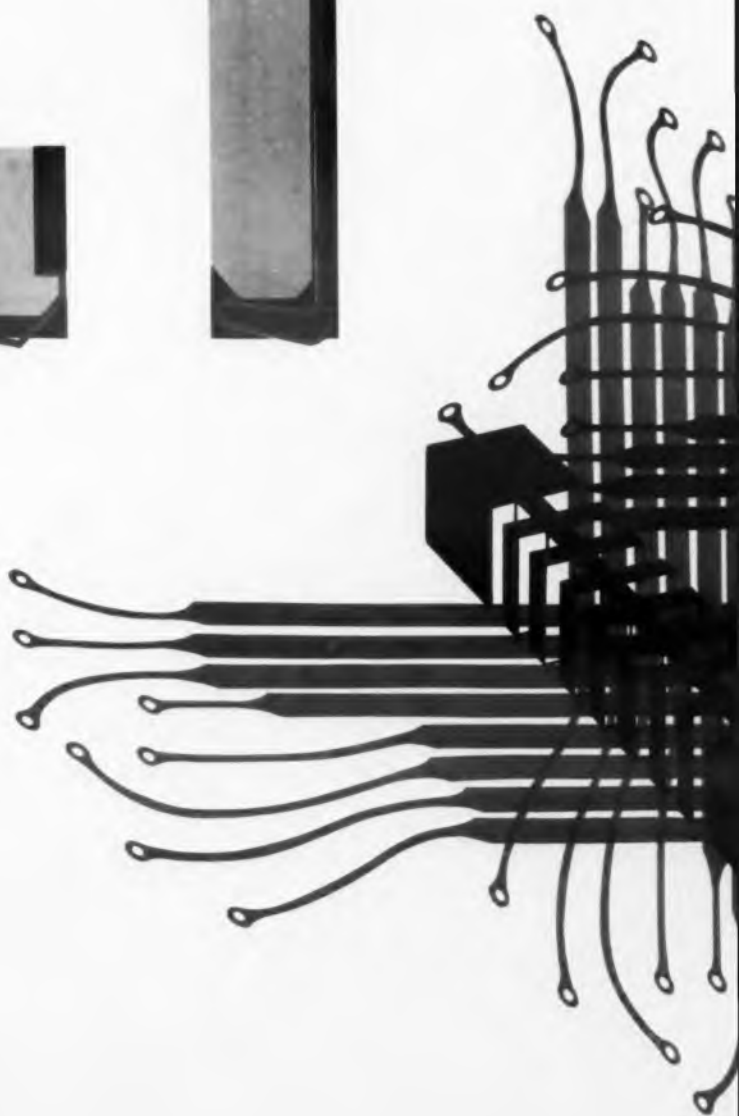
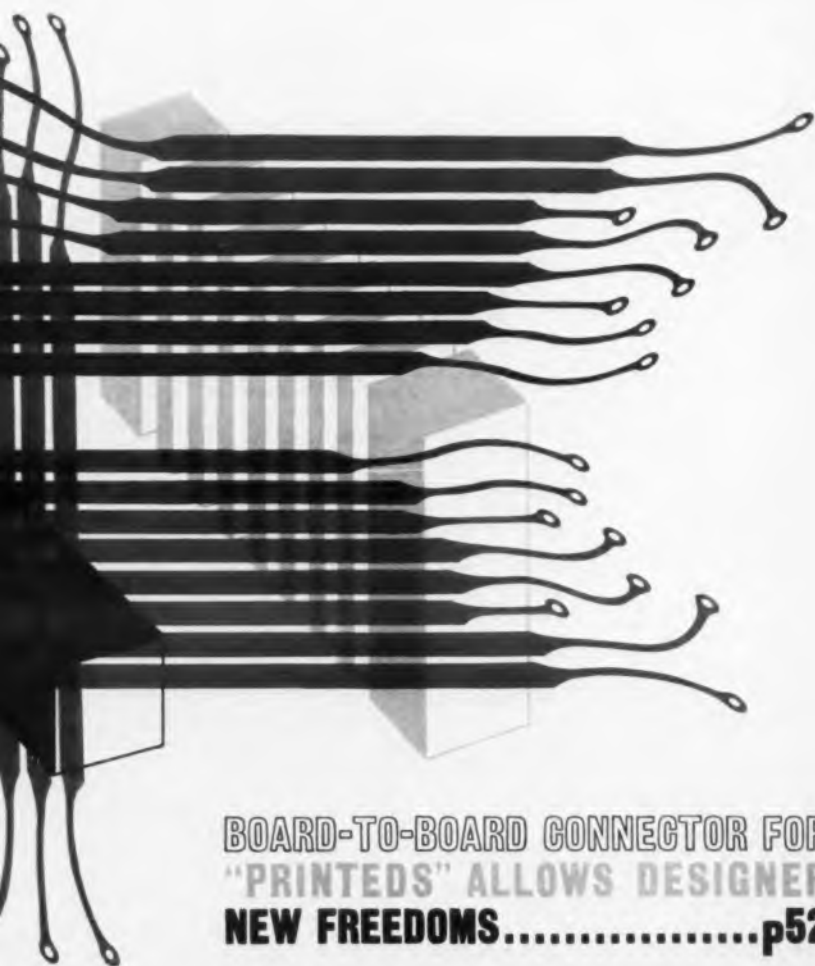


# ELECT D



# RONIC ESIGN



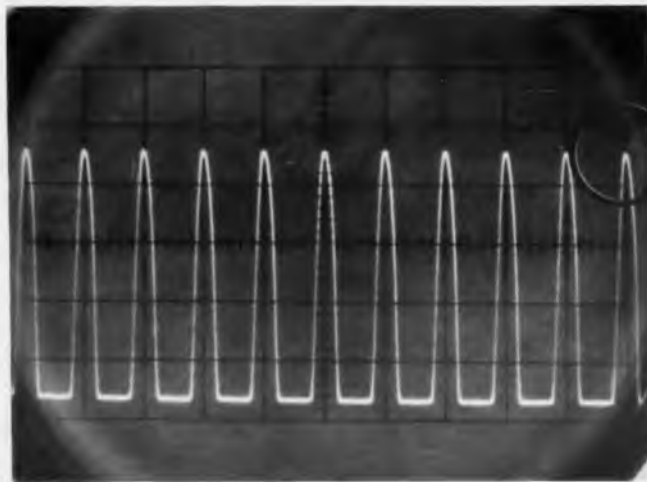
BOARD-TO-BOARD CONNECTOR FOR  
"PRINTEDS" ALLOWS DESIGNER  
NEW FREEDOMS.....p52



*New standard of oscilloscope reading accuracy*

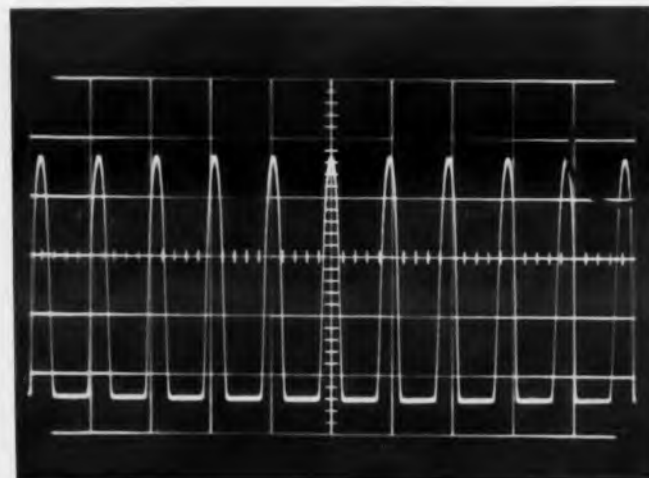
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Perfectly linear signal reads perfectly. Each wave peak appears, and is, precisely on proper graticule line.



### **ERROR-PRONE OLD WAY!**

Identical signal on old-type cathode ray tube. Note apparent non-linearity caused by scope face parallax!

*Turn the page*

*to see how  
**hp** does it...  
and read about  
the versatile new  
**hp** 120B 450 KC  
oscilloscope*





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# New, no-parallax **hp** 12 easiest-to-use, surest- reading, 450 KC oscilloscope!



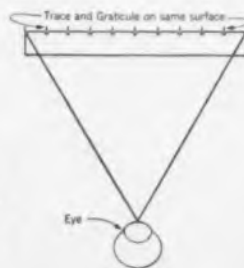
HERE'S

HOW



DOES

IT!

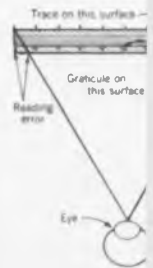


NEW WAY!

Exclusive **hp** development scribes calibrating graticule in identical inside plane with trace. No layers of glass, filter or plastic optically alter perfect reading. What you see —IS! Parallax is eliminated at last!

OLD WAY!

Conventional oscilloscopes have calibrating graticule a full 1/4 inch in front of trace. Between are optically confusing plastic graticule body, filter, and CRT envelope end. Parallax is inescapable; errors up to 5% are possible.



LIFT PAGE

# 120B...

This new  $\Phi$  120B Oscilloscope combines probably more actual measuring help and desirable features than any 450 KC scope ever produced.

Not only is reading error from parallax ended and not only are distracting reflections eliminated (the CRT has a new, non-reflecting face developed by  $\Phi$ ); but you also have a genuinely unique array of electrical and convenience features for measurements from dc to 450 KC.

Details of the 120B's electrical capabilities are given in the specs below. You may particularly wish to note such features as direct reading calibration, "times-5" sweep expander, linear integrator for accurate sweeps and built-in amplifier calibrator. Also the slow sweep speeds for mechanical or medical work, and fast sweeps for transient measurements.

Many engineers who have tested the new 120B feel it is perhaps the easiest-to-use, most widely versatile, and highest value commercial 450 KC scope ever offered. Why not confirm their opinions with a test on your own bench.



#### Accessories available:

- $\Phi$  AC-83A Viewing Hood; face-fitting molded rubber, \$5.00
- $\Phi$  196A Oscilloscope Camera, \$440.00
- $\Phi$  456A AC Current Probe, \$190.00
- $\Phi$  AC-21J Probe, \$9.00

#### Price:

- $\Phi$  Model 120B Oscilloscope, \$475.00  
Supplied with rack-mounting hardware.

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

## HEWLETT-PACKARD COMPANY

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Further, the 120B has automatic triggering which ends trigger adjustment and insures a bright, clear baseline even without a sync signal. For manual level adjustment 10 to -10 volts, a panel control overrides the automatic trigger.

The 120B is also a boon physically. The front panel reads easily, and controls are where you expect them—simple, logical. When the trace strays, a push-button finds it instantly. The whole arrangement is such that, in an engineer's hands, the instrument is quick and sure; yet it is readily understood and used by non-technical personnel.

Finally, Model 120B is either a sleek, modern bench instrument or (with a handful of hardware supplied) a precision-fit rack mount unit. Access to the inside is instantaneous, and the top cover contains a complete adjustment guide.

## SPECIFICATIONS

### SWEEP

**Sweep Range:** 1  $\mu$ sec/cm to at least 0.5 sec/cm. 15 calibrated sweeps, accurate within  $\pm 5\%$ , in a 1, 2, 5, 10 sequence, 5  $\mu$ sec/cm to 200 msec/cm. Vernier for continuous adjustment of sweep time between calibrated steps, extends slowest sweep to at least 0.5 sec/cm.

**Sweep Expand:** x5 sweep expansion usable on all ranges, expands fastest sweep to 1  $\mu$ sec/cm, accuracy  $\pm 10\%$ .

**Synchronization:** Automatic, 50 cps to 450 KC.

**Trigger Point:** Zero crossing, negative slope of external sync signals, zero crossing, positive or negative slope of vertical deflection signals. Front panel control locks out automatic and permits trigger point to be set between -10 to +10 v.

### VERTICAL AMPLIFIER

**Bandwidth:** DC coupled: dc to 450 KC; ac coupled: 2 cps to 450 KC.

**Sensitivity:** 10 mv/cm to 100 v/cm. 4 calibrated steps with attenuator accuracy of  $\pm 3\%$ , 10 mv/cm, 100 mv/cm, 1 v/cm, 10 v/cm. Vernier for continuous adjustment of sensitivity between steps and extends 10 v/cm step to at least 100 v/cm.

**Internal Calibrator:** Calibrating signal automatically connected to vertical amplifier for standardizing of gain, accuracy  $\pm 2\%$ .

**Input Impedance:** 1 megohm, approx. 50 pf shunt.

**Balanced Input:** On 10 mv/cm range. Input impedance 2 megohms shunted by approx. 25 pf.

**Common Mode Rejection:** At least 40 db, should not exceed  $\pm 3$  volts peak.

**Phase Shift:** Vertical and horizontal amplifiers have same phase characteristics within  $\pm 2^\circ$  to 100 KC when verniers are in CAL.

### HORIZONTAL AMPLIFIER

**Bandwidth:** DC coupled: dc to 450 KC; ac coupled: 2 cps to 450 KC.

**Sensitivity:** 0.1 v/cm to 100 v/cm. 3 calibrated steps, accurate within  $\pm 5\%$ , 0.1 v/cm, 1 v/cm, 10 v/cm. Vernier for continuous adjustment of sensitivity between steps and extends 10 v/cm step to at least 100 v/cm.

**Input Impedance:** 1 megohm, nominal, shunted by approx. 100 pf.

### GENERAL

**Internal Graticule:** 10 cm x 10 cm marked in cm squares.

**NEW  
TIME-DELAY  
RELAY**  
■■■  
**ENCLOSED  
SNAP-ACTION  
CONTACTS  
(SPDT OR DPDT,  
5 AMPS)**  
■■■  
**CONTINUOUS-DUTY  
COIL**  
■■■  
**MODERATE  
PRICE**



Quite a job, this new Heineemann Type B Relay. Loaded with engineering refinements. Like totally enclosed contacts (for protection against environmental contamination and tampering). And a balanced armature (for improved shock and vibration resistance). And a smaller pole-piece (to reduce chatter noise). • Electrically, the Type B has a lot to offer, too. Most notably, the continuous-duty coil. It permits the relay to work not only as a delay device, but as a load-carrier, too. (In most applications, there is no need for slave or lock-in circuits since the coil can remain energized continuously after actuation.) • Think you might have use for the Type B? It's available in sixteen standard timings, from 1/4 to 120 seconds, and can be furnished for operation on any of a whole slew of AC or DC voltages. Our new Bulletin No. 5004 will give you detailed specifications.

HEINEMANN ELECTRIC COMPANY, 2818 BRUNSWICK PIKE, TRENTON 2, N. J.

CIRCLE 3 ON READER-SERVICE CARD

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### Early Birds—Attention!

"Sure, I have an interesting approach to a design problem. But I just don't have the patience or desire to spend several weekends preparing an article."

This is the lament heard frequently by ELECTRONIC DESIGN editors as they discuss potential articles with engineers during plant visits.

To help engineers past the mental block to writing assignments, ELECTRONIC DESIGN will present a writing seminar in conjunction with the NEREM conference in Boston.

Edward E. Grazda, editor of ELECTRONIC DESIGN, will discuss "Let's Write an Article Together." The time and place: Nov. 15, at 8 am, in the Cleveland Plaza suite of Boston's Somerset Hotel—the convention headquarters. All NEREM visitors are invited. It will be a rewarding session.



ELECTRONIC DESIGN is published biweekly by Hayden Publishing Company, Inc., 850 Third Avenue, New York 22, N. Y. T. Richard Gascoigne, Chairman of the Board; James S. Mulholland, Jr., President; Edmund C. Grainger, Jr., Secretary. Printed at Poole Bros., Inc., Chicago, Ill. Controlled circulation postage paid at Chicago, Ill., and New York, N. Y. Copyright © 1961, Hayden Publishing Company, Inc., 38,950 copies this issue.



## Micatemp Aerospace Wire Resists Nose Cone Heat in Minuteman

Rockbestos Micatemp wire is an ultra-high temperature lead wire that will withstand temperatures up to 2000°F. Because of its ability to carry current at such extreme temperatures, it is used for wiring sub-assemblies in the Minuteman nose cone. Micatemp is also highly resistant to vibration fatigue and radiation.

Developed specifically for missile and satellite wiring, Rockbestos Micatemp wire offers interesting design capabilities for many other military and industrial applications. If you are looking for an ultra-high temperature or radiation resistant wire for your project, be sure to consider Micatemp.

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CIRCLE 4 ON READER-SERVICE CARD



# More Switching, High-Frequency Barriers Fall

*Electron Devices Meeting Told of Transistor Advances;  
Gains in GaAs Solar Cells, Microwave and Data Units Noted*

**Robert Haavind**  
Chief News Editor

**S**OLID-STATE devices for faster switching or higher frequency operation were prominent among developments unveiled at the Electron Devices Meeting in Washington, Oct. 26-28. New advances in microwave, data-handling, and energy-source devices also were introduced to the industry.

Some of the more important developments for the design engineer were:

- Producing planar-silicon transistors, capable of operating to over 2 Gc, and of switching with less than 2-nsec propagation-delay time.
- Mesa-type switching transistors for switching rates up to 100 mc in saturated circuits.
- Gallium arsenide solar cells with efficiencies up to 13 per cent.
- A multiposition core driver using electron-beam-switched silicon diodes in place of transistors.
- A new type 1.5-megawatt magnetron said to have four times the frequency stability of present types.
- A microspot cathode-ray tube capable of displaying 92 million picture elements on a 5-in. face.
- Gallium antimonide (GaSb) tunnel diodes with  $f_{max}$  up to 10 Gc, said to have half the shot noise constant of equivalent germanium devices.
- Cryosistor—a three-terminal field-effect-controlled fast germanium switch for operation at liquid-helium temperatures.

**Lead Areas Larger Than Active Regions  
In New Gc-Operating Silicon Transistors**

Gigacycle silicon transistors, reported by Fairchild Semiconductor Corp., are designed

## Verdict on Tunnel Diodes: Useful, But Can't Replace Transistors

Design philosophy held as much attention as the new devices unveiled at the Electron Devices Meeting.

A definitive statement on the status of the tunnel diode was presented by E. O. Johnson of RCA Laboratories, Princeton, N. J. "They will never replace transistors," as some believed when they were first developed, Mr. Johnson said. The greatest interest in tunnel diodes at present, he said, is for microwave and special applications.

In microwaves, tunnel diodes offer higher gain at higher frequencies than transistors, with the added factor of low-noise characteristics. Mr. Johnson thinks that when the devices are integrated in distributed-circuit structures, to minimize serious inductance effects, they will reach frequencies of 100 Gc, compared with an expected 10-Gc limit for transistors. Present limits of about 10 mw for the tunnel diode at 2 Gc should be pushed to about 1 w in the gigacycle region, he predicted. Aside from the microwave use, special applications cited for the devices were in pulse discriminators, scalars, pulse calibrators and coincidence detectors. In these applications low-noise and high-speed characteristics offered by tunnel diodes are of particular advantage.

Another important use is in down converters because of the inherent low noise of the devices in this application. Initial work attempted to get optimum values for all parameters at once, but

resulted in poor stability. Excellent stability has been achieved, however, by sacrificing gain and operating at unity gain factor while biasing in the positive  $R$  region of the  $I-V$  characteristic toward the origin and pumping hard toward the negative  $R$  region of the curve.

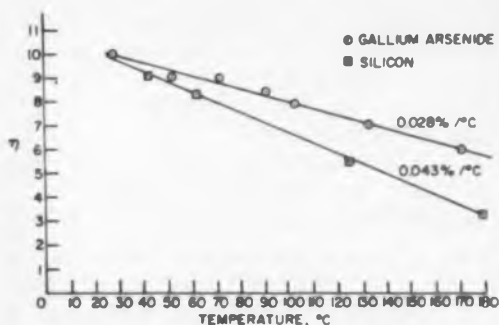
Tunnel-diode down converters are being used in place of crystal mixers. The mixers gave about 7-db insertion loss and 8-db noise compared to no insertion loss and 1- to 2-db noise with the new tunnel diode devices, Mr. Johnson said.

Interest in tunnel diodes for computer logic is dwindling, Mr. Johnson commented, because of the difficulty in fanning out for more than two or three levels due to the low gain of the devices. Tolerance of all elements in these circuits must be held to 1 or 2 per cent to achieve this. Although the tunnel diode is a simpler device than the transistor, this tolerance is a tough requirement to meet. The relatively low cost of transistors, especially now makes them more attractive for this application. The tunnel diode will be used, however, in small, fast computer memories because of their high-speed capability and low noise, allowing design for low power.

An additional important advantage cited for the tunnel diode in comparison with the transistor was its ability to operate in and to survive high radiation conditions.



Array of gallium-arsenide solar cells converts light energy from lamp to drive small electric motor and wheel.



