at Metex feel we have the approach to your dry circuit contact problems... the Metact... a resilient, gold plated mesh contact. Its self-wiping and anti-bounce characteristics, combined with multiple contact areas, insure a greater degree of contact. These Metex engineered units, now available down to  $\frac{1}{32}$ " in diameter, have possible applications on relay, switch, chopper and computer design contact problems. ■ We would appreciate the opportunity to discuss their broad range of contact applications with you. Metex also manufactures a complete line of electronic weather stripping, RF and combination gaskets, and heat dissipating tube shields. There's no obligation; why not give us a call. Metal Textile Corporation, Electronics Division, Roselle, New Jersey. Phone Chestnut 5-3000. TWX Roselle, N. J. 760.

## CONTACT RELIABILITY PROBLEMS SOLVED HERE!



THE WORLD'S LARGEST & OLDEST PRODUCER OF KNITTED WIRE PRODUCTS ■ A DIVISION OF GENERAL CABLE CORPORATION



# METAL TEXTILE CORPORATION

CIRCLE 37 ON READER-SERVICE CARD

## Designing With Digital Computers

of radio-propagation research, too. These have included analyses of specular reflection of ionized meteor trails, world-wide prediction of transmission loss over ionospheric and tropospheric propagation paths and preparation of a number of maps of ionospheric and tropospheric characteristics.

Similar studies have been conducted by Stanford Research Institute of Menlo Park, Calif. SRI used an IBM 704 to determine the reliability of multi-path communications. The computer analyzed propagation parameters and geographic factors for a world-wide communications system. SRI has also used computers to develop data for antenna design and to prepare antenna radiation patterns.

### Antenna Design

The Mattern Div. of Land-Air, Inc. in Chicago used a Bendix G-15 for aircraft-antenna design, for transmission-line design, and for calculating high-frequency cable attenuation and loss. In these problems, the G-15 analyzed not only cable-test parameters, but transmission-line physical parameters, antenna physical characteristics, and test results.

Information from the computer included equivalent impedance, reflection coefficient, antenna vswr, proportions of antenna dimensions, transmission-line length and transmission characteristics. In one instance, the G-15 provided a seven man-hour calculation in 23 minutes.

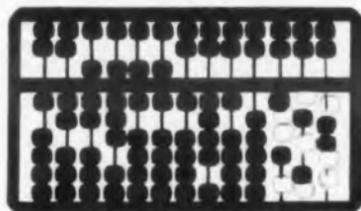
Engineers at Bendix Radio in Baltimore use the Bendix G-15 to design radar antennas. Information fed to the computer includes: (1) for the central section design—elevation range, distance from feed to antenna at a reference point, strength of incident beam, basic pattern desired; (2) calculation of power pattern using the central section—the polar coordinates of the antenna, strength of the incident beam, wavelength of the radiation, range of angles to be investigated. In addition, if integration is performed over the whole antenna, previously calculated Cartesian coordinates are given for various points.

The G-15 provides: (1) for the central section design—distances from feed to antenna and angles of the parabolic cross sections at specified intervals along the central section; (2) power pattern—this gives the relative strength of the reflected beam at various angles.

With the central section alone, only elevation angles can be investigated. But this is useful as a preliminary check for gross errors in design. For a finer check, the reflection from the whole antenna can be integrated, making it possible to find a power pattern at any combination of elevation and azimuth angles.

This involves double integration of a complex function. It is performed by summing approximately 150 vectors.

In general, the computer's design required about one or two per cent of the manual computation time. Investigation of azimuth patterns was not even attempted before the computer was turned to this task. Now the power at any point can be computed in about eight minutes. Beyond this advantage is the time saved in producing and testing scale models.



Simulation Studies

"Simulation" is more of a design or analysis technique than an area of design. Hence, it can encompass design and analysis of systems, circuits, and even active components. As with systems studies, it is very difficult to estimate cost or time savings.

#### Guidance-System Simulation

C-E-I-R of Arlington, Va., used an IBM 709 to simulate the electronic guidance system for the Titan ICBM. The basic problem in this application was to simulate missile flight under rapidly changing conditions. Information fed to the 709 included system equations and system logic.

The computer's output simulated the performance of Titan under the various conditions to be expected after the missile is launched.

#### Helicopter-Simulator Simulation

In Falls Church, Va., Melpar, Inc., a subsidiary of Westinghouse Air Brake Co., used an IBM 704 to simulate, digitally, an analog simulator for the H-37A helicopter trainer. The digital simulation was used to determine if the helicopter simulator would have the same "performance characteristics," and "flying qualities" as the actual helicopter.

The 704 helped design and analyze the HSS-2 helicopter anti-submarine-warfare weapons sys-

# NEW...

® **Regatron Programmable**

# CONSTANT-CURRENT POWER SUPPLIES

Extremely low ripple . . . 0.1% load regulation\* . . . wide operating range . . . the well-known Regatron features are incorporated in these new constant-current power supplies. Transient response time is less than a millisecond. A modulation input is a standard feature. A vernier permits continuous zero-to-maximum coverage throughout each of 16 current ranges.

These c-c supplies are programmable too. Current output can be controlled by means of a remote resistor at any convenient location. Shunt the programming terminals with the resistor and the Regatron delivers a precise value of constant-current to your load. Voltage compliance, or load voltage capability, rises above the minimum values cited in the brief table below, with decreasing current settings.



#### BRIEF SPECIFICATIONS

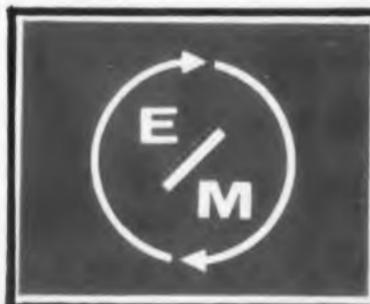
105-125 V, 50-60 CPS LINE  
(Prices are F.O.B. Eatontown, New Jersey)

MODEL	OUTPUT	VOLTAGE COMPLIANCE (MINIMUM)	DIMENSIONS			PRICE
			H	W	D	
C612A	1 $\mu$ A to 100 ma	100 V	3½	19	9¼	\$289
C624A	2.2 $\mu$ A to 220 ma	100 V	3½	19	9¼	\$364
C621A	5 $\mu$ A to 500 ma	100 V	5¼	19	15	\$479
C620A	5 $\mu$ A to 500 ma	50 V	5¼	19	15	\$449

\* Load regulation is 0.1% for all models except 0.2% on 1 and 2.2  $\mu$ A ranges of Models C612A and C624A.

You'll find the programming feature, voltage compliance, and other performance data fully detailed in four-page Specification Sheet 3072A. Ask your local E/M representative or write . . .

®Registered U.S. Patent Office. Patents issued and pending.



**ELECTRONIC MEASUREMENTS**  
COMPANY, INCORPORATED  
EATONTOWN · NEW JERSEY

CIRCLE 38 ON READER-SERVICE CARD

*A new addition  
to VARIAN'S G-22  
Dual Channel  
Potentiometer  
Recorder*



ADJUSTABLE SPAN

# 0-10 MV TO 0-500 VOLTS

More versatile than ever, the Varian G-22 will now record from sources of almost any likely signal voltage. A newly available plug-in input chassis, the B-22 attenuator type, is easily set as needed from spans as little as 10 millivolts full scale to as high as 500 volts. Front-panel adjustment is continuous in between for optimizing use of the chart's full width in any recording situation.

The G-22 can be your best all-purpose recorder in other ways too. Two channels in themselves also mean versatility—they make the recorder a correlator of simultaneous variables (any two you choose). Two plug-in input chassis mean that each channel's recording characteristics can be quickly changed. And zero can be reset anywhere across the chart from left to right—each channel separately. Last

but not least don't underestimate the value of the handle on top. This recorder goes wherever there is recording to be done.\*



\*Varian offers rack mounted versions too—either singles or twins. The latter is pictured, showing how four channels of recording can be fitted within the 19-inch width of a standard rack.

#### SPECIFICATIONS, OPTIONS, AND ACCESSORIES

One second full-scale balancing time • Accuracy 1% of full scale • Sensitivity 0.25% of full scale • Two chart speeds standard, four speeds optional • Wide selection of chart speeds from  $\frac{1}{2}$ " per hour to 16" per minute • Weight 33 pounds • Available accessories include retransmitting slide wires, alarm contacts, event markers, etc.

*For full specifications, write the Instrument Division.*



**VARIAN associates**  
PALO ALTO 21, CALIFORNIA

## Designing With Digital Computers

tem trainer of which the H-37A is a part. Information supplied to the 704 or stored in its memory represented performance of the helicopter rotor over its entire range, pilot actions like throttle position, collective pitch, stick position and cyclic stick position.

The computer provided answers in terms of the results of pilot action such as forward velocity, heading altitude, rate of climb, fuel flow, engine rpm, and hydraulic pressure.

#### Signal-Environment Simulation

W. G. James of American Machine and Foundry Co. in Alexandria, Va., used an IBM 704 to simulate the electromagnetic environment of an airborne receiver for a large deployment of electromagnetic emitters. The program simulated emitter characteristics like antenna-gain patterns and scanning cycles of such propagation phenomena as atmospheric absorption and tropospheric refraction.

Mr. James used the 704 to simulate models of all transmitter parameters and propagation phenomena which could significantly affect signal strength.

The printed out simulation results included the set-by-set signal contribution to the environment (or the mean and standard deviation of the total number of pulsed or cw signals as a function of signal level), and the cumulative pf count and duty cycle of the signal environment.

#### Landing-Approach Simulation

Wolf Research and Development Corp. of Boston used the Bendix G-15 for an error analysis of the equations used in the Volscan AN/FSQ-7 (XD-1), an aircraft landing-approach control system. The exact values of the solutions were computed for a grid covering the area of interest.

These values were compared with approximations developed by the use of nonlinear potentiometers in Volscan. Error values at the grid points were typed out. Functions used for the nonlinear potentiometers were adjusted and recomputed to give a better error curve.

Input information included sample points in the nonlinear curve, and the exact analytical solution in two dimensions. In the final solution, errors developed by the nonlinear potentiometers were shown to be excessive. The Volscan cir-



**Wiring list** at Litton's Electronic Equipments Div. makes it easy to wire new computers, obviates wiring diagrams.

cuitry was redesigned to use resolvers which gave an exact solution of the problem.

#### Guidance-Computer Simulation

Engineers at Space Technology Laboratories, Inc. in Los Angeles used an IBM 709 to simulate a number of different airborne missile-guidance computers. Output media included magnetic tape, printer output, punched cards and paper tape. In some instances, paper tapes were sent to the ballistic missile launch site and used for pre-launch checkout. These tapes, in some cases, became part of the missile flight itself.

The simulation process included, basically, a compiler which produced a bit-by-bit, instruction-by-instruction simulation of what the airborne guidance system would produce. Input to the 709, on cards, then magnetic tape, consisted of Boolean equations describing the logic in the guidance computer.

In such computer-design applications at STL, the 709 produced specifications ranging from functional logic through wiring lists. In simulation work, the computer could produce functional descriptions or discrete instructions like those of the guidance computer being simulated.

In one application, a logic checkout program saved months of time and roughly half the normal checkout effort required. The computer runs necessary for the logic checkout were completed in three days.

Using a bit-by-bit simulation, STL engineers found errors that might not have been found otherwise. These errors could have caused malfunctions during a launch. Set against the cost of an unsuccessful launch and the loss of a missile, the cost of the simulation becomes extremely slight.

STL used the logic compiler with the 709 to check out guidance computers used in the Able series of booster vehicles and in the Titan and Minuteman ICBMs. Projects which benefited most from the program were those where the

## YOU GOT IT MADE \* WITH MECA

**New, tri-dimensional packaging and interconnecting of modern electronic functions.**

Here is simplicity from start to finish . . . the most complicated designs worked out on AMP-MECA's graph layout sheets in hours rather than days or weeks . . . finished modular construction that's "building-block" easy . . . extreme reliability and complete resistance to shock and vibration.

Electronic functions are encapsulated for complete throw away or functions are assembled in open base cells for individual component replacement. Easily replaced, pluggable AMP-Cells work independently of or in harness with each other when programmed into AMP's 3-D circuit boards.

Available in 0.1" or 0.2" grid systems, AMP-MECA offers tri-dimensional flexibility—cells can be made larger or smaller—stacked, spread or lined-up in unlimited scope to accommodate your design needs. And production can be set up to fit your goals . . . by hand, or by programmed automation.

Learn how AMP-MECA can make it simple for you. Send for the full story on simplified interconnection of circuit functions.



# AMP INCORPORATED

**GENERAL OFFICES: HARRISBURG, PENNSYLVANIA**

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • West Germany

CIRCLE 40 ON READER-SERVICE CARD

## Designing With Digital Computers

compiler was used in early development stages. However, even when the compiler was used after test models had been built, it provided valuable information and further verified the computer design. In one instance, the simulation showed several design errors which had not been caught during test-model checkout.

### Circuit Simulation

Engineering consultants Marc Shiowitz and Associates have a computer program which, given a specific circuit with fixed parameters, generates a routine to simulate the circuit. A driving-signal-generating sub-routine is an integral part of the program.

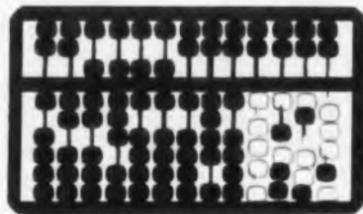
Using this program, the computer calculates the voltages at nodes, the currents in branches, the charge within transistor base regions and temperatures at junctions as functions of time.

Models used in the simulation, such as models of transistors, diodes, driving functions, etc., may be changed without altering the program.

MSA has a subsidiary program which, given a fixed circuit with parameters variable over a specific range and a formula for figure of merit, generates a routine to seek that allowable combination of parameters which provides the best figure of merit.

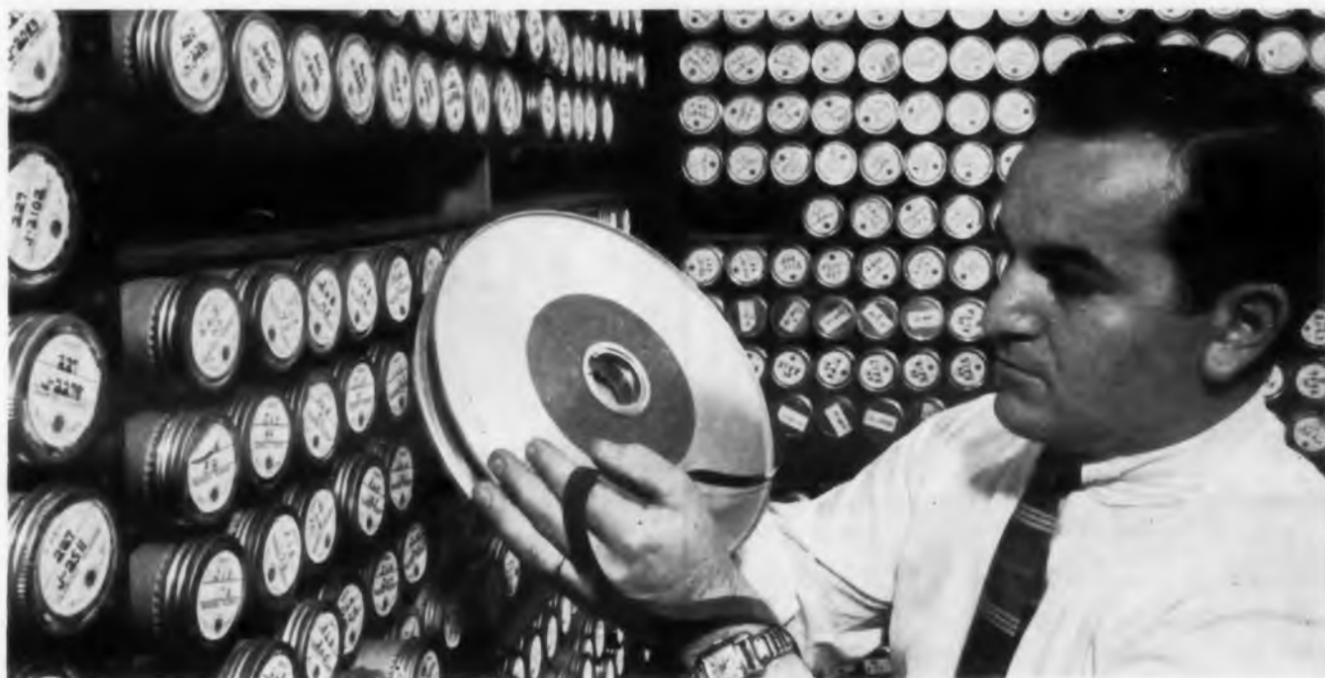
### Logic Simulation

At Ramo-Wooldridge, Tom Connolly developed a logical simulation compiler to generate machine instructions for the IBM 709 which was to evaluate any consistent set of Boolean equations. The logical simulation generator automatically generated instructions to simulate the airborne, RW-33 computer.



## Reliability Control

In reliability analyses and in quality control, the digital computer has proven its value—not only in statistical evaluations—but even in de-



**No longer needed** are these hundreds of blueprints for some 10,000 circuit drawings. Wiring tables, recorded on magnetic tape, replace drawings in production of the Honeywell-800 data processor.

termining the reliability of proposed circuit designs or in weighing the cost of given levels of reliability.

### Circuit-Reliability Analysis

At General Precision Laboratory of Pleasantville, N.Y., engineers used a Librascope LGP-30 to check the reliability of already designed circuits and to redesign them when necessary to improve performance or to alter input-output specifications.

GPL's Herbert A. Seidman and Philip L. Hillman described one such application—a four-transistor flip-flop—at a meeting of the Association of Environmental Engineers. The circuit uses a basic two-transistor flip-flop with a transistorized inverting amplifier at each output.

To begin the analysis, an engineer writes separate, independent, nodal equations to satisfy the circuit. In these equations, the currents are expressed in terms of voltages across resistors. The engineer then establishes the criteria for circuit stability.

The basic equations describing the circuit and giving component values are then inserted in the LGP-30. The computer then makes a run for each set of data with different values of transistor characteristics. It assigns a value to each resistor and voltage in the circuit. Each run differs from others by a variation of one or more of the parameters involved.

The effects of aging, high temperature, fluctuations in power supplies, initial spread of transistor and other component parameters are considered. To reduce the number of machine operations the effects of several parameter changes can be lumped into a single, properly-weighted, hypothetical parameter.

If the computer finds a circuit inadequately reliable, it can "suggest" improvements by introducing modifications of component values.

### Cost vs. Reliability Analysis

C-E-I-R has a program for the IBM 704 computer which determines minimum component cost for a required system reliability. Input includes cost vs tolerance information, the theoretical structure of the system expressed as a complex mathematical function, and the system reliability requirements.

The printed output gives the optimum mix of component specifications to achieve a specified reliability level at minimum cost.

### Quality-Control Analysis

Autonetic's Recomp computer has been used for quality-control analysis too. In this application, Recomp computes maximum and minimum parameter limits for a product like transistors.

To determine quality acceptance limits for a lot of transistors, for example, the resistance between transistor elements is measured for each transistor in a sample lot. Measured resistance values are tabulated by number of transistors per resistance range.

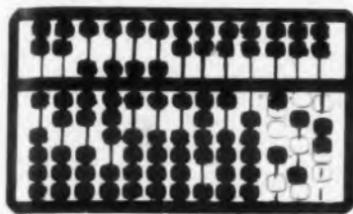
The mean value of resistance for the sample lot is calculated by Recomp which finally expresses the maximum and minimum limits of acceptable transistor resistance.

### Transistor Life Test Evaluation

At Lenkurt Electric Co., Kenneth Smith used the IBM 650 to evaluate the results of transistor life tests. Input to the machine included transistor parameters and performance readings of critical parameters. The computer gave informa-

tion in terms of the mean, mid-mean, median, and standard deviations.

In this application, one hour of machine time per month replaced 40 hours of desk-calculator time.



## Systems Design

In systems design, probably more than in any other field, the designer is less likely to know how much time or money he has saved by using a computer. The savings are real. But they are more difficult to measure than, say, the savings in a component design.

### Instrumentation-System Design

A particularly interesting application of the Burroughs 205 was one by Stanford Research Institute of Menlo Park, Calif. SRI used the 205 to investigate the information transfer requirements for an instrumentation system. The system included position location, simulation, evaluation, and display, and considered fluctuating demands of a variety of servicing procedures and processing times.

### Communications System Design

Page Communications Engineers of Washington, D.C., used a Bendix G-15 for a variety of related communications studies. They used the G-15 for research and for designing communications system, for radio wave propagation analysis, and for antenna analysis.

Information fed to the computer included: the noise probability density function, received signal intensities, two components at right angles, antenna dimensions, and transcendental equations for the binary error rate for amplitude-modulated, digital transmission systems using diversity techniques.

The G-15 provided information on the distribution of the signal-to-noise ratio for radio relay systems in cascade, diversity advantages which could be realized from polarization, antenna power patterns, and optimum threshold for minimum binary error rate. PCE estimates that these four solutions saved, respectively, one man-year, 30 man-weeks, 60 hours per set of antenna patterns and 40 hours.

### Servo-System Analysis

An application by Douglas Aircraft Co. of Santa Monica, Calif., shows how a machine, de-

TYPE	SIZE	CAPACITANCE (uuf)	DCVW	TC	MAX. CASE SIZE
<b>CY</b> uuf for uuf, the smallest, most stable axial lead capacitor you can buy. Probably $\frac{1}{3}$ smaller than you're used to. After load life tests at 125° with 150% of rated voltage, average change in capacitance is less than 0.4% for 1,000 hrs., less than 0.6% for 10,000 hrs. They exceed all requirements of MIL-C-11272A.	CY10	1 to 150 151 to 240	500 300	140 ± 25ppm/° C. from -55° C. to +125° C. at 100 kc or 1 mc	$1\frac{1}{32} \times 1\frac{1}{64} \times \frac{3}{64}$
	CY15	151 to 510 511 to 1,200	500 300		$1\frac{5}{32} \times 1\frac{7}{64} \times \frac{3}{64}$
	CY20	511 to 3,300 3,301 to 5,100	500 300		$4\frac{7}{64} \times 2\frac{7}{64} \times \frac{9}{64}$
	CY30	3,301 to 6,200 6,201 to 10,000	500 300		$4\frac{9}{64} \times \frac{3}{4} \times \frac{9}{64}$
Medium-power transmitting style	CY60	Up to 56,000	Ratings to 4000 peak volts	140 ± 25ppm/° C. from -55° C. to +125° C. at 100 kc or 1 mc	$1 \times 1\frac{1}{8} \times \frac{5}{8}$
	CY70	Up to 150,000	Ratings to 6000 peak volts		$1\frac{1}{2} \times 1\frac{3}{4} \times \frac{3}{4}$
<b>CYF</b> Fusion sealed. Similar to CY, but with glass encapsulation fusion sealed to capacitor and leads to make seal tight against moisture and corrosives. Insures reliable performance under extreme environmental conditions. Guaranteed four times better than MIL specs for moisture resistance.	CYF10	1 to 150 151 to 240	500 300	140 ± 25ppm/° C. from -55° C. to +125° C. at 100 kc or 1 mc	$1\frac{1}{32} \times 1\frac{1}{64} \times \frac{3}{64}$
	CYF15	151 to 510 511 to 1,200	500 300		$1\frac{5}{32} \times 1\frac{7}{64} \times \frac{3}{64}$
<b>W,WL</b> Wafers with or without leads. Smallest high stability capacitor available. Up to 10,000 uuf in .061 sq. in. of PCB area. Electrodes sealed to dielectric sheets in such a way that seal cannot be broken without destroying capacitor. Meets the performance requirements of MIL-C-11272A.	W, WL5	1 to 560	300	140 ± 25ppm/° C. from -55° C. to +125° C. at 100 kc or 1 mc	.281 x .218 x .090
	W, WL4	561 to 1,000	300		.281 x .312 x .090
	W, WL3	1,001 to 2,700	300		.531 x .312 x .090
	W, WL2	2,701 to 4,300	300		.531 x .453 x .090
	W, WL1	4,301 to 10,000	300		.531 x .812 x .090
<b>HT</b> High temperature dielectric and radiation-tolerant metal electrodes with tab leads. Dielectric strength is twice rated voltage applied from one to five seconds. Insulation resistance in ohm x farads is 100 at 175° C., 25 at 250° C., 1 at 300° C., and .05 at 350° C.	HT1	1 to 1,000	300	0-250° C. 115 ± 25	$\frac{1}{2} \times \frac{3}{8} \times \frac{3}{8}$
	HT2	1,001 to 3,000	300	0-300° C. 140 ± 35	$\frac{1}{2} \times \frac{5}{8} \times \frac{3}{8}$
	HT3	3,001 to 10,000	300	0-350° C. 160 ± 45	$\frac{1}{2} \times 1 \times \frac{3}{8}$

## Why you have to smash these Corning capacitors to affect their reliability

Stack alternating layers of glass ribbon and aluminum foil, fuse the stacks under heat and pressure, and you have a solid, practically indestructible capacitor.

The properties of the capacitor are *entirely* those of the closely controlled dielectric. They cannot be altered in processing. They stay the same under heat, moisture, and all other environmental conditions.

There's no problem with delivery. We mass produce them all.

If you need capacitors high in reliability, small in size, and light in weight, you should know more about this Corning design. The coupon will bring you complete technical data. Address: Corning Glass Works, 540 High St., Bradford, Pa.

For orders of 1000 or less, contact your distributor, serviced by Erie Distributor Division.



### CORNING ELECTRONIC COMPONENTS CORNING GLASS WORKS, BRADFORD, PA.

Please send data sheets on  CY  CYF  W, WL  HT

Name .....

Company .....

Address .....

City ..... Zone ..... State .....

CIRCLE 41 ON READER-SERVICE CARD

WHICH  
METER  
WOULD  
YOU  
CHOOSE  
TO GET  
MORE SENSITIVE  
LINE  
VOLTAGE  
READ-  
INGS?

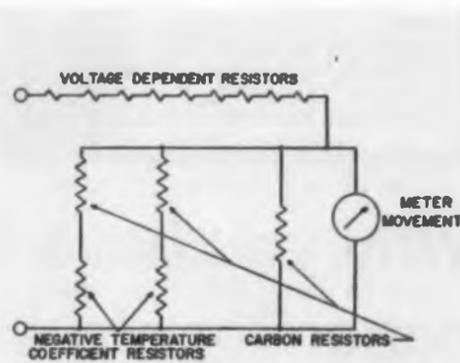


No need to hesitate. If you are facing exceptionally tough voltage sensing problems your No. 1 choice is the meter shown at your right.

Easy to see our suggestion is well-founded. This meter is far more sensitive because it employs non-linear elements that precisely control voltage and compensate for temperature: FXC's Varistors (VDR's) and Thermistors (NTC's).

Easy to understand how these components make for more simplified circuitry . . . greater stability . . . and less susceptibility to overloads. Take a look at the circuit shown below . . .

The meter is but one of many products made better by the use of FXC's VDR's and NTC's.\* Write for complete technical information—or, better still, obtain the VDR's and NTC's you'll need for making initial investigations by ordering our FERROXKIT NO. VT-1. The kit, priced at \$10.00, contains the 9 Varistors and 2 Thermistors used in the circuit illustrated here.



\*These same units also provide improved sensitivity in automatic feedback control circuits.



**FERROXCUBE**  
CORPORATION OF AMERICA

50 East Bridge Street, Saugerties, New York

CIRCLE 42 ON READER-SERVICE CARD

## Designing With Digital Computers

signed basically for process control applications, can be used very successfully in design work. The machine, Ramo-Wooldridge's RW-300, was used by Douglas for closed-loop control of the testing of short-life, high-tolerance, airborne servo systems.

In this application, the RW-300 receives its input from a function generator. An  $x-y$  plotter at the computer output plots amplitude ratio and phase angle as functions of frequency. At each frequency, the computer samples the output amplitude and performs a Fourier analysis, computing the fundamental frequency of the usually distorted output, and from this, the amplitude ratio and phase angle. In addition, the computer takes the logarithm of the amplitude ratio so the plot can be printed on a decibel scale.

Gain-margin tests are made by automatically increasing loop gain until oscillations occur. The oscillation frequency, calculated by the computer, is recorded on the frequency-response graph. In this application, the RW-300 cut testing time from 90 minutes for each servo system to less than three minutes. In addition, it enabled Douglas designers to make more elaborate tests, and to scan and check more parameters.

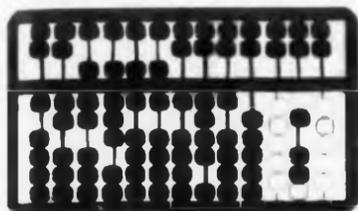
### Flight-Data Analysis

Space Technology Laboratories of Los Angeles used a computer to design a computer-entry



Checking a tape on Recomp, C. C. McConkle of Autonetics prepares the computer for an engineering problem.

processing machine. The processor takes flight data from ballistic missile and space flights (such as pulse-coded telemetry data from ICBM flights) and prepares the data for entry into an IBM 709. The system is flexible enough so it can be used at the receiving end of a data-carrying telephone link.



Other Applications

Computer applications by electronics designers are far from limited to those which can be encompassed by a few broad categories.

■ Stanford Research Institute, for example, used a Remington-Rand 1103A to design magnetic characters for an automatic check-reading system. This led to the adoption of magnetic character reading as the standard for the American Bankers' Association.

■ Engineers at Daystrom Electric in Poughkeepsie, N.Y., use an IBM-610 to calculate underwater acoustic Ray diagrams, (Ray diagrams show the path of sound waves through water under different conditions of pressure, temperature, and salinity.)

Daystrom engineers feel that, in 20 minutes with the 610, they can prepare Ray diagrams that would require at least a week of manual computation.

■ The GPL Division of General Precision Inc. has used an LGP-30 for a wide variety of design applications. These include: (1) exploring the characteristics of filters for frequency trackers of doppler-radar navigation systems, (2) studies of the altitude-hole effect and its relation to antenna design in doppler systems, (3) space-navigation studies and error calculations and (4) calculations of the effects of frequency modulation in a carrier.

■ The Link Div. of General Precision Inc. used an LGP-30 to prepare punched tapes to load a digital function generator, a storage bank for binary data. Input to the LGP-30 included selected points along a curve or family of curves.

The LGP-30 converted the decimal numbers defining the selected points to their binary equivalents. The binary equivalents were punched out on tape according to a prescribed format. It is estimated that the computer cut the time in preparing loading tapes by a factor of 20. ■ ■

## Here's why the NEW AO TRACE-MASTER is the world's finest 8-channel direct writing recorder!

American Optical Company, famous for precision instrumentation for 138 years, introduces an electronic direct-writing recorder of unique design, in which ultra-precise electromechanics has been combined with advanced electronics to achieve *truly superior performance*.

### Finest Writing Method Ever

Unique direct-carbon-transfer writing method. Trace is uniformly black and up to four times thinner than that made by any other recorder. Minute variations in phenomena measured are more faithful, meaningful. Carbon trace cannot fade... may be easily reproduced.

### Finest Frequency-Amplitude Performance

TRACE-MASTER'S multiple-feedback wide-range Driver circuitry, combined with the advanced pen-motor design, produces wider frequency response at larger amplitudes than any other recorder. TRACE-MASTER response is flat—within 1%—from dc to 110 cps at 40 mm!

Band Amplitude Product (i.e. Bandwidth times Amplitude) is 5600...140 cps (3 db point) x 40mm!

### Finest Chart-Drive Facilities

TRACE-MASTER provides widest chart-speed range...0.1 to 500 mm/sec...of any direct-writing recorder! Convenient

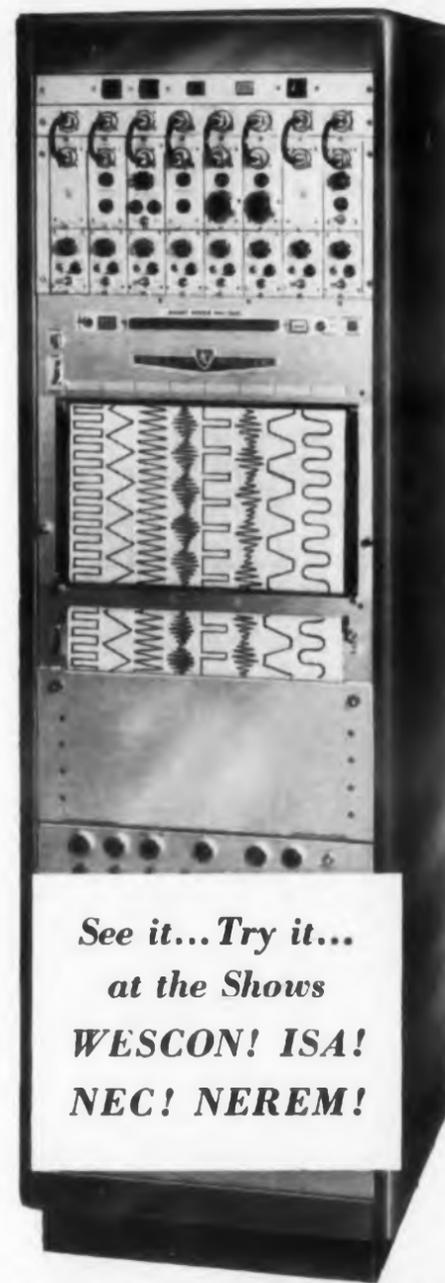
push-button selection. Take-up reel automatically stores full 1000 ft. record. Writing table tilts for easy chart annotations. Guide rails permit quick, easy paper-roll changes. Low cost chart paper makes practical protracted recording at high speeds.

### Finest Resolution, Linearity, Stability

Thin carbon trace (thinner by 4 to 1 over most recorders) and high Band Amplitude Product (higher by 6 to 1 over other recorders) provide up to 24 times the resolving power or ability to detect short, sharp variations in the record. The superior linearity ( $\pm 1\%$ ) and stability in rectilinear presentation permit full use of this unexcelled resolution.

### Finest Systems Oriented Compatibility

Fully transistorized circuitry...application of combined dc level and signal multiple feedback...complete interchangeability of modular signal-conditioning elements... are some of the features that make the AO TRACE-MASTER the world's finest 8-channel direct writing recorder.



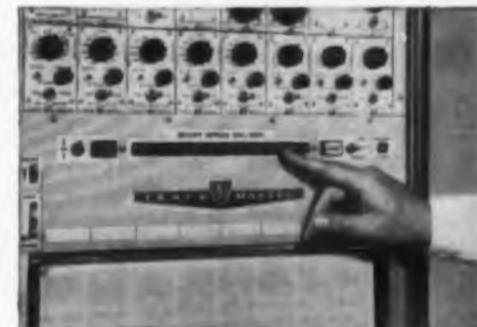
See it... Try it...  
at the Shows  
**WESCON! ISA!**  
**NEC! NEREM!**



Entire channel easily accessible and completely interchangeable as single unit.



Platen tilts to convenient writing angle.



Widest range chart speed... push-button selection through 0.1 mm/sec to 500 mm/sec.

**WRITE, WIRE, TELEPHONE TODAY FOR COMPLETE INFORMATION!**

Complete Engineering Bulletins available. Field Sales Engineers at your service everywhere.

**American Optical**  
COMPANY

INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

Dept. H281  
Please send Engineering Bulletins on the complete AO TRACE-MASTER line of recording modules and systems.  
Name \_\_\_\_\_  
Business Address \_\_\_\_\_  
City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 43 ON READER-SERVICE CARD

# Computer-Prepared Tables Enable Design of Ultra-Flat Networks

**Philip R. Geffe\***

Senior Staff Engineer  
Columbia Technical Corp.  
Woodside, N. Y.

**R**ECENT ADVANCES in predistortion theory provide practical design data for ultra-flat networks. The design data included in the tables in this article have not been available before to

the extent that they are available here.

The uniformly predistorted element values have been given elsewhere, but in limited fashion. The tables here offer a wider range of designs and they allow easy, accurate interpolation. In the lossy- $L$  case, the design procedure has not been possible previously in any straightforward fashion.

*People who work in modern network theory, says author Philip Geffe, have trouble convincing engineers that network synthesis is a practical discipline. This article, with computer-prepared design tables, shows one way modern methods can solve problems which are hopeless by conventional means.*

Calculations, performed on an IBM 650, have been spot-checked with hand computations. Where appropriate, the results have been compared with the Weinberg tables, and no disagreements found.

Rounding off of last figures was done in such a way that rounding off again to three figures would give the correct result. Thus, a number such as 1.25493 was rounded off to 1.254 rather than to 1.255, since the correct 3-figure round-off would be 1.25.

## Theoretical Limits Restrict Network Choice

In critical applications it is often necessary to design selective networks in which the pass-band attenuation is constant within a small percentage tolerance. Severe theoretical limits on realizability greatly restrict the choice of networks which will be practical from the user's point of view.

For example, the highly selective Elliptic-Function filter<sup>1</sup> is, in general, not realizable in a ladder network<sup>2</sup> when we choose extremely small values of pass-band ripple together with a rapid transition from pass band to stop band.

If, in taking account of this, we choose the Tschebyscheff response (with equal ripples in the pass band, and a monotonic stop band), we find that arbitrary values of pass-band ripple always lead to ladder realizability.

But a further difficulty appears. The poles of the complex response function for this type of filter lie so close to the axis of real frequencies in the  $S$ -plane that both high- $Q$  elements and close element-value tolerances are required for precision applications. These networks, therefore, require bulky, expensive materials, and manufacturing reproducibility is poor.

When an ultra-flat pass band is the prime requirement, we must choose networks whose response poles are remote from the  $j\omega$ -axis. In addition, we must accurately compensate for the use of low- $Q$  elements.

## Ultra-Flat Response Shapes Suggest Butterworth Networks

These restrictions lead immediately to the choice of the Butterworth family of response

\*Formerly with North Hills Electric Co., Inc., Mineola, N.Y.

Uniform-Dissipation Networks

d	Table 1 2-Pole			Table 2 3-Pole				Table 3 4-Pole				
	L <sub>1</sub>	C <sub>2</sub>	$\alpha$ -db	C <sub>1</sub>	L <sub>2</sub>	C <sub>3</sub>	$\alpha$ -db	L <sub>1</sub>	C <sub>2</sub>	L <sub>3</sub>	C <sub>4</sub>	$\alpha$ -db
0	.7071	1.414	0	.5000	1.333	1.500	0	.3827	1.082	1.577	1.531	0
.05	.7609	1.410	.614	.5405	1.403	1.457	.868	.4144	1.156	1.636	1.454	1.13
.10	.8236	1.398	1.22	.5882	1.481	1.402	1.73	.4518	1.240	1.701	1.362	2.27
.15	.8974	1.374	1.83	.6452	1.567	1.334	2.60	.4967	1.339	1.777	1.250	3.39
.20	.9860	1.340	2.42	.7143	1.667	1.250	3.45	.5515	1.459	1.879	1.113	4.51
.25	1.094	1.290	2.99	.8000	1.786	1.149	4.30	.6199	1.609	2.039	.9400	5.63
.30	1.228	1.223	3.53	.9091	1.939	1.026	5.15	.7077	1.812	2.384	.7099	6.73
.35	1.400	1.138	4.05	1.053	2.164	.8743	5.98	.8243	2.124	3.848	.3651	7.82
.40	1.628	1.034	4.52	1.250	2.581	.6798	6.82					
.45	1.944	.9083	4.94	1.538	3.806	.4126	7.66					
.50	2.414	.7630	5.30									
.55	3.183	.5989	5.59									
.60	4.669	.4188	5.82									
.65	8.756	.2267	5.96									

d	Table 4 5-Pole						Table 5 6-Pole						
	C <sub>1</sub>	L <sub>2</sub>	C <sub>3</sub>	L <sub>4</sub>	C <sub>5</sub>	$\alpha$ -db	L <sub>1</sub>	C <sub>2</sub>	L <sub>3</sub>	C <sub>4</sub>	L <sub>5</sub>	C <sub>6</sub>	$\alpha$ -db
0	.3090	.8944	1.382	1.694	1.545	0	.2588	.7579	1.202	1.553	1.759	1.553	0
.02	.3189	.9199	1.412	1.712	1.504	.562	.2671	.7804	1.232	1.581	1.772	1.502	.671
.04	.3294	.9468	1.443	1.730	1.461	1.12	.2760	.8043	1.264	1.611	1.786	1.446	1.34
.06	.3406	.9754	1.476	1.750	1.414	1.69	.2854	.8297	1.297	1.643	1.802	1.386	2.01
.08	.3526	1.006	1.512	1.771	1.364	2.25	.2955	.8569	1.333	1.679	1.821	1.321	2.68
.10	.3654	1.038	1.549	1.794	1.309	2.81	.3064	.8860	1.372	1.714	1.844	1.250	3.35
.12	.3794	1.073	1.589	1.822	1.250	3.37	.3181	.9172	1.413	1.755	1.874	1.171	4.02
.14	.3943	1.111	1.633	1.854	1.184	3.93	.3307	.9508	1.458	1.802	1.917	1.083	4.69
.16	.4104	1.151	1.681	1.894	1.113	4.48	.3443	.9871	1.508	1.860	1.979	.9839	5.30
.18	.4281	1.195	1.734	1.946	1.034	5.04	.3594	1.027	1.558	1.923	2.080	.8690	6.00
.20	.4472	1.243	1.796	2.018	.9452	5.59	.3754	1.070	1.621	2.008	2.258	.7313	6.68
.22	.4681	1.296	1.867	2.124	.8434	6.15	.3931	1.117	1.690	2.122	2.646	.5586	7.34
.24	.4911	1.354	1.953	2.300	.7242	6.70							
.26	.5165	1.419	2.061	2.631	.5798	7.25							
.28	.5446	1.493	2.204	3.453	.3965	7.79							
.30	.5760	1.578	2.409	8.084	.1476	8.34							

d	Table 6 7-Pole								Table 7 8-Pole								
	C <sub>1</sub>	L <sub>2</sub>	C <sub>3</sub>	L <sub>4</sub>	C <sub>5</sub>	L <sub>6</sub>	C <sub>7</sub>	$\alpha$ -db	L <sub>1</sub>	C <sub>2</sub>	L <sub>3</sub>	C <sub>4</sub>	L <sub>5</sub>	C <sub>6</sub>	L <sub>7</sub>	C <sub>8</sub>	$\alpha$ -db
0	.2225	.6560	1.054	1.397	1.659	1.799	1.558	0	.1951	.5776	.9371	1.259	1.528	1.729	1.824	1.561	0
.02	.2297	.6759	1.084	1.428	1.684	1.808	1.496	.781	.2014	.5954	.9636	1.290	1.558	1.752	1.830	1.488	.890
.04	.2373	.6972	1.114	1.461	1.712	1.818	1.428	1.56	.2081	.6144	.9918	1.323	1.590	1.777	1.838	1.409	1.78
.06	.2454	.7198	1.146	1.496	1.742	1.832	1.354	2.34	.2152	.6347	1.022	1.357	1.624	1.806	1.851	1.321	2.67
.08	.2542	.7440	1.180	1.533	1.775	1.851	1.274	3.12	.2229	.6564	1.054	1.394	1.662	1.839	1.872	1.224	3.56
.10	.2636	.7699	1.217	1.573	1.813	1.878	1.184	3.90	.2312	.6796	1.088	1.434	1.703	1.880	1.908	1.114	4.45
.12	.2739	.7980	1.254	1.614	1.860	1.923	1.085	4.68	.2400	.7046	1.124	1.478	1.750	1.932	1.972	.9856	5.33
.14	.2846	.8281	1.294	1.659	1.910	1.992	.9701	5.45	.2496	.7316	1.164	1.526	1.804	2.003	2.101	.8305	6.22
.16	.2966	.8608	1.344	1.715	1.979	2.111	.8350	6.23	.2600	.7608	1.208	1.579	1.869	2.110	2.414	.6307	7.10
.18	.3091	.8960	1.394	1.778	2.073	2.356	.6679	7.00	.2713	.7926	1.255	1.639	1.951	2.294	3.683	.3439	7.98
.20	.3232	.9243	1.453	1.862	2.233	3.177	.4220	7.77									

shapes. These responses have been fully described in the literature.<sup>3,4,5</sup> Our discussion is restricted to the normalization which employs a 1-ohm source, and the 3-db point occurs at one radian per second ( $\omega_c = 1$ ).