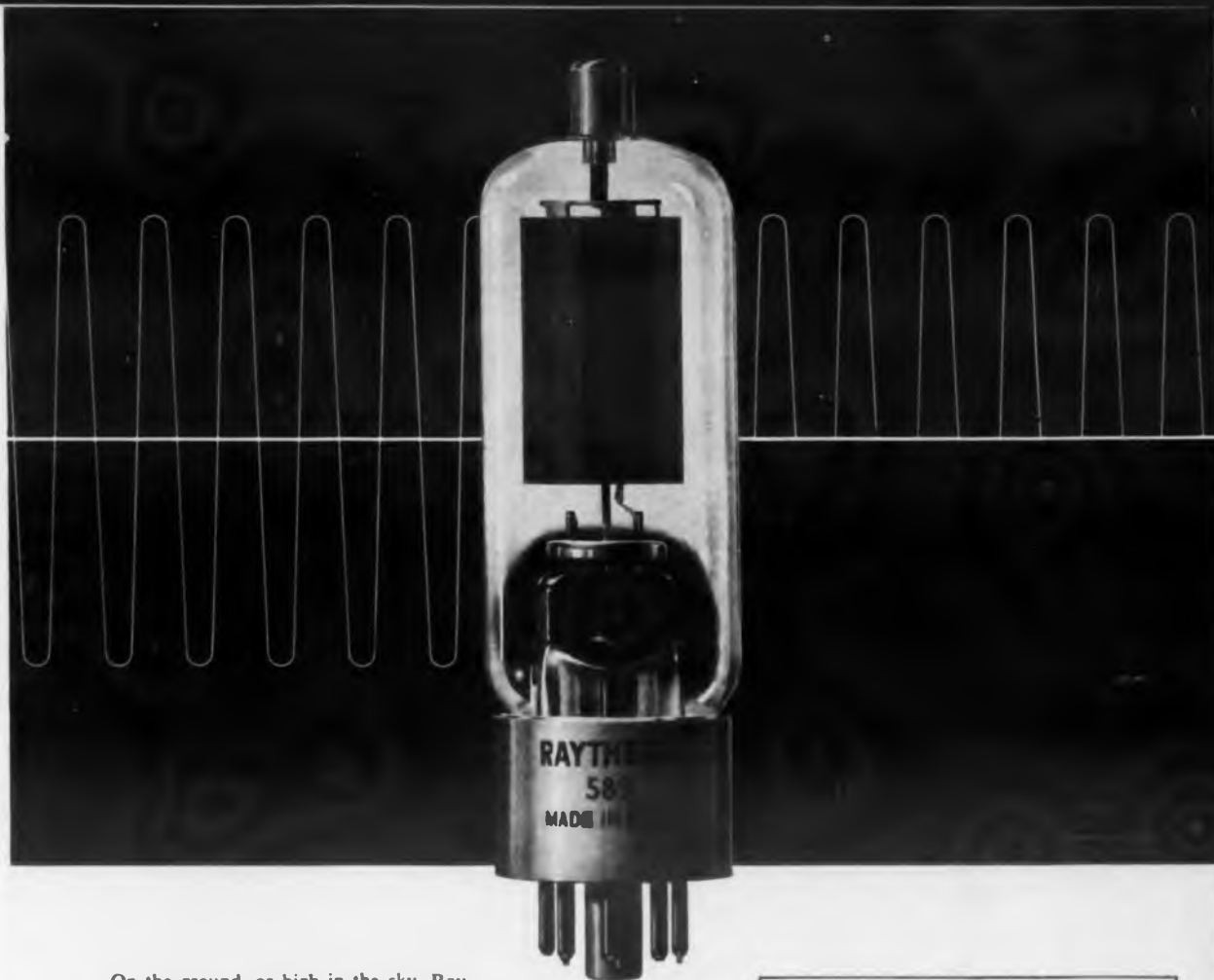
Comparison of efficiency of gallium arsenide solar cells and silicon units shows advantages claimed for GaAs cells.

so that areas where leads can be attached are larger than the actual active areas. This is said to make production simpler and is expected to result in devices cheaper than many existing types that have poorer characteristics. Measurements at 1 Gc with 625 mw into one of these devices showed 50 mw out, according to Fairchild. The 2-msec time was obtained by dividing total delay time through an 11-stage ring counter by 11, Fairchild reported.

Germanium epitaxial maser-type switches reported by Texas Instruments Inc., are said to have a unity-gain frequency of 1.5 to 4 Gc.

Gallium-arsenide solar cells developed by RCA's Semiconductor Div., are said to have considerably higher radiation tolerance than silicon cells. Efficiency is said to decrease less with temperature for GaAs than for Si types.

CIRCLE 5 ON READER-SERVICE CARD ➤



On the ground, or high in the sky, Raytheon's line of rugged diode rectifiers gives dependable arc-free operation.

Example: Raytheon 583, one of six Raytheon half-wave rectifier types. Operating as a clipper diode at altitudes to 36,000 feet, maximum ratings are 15,000 volts PiV, 8 amperes peak plate current. Arc-free clipping action makes sure a magnetron can be fired once *without* re-firing automatically or uncontrollably!

The reliability of Raytheon diode rectifiers is the result of exceptional care in design and manufacture . . . with no compromise in quality control. Gold-plated plates and zirconium coatings assure reliable operation at high voltages. Cathodes are heliarc welded. Higher exhaust temperatures mean less gas and longer life. For more information on Raytheon's growing line of dependable diode rectifiers, please write: Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

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POWER  
WITH  
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INDUSTRIAL COMPONENTS DIVISION

RAYTHEON DIODE RECTIFIERS						
TYPE	SERVICE	HEATER		MAX. PLATE RATINGS		
		VOLTS	AMPS	PEAK INVERSE (VOLTS)	PEAK CURRENT (AMPERES)	AVERAGE CURRENT (AMPERES)
583*	H. W. RECT. (to 36,000 Ft.) CLIPPER DIODE	2.5	4.9	17,000	3.250	0.065
	(to 36,000 Ft.)	2.5	4.9	15,000	8.0	0.240
3024W 3024WA	H. W. RECT. (HALF FIL.) (FULL FIL.)	2.5	3.0	20,000	3.150	0.030
		5.0	3.0	20,000	0.300	0.060
1020	CLIPPER DIODE	2.5	4.75	15,000	8.0	0.020
1020	H. V. RECT. (OP. 1) (OP. 2) (OP. 3) CLIPPER DIODE	2.5	4.0	16,000	0.250	0.065
				7,700	0.300	0.080
				5,000	0.300	0.095
4021*	H. W. RECT. CLIPPER DIODE	5.0	5.0	16,000	0.470	0.150
		5.0	5.0	16,000	12.0	0.060

\*Mil-Sit-200 Preferred Type

**RAYTHEON**

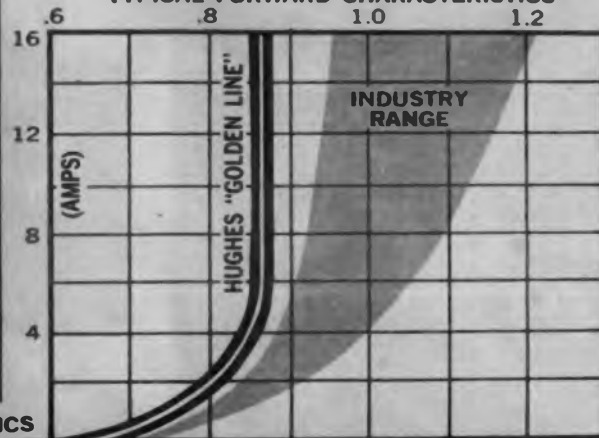


Introducing Hughes

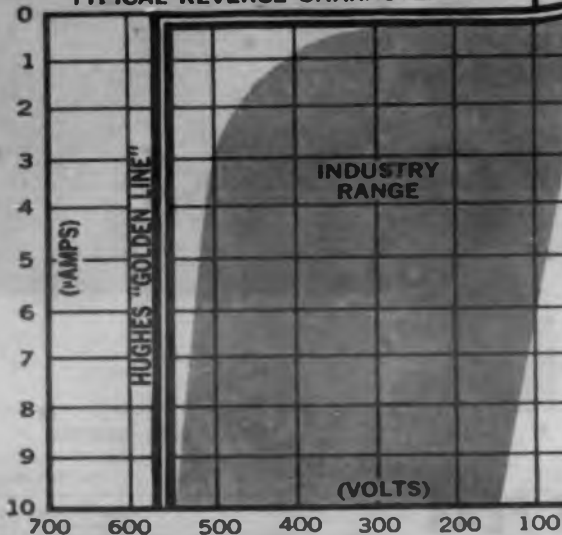
# GOLDEN LINE

Silicon Power Rectifiers

TYPICAL FORWARD CHARACTERISTICS



TYPICAL REVERSE CHARACTERISTICS



COMPARISON CHART.

	Standard	Improved	Standard	Improved
	IN 1199— IN 1206	<b>B</b> Version	IN 1341— IN 1348	<b>B</b> Version
Fwd. Voltage Drop @ Rated Current	1.3 V	1.1 V	1.3 V	1.1 V
Max. Peak Surge Current 1 Cycle 60 cps	200 A	250 A	150 A	150 A
Max DC Reverse Current @ Rated PIV @ 150°C	50 mA	1.0 mA	25 mA	0.5 mA
Reverse Recovery Time			None	5 micro-seconds

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**1. Low Reverse Leakage**—Typically less than one microamp. at rated voltage at room temperature. **2. High Reverse Stability**—All units 100% heat-soaked at 200°C for 200 hours. **3. Low Forward Voltage Drop**—Typical units will have a forward voltage drop of less than one volt at rated current. **4. Fast Reverse Recovery**—Typically less than 2.0 microseconds! **5. Low Dynamic Impedance**—Typically .0035 ohms at rated current. **6. Low Thermal Impedance**—Typically 2°C per watt. **7. High Current Surge Capability**—Up to 240 amps. for one cycle 60 cps non-recurrent. **8. No Junction Stress**—The Golden Line has a fine silver braided internal lead wire that adjusts for thermal expansion and contraction. Hughes silicon rectifiers are available with regular stud or with insulated type stud for even greater heat dissipation.

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HUGHES AIRCRAFT COMPANY  
SEMICONDUCTOR DIVISION

CIRCLE 6 ON READER-SERVICE CARD

## NEWS

### Electron Devices . . .

(continued from p 5)

An in-flight comparison of these devices with silicon cells will be made next year on the Relay communications satellite, which will be orbited in the Van Allen radiation belts. The chief disadvantages of these devices at present is the expense in obtaining gallium and the difficulty in producing suitable crystals, according to an RCA spokesman.

High-speed driving of memory core arrays has been achieved using an array of silicon-diode junctions by switching with an electron beam, Dr. A. V. Brown of International Business Machines Corp. reported. Higher output currents and shorter switching times than those obtained with present transistor drivers were achieved, he said.

A new type magnetron using an improved anode structure, reported by S-F-D Laboratories Inc., was said to have achieved X-band operation at over 50 per cent efficiency, delivering 1.5-megawatt peak and 750-w average power. The device is called the CEM Coaxial Magnetron.

Information-retrieval systems can make use of the new microspot crt reported by Kurt Schlesinger, consultant to GE's Cathode

### Metal-Amplifier Paper Hastily Withdrawn

Disclosure of a complete metal-metal oxide thin-film amplifier was held back at the meeting by the last-minute withdrawal of a paper by L. E. Godycki, D. P. Foote and I. Weiman of Electro-Optical Systems Inc. because of patent considerations.

Operation of a metal-metal oxide amplifier using a germanium collector—the Metal Interface Amplifier—was previously reported by Philco Corp. (see ED, June 7, p 24; June 21, p 18). An energy-level structure similar to that of the junction between metal oxide and germanium in the MIA is said to be achieved in the Electro-Optical device by substitution of a metal-metal oxide-metal sandwich for the germanium. Thus, a five-layer device with triode-like characteristics was said to have been achieved. Tantalum, niobium and aluminum with oxides, were said to have been used.

This work is being done under an Air Force contract.

Ray Tube Dept. Unusual features include a spiral anode that doubles the effective length of the neck; use of a grainless thin-film phosphor; and a special microgun to generate an electron-focus whose brightness is said to exceed that of the cathode by a factor of 10.

GaSb tunnel diodes described by Micro State Electronics Corp. are said to be available now with  $f_{max}$  up to 4 Gc. Cutoff frequencies of 6 to 10 Gc have been achieved in the laboratory, the company said, and future plans are to make devices for use at up to 30 Gc.

Operation of the Cryosistor is based on impact ionization of impurities in germanium at liquid-helium temperatures. Impact ionization between two contacts on a germanium wafer is controlled by a reverse-bias rectifier junction situated between the two contacts. Short voltage pulses applied to the junction can switch the device in or out of breakdown in a few nanoseconds. Many Cryosistors can be put on a single germanium wafer, according to its developer, Ivars Melngailis of MIT's Lincoln Laboratory. His initial work on the device was done at Carnegie Institute of Technology. ■ ■

## IRE, AIEE Consider Consolidation By '63

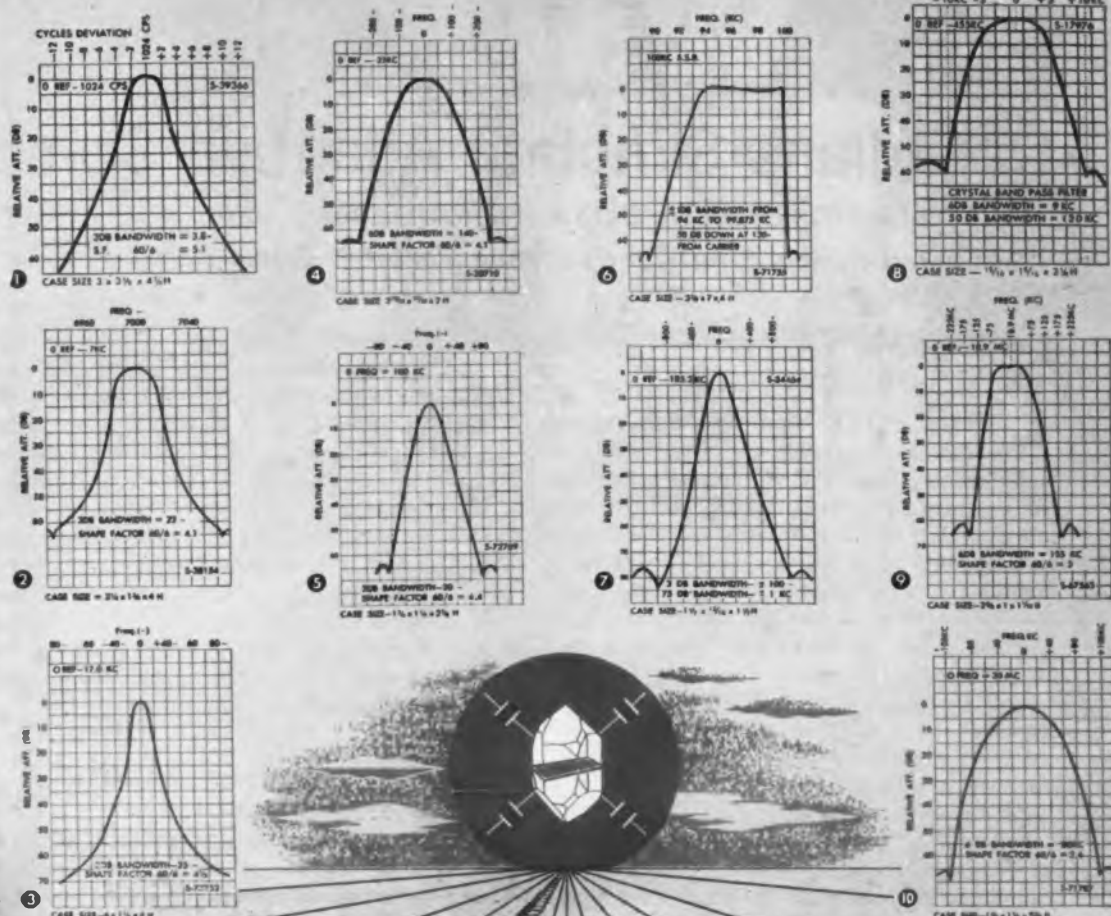
Merger talks have been launched by the two largest engineering societies in the world—the American Institute of Electrical Engineers and the Institute of Radio Engineers.

The proposed new organization would involve 150,000 engineers, scientists, educators and industrialists. A resolution approving a merger study by a special committee, was adopted by the IRE board of directors in New York and by the AIEE board in Detroit at the close of the fall general meeting of the AIEE.

The committee, which also was asked to prepare a constitution and bylaws, is to submit a report to the societies by Feb. 15, 1962. If approved, the merger proposal would be put to a vote of the members by Jan 1, 1963.

The AIEE was organized in 1884 and has about 70,000 members in the United States and Canada. The IRE, organized in 1912, has 91,000 members all over the world. About 6,000 persons belong to both societies.

Typical response curves indicating the various shape factors available in standardized Burnell Crystal Filters



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CIRCLE 7 ON READER-SERVICE CARD

# Canadians Simulate Adaptive Communications System

*Test Design, With Variable Data Rate, Demonstrates Ability To Control Symbol Error; Others Pursue Similar Projects*

**Alan Comeretto**  
News Editor

**A**N ADAPTIVE communication system, designed to transfer digital data at a variable rate, has been simulated with digital modules. The performance of the system correlates with predictions and indicates that an on-the-air system would be able to maintain a constant error rate despite channel fluctuations, according to scientists of the Defense Telecommunications Research Establishment, Ottawa.

In the Canadian system, phase-modulated sequences of binary digits are transmitted with a variable degree of redundancy to a receiver, in which the incoming sequence is compared with a local stored copy of the transmitter sequence. After accuracy of the received message is determined, the data rate is modified by changing, through a feedback channel, the amount of redundancy needed to maintain a desired error rate.

The project is one of many by various or-

ganizations to apply the adaptive concept and the developments of feedback theory to communications links. The project was described by Prof. G. S. Glinski of the University of Ottawa at the recent fall general meeting of the AIEE. Adaptive communications studies, he said, fall into two large classes: unidirectional open-loop systems and bidirectional closed-loop systems.

The adaptive-filter systems, under study at General Electric and other organizations, are examples of open-loop systems. So are designs that include matched filters, comb filters, integrators and correlators, Prof. Glinski said.

## Closed-Loop Adaption Due to Feedback Channel

In closed-loop systems adaption is achieved through a feedback channel. This channel is used either to improve error performance at a fixed data rate or to vary data rate in compensation for changing channel conditions. A system called Janet, developed sev-

eral years ago at the Canadian Telecommunications Research Establishment, is an example of a variable-rate system using predecision feedback, in which the feedback channel is used to supply data on the communications channel.

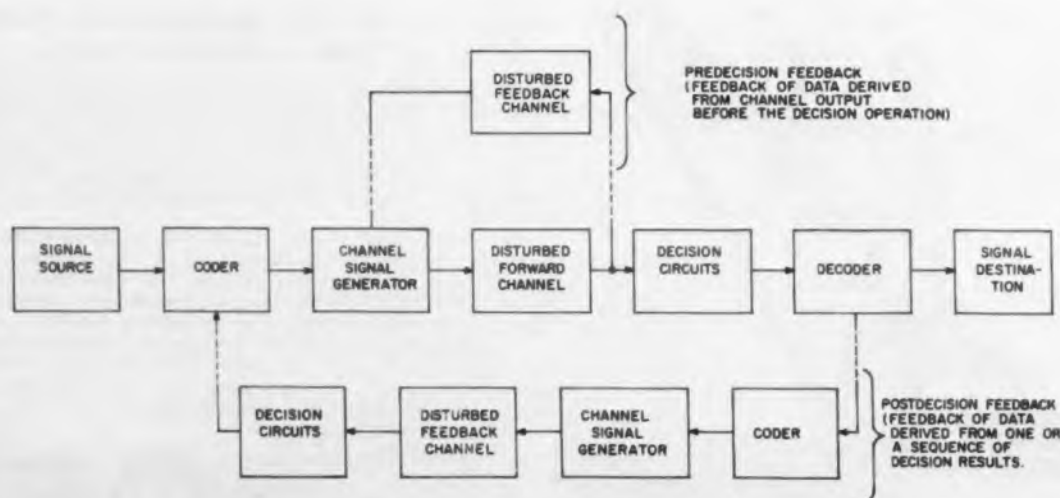
The new Canadian system and two designs under study at the Radio Corp. of America use postdecision feedback to supply information on the results of individual receiver decisions. The Canadian system and a proposed RCA system, described a year ago at the National Communications Symposium, use the feedback information to modify data rate. The other RCA project, described at the Detroit AIEE meeting, is based on using feedback information to vary transmitted energy as needed.

The transmitter of the variable-rate system discussed at Detroit (by N. G. Davies of the Canadian defense agency), contains a binary-sequence generator that feeds an encoder. Combined message symbols and binary sequences go to a phase-modulated transmitter. The sequence generator, encoder and a timer are standard digital modules.

The generator is designed to produce a continuous stream of binary digits that occur with about equal probability and have a repetition period that is long compared with the period of a message symbol. This causes the bandwidth of the phase-modulated signal to approximate the digit rate of the binary-sequence generator.

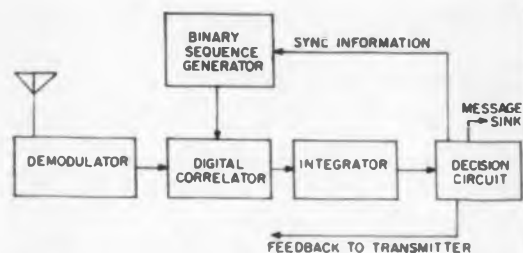
## High Symbol Rates Mean Few Sequence Digits

When the transmitter is operating at high message-symbol-transmission rates—which in the breadboarded equipment range from 100 to 500 kilobits per sec—a small number of sequence digits is transmitted for each message symbol. At lower rates, the number of sequence digits per symbol increases. The period of the sequence digits, rather than the period of message symbols, determines the



**Feedback-type** adaptive communication systems fall into two classes—predecision, in which channel data is supplied to the transmitter, and postdecision, in which the results of individual receiver decisions are supplied. Both types are closed-loop, two-directional systems. Open-loop systems use filtering to achieve adaptation.





Receiver of a breadboarded postdecision feedback adaptive communication system, in which the feedback channel carries information that varies the amount of redundancy in the transmitted signal to assure a desired error rate despite changing channel conditions. Incoming digit sequences are compared with stored sequences to determine the accuracy of reception.

transmission bandwidth. Encoding does not change the bandwidth-determining characteristics of the transmitted waveform, Mr. Davies reports.

At the receiver, the signal is detected, fully clipped and applied to a digital comparator, where it is matched digit by digit with a binary sequence generated by a local sequence generator. After the number of digit coincidences in a message symbol are counted, a decision is made on the most probable transmitted symbol.

The incoming signal is spotted by a phase-sensitive detector, whose coherent phase reference is supplied by the signal itself. This is done by squaring the input signal to remove the phase modulation, using narrow-band filtering and dividing the frequency by two. The filter is a very narrow-band phase-locked loop able to track changes in frequency caused by Doppler shifts and frequency instability.

The basic parameters of the breadboarded system are a digit period of 10  $\mu$ sec and a bandwidth of 100 kc. Transmission was over a few inches of wire and the system did not include a channel for feedback control of the data rate. This feature is to be added to the system, as will synchronization noise. The system was tested with noise-free sync for the transmitter and receiver sequences.

Measurements of the probability of error per message symbol over various signal-to-interference ratios show that for each reduction of the symbol rate by a factor of 2, the required signal power is reduced by 2. When the signal-to-noise ratio is high, messages can be transmitted at a high rate; when the ratio falls, the message rate can be reduced correspondingly to maintain a constant probability of error. Though the reduction in message rate causes no corre-

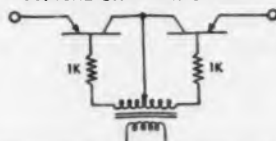
# NEW PHILCO SILICON CHOPPERS

With SPAT Matched-Pair Uniformity  
Bring High Fidelity To Low Level Switching!