Selectivity is sacrificed to obtain the ultra-flat property. Since the response is maximally flat, the pass-band flatness not only exceeds any previously assigned tolerance in some interval which contains the origin, but the interval is larger, for the networks chosen, than it would be for any other network using the same number of reactive elements.

Because of their poor selectivity, the use of these networks is almost completely restricted to the application discussed above. One exception to this rule, however, is their use in the narrow-band case, where the inherent low- $Q$  requirement of the network is desirable.

#### Physical Forms of the Networks With Loss and Without

Fig. 1a shows a 5-pole low-pass network which, with lossless elements, can realize the 5-pole Butterworth shape if the element values are correctly chosen. In Fig. 1b, the incidental dissipation of the reactive elements is shown by inserting conductances in parallel with the

capacitors, and resistance in series with the inductors.

In the synthesis of such networks, we encounter a step which requires factoring a polynomial of high degree. This can only be done approximately, and leads to enormously high computation costs.

When the load resistance,  $R$ , is open circuited, however, factoring degenerates into a trivial calculation, and we may proceed without difficulty. In the case of most desirable response shapes (e.g., Butterworth, Tschebyscheff, Elliptic-Function), the load resistor must be considerably larger, or smaller, than the source resistor; else the network will not be realizable at all. For these reasons, the tables given here are calculated for an open-circuit load.

In Fig. 1c, we show a 5-pole network in which allowance has been made for losses in the inductors only.<sup>6</sup> This feature corresponds closely with practical problems in which the physical capacitors are relatively lossless as compared with the inductors. In building the physical network, therefore, it is not necessary to wire physical resistors across the capacitors since uniform dissipation is not needed throughout the network, and the power losses in the filter are greatly reduced. The lossy- $L$  designs, however, may

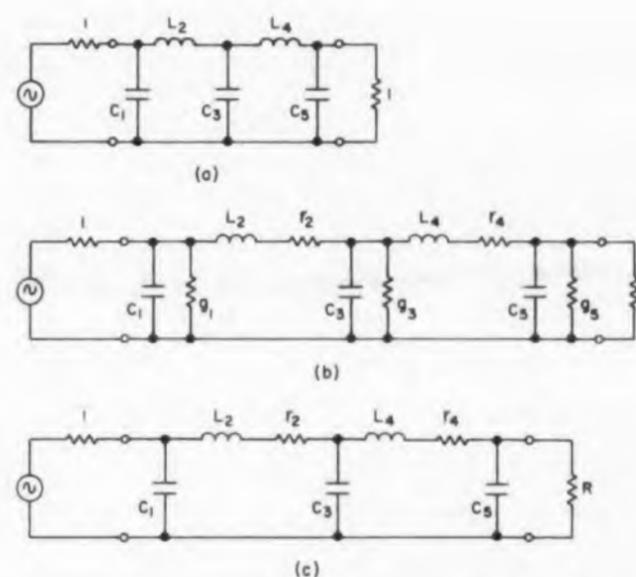


Fig. 1. A 5-pole, low-pass network: (a) as a lossless network; (b) as a uniformly lossy network in which dissipation of the reactive elements is represented by conductances in parallel with capacitors and resistors in series with inductors. Here,  $r_i = dL_i$ ,  $g_i = dC_i$ ; (c) as a lossy- $L$  network in which losses are concentrated in resistors in series with the inductors. Here,  $r_i = dL_i$ .

only be used in low-pass networks.

Fig. 2a shows a typical network whose normalized design may be taken directly from the tables. When the number of reactances is even, the first element is always a series inductor,  $L1$ .

Uniform-Dissipation Networks																							
Table 8 9-Pole											Table 9 10-Pole												
d	C <sub>1</sub>	L <sub>2</sub>	C <sub>3</sub>	L <sub>4</sub>	C <sub>5</sub>	L <sub>6</sub>	C <sub>7</sub>	L <sub>8</sub>	C <sub>9</sub>	α-db	d	L <sub>1</sub>	C <sub>2</sub>	L <sub>3</sub>	C <sub>4</sub>	L <sub>5</sub>	C <sub>6</sub>	L <sub>7</sub>	C <sub>8</sub>	L <sub>9</sub>	C <sub>10</sub>	α-db	
0	.1736	.5155	.8414	1.141	1.404	1.620	1.777	1.842	1.563	0	0	.1564	.4654	.7626	1.041	1.292	1.510	1.687	1.812	1.855	1.564	0	
.02	.1793	.5316	.8659	1.171	1.435	1.649	1.798	1.845	1.480	1.00	.02	.1614	.4800	.7854	1.069	1.324	1.541	1.714	1.831	1.855	1.471	1.11	
.04	.1852	.5488	.8921	1.202	1.469	1.680	1.822	1.851	1.388	2.00	.04	.1669	.4956	.8096	1.099	1.357	1.574	1.744	1.853	1.860	1.367	2.22	
.06	.1916	.5671	.9199	1.236	1.504	1.713	1.850	1.864	1.286	3.00	.06	.1726	.5123	.8353	1.132	1.392	1.610	1.777	1.882	1.875	1.249	3.33	
.08	.1984	.5867	.9496	1.272	1.543	1.751	1.884	1.891	1.171	4.00	.08	.1788	.5301	.8629	1.166	1.430	1.648	1.814	1.920	1.910	1.114	4.44	
.10	.2058	.6077	.9814	1.311	1.584	1.794	1.931	1.942	1.036	5.00	.10	.1854	.5493	.8924	1.203	1.471	1.692	1.860	1.976	1.991	.9508	5.55	
.12	.2137	.6303	1.016	1.353	1.630	1.844	1.997	2.054	.8735	5.99	.12	.1926	.5698	.9242	1.243	1.516	1.741	1.918	2.067	2.201	.7409	6.65	
.14	.2223	.6547	1.053	1.398	1.682	1.907	2.101	2.340	.6614	6.99	.14	.2003	.5921	.9584	1.286	1.566	1.798	1.997	2.239	3.051	.4349	7.76	
.16	.2315	.6812	1.093	1.448	1.742	1.991	2.293	3.620	.3486	7.98													

Lossy-L Networks																						
Table 10 2-Pole				Table 11 3-Pole			Table 12 4-Pole				Table 13 5-Pole					Table 14 6-Pole						
d	L <sub>1</sub>	C <sub>2</sub>		C <sub>1</sub>	L <sub>2</sub>	C <sub>3</sub>	L <sub>1</sub>	C <sub>2</sub>	L <sub>3</sub>	C <sub>4</sub>	d	C <sub>1</sub>	L <sub>2</sub>	C <sub>3</sub>	L <sub>4</sub>	C <sub>5</sub>	L <sub>1</sub>	C <sub>2</sub>	L <sub>3</sub>	C <sub>4</sub>	L <sub>5</sub>	C <sub>6</sub>
0	.7071	1.414		.5000	1.333	1.500	.3827	1.082	1.577	1.531	0	.3090	.8944	1.382	1.694	1.545	.2588	.7579	1.202	1.553	1.759	1.553
.05	.7330	1.364		.5128	1.403	1.390	.3979	1.087	1.698	1.362	.02	.3129	.9127	1.369	1.762	1.452	.2629	.7631	1.235	1.519	1.850	1.436
.10	.7609	1.314		.5263	1.480	1.284	.4144	1.091	1.834	1.205	.04	.3168	.9316	1.355	1.834	1.363	.2671	.7683	1.271	1.485	1.947	1.326
.15	.7910	1.264		.5405	1.565	1.182	.4323	1.095	1.990	1.061	.06	.3209	.9514	1.342	1.911	1.278	.2714	.7736	1.308	1.451	2.052	1.223
.20	.8236	1.214		.5556	1.660	1.084	.4518	1.098	2.170	.9289	.08	.3251	.9719	1.327	1.993	1.197	.2760	.7789	1.347	1.417	2.165	1.125
.25	.8589	1.164		.5714	1.766	.9911	.4732	1.100	2.380	.8072	.10	.3294	.9934	1.313	2.080	1.119	.2806	.7843	1.388	1.383	2.288	1.034
.30	.8975	1.114		.5882	1.885	.9018	.4967	1.102	2.628	.5955	.12	.3338	1.016	1.298	2.173	1.046	.2854	.7897	1.432	1.349	2.421	.9487
.35	.9397	1.064		.6061	2.021	.8164	.5227	1.102	2.926	.5933	.14	.3383	1.039	1.283	2.273	.9754	.2904	.7952	1.478	1.315	2.565	.8684
.40	.9860	1.014		.6250	2.177	.7350					.16	.3429	1.063	1.268	2.380	.9086	.2955	.8007	1.527	1.281	2.723	.7932
.45	1.037	.9642		.6452	2.358	.6573					.18	.3477	1.089	1.253	2.494	.8450	.3009	.8063	1.579	1.248	2.896	.7227
.50	1.094	.9142									.20	.3526	1.116	1.237	2.620	.7844	.3064	.8118	1.634	1.214	3.087	.6567
.55	1.157	.8642									.22	.3576	1.144	1.221	2.754	.7269	.3121	.8174	1.692	1.181	3.298	.5949
.60	1.228	.8142									.24	.3628	1.173	1.204	2.901	.6721						
.65	1.309	.7642									.26	.3682	1.204	1.188	3.061	.6201						
											.28	.3737	1.237	1.171	3.237	.5706						
											.30	.3794	1.271	1.154	3.431	.5236						

When an odd number of reactances is used, the first element is a shunt capacitor,  $C_1$ .

Incidental dissipation is not represented in Fig. 2, but various forms of the networks are shown there. Thus Fig. 2 employs a current source instead of a voltage source, and follows from Fig. 2a by reciprocity. In this case, the response function is not  $E_2/E_1$  as in Fig. 2a, but  $E_2/I_1$ .

Fig. 2c shows the network which is dual to that in Fig. 2a, and whose transfer function is  $I_2/E_1$ . Element values are numerically equal to those of Fig. 1a, but are read in henries instead of farads, and vice versa. Fig. 2d follows from Fig. 2c by reciprocity and is dual to Fig. 2b. It is important to note that the tables are labeled for the network form shown in Fig. 2a.

### How to Use the Network Design Tables

In each table of element values, the first column gives the dissipation factor  $d$ . If, say, a low-pass 5-pole Butterworth network is desired

with coil  $Q$ 's of 10, then we use the lossy- $L$  tables, and enter the row of Table 13 for which  $d = 1/Q = 0.10$ . This gives the design of Fig. 3a. It is important to realize that this network *does not* have the desired response. This is obtained only by adding the indicated losses, as shown in Fig. 3b.

Tables 1 through 9 are for networks in which all the reactive elements have the same  $Q$ . Tables 10 through 18 are for the lossy- $L$  case, in which all capacitors are lossless. In the first nine tables, the column headed  $a$  gives the flat loss, in decibels.

Thus the lossy- $L$  tables may be used only for low-pass filters, but the tables for uniform dissipation may be used for either. For instance, if paper capacitors, with a  $Q$  of 50, are to be used with coils of the same  $Q$ , then  $d = 0.02$  uniformly throughout the network, and Tables 1 through 9 would be used.

If a bandpass filter were desired, it would be necessary to use tables for uniform predistortion<sup>7,8</sup> and then to effect the usual low-pass to

bandpass transformation. The bandpass procedure, then, is summarized in the following steps:

### Design Procedure For Bandpass Networks

**Step 1.** The normalized low-pass network (from Tables 1 through 9) is scaled to a cutoff frequency which is equal to the desired 3-db bandwidth of the bandpass filter:

$$L' = \frac{L}{2\pi(f_2 - f_1)} \quad (1)$$

$$C' = \frac{C}{2\pi(f_2 - f_1)} \quad (2)$$

where the unprimed  $L$  and  $C$  indicate the tabulated values.

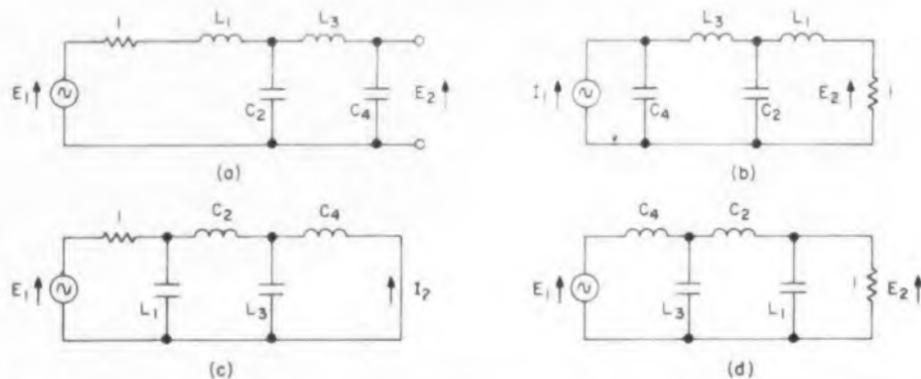
**Step 2.** The scaled low-pass reactances are resonated to the desired center frequency,  $f_0$ , by inserting the appropriate capacitors *in series* with the scaled low-pass inductors and inserting appropriate inductors *in parallel* with the scaled low-pass capacitors.

**Step 3.** After the correct amount of dissipation has been added to all the reactive branches, the bandpass filter will have a bandwidth, at any given attenuation, which is equal to the bandwidth of the scaled low-pass filter which was obtained in Step 1.

**Step 4.** All impedances are multiplied by the desired factor. Thus, in a filter to be driven by a 600-ohm source, all impedances would be multiplied by 600.

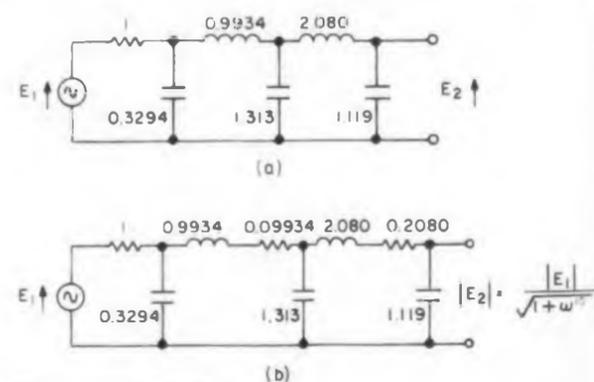
### Q of Network Elements Must Be Considered

In all cases, it should be apparent from Fig. 1b that the  $Q$  of series coils must be proportional to



**Fig. 2.** Typical networks whose normalized design may be taken directly from the table: (a) uses a voltage source; (b) uses a current source; (c) and (d) are duals of (a) and (b).

Lossy-L Networks																			
Table 15 7-Pole								Table 16 8-Pole											
$d$	$C_1$	$L_2$	$C_3$	$L_4$	$C_5$	$L_6$	$C_7$	$d$	$L_1$	$C_2$	$L_3$	$C_4$	$L_5$	$C_6$	$L_7$	$C_8$			
0	.2225	.6560	1.054	1.397	1.659	1.799	1.558	0	.1951	.5776	.9371	1.259	1.528	1.729	1.824	1.561			
.02	.2255	.6688	1.053	1.449	1.602	1.913	1.417	.02	.1982	.5829	.9613	1.243	1.602	1.648	1.963	1.398			
.04	.2286	.6822	1.051	1.504	1.546	2.038	1.288	.04	.2014	.5884	.9868	1.227	1.680	1.569	2.116	1.249			
.06	.2318	.6960	1.048	1.564	1.490	2.173	1.167	.06	.2047	.5939	1.014	1.211	1.764	1.493	2.285	1.113			
.08	.2351	.7104	1.045	1.627	1.436	2.322	1.056	.08	.2081	.5996	1.042	1.194	1.856	1.419	2.472	.9894			
.10	.2384	.7255	1.043	1.694	1.382	2.484	.9532	.10	.2116	.6053	1.071	1.178	1.954	1.347	2.681	.8768			
.12	.2419	.7412	1.039	1.766	1.330	2.664	.8581	.12	.2152	.6111	1.102	1.160	2.061	1.278	2.914	.7743			
.14	.2454	.7575	1.036	1.842	1.278	2.862	.7703	.14	.2190	.6170	1.134	1.143	2.177	1.211	3.178	.6810			
.16	.2491	.7746	1.032	1.924	1.228	3.083	.6892	.16	.2229	.6231	1.169	1.124	2.302	1.147	3.477	.5962			
.18	.2529	.7924	1.028	2.013	1.178	3.330	.6144	.18	.2270	.6292	1.206	1.107	2.440	1.084	3.819	.5191			
.20	.2568	.8110	1.024	2.108	1.130	3.609	.5454												
Table 17 9-Pole																			
$d$	$C_1$	$L_2$	$C_3$	$L_4$	$C_5$	$L_6$	$C_7$	$L_8$	$C_9$	Table 18 10-Pole									
$d$	$C_1$	$L_2$	$C_3$	$L_4$	$C_5$	$L_6$	$C_7$	$L_8$	$C_9$	$L_1$	$C_2$	$L_3$	$C_4$	$L_5$	$C_6$	$L_7$	$C_8$	$L_9$	$C_{10}$
0	.1736	.5155	.8414	1.141	1.404	1.620	1.777	1.842	1.563	.1564	.4654	.7626	1.041	1.292	1.510	1.687	1.812	1.855	1.564
.02	.1761	.5253	.8432	1.180	1.371	1.716	1.672	2.006	1.377	.1589	.4704	.7812	1.034	1.348	1.457	1.807	1.682	2.044	1.357
.04	.1786	.5354	.8450	1.221	1.338	1.821	1.571	2.189	1.211	.1614	.4754	.8006	1.027	1.408	1.404	1.939	1.560	2.258	1.173
.06	.1812	.5460	.8467	1.264	1.304	1.934	1.474	2.393	1.061	.1641	.4806	.8209	1.019	1.472	1.353	2.084	1.444	2.501	1.010
.08	.1839	.5570	.8483	1.310	1.271	2.058	1.383	2.623	.9261	.1669	.4859	.8422	1.011	1.541	1.302	2.245	1.336	2.778	.8660
.10	.1866	.5684	.8497	1.359	1.238	2.193	1.294	2.884	.8054	.1697	.4913	.8603	1.003	1.614	1.251	2.423	1.234	3.096	.7387
.12	.1894	.5802	.8510	1.412	1.204	2.342	1.211	3.180	.6971	.1726	.4969	.8880	.9949	1.694	1.201	2.621	1.139	3.466	.6263
.14	.1924	.5926	.8522	1.467	1.171	2.505	1.132	3.521	.6001	.1757	.5024	.9127	.9861	1.780	1.152	2.842	1.050	3.901	.5270
.16	.1954	.6054	.8533	1.527	1.137	2.686	1.057	3.917	.5132										



**Fig. 3.** A low-pass, 5-pole Butterworth network with coil  $Q$ 's of 10 designed with the aid of Table 13. The lossless network (which does not have the desired response) is shown at (a). Adding the indicated losses for the proper response gives the network in (b).

frequency, and the  $Q$  of shunt coils must be inversely proportional to frequency. Thus, in high-precision applications, we must use components which substantially meet these requirements.

If high- $Q$  inductors are available, a design for low element- $Q$  can be chosen, and resistors can be wired in series with the series elements, and in parallel with the shunt elements. If element  $Q$  is limited, then series coils should be chosen whose  $Q$ -curves show maximum  $Q$  at a relatively high frequency. For the shunt coils, the frequency of  $Q_{max}$  should be low.

In bandpass filters, it is essential that the  $Q$  of the resonant branches be carefully considered. This number, which we call  $Q_B$ , is the net  $Q$  of the branch coil and capacitor together, measured at the center frequency,  $f_0$ . If the capacitors are nearly lossless, it is substantially the  $Q$  of the inductor alone. In either case, it must meet the requirement

$$Q_B = Q_p Q_c \quad (3)$$

where  $Q_p$  is the normalized low-pass  $Q$ , i.e.,  $Q_p = 1/d$ , where  $d$  is the number tabulated here. This figure is always evaluated at the 3-db loss frequency.  $Q_c$  is the circuit- $Q$  which is given by:

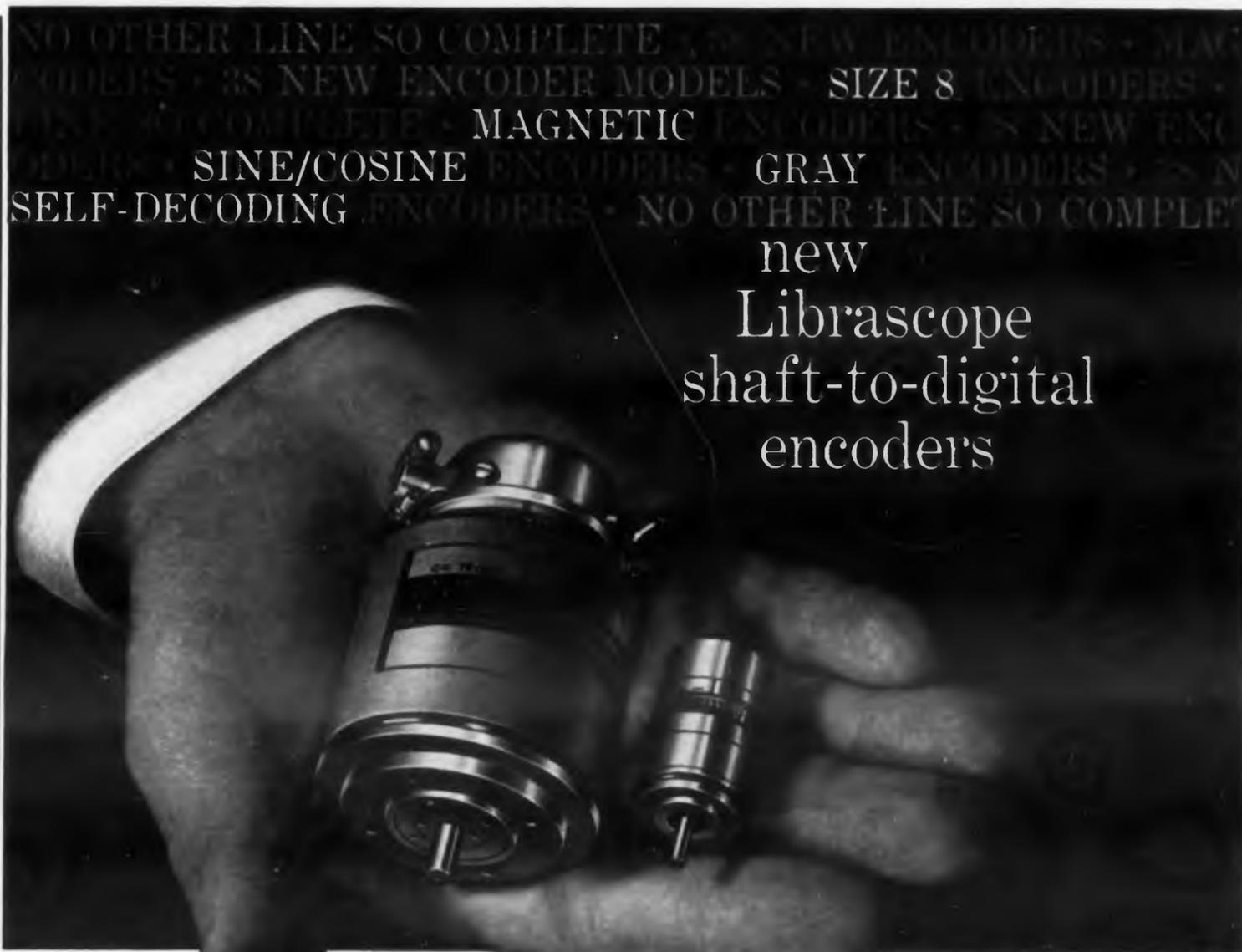
$$Q_c = \frac{f_0}{f_2 - f_1}, f_0 = \sqrt{f_1 f_2} \quad (4)$$

where  $f_1$  and  $f_2$  are the 3-db frequencies of the desired bandpass filter.

The value of  $Q_B$  can be measured accurately by using a Wheatstone bridge with an ac signal whose frequency coincides exactly with the tuning frequency of the  $LC$  branch. At resonance, the branch is entirely resistive. Once this resistance is known, the  $Q$  can be calculated from an accurate knowledge of the element values. The result can be made accurate within one percent if due care is exercised. ■ ■

#### References

1. A. J. Crossman, "Synthesis of Chebyshev Parameter Symmetrical Filters," *Proc. IRE*, pp. 454-473, April, 1957.
2. J. Meinguet & V. Belevitch, "On the Realizability of Ladder Filters," *IRE Transactions on Circuit Theory*, pp. 253-255, December, 1958.
3. L. Weinberg, "Network Design by Use of Modern Synthesis Techniques and Tables," *Proc. Nat'l. Electronics Conf.*, 1956.
4. L. Weinberg, "A,B,C,D—Network Design Easy as Pie," *Proc. Nat'l. Electronics Conf.*, 1957.
5. Reference Data for Radio Engineers, I.T.T. Corp., New York, 1949, pp. 193-204, (Fourth Edition).
6. Philip R. Geffe, "A Note on Predisortion," *IRE Transactions on Circuit Theory*, p. 395, December, 1959.
7. L. Weinberg, "Exact Ladder Network Design Using Low- $Q$  Coils," *Proc. IRE*, April, 1958.
8. Philip R. Geffe, "Predisorted Filter Design with a Digital Computer," *IRE Wescon Conv. Record*, 1958, pp. 10-15.



## NO OTHER LINE SO COMPLETE SINE/COSINE SELF-DECODING

MAGNETIC

GRAY

new  
Librascope  
shaft-to-digital  
encoders

Librascope Shaft-to-Digital Encoders are highly accurate, reliable, shock-resistant, and versatile... ready to serve in a variety of applications including missiles, aircraft, machine control, computers, Doppler navigation and data processing. Accuracy that counts is the by-word of a Librascope Encoder... backed by the superior technology and reputation of one of the world's largest producers of Computers that Pace Man's Expanding Mind.

#### other popular Librascope encoders

Code	Model no.	Full scale capacity	Resolution per input shaft turn
Binary	773	13 bits	128 counts
	0-773	oil-filled unit for increased life	
Binary	710	10 bits	1024 counts
	707 (707D*)	7 bits	128 "
	713 (713D*)	13 bits	128 "
	717 (717D*)	17 bits	128 "
Binary	719 (719D*)	19 bits	128 "
	0-713	oil-filled unit for increased life	
Self-Decoding Binary	740	10 bits	1024 counts
	723 (723D*)	2,000 counts	200 "
B/C/D	724 (724D*)	20,000 "	200 "
	733 (733D*)	3,600 "	200 "
	734 (734D*)	36,000 "	200 "
Sine/Cosine	735	360,000 "	200 "
	757-S**	4 quadrants per turn	7 bits per quadrant + limit 1
Sine/Cosine	758	4 quadrants per turn	8 bits per quadrant + limit 1
	758-S**	4 quadrants per turn	8 bits per quadrant + limit 1
Gray	708	8 bits	256 counts

\*Contain isolation diodes for multiplexing

\*\*Servo driven, hermetically sealed

#### new noncontact magnetic encoder

MODEL NO. 807

##### FEATURES:

Long life, high reliability, high speed, natural binary V-Scan readout.

##### SPECIFICATIONS:

Output Code: natural binary  
Resolution: (per input shaft turn) 128 counts  
Full Scale Capacity: 7 bits\*  
Speed: operating from 0 to 10,000 rpm  
Life Expectancy: 20,000 hours at 4,000 rpm; 4 x 10<sup>9</sup> revolutions  
Starting Torque: 0.1 in.-oz. max.  
Diameter: 2"  
Length: 1 13/16"  
Weight: 5 ounces

\*ALSO AVAILABLE IN 13, 17, AND 19 BIT CAPACITIES.

NEW CATALOG AVAILABLE write today for your copy



#### new subminiature size 8 encoder

MODEL NOS. 787 & 793

##### FEATURES:

Low torque, low inertia, long life, high reliability, withstands severe environments.

##### SPECIFICATIONS:

Output Code: natural binary  
Resolution: (per input shaft turn) 128 counts  
Full Scale Capacity: 7 bits, 13 bits  
Speed: operating 200 rpm, slew 600 rpm  
Life Expectancy: 2 x 10<sup>6</sup> revolutions at 200 rpm  
Starting Torque: 0.5 oz.-in. maximum  
Diameter: .750"  
Weight: 3 ounces

BURBANK BRANCH  
LIBRASCOPE DIVISION  
GENERAL PRECISION, INC.  
100 East Tujunga • Burbank, Calif.



For career opportunities, write John Schmidt Engineering Employment

CIRCLE 44 ON READER-SERVICE CARD

# Stripline Technique Produces A Simple 3-Db Directional Coupler

*In this article, author John Dent describes a 3-db directional coupler which employs stripline techniques and provides directivity in excess of 20 db over a 30 per cent frequency band. The unit demonstrates excellent power division characteristics and contains no critical dimensions or construction practices.*

**John R. Dent,**  
Electronic Engineer,  
Melpar, Inc.,  
Falls Church, Va.

EMPLOYING stripline techniques in the design of directional couplers has led to a class of device that is compact and lightweight. This, together with the lack of an external termination, results in a unit well suited to airborne and missile applications. Fig. 1 illustrates one possible configuration of this device.

Radio-frequency power entering at A is divided equally between lines AB and AC by virtue of the symmetry of the directional coupler design. The resulting fields at B and C are equal in phase and amplitude. The result is that no power is dissipated in resistor R when matched loads are connected to the output terminals. However, by choosing the proper circuit components, a high degree of isolation between terminations (or sources)

connected to terminals ZOB and ZOC will exist for power entering at either terminal. Experimental results of two units, operating about the 1100-mc and 3000-mc frequency bands, are shown in Figs. 2 and 3 respectively.

To obtain isolation, two possible paths of propagation are provided between B and C for power entering at terminals ZOB or ZOC. These paths must offer equal impedances to the signal, and they must be separated by 180 deg at resonance.

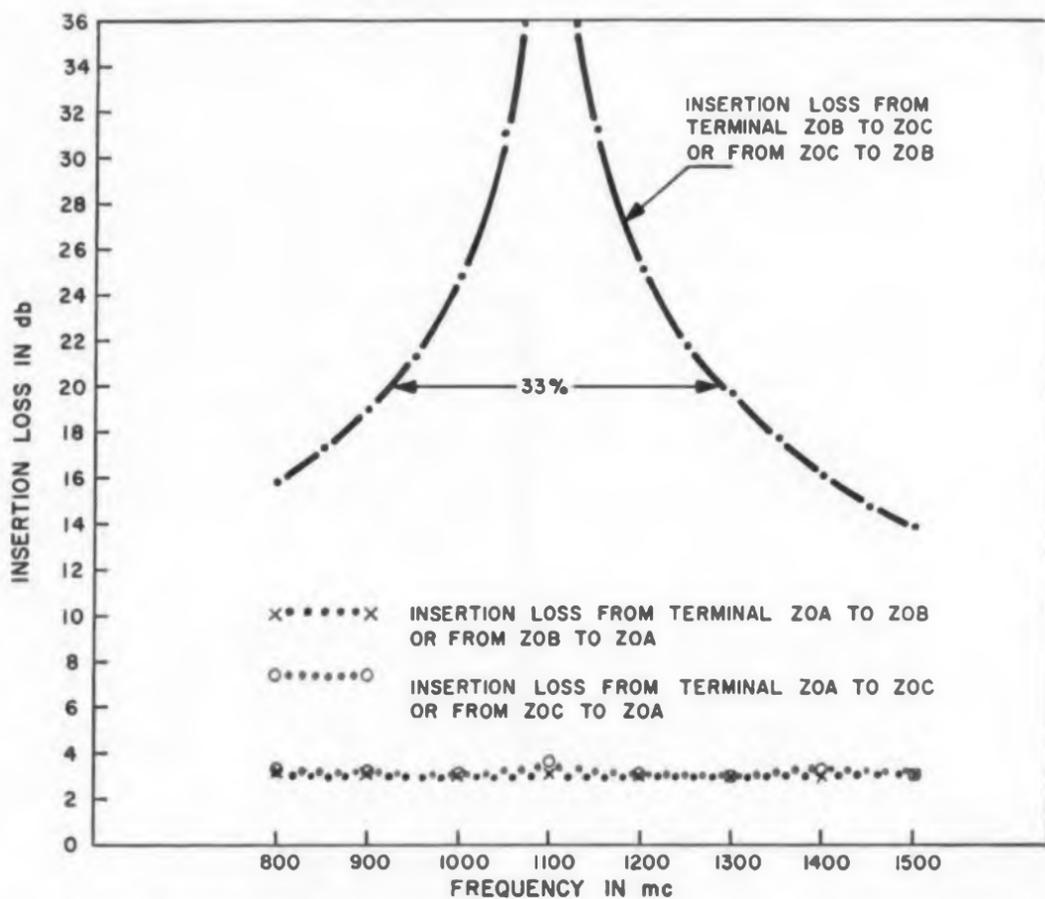
By making the line lengths from A to B and A to C 1/4-wavelength long, and by choosing the proper line impedance and resistor value, an equal power split and proper impedance matching exist.

A signal entering at terminal ZOB is split equally at junction B, and travels toward junction C via the resistor and the 1/2-wavelength long path, B to A to C. At junction C, the two parts of the signal are of equal amplitude and 180 deg

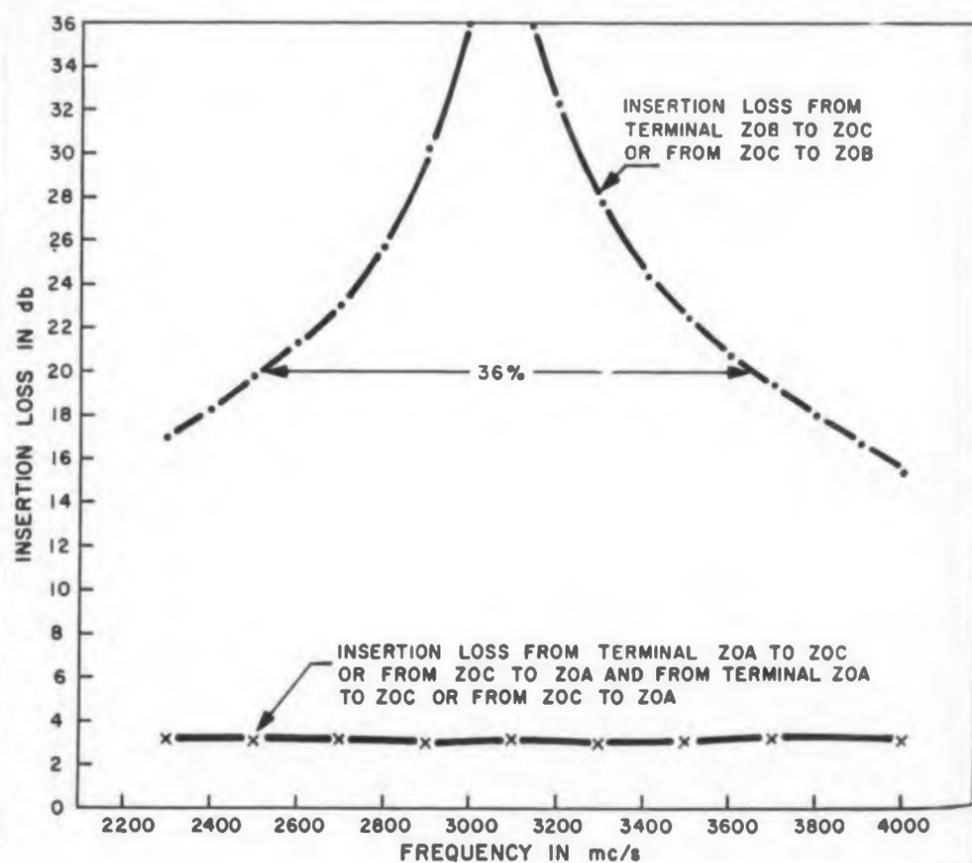


**Fig. 1.** The stripline directional coupler with a 3-db insertion loss shown here is designed about a simple path-length difference.

out of phase, if the path length through the resistor is considered to be negligible, and complete cancellation occurs. This makes junction C a voltage-null point with zero impedance. As a result, no power will be transmitted to terminal ZOC.

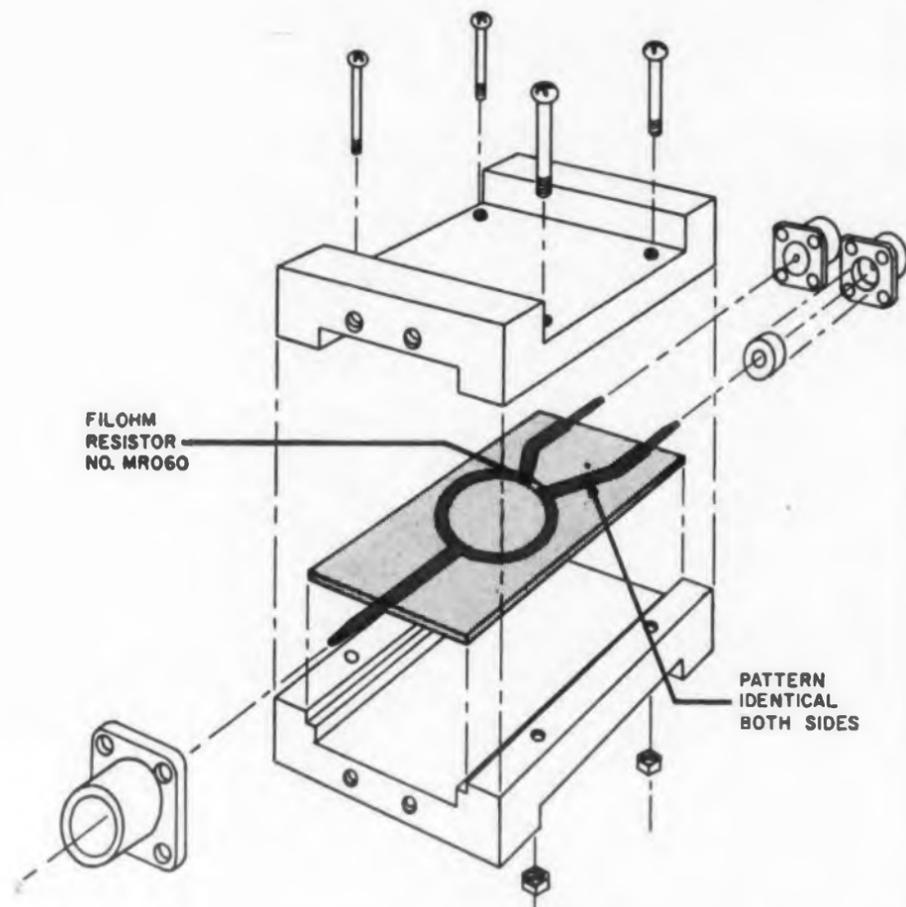


**Fig. 2.** Experimental stripline directional coupler achieved directivity of 20 db over a 33 per cent frequency band at 1,100 mc, with an insertion loss of 3 db.



**Fig. 3.** A second stripline directional coupler, operating at a frequency of about 3,000 mc, achieved a 20-db directivity of 20 db over a 36 per cent frequency band.

Fig. 4. Construction of the stripline directional coupler, as shown in this exploded view, is simplicity itself.



and the power will be equally divided between the resistor and the termination (or source) connected to terminal ZOA.

By making impedance  $ZOA = ZOB = ZOC$ , the impedance of lines AB and AC for proper impedance matching can be determined from the quarter-wave transformer expression:

$$Z_{AB} = Z_{AC} = \sqrt{(2ZOA)(ZOC)} \\ = \sqrt{(2ZOA)(ZOB)} = \sqrt{2}(ZOA) \quad (1)$$

The impedance of the resistor is determined readily since junction C appears as a point of minimum impedance for signals entering at terminal ZOB. Conversely, junction B appears as a point of minimum impedance for signals entering at terminal ZOC. This minimum impedance at C is reflected along the 1/4-wavelength transformer, line AC, as an open circuit at junction A. The path impedance toward junction A from junction B is, therefore, the impedance ZOA transposed along the 1/4-wavelength transformer, line AB as  $2ZOA$ .

By making the value of the resistor equal to  $2ZOA$ , an equal power split can exist at junction B for power entering at ZOB and at junction C for power entering at ZOC (a requirement for maximum isolation), and proper impedance matching will exist.

To determine if the design could be realized in practice, units were constructed using the techniques shown in Fig. 4. The configuration was hand-cut in register on both sides of a copper-clad teflon fiberglass board 1/16-in. thick, with 3/16-

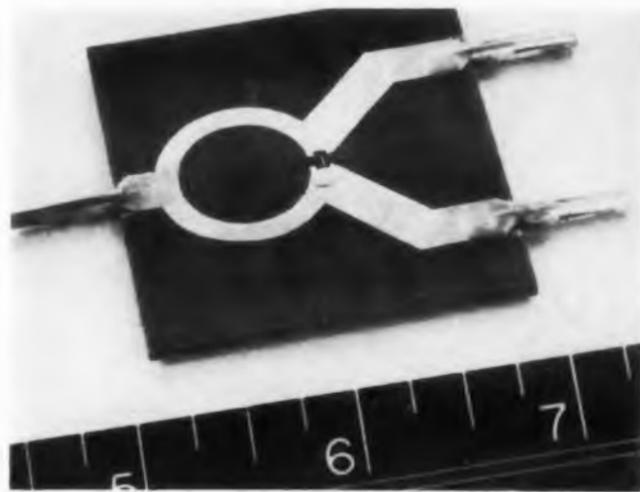


Fig. 5. The high frequency unit, minus the housing, comprises the stripline mounted in register on both sides of a 3-in. sq. of copper-clad teflon fiberglass.

in. ground plane spacing. The strip widths for the desired impedance were determined from reference 1. The resistors employed are of the evaporated film type designed for microwave use. The higher frequency unit, less its housing, is shown in Fig. 5.

With proper choice of dielectric materials, high-frequency resistors and connectors, this unit can be readily adapted to a wide variety of multiplexing and coupling applications, both commercial and military.

#### References

1. S. B. Cohn, "Characteristic Impedance of the Shielded-Strip Transmission Line", *IRE Transactions on Microwave Theory and Techniques*, Vol. MTT-2, No. 2, pp 52-57; July, 1954.

**INSTEAD OF THIS...**



**YOU'LL DO THIS...**



**with American Aluminum  
Quality ... Dependability ... Service!**

And when it comes to quality and dependable service . . . everyone at American Aluminum gets in the act. The minute you call American Aluminum, all members of our family concentrate on giving you the aluminum products that serve your specific needs. From the design to the finished product, all under one roof, you can depend on American Aluminum for quality and service . . . when you need it!

**SPECIALISTS IN CONTRACT MANUFACTURING  
OF ALUMINUM FOR THE ELECTRONICS INDUSTRY**

Complete fabricating facilities for Deep Drawing, Heat Treating, Spinnings, Assembly, Brake Work, Stampings, Anodizing, Welding, Finishing.

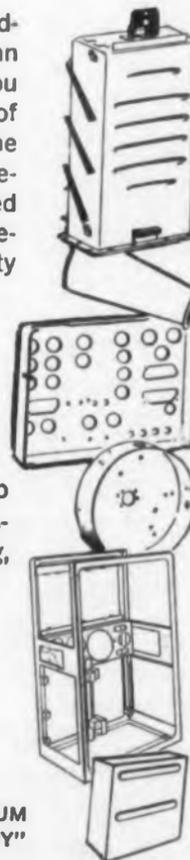
Complete die making facilities  
Stock dies on hand for many shapes  
Complete inspection facilities

Send for brochure "ALUMINUM  
FABRICATING FOR INDUSTRY"

**AMERICAN ALUMINUM COMPANY**

Manufacturers of Aluminum Products  
for industry since 1910

Sheffield Street, Mountainside, New Jersey  
CIRCLE 45 ON READER-SERVICE CARD



the re-  
complete  
a volt-  
result.  
l ZOC.

4000

about 3,000  
nd.

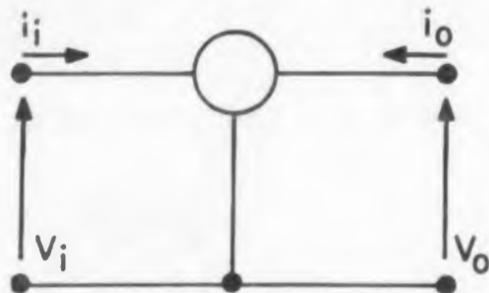


Fig. 1. Generalized transistor circuit.

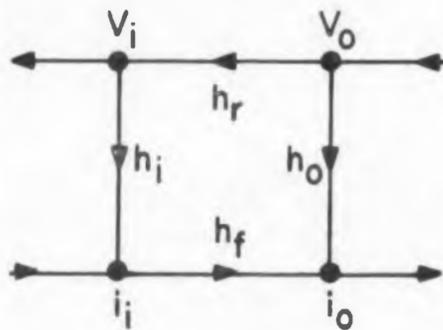


Fig. 2. Flow graph for generalized transistor circuit of Fig. 1.

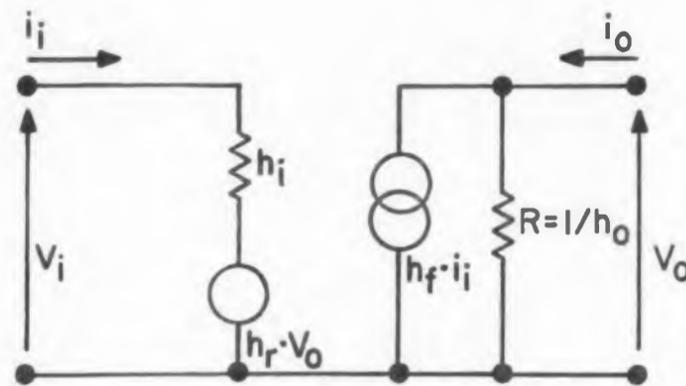


Fig. 3. Electrical equivalent of generalized circuit derived from flow graph of Fig. 2.

## Flow Graph Speeds Transistor Circuit Analysis

*What's going on electrically in a transistor circuit can be determined readily, and without looking up equations, from a flow graph. This application of flow graphs, presented by T. R. Nesbit, enables the designer to easily keep track of resistive parameters, hybrid parameters, voltages and currents.*

**T. R. Nesbit**  
Lockheed Aircraft Corp.  
Palo Alto, Calif.

**T**HE FLOW GRAPH is a useful device for tying together the equivalent circuit, the characteristic curves and the definitions of the various  $h$ -parameters of a transistor.

Fig. 1 defines what is meant by  $v_i$ ,  $i_i$ ,  $v_o$ , and  $i_o$  without reference to the type of circuit connection.

The flow graph, Fig. 2, illustrates all the relevant equations. Note the distinction between dependent and independent variables. To determine  $y$  in the equation  $y = ax + b$ , one must allocate a value to  $x$ . With the flow graph, one must allocate a value to the independent variables  $i_i$  and  $v_o$  to evaluate the dependent variables  $v_i$  and  $i_o$ .

Allocating a zero value gives the definitions.

For example, if  $v_o = 0$ , then  $v_o$  contributes nothing along the  $h_r$  path to  $v_i$  (Fig. 2), so that  $v_i$  is equal to  $i_i \cdot h_i$ . In conventional form,  $h_i = v_i/i_i$  if  $v_o = 0$ .

When the independent variables are not zero the system equations can be written from the flow graph. For example:

$$v_i = [h_i \cdot i_i + h_r \cdot v_o]$$

Because generators in an equivalent circuit represent dependent variables, it is easy to construct an equivalent circuit from the flow graph, as in Fig. 3.

When drawing a graph, one intuitively puts the independent variable on the X axis. The common-emitter characteristic curves therefore are plotted as in Fig. 4, with the second independent variable, input (base) current as a parameter. Similarly, the input characteristic would be plotted as base

voltage (X axis) vs base current (Y axis) with collector voltage as a parameter.

The  $T$  equivalent-circuit parameters for the common emitter connection are shown in Fig. 5, and the flow graph in Fig. 6. The flow graph with the path  $i_o$  to  $v_{ce}$  inverted is shown in Fig. 7.

Comparison of the flow graph Fig. 7 and Fig. 2 shows that the arrangement of input and output variables is the same. Therefore to express  $h_r$  in terms of the equivalent-circuit parameters, note where it appears in the flow graph, in Fig. 2, and write down, from flow graph rules, (see *ED*, Dec 9, 1959, p 32) an expression for the same path in Fig. 7; by implication, the "unused" independent variable,  $i_i$  or  $i_b$  is set equal to zero in both cases. There is one loop, so  $h_r$  is evaluated as:

$$h_r = \frac{1}{r_d} \cdot r_e \left[ \frac{1}{1 + r_e/r_d} \right] = \frac{r_e}{r_d + r_e}$$

# "FRIGID MIDGET" for electronic systems

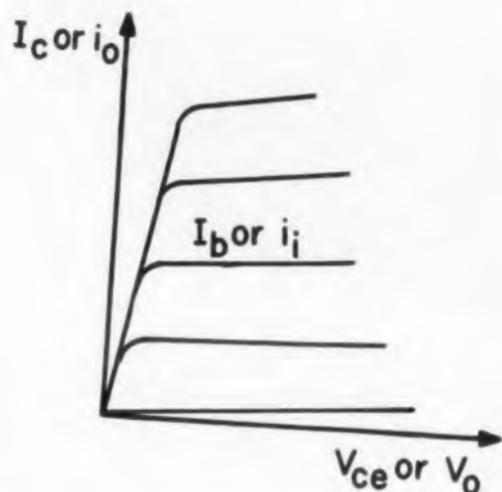


Fig. 4. Common emitter characteristic curves.

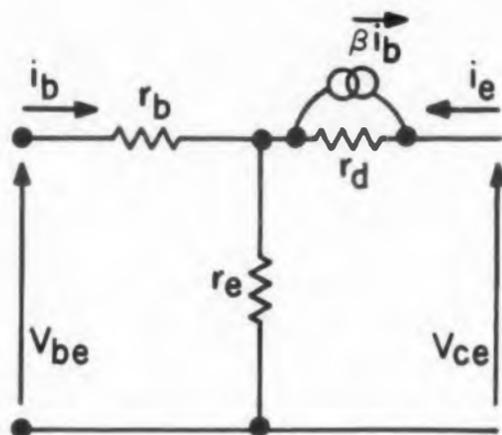


Fig. 5. Common emitter equivalent T circuit.

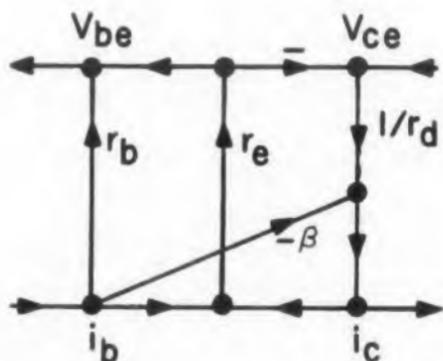


Fig. 6. Flow graph for equivalent T circuit of Fig. 5.

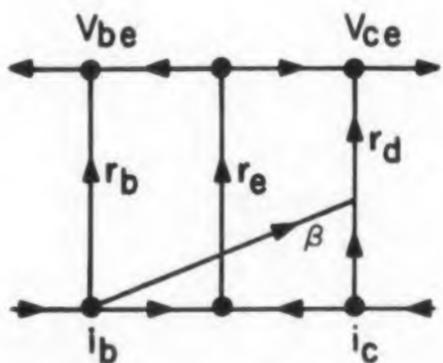


Fig. 7. Equivalent T flow graph with  $i_c$ - $v_{ce}$  path inverted.



❄️ **OPTIMUM DESIGN FOR A BALANCED COOLING SYSTEM** . . . and the customer receives perfection in miniature, assured performance . . . plus single-source responsibility from Pesco — the only manufacturer that produces all its own micro-matched components for electronic cooling packages. Designed by a creative team of Pesco engineers, this compact package features a liquid flow rate of 1 gpm . . . high heat transfer of 2½ KW at 212° F and 50,000 feet altitude . . . liquid temperature range from -65° to +212° F . . . plus built-in thermal bypass for low temperature operation requiring no cooling. It is particularly adaptable to electronic systems utilizing liquid-cooled power tubes in either airborne or ground installation where space and weight are of critical importance. For customized cooling packages engineered to meet your environmental requirements, contact the Pesco Sales Office nearest you or write today to . . .

**PESCO PRODUCTS DIVISION**  
**Borg-Warner Corporation**

24700 North Miles Road • Bedford, Ohio

EXPORT SALES: Borg-Warner International Corp., 36 South Wabash Avenue, Chicago 3, Illinois

CIRCLE 46 ON READER-SERVICE CARD

*Creative  
Engineering . . .  
for  
Electronics*



3499-PC

# NWL PULSE TRANSFORMER

(up to 10,000 KVA).

an aid in the production  
of nuclear energy.



The unit illustrated is the largest transformer manufactured by NWL. It can be made in either air, air-blast or oil-filled versions. The pulse transformer has an output of 10,000 ampere pulses at 1000 volts. The approximate weight is 11,000 lbs. This transformer is typical of the many special units currently being produced by NWL. Pulse transformers can be manufactured up to 200 KV and up to 50,000 KW peak power.

Each NWL unit is thoroughly tested and must meet all customer requirements before shipment. We shall be pleased to quote you according to your individual requirements.



*Notthelfer*  
SAY: NO-TEL-FER

NOTHELPER WINDING LABORATORIES, INC., P. O. Box 455, Dept. ED8 Trenton, N. J.  
(Specialists in custom-building)

CIRCLE 47 ON READER-SERVICE CARD



## Power Sensing Circuit

*Protects New Line of Power Supplies Against Overload*

A CIRCUIT which provides overload and short circuit protection by sensing the power being dissipated in the output-regulating transistors, is the outstanding feature of the GE's new line of transistorized power supplies. Designed by General Electric's Low Voltage Switchgear Dept. (6901 Elmwood Ave., Philadelphia 42, Pa.), the supplies are available in 30 standard models with output voltages ranging from 1.5 to 100 v. Current output is rated up as 20 amp.

The supplies are protected against overload by a patentable "constant-watts" circuit. Because the patent has only recently been applied for, a complete discussion of this circuit cannot be given. However, some details have been made available.

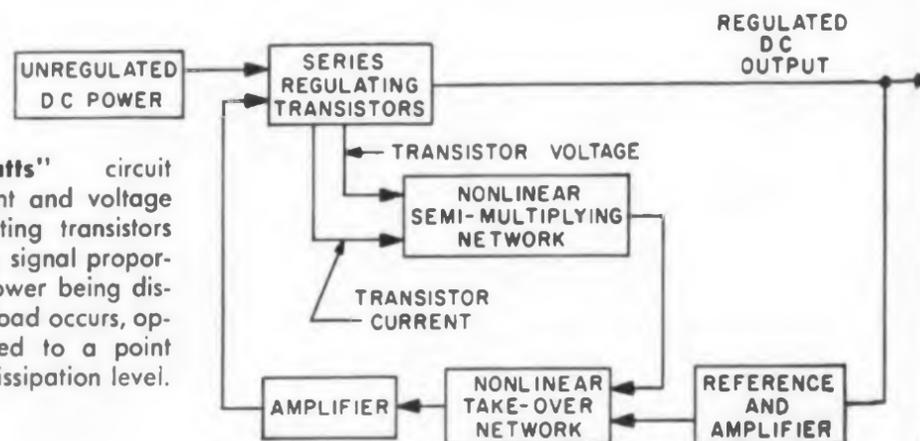
The diagram shows how the constant-watts circuit is placed across the series-regulating transistors. Voltage across, and the current through the transistors are measured. These parameters are then mixed in a nonlinear network whose output is proportional to the power dissipated in the transistors.

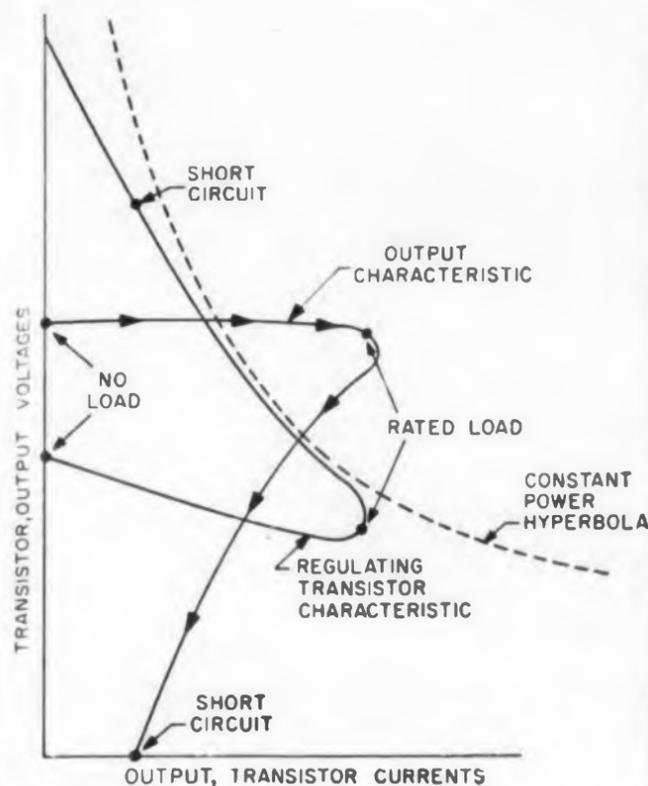
If excessive power dissipation occurs (as would be caused by an overload), the operating point of the transistors is shifted to a position having a safe dissipation level. When the overload condition is removed, normal operation is automatically resumed within 3  $\mu$ sec.

Thus, the effect of the constant-watts circuit is to superimpose power-limited operation on the voltage-regulating system of the supply. This is illustrated by the graph which plots the voltage and current passing through the regulating transistor. The dashed line represents the locus of constant transistor dissipation and shows where the power-limiting circuit will take over from the voltage-regulating one. This curve, which approximates the constant dissipation hyperbola in the middle range, is produced by the nonlinear multiplying network.

Also shown is the power supply's output current-voltage characteristic. The direction of the arrows indicates the change from no load to short circuit conditions. It can be noted that with a shorted output, some current is still be-

"Constant-watts" circuit measures current and voltage in series-regulating transistors and develops a signal proportional to the power being dissipated. If overload occurs, operation is shifted to a point having a safe dissipation level.





Current-voltage characteristics are shown for the output of the supply and for the regulating transistors. Arrows show direction of operation as loading increases from no load to short circuit. (Curves are to scale and apply approximately to each unit.)

ing supplied—that is, the supply is not completely shut off. This characteristic makes these units very suitable for certain applications where initially the load is approximately a short. Such applications would include the charging of capacitors and dc motor starting.

All ratings in the standard line of supplies are for 115 or 220-v single-phase, 60-cps input. Units are also available for 400-cps, and three-phase inputs. Output voltage is variable from 0 to 100 per cent volts.

Line regulation is less than 10 mv for line changes of  $\pm 10$  per cent, or 0.03 per cent, whichever is greater. Load regulation is less than 0.1 per cent or 30 mv, whichever is greater, for load changes of zero to 100 per cent. The dynamic regulation is 0.1 per cent instantaneously for 5 per cent step line, or a 50 per cent step load change.

The units are designed for mounting in 19 in. racks, or for bench mounting, and are convection cooled. Prices range from \$350 to \$1100 with slight increase in cost for such optional features as remote sensing and output voltage control, instantaneous overvoltage protection, and multiple-unit packaging.

For more information on these power supplies circle Reader-Service 251.

## V44 - the new, ultra-stable, all-electronic digital voltmeter

No longer must you trim decade or amplifier gain potentiometers to make accurate, high-speed measurements with an all-electronic digital voltmeter. The new transistorized NLS V44 has *no pots at all* in its decade circuits because of ultra-stable electronic switches . . . *no pots at all* in the amplifier because amplifiers are used only within the feedback loop, where amplifier drift becomes inconsequential. Here is the speed you need — 3 milliseconds per reading — for measuring high-speed transient data . . . for multi-channel data logging. Contact NLS for complete information.



Originator of the Digital Voltmeter

**non-linear systems, inc.**

DEL MAR (SAN DIEGO), CALIFORNIA

CIRCLE 48 ON READER-SERVICE CARD



**BRIEF SPECIFICATIONS:** Accuracy  $\pm 0.01\%$  . . . speed 3 milliseconds per reading . . . input impedance 10 megohms . . . "anti-jitter" circuit . . . DC voltage ranges  $\pm 9.999/99.99/999.9$  . . . millivolt ranges with preamplifier  $\pm 99.99/999.9$  . . . AC ranges with AC/DC converter 9.999/99.99/999.9 from 30 cps to 10 kc . . . 98% plug-in modular construction . . . digital output in both decimal and binary coded decimal form . . . simple plug-in accessories for automatic data logging and measuring systems . . . complete, \$6,150.

**TO 600,000 VDC**  
 ... something new in high voltage!

## ELECTROSTATIC GENERATORS FOR INDUSTRY

SAMES Electrostatic Generators, producing substantial amounts of output power at voltages up to 600 kv, are the first such generators ever designed for day-to-day industrial use. They're marketed in the U.S. exclusively by Sorensen.

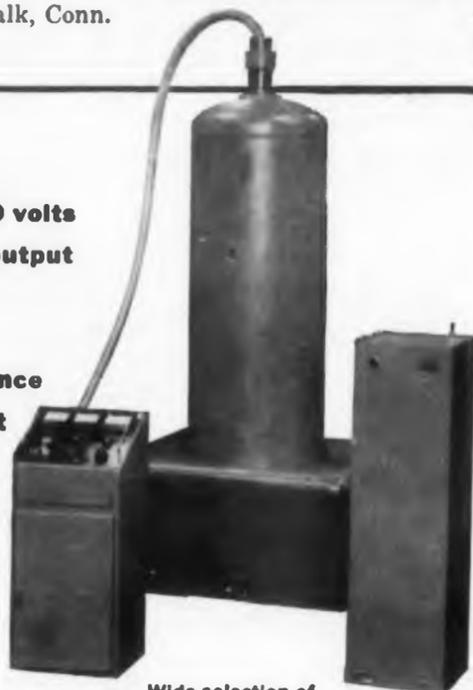
Output voltage is very nearly pure d-c, marked by the almost complete absence of ripple or other a-c components. Voltage regulation ranges from 4% to 0.33% for medium stability models and from 0.1% to 0.001% for high stability models.

You'll find these advanced high-voltage d-c sources described in the new 6-page SAMES brochure. A new 32-page Sorensen catalog is also available which lists more than 400 models of high-precision power supply equipment and gives valuable selection and application data. Write for your copies today. Sorensen & Company, Richards Avenue, South Norwalk, Conn.

- \* 18 models available
- \* Voltages up to 600,000 volts
- \* Substantially pure d-c output
- \* Powers to 2.4 kw
- \* Outstanding safety:
  - Low output capacitance
  - Low overload current



Wide selection of portable models — to 100 kv.



Wide selection of floor-mounted models — to 600 kv.

**Sorensen** CONTROLLED POWER PRODUCTS

A SUBSIDIARY OF RAYTHEON COMPANY

... THE WIDEST LINE MEANS THE WISEST CHOICE  
 CIRCLE 49 ON READER-SERVICE CARD



## Solid-State Pressure Transducer

A SOLID-STATE pressure transducer that is reported to combine the best over-all characteristics of both strain gage and potentiometer-type transducers, but has the disadvantages of neither, is available from Fairchild Controls Corp. The unit, which is compatible with microminiature solid-state amplifiers, withstands military transducer environments.

Designated type 3S-G, the transducer is "conservatively regarded as representing a 10-fold increase in the state of the transducer art," according to the Fairchild Controls Corp. It "obviates the need for an amplifier, required by conventional strain gage transducers, to increase output signal strengths from an average 20 to 40 mv to approximately 5 v dc," it was added.

The transducer consists essentially of three modules contained in an anodized aluminum case 1-1/8 in. in diameter and 3 in. long. These modules perform the functions of energy conversion, signal conditioning, and calibration.

Energy conversion is accomplished by a sensitive element made of several piezoresistive semiconductor elements coupled to a resilient, high-alloy steel, low-mass diaphragm. These elements form the resistive arms of a Wheatstone bridge. The diaphragm is proportioned to fit selected pressure ranges from 0 to 100 psi and from 0 to 10,000 psi, full scale. Pressures which deflect the diaphragm create an unbalance in the bridge, producing a dc signal proportional to the deflection. Input excitation to the transducer is from 10 to 25 v dc

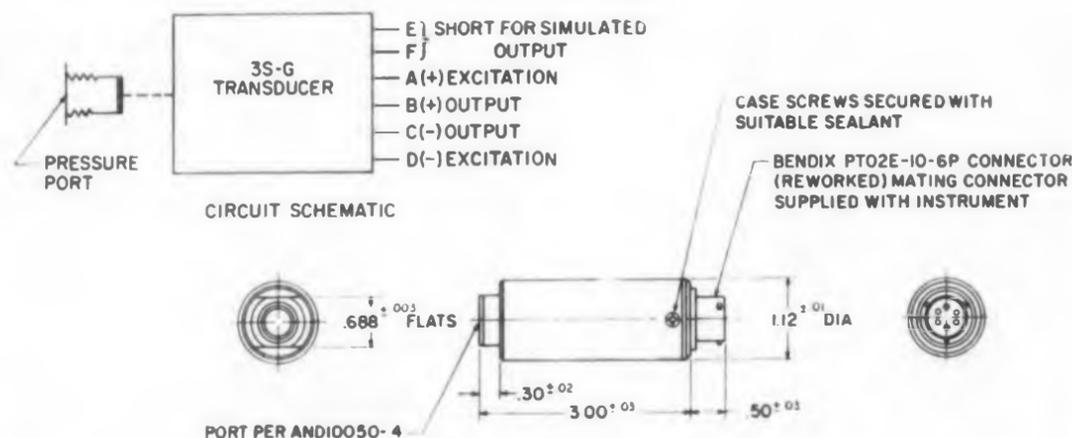


Diagram illustrates the configuration of the pressure transducer, and transducer excitation and output.

nominal; it can take up to 30 v dc without damage. Input impedance is approximately 700 ohms with an output impedance of less than 4,500 ohms. Input pressures up to 150 per cent of rated have negligible effect on instrument calibration while pressures in excess of 200 per cent have caused no damage.

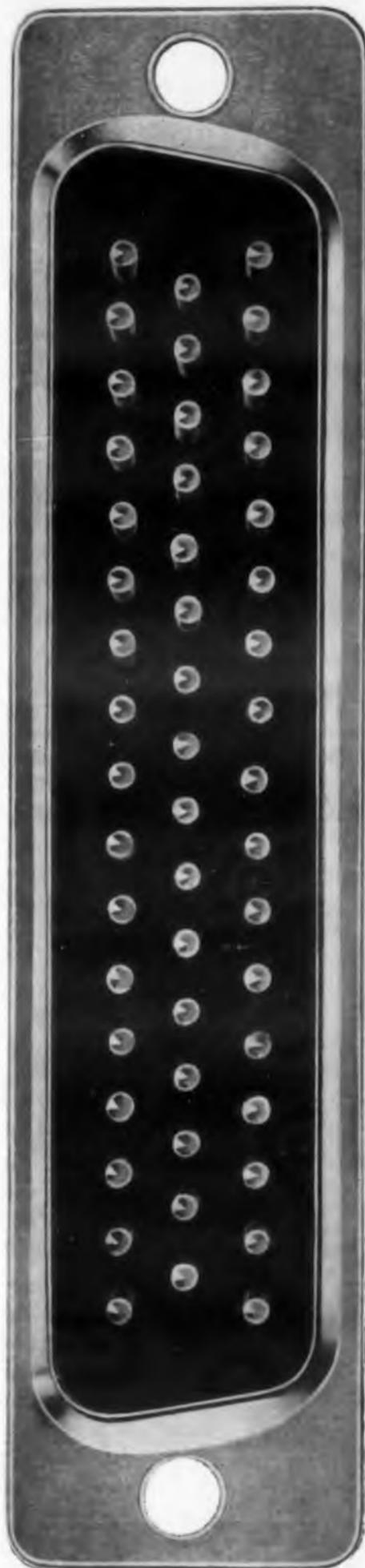
Signal conditioning is accomplished by a completely transistorized amplifier which receives the differential signal generated in the sensing element and produces the output signal. The transducer transfer function is 25 per cent, giving a 5-v dc output signal for a full range change in pressure at 20 v dc.

Calibration is accomplished by an internally-contained shunt resistor. When it is keyed across one leg of the Wheatstone bridge, the transducer produces an output signal equivalent to one-half full scale rating.

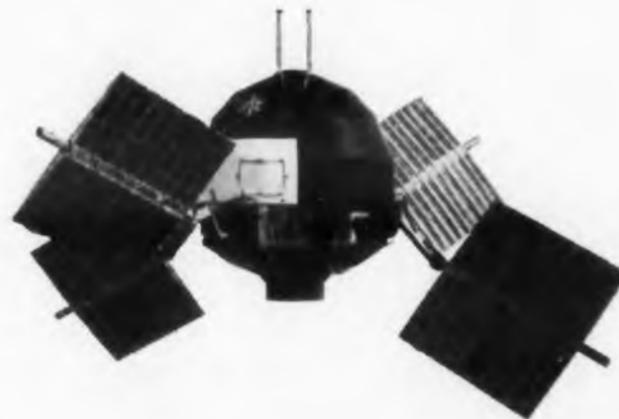
The 3S-G transducer, made by Fairchild Controls Corp., Components Div., 225 Park Ave., Hicksville, N.Y., is responsive to static pressures and to dynamic pressures in the kilocycle range. Frequency response is limited only by the type of plumbing that conducts the measured pressure media to the 3S-G pressure port. It has better than  $\pm 0.1$  per cent linearity, an 0.1 per cent hysteresis over a temperature range of  $-65$  to  $+250$  F; it has infinite resolution. Both zero and full range sensitivity change less than  $\pm 0.5$  per cent over any 100 F temperature excursion within the rated temperature range. Designed to meet the Mil-E-5272C environmental requirements, it can withstand 50 g vibration to 2,000 cps without damage. Materials used allow the measurement of all gaseous and liquid media, including liquid oxygen, strong alkalis and acids such as nitrozone and red fuming acid. A ruggedized design, which adds 3/16 in. to the wall thickness, is available for usage where the most severe environments are encountered, such as a rocket test stand. The problem of noise pick-up and signal distortion are eliminated by the 5-v dc output that requires no amplification for instrumentation purposes.

These units are available in sample quantities up to 2 within 60 days, for larger quantities up to 10 the availability is 60 to 90 days after the date of order.

For more information on this solid-state transducer, turn to the Reader-Service Card and circle 252.



THREE AND ONE-HALF TIMES ACTUAL SIZE.



## CANNON GOLDEN-D SUBMINIATURE PLUGS

**DESIGNED ESPECIALLY FOR MISSILE CIRCUITRY  
AND MAXIMUM RELIABILITY APPLICATIONS**

The "Golden-D" Cannon Plugs are engineered to deliver superior performance in a subminiature size! Supplementing our famous standard D-Subminiature line, the "Golden-D" has these

new design features: • MONO-BLOC INSULATORS • PROBE-PROOF CLOSED-ENTRY SOCKET CONTACTS • LOW ENGAGEMENT/SEPARATION FORCES • GOLDEN CADMIUM SHELL FINISH • MATES WITH ANY CANNON "D" OF SAME SIZE AND LAYOUT. Wherever maximum reliability

is needed in a subminiature multi-contact plug—for both military and industrial applications—ask for the new "Golden-D" ... another reason why you should contact the world's most experienced plug manufacturer for *all* your plug requirements. The "Golden-D" is available in four types with a large variety of contact layouts. For further information write to:



**CANNON ELECTRIC COMPANY, 3208 Humboldt St., Los Angeles 31, Calif.**

CIRCLE 50 ON READER-SERVICE CARD

# NEW PRODUCTS

Covering all new products generally specified by engineers designing electronic original equipment. Use the Reader's Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.



## Miniature Circulators 455 Have No External Permanent Magnets

These miniaturized coaxial-line circulators have no external permanent magnets. They can be designed for operation in the C-, S- and L-bands. They operate over 10% bandwidths and provide more than 20-db isolation and less than 0.5-db insertion loss with a maximum input vswr of 1.3 in any arm. The size of the C-band unit is 1.4 in. in diameter and 1.4 in. height, exclusive of connectors; it weighs 6 oz.

Sperry Rand Corp., Sperry Microwave Electronics Div., Dept. ED, Clearwater, Fla. **Price & Availability:** C-band, \$225; S-band, \$245; L-band, \$325. Delivery is from stock for small quantities; 30 to 60 days after order for production quantities.



## Miniature Wafer Switch 454 For Rotary-Type Applications

This wafer switch is designed for miniature installations requiring a rotary-type switch. As many as 20 circuits may be installed through a 1 in. hole. Plated-through segments of the hole provide contact to the desired circuits by means of a positive-stop rotary wafer. Up to 10 wafers per in. can be stacked in any design.

Allied Allegri Machine Co., Inc., Dept. ED, 141 River Road, Nutley 10, N.J.

**Availability:** For quantities of 1 to 49, up to 4 weeks.



## Relays Have Life Of 451 Over 300,000 Cycles

The BR-14 series of 4pdt relays provide a life span of better than 300,000 operations. Two types are offered: the BR-14X with 10-amp contacts and the BR-14Y with 5-amp contacts. Units are rated to 25 amp, minimum overload, with a maximum coil dissipation of 6 w. Ambient temperature range is -65 to +125 C. Maximum operate and release time is 7 msec with the dropout adjustable between 10% and 40% of pull-in.

Babcock Relays, Inc., Dept. ED, 1640 Babcock Ave., Costa Mesa, Calif.



### Low-Current Silicon Rectifiers 450 Rated from 25 to 400 V, 4.7 Amp Avg

Peak-inverse-voltage ratings from 25 to 400 v and average forward-current ratings up to 4.7 amp are provided by the series C11 low-current silicon controlled rectifiers. Typical gate current is 4 ma at 0.6 v; maximum gate voltage to fire is 2 v. Typical turn-on and turn-off times are 2 and 15  $\mu$ sec, respectively. Maximum reverse or forward leakage current is 4.5 ma for the 25-v device, and 1 ma for the 400-v unit. Peak-surge-current ratings are 60 amp at rated load, or 125 amp during the turn-on time interval.

General Electric Co., Dept. ED, Charles Bldg., Liverpool, N.Y.

Price: \$4.50 to \$35.50, depending on voltage rating.



### Voltage Reference Diodes 452 Are Stable Within $\pm 16$ And $\pm 8$ Mv

Stable within  $\pm 16$  and  $\pm 8$  mv from  $-55$  to  $+100$  C, these silicon Zener voltage-reference diodes have a temperature coefficient of  $\pm 0.002\%$  per C. Designated types 1N1530 and 1N1530A, respectively, the units provide a reference voltage of 8.4 v at 10-ma bias current and have a dynamic resistance of 11 ohms avg. The devices, designed for insertion into printed-circuits, measure 0.56 in. in diameter and 0.59 in. high. They are said to withstand severe shock and vibration.

International Rectifier Corp., Dept. ED, 1521 E Grand Ave., El Segundo, Calif.

Price: 1N1530: \$18; 1N1530A: \$27.

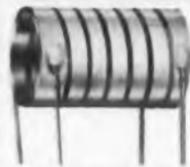


## NEW FROM **JFD** FIXED MINIATURE METALIZED INDUCTORS

JFD now offers a complete line of fixed-value miniature Metalized Inductors in inductances to cover a wide variety of circuit application requirements



MODEL LF-1P010  
ACTUAL SIZE



MODEL LF-2W008  
ACTUAL SIZE

#### TYPICAL PANEL MOUNT JFD METALIZED INDUCTORS

Model	Inductance $\mu$ h ( $\pm 5\%$ )	Q Min.
LF-1P010	0.10	145
LF-1P025	0.25	135
LF-1P040	0.40	105
LF-1P070	0.70	120
LF-1P100	1.00	135
LF-1P200	2.00	180

Listed above are only six of 23 standard JFD Metalized Inductors available in panel mount and printed circuit types from .05  $\mu$ h to 2.00  $\mu$ h.

The new JFD Inductor series employs silver film permanently fused to a low loss dielectric glass cylinder. This lightweight monolithic construction achieves a new high in stability, durability and economy; a new low in temperature coefficient of inductance and distributed capacitance. Assures you of utmost reliability for critical circuit operation in severe environment.

JFD Metalized Inductors can also be designed to help solve any development, design, or production problem. The number of turns, types of windings, size and distributed capacitance, Q and other parameters can be designed to suit individual circuit requirements. Write for bulletin 223 for full specifications.

#### Features

1. Rugged construction affords unusually high stability under conditions of severe shock and vibration.
2. Use of glass dielectric assures low temperature coefficient of inductance and operation without derating over a wide range of extreme environmental conditions.
3. Low distributed capacity.
4. Special alloy plating protects metal parts from corrosion.
5. A high Q over a broad frequency range.
6. Silver plated copper leads.
7. Available in panel mount and printed circuit mount types.

# JFD

PRECISION COMPONENTS FOR PRECISION PERFORMANCE

## JFD ELECTRONICS CORPORATION

6101 Sixteenth Avenue, Brooklyn 4, New York

JFD WESTERN REGIONAL DIVISION  
7311 Van Nuys Boulevard, Van Nuys, California

JFD CANADA LTD.  
51 McCormack Street, Toronto, Ontario, Canada

JFD INTERNATIONAL  
15 Moore Street, New York, N. Y.

VARIABLE TRIMMER PISTON CAPACITORS • FIXED METALIZED INDUCTORS • LC TUNERS.  
FIXED AND VARIABLE, DISTRIBUTED AND LUMPED CONSTANT DELAY LINES • PULSE FORMING NETWORKS • DIPLEXERS

CIRCLE 51 ON READER-SERVICE CARD



## Considerations In Selecting Mica Capacitors

Mica Capacitors may have identical capacitance and voltage rating on their name plates, yet one may be up to a hundred times larger than another—why? It is the purpose of this article to discuss how the dc voltage rating, rf voltage rating, rf current rating, corona starting voltage, and pulse application affects size and physical configuration of mica capacitors. Examples will be given showing typical Sangamo types that are used to account for these electrical environmental variations.

**DC Voltage Rating** — Many electronic applications require that a mica capacitor be used in a circuit of moderate to high-voltage dc with a slight ac voltage superimposed on it. Because mica exhibits a very low dissipation factor, very little heat is generated due to the small amount of ac. Of primary concern is the dc voltage stress. Mica has a very high dielectric-strength capability. Hence, required capacity can be contained in a package that is significantly small such as Sangamo's Types D, DR, KR, CR, H and A. (Figure 1)

Fig. 1



**RF Voltage and Current Rating** — Like the small mica capacitors described above, capacitors of a larger size are frequently required to operate with a comparable dc voltage across their terminals. However, in transmitting rf oscillator tank circuits, radio frequency is predominant and the primary requirement is the ability to handle a large magnitude of rf current. It is therefore necessary to use a capacitor that can dissipate the heat generated

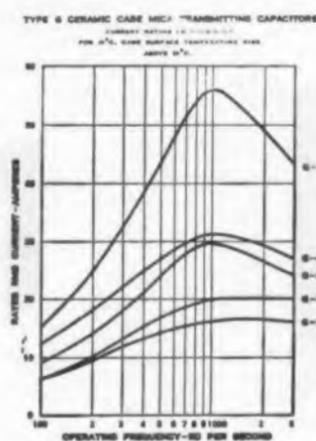


Fig. 2

by the rf field. Because these factors are so important, transmitting capacitors are rated in rms current and peak working volts. They are usually potted in a material that has a high thermal conductivity and packaged to have a large surface area. Sangamo's Types E, F, and G are ex-

Folio 11

REFERENCE  
DATA FILE



amples of high rf current application capacitors. Figure 2 shows, for example, the relative size and current-carrying ability of Types G1, G2, G3, G4 and G5.