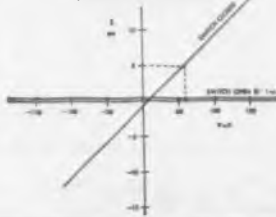
#### T2363 CHARACTERISTICS

Emitter Voltage, $BV_{Eco}$	-30 volts
Collector Cutoff Current $I_{Cco}(V_{CB} = -10V)$	0.001 $\mu$ a max.
Emitter Collector Current $I_{Eco}(V_{CB} = -10V)$	0.001 $\mu$ a max.
Offset Voltage $V_{e}(I_o = -200 \mu a, I_r = 0)$	1.5 mv max.
Offset Voltage $V_{e}(T2357$ Matched Pair, $I_o = -1ma$ at all temperatures from 25° to 85° C)	50 $\mu$ v max.

#### TYPICAL CHOPPER CIRCUIT



#### T2363: I-V CHARACTERISTIC (in above circuit)



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- Low offset current—1 nanoampere maximum;
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Take Electronic Measurements' Model C638A shown here. It's an easy matter to set the current control to any value desired—from a few microamperes up to 100 ma—manually or programmably. And there's no juggling with makeshift, extra circuitry. Then you can adjust the voltage compliance to any value from 0 to 1500 V. There's no fear that the voltage may be

too great or not enough; the voltage control sets the upper limit.

Here are some additional features of the C638A: Output impedance is  $10^3$  megohms at  $0.5 \mu\text{a}$  to 0.5 megohms at 100 ma. Above  $2.2 \mu\text{a}$ , regulation is better than 0.15%, line or load. Ripple is less than  $0.01\% + 1 \mu\text{a}$  rms. A modulation input is provided.

But to get back to the point; to check the peak inverse voltage rating of a solid state junction, simply set the output current control of an E/M Constant-Current Power Supply at the specified current. Connect the output to the junction, turn the power supply on, and measure the voltage drop across the junction. What could be easier? And other measurements can be made almost as easily.

For a complete discussion of constant-current power supplies with ratings up to 1A, ask for Specification Sheet 3072B. It lists all the models and specifications, too.

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CIRCLE 9 ON READER-SERVICE CARD

## NEWS

### Canadians Simulate . . .

(continued from page 9)

sponding changes in the transmitted signal bandwidth, the period of the receiver counters must be increased.

At lower values of message-symbol rates, an acceptable probability of error can be achieved when the signal power is considerably below the noise power, according to Mr. Davies.

W. L. Hatton, co-author of the paper describing the system, reports that the experimental data link is simple, yet lends itself well to combining with other communications techniques such as novel coding procedures and spread-spectrum methods.

Similarly, the variable-bandwidth system under development at RCA's Applied Research Laboratory, Camden, N. J.—though intended mainly for tropospheric-scatter communications—is said to be practical for other types of systems where received signal statistics vary in Rayleigh fashion. ■ ■

### Usable Current Obtained From Bio-Power Devices

Conversion of "life-energy" into usable electric power has gone far beyond the test-tube stage, according to a company that has had such conversion devices—known as bio-power units—in operation for more than a year.

Military secrecy has prevented the developer, Magna Products, Inc., Santa Fe Springs, Calif., from giving more than a bare outline of the project. But the company, a subsidiary of Thompson Ramo Wooldridge, Inc., hinted that bio-power devices are feasible and even competitive with some conventional systems.

The company has tested three types of bio-power units: a bio-battery, in which millions of bacteria, consuming minerals and organic matter found in sea water, produce an electrical potential; a bio-fuel cell, utilizing organic matter and air; and a bio-solar cell, which uses photosynthetic organisms that convert solar energy directly into electricity.

Magna Products declined to give an efficiency level for the solar cell, but predicted that its rating might eventually outstrip that of any known device.

Bio-power units already are generating



Bacteria culture in the battery cells produces electricity, as illustrated by Dr. Gilson H. Rohrback, president of Magna Products, Inc., Santa Fe Springs, Calif.

enough power to operate radio beacons, signal lights and other apparatus at sea, Magna Products said.

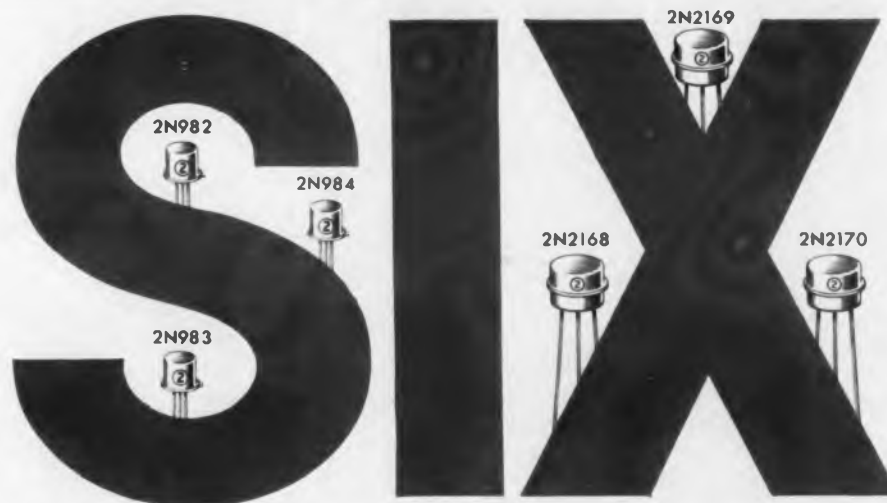
Dr. Gilson H. Rohrback, president of the company, evolved the basic concepts of the bio-power devices. The company encountered the phenomenon while doing basic research on the causes of corrosion in oil wells and ocean-water pipelines.

### Huge Antenna Takes Shape



Radar and radio explorations of the solar system will be made with this 70-ton, 150-ft steel and aluminum parabolic antenna. The dish, covering nearly a half acre, will be linked to a 20-55-mc radio transmitter. The transmitter's 1,000,000-w input will give the dish a 300-400-kw radar probe. The radio telescope was erected on the Stanford University campus.

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#### THIS NEW FAMILY OF SWITCHES OFFERS:

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- Low Saturation Voltage
- Low Storage Time
- Low Output Capacitance
- Excellent Frequency Response
- Close Parameter Control in Your Choice of Package

#### HERE ARE SOME KEY PARAMETERS:

Type No.	JEDEC CASE	Max. $I_{CBO}$ ( $\mu a$ )	Min. $BV_{CES}$ (volts)	Min. $BV_{CEO}$ (volts)	Min. $h_{fe}$	Typ. $f_T$ (mc)
2N982	TO-18	3	20	15	50	450
2N2168	TO-9					
2N983	TO-18	3	15	15	40	450
2N2169	TO-9					
2N984	TO-18	5	15	10	20	350
2N2170	TO-9					

For application engineering assistance, write Product Marketing Section, Transistor Division, Sprague Electric Co., Concord, N.H.

For complete engineering data, write Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

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Model B-7B



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us; delays to 10,000 us



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Offers a combination of good, clean pulses and high rep. rate with no greater than 8 mus rise and fall time.

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CIRCLE 11 ON READER-SERVICE CARD

## NEWS

### Electronics to Test Leg-Brace Forces

*Strain Gages, Relays Rigged Up by NYU Researchers  
In Quest of Better Mechanical Aids for Handicapped*



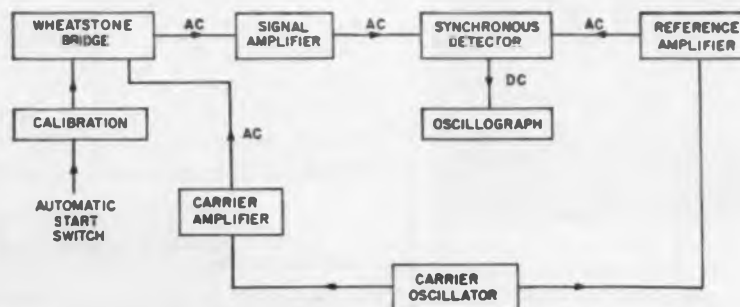
Short leg brace is instrumented with strain gages oriented to permit analysis of the various forces involved in walking with a brace.

**E**LECTRONIC techniques will play a major role in a research project on braces and artificial legs for the handicapped. The objective of the studies, to be conducted in a special laboratory now being outfitted at the orthotics section of New York University's Research Div., New York, is the analysis and eventual improvement of brace construction.

In the past, according to Dr. Edward Peizer, who heads the NYU research program, braces for the legs and lower body have been built by skilled craftsmen on the basis of experience and common sense. Experimental data on such factors as the forces involved in walking, the effects of varying brace construction, and pressures at body-brace interfaces have not been available.

As a start in this direction, an NYU group including engineers, doctors and prosthetic-device specialists, will analyze eight specific problems in this field. One of these, for example, is the difficulty paralytics wearing short leg braces have in maintaining balance while walking, particularly at the moment of heel-strike. Transmission of forces applied to the calf through the calf-band will be studied, as will the effects on knee stability of redirecting these forces.

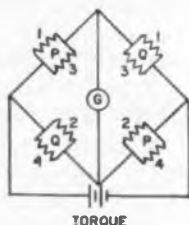
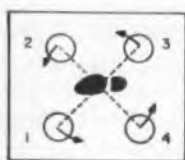
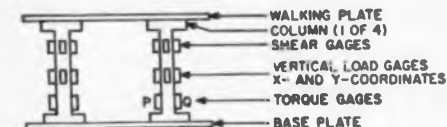
A special leg brace fitted with an array of strain gages has been developed by the



Conventional Wheatstone-bridge circuits, fed by a 1,000-cycle oscillator, are used to sense forces in both the force table and the leg braces being used in NYU studies.

# NEW SILICON PLANAR 2N2049

## 3 db MAX. 1kc NOISE FIGURE



**Force plate** used to analyze the forces involved in walking consists of a walking plate supported by four strain-gage-instrumented columns. Lower diagrams show how the torque-measuring gages are connected in bridge to sense the magnitude of the turning torque exerted by a person stepping at any point on the walking plate.

NYU researchers. By mounting the gages with varying orientations on the side-bars of the brace, and arranging them in Wheatstone-bridge circuits, the forces involved in walking can be analyzed from ink-recorded records.

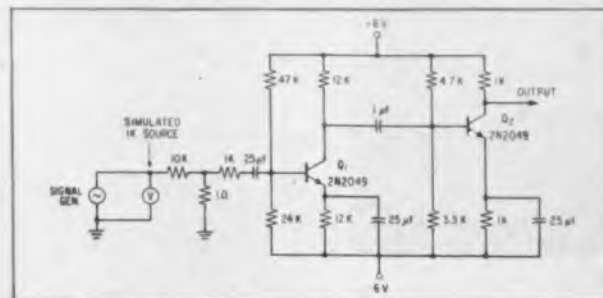
Another tool being used by the group is known as the force plate. A plate upon which a test subject steps is supported by four symmetrically placed columns, each supplied with 12 strain gages. Again, Wheatstone-bridge circuits are used to obtain information on direction and magnitude of the force applied in the step. The diagram illustrates the bridge arrangement used to measure the twisting torque applied to the force plate when a subject steps on it. Similar bridge arrangements are used to measure other components of the force.

Another instrument devised by the group is a tilt table. A test subject stands on a tilt-board with each foot pressing three contacts that hold relays fastened in an open position underneath the board. The square tilt-board is attached to a long plank that has a wire attached at the opposite end. A motor-pulley system is used to pull the wire and gradually tilt the board until the subject loses his balance, thus allowing relay closure. By testing various types of braces with different force distributions with this tilting system, the researchers hope to find optimum configurations for good balance.

The special needs of this project could be met by some of the following types of devices, according to Elliot Dembner, chief engineer for the program:

- Wafer-type pressure transducers for

### EXAMPLE OF LOW-NOISE AMPLIFIER DESIGN



Send for APP 11/2 and APP 36

#### MINIMUM BETA OF 75

Guaranteed noise figure below all other devices, germanium or silicon, results from: high gain (reduces middle frequency shot noise), passivated surface (cuts low-frequency flicker), and alpha cutoff of 0.8mc @ 10μA (shifts high-frequency noise above the audio range). Extremely low leakage (typically 0.4μA) makes possible low current operation.

#### PLANAR RELIABILITY, STABILITY

Performance characteristics of the 2N2049 are largely attributed to high degree of uniformity inherent in the Fairchild Planar Process. Parameter stability is assured as all junctions are protected against contamination or environmental change from the start of manufacture by an integral oxide layer.

#### HIGH YIELD, LOW PRICE

Low price, resulting from high Planar yields, makes it practical and economical to specify the 2N2049 for a wide variety of audio applications, and for differential amplifiers and d-c amplifiers where stability, low leakage, and low noise are prime considerations. Get complete data and pricing information from your Fairchild distributor or sales office. Or write direct.

### 2N2049 ELECTRICAL CHARACTERISTICS (25°C) JEDEC TO-5

	MIN.	MAX.
$I_{CBO}$ at $V_{CB} = 60V, I_E = 0$		10 μA
$h_{fe}$ at 1 kc, $I_C = 1.0mA$	75	
$h_{ib}$ at 1 kc, $I_C = 1.0mA$	24	34 ohms
$h_{ob}$ at 1 kc, $I_C = 1.0mA$	0.1	0.5 μmhos
NF at $I_C = 100μA, V_{CB} = 10V,$ $f = 1kc, R_g = 2K, BW = 1cps.$		3.0 db
$h_{FE}, d.c. pulse, I_C = 100μA,$ $V_{CE} = 10V$	60	

## FAIRCHILD SEMICONDUCTOR

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A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

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New KIN TEL solid-state DC amplifier gives you

200 kc  
response...

0.005%  
linearity...

ten fixed gains from +1 to +1000



KIN TEL's Model 121A/A non-inverting DC amplifier has fixed gains of 0, +1, +10, +20, +30, +50, +100, +200, +300, +500, and +1000. A variable gain control adjusts any fixed gain from  $\times 1$  to  $\times 2.2$ . A gain calibration control gives  $\pm 2.5\%$  adjustment for each gain other than +1.

With this new instrument, you can amplify accurately all low-level signals from DC to beyond 200 kc for the reliable measurement of strain, temperature, flow, vibration, displacement, or other physical phenomena. The 121A/A has the same dimensions, fits the same cabinets and modules as other KIN TEL DC amplifiers.

For more information on this new, more usable DC amplifier, write to KIN TEL. Engineering representatives in all major cities.

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#### ADDITIONAL SPECIFICATION NOTES:

The Model 121A/A is a non-inverting (positive input produces a positive output), wideband, DC amplifier. Amplification is accurate within 0.1% for all gains other than +1 (gain accuracy is 0.2% at +1), linear within 0.005% for outputs up to  $\pm 15$  volts DC with load impedances of 200 ohms or more. The amplifier provides up to 100 ma  $\pm$  DC or peak AC — into loads of 100 ohms or less. Input impedance is greater than 10 megohms; output impedance is less than 0.3 ohm. Frequency response is flat within 0.25% to 2 kc, within 4% to 10 kc, within 3 db to 200 kc. Drift is less than  $\pm 2.0$   $\mu$ volts equivalent input for over 40 hours at +1000 gain. Amplifier recovers from 100% overload in 0.4 second, is undamaged by sustained, direct short across output terminals. Price \$1000.



## NEWS

### Leg Braces . . .

(continued from p 13)

measuring pressure between brace bands and the body.

- Wireless data transmitters so that test subjects do not have to carry a bundle of wires with them.
- More sensitive strain gages (semiconductor types are being investigated) to eliminate the need for amplifiers.
- A small, light triaxial accelerometer that could be used in force and motion studies of walking.

The NYU group hopes eventually to move into studies of some of the advanced areas currently being opened up in the medical-electronics field. Research in the potential variations within muscles and the electrical activity of the nerves suggests two important studies with paralytics or amputees. One possibility is the use of generated electrical signals to control the muscles of a person whose nerves are not functioning properly. The second possibility is the use of nerve signals in amplified form to control the operation of artificial limbs.

The entire NYU research program is coordinated by Dr. Sidney Fishman, under the sponsorship of the Easter Seal Research Foundation and the Office of Vocational Rehabilitation, Dept. of Health, Education and Welfare. Laboratory facilities and special equipment are being made available by the Veterans Administration. ■ ■

### Fifty Navy Vessels To Use Improved Echo Depth Sounder

Fifty Navy vessels soon will be outfitted with an improved electronic echo depth sounder, known as the DE-714/715.

The depth sounders, developed by Raytheon Co., Newton, Mass., give shipmasters instantaneous readings of the depth of water on a flashing-light indicator. The units also provide a simultaneous continuous graph of the ocean or harbor floor for navigation purposes.

Receiver sensitivity is varied automatically within the depth sounders to provide accurate readings from less than 2 ft to more than 780 fathoms.

## Digital Programmer Operates With Accuracy of 0.1 Per Cent

A solid-state digital programmer, with accuracy of better than 0.1 per cent, has been developed as part of an arming and fusing system for future atomic weapons.

The all-electronic programmer, developed by Tempo Instrument, Inc., Hicksville, L. I., N. Y., consists of two identical, independent programmer channels. Each channel has a four-stage, adjustable timing program accurate to better than 0.1 per cent under extreme conditions, such as:  $-65^{\circ}\text{F}$  to  $+165^{\circ}\text{F}$ ;  $\pm 5.5$  v dc; 50 g at 2,000 cps (vibration); and 100 g (shock and acceleration).

The circuits for each channel are contained on five printed-circuit disks. Each disk is potted in rigid polyurethane foam to encapsulate all components. The potted disks are bolted together and interconnected. The entire assembly is mounted in an outer shell and the volume between is filled with silicone rubber.

All timing errors observed during testing were reported far below the 100-msec allowed by the specification and directly reflected oscillator accuracy. The greatest error occurring during temperature tests was 27 msec at a preset fusing time of 109.9 sec. This represents an accuracy of 0.024 per cent for the longest time required.

Development of the timing programmer was under the direction of the Special Weapons Group of the Army Ordnance Corps' Picatinny Arsenal, Dover, N. J.

## Thermal Problems Under Attack



Electronic heat-transfer devices will be tested and developed in this new research laboratory, set up by the Bircher Corp. Industrial Div., Monterey Park, Calif. The facility is equipped with environmental chambers to simulate internal and external ambients and flow patterns. It contains also calibrating equipment for direct measurement of thermal problems, in which the transistor's own junction will act as a thermocouple to measure heat transfer.



**SHOCKING NEWS FROM EIMAC:** there's now a 250-watt tetrode that can withstand shock of 90G for 11 milliseconds and vibration from 20-750 cps at 10G, with maximum rated voltages applied! It's Eimac's 4CX250R (shown  $1\frac{1}{2}$  times actual size). This new tube in the 4CX250B family is electrically equivalent to Eimac's 7580. The difference: the 4CX250R is ruggedized for extreme environments—as are other members of the family. And what a difference! Call your Eimac representative or write: Power Grid Tube Marketing, Eitel-McCullough, Inc., San Carlos, Calif.



CIRCLE 14 ON READER-SERVICE CARD



## NOW! a 3 amp glass diode

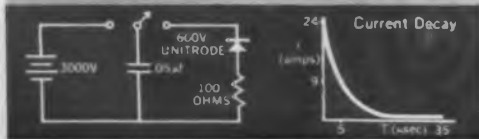
- takes voltage spikes to 5,000 volts
  - conducts 1.5 amps at 150°C
  - withstands 10 watts continuous overload
- all without heat sinks

### THE DIODE DESIGN THAT ELIMINATES FAILURE!



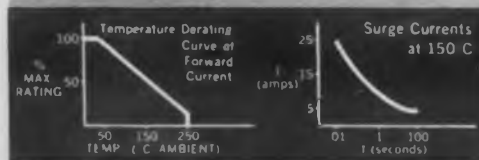
#### FORWARD CURRENT CHARACTERISTICS

The large capacitor filter in this bridge rectifier circuit causes 10 amp surges to flow every half cycle. The heat generated in the junction of the Unitrode is quickly dissipated through the terminal pins, bonded throughout the full area of both faces of the silicon. There is no whisker to burn out. The original condition of the diffused silicon surface, in contact only with pure inert hard glass, is preserved. To add a safety factor, all materials are stable to over 600°C.



#### INVERSE VOLTAGE CHARACTERISTICS

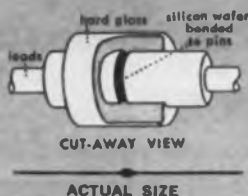
In this circuit, a .05µf condenser charged to 3000V discharges into the diode in the *inverse* direction. With no degradation, the Unitrode conducts current in the *zener* (breakdown) region until the transient voltage drops to the 600V level. Heat due to zener currents and voltage concentrations, is immediately dissipated across the wafer and out through the pins. Elimination of internal voids prevents arcing.



#### HIGH TEMPERATURE OPERATION

A Unitrode rated at 3 amps at 25°C will conduct 1.5 amps at 150°C, 300ma at 250°C, and will withstand 25 amp surges at 150°C, because of the high temperature materials used and the high thermal conductivity of the package. Since all materials have the same low coefficient of expansion, Unitrodes easily withstand thermal shock from -195°C to +300°C. No heat sinks are required. Unitrodes need only the thermal mounting of a 2 watt resistor.

Both faces of the silicon wafer are bonded throughout their entire surfaces to the terminal pins. A hard glass sleeve is fused to all exposed silicon and terminal pin surfaces to positively exclude any space, air, or contaminants. The volume is approximately 1/4 that of other glass package diodes, and 2% of stud-mounted rectifiers.



#### RATINGS

Single diodes:  
10 milliamperes to 3 amperes  
50 volts to 800 volts

Miniature potted assemblies:  
Full wave rectifiers and bridges:  
50 volts to 5000 volts  
Selected matched pairs and quads for bridge and ring modulators:  
1 milliamperes to 50 milliamperes

Stacks (strings):  
1000 volts to 20,000 volts

Storage and operating temperature:  
-195°C to +300°C

Unitrodes are presently being specified for extremely difficult circuit applications, trouble spots, and retro-fit programs requiring extreme reliability against overloads in both directions and continuous operation in elevated ambients.

Price is comparable to the rectifiers you are now using. Write for full data. Send for Unitrode samples to meet your needs.

# Unitrode

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CIRCLE 15 ON READER-SERVICE CARD

## NEWS

# SIGNIFICANT BITS

Important Industry News Written For Fast Scanning by Engineers

Research spending in the United States will amount to almost \$16 billion next year, according to George W. James, economist for the Battelle Memorial Institute, Columbus, Ohio. The total for 1960, he said, was \$14 billion, and that for 1950 only \$3 billion. Mr. James estimated that 1962 spending would include: government research, \$10 billion; industry, \$5.5 billion; and universities and foundations, \$350 million.