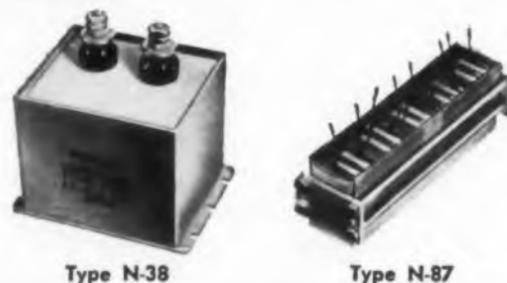
**Corona Starting Voltage** — Corona can occur in any capacitor where the conditions are right. Capacitor manufacturers are aware of this and design accordingly. Where amplitude and frequency of ac voltage across the capacitor are relatively low, a wax impregnant can be used. However, when voltage is low and frequency is high, a liquid impregnant is used. The difference is due to the physical nature of the impregnant. The wax, when cooling, leaves holes and promotes corona, while a liquid impregnant is homogeneous. A typical example of a liquid impregnated capacitor that is used for miniaturization, low distributed inductance, and high frequency applications is the Sangamo Button® Capacitor. (Figure 3)

Fig. 3



**Pulse Application** — Unfortunately there are no industry standards on capacitor ratings for pulse applications. Design and testing of these capacitors follow individual specifications at the present time. Applications involving high-frequency pulse operation should be reviewed carefully with regard to corona and peak stresses. These two factors are very closely related to life expectancy of the capacitor. With the growth of pulse circuitry, users and manufacturers must begin to develop meaningful specifications, standards, and test procedures for pulse capacitors. Figure 4 shows typical examples of Sangamo Capacitors designed for pulse applications. The Type N-87 is a multiple-section Sangamo mica capacitor designed for packaging with other components in a hermetically sealed, oil-filled enclosure.

Fig. 4



Your inquiry for more complete information on special applications of Sangamo mica capacitors is invited.

SC60-5

**SANGAMO ELECTRIC COMPANY, Springfield, Illinois**  
—designing toward the promise of tomorrow

CIRCLE 52 ON READER-SERVICE CARD

## NEW PRODUCTS

### Power Rheostats

564

#### Have torsion spring assembly

Types R-50, 75, 100 and 150 power rheostats have a torsion spring assembly that provides uniform pressure of the contact brush against the winding at all times. Current flows from the brush through a flexible shunt wire to a large size slip ring. Having all-ceramic construction, the rheostats can operate at extreme temperatures.

Tru-Ohm Products, Dept. ED, 2800 N. Milwaukee Ave., Chicago 18, Ill.

**Availability:** Available from stock 10 days to 2 weeks after order received.

### Voltmeter

649



Accuracy is 1%

Type 300-G electronic voltmeter has an accuracy of 1% over the meter scale from 1 mv to 250 v and over the band of 20 cps to 20 kc. Accuracy is better than 2% up to 1,000 v and from 10 cps to 250 kc. The instrument covers 1 mv to 1,000 v in six decade ranges. It has a 5-in., mirror-backed scale.

Ballantine Laboratories, Inc., Dept. ED, Boonton, N.J.

**Price & Availability:** \$315 ea; from stock.

### DC Amplifier

666

#### Stability is $\pm 1\%$

This dc, airborne, telemetry amplifier has  $\pm 1\%$  stability and a voltage gain of 1000, adjustable to  $\pm 10\%$ . Signal input is  $\pm 5$  mv, resulting in an output of  $\pm 5$  v. Bandwidth is dc to 100 cps with less than 1% attenuation. Linearity is within 0.5%. Input impedance is greater than 10 K; output impedance is less than 1.5 K. Ripple and noise referred to the output is less than 25 mv, peak-to-peak. The unit operates from  $28 \pm 4$  v dc with a current drain of less than 60 ma.

Networks Electronic Corp., Dept. ED, 14806 Oxnard, Van Nuys, Calif.

**Availability:** The unit is made on order.

# Transitron

introduces

an exciting new device for simpler, more reliable, more economical switching circuitry

# BINISTOR

(BY-NIS-TOR)

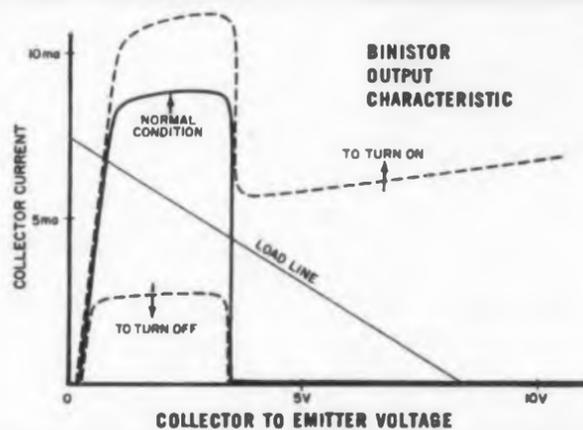
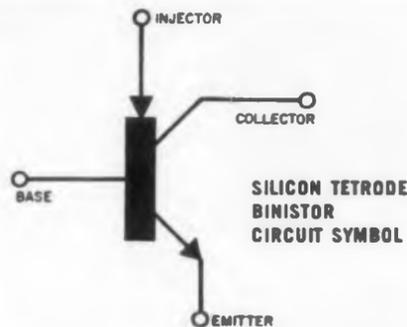
The Silicon NPN Tetrode binistor is a new component and a new concept for the circuit designer!

The key parameters of this bi-stable, negative resistance device are determined by external circuitry in contrast to existing devices. The significant reduction of peripheral circuitry results in outstanding savings in cost, space, weight and solder connections. For example, a typical flip-flop requires at least 13 components versus only 4 in an equivalent binistor stage. Very large current and voltage gains are realized in both on and off directions. Inputs and output are compatible in level with typical transistor and diode circuits. The tetrode binistor can operate from  $-80^{\circ}\text{C}$  to  $+200^{\circ}\text{C}$ .

To learn more of this important new development — THE BINISTOR — and how it works — write for Bulletin No. TE-1360.

#### CONDENSED SPECIFICATIONS TRANSITRON BINISTOR

Typical Turn-off Current Gain	50 @ 15ma Collector Current
Operating Collector Current Range	50 $\mu\text{a}$ to 15ma
$I_{j}$ critical	0.5ma @ 5ma Collector Current
Operating Temperature Range without Temperature Compensation	$-65^{\circ}\text{C}$ to $150^{\circ}\text{C}$



# Transitron



electronic corporation  
wakefield, melrose, boston, mass.

SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U.S.A. AND EUROPE • CABLE ADDRESS: TRELCO



"Leadership in  
semiconductors"

FOR TECHNICAL ASSISTANCE AND SERVICE  
CONTACT THE TRANSITRON FIELD OFFICE  
NEAREST YOU AS LISTED BELOW.

**BALTIMORE, Maryland**  
2319 Maryland Ave. ....CHesapeake 3-3220

**BOSTON, Massachusetts**  
168-182 Albion St.  
Wakefield, Mass. ....CRystal 6-5640

**CAMDEN, New Jersey**  
227 S. Sixth St. ....WOodlawn 6-2877

**CHICAGO, Illinois**  
6641 W. North Ave.  
Oak Park, Ill. ....Village 8-5556

**CLEVELAND, Ohio**  
14625 Detroit Ave.  
Lakewood, Ohio ....ACademy 1-9191

**DALLAS, Texas**  
511 Braniff Airways Bldg.  
Dallas 35, Texas ....FLeetwood 7-9448

**DAYTON, Ohio**  
379 W. First St. ....BAldwin 4-9651

**DENVER, Colorado**  
First National Bank Bldg.  
621 Seventeenth St. ....AComa 2-1686

**DETROIT, Michigan**  
2842 West Grand Blvd. ....TRinity 5-2440

**KANSAS CITY, Missouri**  
Wirtham Bldg.  
31st and Troost Sts. ....VAentine 1-1819

**LOS ANGELES, California**  
6362 Hollywood Blvd.  
Hollywood 28, Calif. ....HOLlywood 2-2381

**NEWARK, New Jersey**  
1060 Broad St. ....MArket 3-3151

**ORLANDO, Florida**  
#10 Jacklind Bldg.  
205 E. Jackson St. ....CHerry 1-4526

**PHOENIX, Arizona**  
2727 North Central Ave. ....CRestwood 7-3366

**ST. PAUL, Minnesota**  
Griggs-Midway Bldg.  
1821 University Ave. ....Mldway 6-1891

**SAN FRANCISCO, California**  
535 Middlefield Rd.  
Palo Alto, Calif. ....DAvenport 1-2064

**SEATTLE, Washington**  
3466 East Marginal Way ....MAin 4-0783

**SYRACUSE, New York**  
2360 James St. ....HOward 3-4502

**WINSTON-SALEM, North Carolina**  
Nissen Building  
310 W. Fourth St. ....PArk 3-0363

**Transitron**  
electronic corporation  
wakefield, massachusetts

Sales offices in principal cities throughout the U.S.A. & Europe  
cable address: Trelco

CIRCLE 53 ON READER-SERVICE CARD

CIRCLE 54 ON READER-SERVICE CARD



Here is an equipment designer's dream come true: tests prove that the greater the stress, the **greater** the security with Atlee holders.

**PUNISHING TEST:** Components mounted in Atlee holders were subjected to 500 cps vibration at 90 G peak acceleration, 2,000 cps vibration at 65 G peak acceleration, and 200-G shocks at right angles to and also along the axis of the holder. Force required to remove the component was measured before, during and after this punishing test.

**RESULTS:** Required removal force was higher by a substantial amount during and after vibration, and after the impact shocks. There was no shifting of the component in the holder, and no resonances developed at any frequency under vibration.

As shock and vibration increase, this holding power automatically increases because Atlee Component Holders have been **engineered** to meet the most severe operating conditions.

**DESIGN FOR RELIABILITY WITH atlee** — Benefit from a complete line of superior heat-dissipating holders and shields of all types, plus the experience and skill to help you solve unusual problems of holding and cooling electronic components.



CIRCLE 55 ON READER-SERVICE CARD



STATIC GRIP



DYNAMIC GRIP

## NEW PRODUCTS

### Speed Control

667

Is power compensating

The Reactron, an ac saturable reactor, is essentially an inductor which has a laminated-iron core. It acts as a static power-compensating transformer and has a very fast response time. Typical uses are operation and control of ac-dc series universal type motors as well as dc shunt motors driven directly from an ac source.

Vee-Arc Corp., Dept. ED, Westboro, Mass.  
Availability: Made to customer specs.

### Noise Figure Bridge

405

Frequency range is 2 to 2000 mc



The Auto-Node automatic noise figure bridge is designed to obtain noise-figure meter displays for making noise-figure adjustment. Useful frequency range is 2 to 2000 mc. Sine-wave temperature-modulation is 10 cps with temperatures from 300 to 400 K. Noise-figure stability is better than 3.5 db and the gain is sufficient to raise the input noise to 10 v after final detection. The bandwidth is 2 mc and center frequencies can be 30, 60, or 70. The accuracy is 0.2 db for gain or loss measurements.

Kay Electric Co., Dept. ED, Maple Ave., Pine Brook, N. J.

### Guidance Package

574

Takes shock of 15 g

Designed to supply stable reference data to a self-guided weapon, this guidance package takes 150 g of shock and 30 g of vibration to 2,000 cps. It consists of three subminiature, floated-rate gyros, type RG-101, and two subminiature, floated-pendulous linear accelerometers, type TA-400. Each of the three gyros is oriented in one of three mutually perpendicular axes: roll, pitch, and yaw.

Fairchild Controls Corp., Components Div., 225 Park Ave., Hicksville, L.I., N.Y.  
Availability: Made on special order only.

## GUDELACE is engineered for problem-free lacing



It's no accident that Gudalace is the best lacing tape you can buy. Excellence is *engineered* into Gudalace. A sturdy nylon mesh is meticulously combined with the optimum amount of special microcrystalline wax. Careful selection of raw materials and superior methods of combining them give Gudalace outstanding strength, toughness, and stability. Gudalace is the original *flat* lacing tape which distributes stress evenly over a wide area. It is engineered to stay flat; it will not stretch out of shape when pulled. Gudalace's nonskid surface prevents slipping, eliminating the too-tight pull that causes strangulation and cold flow. Durability and dependability make Gudalace your most economic buy—with no cut insulation, fingers, or feelings.

Write for Data Book with specifications on Gudalace and Gudabrod's complete line of braided lacing tapes and dial cords—Temp-Lace, Stur-D-Lace, and Gude-Glass.

Visit Gudabrod Booth No. 228 at the WESCON SHOW

## GUDEBROD BROS. SILK CO., INC.

Electronic Division  
225 West 34th Street, New York 1, N.Y.

Executive Offices  
12 South 12th Street, Philadelphia 7, Pa.

CIRCLE 56 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 31, 1960

ha  
an  
U  
fo  
in.  
De  
Pr  
an  
we  
spe  
Di  
M  
the  
pow  
unit  
reve  
sepa  
have  
late  
at se  
Cr  
St.,  
Price  
Puls  
Mod  
of 10 c  
10 mps  
pulse c  
msec.  
applica  
and mi  
E-H  
line St.  
ELECTR

## Wirewound Resistors

354

Have bushings for stacking



The Series 400 R-Stack wirewound resistors have screw-mounted, bushing-terminated resistance elements. Tolerance is 1% through 0.005%. Units measure 1/2 in. in diameter, 3/4 in. long for 1/2-w resistors and 7/8 in. in diameter, 15/16 in. long for 1-w resistors. Mil specs are met.

Consolidated Resistance Co. of America, Inc., Dept. ED, 44 Prospect St., Yonkers, N. Y.  
**Price & Availability:** \$2.50 each with 0.05% tolerance in lots of 100. Normally available in 4 weeks, units can be delivered in 48 hours on special request.

## Diode Tester

686

For germanium and selenium units

Model DT-257A diode tester is for measuring the static characteristics of germanium and low-power selenium diodes. Offered as an accessory unit is a millimicroammeter, which measures low reverse currents of silicon diodes. The tester has separate forward and reverse power supplies that have continuously variable outputs or preset regulated reverse potentials to permit measurements at selected operating points.

Crosby-Teletronics Corp., Dept. ED, 57 Kinkel St., Westbury, L.I., N.Y.

**Price & Availability:** \$295; from stock.

## Pulse Generator

404

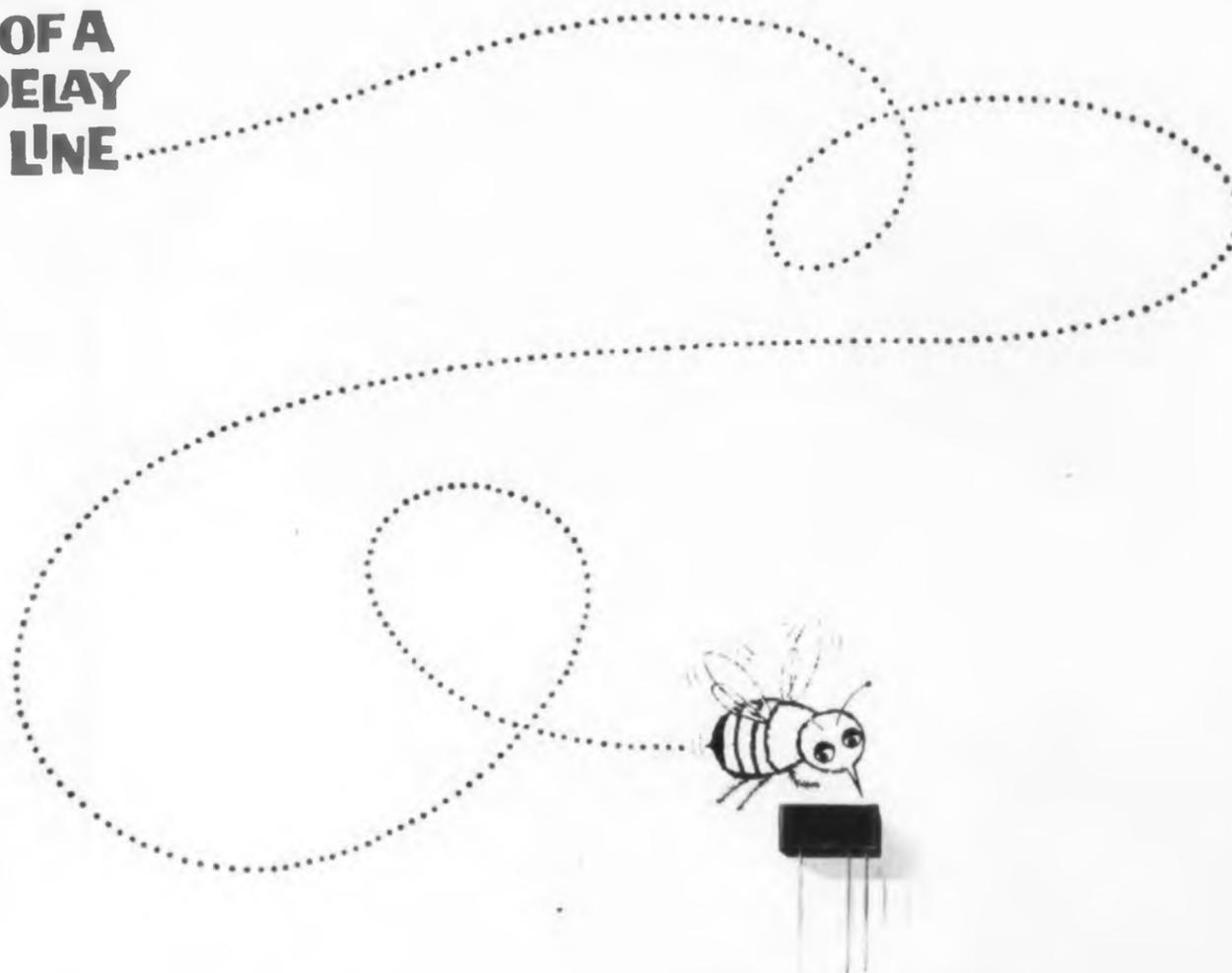
Repetition rate is 10 cps to 1 mc



Model 130 pulse generator has a repetition rate of 10 cps to 1 mc, a rise and fall time of less than 10  $\mu$ sec, and two pulse outputs with a relative pulse delay between them of 200  $\mu$ sec to 50 msec. The instrument is suited for fast circuit applications in computer work, transistor testing, and missile applications.

E-H Research Labs., Inc., Dept. ED, 163 Adeline St., Oakland 20, Calif.

A  
HONEY  
OF A  
DELAY  
LINE



ESC'S NEW  
SUBMINIATURE  
LUMPED CONSTANT  
DELAY LINE\*

Model 16-92 is the latest example of creative versatility from ESC, America's largest producer of custom-built and stock delay lines. The specifications: 1/10  $\mu$ sec. delay, 1,600 ohm impedance, 1/4" x 1/4" x 1/2" dimensions. Only ESC produces so many different delay lines, for so many varied applications. From the largest to the smallest, ESC has the best, most economical answer to your particular delay line problem. Write today for complete technical data.

\*shown actual size



ESC

exceptional employment opportunities for engineers experienced  
in computer components...excellent profit-sharing plan.

**ELECTRONICS CORP.** 534 Bergen Boulevard, Palisades Park, New Jersey

Distributed constant delay lines • Lumped constant delay lines • Variable delay networks • Continuously variable delay lines • Step variable delay lines • Shift registers • Video transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

CIRCLE 57 ON READER-SERVICE CARD

## NEW PRODUCTS

### Detergent And Solvent Compounds

572

For epoxy and polyester resins

Meta-Terge 1405 is a safety cleanup detergent for uncured epoxy and polyester resins. It allows the insoluble resins to be cleaned with water. Meta-Strip 702 is a synergistic, non-corrosive solvent for removing and stripping cured epoxy resins. It can be used in salvaging expensive and sensitive electronic components that have been encapsulated. Both the materials are available in liquid and the thixotropic gel forms.

Metachem Resins Corp., Dept. ED, 530 Wellington Ave., Cranston 10, R.I.

Price: Meta-Strip ranges from \$1.25 to \$1.50 per lb, depending on quantity; Meta-Terge ranges from \$0.65 to \$0.75 per lb, depending on quantity.

### DC Timing Motor

650



Speeds are 1/15 to 60 rpm

Model MD-83 dc timing motor is reversible by changing polarity. Speed is directly proportional to voltage. Constant voltage speeds are 1/15 to 60 rpm. Standard voltages are: 6, 12, and 28 v.

Haydon Div., General Time Corp., Dept. ED, Torrington, Conn.

### Digital Computer

569

For scientific, industrial, military problems

Type PB250 digital computer can be applied to a broad range of scientific, industrial and military problems. For a word consisting of 21 bits plus sign, the speeds are: add-subtract, 12  $\mu$ sec; multiply, 276  $\mu$ sec; divide and square root, 252  $\mu$ sec. The memory is expandable from 1,808 words to 15,888 words internally. The unit offers 46 commands including double precision operations, block transfer, and Gray-to-binary conversion. Programing is achieved by single-address in-



**ATTUNED  
TO YOUR NEEDS**  
INDUCTANCE INCREASED  
TENFOLD IN NEWEST  
**JEFFERS**  
MINI-STAB INDUCTORS  
**MINIature-STABLE**

### NEW TYPES EXTEND MINI-STAB INDUCTANCE RANGE TO 10,000 MICROHENRIES!

Now, from Jeffers Electronics, pioneers in MINIature, STABLE inductors, come the most recent additions to the line—MINI-STAB Inductors Types 2 and 3. Supplementing the Jeffers Type 101 and MINI-STAB Type 1 line, the two new miniatures increase the inductance values available from Jeffers to a range of 0.15 to 10,000  $\mu$ h.

#### Miniaturization PLUS Stability

In Jeffers MINI-STAB inductors, *miniaturization* is achieved through more efficient use of coil winding space. *Stability* is made possible through the use of an open magnetic circuit as obtained with a conventional powdered iron coil form.

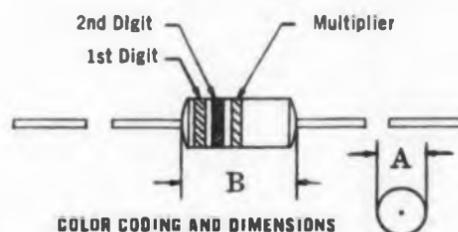
TYPICAL CHARACTERISTICS OF INDUCTOR DESIGNS BASED ON 1000  $\mu$ H VALUE

INDUCTOR CHARACTERISTICS	JEFFERS MINI-STAB DESIGN	CONVENTIONAL DESIGNS	
		MINIATURIZED*	NON-MINIATURIZED
Miniaturization (wt. in grams)	1.0	0.5 to 2	2 to 10
Stability of Inductance with temp. -55 to +125°C	$\pm 2\%$	$\pm 10\%$	$\pm 2\%$
with applied current (zero to 90 MA)	-1%	-30%	NIL
with applied voltage (test or signal)	GOOD	POOR	GOOD

\*Utilizing closed magnetic circuits such as toroids, cup-cores, etc.

A comparison of typical MINI-STAB performance with that of conventional miniaturized and non-miniaturized inductors appears above. Inductor designs of the closed magnetic circuit type such as toroids, cup cores, etc. tend to be inherently unstable.

## THIS IS THE EXPANDED MINI-STAB LINE



TYPE	A±.015	B±.015	LEADS
1	.190	.440	AWG. #22 1½ Min. Length
2	.220	.600	AWG. #21 1½ Min. Length
3	.240	.740	AWG. #20 1½ Min. Length

MINI-STAB TYPE 1

PART NUMBER	TYPE	INDUCTANCE (Microhenries)	MEAS. FREQ. (MC)	Q MIN.	SRF MIN. (MC)	D.C. RES. MAX. at 25°C (OHMS)	CURRENT* RATING (MA)	COLOR-CODING		
								1st	2nd	3rd
1311-1	1	18 ± 10%	2.5	50	25	1.8	315	BRN	GRY	BLK
1311-2	1	22 ± 10%	2.5	50	24	2.0	300	RED	RED	BLK
1311-3	1	27 ± 10%	2.5	50	20	2.8	255	RED	VLT	BLK
1321-1	1	33 ± 10%	2.5	50	19	2.5	270	ORG	ORG	BLK
1321-2	1	39 ± 10%	2.5	50	18	3.0	245	ORG	WHT	BLK
1321-3	1	47 ± 10%	2.5	50	17	3.5	225	YEL	VLT	BLK
1321-4	1	56 ± 10%	2.5	50	15	4.2	205	GRN	BLU	BLK
1321-5	1	68 ± 10%	2.5	50	14	5.0	190	BLU	GRY	BLK
1321-6	1	82 ± 10%	2.5	50	12	5.5	180	GRY	RED	BLK
1321-7	1	100 ± 10%	2.5	50	11	6.0	170	BRN	BLK	BRN
1321-8	1	120 ± 10%	0.79	50	9.0	7.0	160	BRN	RED	BRN
1321-9	1	150 ± 10%	0.79	50	8.6	8.0	150	BRN	GRN	BRN
1321-10	1	180 ± 10%	0.79	50	8.0	9.0	140	BRN	GRY	BRN
1321-11	1	220 ± 10%	0.79	50	6.6	10.0	130	RED	RED	BRN
1331-1	1	270 ± 10%	0.79	45	4.0	6.8	165	RED	VLT	BRN
1331-2	1	330 ± 10%	0.79	45	3.6	7.4	155	ORG	ORG	BRN
1331-3	1	390 ± 10%	0.79	45	3.4	10.6	130	ORG	WHT	BRN
1331-4	1	470 ± 10%	0.79	45	3.1	11.5	125	YEL	VLT	BRN
1331-5	1	560 ± 10%	0.79	55	2.9	15.2	110	GRN	BLU	BRN
1331-6	1	680 ± 10%	0.79	50	2.6	17.0	105	BLU	GRY	BRN
1331-7	1	820 ± 10%	0.79	50	2.4	19.0	100	GRY	RED	BRN
1331-8	1	1000 ± 10%	0.79	45	2.2	21.3	90	BRN	BLK	RED

NEWEST MINI-STAB TYPES 2 AND 3

1312-1	2	1200 ± 10%	.25	60	2.2	21.0	110	BRN	RED	RED
1312-2	2	1500 ± 10%	.25	60	2.1	24.0	105	BRN	GRN	RED
1312-3	2	1800 ± 10%	.25	65	1.9	27.0	100	BRN	GRY	RED
1312-4	2	2200 ± 10%	.25	70	1.7	30.0	95	RED	RED	RED
1312-5	2	2700 ± 10%	.25	70	1.6	33.0	90	RED	VLT	RED
1312-6	2	3300 ± 10%	.25	70	1.4	37.0	85	ORG	ORG	RED
1313-1	3	3900 ± 10%	.25	75	1.5	44.0	90	ORG	WHT	RED
1313-2	3	4700 ± 10%	.25	80	1.4	49.0	85	YEL	VLT	RED
1313-3	3	5600 ± 10%	.25	80	1.2	54.0	80	GRN	BLU	RED
1313-4	3	6800 ± 10%	.25	80	1.1	60.0	75	BLU	GRY	RED
1313-5	3	8200 ± 10%	.25	80	1.0	67.0	70	GRY	RED	RED
1313-6	3	10000 ± 10%	.25	80	0.9	75.0	70	BRN	BLK	ORG

\*Based on a 25° C Maximum Temperature Rise.

MINI-STAB inductors are capable of meeting the requirements of MIL-C-15305, Grade 1, Class B, as outlined in Jeffers Product Specification SK-393. Details are available on request.



## JEFFERS ELECTRONICS DIVISION

### SPEER CARBON COMPANY

DU BOIS, PENNSYLVANIA

Other Electronics Divisions of Speer Carbon Company -

Onondaga Electronics, Syracuse, N.Y. • Speer Resistor, Bradford, Pa.

CIRCLE 58 ON READER-SERVICE CARD

structions, command indexing, and automatic double-precision operations.

Packard Bell Electronics, Packard Bell Computer Div., Dept. ED, 12333 W. Olympic Blvd., Los Angeles 64, Calif.

Price: \$30,000.

## Servo Drive System

372

Volume is 1.75 cu in.



This solid state, subminiature servo drive system has a volume of 1.75 cu in. and delivers a torque of 2 in.-lb from a change of 0.001 v. Actuator arm speed is 270 deg per sec. The device consists of a servo amplifier, a precision gear train and a high-torque servo drive motor.

Electrosolids Corp., Solidtronics Div., Dept. ED, 14751 Keswick St., Van Nuys, Calif.

## Impedance Bridge

371

Portable, self-contained, direct-reading



The model 385 general-purpose impedance bridge is a portable, self-contained, direct-reading unit which contains a Wheatstone bridge (ac or dc) with a range of 0 to 1 meg, a modified capacitance bridge with a 0 to 100 µf range, or an inductance bridge with a range of 0 to 100 h. The instrument provides for tests at 1 kc as well as at dc. External signals from 60 to 10,000 cps can be introduced. A separate oscillator-amplifier accessory is available.

The Winslow Co., Dept. ED, 701 Lehigh Ave., Union, N. J.

## NEW PRODUCTS

### Elastic Flexible Wire 568

Stretches to three times its length

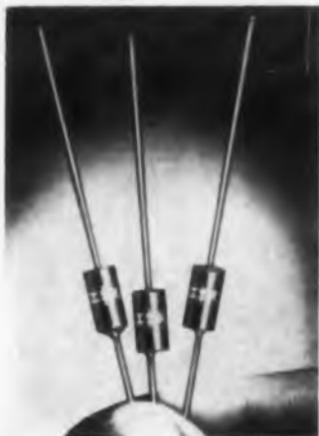
Elasticable, elastic flexible wire, stretches to three times its relaxed length without losing its electrical properties. Cables can be furnished with single and multiple conductors. Commercial types have a natural rubber core with insulation of braided nylon and conductors of copper magnetic wire, bronze tinsel, or copper tinsel. Military types have a silicon rubber core with insulation of braided nylon and conductors of copper wire or bronze tinsel.

National Radio Co., Inc., National Co., Inc., Dept. ED, Malden, Mass.

*Availability: Both commercial and military types are in stock. The products can also be made to order for individual needs.*

### Silicon Diodes 519

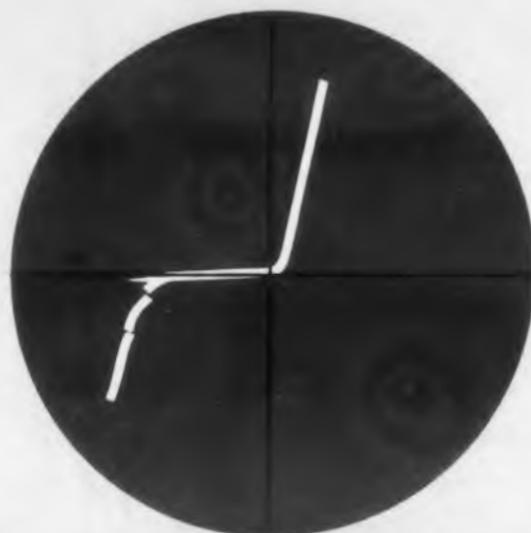
Are rated at 750 ma



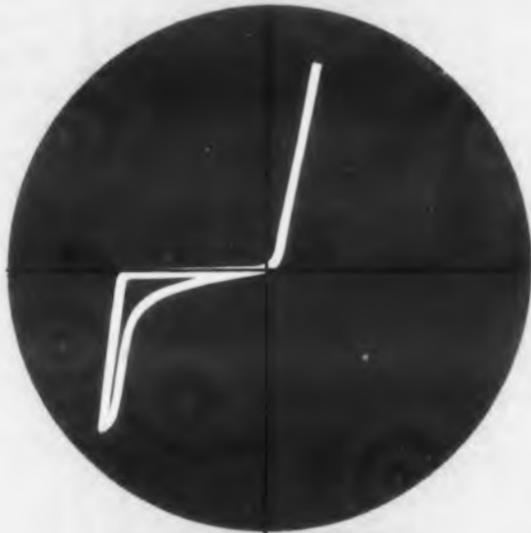
This series of miniature silicon diodes are diffused-junction units rated at 750 ma. Reverse current is 200  $\mu$ a, surge current rating is 50-amp peak for one cycle, and forward voltage drop is 0.92 v. Designated types X5A2, X5A4, X5A5, and X5A6, the units have piv ratings of 200, 400, 500, and 600 v. Operating temperature range is  $-65$  to  $+130$  C. A typical unit measures 0.29 x 0.2 in., not counting leads.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

*Price: \$0.95 to \$1.45 ea in quantities to 100.*



NO MULTIPLE BREAKS OR DISCONTINUITIES



NO HYSTERESIS



NO ROUND KNEES



**ALL PSI  
ZENER  
DIODES  
ARE  
100%  
SCOPE-  
CHECKED**

**IMMEDIATE DELIVERY!**  
**MILITARY TYPE**  
**1N746A thru 1N759A**



THE PSI POLICY OF 100% OSCILLOSCOPE TESTING OF ALL ZENER diodes and assemblies is your protection against circuit instability due to double peak, soft knee, hysteresis and the many other "ailments" commonly found in less carefully screened zener diodes. Reliability and electrical performance is substantially higher power dissipation of 500 mW make this broad line of zener diodes well worth your early investigation. Tight leakage at 75% or 80% of zener voltage may be specified when ordering.

**NEW! LOW VOLTAGE REGULATING DIODES...1.5 TO 3.0 VOLTS.** These new types are characterized by extremely low dynamic impedance and extended operating temperature range. Available in  $\pm 5\%$  and  $\pm 2\%$  types. Rugged and compact, the units measure 3/8" diameter by .53" long and are furnished with wire leads for easy mounting on printed circuit boards.

**LOW VOLTAGE REGULATORS**—PSI offers the highest surge, power and current rating of any subminiature regulator available.

**VOLTAGE REFERENCE DIODES**—These six types, with nominal voltage ranging from 6.8 to 40.8 volts, provide a temperature coefficient of less than  $100\%/^{\circ}\text{C}$  and by specifying version "A" can be supplied at less than  $.0025\%/^{\circ}\text{C}$ .

All types available now in production quantities

**Pacific Semiconductors, Inc.**

SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.  
 12955 Chadron Avenue, Hawthorne, California



Offices in: NEWARK · BOSTON · DE WITT, N.Y. · OTTAWA · BALTIMORE · CHICAGO (Oak Park)  
 PHILADELPHIA (Rockledge) · ST. PETERSBURG · DALLAS · DETROIT · LOS ANGELES · PALO ALTO

Authorized distributors coast-to-coast

**500mW POWER DISSIPATION**

PSI Type Number	Elect. Equiv.	Zener Voltage @ 5mA @ 25°C		Maximum Dynamic Resistance (ohms) 1	Maximum Inverse Current		At Inverse Voltage (v)
		E <sub>Z</sub> Min. (v)	E <sub>Z</sub> Max. (v)		I <sub>b</sub> @ 25°C (μA)	I <sub>b</sub> @ 100°C (μA)	
PS6465	1N465	2.0	3.2	60	75	100	1
PS6466	1N466	3.0	3.9	55	50	100	1
PS6467	1N467	3.7	4.5	45	5	100	1
PS6468	1N468	4.3	5.4	35	5	100	1.5
PS6469	1N469	5.2	6.4	20	5	100	1.5
PS6470	1N470	6.2	8.0	10	5	50	3.5

1. Measured at 10mA DC Zener current with 1mA RMS signal superposed. Also available PS6313-6318 covering 7.5v to 27v Zener Voltages.

EIA Type	Zener (Breakdown) Voltage @ 5mA		Maximum Inverse Current		At Inverse Voltage (v)	Maximum Dynamic Resistance (ohms) 1
	E <sub>Z</sub> Min. (v)	E <sub>Z</sub> Max. (v)	I <sub>b</sub> @ 25°C (μA)	I <sub>b</sub> @ 100°C (μA)		
1N702	2.0	3.2	75	100	-1	60
1N703	3.0	3.9	50	100	-1	55
1N704	3.7	4.5	5	100	-1	45
1N705	4.3	5.4	5	100	-1.5	35
1N706	5.2	6.4	5	100	-1.5	20
1N707	6.2	8.0	5	50	-3.5	10

1. Measured at 10mA DC Zener current with 1mA RMS signal superposed. Also available 1N708-1N723 covering 5.6v to 27v Zener Voltages.

PSI Type Number	Elect. Equiv.	Zener Voltage @ 200 μA @ 25°C		Maximum Inverse Current		At Inverse Voltage (v)
		E <sub>Z</sub> Min. (v)	E <sub>Z</sub> Max. (v)	I <sub>b</sub> @ 25°C (μA)	I <sub>b</sub> @ 100°C (μA)	
PS6313	1N1313	7.5	10	.5	5	6.8
PS6314	1N1314	9	12	.5	5	8.2
PS6315	1N1315	11	14.5	.5	5	10.0
PS6316	1N1316	13.5	18	.5	5	12.0
PS6317	1N1317	17	21	.5	5	15.0
PS6318	1N1318	20	27	.1	10	18.0

EIA Type <sup>1</sup>	Zener Voltage E <sub>Z</sub> (Volts) <sup>2</sup>	Max. Inverse Current E <sub>a</sub> = -1V @ μA		Max. Dynamic Resistance I <sub>Z</sub> = 20mA I <sub>AC</sub> = 1mA Ohms (Max.)
		25°C	150°C	
1N746	3.3	10	30	28
1N747	3.6	10	30	24
1N748	3.9	10	30	23
1N749	4.3	2	30	22
1N750	4.7	2	30	19
1N751	5.1	1	20	17
1N752	5.6	1	20	11
1N753	6.2	0.1	20	7
1N754	6.8	0.1	20	5
1N755	7.5	0.1	20	6
1N756	8.2	0.1	20	8
1N757	9.1	0.1	20	10
1N758	10.0	0.1	20	17
1N759	12.0	0.1	20	30

1.  $\pm 10\%$  Zener Voltage Tolerance. 2. E<sub>Z</sub> measured at Test Current I<sub>Z</sub> = 20mA. All of the above types can be supplied in  $\pm 5\%$  Tolerance. Add "A" suffix to indicate units with  $\pm 5\%$  Tolerance of center Zener Voltage Value.

**LOW VOLTAGE REGULATORS**

PSI Type	E <sub>i</sub> + 1mA (volts)	I + 1 min. (mA)	Max. Dyn. Res. @ 1mA (ohm)	I <sub>b</sub> @ 25°C (μA) Max.
1N912	0.62 $\pm$ 10%	100	60	1.0 @ -5v
1N913	0.62 $\pm$ 10%	250	60	5.0 @ -5v

**VOLTAGE REFERENCE DIODES**

EIA Type Number	REFERENCE VOLTAGE @ 7.5mA @ 25°C (volts)			Max. Voltage change from 25°C Reference Voltage (volts) -55°C to +100°C	Max. Dynamic Resistance (ohms)
	Min.	Avg.	Max.		
1N2765	6.46	6.80	7.14	$\pm 0.050$	20
1N2766	12.92	13.60	14.28	$\pm 0.100$	40
1N2767	19.38	20.40	21.42	$\pm 0.150$	60
1N2768	25.84	27.40	28.56	$\pm 0.200$	80
1N2769	32.30	34.00	35.70	$\pm 0.250$	100
1N2770	38.76	40.80	42.84	$\pm 0.300$	120

1. Measured with 1mA AC superimposed on 7.5mA DC. Max. Operating Temp. @ I<sub>Z</sub> = 7.5mA: -65°C to +175°C. Also available in "A" version— $.0025\%/^{\circ}\text{C}$ .

CIRCLE 59 ON READER-SERVICE CARD

**DC Power Supply 415**

For photo multiplier tubes

This dc power supply provides an output of -55 to -1,000 v. Its principal use is powering an RCA 6655-A photo multiplier tube. The supply operates from an input of 115 v  $\pm 10\%$  at 60-cps or from the firm's model 1935 multi-vibrator switch. Ripple does not exceed 0.1% peak-to-peak.

Lumen, Inc., Dept. ED, P. O. Box 905, Joliet, Ill.

**Pyrotechnic Free Gyro 524**

For one-time missile use



Type PHM pyrotechnic free gyro is for one-time use in short range missiles. Measuring 4.5 x 2.75 in. and weighing about 800 g, the unit stands 100 g shock. It has 2 deg of freedom. Active gyro life is 3 min with an average drift of 1 deg per min.

Greenleaf Manufacturing Co., Dept. ED, 7814 Maplewood Industrial Court, St. Louis 17, Mo.

**Power Connectors 396**

For 25- or 250-amp duty

These single-conductor plugs and receptacles with 25- and 250-amp ratings incorporate a fishtail plug design and provide simplified, quick assembly. All current-carrying parts are of brass, gold-plated for stable electrical contact and resistance to corrosion.

The Superior Electric Co., Dept. ED, Bristol, Conn.

Price & Availability: Price ranges from \$1.30 to \$5.50. Delivery is from stock.

YOU CAN SPECIFY savings in weight, improvements in performance, increases in reliability for your electronic systems from this box. This is Sperry's Speci-File—a complete electronic and physical biography of the traveling wave and klystron tubes offered by Sperry Gainesville. To speed your specifying, to make it more accurate, and to secure the benefits of outstanding microwave tube performance for your systems, order your free Sperry Speci-File today. Just fill in and mail the attached coupon.



Gainesville, Florida A Division of Sperry Rand Corporation

Section D-101  
Sperry Electronic Tube Division  
Gainesville, Florida

Please send me a FREE Sperry  
Speci-File:

NAME \_\_\_\_\_

TITLE \_\_\_\_\_

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_

STATE \_\_\_\_\_

## NEW PRODUCTS

### Thermal Inductor 424

Is stable from  $-55$  to  $+375$  C

The Therm-L, high-Q, fixed inductor is stable under temperatures from  $-55$  to  $+375$  C. It is offered in inductances from 0.068 to 0.56  $\mu$ h and in close tolerances. Completely inorganic, the unit is of one-piece construction and complies with MIL-C-15305-A, class C.

Essex Electronics Div., Nytronics, Inc., Dept. ED, 550 Springfield Ave., Berkeley Heights, N.J.

### Signal Generator 401

For measuring reflection coefficients

Model X775A sweep signal generator, with automatic gain control, provides a means of measuring the reflection coefficient of microwave components by direct oscilloscope presentations. The rf power source of the instrument is an electronically-swept permanent magnet type backward-wave-oscillator tube. A built-in amplifier can be used with an external detector to provide a reference source that is flat within  $\pm 0.5$  db over the range of 8.2 to 12.4 kmc. Dial settings are provided for the upper and lower frequencies; dial accuracy is  $\pm 1\%$ .

FXR, Inc., Dept. ED, 25-26 50th St., Woodside 77, N. Y.

### Trimmer Potentiometers 392

Range is 10 ohms to 65 K

The W4 series trimmer potentiometers are offered in resistance values of 10 ohms to 65 K. The units are miniature. They are rated at 1 w up to 70 C, derating to 0 at 200 C.

Atohm Electronics, Dept. ED, 7648 San Fernando Road, Sun Valley, Calif.

Price & Availability: \$7.50 to \$12 ea in quantities of 1 to 24; from stock.

◀CIRCLE 60 ON READER-SERVICE CARD



## Silicon Rectifier Stack 412

With choice of two diode types

Having standard and reverse polarity double-diffused diodes, this silicon rectifier stack can be furnished with style 40 or style 51 diodes. Bridge assemblies using the style 40 are rated up to 180 amp, single phase, and 270 amp three phase. Bridge assemblies up to 260 amp, single phase, and using the style 51 diodes are rated 390 amp, three phase. The design used permits rapid adaptation to any current configuration.

Syntron Co., Dept. ED, 283 Lexington Ave., Homer City, Pa.  
**Availability:** Delivery time is two to three weeks.

## Parabolic Antennas 410

Range is 5,925 to 7,425 mc

For performance over the range of 5,925 to 7,425 mc, these parabolic antennas are offered in 2, 4, 6, 8 and 10-ft diameters. They are suitable for industrial applications such as data transmission, operational relay, and local point-to-point communications.

Gabriel Electronics, Dept. ED, Millis, Mass.

## Microwave Mixer Diodes 562

Have low noise figure

Types 1N53C and 1N53RC microwave mixer diodes, made for use at 35,000 mc, have a maximum over-all noise figure of 9 db. Also available, types 1N23F and 1N23RF, for 9375-mc use, have a noise figure of 7 db; types 1N21F and 1N21RF, for use at 3000 mc, have a noise figure of 6 db. Uses are in microwave communications links, long range radar, telemetering, and countermeasures.

Sylvania Electric Products Inc., Dept. ED, 730 Third Ave., New York 17, N.Y.

**Price & Availability:** Types 1N53C and 1N53RC are priced at \$60.50 and \$90.75 ea for orders of 1 to 9 units. Delivery is immediate.

CIRCLE 61 ON READER-SERVICE CARD

# CONVECTION COOLED GUARANTEED 5 YEARS

## LAMBDA Transistorized Power Supplies

### LA Series

5 and 10 AMP • 0-34 VDC



3 1/2" Panel Height on 5 AMP Models

#### CONDENSED DATA ON LA SERIES

LA 50-03AM (with meters)	0-34 VDC, 0-5A	\$425.
LA 100-03AM (with meters)	0-34 VDC, 0-10A	540.
LA 50-03A (without meters)	0-34 VDC, 0-5A	395.
LA 100-03A (without meters)	0-34 VDC, 0-10A	510.

#### MODEL

#### VOLTAGE STEPS

LA 50-03A, LA 50-03AM-2, 4, 8, 16 and 0-4 volt vernier  
LA100-03A, LA100-03AM-2, 4, 8, 16 and 0-4 volt vernier

**Regulation:** Line Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 100-130 VAC. Load Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

**AC Input:** 100-130 VAC, 60 ± 0.3 cycle. This frequency band amply covers standard commercial power lines in the United States and Canada.

**Ripple and Noise:** Less than 1 millivolt rms.

**Ambient Temperature:** 50°C—continuous duty.

**Remote DC Vernier:** Provision for remote operation of DC Vernier.

**Remote Sensing:** Provision is made for remote sensing to minimize effect of power output leads on DC regulation, output impedance and transient response.

#### Size:

LA 50-03A	3 1/2" H x 19" W x 14 3/8" D
LA 100-03A	7" H x 19" W x 14 3/8" D

### LT Series

1 and 2 AMP • 0-32 VDC



Compact 3 1/2" Panel Height

#### CONDENSED DATA ON LT SERIES

LT 1095M (with meters)	0-32 VDC, 0-1 AMP	\$315.
LT 2095M (with meters)	0-32 VDC, 0-2 AMP	395.
LT 1095 (without meters)	0-32 VDC, 0-1 AMP	285.
LT 2095 (without meters)	0-32 VDC, 0-2 AMP	365.

#### MODEL

#### VOLTAGE BANDS

LT 1095, LT-1095M	0-8, 8-16, 16-24, 24-32
LT 2095, LT-2095M	0-8, 8-16, 16-24, 24-32

**Regulation:** Line Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 105-125 VAC. Load Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

**AC Input:** 105-125 VAC, 50-400 CPS.

**Ripple and Noise:** Less than 1 millivolt rms.

**Ambient Temperature:** 50°C—continuous duty.

**Remote DC Vernier:** Provision for remote operation of DC Vernier.

**Remote Sensing:** Provision is made for remote sensing to minimize effect of power output leads on DC regulation, output impedance and transient response.

#### Size:

LT 1095	3 1/2" H x 19" W x 14 3/8" D
LT 2095	3 1/2" H x 19" W x 14 3/8" D

SEND TODAY FOR COMPLETE DATA.



# LAMBDA ELECTRONICS CORP.

11-11 131 STREET • DEPT. 2 • COLLEGE POINT 56, N. Y. • INDEPENDENCE 1-8500



New Series of Indium Antimonide Infrared Detectors by Radiation Electronics Co.: l. to r.—PC-02, A-04 (J-02 same dewar as PC-02).

## Indium Antimonide Infrared Detectors

**PHOTOVOLTAIC** detector, Model J-02, operates at liquid nitrogen temperature and exhibits high sensitivity from the visible region to 5.7 microns. Because of its very small area ( $0.1 \times 0.1 \text{ mm}^2$ ), fast response, and sensitivity, the J-02 detector permits the design of infrared systems with high optical gain, high resolution, and very rapid scanning rates. Impedance is approximately 50,000 ohms. The J-02 is efficiently coupled to both transistor and vacuum tube preamplifiers. Linear arrays of detection elements can be fabricated for special applications.

**PHOTOCONDUCTIVE** detector, Model PC-02, operates at the dry ice point with sensitivity from the visible region to 6 microns. The PC-02 is conveniently coupled to both transistor and vacuum tube amplifiers. Standard detector area is  $1 \times 1 \text{ mm}^2$ ; other detector areas available from  $0.5 \times 0.5 \text{ mm}^2$  to  $2 \times 2 \text{ mm}^2$ . Time constant less than one microsecond.

**PHOTOELECTROMAGNETIC (PEM)** detector, Model A-04, operates at

ambient temperatures and does not require bias supply. Sensitive from the visible to seven microns with a time constant of less than one microsecond. Standard detector element is  $1 \times 1 \text{ mm}^2$ , and other sizes from  $0.5 \times 0.5 \text{ mm}^2$  to  $2 \times 1 \text{ mm}^2$  can be furnished. Normally used with an input transformer for efficient coupling to transistor or vacuum tube amplifiers. Housed in a hermetically sealed, ruggedized package, the A-04 is supplied with a magnesium oxide window. Other window materials, such as sapphire or arsenic trisulfide, are also available.

Radiation Electronics Company also manufactures high speed radiometers, industrial radiation thermometers, thermal scanning devices, blackbody reference sources, and low noise preamplifiers. Prompt attention will be given to your special problems by our experienced scientific and engineering staff. Contact RADIATION ELECTRONICS COMPANY, Division of Comptometer Corporation, 5600 Jarvis Avenue, Chicago 48, Illinois. Dept. D.

### SPECIFICATIONS

	PEM	PHOTOCONDUCTIVE	PHOTOVOLTAIC
Operating Temperature	20°C	-78°C	-196°C
NEP* (500°K), watts	$3.3 \times 10^{-9}$	$1.5 \times 10^{-10}$	$7 \times 10^{-12}$
NEP* (5 microns), watts	$1 \times 10^{-9}$	$3 \times 10^{-11}$	$1.4 \times 10^{-12}$
Spectral Cutoff, microns	6.9	6.1	5.7
Sensitive Area, $\text{mm}^2$	$1 \times 1$	$1 \times 1$	$0.1 \times 0.1$
Time Constant, microseconds	<1	<1	<1
Typical Resistance, ohms	5	100	50,000

\*1 cps bandpass at 500 cps

CIRCLE 62 ON READER-SERVICE CARD

## NEW PRODUCTS

### DC Power Supplies

406

Panel height is 3.5 in.



The QR power supplies have a panel height of 3.5 in. The units have an ammeter and a voltmeter accurate to 2% of full scale. A 10-turn potentiometer provides resolution of one part in 10,000. Model QR-36-4, shown, has an output of 0 to 36 v at 0 to 4 amp, which may be used as negative or positive and may be floated up to 500 v above or below ground. Input is 105 to 125 v at 55 to 65 cps. Ripple is 1 mv rms, static load regulation is  $\pm 0.01\%$  or  $\pm 1$  mv, static or dynamic line regulation is  $\pm 0.03\%$  or 3 mv. Maximum load transient response time is 25  $\mu\text{sec}$ .

NJE Corp., Dept. ED, 20 Boright Ave., Kenilworth, N.J.

Price: Model QR-36-4 is priced at \$485 ea.

### Triode

363



Switches 180 amp at 25,000 v

Type 7545/XD-45 forced-air-cooled triode is for use in pulsed service as an amplifier and modulator switch tube. It will switch 180 amp at 25,000 v with a duty of 0.002. Peak power handling capacity is 3.4 megawatts. Additional ratings up to 0.06 duty are provided. Plate voltage is 25 kv dc in pulse applications, 8 kv dc in cw applications.

Central Electronic Manufacturers, Dept. ED, 2 Richwood Place, Denville, N.J.

Price & Availability: \$380 ea; 30-day delivery time.

## Environmental conditioning

for  
missile  
ground support  
systems



**AiResearch electronic cooling** units for U.S. Army Hawk missile mobile ground radar equipment require only half the space originally allotted. These lightweight production units, with a heat rejection capacity of 10 KW, measure 20" x 24" x 24".

A complete system package, the liquid-to-air unit includes an accumulator, pump, heat exchanger, fan, switches and valves.

Contact AiResearch early in your planning and design stage for greater reliability, smaller unit size and weight. AiResearch is the leading designer and manufacturer of advanced electronic conditioning equipment and systems for missile and ground support applications.

Environmental conditioning equipment has been produced for the following electronic systems:  
**Detection • Communication • Control • Ground Support • Guidance**

Write for literature today.



**AiResearch Manufacturing Division**

Los Angeles 45, California

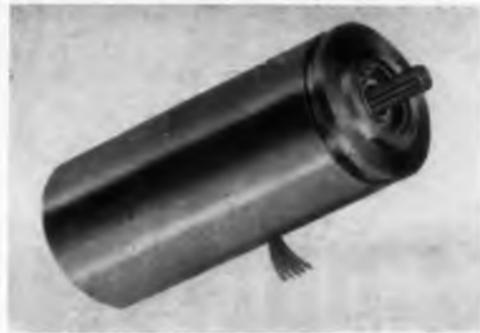
CIRCLE 63 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 31, 1960

## Size 8 Servo Motor

375

Device is viscous damped



A size 8 servo motor, type 5702-03 is an adjustable viscous damped unit for feedback damping applications. The unit is 1-3/4 in. long and weighs 2 oz. Damping, gain and no-load speed are adjustable. Rotor moment of inertia is 0.65 g-cm<sup>2</sup>; stall current is 0.113-amp fixed phase and 0.077-amp control phase; stall power is 2.4 w per phase; stall torque is 0.2 oz-in. min. Housing is bright finish stainless steel.

John Oster Manufacturing Co., Avionic Div., Dept. ED, Racine, Wis.

Availability: Delivery, from stock, is about 30 days.

## AC Servo Amplifier

382

For aircraft and missile use



Developed for 115-v, 400-cps servo systems used on aircraft and missiles, this solid-state amplifier drives standard size 11 or smaller 40-v center-tapped servo motors. It can also be used to operate 40-v motors in larger frame sizes where the 3.5-w output is adequate. The unit has a gain stability of  $\pm 2$  db over an operating temperature of  $-55$  to  $+102$  C and operates with only slightly reduced gain at  $+125$  C. Normal power gain is 90 db max with no feedback or 70 db min with feedback.

United Control Corp., Dept. ED, 4540 Union Bay Place, Seattle 5, Wash.

Price & Availability: \$250 ea in quantities to 10; \$241 in quantities of 11 to 25. Delivery is from stock.

# for maximum flexibility in rectifier circuit design

## CHOOSE HUGHES SILICON RECTIFIERS

With over 100 different JEDEC types available, Hughes offers you one of the industry's largest selections of stud mounted and top hat silicon rectifiers. And with their hermetically sealed, corrosion resistant packages, these rectifiers give you maximum reliability!

To order any of these devices please contact the Hughes Semiconductor Sales Office or Distributor nearest you. Or, for further information write Hughes, Semiconductor Division, Marketing Department, Newport Beach, California. For export write: Hughes International, Culver City, California.



### PIGTAIL TOP HAT SILICON RECTIFIERS

E.I.A. Number PIV

1N536	50
1N599	50
1N599A	50
1N1217	50
1N440B	100
1N530	100
1N537	100
1N600	100
1N600A	100
1N1100	100
1N1218	100
1N601	150
1N601A	150
1N1219	150
1N441B	200
1N531	200
1N538	200
1N602	200
1N602A	200
1N1101	200
1N1220	200
1N442B	300
1N532	300
1N539	300
1N603	300
1N603A	300
1N1102	300
1N1221	300
1N443B	400
1N533	400
1N540	400
1N604	400
1N604A	400
1N1103	400
1N1222	400
1N444B	500
1N534	500
1N605	500
1N605A	500
1N1104	500
1N1223	500
1N445B	600
1N535	600
1N547	600
1N606	600
1N606A	600

1N1096	600
1N1224	600
1N1225	700
1N560	800
1N1226	800
1N561	1000



### STUD MOUNTED SILICON RECTIFIERS

E.I.A. Number PIV

1N607	50
1N607A	50
1N340	100
1N338	100
1N349	100
1N348	100
1N347	100
1N253	100
1N608	100
1N608A	100
1N609	150
1N609A	150
1N336	200
1N337	200
1N346	200
1N345	200
1N254	200
1N610	200
1N610A	200
1N334	300
1N335	300
1N344	300
1N343	300
1N611	300
1N611A	300
1N332	400
1N333	400
1N342	400
1N341	400
1N255	400
1N612	400
1N612A	400
1N613	500
1N613A	500
1N256	600
1N614	600
1N614A	600
1N562	800
1N563	1000

Creating a new world with ELECTRONICS

# HUGHES

© 1960 HUGHES AIRCRAFT COMPANY

SEMICONDUCTOR DIVISION

CIRCLE 64 ON READER-SERVICE CARD

## NEW PRODUCTS

### DC Voltmeter

566

Rated at 200,000

Model M200DC Kilovoltmeter is rated at 200,000 v dc and is constructed in two pieces for remote metering. Composed of a high-voltage multiplier resistor in a tall bakelite tube and an indicating instrument in a small metal cabinet at ground potential, the device has an input resistance of 2,000 meg. It takes an overload of 150%. The indicating instrument is 4.5-in. sq.

Peschel Electronics, Inc., Dept. ED, Towners, Patterson, N. Y.

**Price & Availability:** Made on order only; delivered 60 days after receipt or order. Price per unit is \$800.

### Attenuator

383

For operation from dc to 4 kmc



Model A 101, 10-w coaxial power attenuator is designed for operation from dc to 4 kmc. It can be supplied in attenuation values from 0 to 60 db. The attenuator accuracy of pads up to 30 db, including absolute accuracy and variation of attenuator as a function of frequency is 0.5 db; the accuracy of pads from 30 to 60 db is 0.75 db. The units are calibrated at 1.2 kmc and 2.8 kmc and can be supplied with type N, TNC, C, and BNC connectors. The vswr of units having type N connectors is 1.3 max from dc to 4 kmc.

R L C Electronics, Inc., Dept. ED, 805 Mamaroneck, N. Y.

**Price & Availability:** \$115 to \$170; delivery from stock to 30 days.

### Ultrasonic Immersible Transducers

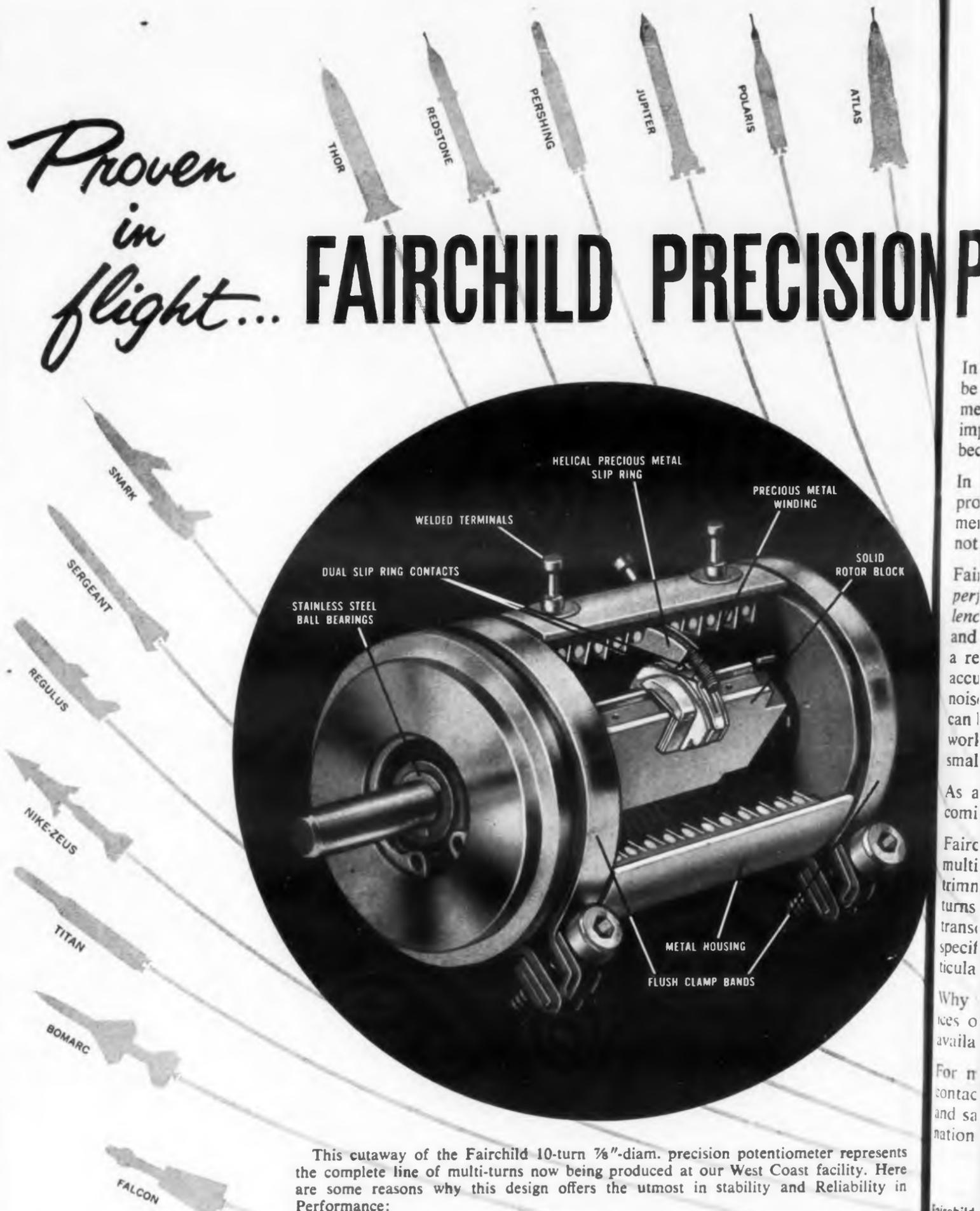
567

End fitting and bulkhead type

This line of both end-fitting and bulkhead type, immersible ultrasonic transducers can be used to add ultrasonic cleaning stages to existing tanks or vapor degreasers. They are designed for use with most cleaning solutions, solvents and detergents, mild acids and caustics at temperatures to 180 F. The transducers are produced in three standard sizes with a rated input power of 60, 125, and

*Proven  
in  
flight...*

# FAIRCHILD PRECISION



This cutaway of the Fairchild 10-turn  $\frac{7}{8}$ "-diam. precision potentiometer represents the complete line of multi-turns now being produced at our West Coast facility. Here are some reasons why this design offers the utmost in stability and Reliability in Performance:

- One-piece precious metal wiper-collector ring pick-off eliminates all welds and soldered joints and pressure contacts between slip ring pick-off and wiper.
- Parallel slip ring-winding design reduces friction and torque.
- Specially-designed flush clamp bands — new cross-section combined with new material selection — assure higher anti-rotational and axial holding power.
- With this design, many cups can be ganged on a common shaft.
- The number of taps possible per cup is limited only by mechanical considerations.

# POTENTIOMETERS

In our country's defense program, failure cannot be tolerated. The "Reliability Factor" of all elements of this defense is becoming more and more important as the arsenals of both East and West become more and more sophisticated.

In the future, less business will go to the unproven though low priced producer. Management has learned that the lowest initial cost does not always result in the lowest end cost.

Fairchild precision potentiometers are *proven performers*. They are flying with *predicted excellence* in many important missile, special weapon and space vehicle applications. They have earned a reputation over the years for sustained high accuracy over a wide temperature range, lowest noise level and long life — quality features that can be achieved only with experienced, precision workmanship and painstaking attention to the smallest detail.

As a result, "Fairchild Reliability" is fast becoming an industry standard.

Fairchild produces complete lines of precision multi-turn, single-turn, rectilinear and rotary trimmer pots, deposited metal FilmPot® single-turns and trimmers, and linear displacement transducers. Variations on most standard model specifications can be obtained to suit your particular needs.

Why not consult Fairchild? The complete services of our experienced Engineering Dept. are available to help you.

For more information, write or call direct, or contact any one of the many leading engineering and sales organizations that represent Fairchild nationally and in Canada.

Fairchild components . . . built and tested beyond the specs for Reliability in Performance.

**FAIRCHILD CONTROLS CORPORATION**  
COMPONENTS DIVISION  
225 Park Avenue, Hicksville, L. I., N. Y. • 6111 E. Washington Blvd., Los Angeles, Calif.  
A Subsidiary of Fairchild Camera and Instrument Corporation

GYROS  
PRESSURE  
TRANSDUCERS  
POTENTIOMETERS  
ACCELEROMETERS

CIRCLE 65 ON READER-SERVICE CARD



**Multi-Turn**  
— 3, 5, 10, 20

The complete line of multi-turns consists of two diameters— $\frac{7}{8}$ " and  $1\frac{1}{8}$ "—with four models in each diameter—3- 5- 10- and 20-turns. All have a linearity of  $\pm 0.25$  to  $\pm 0.05\%$  over a temperature range of  $-55^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$ , standard. Hi-temp. units available on special order. Power rating: 2.5 watts at  $40^{\circ}\text{C}$ . This design lends itself to multi-tapping and multi-gang.



**Single-Turn**  
— Linear  
Non-Linear  
Sine-Cosine

There are over 28 standard models available in sizes that range in diameter from  $\frac{3}{4}$ " to 5". They feature high functional accuracy, high resolution, low noise, wide electrical angle, wide temp. range, one-piece wiper, simplified precious metal slip-ring construction, welded taps and terminals, and precious metal contacts and resistance wires. Bushing or servo mounts, sleeve or ball bearings. Gangable, with no increase in diameter.



**Linear Displacement Transducers**

Linear displacement transducers — with or without spring-loaded return stroke — are available in all sizes, from  $\frac{1}{2}$ " to 6" strokes. Smallest in the line is only  $1\frac{1}{4}$ " x  $1\frac{3}{32}$ " x  $1\frac{1}{32}$ ".

**Trim-Tite®**  
Microminiature Trimmers

Trim-Tite® microminiature trimmers — Type 926 and 927 — can fit under a postage stamp. They meet and exceed MIL-STD-202A shock requirements (100-G's), vibration (25-G's at 2000 cps), temp. cycling and load life; and MIL-E-5272B for environmental conditions. Available in a wide range of resistance values.



**Rotary & Rectilinear Trimmer FilmPots®**

Fairchild FilmPots® use a continuous film of evaporated alloys of precious metals as the resistance element. This exclusive Nobl-Ohm® resistance element provides infinite resolution and is electrically stable over a wide temp. range of from  $-55^{\circ}\text{C}$  to  $+225^{\circ}\text{C}$ .

Rotary FilmPots® (left) are available in  $\frac{7}{8}$ " to 2" diameters. They can be supplied in ganged assemblies and can also be ganged with similar size Fairchild wire-wound pots.

Rectilinear FilmPot® trimmers (right) come in two sizes. Precise adjustments are made by a  $28\frac{1}{2}$  turn screw. Resistance ranges: 50 to 25K $\Omega$ ; up to 50K $\Omega$  on special order.

250 w, respectively; they can be used either individually or in combination.

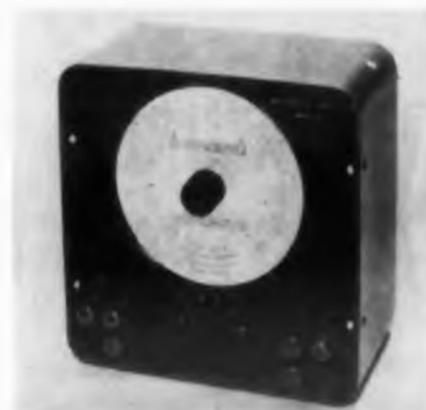
National Ultrasonic Corp., Dept. ED, 111 Montgomery Ave., Irvington 11, N.J.

**Price & Availability:** Delivered 7 days after order received; prices range from \$115 to \$625 for various models.

## Impedance Analyzer

378

For precision measurements



Model W-2 impedance analyzer is designed for precision measurement of polar parameters, phase angle and ohmic values of impedance. It computes and directly indicates phase angle as well as its sin, cos, and tan, power factor, Q, and D. Measurements can be made at the actual operating voltage and frequency of the component being tested. Accuracy is 1% from 60 cps to 12 kc, impedance measurements can be made to 1 meg.

Western Electronic Products Co., Dept. ED, 2420 N. Lake Ave., Altadena, Calif.

**Price & Availability:** Price is \$135 fob Altadena, Calif., with immediate availability.

## Resistive Heating Devices

685

For continuous use at 450 F

These electric heating elements or power resistors use silicone rubber and fiber-glass cloth insulation and are capable of continuous operation at temperatures above 450 F. Width is 1 in., over-all lengths are 1.5 to 12 in., and thickness is 0.12 in. or less. Resistance per unit of length is 1.27 to 1,800 ohms per in. of heated length. Resistance tolerance is  $\pm 7\%$ . Units cemented to metal dissipate up to 25 w per sq in.

Electro-Flex Heat, Inc., Dept. ED, 83 Woodbine St., Hartford 6, Conn.

**Price & Availability:** Available for 15-day delivery, units with lugs are priced at \$0.33 ea plus \$0.07-1/3 per in. of length (in quantities of 200 or more). Units with leads are priced at \$0.42 ea plus \$0.07-1/3 per in. of length.

resents  
y. Here  
bility in

soldered

material

ration:

1, 1960

# IN PRODUCTION AND IN USE

## BELL AVIONICS

## MINIATURE ACCELEROMETER



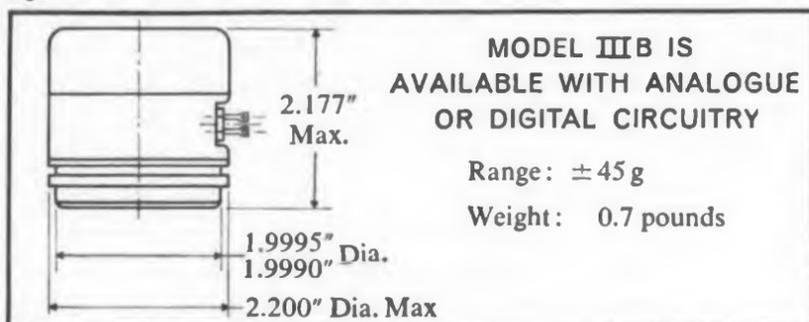
It's the **LIGHTEST** and **SMALLEST** with **HIGHEST PERFORMANCE** of any Accelerometer available in quantity today.

The BELL Model III B Accelerometer\* is an electrically constrained, linear, inverted pendulum type with a D-C forcer and spring suspension. This precision instrument has been thoroughly tested and evaluated by government laboratories.

The superiority of Bell Accelerometers has been proved in many competitions. They have already been selected for such programs as:

**SERGEANT — AGENA (including SAMOS and MIDAS)  
RANGER — SKY BOLT**

\* A new Model V A will shortly be available with the same performance but a substantial reduction in both weight and size.



**OTHER BELL AVIONICS PRODUCTS** also designed and developed by Bell's Inertial Systems Laboratory under the direction of Dr. Helmut Schlitt include:

- Digital Velocity Meters
- Inertial Guidance Platforms
- Gyroscopes
- Gravity Gradient Meters

Direct inquiries to: Instrument Laboratory • 4515 Superior Ave. • Cleveland 3, Ohio



**BELL AEROSYSTEMS COMPANY**  
FORMERLY: Bell Aircraft Corporation **BUFFALO 5, N. Y.**

CIRCLE 66 ON READER-SERVICE CARD

## NEW PRODUCTS

### Servo Motor-Generator

573

Size 11

Model R830-26 servo motor-generator is a size 11 unit. It has 0-deg phase shift and a signal-to-noise ratio of 290:1. It is designed primarily as a low-inertia rate generator, but can also be used to replace most size 15 units in high-gain applications. The motor section operates on 115 v, 400 cps and draws 53 ma. The generator section requires an excitation of 115 v at 400 cps and 65 ma.

General Precision Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

### Power Supply

366

For servos and transistorized amplifiers



An output of 29 v dc at 300 ma, filtered and unregulated, and two isolated ac outputs rated at 4 w and 0.5 w respectively are provided by the model H3900-01 power supply. The dc source is suitable for transistorized amplifiers and small servos. Input is 115 v, 400 cps. The device can be used to circumvent noise and severe transient voltages in 28-v dc lines of aircraft and missiles. Units, weighing 28 oz, are potted and sealed.

Kearfott Div., General Precision Inc., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

### Magnetic Amplifiers

664

Servo-motor type

These servo-motor, magnetic amplifiers meet full Mil specs for temperature, shock, and vibration. Model 224, typical of the series, drives a standard 3.5 w, size 11 servo motor from 115 v at 400 cps. Less than 1 ma dc is required for full motor torque.

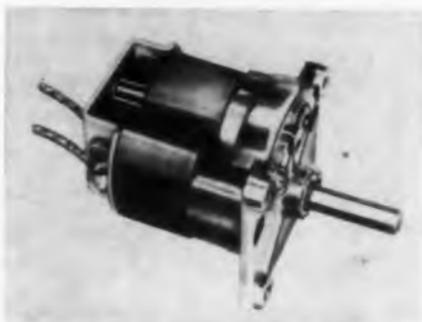
Acromag, Inc., Dept. ED, 22515 Telegraph Road, Southfield, Mich.

**Price & Availability:** Model 224 is priced at \$148. Delivery is from stock.

## High-Torque AC Motors

Units weigh 10 oz

351



These Rotorac motors, having a typical weight of 10 oz, are capable of delivering a 6 lb-in. at 20 rpm from a 115-v, 60-cps source at 0.75 amp. The units have rapid starting and stopping characteristics, and are not damaged by stalls.

Airborne Accessories Corp., Dept. ED, 1414 Chestnut Ave., Hillside 5, N. J.

**Price & Availability:** Units are available from stock, and are priced from \$25 to \$40 each in quantities of 100.

## Microwave Monitor And Alarm 357



Handles 480 functions

This alarm and fault-finding system will monitor as many as 480 functions in a microwave system. The system, Model MA-1, indicates station condition, over-all system conditions, and individual function condition of up to 20 functions at any of 24 remote reporting stations. Faults are indicated at a master alarm station, illustrated. Such functions as tower lights, illegal entry, operation of emergency power unit or auxiliary rf units, high temperature or low pressure could be indicated.

Motorola, Inc., Communications and Industrial Electronics Div., Dept. ED, 4501 W. Augusta Blvd., Chicago 51, Ill.

## General Electric RTV\*

\*Room Temperature Vulcanizing



The latest addition to General Electric's RTV family offers lower viscosity than any other available silicone rubber compound — a typical viscosity of 120 poises. Easily pourable, it flows freely in and around intricate contours, making it ideal for protecting electrical and electronic components.

With RTV's new low viscosity, the range of G-E RTV compounds now extends from 120 to 12,000 poises. You can now meet your specific requirements by selecting from several G-E RTV compounds, all of which offer room temperature cure, heat and ozone resistance, and good electrical properties. Write for a free test sample, briefly describing your application.

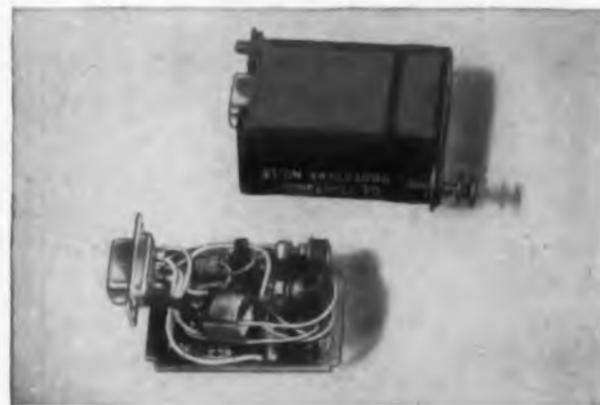


## liquid silicone rubber

New low viscosity for easier encapsulation and impregnation



General Electric silicone rubber used extensively by Aerojet-General Corp. for the Titan ICBM's propulsion-system wiring harness. Break-outs and junctions molded from G-E RTV, wiring is silicone insulated, jacketing is high-strength G-E silicone rubber — all chosen for their stable insulating properties, resistance to temperature extremes and weathering, and stability in storage for many years.



Sight amplifier module potted with RTV by the Armament and Control Section of G.E.'s Light Military Electronics Department. Used on the Lockheed CF-104 and F-104G jet aircraft, RTV provides mechanical support and vibration damping, protects unit against moisture and ozone. (Bottom photo shows module before potting.)



High-voltage, high-altitude transformers from Laboratory For Electronics, Inc. are encapsulated with General Electric RTV to meet MIL-T-27A specs. This prevents flashover at maximum ratings of 2200 volts rms and 80,000 feet. General Electric RTV was selected for its good heat transfer, low viscosity and mechanical strength.

# GENERAL ELECTRIC

Silicone Products Department, Waterford, New York  
CIRCLE 67 ON READER-SERVICE CARD

## NEW PRODUCTS

### Instrument Wire

665

Has 1 to 6 mil insulation

This instrument wire has Teflon-insulated walls measuring from 1 to 6 mil. Silver-plated copper conductors from AWC 28 to 36 are available. The wire is rated for 300 v at temperatures from -90 to +250 C. Any length can be furnished.

Tensolite Insulated Wire Co., Inc., Dept. ED, 1000 N. Division St., Peekskill, N.Y.

### Precision Band-Pass Filters

352

Available for 90, 150 and 180 cps



The Series F bandpass filters, available in 90-, 150- and 180-cps models, have bandwidths of 8, 11 and 12 cps respectively a 1 db down. Insertion loss, input and load impedances are the same for the three units. The instruments are designed for navigational aids, instrument landing systems, receivers, control units, monitors and associated test instruments. Units are hermetically sealed in 3 x 3-1/2 x 3-13/16 in. metal cases. Ambient temperature range is -20 to +60 C.

Barker & Williamson, Inc., Dept. ED, Bristol, Pa.

**Availability:** Units are made to order and can be delivered in 30 days.

### Image Orthicon Tube

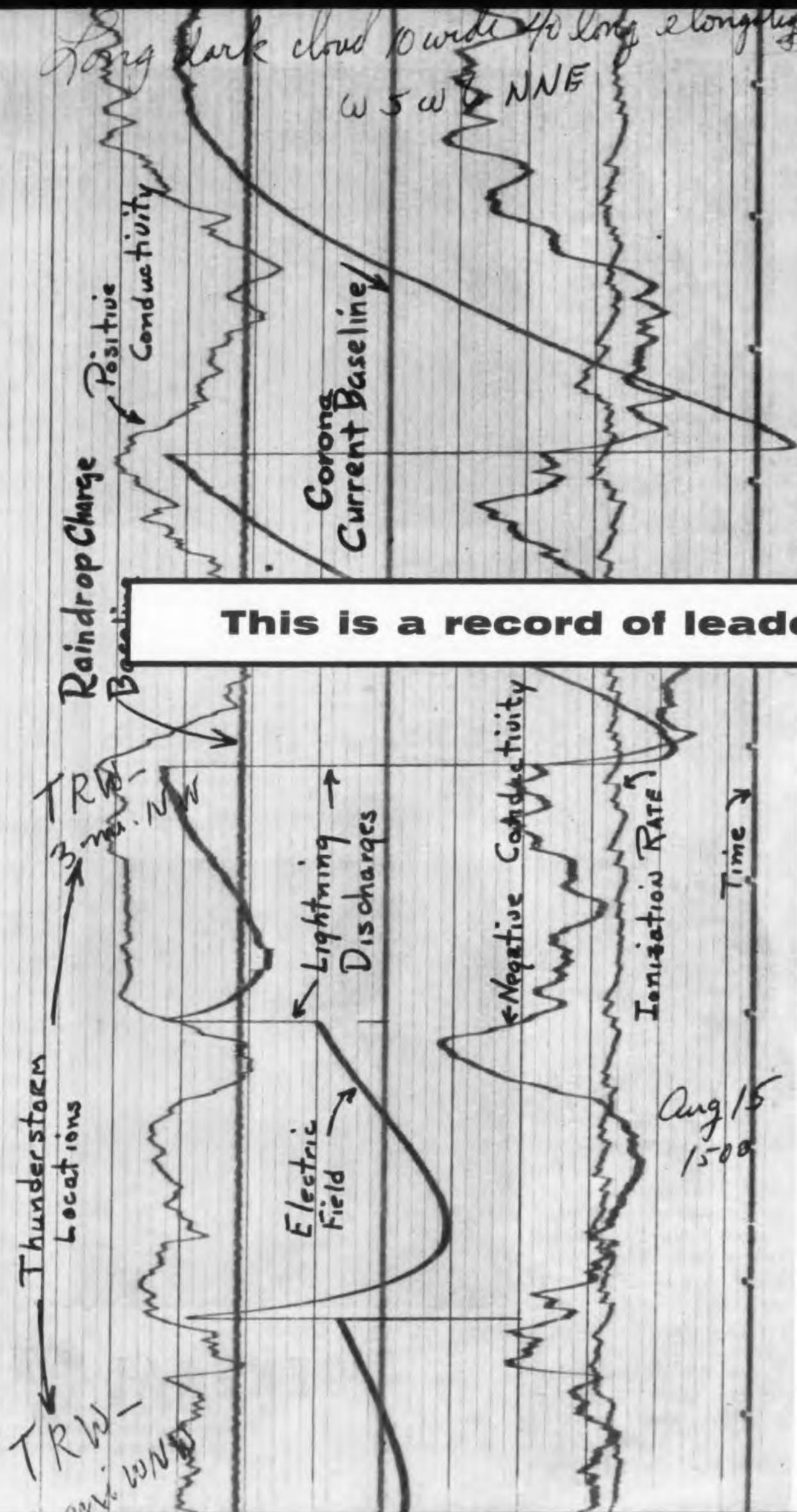
360

Field mesh improves image

Type GL-7293, designed to replace the standard 5820, uses a field mesh in the scanning section to improve beam landing by creating a more uniform electric field in back of the target. The tube is interchangeable, electrically and physically, with the 5820, but differs slightly in construction and operation. Spectral response is close to that of the human eye.

General Electric Co., Dept. ED, Schenectady 5, N. Y.

**Price & Availability:** The tube is available in sample quantities at a user price of \$1,300.



This is a record of leadership in

Honeywell 906.A Visicorder record, actual size. Note longitudinal grid lines

The U.S. Weather Bureau used a Honeywell Model 906B Visicorder Oscillograph to record directly this diary of a thunderstorm as it passed near the observation station on Mt. Washburn in Yellowstone National Park.