0001

Tough nonmagnetic and corrosion-resistant alloys have been developed by Navy scientists. The alloys, named Nitinol, are based on the intermetallic compound TiNi (a combination of titanium and nickel). Nitinol can be hardened to 62 Rockwell "C." The new alloys are expected to find uses in aircraft and space components by virtue of their low density, toughness and strength over a wide temperature range. They are easy to weld, according to reports from the Magnetic Materials Div. of the Naval Ordnance Laboratory, Silver Spring, Md.

0010

Regional instrumentation centers for biological and medical research have been promised limited federal assistance. The National Institutes of Health will support development of such centers, beginning next year. The proposed centers, which would include electronic data-processing equipment, could serve scattered research laboratories, the U. S. agency pointed out.

0011

Modular arithmetic for computers promises to speed multiplications, additions and subtractions by eliminating the carry term used in conventional binary arithmetic. The

idea behind the use of this approach by the computer group at Lockheed Missiles & Space Co. is based on a 2,000-year-old Chinese theorem on remainders, recently revived in a Czech scientific journal by a Czech mathematician. Harvard's Howard Aiken, a Lockheed consultant, picked up the idea and suggested its application.

0100

**Design work** on a high-powered vlf radio transmitter for fleet communications in the Pacific has been awarded by the Navy to Continental Electronics Manufacturing Co., of Dallas, a subsidiary of Ling-Temco-Vought, Inc. The facility, destined for Australia, will be similar to the Navy's most powerful radio station—a 2-million-w transmitter in Cutler, Me.

0101

**Ground-based optical techniques** for detection of nuclear explosions in space will be developed by Geophysics Corp. of America, Bedford, Mass., under an Air Force contract. The proposed technique is based on observation of the scattering of sunlight by the debris which results from the nuclear blast.

0110

**An undisclosed number** of advanced video magnetic tape recorders will be made by Ampex Corp., Redwood City, Calif., under a \$500,000 contract from Bell Telephone Laboratories. The recorders are for the Army's Nike-Zeus anti-missile program, for which Bell Laboratories has systems-design responsibility. Western Electric Co. is prime contractor.

0111

**The post of assistant secretary** of commerce for science and technology probably will be created by the next session of Congress. An administration request for such a position was killed by the House of Representatives during the last session.



IN ELECTRICAL CONNECTORS, TOO



### Craftsmanship produces enduring quality

For over three centuries, the Stradivarius has provided unmatched violin quality, reflecting the integrity of its maker. Similarly, companies today achieve their goals—or fall short—through varying degrees of quality and integrity.

Bendix® Electrical Connectors, made by the Scintilla Division, are recognized by their users as products of the highest quality—with no premium in cost. If connector quality interests you, write us at Sidney, N. Y.

**Scintilla Division**



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# Shop here for Relays

## Block that shock!

Leach balanced-armature relays provide high resistance to shock (50 G's) and vibration (15 G's to 2000 cps) in 5 to 15 amp switching. They meet or exceed MIL-R-6106C, MIL-R-25018, and MIL-R-5757C. Choose from 4,000 variations of 20 basic types!

Bulletin BA-859.



## Complete line of subminiatures for sale

Leach crystal can relays give you big performance in small packages in every standard relay configuration. Standard, Half-Size, Sensitive and Magnetic Latch in 0.20 inch grid spacing and "lazy S" header. Each type is capable of switching loads from low level to 2 amp in aerospace and electronic control applications. Bulletin CC-861.



## It's what's inside that counts in time delay relays

Especially when milliseconds count! Note the printed circuit construction of Leach's optional output time delay relays. This economical line of off-the-shelf electronic units includes time delays on release and time delays on operate—in a timing range of 100 milliseconds to 60 seconds. These standard components are available with fixed or adjustable timing to meet your most critical requirements. And they're all 100% inspected during manufacture for highest reliability! Bulletin TD-200.



## LEACH literature anyone?

Write for bulletins, write for information, write for details and specifications. Or mail your request on the Reader-Service Card.

## Not a square in the whole family!



When only a round can relay will fit your need, Leach offers this family group in contact configurations of 2, 4 and 6 PDT and in contact ratings ranging from dry circuit to 10 amps. Bulletin RC-300

## Need help fast?

Sales engineers in Leach District Sales Offices are eager to help you with critical application problems, or to see that you get fast delivery on prototype quantities from nearby Leach Distributors.

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CIRCLE 17 ON READER-SERVICE CARD

## NEWS

### Optical Electronics To Highlight NEREM

*Talks Set on Light Modulation, Demodulation and Harmonics*

**D**EVELOPMENTS that ride the boundary between electronics and optics will be prominent among topics for discussion at the 15th Northeast Electronics Research and Engineering Meeting (NEREM), to be held next week in Boston.

Microwave modulation of light through use of the Pockels electro-optic effect is scheduled to be described by I. P. Kaminow, Bell Telephone Laboratories, Inc., Holmdel, N. J. At Bell Laboratories, an experimental modulator, using potassium dihydrogen phosphate crystals (KDP), has been operated in a pulsed mode at 9.25 Gc as part of an effort to develop optical communication systems.

According to Mr. Kaminow, about 2 kw are required to produce a peak phase retardation of 1.9 radians. To achieve modulation, the KDP crystal is placed in a microwave cavity where the forward wave component of the cavity standing wave in effect causes the crystal to rotate the polarization vectors of light passing through it. The light first passes through a polarizer; after modulation, it passes through an analyzer.

#### Microwave-Modulated Light Demodulated With Photoconductors and Phototubes

A method of demodulation of microwave-modulated light from optical masers through use of semiconductor photodetectors and microwave phototubes will be described by A. E. Siegman of Stanford University, Palo Alto, Calif.

At Stanford, the output from a ruby laser was fired at an improvised phototube consisting of a 2-4 Gc traveling-wave tube whose cathode was visible through the glass envelope. Photocurrent pulses of from 1  $\mu$ a to 500  $\mu$ a were measured at the cathode and strong outputs were obtained at intervals from 1.8 to 4.2 Gc. The microwave signals were coherent and nearly monochromatic.

Mr. Siegman also plans to discuss a novel microwave-discriminator phototube for demodulating frequency-modulated coherent light.

A third optical technique, the generation

of optical harmonics is scheduled to be described by researchers of the University of Michigan, Ann Arbor. By focussing a beam from a pulsed ruby optical maser inside crystalline quartz, the Michigan investigators achieved a second harmonic of the fundamental laser beam. The laser produced about 3 joules of light in a 1-mc pulse at 6,943 Å. Detectable amounts of the optical second harmonic were present at about 3,472 Å.

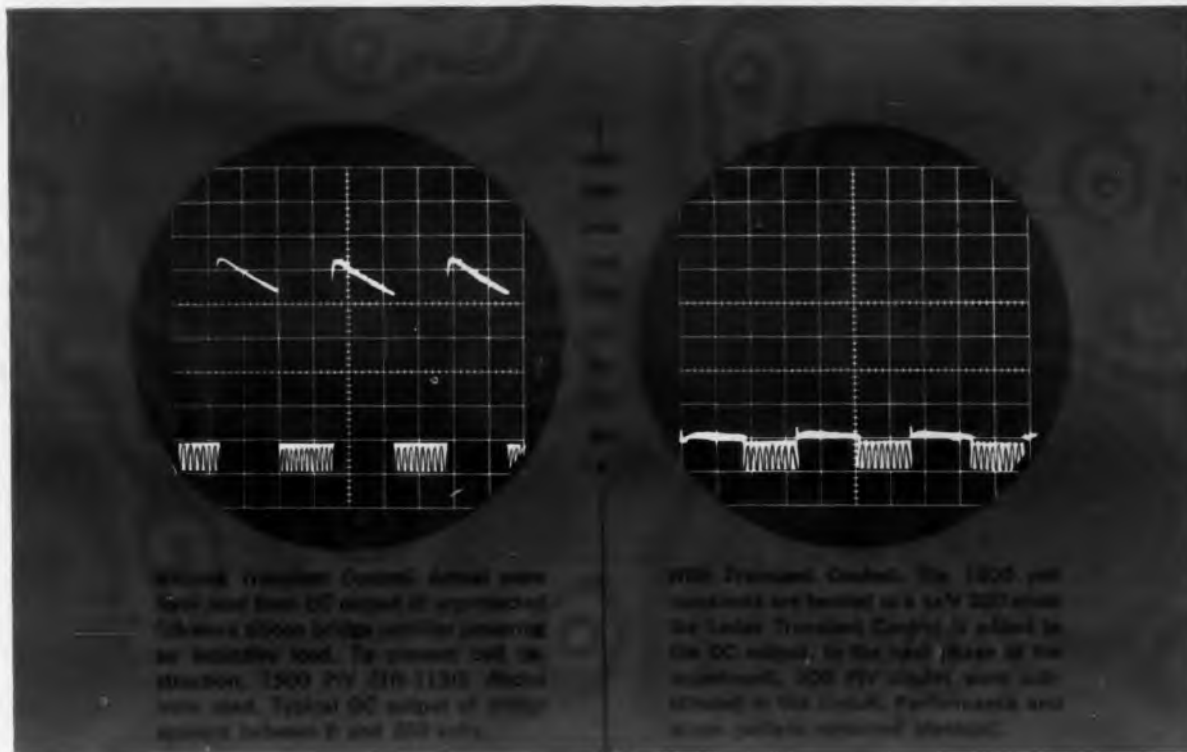
In addition to quartz crystals, the researchers have found that KDP, ADP, and triglycerin sulphate also are effective in producing harmonics.

The meeting will be held at Boston's Commonwealth Armory; the headquarters hotel is the Somerset. About 15,000 persons are expected to participate. NEREM this year will offer about 400 exhibits and some 90 technical papers. Among scheduled speakers are J. A. Volpe, the governor of Massachusetts and J. L. Burns, president of Radio Corp. of America, and Charles H. Townes, new provost of Massachusetts Institute of Technology. ■ ■

### Test Transformer Unveiled



Tests for corona starts, flash over, dielectric breakdown voltage and related electrical properties will be performed by this high-voltage transformer. The equipment was installed by Ceramaseal, Inc., New Lebanon Center, N.Y., as a service for purchasers of bushings and terminals, and for its own research. The equipment includes a Peschel Electronics 150-kv (rms) test transformer and cathode-ray oscilloscope-type corona detector. Transformer and detection circuitry are inside a copper-screen enclosure to reduce interference effects.



## New low-cost Transient Control\* makes silicon rectifiers reliable by clipping voltage spikes

The new Ledex Transient Control guarantees positive dependability of 200 PIV silicon rectifiers. It's a non-polarized device that automatically clips voltage spikes by providing a low resistance shunt for all potentials above 200 volts—on the AC or DC side. It draws no current in normal operation.

As shown in the actual scope shots above, the control will repeatedly clip transients or reverse voltages to a safe level of 200. To the design engineer, it is a guarantee that the maximum voltage will go no higher than 200. Compact, light, and economical, the new development puts low-cost 200 PIV diodes in a reliability class of their own.

While the device is mainly intended for protection of 115 VAC silicon rectifier circuits, it can also be designed to clip spikes and protect other semi-conductor circuits at lower or higher control voltages.

**NEW LEDEX TRANSIENT CONTROL** is small ( $\frac{3}{4}$ " dia. by  $1\frac{3}{8}$ " long), lightweight ( $\frac{2}{3}$  oz.) low cost (\$1.60 to \$2.05 in small quantities). Part No. A-46800-001 has 200 volt control and 2" leads.



**NEW LEDEX SILICON BRIDGE RECTIFIER** is protected by a built-in Ledex Transient Control. Voltage spikes are automatically clipped at 200. The rectifier is sealed in epoxy resin and meets the general requirements of MIL-E-5400 on insulation, terminals, vibration, shock, sand and dust, fungus and salt atmosphere. Operating temperature is  $-65^{\circ}\text{C}$  to  $+120^{\circ}\text{C}$ . Part No. A-46501-001 is rated as follows: 115 volt AC input, 100 volt DC output, maximum surge 50 amp for 8 msec. \$6.80 to \$8.15 in small quantities.

**VALUE ANALYSIS RECTIFIER TRANSIENT CONTROL KIT** consists of Transient Control, Silicon Rectifier with built-in Control and outline for evaluation tests to compare costs and reliability with your present circuits. Part No. A-47609-001. \$11.00 per kit.

Other Ledex products are ready to go to work as compact solutions to your actuating, stepping or circuit switching applications.

**FOR LITERATURE**, clip this ad, check boxes above, attach to your letterhead and mail to Ledex Inc., Dayton 2, Ohio; Marsland Engineering, Ltd., Kitchener, Ont.; NSF Ltd., 31 Alfred Place, London, Eng.; AEMGP, 115 Ave. Clement, Boulogne, France.

\*PAT. PENDING



CIRCLE 18 ON READER-SERVICE CARD

# MAG AMPS



## Confidence in a quality product

The fast response, wide dynamic range, high gain and light weight of an Airpax MAG AMP provide the systems engineer with that extra degree of versatility which permits a successful design rather than a marginal system.



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CIRCLE 19 ON READER-SERVICE CARD

## WASHINGTON REPORT



Wilbur H. Baldinger  
Washington Editor

### DEFENSE R&D BEING SHIFTED TO GOVERNMENT LABS

The administration is quietly beginning to divert electronic research and design from private contractors to government laboratories under military management and supervision.

This is no wholesale reversal of the Eisenhower policy of farming out such R&D work to industry and "nonprofit" companies. But a trend to in-house laboratory work has been discernible as a result of a directive from Secretary of Defense Robert S. MacNamara. The secretary expressed "profound concern" over Pentagon R&D policy.

A drive to beef up government R&D facilities has been signalled by Dr. Harold Brown, the Pentagon's research and engineering director. In what had been billed as merely a pep talk for personnel at the Anacostia Naval Research Laboratory, Dr. Brown spelled out some of the Kennedy administration's thoughts. Rarely has a high defense official spoken with such candor outside the Pentagon corridors about a subject that has long disturbed military scientists.

Dr. Brown told the Anacostia weapons developers that he is aware of "bad" morale at such government installations. He said the causes of bitterness and frustration—lack of recognition, poor Pentagon management and low pay—now are recognized officially, and that the Pentagon intends to do something to eliminate them.

The weapons research chief did not promise that all of the 100-odd in-house defense establishments would be upgraded immediately at the expense of outside contract work. The speech acknowledged valid arguments for both types of research, but made the weightier case for the Defense Dept's own shops.

Dr. Brown said that in view of urgent needs, most of the Pentagon's billion-dollar spending program had properly been contracted to private industry—which includes 350 small companies set up during the Eisenhower years to perform government services. But he also promised that the Pentagon is going to have strong laboratories of its own, staffed by first-rate (and better paid) workers who will do their jobs with a new feeling of importance—and provide expert supervision over projects farmed out to industry.

### SHOWDOWN DUE IN FIGHT ON PATENT RIGHTS

A smoldering controversy over conflicting patent policies of federal agencies is heading for a showdown in the next session of Congress. Inventors who claim rights to patents developed under government contracts may get some legislative breaks.

Emilio Q. Daddario (D-Conn.), chairman of the House Space Subcommittee on Patents, predicts the panel will endorse his bill to relax patent practices of the National Aeronautics and Space Administration (See *ED*, Oct. 11, p 20). NASA now is required by law to retain title to most patents resulting from farmed-out re-



search. Final hearings on the Daddario bill are set for December—just before Congress comes back.

"We cannot hobble the inventive power of our industry," Daddario told the National Association of Manufacturers' patents committee at a luncheon meeting marking the 125th anniversary of the U.S. patent system. "We must encourage initiative and the useful contributions that all in the free world can make."

#### **The effect of government restrictions** on the rights of researchers, Rep.

Daddario said, is "to retard the interest of American enterprise to invent—and particularly to deter small business from entering into research contracts with the U.S. government."

On the Senate side, John L. McClellan (D-Ark.), chairman of the Judiciary Subcommittee on Patents, says it is high time for action: "If the government is to have a consistent policy, the Congress will have to decide whether ownership of these inventions should reside in the contractor or the government."

The McClellan subcommittee is drafting a unified patent-policy bill. The subcommittee began to move after issuing a report on patent practices of the Defense Dept. Unlike NASA, Defense permits most contractors to retain commercial rights to inventions, although royalty-free licenses go to the government.

#### **ELECTRONIC DEVICE READS FOR THE BLIND**

After four years of work, the Veterans Administration and researchers at the Mauch Research Laboratories, Inc., Dayton, and Battelle Memorial Institute, Columbus, Ohio, have come up with machines that enable the blind to read without Braille. Demonstrated at a VA press conference, the electronic gadgets are designed to translate written characters into sounds of actual words or into a special musical alphabet. Dr. Robert E. Stuart of the VA expressed "cautious optimism" about developmental prospects. He said it may be many years before a compact, low-cost aural reading aid is available.

#### **PROMISING REPORT CARD ON TEACHING MACHINES**

There is no technical reason why digital computers cannot equal or surpass capabilities of classroom teachers, J. E. Coulson of System Development Corp. argued at a three-day Washington symposium, co-sponsored by the Office of Naval Research.

Properly programmed machines of the future will be as informed, flexible, sophisticated, subtle and responsive to individual needs of students as skilled instructors themselves, Mr. Coulson said. He conceded that such devices are as far beyond present prototype teaching machines as computers are beyond adding machines.

But Mr. Coulson predicted the machines will be used not only to take the roll, give tests and grade papers but also to argue Greek philosophy, teach idiomatic languages, pose complex mathematical questions and answer them—and still not be taxed beyond their educational capacities.

#### **CAPITAL CAPSULES**

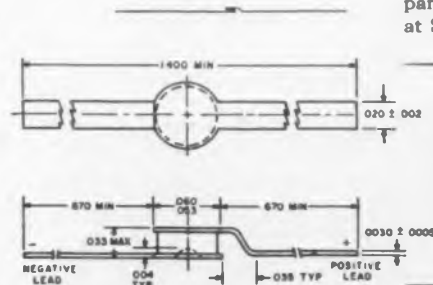
The Army has tracked down the culprit responsible for a \$7.4-million excess supply order in Europe. It was a calculating machine whose wires got crossed ■ ■ ■ The Diamond Ordnance Fuze Laboratory has developed an automatic sensing device as part of the trigger for anti-missile warheads.



## semiconductor products news

### **Good Things Come in Small Packages**

... is an old saying often used by mothers and fathers who don't want to give the kids too much candy. Big things are nice in their place too, of course, like say a Rolls Royce, or a Chris Craft. But when you're designing very high speed computer circuits, you've got to agree with Mom and Dad. Small packages are important. And the new G-E MSD-150 micro-miniature silicon switching diode is a perfect case in point. *Planar Epitaxial Passivated* construction makes possible a diode having high conductance, fast recovery time, low leakage and low capacitance combined with improved uniformity and reliability. Minimum conductance is 50 ma at one volt; recovery time is less than 2 nanoseconds. And just try this outline drawing on for size:



The standard subminiature SD-150 PEP diode is available in matched pairs and matched quads for highest performance and reliability in discriminators, gates, choppers, ring modulators and bridge modulators. Just ask for complete information on G-E PEP diodes when you write to Section 11K112.

**QUESTION:** *Where can I get a Planar Epitaxial Passivated silicon transistor with the lowest  $V_{CB}$  (sat.) which will replace standard units without changing circuits?*

**ANSWER:** *At G-E, of course. Ask about the new 2N2193-2195 PEP transistors, with "A" versions.*

### **The Power-Size Ratio**

There wouldn't be much sense in putting a 350 hp motor in a Volkswagen.

CIRCLE 20 ON READER-SERVICE CARD

matching a tall lightweight with a short heavyweight, sending a boy to do a man's job, or arguing with the swift, sure logic of a woman. What would it get you? But putting 15 watts power dissipation at 25°C case temperature into a compact, rugged and reliable silicon power transistor gets you a power-size ratio that means important benefits in aircraft servo and industrial power supply applications. The new G-E 2N2201-2204, 2N2196-2197 series and other types offer you 16 different devices in your choice of 4 different packages to satisfy your particular circuit requirements. Applications include:

- servos
- power supplies
- dc to dc converters
- dc to ac inverters
- static switching

We also have an interesting hi-fi circuit developed using the 2N2196. We'll part with it for free. Just write to us at Section 11K112.

Now hear this: a germanium epitaxial mesa transistor with typical 45 nanosecond switching speed in conservative circuitry and Beta of 60, in a TO-18 package... and available now! Ask your District Sales Manager about the new G-E 2N994. You'll be glad you did.



Need specs? Have questions? Write Semiconductor Products Department, Section 11K112, General Electric Company, Electronics Park, Syracuse, New York. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: International General Electric, 150 East 42nd St., New York 17, N.Y.



## GENERAL ELECTRIC

NEWS

## Transportable Electronics Built For Rugged Treatment

*Mobility has become a primary concept in the design of electronic systems for national defense. Tight packaging techniques, ruggedized design approaches, and human engineering are some of the major considerations that must be used by the design engineer working on equipment to be built for air-drops or movement over rugged terrain. Here are some examples of the systems being readied for possible military needs.*



**A fifth-wheel, odometer-type ground navigator for mobile missiles has passed road tests successfully. A Chrysler Corp. fifth-wheel odometer was hitched to an inertial-reference system made by Kearfott Div. of General Precision, Inc., Little Falls, N. J. Technicians are shown during the road tests, run at 50 mph over varied terrain. The passive navigator is designed to fix launching positions for inertially guided mobile missiles.**



**Air-transportable terminal station, above, and mobile field subscriber station, left, are part of the Army's Strategic Army Communication (STARCOM) network. A family of three sideband-type systems, varying in power and channel capacity, were built for the Army by Adler Electronics, Inc., New Rochelle, N. Y. The AN/TSC-18, 19 and 20 provide, respectively, ranges of 7,000; 5,000; and 2,500 miles. The AN/TSC-18 and 19 each provide 3 voice and 16 teletype channels, and the remaining system has 1 voice and 3 teletype channels. Facsimile equipment in all three versions of the system allow sending of photographs. Spare parts for the Army's fixed communications equipment can be used with the new transportable systems. World-wide communications would be possible with the STARCOM net from remote areas without fixed communications.**

(Advertisement)

NEW PRODUCT  
**Solder BANTAM**  
Miniature Round Connector



BURNDY now has available to the industry its BANTAM miniature round connector which conforms to the requirements of MIL-C-0026482A (WEP). These connectors are supplied with a variety of insert configurations in nine shell sizes. Number 16 and 20 size contacts are supplied depending on the insert configurations.