As the storm passed, the Visicorder measured and recorded 1) positive and negative electrical conductivity of the air, 2) the rate of ionization of air due to airborne radio-active particles and extra-terrestrial radiation, 3) the size and charge of individual raindrops, 4) the corona discharge current from an insulated tree and from a 4'x 6' grass plot to determine current flow from the earth's surface to charge centers in the clouds, 5) times of camera exposure photographing cloud droplet size and electrical charge, 6) atmosphere potential gradient, and 7) time.

The Visicorder made this and many other records on Mt. Washburn without the use of power amplifiers. This feature, plus the extreme portability of the Visicorder, made it the ideal oscillograph for use in these studies.



Byron Phillips, U. S. Weather Bureau Scientist, monitors thunderstorm data as it is recorded by the Honeywell Model 906 Visicorder.

## ip in weather research



Recent Models of the 906 Visicorder incorporate time lines and grid lines and record up to 14 simultaneous channels of data.



The NEW Model 1108 Visicorder with many automatic features and the convenience of push-button controls, is ideal for intermediate uses requiring up to 24 channels of data.



The Model 1012 Visicorder is the most versatile and convenient oscillograph ever devised for recording as many as 36 channels of data.

The Honeywell Visicorder is the pioneer, completely proven, and unquestioned leader in the field of high-frequency, high-sensitivity, direct-recording ultra-violet oscillography. Here are some of the reasons why Visicorders provide the most accurate analog recordings available: constant flat response and sensitivity of galvanometers; grid-lines simultaneously recorded with traces to guarantee exact reference regardless of possible paper shift or shrinkage; flash-tube timing system for greater accuracy of time lines; superior optics for maximum linearity of traces.

No matter what field you are in . . . research, development, computing, rocketry, product design, control, nucleonics . . . the high-frequency (DC to 5000 cps) Visicorder Oscillograph will save you time and money in data acquisition.

Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: write for Bulletins 1108, 1012 and HC-906B

Minneapolis-Honeywell Regulator Co.

Industrial Products Group, Heiland Division

5200 E. Evans Avenue, Denver 22, Colorado

# Honeywell

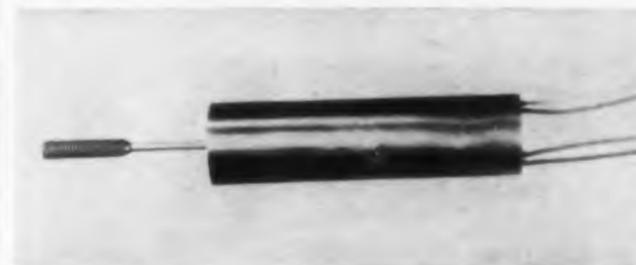


Industrial Products Group

## Displacement Transducers

353

Have solid-state circuitry



These displacement transducers have built-in solid-state circuitry and provide a dc output signal from dc excitation. Electro-mechanical response is beyond 1,000 cps. Units have germanium components for 6-v excitation, silicon components for 10-v dc excitation. The devices replace carrier amplifier systems to permit direct operation of recorders and indicators.

G. L. Collins Corp., 2820 E. Juliett St., Long Beach, Calif.

Price & Availability: Units, available from stock, are priced from \$87 to \$174.

## Pressure Transducers

384

For missile applications



Designed to meet the requirements of telemetry and control applications in advanced missiles, type P104 pressure transducers measure 1 in. in diameter and 2 in. long. They weigh 3.5 oz, including pressure and electrical connectors. Standard units are furnished in eight ranges from 0 to 500 and 0 to 5,000 psia. Output up to 75-v full scale may be obtained without amplification. Effects of linearity, hysteresis, resolution, friction, repeatability, and interchangeability are within a static accuracy band of  $\pm 1.5\%$ . Time constant is less than 2 msec and temperature sensitive is less than 0.005% per deg F over the operating temperature range of  $-150$  to  $+225$  F.

Trans-Sonics, Inc., Dept. ED, Burlington, Mass.

Price & Availability: \$400 ea, from stock.

FROM HONEYWELL... A DIAMOND JUBILEE PARADE OF PRODUCTS

CIRCLE 68 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 31, 1960

79



CUT COSTS ON BLIND

OR OPEN

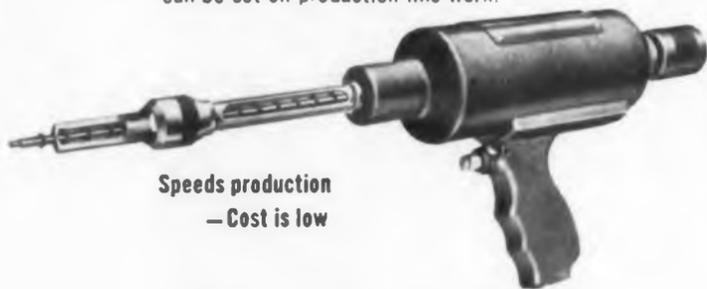
FASTENING

with HIGH SPEED

**Chobert®**

### AUTOMATIC RIVETING

The fastest blind riveting method known... gives uniformly excellent fastening every time. One man, even unskilled, easily completes rivet installation from one side of the work in either open or blind riveting applications in less than 2 seconds. Up to 2000 rivets an hour can be set on production line work.



Speeds production  
— Cost is low

### EASILY OPERATED...FAST...DEPENDABLE

The Automatic Chobert High Speed Riveting Gun holds a mandrel of up to 65 rivets, each automatically held ready for installation as fast as the operator can position the portable gun. Hand placing and bucking of rivets is eliminated...no finishing is required. Chobert simplifies blind or open fastening on vertical, horizontal or overhead surfaces, even areas normally considered inaccessible.

### EVERY RIVET UNIFORMLY SET

Each rivet expands evenly, assuring uniformity of strength and vibration resistance, without distortion or marring sheet metal. Chobert aluminum or mild steel rivets are available in diameters from  $\frac{3}{32}$ " to  $\frac{1}{4}$ ".

The Chobert System is successfully used by leading manufacturers of appliances, industrial equipment, electronic components, aircraft, missiles and other sheet metal fastening operations.



WRITE TODAY FOR BULLETIN R-660

**AVDEL**

210 SOUTH VICTORY BOULEVARD • BURBANK, CALIFORNIA

CIRCLE 69 ON READER-SERVICE CARD

## NEW PRODUCTS

### Coaxial Mixer

680

Comes in frequencies of 250 to 8,000 mc

The PC-Mix printed-circuit broadband coaxial mixer is available in frequency ranges of 250 to 8,000 mc in five basic units. Signal vswr is 2:1 max; line-open vswr is 1.5:1 max; and noise figure is better than 9 db. Mixing is single or balanced. The unit is capable of withstanding severe shock and vibration.

Premier Instrument Corp., Dept. ED, New Broad St., Port Chester, N.Y.

### Lead and Quadrature Rejection Amplifier

376

Rejection is 20:1 or better



Model 1805-0100 amplifiers provides a transistorized compensating lead network for 400-cycle servo systems. Quadrature rejection of the unit is 20:1 or better. Input impedance is 10 K, output impedance is 2 K. Dynamic voltage gain is 4. Power source is 28 v dc and 115 v, 400 cps. The unit is hermetically sealed and meets MIL-E-5400 specifications. It measures 1-3/16 x 1-11/16 x 2-5/8 in. and weighs 7 oz.

M. Ten Bosch, Inc., Dept. ED, 80 Wheeler Ave., Pleasantville, N. Y.

**Price & Availability:** Price is \$290; delivery is 4 weeks.

### Taper-Pin Plugs

696

In solder and solderless types

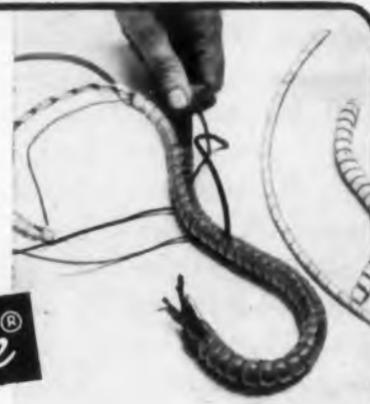
For use in connections of all types of circuits, types 2471 and 2472 machined, taper-pin plugs are solder and solderless types, respectively. Made of brass, the plugs measure 0.053 in. in diameter with a 0.061-in. taper per in. Finish is 0.0002-in. silver plate plus 0.0001-in. gold plate, or 0.001-in. copper plate and 0.005-in. electro-tin plate.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

**Price & Availability:** Type 2471, \$41.75 per 1,000 in quantities of 5,000; type 2472, \$19.21 per 1,000 in quantities of 5,000. Delivery is from stock.

Bind Wires  
Fast...  
At Low Cost  
with

**Heli-Tube®**



HELI-TUBE is a spirally-cut plastic tubing. Its shape-retaining characteristics make it ideal for binding electrical wires into cables. Wraps on like tape; holds wires together tightly; individual wires, taps, or lead-offs can be led out at any point. Earns cost back in time and labor-saving.

Available in 5 forms...

- Clear for general applications
- Nylon — wide temperature range... very light weight
- Ultraviolet-Resistant
- Fire-Resistant
- Type 275°F (High-temperature)

Each form in three diameters:

- Instrument Size:  $\frac{1}{8}$ " O.D. — for bundles up to  $\frac{1}{2}$ " dia.
- Harness Size:  $\frac{1}{4}$ " O.D. — for bundles up to 2" dia.
- Giant Cable Size:  $\frac{1}{2}$ " O.D. — for bundles up to 4" dia.

At your distributor for immediate delivery or write

**M. M. NEWMAN CORPORATION**

Dept. 22, 79 Clifton Ave., Marblehead, Mass.

CIRCLE 70 ON READER-SERVICE CARD



Splendid opportunities for maximum professional growth and recognition await you at the Instrumentation Center of Texas Instruments in Houston, the South's largest city.

- **MECHANICAL DESIGN ENGINEERS**—BS or MS in ME to design small electro-mechanical mechanisms.
- **ELECTRICAL DESIGN ENGINEERS** — BS in EE or Physics to design and construct: a. *Supervisory Control Systems* of electro-mechanical and electronic design; b. *Transistor Test Equipment*, heavy experience on circuit design preferably with transistors; c. *Digital Computers* with experience in detailed logic design.

- **SALES ENGINEERS**—BS in EE, ME or Physics with sales experience in electro-mechanical instruments.

With TI... receive liberal company-paid benefits, including profit sharing... work in a completely modern suburban plant near Houston's most attractive residential areas... enjoy pleasant Gulf Coast living and recreations the year-around.

Please direct your resumé to  
D. G. Turner, Department ED



**TEXAS INSTRUMENTS**  
INCORPORATED

GEOSCIENCES & INSTRUMENTATION DIVISION  
3601 BUFFALO SPEEDWAY • HOUSTON 6, TEXAS • CABLE: TEXINS

CIRCLE 901 ON CAREER INQUIRY FORM, PAGE 99

CIRCLE 71 ON READER-SERVICE CARD

**Stops  
Costly  
Scratches**

**MYSTIK BRAND®  
Protecto-Mask®**



### SELF-ADHERING COVERINGS

Like putting mittens on kittens, you can protect polished finishes on aluminum, stainless steel, plastics, glass... metals and materials of all kinds... This self-stik "skin" applies quickly from the roll—provides a tough, scratch-proof covering during all processing, fabricating, handling, shipping, storage. Write today for information and samples.



**Mystik Adhesive Products, Inc.**  
2635 N. Kildare Ave., Chicago 39

CIRCLE 72 ON READER-SERVICE CARD



Now you can read shaft  
positions to one second of arc  
...directly...with the Gurley

**UNISEC®**  
Optical Coincidence  
Reading System  
complete with  
a precision  
glass circle

A bulletin illustrating the how and why  
of UNISEC is yours for the asking.

**W. & L. E. GURLEY · TROY, NEW YORK**

WRITE FOR BULLETIN UE

CIRCLE 71 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 31, 1960

## Oscilloscope Accessory

358

Provides 0 to 300 v dc



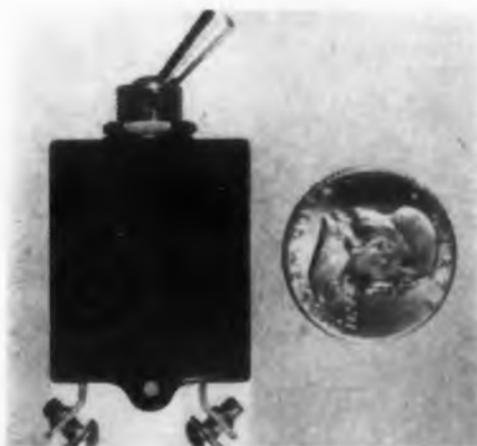
Designed for coupling to an oscilloscope, the Scope-O-Trol accessory unit provides an output of 0 to 300 v dc operating from an input of 115 v at 60 cps. The unit observes on the oscilloscope the regulation, ripple, transient response and other characteristics of dc power supplies by removing the dc component and using the scope to its maximum capacity. Voltage adjustment of the unit is in 75-v steps for coarse adjustment. Ripple is less than 1 mv rms.

Acme Electric Corp., Dept. ED, Cuba, N.Y.  
**Price & Availability:** Units are priced at \$125 and are furnished from stock.

## Toggle Switch

380

With circuit breaker



By combining both toggle switch and circuit breaker in this miniature unit, the need for replaceable fuse, fuse holder, and switch is eliminated. Weighing less than 50 g, the unit is suitable for use in radio, aircraft, and industrial electronic equipment. Its dielectric strength is over 3,500 v. Called the 3100 series, the device can interrupt circuits carrying up to 5,000 amp at 120 v, 60 cps. Units have current ratings of 5 to 50 amp.

Wood Electric Corp., Dept. ED, 244 Broad St., Lynn, Mass.

**Availability:** Up to 100 pieces can be furnished from stock.



## DATA-CABLE

**A COMPLETE  
SERIES OF  
DATA-  
PROCESSING  
AND TRANSMISSION  
CABLE**

TIMES' Data-cable is the first full line of engineered cable to meet every data-system requirement, and includes—

- Miniature low-capacitance coaxial cables.
- Low mutual capacitance twisted and multi-pair cables.
- Miniature low attenuation 95 ohm system cables.
- U/L approved Teflon® insulated backpanel wire.
- Wide-band matched impedance coaxial cables.
- Large multi-conductor cables incorporating any or all of the above types.

Data-cable is the result of TIMES' years of experience in cable application and design engineering for the computer industry. Select the cable for your application from the many "standard" Data-cables, or let our engineers assist you in developing or adopting a cable to your special requirements.

® DuPont

**TIMES WIRE & CABLE DIVISION**  
**The International Silver Company**  
WALLINGFORD, CONNECTICUT, U.S.A.

Clip This Coupon To Your Calling Card or Letterhead

Please rush FREE literature on:

- Coaxial Cables
- Data Transmission Cables
- Multi-Conductors & Hook-up Wire
- For Info. Only       Have Rep. Call



CIRCLE 73 ON READER-SERVICE CARD

# How Reader Service Can Help Solve Your Design Problems

## PROBLEM:

You have narrowed the selection of a product to three or four brands. You want more detailed information . . . a sound basis for making the best selection.

## PROCEDURE:

You circle the Reader Service Numbers of the advertisements or new product articles you're interested in, and mail the postage-free card to ELECTRONIC DESIGN. Our Reader Service Dept. speeds your requests to the manufacturers of the products you're considering.

## RESULT:

The manufacturers then provide data in depth; product descriptions, specifications, diagrams. Your product search is simplified—the problem soon solved.

## CONCLUSION:

When seeking more information about products displayed in ELECTRONIC DESIGN, simply circle the corresponding Reader Service Numbers. It's the fastest way—the most convenient way.

## NEW PRODUCTS

### Six-pdt Relay

523

Has 2-amp contacts



Type JH-18 6 pdt miniature relay has 0.2 in. grid spacing, 2-amp contacts, and occupies less than 1 cu in. of space. It weighs less than 1.8 oz. Standard coils include nominal voltage ratings of 6 to 115 v dc with a power rating of 2.5 w. Dielectric strength is 1,000 v rms at sea level or 750 v rms across open contacts. Insulation resistance is 1000 meg min. The unit stands shock to 50 g and vibration of 28 to 2,000 cps at 20 g or 5 to 28 cps at 0.5-in. double amplitude.

Allied Control Co., Inc., Dept. ED, 2 E. End Ave., New York, N.Y.

### Ceramic Capacitors

386

Measure 0.25 in. long



The Ceramin ceramic capacitors measure only 0.25 in. long without leads. Units having a diameter of 0.098 in. are for capacitances of 47 to 560 pf and units with a 0.125-in. diameter, 680 to 1,200 pf. These barium-titanate units are tuned to a tolerance of  $\pm 5\%$  up to 125 C or 10% up to  $\pm 150$  C. They comply with applicable portions of MIL-C-11015A and EIA-SMC-1 specs.

Electronics Corp., Dept. ED, Solana Beach, Calif.

Price & Availability: \$10; from stock.

## BRAND-REX CABLEMANSHIP

The Big Difference  
In MIL-C-13777B  
Neoprene  
Jacketed Cables!

Missile men, especially, know the advantages of Neoprene jacketed cables . . . low temperature flexibility, abrasion resistance and resiliency. And missile men who are also cablemen know it pays at the count down to count on Brand-Rex Cablemanship! And you should too.

There's more to the absolute reliability of Brand-Rex cables than just rigid adherence to specifications. Brand-Rex Cablemanship combines technology, skill, broad cable engineering services, production capability of three coast-to-coast plants and technical field service . . . all delivered by a tightly-knit organization backed by the vast resources of the American Enka Corporation.

Whatever your requirements for wire or cable, regardless of the rigidity of your specifications for conductors, layup patterns, insulation materials, shielding or armoring, you can count on the Cablemanship of Brand-Rex.



Write for samples and information today!

BRAND  
REX

WILLIAM BRAND-REX  
DIVISION

American ENKA Corporation  
SUDBURY ROAD, CONCORD, MASS.

CIRCLE 74 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 31, 1960

## Limit Switch

702

Temperature range is -65 to +250 F

Designed for missile, aircraft, and general mobile applications, this subminiature limit switch operates over the temperature range of -65 to +250 F. The spdt switching unit is housed in a sealed enclosure which has been evacuated and filled with inert gas to insure constant operating characteristics. Electrical rating at 28 v dc is 24-amp in-rush, 4-amp resistive, 1.5-amp inductive, at 100,000 ft, 4-amp motor, and 2.5-amp lamp load.

Micro Switch, Dept. ED, Freeport, Ill.  
Price: \$32.50.

## Servo Motor-Generator

367

For rate servo applications



This size 23 precision servo motor-generator is designed for application as a rate servo and to provide damping in very high gain systems. Motor stall torques are available from 5.5 to 9 in.-oz. No-load speed is 9,000 rpm. Generator characteristics include 2.9 v per 1,000 rpm and a linearity of 0.2% to 3,600 rpm. The unit is available with either a plain or pinion shaft.

Kearfott Div., General Precision Inc., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

## Analog Computer

697

Provides real time solutions

Model CM-3 solid-state analog computer provides continuous real time solutions for mathematical computations and real time control of variables in process industries. A single cabinet contains up to 12 amplifiers. Any number of amplifiers, square root and logarithmic networks may be specified according to functional requirements. Two or more of these computers can be used with their programming boards interconnected.

Southwestern Industrial Electronics Co., Inc., Dept. ED, 10201 Westheimer Road, P.O. Box 2187, Houston 27, Tex.

Price & Availability: Made to customer specs, units can be delivered in three to four months at prices ranging from \$5,000 to \$20,000 ea.

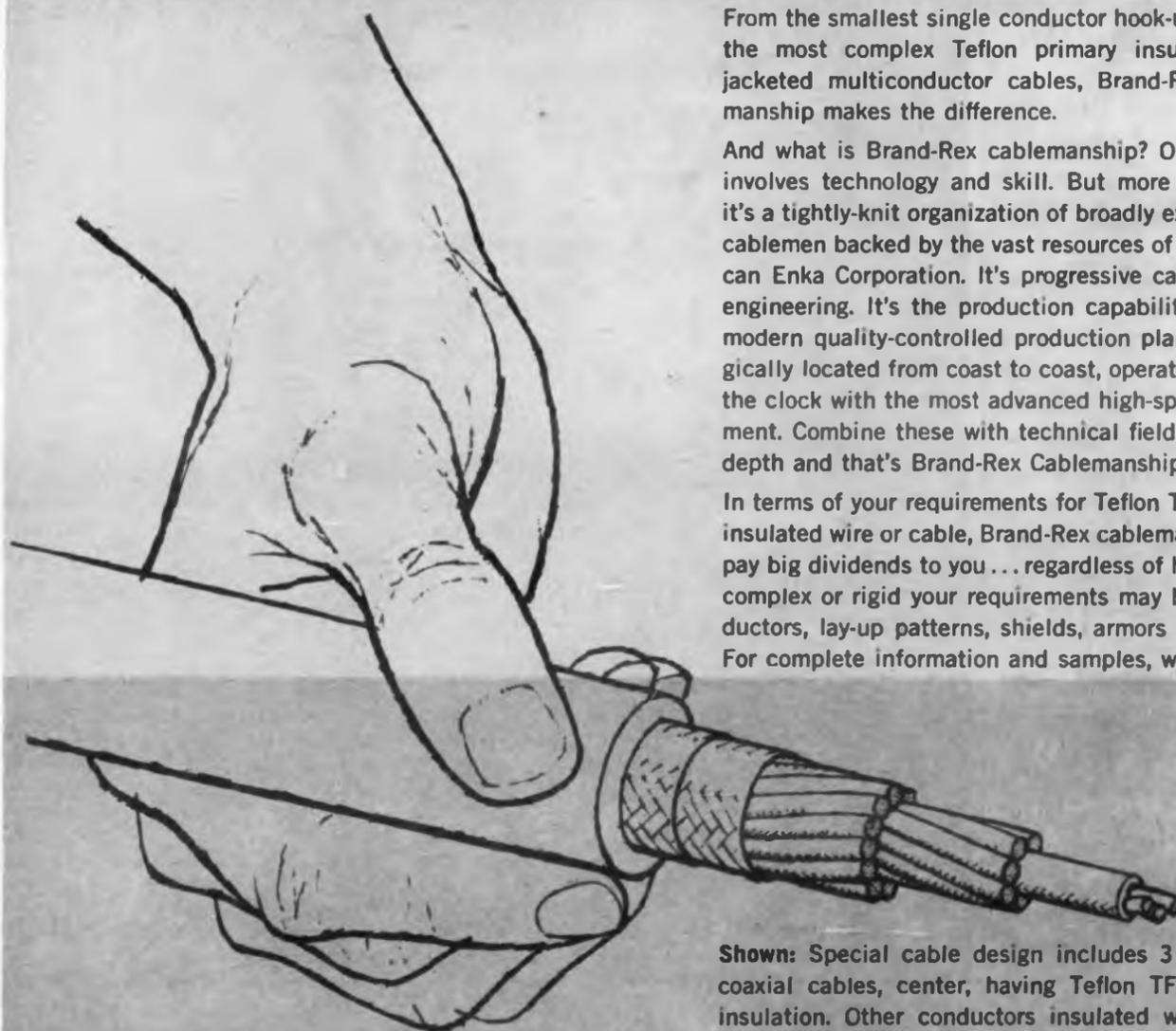
# BRAND-REX CABLEMANSHIP

### the big difference in Teflon® Insulated Wire and Cable!

From the smallest single conductor hook-up wires to the most complex Teflon primary insulated and jacketed multiconductor cables, Brand-Rex Cablemanship makes the difference.

And what is Brand-Rex cablemanship? Of course it involves technology and skill. But more than that, it's a tightly-knit organization of broadly experienced cablemen backed by the vast resources of the American Enka Corporation. It's progressive cable design engineering. It's the production capability of three modern quality-controlled production plants, strategically located from coast to coast, operating around the clock with the most advanced high-speed equipment. Combine these with technical field service in depth and that's Brand-Rex Cablemanship!

In terms of your requirements for Teflon TFE or FEP insulated wire or cable, Brand-Rex cablemanship will pay big dividends to you... regardless of how varied, complex or rigid your requirements may be for conductors, lay-up patterns, shields, armors or jackets. For complete information and samples, write today!



Shown: Special cable design includes 3 miniature coaxial cables, center, having Teflon TFE primary insulation. Other conductors insulated with Teflon FEP. Braids Dacron. Jacket Neoprene.



Left: Cables can be furnished with individual coaxials, pairs, triples or other components positioned within the cable exactly to specs. Center: Brand-Rex coaxial cables use Teflon dielectrics and meets all government and commercial requirements. Right: Brand-Rex quality-control procedures cover every step of manufacture.

®Registered Trademark of DuPont

BRAND  
REX

## WILLIAM BRAND-REX DIVISION

American ENKA Corporation

DEPT. W, 39 SUDBURY ROAD, CONCORD, MASSACHUSETTS  
Telephone: EMerson 9-9630

Vinyl, Teflon, Polyethylene, Nylon and Silicone Rubber Wires and Cables  
Electrical Tubing and Sleeving — UHF Cast Plastics — Plastic Extrusions

CIRCLE 75 ON READER-SERVICE CARD

## NEW PRODUCTS

### Slicing Machine 394

Reduces scrap loss

The I/D Micro-Slicer for slicing friable materials cuts scrap loss in half and yields more wafers per ingot. Cutting wheels 0.008 to 0.01 in. thick are used. Slicing is automatic. This unit is supplied with the MTA-70 high-production, automatic slicing machine.

The DoAll Co., Dept. ED, 254 N. Laurel Ave., Des Plaines, Ill.

### Printed Board Chopper 407

Operating frequencies are  
1 to 500 cps

This miniature, printed-circuit board chopper package is suitable for low-level signal applications in military and commercial equipment. Models are available for operating frequencies from 1 to 500 cps. Both MBB and BBM switching configurations are offered. The package can be either directly soldered into a printed circuit board or plugged into standard transistor sockets. The temperature range is  $-55$  to  $+125$  C. Units stand shock to 50 g and vibration of 30 g from 10 to 2,000 cps. Residual noise is less than 15 mv at 400 cps into 1 meg.

James Electronics, Inc., Dept. ED, 4050 N. Rockwell St., Chicago 18, Ill.

### Coaxial Connectors 400

For 50-ohm use

These type N, coaxial connectors for 50-ohm use are offered in two types. Type 920 provides a vswr of less than 1.2 to 1 over the frequency range of dc to 5,000 mc. Type 921 has the same vswr range for a frequency range extending to 11,000 mc. Dimensions for both types are 0.824 in. OD and 1-13/32 in. in length.

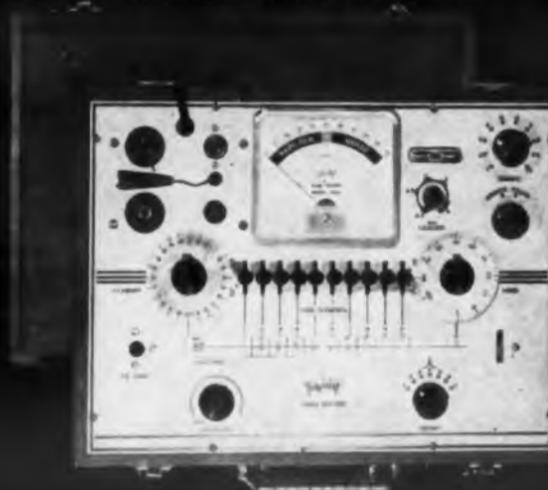
Saga Laboratories, 3 Huron Drive, Natick, Mass.

**Price & Availability:** Type 920 is priced at \$12.50 ea; type 921, \$40 ea. Delivery is from stock.

# it takes two...to test

# TRIPLETT

## PROFESSIONAL TEST EQUIPMENT



Model 3414 TUBE TESTER

Fast and extremely flexible. Provides easy, accurate testing. All switch settings can be made before the tube warms up . . . you're ready to test before the filaments have heated to the proper temperature. Rejects burned out tubes instantly without waiting for the filaments to heat. Neon indicator shorts test, new fast and accurate. Full range filament Voltages—0.65 to 117 in 23 steps. Improved lever switching for complete control of each tube element. Quick-change roll chart. TV picture tube test by means of BV adapter (available at extra cost of \$5.40) without removing tube from receiver. Large, clear-view meter has three-color GOOD-?-BAD scale.

Counter-Portable Type case. Ultra-professional appearance in dark gray leatherette covered wood:  $15\frac{3}{4}$ " x  $11\frac{1}{2}$ " x  $6\frac{1}{2}$ ". Hinged removable cover. Chrome hardware and feet. Model 3414. . . . . \$79.50



Model 2590 TRANSISTOR TESTER

Test Power Type Transistors and Signal Type Transistors under SIMULATED OPERATING CONDITIONS. Tests for shorts and leakage. Provides for testing ICEO (at 9.5 volts), ICBO (at 9.5 volts), and BETA (at 3 volts) on both NPN and PNP transistors. Checks leakage and forward currents of Diodes. EXTREMELY SIMPLE TO OPERATE. No roll charts or special technical data required. The only information needed to make a test is the transistor type. A transistor socket and a set of external leads permits use with any basing arrangement. Power-115 volts, 50-60 cycles AC. No batteries are required. The recessed panel is of etched heavy-gauge aluminum. It has a natural finish with black and red markings and trim.

Counter-Portable Type case in gray leatherette-covered wood:  $11\frac{3}{8}$ " x  $8\frac{3}{8}$ " x  $5\frac{1}{8}$ ". Case has rubber feet. Model 2590. . . . . \$49.50

### Model 690-A TRANSISTOR TESTER



Light and extra-portable. Provides leakage and gain tests for all low and medium power PNP and NPN type transistors. Measures DC BETA (current gain from base to collector with grounded emitter) from 5 to infinity. The long GOOD scale provides a better indication of the degree of quality. Affords an exact test for shorts and leakage . . . checks forward and reverse leakage of diodes. Prevents drain on batteries in case of accidental shorting of leads. Battery operation eliminates need for external power supply. Error-proof controls. Transistor socket and external leads for any basing layout. The panel has black and red markings etched on aluminum. The black molded case is  $2\frac{1}{2}$ " x  $5\frac{1}{2}$ " x 6". Model 690-A. . . . . \$29.50

TRIPLETT ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO



PANEL METERS

All Triplett testers and instruments are available nationally through authorized Triplett distributors. A list of the distributors in your area is available on request.

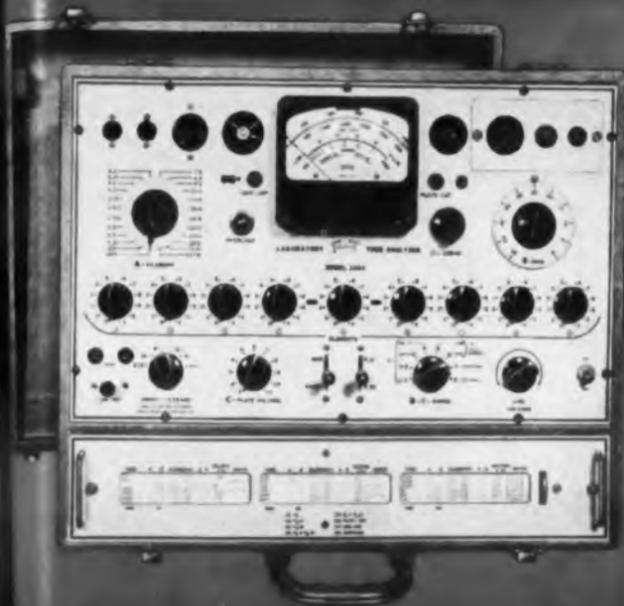
# TRIPLETT

# st both tubes and transistors

## HAS THE ANSWER!

Among these five outstanding Triplett testers you will find those that are perfectly suited to your particular requirements for tube and transistor analysis. Whether they be efficient lightweight models for quick readings on service calls . . . or industrial models to solve the most perplexing analysis problems, Triplett testers will give you dependable service and accurate measurements.

### LABORATORY ANALYZERS / Model 3444 TUBE ANALYZER



The finest instrument of its type available today. It speedily and accurately solves the most puzzling tube analysis problems in any field: Laboratory, Research, Industrial, Radio-Television, etc. This model measures true Gm without any extra compensating factors. **The first Portable Gm Tube Tester** with signal levels the same as those used in the large competitive units considered standards for tube testing.

**The first Portable Tube Tester** with self calibrating Mutual Conductance System.

**The first Portable Tube Tester** reading directly in volts, milliamperes and micromhos the conditions of tube measurement.

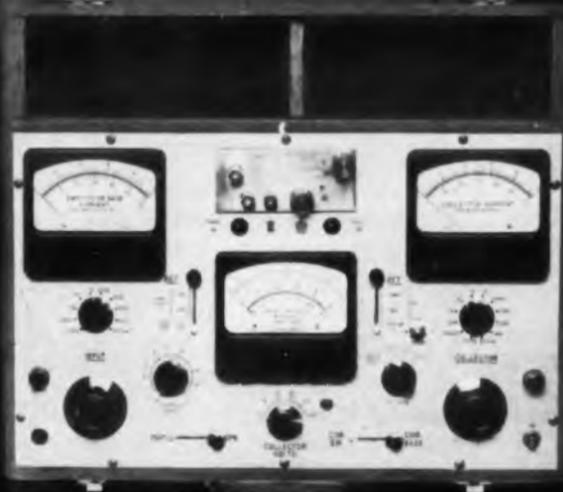
**The first Portable Tube Tester** equipped for plotting or developing characteristic curves. (Dual triode sections for example, may be compared at bogie and cut off plate current in volts and milliamperes, not arbitrary numbers.)

THE FIRST portable analyzer able to test the new Nuvistor tubes used in computer work. CHECKS PLATE current cutoff. CHECKS GAS under actual operating conditions (measures to a fraction of one UA of gas current). CHECKS RECTIFIERS under load. CHECKS THYRATRON firing voltage and grid current. CHECKS DUAL section tubes with only one lever movement. PROVIDES SHORTS and leakage measurements from 0-10 megohms using a filtered DC supply of 85 volts.

Counter-Portable Type Case in gray leatherette-covered wood: 15 $\frac{1}{16}$ " x 18 $\frac{13}{16}$ " x 7 $\frac{3}{4}$ ". Hinged removable lid, sloping panel, compartment for line cord, leads, acorn adapter and removable roll chart. Chrome hardware and feet.

Model 3444 . . . . . \$249.50

### Model 3490 TRANSISTOR ANALYZER



For superior transistor analyses—both power and signal types. Performs numerous functions not available in other portable transistor analyzers. The perfect choice for laboratory and industrial work.

**THREE** Independent Power Supplies

**COLLECTOR** Currents to 10 Amperes

**INPUT** Currents to 1 Ampere

Separate 4 $\frac{1}{2}$  inch Input and Collector meters monitor emitter or base. (Register continuously; easily readable). Continuously Variable (Variac) Collector Voltage or Current. Continuously Variable Emitter or Base Voltage or Current. Continuously Variable Tetrode Voltage. Measurement of ICO at any potential. Measurement of ICEO at any potential. Measurement of DC Alpha or Beta on Signal and Power types. Measurement of AC Beta on Signal types, at 1000 cycles. Continuous Instrument Coverage, No skip ranges. Also handles Punch through, Saturation and Floating potential measurements. Analyzes transistors in either the Common Base or Common Emitter configuration.

Extremely versatile . . . with provision for many different parameters. You get a common base or common emitter configuration at the turn of a switch. Prominent interlocked warning lights protect meters and transistor under test. Analyzer provides continuous current control and continuous voltage control. Hi-power silicon full wave rectifiers deliver up to 10 Amp DC collector current and 1 Amp input current. This model provides for Tetrode test using separate DC power supply. ICEO and ICO leakage tests.

#### RANGES:

INPUT CURRENT (Emitter or Base)	COLLECTOR CURRENT	ICEO, ICO (ICBO)	COLLECTOR VOLTAGE	EMITTER OR BASE VOLTAGE	TETRODE
0-1 Amp, 0-300 Ma, 0-100 Ma, 0-30 Ma, 0-10 Ma, 0-3 Ma, 0-1 Ma, 0-300 Ua.	0-10 Amp, 0-3 Amp, 0-1 Amp, 0-300 Ma, 0-100 Ma, 0-30 Ma, 0-10 Ma, 0-3 Ma, 0-1 Ma, 0-300 Ua.	0-60 Ma, 0-6 Ma, 0-600 Ua, 0-60 Ua.	0-120V, 0-60V, 0-30V, 0-12V, 0-6V, 0-3V	0-12V, 0-1.2V	0-10V Calibrated Control

Counter-Portable Type Case in gray leatherette-covered wood: 15 $\frac{1}{16}$ " x 18 $\frac{13}{16}$ " x 7 $\frac{3}{4}$ ". Hinged removable cover with accessory compartment and sloping panel. Chrome hardware and feet. Model 3490 . . . . . \$399.50



630-PL 630-APL 630-NA 630-T 631 310 666-HH 666-R

WORLD'S MOST COMPLETE LINE OF VOMS FOR EVERY PURPOSE

Available for  
immediate delivery  
call your  
distributor first

## Microwave Isolators 422

Covers 8,200 to 12,400 mc

Model IXH7 resonance-type isolator covers X-band frequencies of 8,200 to 12,400 mc. It handles a peak power of 25 kw and an average power of 150 w. Minimum isolation is 23 db, insertion loss is 0.8 db max and 0.5 db min, and vswr is 1.17 max and 1.04 min. The unit is equipped with a RG-52/U waveguide and UG-39/U flanges; it weighs 25 lb and measures 3.75 in. long.

Raytheon Co., Special Microwave Device Operations, Dept. ED, 130 Second Ave., Waltham 54, Mass.

Price & Availability: \$175; 30 days.

## Socket Screw 397

Has up to 2-1/3 times more holding power

The Unbrako socket screw combines the strong head and large bearing area of the recent 1960 series with the smoothly radiused root configuration of the Hi-Life thread. The large socket head provides up to 2-1/3 times more holding power without indentation of softer materials; the new thread increases fatigue performance.

Standard Pressed Steel Co., Dept. ED, Jenkintown, Pa.

## Crystal Discriminators 418

Bandwidths are 1 to 21 mc

The KCD series crystal discriminators can be made with a range of bandwidths from 1 to 21 mc. A unit having a center frequency of 11.5 mc has a peak-to-peak bandwidth of 75 kc, an input impedance of 10 K, an output impedance of 500 K + 20 pf, and a linearity of  $\pm 20$  kc. Its size is 1 cu ft. The discriminators are suitable for close-loop feedback networks, fm detection, demodulation, and wherever high-stability, narrow bandwidths are required.

The Keystone Electronics Co., Dept. ED, 65 Seventh Ave., Newark 4, N.J.

◀ CIRCLE 76 ON READER-SERVICE CARD

# this standing wave amplifier defies comparison

## FEATURES:

- A new low in noise levels — down to 0.007  $\mu\text{v}$  providing 0.02  $\mu\text{v}$  full scale sensitivity at minimum bandwidth.
- 5 db steps
- Attenuation range of 85 db
- FOUR regular VSWR scales plus one expanded
- All meter scales automatically normalized when switching ranges
- Large 5 $\frac{3}{4}$ " meter with 1% linearity
- Continuous gain control over 15 db range
- Continuously variable bandwidth control
- Front panel meter monitors bolometer bias current

## SPECIFICATIONS:

**Frequency:** 1,000 cps; adjustable over a 2% range.

**Sensitivity:** 0.02  $\mu\text{v}$  at minimum (4 cps) bandwidth. 0.1  $\mu\text{v}$  at maximum (40 cps) bandwidth.

**Noise Level:** 5db below full scale (0.007  $\mu\text{v}$  at minimum bandwidth).

**Amplifier Q:** 250 at 4 cps; 25 at 40 cps.

**Bandwidth:** Continuously variable from 4 to 40 cps.

**Calibration:** Square Law. Meter reads SWR, db.

**Range:** 85 db. Input attenuator provides 70 db in 5 db steps. Gain control provides 15 db adjustable. Accuracy  $\pm 0.1$  db per 10 db. Maximum cumulative error of  $\pm 0.2$  db at 40 cps bandwidth.

**Scale Selector:** Expanded, Regular, and Bolometer Current. Meter scale always normalized when switching from scale to scale or from expanded to regular.

**Meter Scales:** SWR: 1-4; SWR: 1.8-6; SWR: 3.2-10; SWR: 6-15; Expanded SWR: 1-1.3; db: 0-10; Expanded db: 0-2.3.

**Input Selector:** 220,000 ohms; Crystal; Bolometer. Bias provided for high 8.4 ma bolometer or 4.3 ma low current bolometer. Bias adjustable  $\pm 15\%$ . A bolometer protective circuit permits any switching operation or cable connect-disconnect without damage to bolometer.

**Output:** Jack for 1500 ohm recorder, 1 ma full scale deflection.

**Input Connector:** BNC Jack.

**Power:** 115/230 v  $\pm 10\%$ , 50-60 cps, 40 watts.

**Dimensions:** Cabinet: 7 $\frac{3}{4}$ " wide, 10 $\frac{1}{2}$ " high, 11" deep.

**Weight:** 14 lbs. net.



The new portable PRD 277-B Standing Wave Amplifier is designed to meet the present and future needs of microwave test laboratories. Due to its extremely low inherent noise, 0.007  $\mu\text{v}$ , weak signals which once were undetectable by conventional instruments can now be measured. Attenuation in 5 db steps combined with 4 VSWR scales and a large meter permit VSWR measurements to be made with maximum resolution and accuracy.

To find out more about the new PRD 277-B Standing Wave Amplifier, contact your local PRD representative or phone, write, or wire:

**PRD ELECTRONICS INC.**  
A Subsidiary of Harris-Intertype Corporation  
Formerly Polytechnic Research & Development Co., Inc.  
Factory and General Office: 202 Tillary Street, Brooklyn 1, New York, ULster 2-6900  
Western Sales Office: 1605 Centinella Ave., Lakewood, Calif., ORegon 5-8523

CIRCLE 77 ON READER-SERVICE CARD

## NEW PRODUCTS

### Epoxy Resin Powder

703

For insulating electronic components

Scotchcast XR-5026 one-part, epoxy-resin powder is for use in insulating rotors, resistors, capacitors, and intricately shaped objects. The powder adheres to a hot object, melts, flows slightly, then cures. Electrical strength is 500 to 800 v per mil, dielectric constant is 3.61 at 23 C, and dissipation factor is 0.0053 at 23 C and at 60 cps.

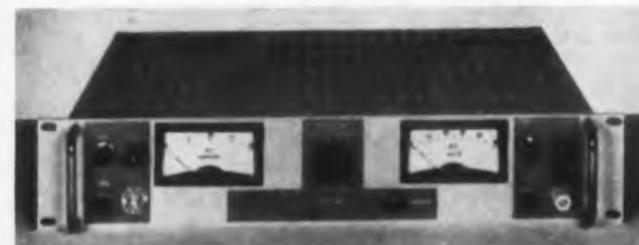
Minnesota Mining and Manufacturing Co., Dept. ED, 900 Bush Ave., St. Paul 6, Minn.

**Price & Availability:** An aerator test kit is available from the manufacturer at the price of \$25.

### Transistorized Power Supply

370

Regulated to 0.005%



The model LQ35-2A dc power supply has an output voltage of 0 to 35 v at 0 to 2 amp. Regulation is 0.005% or 1 mv, whichever is greater, per 10% of line change at any rated load. Load regulation is less than 5 mv from no-load to full-load. Ripple is less than 50  $\mu\text{sec}$ . Line input is 105 to 125 v ac, single phase, 60 cps. Panel measures 3-1/2 x 19 in.; chassis is 17-7/8 in. deep.

Universal Electronics Co., Dept. ED, 1720 22nd St., Santa Monica, Calif.

### Environmental Chamber

571

For temperature-shock, temperature-humidity work

Model WD-585-50-50-50-50 environmental chamber is for temperature-shock and temperature-humidity applications. It has independent refrigeration, heating and humidity systems for the left half and the right half of the chamber; each half is controlled independently. It is possible to have +500 F on one half and -100 F on the other half of the chamber. Gages show the equipment's performance characteristics. The humidity control range is 20% to 98% from 35 F dew point to +185 F dry bulb limits.

Conrad, Inc., Dept. ED, 141 Jefferson St., Holland, Mich.

**Availability:** Deliveries can be made promptly.



PRECISION FILM POTS

AVAILABLE FROM STOCK!

You can have any of these precision film pots on their way to you within hours. No need to wait for "custom" pots.

LINEAR SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Linearity
1/2"	1K.....	± .5%
	10K.....	± .5%
	50K.....	± .5%
7/8"	1K.....	± .5%
	10K.....	± .5%
	50K.....	± .5%
	1K.....	± .25%
	50K.....	± .25%
1-3/32"	1K.....	± .5%
	10K.....	± .5%
	50K.....	± .5%
	1K.....	± .25%
	50K.....	± .25%
2"	5K.....	± .25%
	20K.....	± .25%
	50K.....	± .25%
	5K.....	± .1%
	20K.....	± .1%
3"	5K.....	± .1%
	20K.....	± .1%
	50K.....	± .1%
	5K.....	± .05%
	20K.....	± .05%

SINE-COSINE SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Conformity
1-3/32"	10K.....	± .75%
	20K.....	± .75%
2"	10K.....	± .25%
	20K.....	± .25%
3"	10K.....	± .15%
	20K.....	± .15%

LINEAR MOTION FILM POTENTIOMETERS

Size	Resistance	Stroke	Linearity
1" Sq.	10K....	1" Stroke	± .5%
	20K....	1" Stroke	± .5%
	10K....	2" Stroke	± .25%
	20K....	2" Stroke	± .25%
	10K....	3" Stroke	± .1%
	20K....	3" Stroke	± .1%

Write or call in your order! Potentiometers will be in your plant within 24 hours.



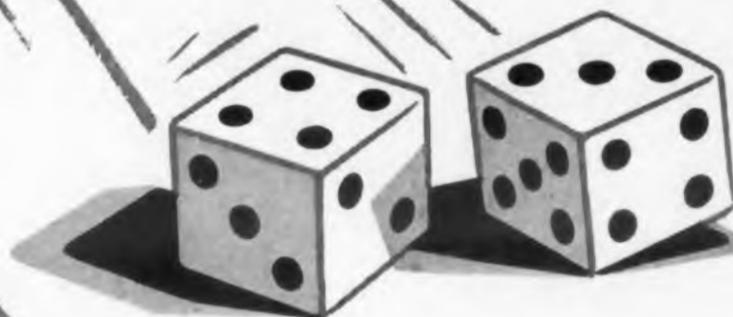
90 MADISON AVE., HEMPSTEAD, L. I., N. Y.

CIRCLE 76 ON READER-SERVICE CARD

WHY GAMBLE?

RELIABILITY

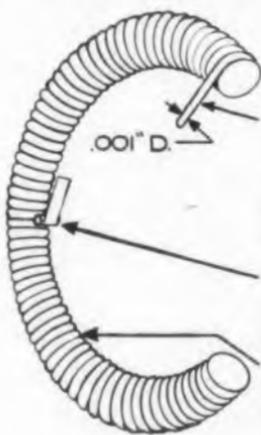
is a NATURAL...



WITH CIC PRECISION FILM POTS!

HERE'S WHY!

WIRE-WOUND... THE HARD WAY

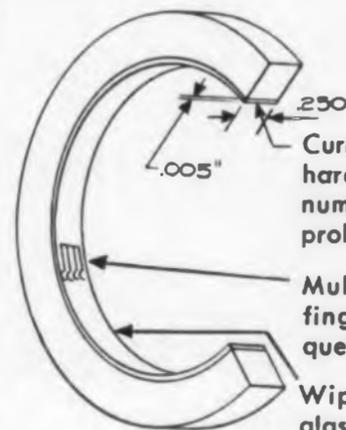


All current carried by a single fragile hair-like wire. Cutting any one turn causes no-warning, catastrophic failure—for 2,000 turns, 2,000 chances for element failure!

Single bar contact wiper — one microscopic dust particle can cause an open — 1:1 odds on failure!

In one traverse wiper must make switch-like contact to each turn for continuity — for 2,000 turns, 2,000 chances for opens!

FILM POT... THE EASY WAY



Current carried by broad band of hard carbon film with an infinite number of current paths — ZERO probability of element failure!

Multiple fingered wiper — each finger with different natural frequency — odds on opens 1:16!

Wiper rides on continuous film, glass smooth, self-lubricating carbon — ZERO probability of opens!

Precision film potentiometers are inherently four million times more reliable than wire-wound types! Write for our Tech Note "Reliability Factors in Precision Potentiometers" for the whole story.

FIRST IN FILM POTS



92 MADISON AVENUE, HEMPSTEAD, L. I., N. Y.

CIRCLE 79 ON READER-SERVICE CARD



**Model 791D** **\$920**

**DEVIATION MEASURED**  
10cps to 125kc

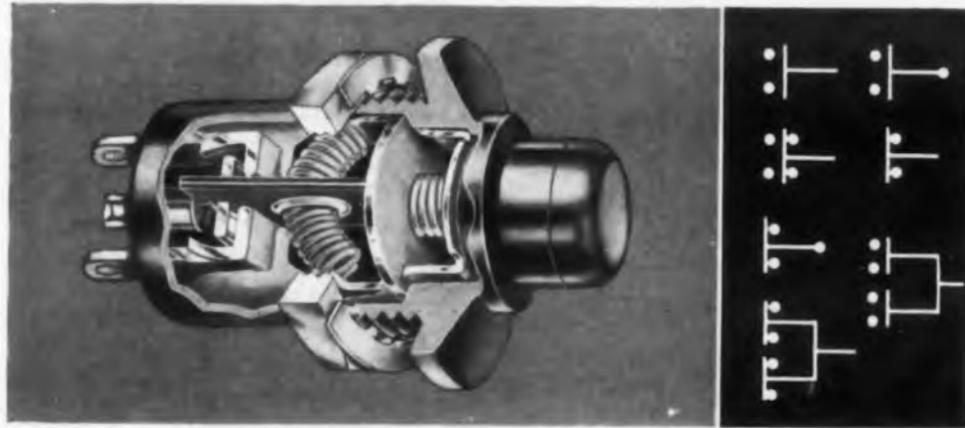
New FM Deviation Meter has carrier frequency range 4—1024Mc; crystal controlled LO enables measurement down to 10cps deviation. Used with a 'scope, it measures peak deviation of complex wave-forms. Very easy to operate, Model 791D *s p e e d s* deviation measurements.

Carrier Freq. Range: 4—1024Mc, xtal locked  
Mod. Freq. Range: 25cps to 35kc  
Deviation Ranges: 0.5, 25, 75, 125kc  
Accuracy: 3% Xtal standardized  
Distortion: Less than 0.2%  
21 tubes: 6AK5, 6C4, 0B2, 5651, 6CD6G, 5Z4G, 5647, 6AS6



## SWITCHES

FOR AIRBORNE & MISSILE GROUND SUPPORT EQUIPMENT



**FAST, POSITIVE ACTION**  
**LONG SERVICE LIFE • MOISTURE-PROOF**

A broad line of sinusoidal toggle spring switches designed for compactness, light weight and high reliability in airborne and ground support missile control systems. Extremely fast, audible, double break action reduces arcing and contact wear to negligible minimum. Positive snap action mechanism cannot be teased on or off contact. All contacts made of heavy coin silver for long life and low contact resistance. Available with color coded buttons. These switches exceed military requirements for vibration, shock, humidity and corrosion resistance.

Western Distributor: Western-Electromotive, Inc., Los Angeles.



**The UCINITE COMPANY**

Division of United-Carr Fastener Corporation, Newtonville 60, Mass.

CIRCLE 81 ON READER-SERVICE CARD

## NEW LITERATURE

### Instrument Catalog 261

This 48-page catalog, No. 604, describes and illustrates the company's complete line of noise and field intensity meters, impulse generators, power density meters, modulation meters, coaxial attenuators and terminations, crystal mixers and microwave components. Line drawings and tabular data are included. Empire Devices Products Corp., Amsterdam, N. Y.

### Telemeters 262

This 52-page bulletin, No. M1715, describes the company's Metameter telemeters. Included are principles of operation, application to various measurands, and electrical quantities. Computer control, pump control, remote control, selective calling, and Metaphone are also illustrated. Bristol Co., Waterbury 20, Conn.

### Magnetic Shielding 263

Bulletin No. F-1 gives design and performance data of magnetic alloy shields for high gain input transformers and electron beam tubes. Charts show shielding efficiency of single and multiple layer rectangular as well as cylindrical shielding containers of several magnetic alloys. Magnetic Metals Co., Hayes Ave. at 21st St., Camden 1, N. J.

### Resistor 264

A new type of glass-enclosed resistor is described in data sheet No. CE-2.02. Illustrated in the bulletin are the 1/8 watt and the 1/4 watt NF-60 and NF-65. Resistance range is 100 ohms to 360 K; voltage ratings are 250 and 300 v. Write on company letterhead to Corning Glass Works, Electronic Components, Dept. ED, Bradford, Pa.

### Transformer Kit 264

This catalog page gives complete technical specifications of model C-2650 microminiature transformer kit. The kit is complete with 10 precision transformers, case, technical manual and test data. James Electronics Inc., 4050 N. Rockwell St., Chicago 18, Ill.

### Power Supplies 265

Information and specifications on dc-dc converters, dc-ac inverters and ac-dc power supplies for laboratory, airborne, mobile, communications and automation applications are given in this four-page brochure. Output and dimensions are covered. Electrodynamics Instrument Corp., 1841 Old Spanish Trail, Houston 25, Tex.

### Trimming Potentiometers 266

Two 1/2-in., square, high-performance trimming potentiometers are featured in this four-page bulletin. Photographs, outline drawings, power input charts, electrical and mechanical specifications, standard coil data, and a list of available modifications tell the complete product story. Helipot Division of Beckman Instruments, Inc., 2500 Fullerton Road, Fullerton, Calif.

### Rotary Switch 267

Manufactured to BUShips and MIL specifications, this rotary multipole switch is the subject of two-page bulletin No. 19. Included are dimensional drawings, special-assembly drawings, technical data, and a photograph of the switch. Electro Switch Corp., King Ave., Weymouth (Boston 88), Mass.

### Frequency Discriminator 268

Details of a 115-v, 400-cycle, 0 to 5 v dc frequency discriminator appear in this data sheet. Specifications, outline drawings, a schematic diagram, signal frequency graph, and a description of operation and applications are included. Magnetic Research Corp., 3160 W. El Segundo Blvd., Hawthorne, Calif.

### Infrared Source 269

This data sheet describes a miniature infrared source for calibrating the seeking head of infrared guided missiles and other sensitive elements in the 200 to 600 C temperature range. Construction, operation and specifications of the infrared source and temperature controller are included. Perkin-Elmer Corp., Norwalk, Conn.

## Application Notes 270

This four-page index of some 40 "Application Notes" issued by the firm over the past months contains abstracts of a variety of subjects for users of electronic measuring instruments. The "Application Notes" themselves describe electronic theory, measurements, and applications of the firm's instruments. Typical topics covered are traveling wave amplifiers, solid-state devices, masers, various frequency, microwave and current measurements, and applications for oscilloscopes and oscillators. Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif.

## Complex Ratio Bridge 271

Technical specifications, a detailed circuitry description and a simplified block diagram of a complex ratio bridge appear in this four-page, illustrated brochure. Also shown are schematics of typical applications involving transformers, resolvers, transducers, and synchros. Gertsch Products, Inc., 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

## Trimmer Potentiometers 272

Technical descriptions, outline drawings, performance data, a power rating curve, price and availability data are included in this two-page, color bulletin on trimmer potentiometers. Fairchild Controls Corp., Components Div., 225 Park Ave., Hicksville, L.I., N.Y.

## Chart Drives 273

This catalog describes chart drives that offer quick, easy chart speed changing, savings in chart paper costs, and an ability to match chart speed to test requirements. Included are instructions for ordering proper models and photographs of unit installed. Barry Controls Inc., Inesco Co. Div., Hollis St., Groton, Mass.

## AC Motors 274

This six-page, two-color catalog presents information on horsepower, torque, speed, duty cycle, weight and size of the firm's ac motors. These motors, designed for electro-mechanical linear and rotary actuators, servos, pumps and valves, have qualified for Mil specifications. Lear Inc., P.O. Box 688, Grand Rapids 2, Mich.

## Solid-State Circuits 275

The firm's capabilities in solid-state circuits is illustrated in this four-page, two-color brochure. In addition to specifications and characteristics of major circuits, the brochure outlines the design and development capabilities of the company. Pennon Electronics, Inc., 7500 S. Garfield, Bell Gardens, Calif.

## Precision Bearings 276

"How to Reduce Cost and Eliminate Overdesign in the Selection of Precision Miniature Bearings" is a four-page, illustrated catalog that describes how sintered bronze bearings have been designed to replace miniature precision ball bearings in a variety of applications. Included in catalog No. 60-04 are MIL specs, design features, available styles and sizes, specifications, applications, and installation procedures. Northfield Precision Instrument Corp., 4400 Austin Blvd., Island Park, L.I., N.Y.

## Trimmer Capacitors 277

Seven models of direct-traverse, trimmer capacitors with pan terminals and five models with wire terminals are described in reference sheet CE-4.01. In addition to a picture and diagrams of the trimmers, the sheet covers dimensions, capacitance range, core and shaft plating, material, and finish of the models. Corning Glass Works, Electronic Components Dept., Bradford, Pa.

## Instrument Cases 278

Brochure No. 403-G gives details of a comprehensive line of instrument cases, covering features, sizes and colors. This 12-page, color, booklet describes the standard hardware that may be obtained when ordering the predesigned cases. TA Manufacturing Corp., 4607 Alger St., Los Angeles 39, Calif.

## Pulse Switch 279

An adjustable industrial pulse switch is described in this two-page data sheet, No. 173. It contains photographs, dimensional drawings, characteristics and pricing information. Minneapolis-Honeywell Regulator Co., Micro Switch Div., Freeport, Ill.

# Resistance Thermometers by REC.....

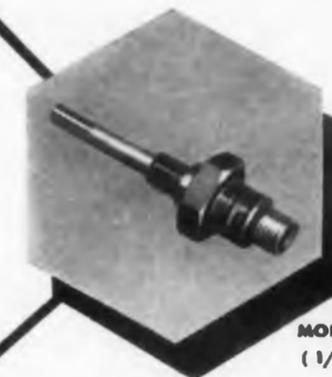
REC specializes in platinum resistance thermometers of exceptional stability and high calibration accuracy.



MODEL 172  
(actual size)

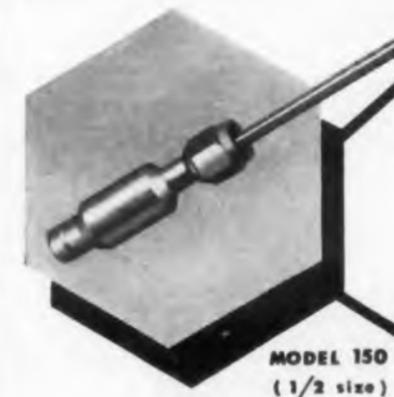
MODEL 172 series is a miniature element encased in a platinum-rhodium tube, useful from  $-260$  to  $750^{\circ}\text{C}$  or up to  $1100^{\circ}\text{C}$  for short term use, and having a resistance of 100 ohms at  $0^{\circ}\text{C}$ , with other values available. It can be cemented or clamped to a surface, inserted in a hole, or molded into a body.

MODEL 152 probe features open platinum wire supported at intervals, resulting in extremely fast response and excellent thermal isolation between the element of the probe and the head of the probe. It is primarily intended for gases at moderate and low velocities, useful from  $-260$  to  $+260^{\circ}\text{C}$  or higher.



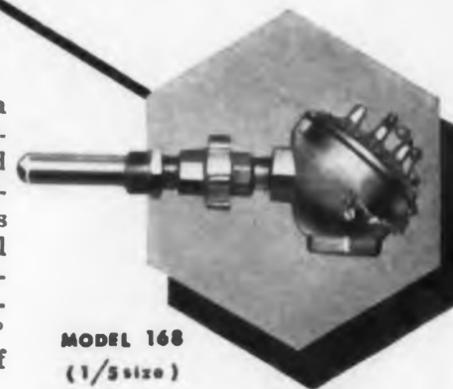
MODEL 152  
(1/3 size)

MODEL 150 probe features a miniature element, only 0.160 OD outside the guard tube. It is useful from  $-260^{\circ}\text{C}$  up, and finds wide applications in  $\text{LO}_2$  and  $\text{LH}_2$ , and is available with various immersion lengths and is normally mounted by a flare fitting.



MODEL 150  
(1/2 size)

MODEL 168A series probe uses a precision platinum resistance sensing element which is fully supported by a ceramic insulation. The element is protected by a stainless steel guard tube with additional support at the element tip for maximum protection to flow. The temperature range is  $+700^{\circ}\text{F}$  to  $-435^{\circ}\text{F}$ , and has a normal resistance of 1380 ohms at  $0^{\circ}\text{C}$ .



MODEL 168  
(1/5 size)

Write for further information . . . .



**ROSEMOUNT  
ENGINEERING  
COMPANY**

DEPT. MR-1

4900 West 78th St. Minneapolis 24, Minn.

See us at Booth No. 1507,  
I.S.A. Show, Sept. 26-30.

CIRCLE 82 ON READER-SERVICE CARD



**CONRAD**  
MODEL  
FB-6-2-2-CC-S

## HYPER ENVIRONMENT TEST CHAMBER

Production models now available for quality control in manufacturing temperature-sensitive components such as thermistors and resistors. Write for new 52-page catalog.



**HOLLAND, MICHIGAN**  
Subsidiary, Crompton Mfg. Co.,  
Grand Rapids, Mich.

CIRCLE 83 ON READER-SERVICE CARD

**PROVEN, DEPENDABLE REAR-PROJECTION TYPE IN-LINE DIGITAL DISPLAYS**

*A Model and Size For Your Every Requirement*

**PRICES**

<b>Series 10000</b> 1 7/8" wide 2 3/8" high 5 5/8" long <b>\$18.00 each</b>
<b>Series 80000</b> 3 1/4" wide 5 1/4" high 11 1/4" long <b>\$33.00 each</b>
<b>Series 120000</b> 1" wide 1 5/8" high 3 7/8" long <b>\$35.00 each</b> Quantity Prices On Request

**Series 120000**

- All digits displayed on front viewing screen
- All digits uniform in size and intensity
- High-contrast viewing screen
- Digit style of your choice
- Colored digits of your choice
- Individual units may be group assembled for panel mounting

**Series 80000**

Today's advances in digital computers, missile checkout, airborne equipment, control systems, and electronic test equipment call for fast, accurate, dependable readout displays. Thousands of engineers in these fields are finding out through experience that the In-Line Digital Displays manufactured by Industrial Electronic Engineers Inc. fill the bill better than any other equipment on the market... and at a substantial savings in money.

**WRITE TODAY FOR COMPLETE DETAILED SPECIFICATIONS**

**INDUSTRIAL ELECTRONIC ENGINEERS, INC.**  
Engineers and Manufacturers of Fully Automatic Systems and Machines  
5528 Vineland Avenue, North Hollywood, California

Representatives in principal cities

CIRCLE 84 ON READER-SERVICE CARD

## NEW LITERATURE

### Power Transistors 280

Specifications, illustrations and technical data for silicon, intermediate-power transistors, types 2N1047, 2N1048, 2N1049 and 2N1050, are included in this one-page data sheet. Silicon Transistor Corp., Carle Place, L.I., N.Y.

### Mil-Spec Knobs 281

Illustrations and dimensional drawings of Mil-Spec knobs are included in this two-page bulletin, No. 59-3A. These knobs are available in five sizes, six styles, three shaft diameters and three finishes. National Radio Co., Inc., 37 Washington St., Melrose 76, Mass.

### Oscilloscope 282

A transistorized, battery-operated, portable oscilloscope is featured in this four-page pamphlet. Specifications, photos, block diagram, and performance details of the 3-in. instrument are provided. Tektronix, Inc., P.O. Box 500, Beaverton, Ore.

### Mobile Tracking Antenna 283

Specifications, antenna pattern data, and detailed information and illustrations are reported in this two-page, two-color bulletin. The antenna features a folding 28-ft reflector, tilting mast, and hand operated azimuth. D. S. Kennedy & Co., Cohasset, Mass.

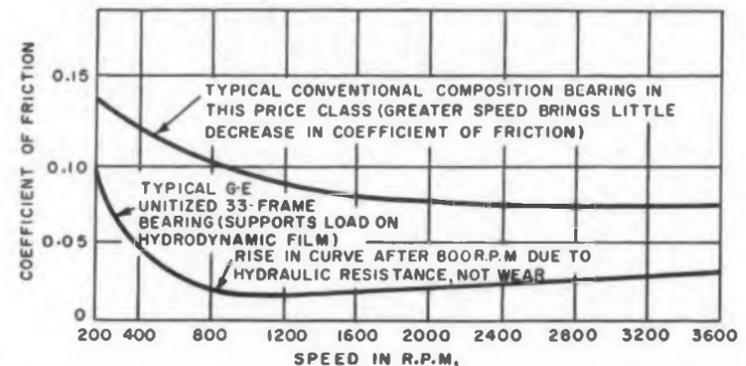
### Power Supply Transformers 284

Wiring diagrams and schematics of transformers for transistor power supplies are contained in this brochure, No. TY-61. Electrical and mechanical specifications on all units of the firm's line are included. Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.

### Screws and Bolts 285

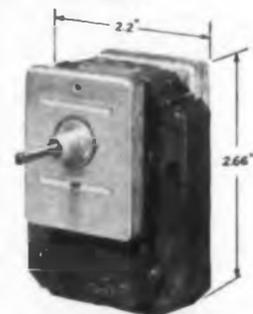
The advantages of Holtite Nylok screws are explained in this eight-page booklet. Included is a graph of manufacturing standards. Continental Screw Co., New Bedford, Mass.

### WEAR-FRICTION COMPARISON GENERAL ELECTRIC VS. CONVENTIONAL MOTOR



### Long life in *Unitized*\* motors results from new bearing design

Bearing wear in General Electric Unitized motors is greatly reduced as compared to conventional composition bearings. This is due to the hydrodynamic oil film developed by the G-E lubrication system. Thus these motors are ideal for refrigeration and other applications where long life without maintenance is essential. G-E Unitized motors operate at sound levels 25% below conventional motors, and their starting characteristics are excellent even at low temperatures.



G-E shaded-pole Unitized motor. From 1 mhp to 20 mhp, 2 pole.

**FREE BULLETIN**

Write to Section 727-02,  
Schenectady 5, N. Y.

**GENERAL ELECTRIC**

CIRCLE 85 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 31, 1960

### Digital Voltmeter 286

Performance characteristics of a digital voltmeter designed for military applications are covered in eight-page bulletin 19-77. History, design and construction, and environmental design goals for the voltmeter are included. Kin Tel, Div. of Cohu Electronics, 5725 Kearny Villa Road, San Diego 12, Calif.

### Teflon Terminals 287

This 18-page catalog, No. T110, provides engineering and technical data such as voltage and capacitance micromicrofarad ratings on the firm's subminiature Teflon terminals. Tri-Point Plastics Inc., 175 I.U. Willets Road, Albertson, L.I., N.Y.

### Electronic Catalog

This 228-page, full file-size catalog lists specifications for hundreds of products and systems including photomultiplier tubes, klystrons and cavities, secondary emitters, travelling wave tubes, oscilloscopes, analog computers, tape decks, stroboscopes, transducers, balancing ma-

chines, closed-loop TV systems, power supplies, signal generators, attenuators, and others. Write on company letterhead to Hoffman Electron Tube Corp., 804 Newbridge Ave., Westbury, L.I., N.Y.

### Silicon Diode 288

Type FD200, diffused silicon diode having ultra-fast recovery and ultra-high conductance, is described in data sheet No. SL-110/1. This two-page bulletin is illustrated with performance graphs and a test circuit diagram. Fairchild Semiconductor Corp., 4300 Redwood Highway, San Rafael, Calif.

### Silicon Rectifier Handbook 289

Illustrations, specifications and dimensional drawings on the firm's entire line of silicon, power rectifiers are included in this 42-page handbook. Extensive technical data on the selection and application of the products is outlined. The company's national network of representatives and a customer price list are covered. Standard Rectifier Corp., 620 E. Dyer Road, Santa Ana, Calif.

## NEW PHOTOMULTIPLIERS



CBS LABORATORIES new line of photomultipliers are specially designed for counting or scanning applications.

Unique photocathode geometry (1) and improved linear dynode structure (2) are combined to provide excellent uniformity of response across the face of the tube and extremely short transit time spread.

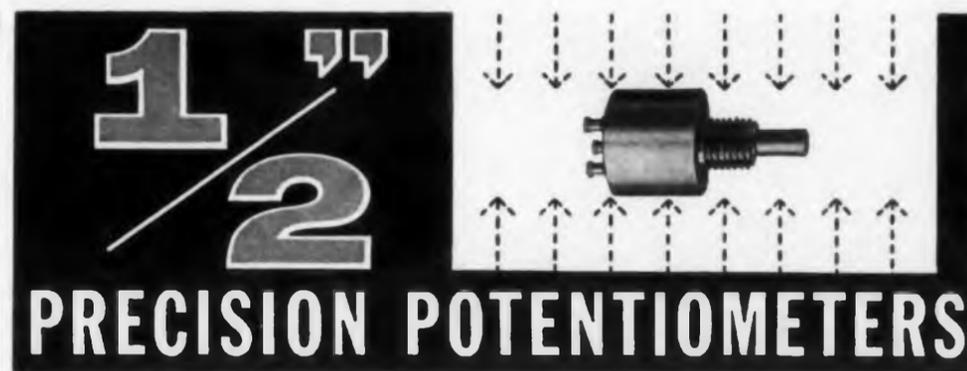
The new, rugged photomultipliers are available as illustrated in 2", 3" and 5" diam. cathodes with visible (S-11) or infra-red (S-1) response and 10 stages of multiplication; or with quartz windows in 2" and 3" diam. with ultraviolet (S-13) response. Special types can be developed to order.

For technical bulletins or complete information, write: CBS LABORATORIES, Electron Tube Department.

# CBS LABORATORIES

HIGH RIDGE RD. STAMFORD, CONN. • A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

CIRCLE 86 ON READER-SERVICE CARD



Immediate  
delivery  
from  
local stock!

### SERIES 57

The answer to miniaturized precision control—1.5 watts @ 40°C. ± 5% resistance tolerance. Dielectric strength, 1000 v.a.c. for 1 minute at atmosphere. Exceeds MIL-R-19 specifications...and best of all, your local Clarostat industrial distributor has them for off-the-shelf delivery!

## CLAROSTAT DIRECT LINE SERVICE

A complete line of precision and industrial electronic resistance devices as close as your telephone—right at your Clarostat industrial distributor...



**CLAROSTAT MFG. CO., INC.**

DOVER, NEW HAMPSHIRE

In Canada: CANADIAN MARCONI CO., LTD., TORONTO 17, ONT.

CIRCLE 87 ON READER-SERVICE CARD

## DO YOU HAVE TO MARK ..... SHORT RUNS of Hard-to-Mark Products Requiring Frequent Copy Changes?

KRENGEL's Bakelite Typeholder with interchangeable engraved Deep-Kut type is the ideal answer wherever sharp permanent markings are required on hard-to-mark products.

Bakelite Typeholders permit speedy interchange of perfectly aligned, engraved Deep-Kut Vinylite letters and numbers. These holders are equipped with a winding adjustment button and slots for type characters and numbers in the sizes and style shown along side. Four different size holders for every use.

1/16 ABC123  
3/32 ABC123  
1/8 ABC123  
5/32 ABC123  
3/16 ABC12  
1/4 A B C

Complete sets of letters and figures (one of each) available at \$5.95 in any one size.

Bakelite holders in 4 sizes from \$3.95 to \$5.30.

Krengel Engraved Deep-Kut Stamps give you razor-sharp stamping impressions every time!



# KRENGEL

MANUFACTURING CO., INC.

227 Fulton Street, New York 7, N. Y.  
COntlandt 7-5711

CIRCLE 88 ON READER-SERVICE CARD



what makes one  
micro-miniature  
relay more  
reliable  
than another?

answer:

**SEALED  
CONTACT  
CHAMBER**

## NEW Couch Relay isolates Contacts from Contamination

Organic material can't contaminate the contacts in the new Couch Type 2M micro-miniature relay. They're hermetically sealed in a separate chamber — and without rosin flux.

Also contributing to reliability is Couch's patented rotary armature, pivoted on two sapphire jewels and virtually immune to present day levels of shock and vibration.

Designs like this, produced within an unusually narrow range of manufacturing tolerances, help explain why Couch relays are being called on to provide reliability in many complex systems.

Write for additional information.

### ENGINEERING DATA:

Shock.....	50G Min.
Vibration.....	30G's to 2,000 CPS
Dielectric Strength.....	1000 Volts RMS Min.
Height.....	.875" max.
Width.....	.800" max.
Thickness.....	.400" max.
Weight.....	18 ± 1 gram
Contact Arrangement.....	2 form C(2 PDT)



**COUCH ORDNANCE, INC.**

A Subsidiary of S. H. Couch Company, Inc.

3 Arlington St., North Quincy 71, Mass. Tel.: (Boston) BLuehills 8-4147

CIRCLE 89 ON READER-SERVICE CARD



## LETTERS

### ASW: How To Meet The Challenge

Although our consulting group has been in the ASW field for nearly a decade, your article covered several developments we had not seen mentioned before. Your work in delineating the ASW field in such a thorough manner is appreciated.

In my opinion, careful consideration must be given to the division of responsibility in the Department of the Navy. For example, BuShips is responsible for sonar, and BuWeapons for fire control. Without perfect coordination and the freest flow of information, we will not get the perfect ASW system in the shortest possible time, at the lowest possible cost, when sonar is the detection means in an ASW fire control system. Perhaps joint responsibility is the answer, as demonstrated by BuShips and the AEC in the atomic submarine program.

Since we are committed for many years to come to supplying our bases overseas by water, we are forced to strengthen our ASW posture. It is discouraging and alarming to have to vote to be on the submarine in an ASW battle.

N. A. Denman -

Manager, Basic & Experimental Physics  
Engineering Services  
Falmouth, Mass.

► *The last line of the letter refers to a question the authors of the ASW article asked frequently: "In a battle between a submarine and an anti-submarine task force, would you rather be in the task force or in the submarine?" Unanimously, the answer was, "The sub."*

### From the Navy

You will appreciate the fact that I cannot comment on our technical advantages and disadvantages in the anti-submarine warfare field without immediately prejudicing classified information. In this technical connection I find the largest void in the article is its failure to mention the participation of the National Security Industrial Association in the ASW technical field.

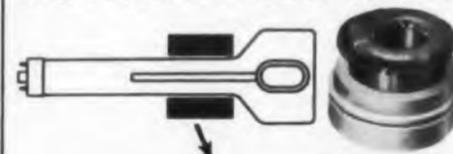
The Anti-Submarine Advisory Committee of the NSIA is composed of representatives of about 100 industrial concerns who study all phases of ASW technical problems. The chairman of the committee made the annual report to the Secretary of the Navy at a recent meeting of the Sec-



a spot is a spot  
is a high  
resolution spot  
with

## CELCO YOKES

- **Celco YOKES**  
keep spots **smallest**
- **Celco YOKES**  
keep spots **roundest**
- **Celco YOKES**  
keep spots **sharpest**



Use a **CELCO DEFLECTION YOKE** for  
your high resolution applications.

In a **DISPLAY SPOT?** call **Celco!**

**Celco**

Constantine Engineering  
Laboratories Co.

Main Plant: MAHWAH, N. J. DAvis 7-1123

• Pacific Division - Cucamonga, Calif. - YUkon 2-2688

CIRCLE 90 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 31, 1964

a measure of  
perfection...  
**IDEAL**  
**PRECISION**  
Panel Meters  
*the complete line  
for every application*



Here's the demand line that's setting sales records across the nation... engineered and produced to the highest standards... assembled in controlled atmospheric and climatic conditions... 100% inspected at every step of production to ensure highest quality and dependability.

- Accurate to within 2% of full scale
  - All sizes and types available
  - Scales to customers specifications
- For complete information, write to

**IDEAL**

**IDEAL PRECISION METER CO., INC.**  
214 Franklin Street, Brooklyn 22, N. Y.

Sold to Electronic Parts Distributors  
exclusively through

**WALDOM**

**WALDOM ELECTRONICS, INC.**  
4625 W. 53rd Street, Chicago 32, Ill.

CIRCLE 91 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 31, 1960

retary's ASW Committee. The report should be most beneficial in dissemination to industry of classified information concerning ASW technical problems.

The efforts of ELECTRONIC DESIGN and the resulting space devoted to the Anti-Submarine Warfare problem is appreciated. The broader awareness of ASW provided by the article is of course beneficial.

Adm. James S. Russell  
Vice Chief of Naval Operations  
Washington, D. C.

**Kudos**

My congratulations on the anti-submarine warfare article. It was a job well done and deserves commendation. We found much useful information in it.

George Kaufer  
Assistant to Vice President—Engineering  
Polarad Electronics Corp.  
New York City

We have passed your article on ASW around the shop. The general consensus here is that you have produced a first-rate wrap-up story on what is probably the Navy's greatest operational problem. Keep it up.

T. Leonard Mikules  
United States Naval Institute  
Annapolis, Md.

Having struggled ourselves with the problem of discussing this particularly sensitive subject without violating security regulations, we can fully appreciate your accomplishment in putting together such a useful story.

George G. Barker  
Technical Publicity Manager  
Raytheon Co.  
Waltham, Mass.

Congratulations on your fine article. Your handling of a very complicated subject through the novel approach of presenting it in the form of a proposal is to be commended. The sections outlining the needs for electronic design engineers' ideas, I thought, were particularly good.

I. R. Howland  
Manager, Advanced Radar &  
Countermeasures Engineering  
General Electric Co.  
Ithaca, N.Y.

The urgent problems facing this country in the anti-submarine defense areas cannot be over-emphasized. It was with great interest, therefore, that I read your recent ASW report. Its coverage and scope were indeed broad and its content informative.

Edward J. Garrett  
Loral Electronics Corp.  
New York City

(continued on p 96)

**SOLID STATE**  
*SMALLEST YET*  
**MICROCHOPPER**  
RUGGED • LOW POWER • HIGH SPEED • HIGH EFFICIENCY • THERMALLY STABLE • INDEFINITELY LONG LIFE  
MICROMINIATURE NONMECHANICAL INERTIALESS LINEAR

-55°C to +90°C



ACTUAL SIZE

The MICROCHOPPER is designed to alternately connect and disconnect a load from a signal source. It may also be used to convert a.c. signals to d.c. (as a synchronous demodulator). The MICROCHOPPER is capable of linearly switching or chopping voltages over a wide dynamic range extending from a fraction of a millivolt up to 10 volts. Having none of the inherent limitations of mechanical choppers, this transistorized chopper is an inertialess device that can be driven from d.c. to a hundred kilocycles.

The switching circuitry used operates the transistors in a manner which provides stability and freedom from drift over a wide temperature range. These units are practically immune to the effects of shock and vibration, making them ideal for military, space vehicle and portable applications; or where power conservation, miniaturization and elimination of maintenance is a necessity. The MICROCHOPPER has an inherently long life and is not subject to contact bounce, wear, pitting or arcing.

**TYPICAL OPERATION**

DRIVING VOLTAGE: Square wave — one to 15 volts peak-to-peak.  
DRIVING SOURCE RESISTANCE: 600 ohms.  
DRIVING INPUT RESISTANCE: 200 ohms.  
INPUT VOLTAGE: Dynamic range from fraction of a millivolt to  $\pm 10$  volts.  
SOURCE RESISTANCE:  $R_g$  less than 100 ohms for minimum noise. High impedance circuits require filtering to minimize electrostatic noise pickup.  
INPUT RESISTANCE: Approximately  $R_L$ .  
OUTPUT VOLTAGE: Equals chopped input voltage.  
OUTPUT RESISTANCE: Approximately  $R_g$ .  
LOAD RESISTANCE:  $R_L$  should be greater than 100 ohms for best operation.

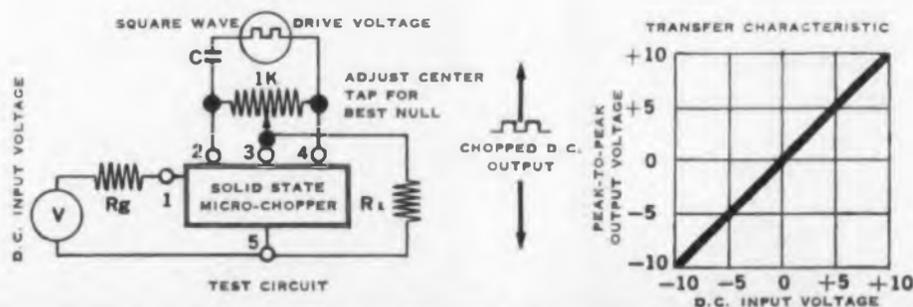
SIGNAL CURRENT: 100 milliamperes maximum.  
LINEARITY: Less than  $\pm 0.5\%$  deviation from best straight line.  
CHOPPING (DRIVING) FREQUENCY: D.C. to 100 kilocycles per second or higher.  
OPERATING TEMPERATURE: -55°C. to +90°C.  
OUTPUT TEMPERATURE COEFFICIENT: Nominal five microvolts rms per degree centigrade at 5 millivolts rms, 400 cps output signal.  
OUTPUT NOISE: Approximately 20 microvolts rms or less for following combinations of maximum values for  $R_g$  and  $R_L$  in ohms.

$R_g$	.1K	.5K	.6K	.8K	1M	infinite
$R_L$	infinite	100K	10K	1K	.1K	.01K

**MECHANICAL**

DIMENSIONS: .38" x .16" Dia. / WEIGHT: 1/2 gram / ENCAPSULATION: Solid embedment in epoxy resin / SHOCK: 7000 G, no detectable effect / VIBRATION: 125 G, zero to 3000 cps / ACCELERATION: 12,000 G / LIFE: Unlimited at 25°C / HUMIDITY: To 100% relative humidity up to 90°C. Also under varying conditions of water and frost condensation / CONNECTIONS: 1. D.C. input; 3. Chopped output; 2. and 4. Drive voltage; 5. Common for input and output.

**ELECTRONIC**



Write or phone for bulletins describing the above unit

**SOLID STATE** ELECTRONICS CO.  
15321 Rayen Street, Sepulveda, California  
EMpire 4-2271

CIRCLE 92 ON READER-SERVICE CARD



# WESTINGHOUSE ANNOUNCES

Westinghouse

SILICON POWER  
RECTIFIERS  
AND  
TRANSISTORS

**NOW IN STOCK**

YOU CAN OBTAIN  
UP TO 1000 PIECES  
OF MOST TYPES  
AT  
FACTORY PRICES  
FROM

# Schweber

**ELECTRONICS**

60 HERRICKS ROAD,

MINEOLA, L. I., N. Y.