The miniature solder BANTAM mates with, or replaces, all connectors which conform to MIL-C-0026482A (WEP).

BANTAM plug and receptacles feature the TRI-LOK bayonet coupling, a positive coupling which can be quickly disconnected. They are vibration resistant and moisture-proof with the required temperature range of  $-67$  to  $+257$  degrees F. They provide an interfacial seal, per the military spec and the need for safety wiring is eliminated by the positive locking bayonet coupling. Polarized inserts and a five point key and keyway eliminate the possibility of mismatching.

BANTAM contacts are machined of high conductivity copper alloy and the sockets feature closed-entry, making them probe-proof. Extra heavy gold silver plating provides high conductivity and extra protection against corrosion. In addition, plating of contacts provides hard gold mating with soft gold, adding durability and minimizing galling. Special plating can be provided.

Solder BANTAM shells are fabricated of a high strength aluminum alloy. The standard finish is cadmium plate, type II, class C, per QQ-P-416, with olive drab iridite finish. Other finish plating can be provided.

For further information consult:

BURNDY, Norwalk, Connecticut.

CIRCLE 21 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

# COAXIAL *feed-thru* HYFEN

- Crimp-type contacts
- Quick disconnect
- Single feed-thru



BURNDY has developed the Coaxial Feed-Thru HYFEN to provide a new solderless, quick-disconnect, single feed-thru connector using proven coax HYFEN® contacts. Installed cost lower than most BNC type panel connectors, the new BURNDY series offers maximum mounting configurations requiring a minimum of components.

FEATURES: ■ connected with standard HYFEN installation tooling. ■ made of tough, lightweight plastic (Polystyrene TMDA 2122) with molded-in ferrules for positive contact retention. ■ receptacle shells are available with either flange or nut mountings. ■ plastic shells will prevent electrolytic corrosion.

For full details and complete technical specifications, contact OMATON DIVISION

# BURNDY

NORWALK, CONNECT. BICC-BURNDY Ltd. Prescott, Lancs., England In Europe: Malines, Belgium TORONTO, CANADA  
CIRCLE 22 ON READER-SERVICE CARD



another  
advance  
in

vibration/shock/noise control



## BTR<sup>®</sup> Elastomeric Mountings

*the answer to high reliability for sensitive  
instruments, guidance systems, electronic equipment*

**A**re you concerned with high reliability for equipment with low vibration/shock tolerance? Is your application on aircraft, missiles, space craft or ground support equipment?

Then here's the vibration isolator that gives you everything you need.

LORD BTR (Broad Temperature Range) Elastomeric Mountings cushion high G shock loads, isolate vibration to 2000 cps, give all-attitude protection, limit resonant amplification to approximately three or less. And this performance is unaffected by extreme environments and temperatures from  $-65^{\circ}$  to  $+300^{\circ}$  F. Size for size, ounce for ounce, they pack more load-carrying and energy-storage capacity than any other isolator.

Performance has been repeatedly proved on the most difficult applications. Even ultra-sensitive inertial guidance systems on operational ICBM's are now protected by *standard* production BTR Mountings.

Utilize this advance in vibration/shock/noise control to achieve higher reliability for your project.

Information on BTR Elastomeric Mountings is contained in Bulletin 301, available from your nearest LORD Field Engineering Office or the Home Office, Erie, Pa.



#### FIELD ENGINEERING OFFICES

ATLANTA, GEORGIA - Cedar 7 9247  
BOSTON, MASS. - Hancock 6-9135  
CHICAGO, ILL. - Michigan 2-6010  
DALLAS, TEXAS - Riverside 1-3392  
DAYTON, OHIO - Baldwin 4-0351  
DETROIT, MICH. - Elgin 7-2150  
KANSAS CITY, MO. - Westport 1-0138

LOS ANGELES, CAL. - Hollywood 4-7593  
NEW YORK, N. Y. (Paramus, N. J.)  
New York City - Bryant 9-8042  
Paramus, N. J. - Diamond 3-5333  
PHILADELPHIA, PA. - PEnnsylvania 3-3559  
SAN FRANCISCO, CAL. - EXbrook 7-6280  
WINTER PARK, FLA. - Midway 7-9501

\*In Canada - Railway & Power Engineering Corporation Limited

**LORD MANUFACTURING COMPANY • ERIE, PA.**

CIRCLE 23 ON READER-SERVICE CARD

## NEWS

### Radiometer to Investigate Re-Entry Plasma Sheath

Hot ionized gases (plasmas), that form about the body of a space craft re-entering the atmosphere, are creating a communications problem. Radio signals over a wide frequency range are severely attenuated by the plasmas.

To investigate this phenomenon, the Air Force Cambridge Research Laboratories, Hanscom Field, Mass., will send sensitive radiometers aloft on re-entry vehicles.

The radiometers are miniature, transistorized, crystal radio receivers capable of detecting the very small plasma noise. The Dickety radiometer compares the plasma noise to a reference-noise source within the receiver.

The radiometer was designed to operate over a wide range of frequencies by changing only the rf components. The first package will operate at 2,000 mc with an input bandwidth of 200 mc and a switching rate of 1,000 cps.

### Oil-Pipe Mill Automated



This fully automatic pipe-weighing, measuring and identification system processes heavy oil-field pipe at the rate of one piece every 18 to 36 sec. The system, developed by Baldwin-Lima-Hamilton Corp.'s Industrial Equipment Div., Eddystone, Pa., handles pipe up to 10-3/4 in. in diam and 50 ft 2 in. in length. According to BLH, the system enables one part-time attendant to do the work of a crew of four to eight men.

## Reservations Network For TWA to Cover Globe

Trans World Airlines has ordered the first intercontinental electronic airline reservation system. The first link—to Europe—is scheduled for operation within 15 months. Eventually, all TWA offices will be connected.

Called Teleflite, the new system, developed by Teleregister Corp., Stamford, Conn., will transact in seconds the reservations that used to require 45 min to 2 hr.

One of the design features, which lends speed to the data transmission, is a communications terminal that permits teletype messages to be introduced into the computer directly from the communications lines instead of having to go through a paper-tape loop.

Reservations messages from overseas will come into the Teleflite center via teletype. There will be no manual handling of the messages once they are transmitted.

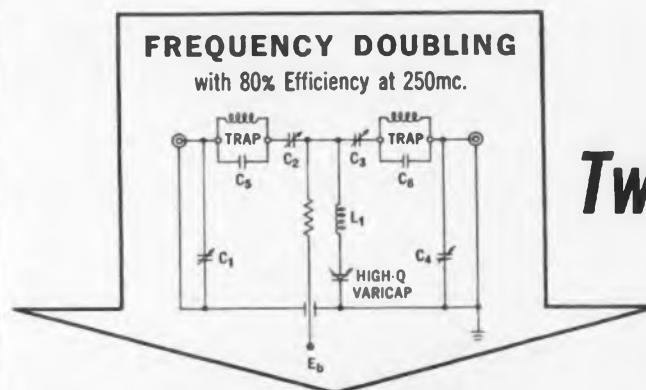
Two real-time computers will process and respond to all in-puts the moment they are received. Two core memories will store 32,000 decimal digits. Initially there will be four drums, each storing over 1,000,000 bits.

The TWA Teleflite system has been designed by Teleregister on a building-block concept. This permits gradual expansion of storage and processing capabilities to keep pace with increasing traffic.

## Designers Use Blackboards



An engineering method, called the Panoramic Design Technique, is said to cut engineering, design and drafting costs from 33 to 50 per cent. Engineers put their designs directly on wall-size blackboards and record them photographically. A project shown in its entirety permits engineers to see how their portion of a design fits the whole pattern. The technique was developed by TAB Engineers, Inc., Chicago.



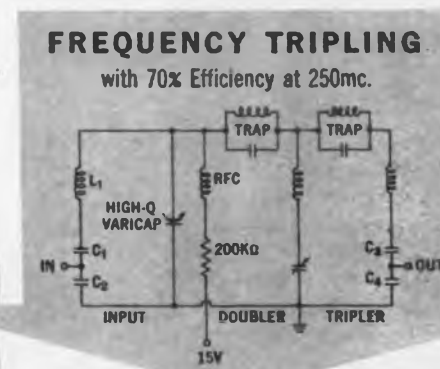
**HIGH POWER-HIGH FREQUENCY**

# POWER GENERATION

with the *PSI High-Q Varicap*

*These new Varicap frequency multipliers in PSI-designed circuitry now make it a simple matter to attain high RF output power in the kilomegacycle range... with high efficiency!*

*Two new approaches...*



The combination of a high figure of merit (Q) and high maximum working voltage (MWV) in conjunction with high performance PSI transistors make these devices ideally suited for harmonic power generation. Note the examples of high efficiency circuits shown above.

These ten new High-Q Varicap types, all available on prompt delivery schedules, give the designer a wide selection of electrical characteristics — capacitance from 6.5 to 47pf, Q values from 50 to 124 and working voltages from 25 to 100V.

The High-Q Varicap frequency multiplier concept and its associated circuitry is original with PSI... another example of why it will pay you to "look first to PSI!"

For complete specifications, prices and delivery, phone, wire or write a PSI field office near you.

VARICAP TYPE	Capacitance (pF) @ 4Vdc (50 mc)	Figure of Merit (Q) @ 4Vdc (50 mc)	Max. Work. Voltage (Vdc)	Min. Saturation Volt. @ 100µA (Vdc)	Maximum Inverse Current (µA dc)	Minimum Capacitance Ratio
PC 113	22	50	80	90	0.5 @ 50V	$C_{2V}/C_{50V} > 4.0$
PC 114	47	50	80	90	0.5 @ 50V	$C_{2V}/C_{50V} > 4.0$
PC 115	10	100	100	110	0.5 @ 75V	$C_{2V}/C_{100V} > 5.2$
PC 122	47	75	100	110	0.5 @ 76V	$C_{2V}/C_{100V} > 5.2$
PC 124	15	125	50	60	0.5 @ 30V	$C_{2V}/C_{50V} > 4.0$
PC 126	15	100	100	110	0.5 @ 75V	$C_{2V}/C_{100V} > 5.2$
PC 128	33	125	50	60	0.5 @ 30V	$C_{2V}/C_{50V} > 4.0$
PC 129	33	50	80	90	0.5 @ 50V	$C_{2V}/C_{50V} > 4.0$
PC 133	22	50	25	30	0.5 @ 10V	$C_{2V}/C_{50V} > 3.0$
PC 141	6.5 (±1.5pf)	125	100	110	0.5 @ 75V	$C_{2V}/C_{100V} > 5.2$

- $C = K (E_s \pm 0.7 \text{ Vdc})^{-n}$  Typical Voltage Sensitivity  $n = 0.48$
- Maximum Operating Temperature: 150°C.
- Capacitance tolerance of 10% available on request.
- All capacitance values are ±20%. All values at 25°C.
- These devices are characterized by 500mW power dissipation in standard package. Up to 750mW power dissipation is available on request.

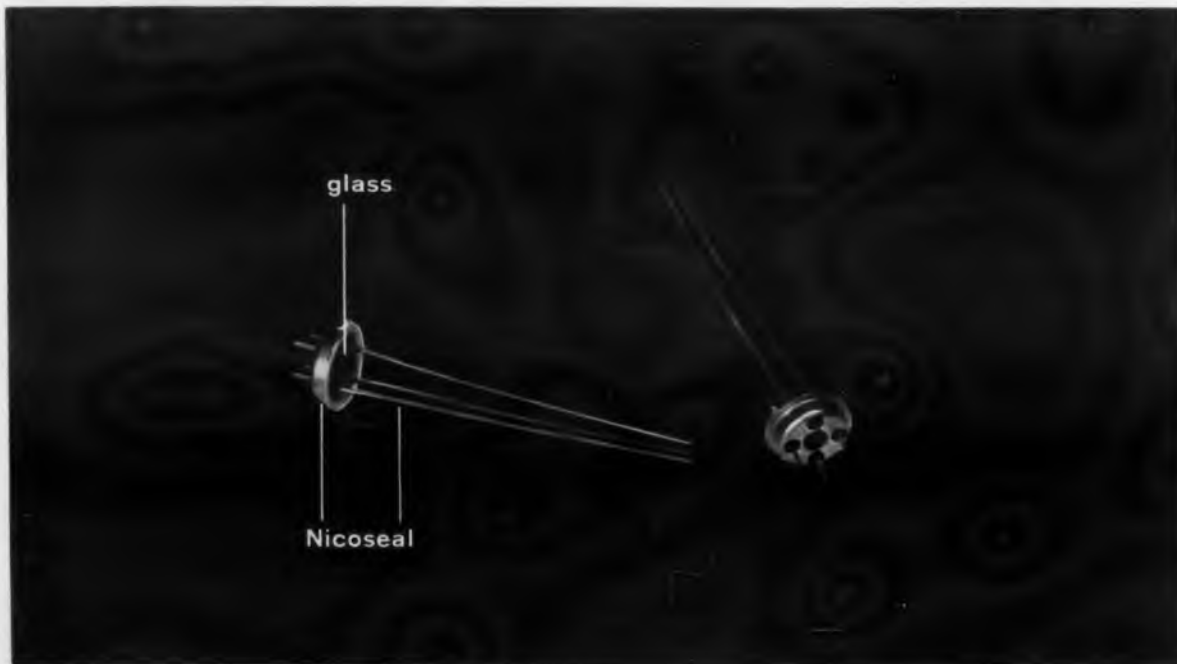


**Pacific Semiconductors, Inc.**

12955 CHADRON AVENUE, HAWTHORNE, CALIFORNIA  
A subsidiary of Thomson Ramo Wooldridge Inc.

Varicap is the registered trademark of silicon voltage-variable capacitors manufactured by Pacific Semiconductors, Inc.

CIRCLE 24 ON READER-SERVICE CARD



Reliability is built into these Type TO-5 transistor headers by using Carpenter VacuMeltrol NICOSEAL alloy for leads and eyelets. NICOSEAL matches commercially hard glasses to provide a stress-free or matched type seal for dependable transistor performance in computers, communication equipment and other precise instrumentation.

matching metal to glass is a *Carpenter* specialty

*In glass sealing alloys, Carpenter offers transistor and other electrical and electronic manufacturers the widest range available from any producer.*

*Excellent deep drawing on strip and better machinability on bar and wire items are extra benefits you get with Carpenter's broad selectivity. Grain size and orientation — directional physical properties—are precisely controlled to eliminate "orange peel" and "earing", and assure you uniform working and performance characteristics on every order.*

*Nico seal (above) is just one of many Carpenter alloys designed to match hard and soft glasses for specific glass sealing problems. All are covered in a new, 34-page technical booklet, "Electronic Alloys Simplified", now available through your Carpenter representative or from The Carpenter Steel Company, 145 W. Bern Street, Reading, Pa.*

## *Carpenter* steel

you can make it **consistently** better with Carpenter Specialty Steels for specialists



The Carpenter Steel Company, Main Office and Mills, Reading, Pa.  
Export Dept., Port Washington, N.Y.—"CARSTEELCO"

Alloy Tube Division, Union, N. J.

Webb Wire Division, North Brunswick, N. J.

Carpenter Steel of New England, Inc., Bridgeport, Conn.

CIRCLE 25 ON READER-SERVICE CARD

## NEWS

### Designers' Datebook

1961 NOVEMBER 1961						
S	M	T	W	T	F	S
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1961 DECEMBER 1961						
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30						

#### November

- 12-16** Phoenix 7th Annual Conference on Magnetism and Magnetic Materials; Hotel Westward Ho; IRE, AIEE, AI Phys., ONR, AIME.
- 13-14** Boston Electrically Exploded Wires Conference; Kenmore Hotel; Air Force Cambridge Research Laboratories.
- 14** Kansas City Electronics Systems Reliability Symposium; Linda Hall Library Auditorium.
- 14-16** Boston NEREM Northeast Electronics Research and Engineering Meeting; Somerset Hotel and Commonwealth Armory; IRE.

- 26-Dec. 1** New York Mechanical Engineers' Winter Meeting; Statler-Hilton Hotel; ASME.

- 30-Dec. 1** Minneapolis 12th National Conference on Vehicular Communications, Radisson Hotel; PGVC.

#### December

- 12-14** Washington Eastern Joint Computer Conference; Sheraton Park Hotel; IRE, AIEE, ACM.

- 26-31** Denver Annual Meeting and Exposition of Science and Industry; Hilton Hotel; AAAS.

### Two Comb-Filter Systems To Detect Tracking Beacons

Two comb-filter spectrographic systems, to be developed by Itek Electro-Products Co., Cambridge, Mass., will be used in Bell Telephone Laboratories' space-communication program.

The comb-filter systems will be installed in the Rumford, Me., ground station and will detect the tracking beacon of the first commercial communications satellite, to be launched next April. The systems will survey a frequency spectrum supplied by a receiver, detect any Doppler returns and identify their frequency within a few cycles.



ENLARGED VIEW  
OF TYPE TR  
RESISTOR IS  
4 TIMES  
ACTUAL  
SIZE

New  
Dimensions  
in Sound...



## ALLEN-BRADLEY TYPE TR RESISTORS are STANDARD for today's miniaturized hearing aids

Because of the engineering ingenuity of the manufacturers, hearing aids have become so tiny they are hardly noticeable—since the principal objection to wearing a hearing aid has been overcome, ever increasing thousands are enjoying this remarkable contribution to the joy of hearing.

Allen-Bradley is proud to play a part in this important development. The extremely tiny Type TR fixed resistor (actually smaller than a grain of rice) is used by virtually every hearing aid manufacturer to help achieve today's amazing miniaturization—without sacrificing reliability!

Tiny as they are, these miniature resistors—made by Allen-Bradley's exclusive hot molding process—*have never experienced catastrophic failure in service*. They are remarkably "uniform" to their resistance rating. Therefore, you are only fair to yourself—and your customers—when you insist on the reliability of the A-B Type TR resistors.

For complete details, please send for Technical Bulletin 5001, and Publication 6024 which also includes information on other A-B space-saving electronic components.

### SOME OF THE MANUFACTURERS OF HEARING AIDS WHO RELY ON A-B TYPE TR RESISTORS

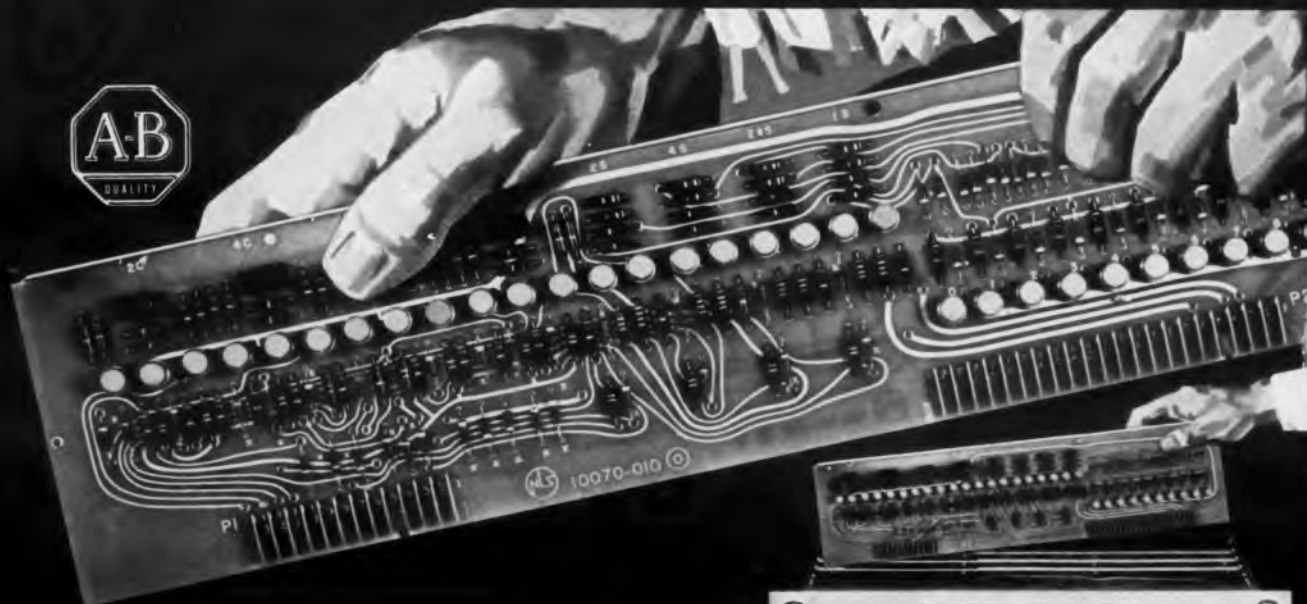
American Sound Products, Inc.  
Adivox, Inc.  
Beltone Hearing Aid Company  
Busse Electronics Company  
Dahlberg Company  
Dictograph Products, Inc.  
Electro Acoustic Research Labs., Ltd.  
Gem Ear Phone Co., Inc.  
Halhen Widex, Inc.  
Johnston Hearing Aid & Electronics, Inc.  
Maico Electronics, Inc.  
The Microtone Company  
E. A. Myers & Sons, Inc.  
Otarion Listener Corp.  
Qualitone Company, Inc.  
Sonotone Corp.  
Telex, Inc.  
Unex Laboratories  
Vari Electronics, Inc.

# ALLEN-BRADLEY

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.  
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

QUALITY  
ELECTRONIC COMPONENTS





Non-Linear Systems, Inc. designs first digital voltmeter to satisfy critical standards for missile work



Digital voltmeters — originated by NLS — permit rapid and accurate voltage measurements. New Series 20 unit — with one plug-in decade board removed — shows the use of Allen-Bradley fixed resistors.

## Resistor Failures UNHEARD OF

...naturally, NLS uses ALLEN-BRADLEY hot molded resistors

To satisfy the high standards of consistent accuracy and reliability demanded for missile and weapons checkout, Non-Linear Systems, Inc., developed this digital voltmeter. It uses scores of Allen-Bradley fixed resistors. (For example, the latest Series 20 unit, shown above, contains about 1,000 in each instrument.) "In the selection of A-B resistors," says NLS, "quality and availability have never been a problem."

A-B resistors have such consistently uniform electrical characteristics that their performance can be accurately predicted over long periods of time under various operating conditions . . . with *complete freedom* from catastrophic failure while in service! The hot molding process used exclusively by A-B is the reason for this uniformity and reliability.

To obtain this same measure of superior performance for your equipment, always insist on Allen-Bradley quality fixed resistors available in various types. For full details, send today for your copy of Technical Bulletin 5000 or Publication 6024. Write to: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.

# ALLEN-BRADLEY

### ALLEN-BRADLEY Hot Molded Resistors ACTUAL SIZE

Hot molded composition resistors are available in all standard EIA and MIL-R-11 resistance values and tolerances.

*\*Pending MIL Spec Assignment*

Type TR 1/10 Watt MIL Type RC 06\*

Type CB 1/4 Watt MIL Type RC 07

Type EB 1/2 Watt MIL Type RC 20

Type GB 1 Watt MIL Type RC 32

Type HB 2 Watt MIL Type RC 42

QUALITY  
ELECTRONIC COMPONENTS

D-61-6

## Marconi TV System Ordered By University of California

Experiments with a 4.5-in. image orthicon TV camera have been so successful at the University of California, Berkeley, that the college will expand educational TV facilities.

An 80-seat classroom has been set aside as a TV teaching laboratory; in addition, a number of lecture courses will be videotaped for subsequent playback.

A year ago, using a Marconi Mark IV camera and Zoomar lens, the university began televising various instructional activities and events around the campus. The Marconi camera televised physics lectures. Through a hook-up with the San Francisco TV-broadcast service, the lectures also could be seen by the public.

The order for installation was obtained by the Ampex Corp. of Redwood City, Calif., sole authorized distributors in the United States of Marconi broadcasting equipment.

## Space Power Unit Tested

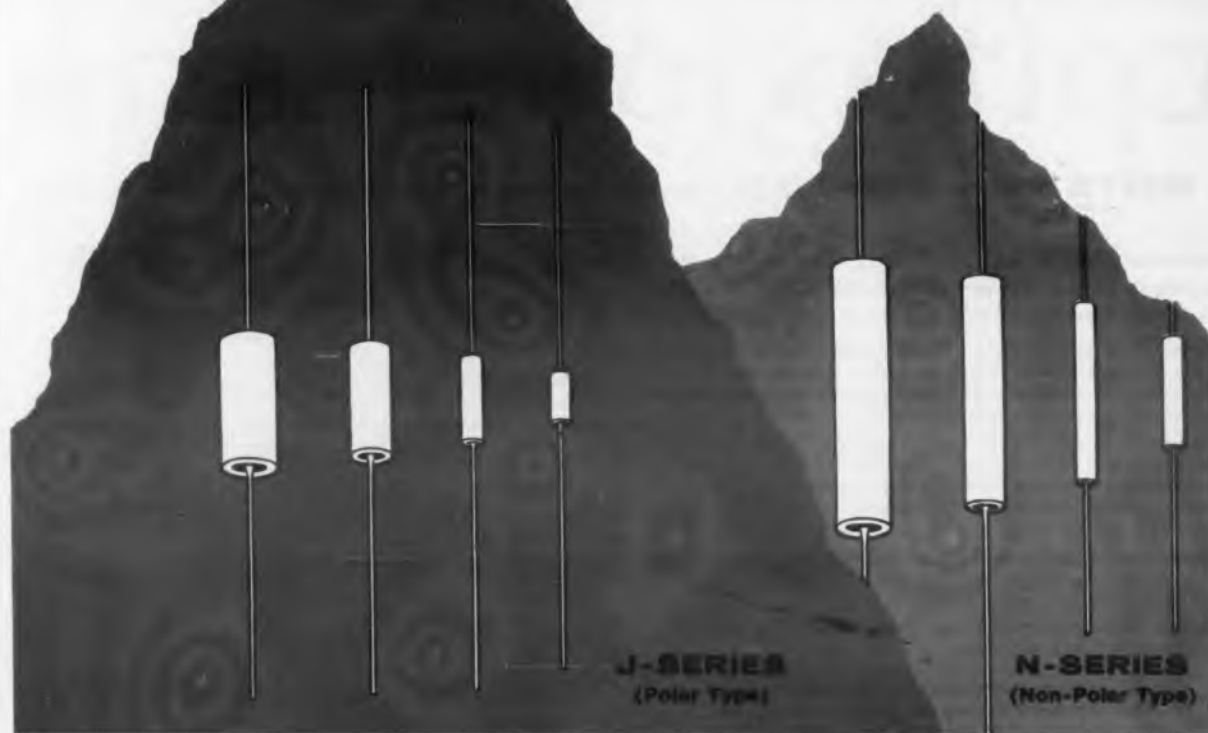


A nuclear thermoelectric power system, which uses the spontaneous decay of curium 242 to produce heat, will be used in space studies. The model shown by a researcher of Westinghouse Corp.'s Aerospace Dept., Lima, Ohio, is designed to produce 50 to 60 kw for three months on the moon's surface. During operation the high-junction temperature is 1,050 F, while the cold-junction temperature is 450 F. The curved shields are waste-heat radiators. Heat is transferred to the generator by liquid sodium potassium.

◀ CIRCLE 26 ON READER-SERVICE CARD

# 75<sup>v</sup> 60<sup>v</sup> 50<sup>v</sup>

—the "Peaks" you want in High-Voltage  
**SOLID TANTALUM CAPACITORS**



## —EXCLUSIVE WITH **KEMET**

TRADE-MARK

Only KEMET can offer you the *widest* selection of dependable *high-voltage* solid tantalum capacitors. Topping the list is KEMET's new 75-volt type—the *highest rated working voltage unit of its kind available today—by a margin of 50%!*

KEMET's complete J-Series and N-Series comprise voltages of 60 and 50—ranging downward through 35, 20, 15, 10, and 6 volts—providing standard E.I.A. values with  $\pm 5\%$ ,  $\pm 10\%$ , and  $\pm 20\%$  tolerances.

J-Series capacitance values range from .0047 to 330 microfarads; operating temperatures from  $-55$  to  $+125^\circ$  C. N-Series capacitance values

range from .0024 to 160 microfarads; operating temperatures from  $-55$  to  $+105^\circ$  C.

"KEMET" solid tantalum capacitors are designed, manufactured, and tested to serve the most demanding industrial/military applications. All are hermetically sealed in corrosion-resistant metal cans, with solderable and weldable leads. Four J-Series case sizes meet or exceed the performance requirements of MIL-C-26655A/2.

For utmost reliability in solid tantalum capacitors—*high or low voltage*—specify "KEMET". Kemet Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio.

Write for technical data on the complete line of "KEMET" Solid Tantalum Capacitors

"Kemet" and "Union Carbide" are registered trade-marks for products of

**KEMET COMPANY**

CIRCLE 27 ON READER-SERVICE CARD

**UNION  
CARBIDE**

**90%** lower  $t_s$ ... 25 nsec max.  
**70%** lower  $V_{CE(sat)}$ ... 0.45 V max.  
**50%** lower  $C_{ob}$ ... 18  $\mu\text{f}$  max.

...with new Sylvania... **SILICON**

# epitaxial mesas

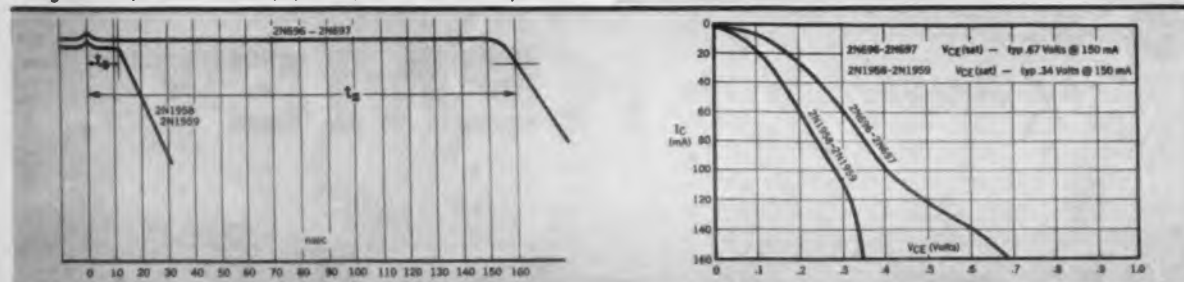
• **2N1958 • 2N1959** (compared with conventional mesa types 2N696, 2N697)

Sylvania 2N1958 and 2N1959... first 2-watt transistors to handle 500 mA of collector current in a total switching time of 110 nsec.

Exclusively epitaxial! Now ALL Sylvania Silicon Mesa transistors are produced by the epitaxial process. Exceptional Sylvania knowledge of solid state physics combined with extraordinarily automated processing and testing techniques continue to advance the state of the art. The new Sylvania 2N1958 and 2N1959—improved 2N696 and 2N697 conventional Silicon Mesa types—are dynamic evidence of the benefits offered design engineers by (1) epitaxial techniques and (2) transistors quantity-produced by Sylvania for switching and amplifier circuitry operating in the nsec range.

Sylvania 2N1958 and 2N1959 Epitaxial Silicon Mesa transistors are now available from your Sylvania Franchised Semiconductor Distributor and your Sylvania Sales Engineer. For tech data write to Semiconductor Division, Sylvania Electric Products Inc., Dept. 185, 1100 Main Street, Buffalo 9, New York.

Curves compare storage time ( $t_s$ ) and saturation voltage  $V_{CE(sat)}$  of 2N696, 2N697 and Sylvania-originated 2N1958 and 2N1959. Note significant improvements offered by Sylvania epitaxial mesas 2N1958, 2N1959.



Absolute Maximum Ratings of 2N1958 and 2N1959 at 25°C

Storage Temperature, $T_{stg}$	-65°C to +300°C
Junction Temperature, $T_j$	+175°C
Collector to Base Voltage, $V_{CB}$	60 Volts
Emitter to Base Voltage, $V_{EB}$	5 Volts
Collector-Emitter Voltage, $V_{CE}$	40 Volts
Collector Current, $I_C$	500 mA
Total Power Diss. (free air), $P_T$	600 mW
Total Power Diss. (case at 25°C), $P_T$	2 Watts



Sylvania 2N1958, 2N1959—TO-5 Package—1/2 Actual Size

Electrical Characteristics at 25°C:	2N1958	2N1959	Unit
$V_{CE(sat)}$ ( $I_C = 100 \mu\text{A}, I_E = 0$ )	60	40	Volts
$V_{EB}$ ( $I_E = 100 \mu\text{A}, I_C = 0$ )	5	5	Volts
$V_{CB}$ ( $I_C = 50 \text{ mA}, I_E = 0, R_{BC} = 10 \Omega$ )	40	40	Volts
$I_{CBO}$ ( $V_{CB} = 30 \text{ V}$ )	—	500	$\mu\text{A}$
$I_{CEO}$ ( $V_{CB} = 30 \text{ V}, T = 150^\circ\text{C}$ )	—	300	$\mu\text{A}$
$M_{FG}$ ( $I_C = 150 \text{ mA}, V_{CE} = 10 \text{ V}$ )	20	60	40
$V_{BE}$ ( $I_C = 150 \text{ mA}, I_B = 15 \text{ mA}$ )	—	1.3	Volts
$V_{CE}$ (sat) ( $I_C = 150 \text{ mA}, I_B = 15 \text{ mA}$ )	—	0.45	Volts
$R_{th}$ ( $V_{CB} = 10 \text{ V}, I_C = 25 \text{ mA}, F = 100 \text{ MC}$ )	1	1	$\mu\text{s}$
$C_{ob}$ ( $V_{CB} = 10 \text{ V}, I_C = 0, F = 1 \text{ MC}$ )	—	18	$\mu\text{f}$
$t_{on}$ ( $I_{B1} = 15 \text{ mA}, I_{B2} = 15 \text{ mA}, I_C = 150 \text{ mA}, V_{CC} = 7 \text{ V}, R_L = 40 \Omega$ )	—	65	nsec
$t_{off}$ ( $I_{B1} = 15 \text{ mA}, I_{B2} = 15 \text{ mA}, I_C = 150 \text{ mA}, V_{CC} = 7 \text{ V}, R_L = 40 \Omega$ )	—	25	nsec
$t_{sp}$ ( $I_{B1} = 15 \text{ mA}, I_{B2} = 15 \text{ mA}, I_C = 150 \text{ mA}, V_{CC} = 7 \text{ V}, R_L = 40 \Omega$ )	—	45	nsec

\* $t_{on}$ ,  $t_{off}$ , and  $t_{sp}$  measured from 50% point of input pulse

# SYLVANIA

SUBSIDIARY OF

**GENERAL TELEPHONE & ELECTRONICS**



CIRCLE 28 ON READER-SERVICE CARD

## NEWS

### Computer's Memory Drum Floats on Helium Film

A new approach to the memory-drum concept—use of a 150-micro-in.-thick film of helium as a bearing—has made possible a smaller, more reliable digital computer for space-vehicle guidance.

The gas-bearing drum is said to eliminate mechanical wear of metal suspension systems and decreases the head-to-drum clearance from 0.001 in. in earlier models to 0.00015 in. The latter feature raises the memory capacity.

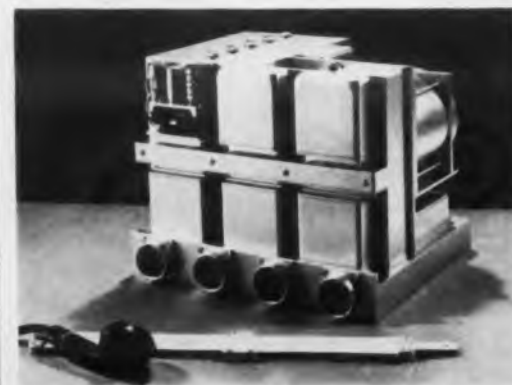
The computer (L-70) was developed by Librascope Div. of General Precision, Inc., Glendale, Calif. It is a follow-on design of Librascope's Centaur guidance computer and, at 19 lb, weighs only half as much as its parent model.

The gas-bearing drum, permitting more accurate location of magnetic heads, made possible recording tracks on 0.045-in. centers. This gives 70 tracks within 3.7 in.

In its original application, the L-70 memory drum has a capacity of 112,000 bits.

Another feature of the L-70 is an output module that weighs only 8 oz and measures 2-1/2 x 2-1/2 x 1 in. It has fewer components, a simplified gear train and increased thermal efficiency. Standard accuracy of the model was given as 0.1 per cent.

The L-70's amplifier is 50 per cent smaller than previous models. Heat sinks are eliminated by improved thermal efficiency. Tachometer feedback for servo damping also has been eliminated, by utilizing integral feedback within the amplifier.



Close-up view of L-70 flight-guidance computer, weighing 19 lb, and with helium memory-drum bearing.

## Bank Uses 'TV Scooter'



Key equipment in a closed-circuit television system is a TV scooter. The scooter moves on tracks in front of files at the Pioneer Bank and Trust Co., Shreveport, La. The scooter transmits TV pictures to monitors in branch banks, where the teller or customer requesting information sees it on his screen. The system is manufactured by Dage Div. of Thompson Ramo Wooldridge, Inc., Michigan City, Ind.

## Computer Accessory Gives Voice Replies to Queries

Voice replies to queries fed into a computer are given by a new alpha-numeric computer input/output device.

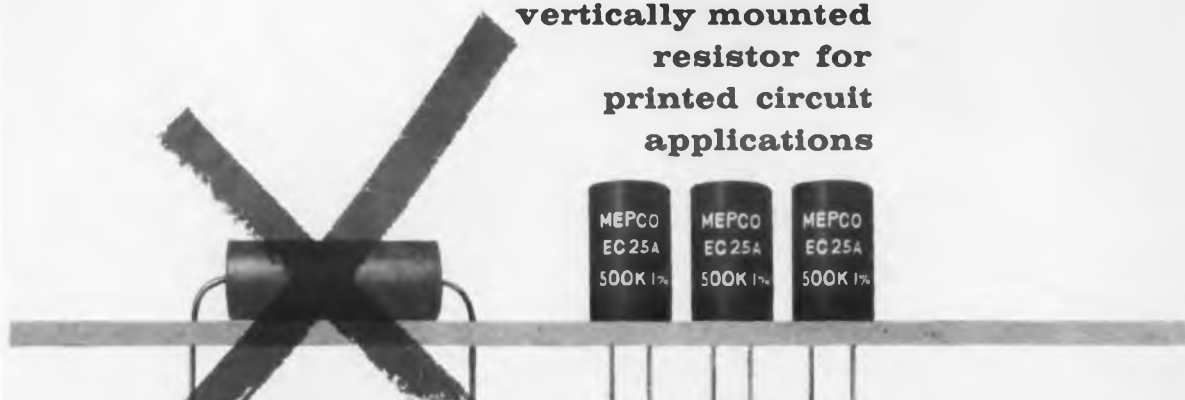
The unit, dubbed Unicall, transmits complete messages (up to 40 alpha-numeric digits) in about 2 sec over long-distance telephone lines. Voice-reply transmission (from magnetic drums at the computer site) begins within a half-second of receipt of a Unicall query.

Remington Rand UNIVAC Div. of Sperry Rand Corp., New York City, developed Unicall. It is engineered for use with UNIVAC real-time computing systems. The company expects Unicall to facilitate reporting of changes in inventory, production, distribution and sales.

Unicall units will rent for about \$30 per month. The price is about \$1,350 per set.

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Resistance Range	5 to 500 K	Leads	1" ± 1/8"
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## New Bourns Precision Potentiometer Resolves the Quality-Price Dilemma!

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Here is military reliability in a competitively-priced industrial potentiometer. Bourns wirewound 10-turn Model 3500 measures just  $\frac{7}{8}$ " in diameter by 1" long—shorter by  $\frac{1}{2}$ " than units available elsewhere—yet has a resistance element 20% longer than that of comparable potentiometers.

Fully meeting military requirements for steady-state humidity. Model 3500 can also be provided at a 10% premium to meet the cycling humidity specs of MIL-STD-202, Method 106. It's the only  $\frac{7}{8}$ " 10-turn potentiometer guaranteed to meet this spec. Its published characteristics incorporate wide safety margins.

Reliability insurance is provided by the exclusive Bourns Silver-weld® bond between terminal and resistance wire. Virtually indestructible under thermal or mechanical stress, this termination

eliminates a chief cause of potentiometer failure. In addition, a special close-tolerance rotor almost completely does away with backlash.

Model 3500 is also subjected to the rigorous double-check of Bourns' exclusive Reliability Assurance Program. In short, every possible step is taken to ensure that the performance you specify is the performance you get. Write for complete data.

Resistances	500Ω to 125K, ± 3%, std. (to 250K spl.)
Linearity	± 0.25% std.
Power rating	2w at 70°C
Operating temp.	-65° to +125°C
Mech. life	2,000,000 shaft revolutions

**INTER-OFFICE MEMORANDUM**

To John Miller - Design Engineer

From Paul Hammond - Reliability Engineer

*John - you'll like this one - reliable + inexpensive! Paul*

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## NEWS

### Digital-Data System Tracks Pollution in Ohio River

A digital-data system will be used to monitor the water quality of the Ohio River.

Data from about 40 points along the Ohio River are obtained on demand or automatically in preselected sequence and transmitted by telegraph to a central recording station in Cincinnati. The system, developed by Datex Corp., Monrovia, Calif., transcribes the telemetered signals from the monitors in a permanent typewritten tabular form and also makes a punched-tape record for computer processing.

The entire system was designed by the Ohio River Valley Sanitation Commission. It is expected to yield clues to the behavior of the river and the performance of waste-control facilities installed to curb pollution.

The automatic system will replace a manually operated data network.

### Field-Emission Theory Confirmed By Experiment

Experiments have verified the theory of emission of electrons from metals at low temperatures—or in the field-emission region.

Previous work had confirmed the theory of thermionic and transition emission, but until recent tests at the National Bureau of Standards the field-emission theory had not been experimentally verified.

A high field, on the order of  $10^7$  v/cm<sup>2</sup>, and temperatures from about 4.2 to 400 K were used in the NBS tests. Liquid helium



This specially designed tube was used at the National Bureau of Standards for experimental verification of the field emission of electrons from metals.

was used to cool the vacuum tube containing the tungsten tip, attached to a tantalum loop. The loop was used as a thermometer for the experiment.

A resistance-temperature curve was determined by calibration at several constant-temperature points. Various temperatures were obtained by resistance heating of the loop. A field was applied to the emitter and a nulling circuit was used to measure the current variation with changes in temperature. The theoretical expectation that the current increment would vary with the square of the absolute temperature was confirmed by the experiment.

The investigation also showed that the field at the emitter surface can be calculated from the slope of the emission current versus temperature squared curve.

One effect that was not observed during the experiment was that of the elimination of the energy band gap as a result of a superconducting-to-normal transition. This had been expected in an experiment with a niobium emitter.

Failure to verify this effect suggests that the surface of the emitter either was not superconducting or that superconductivity at the surface might have been quenched by the applied field.

## DEW Line System Extended



America's DEW (Distant Early Warning) system, which stretches 6,000 miles from the Aleutians to Iceland, has extended its network with the addition of the 7-station DEW East segment. Dye-2 above, is one of the Greenland icecap sites in the 1,200-mile DEW East link. The self-sufficient building houses a rotating antenna, top center. The circular structures, left and right, house 30-ft dish-type antennas. Western Electric Co., Inc., New York City, is the prime industrial contractor.

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Model 610 and 921 Groups have 90° arc movements, high torque to weight ratios, can withstand heavy overloads. Available as AC and DC voltmeters and ammeters, rectifier-type instruments, single element and poly-phase wattmeters and varmeters, power factor and frequency meters, and thermocouple instruments.

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## NEWS

### Simulated Flights Give Lift to Minuteman Tests

The Minuteman's recent successful flights were a foregone conclusion in the miniature "missile-test-range" laboratory at Autonetics, Div. of North American Aviation, Inc.

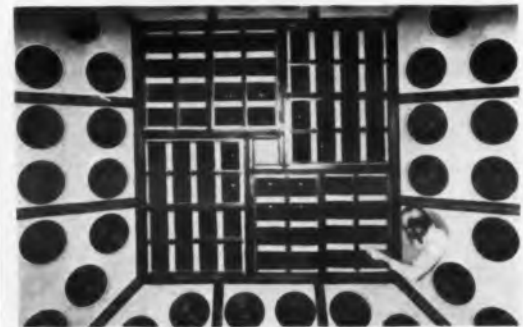
With equipment coded to simulate the many functions of a missile, program tape is run through a typical mission profile. By this direct simulation, using elements of the actual flight-control and guidance equipment of the Minuteman, scientists at Autonetics can locate a defect and thereby prevent costly disaster.

The direct simulator facility is a digital-oriented system. In addition to the Minuteman airborne digital computer, Autonetics' VERDAN airborne-type digital computers have been incorporated into the unit, along with simulation components.