PIONEER 6-6520.

TWX G-CY-NY-580U



CIRCLE 93 ON READER-SERVICE CARD

ELECT

# 50 AMP "ROCK-TOP" TRINISTOR CONTROLLED RECTIFIER

PROVIDES MULTI-FUNCTIONAL CONTROL OF CURRENTS AND VOLTAGES  
WITH FAST SWITCHING TIME AND RESPONSE RATE

New Westinghouse Trinistor 'Rock-Top' construction provides high reliability, low maintenance, and positive protection against arcing at high voltages. Design engineers will find the improved electrical characteristics, listed below, can be used to advantage in a wide range of new control and switching applications.

- Lower Thermal Impedance
- Switching time 600 millimicroseconds
- Efficiencies in excess of 95%
- Simplifies circuitry
- Lower forward drop than thyratrons
- Minimum noise levels
- Parameters ideally suited for high-speed static switch functions
- Peak reverse voltage 60-360 volts

For full information or engineering assistance,  
contact your local Westinghouse representative, or write:  
Westinghouse Electric Corporation, Semiconductor Dept., Youngwood, Pa.

INDUSTRIAL, MILITARY, AND COMMERCIAL APPLICATIONS INCLUDE:  
CONVERTERS / VARIABLE FREQUENCY CONTROLS / MOTOR CONTROL /  
VOLTAGE REGULATION / REPLACEMENT OF MAGNETIC AMPLIFIERS / HIGH  
POWER MODULATION / INVERTERS / REPLACEMENT OF THYRATRONS

YOU CAN BE SURE...IF IT'S **Westinghouse**

SC-4111

CIRCLE 94 ON READER-SERVICE CARD



**Westinghouse**

SILICON POWER  
RECTIFIERS  
AND  
TRANSISTORS

**NOW IN STOCK**

YOU CAN OBTAIN  
UP TO 1000 PIECES  
OF MOST TYPES  
AT  
FACTORY PRICES  
FROM

**Schweber**  
**ELECTRONICS**

60 HERRICKS ROAD

MINEOLA, L. I., N. Y.

PIONEER 6-6520

TWX G-CY-NY-580U



CIRCLE 95 ON READER-SERVICE CARD

### PROBLEM:

Cramped for space and need BOTH INDICATOR LITES and SWITCHES?



### SOLUTION:

Use TEC-LITE BUTTON LITES...

combination switch and lite units that also may be wired as push-to-test lites. Recommended for computers, data processors, control and signal systems. Mount on 9/16" centers. 1/2" diameter body. Either incandescent or neon, with series current limiting resistor if desired. Available with normally open or normally closed switch contacts.



SWITCH LIFE: 500,000 operations min. @ 1/10 amp.

Write for new TEC MBL series catalog sheet and prices.



Transistor Electronics Corporation

3357 REPUBLIC AVENUE MINNEAPOLIS 26, MINNESOTA

CIRCLE 96 ON READER-SERVICE CARD

## NEW line of STANDARD PLASTI-GROMMETS

CUTS FASTENING COSTS



GET THE FACTS—SEND FOR THIS TIMELY BOOKLET!

Using Fastex Plasti-Grommets to mount license plates demonstrates their use in blind applications, just one of their unique solutions to individual or mass-production fastening problems. They snap into place easily, lock tight when the screw is driven.

### FASTEX

A DIVISION OF ILLINOIS TOOL WORKS  
195 Algonquin Road, Des Plaines, Illinois  
In Canada: SHAKEPROOF/FASTEX  
Division of Canada Illinois Tools Ltd.,  
Don Mills, Ontario



CIRCLE 97 ON READER-SERVICE CARD

## LETTERS

(Continued from p 93)

### From the Senate

My reaction to the article on anti-submarine warfare is that it is informative and timely. On the Senate floor, during the debate on the Defense Appropriations bill, I again urged greater emphasis on anti-submarine warfare capability. The following is quoted from my Senate statement:

"Anti-submarine warfare capability should be increased on a high-priority basis.

"I recommend an increase of \$465 million over and above the budget request for building up our capability in this field, and introduce an amendment for that purpose.

"This money would provide additional attack submarines, specialized aircraft, sonobuoys, torpedoes, mines, depth charges, and a wide range of electronic equipment."

Stuart Symington  
United States Senator

### Sonar Is the Key

Those of us involved in helping to solve the ASW problem feel that one reason the problem exists is that very little money and effort have been put into its solution. "Very little" is used in a relative sense as compared to the kind of money that has developed radar to its present state and has given the warning networks which exist today.

We also feel that the solution rests in sonar and not in the many so-called "unsound" methods which are being pursued. There has been a lot of wishful thinking that someone will come up with a magic device which will make the oceans of the world transparent. Our feeling is that the best results will be obtained by developing the only known method of finding a submerged submarine—sonar.

A. M. Brown  
Vice President, Edo Corp.  
New York City

### Naming the ASW Officer

The Anti-Submarine Warfare problem deserves the attention you focused on it. The urgency of the situation may be even more clearly underlined by what we do not know of the Russian submarine development program.

Well-written and informative from beginning to end, your entire "ASW—Designers' Challenge" was adequately spiced and, at the same time, driven home by the item titled, "We Need More and Better Information."



Sizes	Height	Width
8-32, 8-36	500	1.031
10-24, 10-32	500	1.031
12-24, 12-28	546	1.125
1/4-20, 1/4-28	594	1.250
3/8-18	718	1.500
3/8-16, 3/8-24	718	1.500

# ESNA

## SELF-LOCKING WING NUTS with nylon inserts are VIBRATION-PROOF... PRECISELY ADJUSTABLE

The famous ESNA red nylon locking insert gives smooth, consistent locking torque in any position on bolt or stud. Cannot be loosened by vibration, yet is easily adjustable by finger pressure. Gives same dependable locking torque through repeated on-off usage. For full information write Dept. S51-857, Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey.



ELASTIC STOP NUT CORPORATION OF AMERICA

CIRCLE 98 ON READER-SERVICE CARD

# Lepel

## HIGH FREQUENCY INDUCTION HEATING EQUIPMENT

For Hardening • Annealing • Soldering  
Brazing • Zone Refining • Crystal Growing



ELECTRONIC TUBE GENERATORS:  
1 kw; 2 1/2 kw; 5 kw; 10 kw;  
20 kw; 30 kw; 50 kw;  
75 kw; 100 kw.

SPARK GAP CONVERTERS:  
2 kw; 4 kw; 7 1/2 kw;  
15 kw; 30 kw.

WRITE FOR THE NEW LEPEL CATALOG 36 illustrated pages of valuable information.

## Lepel HIGH FREQUENCY LABORATORIES, INC.

55th ST. & 37th AVE., WOODSIDE 77, N. Y.

CIRCLE 99 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 31, 1960

Specify  
**SPERRY**  
 for  
**2N327A**  
**2N328A**  
**2N329A**  
**2N330A**  
 SILICON  
 PNP TRANSISTORS

New low levels of  $I_{CO}$ ;  
 baked at 200°C for  
 200 hours for  
 utmost stability.

Specify Sperry through  
**AVNET**  
 exclusive Sperry  
 Distributor East of the  
 Rockies.  
 Factory Prices, for  
 quantities 1-999

Call your  
 Avnet  
 Applications  
 Engineer

For dependable service



and immediate delivery  
**AVNET**

AVNET-70 State St., Westbury, N.Y. - ED 3-5800  
 AVNET-45 Winn St., Burlington, Mass. - BR 2-3060  
 AVNET-4180 Kettering Blvd., Dayton 39, Ohio - AX 8-1458  
 AVNET-2728 N. Mannheim Rd., Melrose Park, Ill. - GL 5-8160

CIRCLE 103 ON READER-SERVICE CARD  
 ELECTRONIC DESIGN • August 31, 1960

It would be interesting to know the identity of the "ASW officer" who speaks with authority on a topic too frequently obscure to the design engineer. Are his views based on post-World War II experience in the ASW field?

Arthur S. Kramer  
 Staff Engineer  
 Grumman Aircraft Corp.  
 Bethpage, N. Y.

► The officer referred to in "An ASW Officer Speaks" is Robert Shaw, currently with DuMont, a division of Fairchild Camera and Instrument Corp. Mr. Shaw spent 11 years with the fleet in ASW operations. This included time spent in actual ASW problems during the World War II, simulated submarine attacks with the latest post-war equipment available, and a tour of duty as Sonar Project Officer at the Surface Anti-Submarine Detachment in Key West evaluating new electronic ASW equipment.

### Inhale! Exhale!

In the otherwise fine article on speech making ("So You've Got to Make a Speech," ED, June 8, p 166) there are two points I would like to comment on.

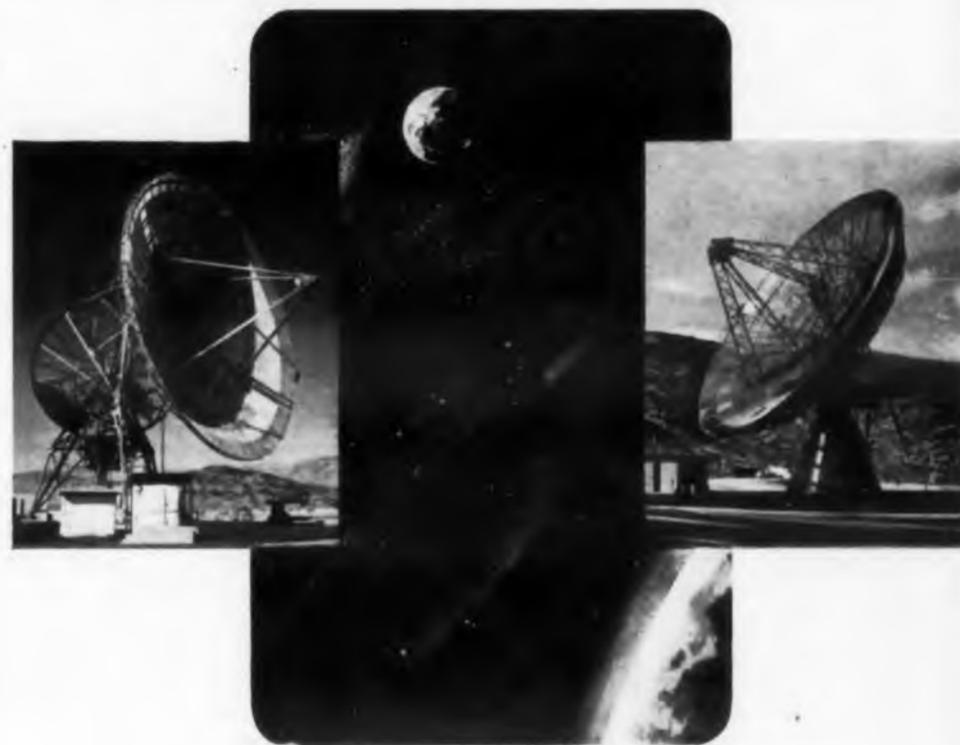
Although it was widely reported in the press at the time that the American hockey team was helped by inhaling oxygen at Squaw Valley, it is doubtful if it really accounted for their victory. In the first place, the body does not store oxygen for any appreciable length of time, especially during violent activity. The most convincing argument against the efficacy of oxygen inhalation is that another team (Canada's, I believe) inhaled from what they believed were tanks of oxygen prior to a game which they subsequently won. Later it was revealed that the valves to the oxygen tanks had never been opened and the team members had actually inhaled air. A compliment to the clean air of the Sierra Nevada perhaps, but not to O<sub>2</sub>.

The second comment is more of an opinion. Breathing deeply 10 or 15 times before delivering a speech is more likely to induce dizziness than clarity, at least in my experience.

Following the Olympics of 1932, held in Los Angeles, the victory of the Japanese swimmers was attributed to their use of oxygen before each event. As in the case of the American hockey team, I believe that the effects were more psychological than physiological, the Japanese being motivated—as was, probably, our hockey team—by nationalistic fervor and the good athlete's desire to win.

Richard G. Gould  
 Menlo Park, Calif.

## LUNAR and PLANETARY COMMUNICATION



### SENIOR RESEARCH SPECIALISTS

New opportunities involving advanced research and development projects are now open at JPL in the Laboratory's Telecommunications Division for engineers and scientists capable of assuming a high level of technical responsibility.

#### SOME SPECIFIC OPENINGS IMMEDIATELY AVAILABLE

##### Communication Specialists

Execution of RF tracking and communication system projects.

##### Radio Research Engineers

Design of advanced RF transmitter / receiver equipment.

##### Antenna Specialists

Analysis, design and evaluation of giant Antenna Structures and Servo Systems.

##### Research Scientists

Digital data and control system analysis and synthesis.

##### Mathematicians or Communication System Analysts

Analog and Digital system analysis.  
 Noise, coding, information theory.  
 Linear and non-linear filter theory.

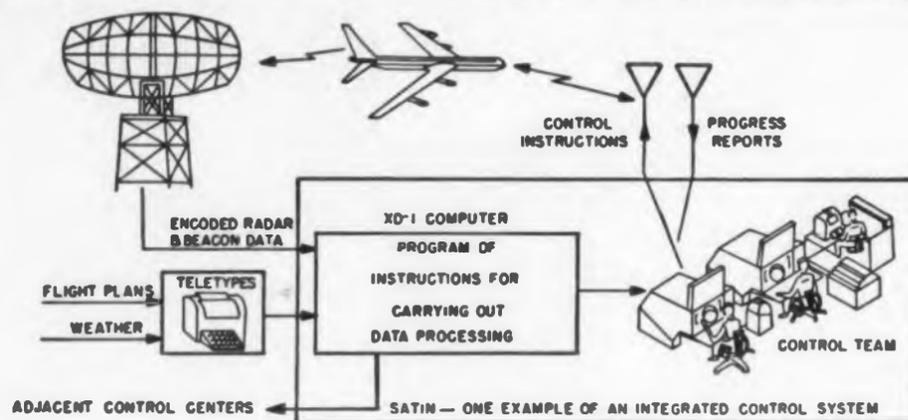
Several openings also exist for supervisors of Research and Advanced Development Projects performed by industry for JPL.



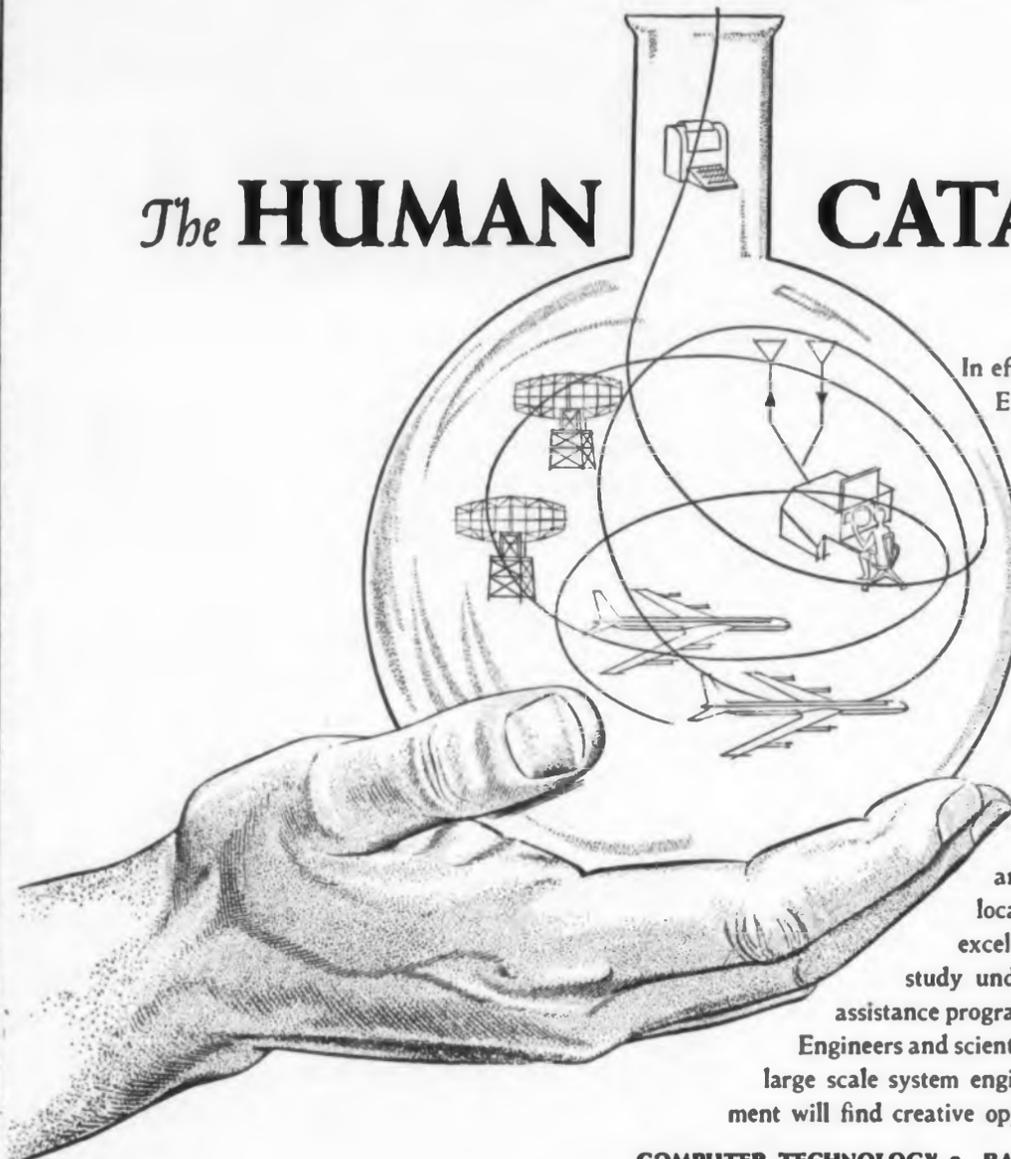
CALIFORNIA INSTITUTE OF TECHNOLOGY

**JET PROPULSION LABORATORY**  
 PASADENA • CALIFORNIA

SEND COMPLETE QUALIFICATION RESUME NOW FOR IMMEDIATE CONSIDERATION  
 CIRCLE 902 ON CAREER INQUIRY FORM, PAGE 99

ENGINEERS  
SCIENTISTS

## The HUMAN CATALYST



In effect, this is the role of the System Engineer at MITRE.

His technical competence and objectivity must maximize the effectiveness of complex interacting communications networks, radar systems, digital computers and countermeasures. The end result must be an integrated command and control system.

MITRE, a system engineering organization, is engaged in the design, development and evaluation of large scale command and control systems. Its convenient location in suburban Boston offers excellent opportunities for advanced study under MITRE's liberal educational assistance program.

Engineers and scientists with an interest in combining large scale system engineering with electronic development will find creative opportunities with MITRE in:

- COMPUTER TECHNOLOGY • RADAR SYSTEM DEVELOPMENT •
- AIR TRAFFIC CONTROL SYSTEM DEVELOPMENT • HUMAN FACTORS •
- ADVANCED SYSTEM DESIGN • COMMUNICATION SYSTEMS •
- OPERATIONS RESEARCH • ELECTRONICS COUNTERMEASURES •

Inquiries may be directed in confidence to:

VICE PRESIDENT — TECHNICAL OPERATIONS

THE  
**MITRE**  
CORPORATION

Post Office Box 31, 15-AV — Lexington, Massachusetts

## YOUR CAREER ENGINEER-IMPROVEMENT COURSES AND SEMINARS

Below are courses and seminars intended to provide the engineer with a better knowledge of various specialties. Our grouping includes several different types of meetings: National Courses—those held on consecutive days and intended to draw attendees from all geographical areas; One-Day Seminars—one-day intensive seminars which move from city to city; and Regional Lectures—regional symposia or lecture series which generally run one night a week for several weeks.

### National Courses

#### Vibration Testing Course

The fourth in a recurring series of courses on vibration testing is being offered space age engineers from Sept. 12 to Sept. 23 by Ling Electronics, a division of Ling-Altec Electronics, Inc., at the company's Anaheim, Calif., plant.

According to Cameron G. Pierce, president of Ling Electronics, the course covers sine, complex and random wave vibration in theory and practice.

Moderator of the session will be John C. Jordan, research engineer for Ling and a graduate of the Georgia Institute of Technology.

Technical information presented in the course will include the most recent and pertinent data derived from the developments and papers of Pierce, Charles Theodore, vice president, marketing, James A. Ross, vice president research and development, and many other experts.

For further information write "Study in Vibrations Registrar," Ling Electronics Division, Ling-Altec Electronics, Inc., 1515 S. Manchester Ave., Anaheim, Calif.

#### Stevens Industries Training School

Industrial employees who wish to add to their knowledge of electrical technology, machine and tool designing, production supervision may do so at the Stevens Industries Training School during the fall semester which starts on Wednesday, Sept. 20.

Highlighting the course sequences offered during the fall and spring semesters are: Manufacturing Processes—Manufacturing Planning; Plastic Product Design—Plastic Mold Design; Instruction Techniques—Effective Speaking; Properties of Metals—Welding Processes; Human Relations I—Human Relations II; and Industrial Organization—Industrial Economics.

Courses are taught in the evening by members of the Stevens Institute of Technology faculty and by experts from nearby industries. Further

ELECTRONIC DESIGN **CAREER INQUIRY SERVICE**

USE BEFORE OCT. 12, 1960

After completing, mail career form to *ELECTRONIC DESIGN*, 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below.

18

(Please print with a soft pencil or type.)

Name \_\_\_\_\_ Telephone \_\_\_\_\_

Home Address \_\_\_\_\_ City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

Date of Birth \_\_\_\_\_ Place of Birth \_\_\_\_\_ Citizenship \_\_\_\_\_

Position Desired \_\_\_\_\_

**Educational History**

College	Dates	Degree	Major	Honors

Recent Special Training \_\_\_\_\_

**Employment History**

Company	City and State	Dates	Title	Engineering Specialty

Outstanding Engineering and Administrative Experience \_\_\_\_\_

Professional Societies \_\_\_\_\_

Published Articles \_\_\_\_\_

Minimum Salary Requirements (Optional) \_\_\_\_\_

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924  
925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949

# Advancement Your Goal? Use CONFIDENTIAL Action Form

*ELECTRONIC DESIGN's* Confidential Career Inquiry Service helps engineers "sell" themselves to employers—as confidentially and discreetly as they would do in person. The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

*ELECTRONIC DESIGN* will act as your secretary, type neat duplicates of your application and send them to all companies you select—the same day the resume is received.

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

All forms are delivered unopened to one reliable specialist at *ELECTRONIC DESIGN*.

Your form is kept confidential and is processed only by this specialist.

The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.

All original applications are placed in confidential files at *ELECTRONIC DESIGN*, and after a reasonable lapse of time, they are destroyed.

If you are seeking a new job, act now!

R  
ENT  
ARS  
nars in-  
eer w th  
ous spe-  
des sev-  
neetin:is  
held on  
nded to  
raphical  
one-day  
ve from  
Lectures  
re series  
night a  
urses on  
ge engi-  
ng Elec-  
ics, Inc.,  
ident of  
complex  
nd prac-  
John C.  
a grad-  
logy.  
e course  
ent data  
apers of  
market-  
arch and  
in Vibra-  
on, Ling-  
ster Ave.  
d to their  
hine and  
may do so  
ol during  
ednesday  
s offer  
e: Manu  
Planning  
esign; In  
ng; Prog  
uman Re  
Industria  
member  
y facult  
s. Furthe  
1, 196



## Bringing to life the principles of magnetic printing



This little hand-cranked model makes practical use of the principles of magnetic printing—principles that have been known in theory for more than a hundred years.

The model represents a big jump from theory to practice. It was developed and built by a group of IBM engineers and scientists brought together for the sole purpose of proving or disproving the feasibility of the magnetic printing process.

These IBM researchers discovered a way to "write" characters on a rotating nickel-cobalt plated drum by casting a magnetic dot image on the drum with time-sequenced electronic pulses. The latent magnetic image attracts and holds powdered iron-resin ink. The ink is transferred to paper and permanently bonded by passage through a heat and pressure fix station.

The machine at left has a working speed of 125 inches per second—equivalent to 1,000 cards a minute. It can be operated for sus-

tained periods at 160 inches per second. A full parallel printer based on these principles is capable of producing many times the output of the fastest IBM impact-type printer.

### Engineering Achievement

The magnetic printer project is typical of the many opportunities for achievement awaiting engineers and scientists in advanced systems development at IBM. Perhaps you might be more interested in what IBM people are doing in such areas as: semiconductors, Teleprocessing\*, computer development, optics or others. If you have an engineering degree and would like to learn more about these assignments, write, outlining briefly your experience and field of interest, to:

Manager of Technical Employment  
IBM Corporation, Dept. 555T5  
590 Madison Avenue  
New York 22, New York

\*Trademark

**IBM**

INTERNATIONAL BUSINESS MACHINES CORPORATION

## ELECTRONIC DESIGN'S

Career Inquiry Form:

Your Personal Representative



"I like to select my applicants through ELECTRONIC DESIGN'S Resume Form—it saves time. Because of its completeness, I am able to match the applicants' total needs with the many opportunities at General Mills." . . .

. . . says Mr. Graham Lambert, Personnel Manager of General Mills' Mechanical Division.

Personnel Managers throughout the electronic industry are voicing favorable comments about ELECTRONIC DESIGN'S Career Inquiry Service. They've found that it saves precious time, and allows them to get in touch with you sooner.

Why not take advantage of this convenient, time-saving form, and let it serve as your personal representative to the companies of your choice.

## CAREER COURSES

information may be obtained by contacting the Industries Training School office at Castle Point Station, Hoboken, N.J.

### Seminar on Creative Action

Methods of achieving "scientific creativity" in large-scale organizations will come under intensive study at a seminar for administrators of scientific and engineering functions to be held at Syracuse University's Minnowbrook Conference Center Sept. 11-17.

The Seminar on Creative Action in Large-Scale Organizations will bring together managers of research institutes, training programs, engineering services, product development, development laboratories and engineering laboratories to explore some of the problems of human relations within large organizations.

Faculty for the seminar will include: William W. Bender, Director, Research Institute for Advanced Science (RIAS); Dr. Donald W. Taylor, Professor of Psychology and Personnel Administration, School of Engineering, Yale University; Dr. Joseph Tussman, Professor of Philosophy, Syracuse University.

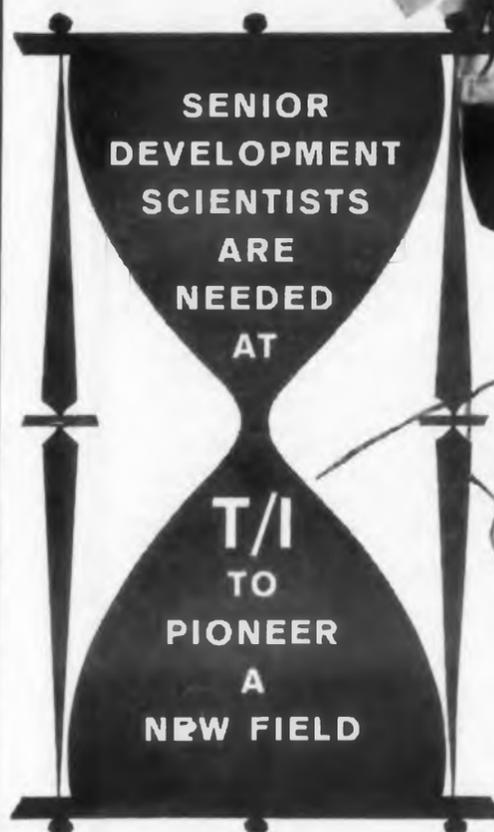
Resident faculty for the seminar will be: Dr. Paul Meadow, Professor of Sociology and Chairman of the Department of Sociology and Anthropology, Syracuse University and Warner Bloomberg, Jr., Assistant Professor of Sociology, Syracuse University. The program is being offered under the direction of University College, the adult education division of Syracuse University.

### One-Day Seminars

**The Industrial Education Institute, Aug. 30-Sept. 29**

The Industrial Education Institute of Boston, Mass., is presenting a one-day seminar on Measuring and Improving the Effectiveness of the Maintenance Department. The seminar schedule is as follows: Montreal (Hotel Sheraton-Mt. Royal)—Aug. 30; Toronto (Hotel Westbury)—Sept. 19; Detroit (Hotel Sheraton-Cadillac)—Sept. 20; Cleveland (Hotel Pick-Carter)—Sept. 22; Chicago (Hotel Sheraton-Gibson)—Sept. 27; St. Louis (Hotel Sheraton-Jefferson)—Sept. 29.

The seminar will be conducted by George J. Martin, president. The registration fee, which includes attendance, luncheon, coffee break, necessary supplies and a complete package of reference material, is \$50 per man. A 10-percent Team Discount is extended to companies having three or more men attend. For further information write Industrial Education Institute, 221 Columbus Ave., Boston 16, Mass.



**THE GOAL** is microelectronics. **THE PROBLEM** is to provide microminiature circuits which are more reliable...smaller in size...lighter in weight...lower in cost...than conventional components. **THE SOLUTION** is *Solid Circuit\** semiconductor networks—a new and rapidly expanding field at Texas Instruments.

This wide-ranging project—the opening of a true frontier—requires continuing and new investigations. Explorations involve such techniques as solid state diffusion, alloying of metals and semiconductors, vacuum deposition of metals, semiconductor surface chemistry, solid state physical measurements. Immediate creative application of skills in various sciences is required: solid state physics, physical chemistry, inorganic chemistry, metallurgy, electronics, and mechanical engineering.

The need is for the scientist or engineer sufficiently experienced that he can explore this project from his own viewpoint and make immediate, significant contribution. Depending entirely on his own qualifications, he may either join a semiconductor network team—or he may take charge of such a group. The opportunity for leadership—whether immediate or in the future—is here.

The desire to see the full semiconductor technology...curiosity concerning both circuits and devices...the ability to direct and inspire...these drives will advance the scientist at TI.

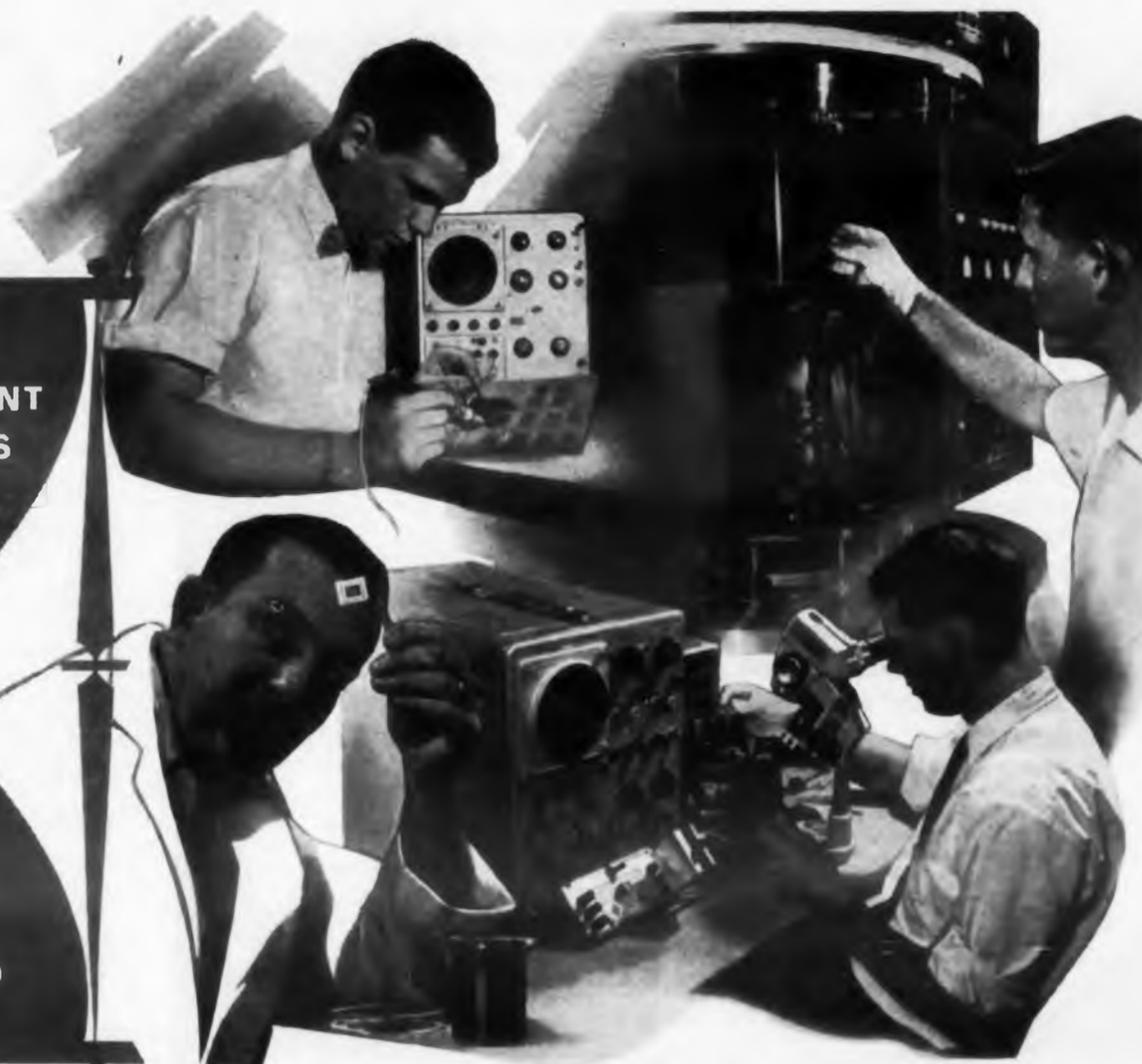
\*Trademark of Texas Instruments Incorporated.

**INTERVIEWS** are scheduled for your area. If the challenge and opportunity of the semiconductor network field at TI intrigues you, please send a confidential resume immediately to C. A. BESIO, Dept. 126.



**TEXAS INSTRUMENTS**  
INCORPORATED

SEMICONDUCTOR - COMPONENTS DIVISION  
POST OFFICE BOX 312 • DALLAS, TEXAS



This—in actual size—is an interconnected stack of 11 semiconductor networks. *Solid Circuit* semiconductor networks are complete electronic circuits synthesized within a semiconductor material. By selectively diffusing and shaping conductance paths in this material, semiconductor networks have been designed to perform such circuit functions as amplification, switching, counting, pulse generation, etc. In addition to effecting a significant advance in microelectronics, semiconductor networks provide improved reliability and performance. This TI development is now producing devices which are being evaluated for satellite, missile and airborne applications.



**TEXAS INSTRUMENTS INCORPORATED**  
Semiconductor-Components Division  
Box 312, Dept. 126, Dallas, Texas

Please send me the booklet *TIPS* containing details on career openings in my field at TI S-C and information on living in Dallas.

NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ STATE \_\_\_\_\_  
My professional field is \_\_\_\_\_  
My specialty is \_\_\_\_\_

CIRCLE 905 ON CAREER INQUIRY FORM

EE, ME, or Physics; BS, MS, Doctoral Degrees

*A Unique Career Spot*

## Investigate New Positions

IN ADVANCED DEVELOPMENT  
AND PRODUCT ENGINEERING

- ▶ **Thermoplastic Recording\***
- ▶ **Electronic Visual Amplifiers\***

for Large Screen, High Brightness, High Resolution,  
Information Display Systems

- ▶ High Power AM, FM, Short Wave, TV (VHF-UHF) & Scatter Transmitters
- ▶ TV Studio Equipment — Monochrome & Color
- ▶ TV & AM Station Audio Equipment
- ▶ UHF, VHF, & Microwave Antennas  
Transmission Line Systems, Studio TV Transmitter Link Equipment
- ▶ Educational TV, Industrial TV

### GENERAL ELECTRIC'S TECHNICAL PRODUCTS OPERATION

...the "hatching place" of new commercial and military products in fields of

### BROADCASTING • CLOSED CIRCUIT TV • SPECIAL VIDEO & DISPLAY

BS or Advanced degrees plus experience in one of the following areas

- A. Geometric, Physical & Electron Optics
- B. Circuit Design (Semiconductor & Tubed)
- C. Mechanical design of products involving complex precision mechanisms,  
vacuum systems, optics, thermodynamics.

*\*Descriptive literature sent on request.*

Write in full confidence to: N. C. Murray, Engineering Sect. 76-M1

TECHNICAL PRODUCTS OPERATION

**GENERAL ELECTRIC**

Electronics Park, Room 215, Bldg. 7, Syracuse, New York

CIRCLE 900 ON CAREER INQUIRY FORM

## GROW

WITH THE FIRM THAT  
PIONEERS in PRECISION



Advanced Data Handling

## ENGINEERS

With Systems Background

### GROWTH OPPORTUNITIES

... await qualified senior level engineers to assist L & N's able staff in the development and engineering of LN3000 Computer Control Systems for Industrial Processes in the Power, Petro-chemical, Steel and Ceramic industries. B.S. or M.S., preferably in E.E. required PLUS several years' design & development experience on data handling circuits incorporating digital computer techniques.

Send Resume to WAYNE L. BESSELMAN, Coordinator Technical Employment

Pioneers in Precision ...

**LEEDS**



**NORTHRUP**

Instruments • Automatic Controls • Furnaces

4901 Stenton Avenue Philadelphia 44, Pa.

CIRCLE 906 ON CAREER INQUIRY FORM



## OPENINGS IN

*Systems Analysis  
Design & Development  
Evaluation*

### Systems Analysis

Weapons Systems analysts with BS or MS in mathematics or physics, or BSEE, to work on weapons system and component lethality, evaluations, optimization studies, feasibility studies, and concept synthesis. Also a BSEE or MSEE with a minimum of 3 years in electronic systems with emphasis on remote control, data handling, signal processing.

### Design and Development

A number of openings now exist for experienced design and development engineers with the following qualifications:

BSEE or MSEE, minimum 3 years experience in any of these fields: Solid state circuit design, including amplifiers and switching circuitry; RF techniques, including circuit design; antenna design, propagation studies, modulation techniques. Signal processing and data handling, including techniques for encoding, decoding, storage, digital data processing, display, system integration. Also: openings for BSEE with minimum one year in synthesis servo analysis or servo application.

### Evaluation

BSEE. Prefer 1-8 years in test, design, or related areas. Work involves testing specific unit systems, parts, or materials. May involve designing and building non-standard testing equipment; field or simulated field testing; tests on production instruments.

*All above openings are in Minneapolis area. For complete information, write Allan J. McInnis, Professional Manpower Staff, Ordnance Division, Honeywell, 600 Second St. North, Hopkins, Minn.*

## Honeywell



*Military Products Group*

*To explore professional opportunities in other Honeywell operations, coast to coast, send your application in confidence to H. D. Eckstrom, Honeywell, Minneapolis 8, Minn.*

CIRCLE 907 ON CAREER INQUIRY FORM

## ELECTRONICS JOBS

**\$6,000 to \$75,000**

**Still Go Begging**

Cadillac, the nation's largest executive & professional placement service represents every "Blue Chip" electronics firm in America—over 450 in all. Cadillac can offer you positions unequalled by any other firm.

### OUR SERVICE FREE OF CHARGE

Our completely confidential placement service is available to you absolutely FREE OF CHARGE. At Cadillac, Electronic Engineers don't receive the "fast shuffle" prevalent in small placement firms. The Electronics Division staff of eleven experienced counsellors is ready to serve you in analyzing the hundreds of available positions.

### FREE MONTHLY JOB SURVEY

Our monthly listing of top electronics positions is free to any Electronics Engineer. For your free survey, send your name and home address to:

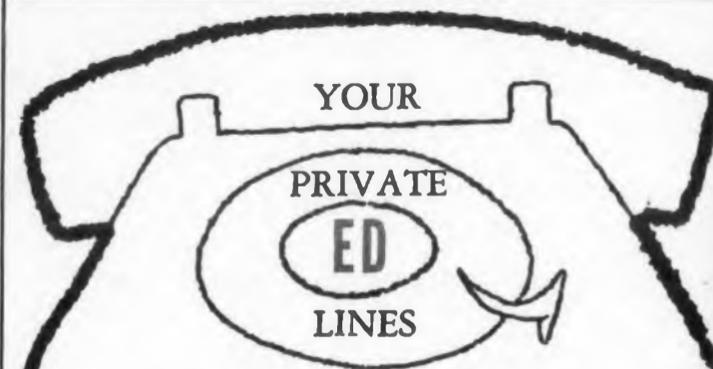


J. L. Higgins, Manager  
Electronics Division

**Cadillac  
Associates, Inc.**

29 E. Madison Bldg. Chicago 2, Ill.  
Financial 6-9400

CIRCLE 872 ON READER-SERVICE CARD



When employment information is obtained through **ELECTRONIC DESIGN**, it's sent direct to your home, so that only you and one prospective employer at a time know about it. You can conduct your employment campaign privately—as it should be conducted.

This is why every Reader Service Card reserves a line for your home address, and why circled numbers are detached from Career Inquiry Service Forms sent to companies.

You can apply for many jobs simultaneously . . . only *you* will know how many.

Use the Career Inquiry Service Form, and the Reader Service Card when job hunting. They're your *private lines* to employment opportunities . . . another service for you from **ELECTRONIC DESIGN**.

ELECTRONIC DESIGN • August 31, 1960

**PAGES  
MISSING  
ARE NOT  
AVAILABLE**