When the command to "launch" is given, the VERDAN computer "flies" the simulated Minuteman from liftoff to thrust termination down the Atlantic missile-range path followed by the actual missile. Digital telemetry data needed for analysis of the test are gathered by tape recorders.

The exact duration of a Minuteman flight is used in the simulated runs.

### Hi-Fi Was Never Like This



Looking like a hi-fi fan's dream, this enormous acoustic testing facility at the Litchfield Park, Ariz., plant of Goodyear Aircraft Corp. will be used to test the destructive qualities of sound vibrations. The Goodyear noise-maker can duplicate sounds ranging from 37 to 10,000 cps. Shown are some of the 48 circular "woofers" and 64 trumpet-shaped mid-range speakers, which constitute "tweeters" because they are of the highest range employed in the installation.



## Titan Guidance Improved



Technicians at Cape Canaveral, Fla., load an inertial guidance package into a Titan ICBM missile. The new system has gone through several successful in-flight tests. Among the innovations of the guidance package are a fluid temperature-control system, welded electrical connections and beryllium gyroscopes. The guidance system was developed by AC Spark Plug Div. of General Motors Corp., Milwaukee.

## Mechanical Arm for Industry



This 900-lb vehicular mechanical-arm is operated from a portable control station having an on-off push button for power regulation. Lever switches control the speed of each of six manipulator motions. Called Little Ranger by its developers, General Mills, Inc., Minneapolis, the system is said to operate at temperatures ranging from -30 F to +120 F. TV cameras and an intercom system can be installed.

ELECTRONIC DESIGN • November 8, 1961



(ENLARGED THREE TIMES)

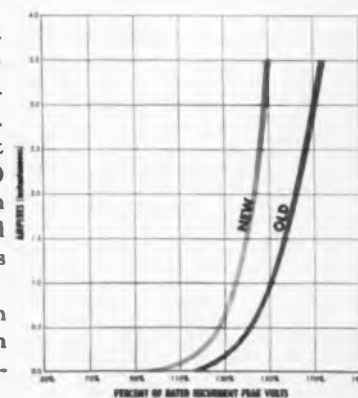
*New Zener-like characteristic of the improved Vickers Captivolt lets you build maximum surge protection into your silicon rectifier circuits... eliminates costly de-rating*

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**SPERRY**ELECTRONIC  
TUBE  
DIVISION

microwave memo

## Sperry adds high-power pulsed TWT's to list of tubes available in 30 days

In a move to simplify design problems in present and future radar systems, Sperry Electronic Tube Division of Sperry Rand Corporation has added two high-power pulsed traveling wave tubes to the list of advanced microwave tubes available in 30 days.

The two tubes covered by the announcement—the STL-114 and the STC-152—operate in L and C bands, respectively. They are typical of a line of pulsed TWT's ranging from P through V bands which Sperry offers on a firm delivery date basis.

### EASY RADAR APPLICATION

Sperry's pulsed TWT's are admirably suited to the demands of application in phased array radars, height finders, search, ECM, and other radar applications. Widely varied in-system experience has proved that their reliability, long life, high power, high gain, and extreme broadband operation make them ideal for radar use.

Design features of this tube family minimize the necessity for system adjustments in the field. Among these features are broadband response, constant voltage operation, and short circuit stability.

### VERIFIED RELIABILITY

These pulsed TWT's, produced at Sperry's Great Neck, N. Y., facility, have compiled an impressive record of in-system experience. Such experience has proved that their resistance to shock and vibration damage, their inherent indifference to ambient conditions, and their mounting flexibility make them ideal for ground or airborne application.

Place your order with your Cain & Company representative. His phone number appears in the adjacent column. Tubes are available within 30 days after receipt of order.

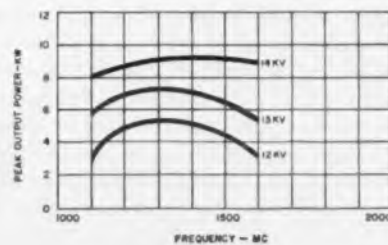
**FREE TECHNICAL INFORMATION** on the Sperry line of high-power pulsed traveling wave tubes may be obtained by writing to Sec. 504, Sperry Electronic Tube Division, Gainesville, Florida.

### V BAND CAPABILITY

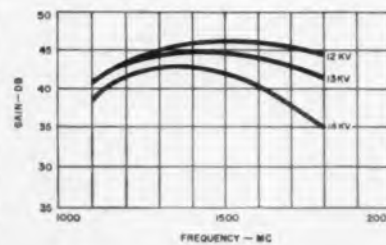
Among Sperry's other interesting activities in pulsed TWT's is the extension of capability into the V Band—26.5 to 40.0 kMc. Although these efforts are largely classified, inquiries are invited from those who have the necessary clearance and need to know.



**FACTORY ALIGNMENT** of a Sperry TWT within its focusing solenoid greatly simplifies field maintenance. Once this operation has been performed by a skilled Sperry technician, the assembly is self-aligning.



Typical saturated power output vs. frequency for a pulsed Sperry TWT.



Typical small signal gain vs. frequency for a pulsed Sperry TWT.

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DIVISIONGAINESVILLE, FLA. / GREAT NECK, N. Y.  
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ELECTRONIC DESIGN • November 8, 1961

# EDITORIAL

## Feast Above, Famine Below

While hundreds of engineers in the space sciences attended the mammoth Space Flight Report to the Nation in New York's Coliseum recently, another technical meeting took place in the near-by New Yorker Hotel. Before a handful of audio engineers, a group of scientists—mostly from Columbia University's Hudson Laboratories—presented a series of papers covering some of the fundamentals of underwater acoustics. The juxtaposition of this session of the annual Audio Society meeting and the space exhibition was rather startling.

The drama of space exploration naturally overshadows that of the study of the oceans and their sound-propagating characteristics. But drama alone is not a reliable index to relative importance.

At the space meeting, speakers ticked off countless planned, proposed or imagined missions into the beyond. Imagination rode free-rein in some of these presentations. Systems were proposed that assumed a succession of breakthroughs.

This approach is necessary as we prepare to engineer for a completely new and hostile environment. It is too early to say what reward might await us in space, but the military implications and scientific interests drive us onward.

By contrast, the potential reward and the problems of the study of sound in the undersea are clearly defined. The reward is the long-range detection and surveillance of undersea craft, possibly bent on our destruction. The Soviet's emphasis on its submarine fleet is a major military threat to the United States.

In the Navy's Project Artemis these scientists accomplished the detection of sound at a range of 12,000 miles. The interpretation of received sound signals, however, is still a mysterious art.

A start has been made on analysis of these echoes, but the problems are tremendous. New techniques are needed for generation and reception of the sound. New approaches are necessary, to process the data received; it often takes months to analyze information gathered in a few hours.

These problems are based on an immediate need. It is evident that the application of more talent and the expansion of undersea scientific programs, would speed solutions. And yet we seem willing to push much harder for the more glamorous, but as yet more distant, space rewards.

It is a tremendous task, with billions of dollars at stake, to choose from a myriad of technical proposals those that offer the greatest rewards, and that have the greatest probability of success. In the by-play of emotions and propaganda spectacles, such as we have witnessed in the past half-decade, it is increasingly important to probe deeply into these matters and to base decisions on real, existing needs—rather than hoopla and holler.

*Robert C. Haavind*

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# Low-Frequency Instability In Cascaded Emitter Followers

*Oscillation is often a severe problem encountered with cascaded emitter followers. Equivalent circuits are developed for low-frequency and high-frequency conditions and techniques for predicting instability as well as remedial action are outlined for single and multistage amplifiers.*

**Karl I. Nordling**

Burroughs Laboratories\*  
Burroughs Corp.  
Paoli, Pa.

CASCADED emitter followers, used in current amplifier designs, can be stabilized by two general approaches developed from a source and input-impedance concept. One technique involves the addition of series resistance to cancel the negative resistance component; with the other method, resonance is made to occur outside the negative resistance range. The phenomenon of low-frequency oscillation in emitter-follower stages is analyzed on the basis of a simple equivalent circuit; test setups and resultant data are presented to illustrate the correlation between calculated and experimental results.

## Equivalent Circuit of a Single-Stage Emitter Follower

The equivalent circuit used for the analysis is shown in Fig. 1. From this circuit, the following approximate expressions for volt-

\*Now with Beckman Instruments, Inc., Beckman Systems Div., Palo Alto, Calif.

age gain and input and output impedances are derived:

$$A_v = \frac{1}{1 + \frac{r_b}{Z_L} (1 - \alpha)} \quad (1)$$

$$Z_{in} = r_b + \frac{r_e + Z_L}{1 - \alpha} \quad (2)$$

$$Z_{out} = r_b + (r_e + Z_g) (1 - \alpha) \quad (3)$$

where the approximation is that  $Z_g$ ,  $r_b$ , and  $r_e$  are assumed negligible compared to  $r_c$ . For the purpose of the single-stage case,  $Z_g$  and  $Z_L$  are defined as follows:

$$Z_g = R_g + j\omega L_g \quad (4)$$

$$Z_L = \frac{R_L}{1 + j\omega R_L C_L} \quad (5)$$

Substituting these and the other frequency variants, the input impedance can be expressed as:

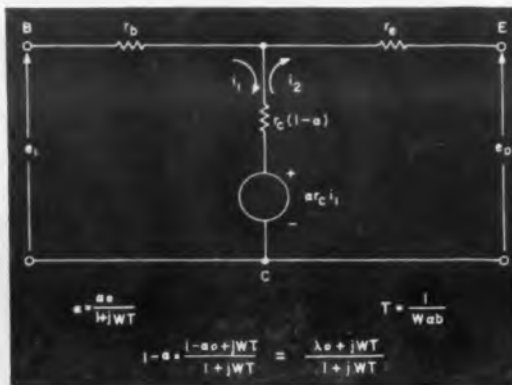


Fig. 1. Equivalent circuit of a single-stage emitter-follower.

$$Z_{in} = R_1 - jX_1 \quad (6)$$

where the real part may be written<sup>1</sup>

$$R_1 = r_b + \frac{R_L \left[ \lambda_0 + \omega^2 T^2 \left( 1 - \frac{\alpha_0 R_L C_L}{T} \right) \right]}{\lambda_0^2 + \omega^2 T^2 (1 + \omega^2 R_L^2 C_L^2)} + \frac{(\lambda_0 + \omega^2 T^2) r_e}{\lambda_0^2 + \omega^2 T^2} \quad (7)$$

where  $\lambda_0 = 1 - \alpha_0$ .

The second term contains a negative term,  $\alpha_0 R_L C_L / T$ , and if this is sufficiently larger than one, the whole expression will be negative for a range of frequencies. Fig. 2 shows a typical polar plot of the impedance of an emitter follower.<sup>1</sup>

It is apparent that if this circuit is driven from an inductive source with insufficient damping, it will oscillate at a frequency determined by the source inductance and the reactive component of  $Z_{in}$ , provided that this frequency is within a range of sufficient neg-

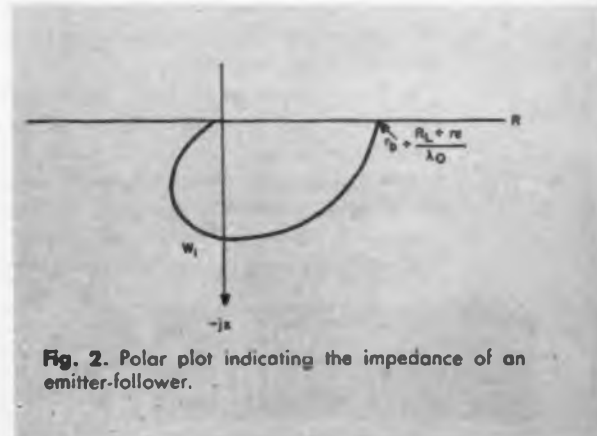


Fig. 2. Polar plot indicating the impedance of an emitter-follower.

ative resistance (above  $\omega_1$  in Fig. 2).

To prove this mathematically, the expression for the voltage gain is expanded in terms of frequency. The equation then takes on the form (using Laplace transforms)

$$A(S) = \frac{R_L(1 + ST)}{K_1S^3 + K_2S^2 + K_3S + K_4} \quad (8)$$

where:

$$K_1 = TR_L C_L L_g$$

$$K_2 = TL_g + R_L C_L [T(R_g + r_b) + \lambda_0 L_g]$$

$$K_3 = T(R_L + R_g + r_b) + \lambda_0$$

$$[L_g + (R_g + r_b) R_L C_L] \quad (9)$$

$$K_4 = R_L + \lambda_0 (R_g + r_b)$$

A linear amplifier is stable if its transfer function has no poles in the right hand half of the  $S$ -plane. In Eq. 8 this is equivalent to the denominator not having roots with positive real parts. To test for this condition, the Routh's Criterion can be used. According to this criterion, the equation has as many roots with positive real parts as there are sign changes in the first column of the following array:

$S^3$	$K_1$	$K_3$
$S^2$	$K_2$	$K_4$
$S^1$	$\frac{K_2 K_3 - K_1 K_4}{K_2}$	0
$S^0$	$K_4$	0

Since  $K_1$ ,  $K_2$ ,  $K_3$ , and  $K_4$  are all real and positive, the only way a sign change can occur is if  $K_2 K_3 - K_1 K_4 < 0$ . This inequality defines the conditions for instability. The same expression as an equation defines the border between stable and unstable operation.

$$K_2 K_3 - K_1 K_4 = 0 \quad (10)$$

The locus of the solutions to this equation in

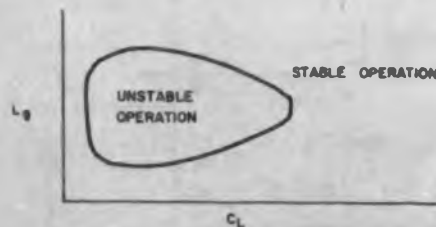


Fig. 3. Locus of solutions to the equation defining the stability of an emitter-follower configuration.

$L_g$  and  $C_L$  is of the form shown in Fig. 3.

Any point in this figure corresponds to a particular combination of values for  $L_g$  and  $C_L$ . Points inside the closed curve correspond to combinations which result in unstable operation, and points outside correspond to stable operation; the curve itself defines the borderline between the two cases.

If some other parameter, such as  $r_b$ , is varied, the area of the enclosed curve will decrease for increasing  $r_b$  and vice versa. This is merely another way of saying that if  $r_b$  increases, the range of sufficient negative resistance decreases, which reduces the range of values of  $L_g$  and  $C_L$  for which the amplifier will oscillate.

#### Analysis and Test Data For a Single-Stage Amplifier

This analysis was performed on a typical amplifier using a 2N553 transistor, and the results checked by measurements of its performance. The calculated data were obtained by computer solution of Eq. 10.

Fig. 5 shows the resulting plots and Fig. 4 a schematic of the circuit used to obtain the experimental data. The values of the transistor parameters were known only to a low degree of precision (from measurements and published data).

The values substituted in Eq. 10 were

$$r_b = 10\Omega, T = 1.9 \times 10^{-7} \text{ sec}, \alpha_0 = 0.988$$

$$R_L = 10\Omega, C_L \text{ and } L_g : \text{variable.}$$

The calculated curve agrees reasonably well with the experimental data.

#### Extending Analysis to Multistage Amplifier Design

The analysis of single-stage circuits can now be extended to multistage amplifiers.

To establish the equivalence between the two cases, first consider the first stage as the source for the second. Then, the output impedance of the first stage is the effective source impedance driving the second stage.

When evaluated in terms of frequency, the expression for  $Z_{out}$  becomes

$$Z_{out} = r_e + (r_b + R_g)(\lambda_0 + \omega^2 T^2) + j\omega T \alpha_0 (r_b + R_g) \quad (11)$$

which is the form  $R_0 + j\omega L_0$  (for small values of  $\omega T$ ) where

$$R_0 = r_e + \alpha_0 (r_b + R_g)$$

$$L_0 = \alpha_0 T (r_b + R_g)$$

This approximation is quite good for values of  $\omega T$  up to 0.1, as can be seen from Fig. 6,

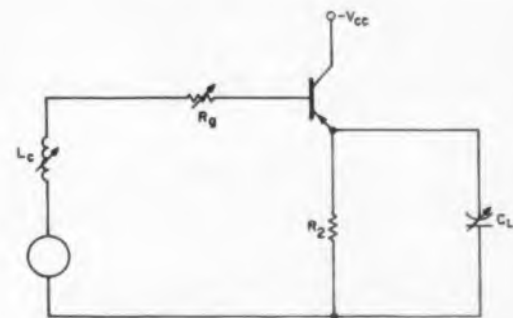


Fig. 4. Schematic of an emitter-follower test circuit using a 2N553.

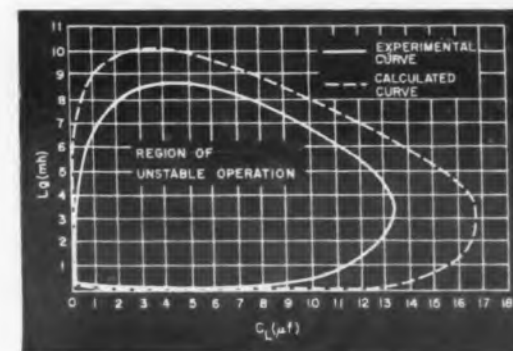


Fig. 5. Experimental and calculated curves for the circuit shown in Fig. 4.

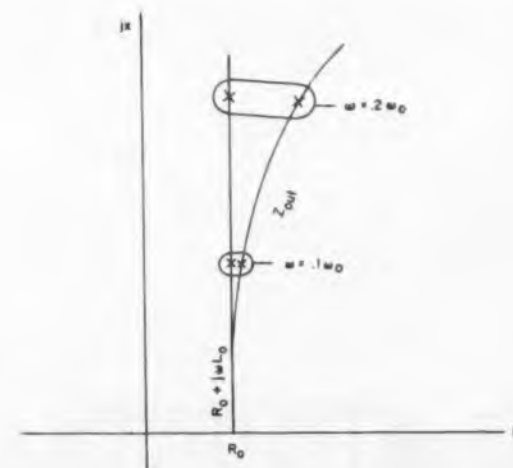


Fig. 6. Plot of actual circuit output impedance compared to  $(R_0 + j\omega L_0)$  indicates reasonable similarity up to  $\omega = 0.1 \omega_0$ .



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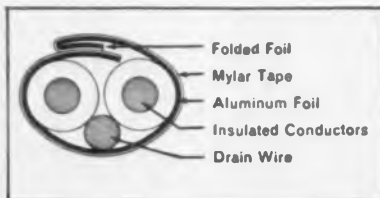


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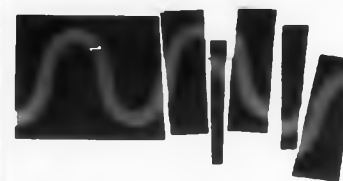
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which shows a polar plot of the actual output impedance compared to one of  $R_o + j\omega L_o$ .

Thus, the driving stage in a two-stage emitter-follower amplifier acts as an inductive source for the second stage. Also, a third stage would provide capacitive loading for the second stage, making the combination potentially unstable without any apparent reactive components.

Fig. 7 shows the locus of instability curves for a two-stage circuit. The experimental results were obtained from a circuit as shown in Fig. 8. The analytical results were obtained by using an equivalent circuit for each

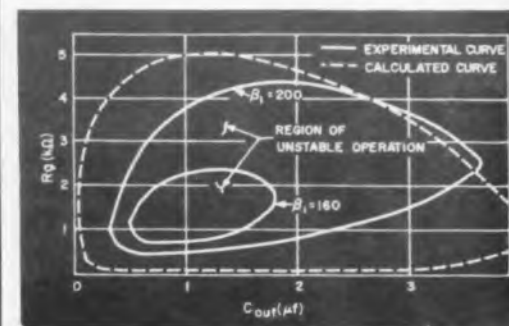


Fig. 7. Locus of instability for a two-stage emitter-follower circuit.

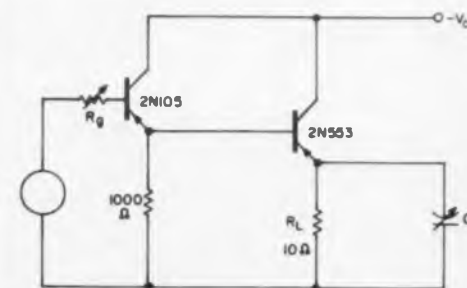


Fig. 8. Test circuit of the two-stage emitter-follower used to obtain the experimental data of Fig. 7.

stage, as shown in Fig. 1. One curve corresponds to a driver stage with a  $\beta = 200$  and the other one to a driver with a  $\beta = 160$ .

As indicated by Eq. 11, varying  $R_o$  in this case has the same effect as varying  $L_o$  in the single-stage case, and varying  $\beta_1$  has the inverse effect of varying  $r_b$  in the single-stage case.

#### Remedial Action to Stabilize The Emitter Follower

On the basis of this analysis, remedial action can be recommended. Returning again to the source and input-impedance concept, it appears that there are two approaches toward stabilizing the circuit. One consists of cancelling the negative resistance by adding positive resistance in series, and the other one consists of arranging for resonance to fall outside the negative resistance range.

There are several ways of mechanizing the first approach; the most obvious, of course, is to insert an actual resistance between the stages. Another way is to select the parameters  $\alpha_o$ ,  $R_f$ ,  $C_L$ , and  $T$  in Eq. 7 so that  $\alpha_o RC < T$ . This is overdesigning appreciably, since it results in a total series resistance of  $r_b + \lambda R_f$  in the input circuit instead of one which is just greater than zero.

A third way is to use feedback around the driver stage to increase its output impedance and, specifically, the resistive component thereof. The circuit in Fig. 9 illustrates this technique.

The effective input voltage to the emitter follower,  $e_e$ , becomes

$$e_e = \frac{e_1 Z_{in}}{Z_{in} + \frac{Z_1 Z_{in}}{Z_f} (K - 1) + Z_1} \quad (12)$$

Based on this equation, the equivalent circuit in Fig. 10 can be drawn to represent the input circuit to the emitter follower.

Letting  $Z_1 = R_1$  and  $Z_f = 1/j\omega C_f$  the resulting output impedance

$$Z_{out} = r_e + \omega^2 T^2 \left( r_b + \frac{\omega^2 T \beta^2 R_1 R_c C_f}{1 + \omega^2 T^2 \beta^2} \right) + j\omega (r_b T + R_1 R_c C_f) \quad (13)$$

which for  $m = 10^6$ ,  $T = 10^{-7}$ ,  $\beta = 100$  becomes

$$Z_{out} = r_e + 0.01 r_b + 10^6 R_1 R_c C_f + j(0.1 r_b + 10^6 R_1 R_c C_f) \quad (14)$$

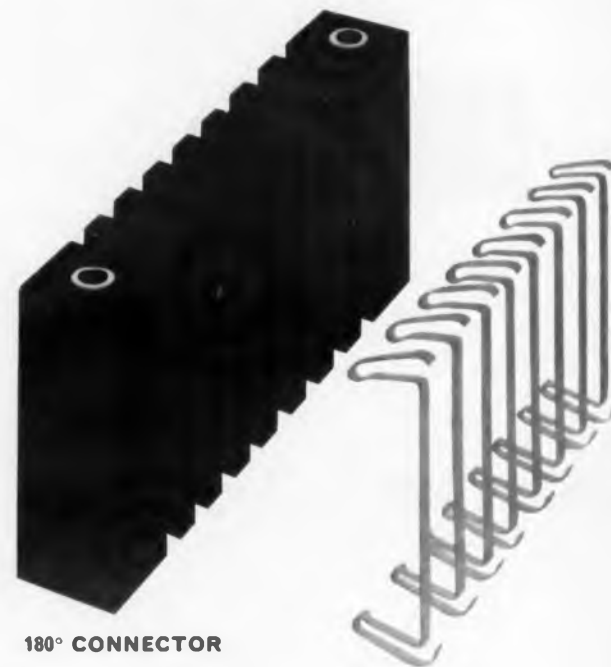
According to this typical example, the amount of damping can easily be controlled by manipulation of  $R_1$ ,  $R_c$ , and  $C_f$ .

A way to mechanize the second approach

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Fig. 9. Feedback around the driver stage may be used to stabilize an emitter-follower circuit.

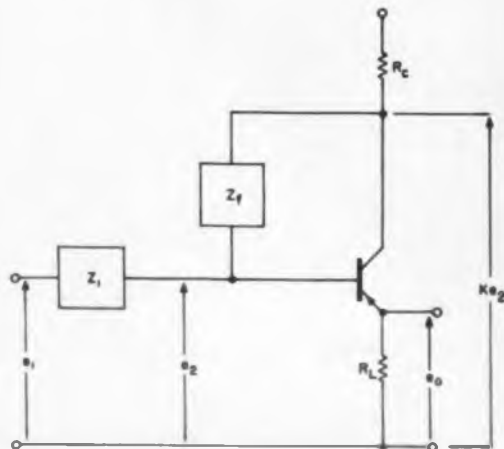


Fig. 10. Equivalent input circuit of an emitter-follower provided with feedback.

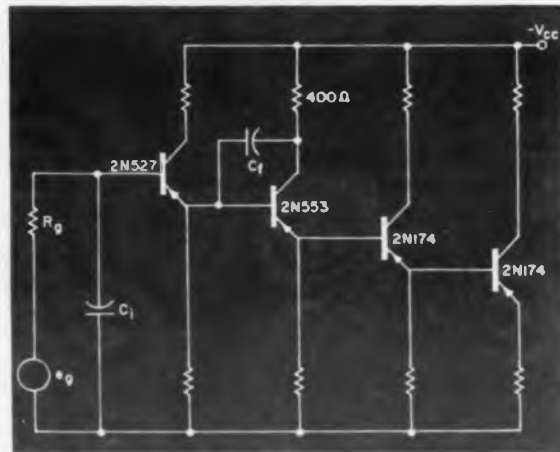


Fig. 11. The design of four emitter-followers, used in a voltage regulator, is outlined to demonstrate the stabilization techniques.

is to shunt the source of the first stage with a capacitance. This also results in an increased output resistance, but its chief effect is in reducing the reactive component, even to the point of making it negative. The output impedance in this case becomes

$$Z_{out} = r_e + \quad (15)$$

$$\frac{(\lambda_0 + \omega^2 T^2)(r_b + R_g) + \omega^2 R_g^2 C_g (\alpha_0 T + \lambda_0 r_b C_g)}{1 + \omega^2 [R_g^2 C_g^2 (1 + \omega^2 T^2) + T^2]} + j\omega T \alpha_0 \frac{r_b (1 + \omega^2 R_g^2 C_g^2) + R_g [1 - \frac{R_g C_g}{\alpha_0 T} (\omega^2 T^2 + \lambda_0)]}{1 + \omega^2 [R_g^2 C_g^2 (1 + \omega^2 T^2) + T^2]}$$

Letting the reactive part equal zero and solving for  $C_g$

$$(16)$$

$$C_{g1,2} = \frac{\lambda_0 + \omega^2 T^2 \pm \sqrt{\omega^2 T^2 \left[ 2\lambda_0 + \omega^2 T^2 - \frac{4r_b (r_b + R_g)}{R_g^2} \right] + \lambda_0^2}}{2\omega^2 T r_b}$$

To resolve the ambiguity of this equation, consider the two extreme values of  $C_g$ , zero and infinity. It is already known that with zero capacitance, the reactive part is positive; it is in fact  $\omega T \alpha_0 (r_b + R_g) / 1 + \omega^2 T^2$  as inspection of Eq. 15 shows. For values of  $C_g$  approaching infinity, the reactive part approaches  $\omega^2 T \alpha_0 r_b R_g^2 C_g^2$ . Thus, values of  $C_g$  between  $C_{g1}$  and  $C_{g2}$  result in negative values for the reactive part. The value of  $\omega$  to be used in Eq. 16 is the upper end of the negative resistance range of the input impedance.

Another mechanization of this process is selection of transistor parameters such that the resonant frequency falls in a range where the circuit is stable. It was seen in Fig. 6 that the area of instability is smaller for a lower value of the driving stage beta. For still lower values of  $\beta_1$ , (100 or less), the amplifier was stable. A conclusion to this effect can be drawn from Eq. 11, where the real part,  $R_o$ , is seen to increase with increasing

$\lambda_0$ , which corresponds to decreasing  $\beta$ . Also, the reactive part,  $\omega L_o$ , decreases with decreasing  $T$ , which corresponds to increasing alpha-cutoff frequency. Thus, the transistors should be so selected that the driving stages have low betas and higher alpha-cutoff frequencies than the succeeding stages.

### Evaluating the Effects of Various Stabilization Techniques

Selecting a technique of stabilization among those presented will in general be dictated by considerations of frequency response and gain. Inserting series resistance between the stages lowers the voltage gain somewhat and causes large dc offsets if the steady-state current is appreciable; however, it has only a slight effect on the frequency response.

Using the feedback technique also reduces the voltage gain but does not produce the dc effects mentioned. Its effects on frequency response, however, are somewhat complex and, since it is a feedback system, should be designed carefully so as not to introduce another source of instability.

Shunting the source with capacitance results in a reduced high frequency response, but in an easily predictable fashion, which makes it suitable for use in amplifiers which are part of a feedback loop. Shunting the load with capacitance has about the same effect, but differs in the value of capacitance required, which is greater by a factor roughly equal to the current gain than that required across the source.

Stabilization by selection of transistor parameters restricts gain and frequency response to the extent the gain-bandwidth product is limited in the first stage.

All these methods result in degraded performance in some form or another. To allow for this it is necessary to overdesign somewhat; the gain-bandwidth product, in particular, must be higher than if no stabilization were required.

### Example of Stabilization Techniques In a Typical Design Problem

An example of a circuit using two of the discussed techniques is shown in Fig. 11. This is part of a voltage regulator where four emitter followers are required to provide the necessary current gain. This four-stage circuit is stabilized by means of a capacitance shunting the input to the first stage and a feedback capacitance between collector and base of the second stage. The first capacitor  $C_1$  is solved for by Eq. 16. By sub-

stituting the following values in Eq. 16

$$\begin{aligned}\lambda_0 &= 0.008 \text{ (min) } 0.014 \text{ (max)} \\ T &= 2.5 \times 10^{-8} \text{ } 1 \times 10^{-7} \\ r_b &= 30 \Omega \\ R_e &= 4,000 \Omega\end{aligned}$$

we obtain maximum  $0.0015 \mu\text{f} < C_i < 0.17 \mu\text{f}$  using the maximum values of  $\lambda_0$  and  $T$  and  $0.013 \mu\text{f} < C_i < 10 \mu\text{f}$  using the minimum values of  $\lambda_0$  and  $T$ . Thus, the range for  $C_i$  is  $0.013 \mu\text{f} < C_i < 0.17 \mu\text{f}$ . A value of  $0.1 \mu\text{f}$  was chosen as being roughly in the center of the range.

To find the value of the feedback capacitor, solve for  $R_e C_f$  in the expression

$$\frac{R_1 R_e C_f \times \omega^2 T^2 \beta^2}{1 + \omega^2 T^2 \beta^2} = R_o \quad (17)$$

This expression results from setting the real part of the equation for  $Z_{out}$  (Eq. 13) equal to  $R_o$ , which is the required value of resistance in the input circuit of the following stage. Resistance  $r_e$  is assumed to be so small as to be negligible.

The worst-case values for  $T$  and  $\beta$  are

$$T = 0.8 \times 10^{-7}$$

$$\beta = 40$$

The maximum value of  $R_o$  was found to be between 10 and 100 ohms at  $\omega = 10^6$ . These values were obtained by measurements; they could also be found by computing  $R_1$  versus  $\omega$  in Eq. 7. The output impedance of the previous stage is assumed to be largely resistive (because of the capacitance across the input) and is roughly equal to the  $r_e$  of the transistor, which is typically about 3 ohms.

Substituting the following values in Eq. 17:

$$T = 0.8 \times 10^{-7}, \beta = 40, R_1 = 3, R_o = 100 \text{ ohms,}$$

$$\omega = 10^6 \text{ and solving for } R_e C_f \\ R_e C_f = 4.4 \times 10^{-4}$$

$R_e$  is 400 ohms as dictated by other considerations, which would make  $C_f = 1 \mu\text{f}$ . By extensive testing, it was found that an optimum value for  $C_f$  was about  $0.1 \mu\text{f}$ . This large discrepancy is apparently due to the assumption that  $Z_{out}$  of the previous stage consists merely of  $r_e$ . Better results would be obtained if Eq. 15 were used to calculate  $Z_{out}$  for the appropriate value of  $\omega$ . ■ ■

#### Acknowledgements

The author wishes to acknowledge the contributions to this analysis made by William Allen and Richard Fussell.

#### Reference

1. Heule & Walsh, "The Application of Transistors to Computers", *Proc. IRE* (June, 1958.)



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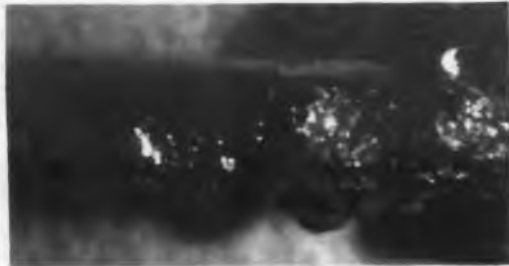
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# Gold-Plated Leads Can Cause Cold-Soldered Joints

*Gold-plated leads have been over-rated, says the author. It has been assumed that they enhance the reliability of a soldered joint but in some cases the gold-plating actually causes cold-soldered joints by dissolving into the solder bath and raising the solder's melting point. He believes that copper-nickel or copper-bronze-nickel-zinc alloy leads without plating are best for soldered joints.*



**Fig. 1.** Gold-plating causes cold-solder joints because it dissolves in the solder and raises the solder's melting point. Here 60/40 solder has been flowed onto a gold-clad nickel wire (from the right) with a 600 F soldering iron. The heavy 0.002-in. thick gold cladding has alloyed with the solder, freezing it, and caused the "cold-solder" look.



**Fig. 2.** A collar of gold-tin-lead alloy was formed above the solder level when this gold-clad nickel wire was dipped for 5 sec in a 450 F 60/40 solder bath. The gold was removed from the immersed (right hand) end of the wire during the formation of this collar.

**Charles W. Brown**  
Laboratory For Electronics, Inc.  
Boston, Mass.

**W**ITH the increased stress on reliability, the materials used for the leads of the many small electrical parts which are soldered into printed-circuit boards or to terminals, are becoming critical. As a result, there has been a tendency to go somewhat blindly to exotic coatings for the leads. The purpose of this article is to show that merely specifying gold-plating on the leads can just as well be a step away from reliability as a step toward it.

Basically, it is necessary for the leads to be clean and easily soldered so that the soldering operation can be accomplished with only rosin flux and reasonably low temperatures to avoid damage to printed-circuit boards or other connections. In an attempt to provide reliable and easily soldered leads, several manufacturers have adopted gold-plated or gold-clad leads, basing this choice on the well-established fact that gold remains easily solderable, even after long storage. Gold-plated lead wire does not solve the problem, however, because the gold dissolves very readily in melted solder; and if the underlying metal is not solderable, a poor connection can result. (See Fig. 1.)

Gold-plated copper or brass lead wires probably will be satisfactory, because even if the gold is dissolved by the solder, the underlying metal is solderable using (activated) rosin flux.

An exception to this condition will occur if heavily gold-clad leads are used. There is enough gold on this type of wire to form an alloy of gold-tin-lead, with a melting point so high that it will not flow; and a "cold-soldered" joint will be formed.

Gold dissolves in melted solder and raises the freezing point of the solder. Thus, when

only a small quantity of solder is used, it may be necessary to use a soldering iron having a temperature of 800 F, or even higher, to flow the solder properly. High temperatures are undesirable for several reasons:

- Soldering iron tips erode rapidly.
- Small-diameter wires of copper or bronze dissolve rapidly in solder.
- Laminated insulating boards and component parts are damaged.

Fig. 2 shows the result (in 5 sec) if a gold-clad nickel lead is immersed with slight agitation in tin-lead (60/40) solder at 450 F. The gold has been removed from the immersed area, and a collar of gold-tin-lead alloy formed on the wire lead above the solder level. A 1-sec dip of a heavily gold-plated nickel lead, however, was too short to permit the gold to alloy, but would also be too fast for practical wave, or dip, soldering.

Most printed-circuit soldering is done at low temperatures in wave-soldering or dip-soldering machines. But even a small amount of gold will quickly "contaminate" the solder, making it sluggish, so that the printed circuits will not be properly soldered. The gold which was dissolved from the leads by the solder remains in the solder pot; and there is no economically feasible method of removing the gold from the solder.

## Gold-Plated Nickel-Wire Leads Not Solderable

Leads which are made of nickel wire, as is the case on tantalum capacitors, are not solderable if gold-plated. The gold dissolves and leaves the nickel lead exposed, and it is unsolderable with rosin flux.

If a moderately active flux is used, such as hydrazine mono-hydrobromide, nickel can be properly solder-alloyed. ("Solder-alloyed" describes the union between solder and another metal whereby it becomes difficult to separate

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For a universal, soldering-welding, lead, two promising candidates are: electrolytically tin-coated cadmium or phosphor bronze and steel wire with copper cladding. In addition to solderability considerations, universal leads must have sufficient electrical resistance and low enough thermal conductivity to permit the weld temperatures to build up.

them, even by wiping while the solder is melted).

Supplies of this flux, and solder with this flux as a core, are readily available. Residues of this flux *must* be removed after solder coating the nickel lead wire. Therefore, this type of flux and solder should not be used on assemblies of parts to printed-circuit boards, as they cannot safely be rinsed to remove surplus flux after soldering.

A coating of solder properly alloyed to the lead wire is the most reliable preparation for good solderability. Gold-plated leads should be avoided unless a "gilded dress-up" is the chief reason for the gold. The solder coating also is more solderable than a coating of pure tin, if storage for more than a few days is likely.

Whenever possible, it is desirable to use leads made of material which is readily solderable without any sort of coating. There are several copper-nickel and copper-nickel-zinc alloys that remain easily solderable after long storage, are ductile, and have better endurance than pure copper under conditions of twisting or bending. These alloys, however, have higher electrical resistivity than copper. ■ ■

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766D	940-1,975 MC	26 db	1.20	1.30	150.00
767D	1,950 MC-4.0 GC	26 db	1.25	1.50	150.00

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# High-Density Electronic Packaging—Thermal Design

*Components in tightly packed microminiature electronic assemblies are extremely susceptible to thermal damage. To achieve the high reliability demanded of High-Density Packages, thermal characteristics of components must be ascertained and proper heat transfer techniques applied.*

*The design steps involved in achieving proper thermal performance during initial assembly analysis, rather than last-minute haste, are outlined. Previous articles relating to HDEP have appeared April 12, May 10, May 24, and July 19.*

Charles Kadlec  
Samuel Francis  
The Sippican Corp.  
Marion, Mass.

**C**LOSE control of component temperature is an important consideration for tightly packed assemblies specified for high-reliability systems. High-Density Electronic Packaging (HDEP) increases the heat-dissipation density and the intercomponent heat transfer; high power dissipation components must be kept within rated operating temperature to minimize failures.

## Heat Transfer by Conduction Key to Successful Thermal Design

It has always been recognized that individual component temperatures, rather than cold-plate or exhaust-air temperatures, are the important factors in system reliability since failures occur at the component level. However, actual calculation of individual component temperatures has been generally considered too complex and time consuming, especially in conventional designs where components are exposed to the ambient gas and the heat is removed primarily by natural or forced convection. In HDEP, the components are encapsulated in epoxy compounds of known thermal characteristics. The heat is removed from the components by conduction, which is not affected by changes in altitude or surface conditions. Simple shapes and simple heat exchangers are used in the design of the heat path from

the circuit module to the outside heat sink. This results in economy of fabrication and relative ease of thermal analysis, using well-known heat transfer equations and empirical data (refer to the material listed in the Bibliography for detailed explanation of heat transfer theory and data on heat exchangers). Even transient temperatures may be evaluated analytically, with a minimum of approximations and adequate accuracy, using graphical or numerical methods.

As a result, the thermal performance of the design can be predicted and excessive component temperatures can be eliminated at the design stage. This step is in agreement with high reliability design thinking.

To further aid in the thermal design, a procedure has been developed which helps to quickly identify those components which require the most careful analysis, as well as those components which are unlikely to cause trouble. The procedure, based on the flow of information shown schematically in Fig. 1, consists of a preliminary analysis of the operational requirements, the thermal environment and the components. The operational requirements and the thermal environment are combined to determine the worst situation from the thermal point of view. The components are analyzed to determine their rating (maximum allowable surface temperature vs dissipation) required by the specified system reliability. Then, the circuit is analyzed to obtain the maximum

dissipation for each component. The maximum operating surface temperature is thus determined for each component and finally, thermal design, to maintain the components below their maximum temperatures under the worst combination of thermal environment and required operation, can proceed in detail.

## Operational Requirements of a Typical High Density Package Assembly

The following operational requirements should be listed:

1. Storage (nonoperating)
2. Ground operation (test and equipment calibration)
3. In-flight operation
  - a. Transient (short-term)
  - b. Steady-state (long-term)

The distinction between transient and steady-state operation is made on the basis of the anticipated thermal time constant of the package which is usually a few minutes to an hour. The thermal time constant can be evaluated at this stage from the proposed weight, size, and dissipation of the package (the dissipation will indicate how good a thermal path there must be to the environment; in general, the higher the dissipation, the shorter the time constant).

Last, the required warm-up time, if any, should be determined. Equipment which requires rapid warm-up from low temperatures may require heaters and complex tem-

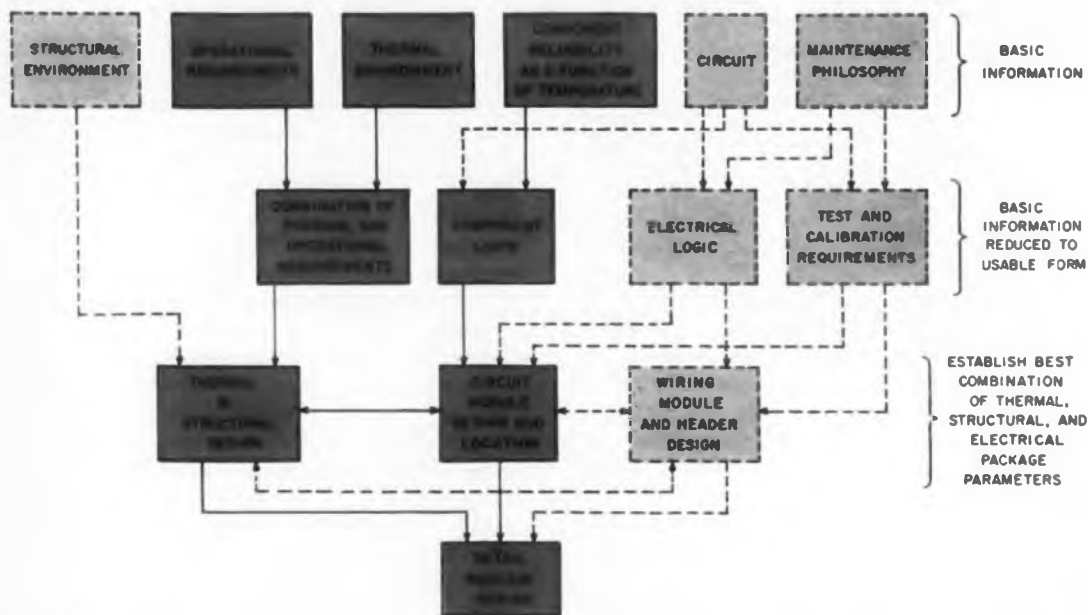


Fig. 1. Information flow chart showing the relationship between package demands and thermal considerations.

perature control equipment.

**Analysis of the Thermal Environment:** The purpose of this analysis is to determine the most important means of heat removal that the package will use. Sometimes this is obvious, as when cooling fluid or gas is supplied, but more often a decision must be made.

The following means are available to remove the heat dissipated by the circuitry:

- Conduction to the mounting structure.
- Free convection to the surrounding atmosphere.
- Forced convection to a fluid or gas supplied to the package.
- Evaporation of a fluid either supplied to the package or stored.
- Radiation to the surrounding equipment or the surrounding space.

Of the above, conduction, free convection, and radiation will always be present to some extent, and may either remove heat from the package or add to the heat dissipated by the package. For example, a package may be cooled by forced convection to a lower temperature than the ambient air, in which case heat is added from the air. This will increase the amount of heat which must be removed by the cooling fluid.

To reach a decision regarding the primary means of heat removal, the expected characteristics of all the available means should be listed for all types of required operation. The important characteristics are:

▪ Conduction—maximum and minimum temperature of the mounting structure.

▪ Free Convection—maximum and minimum temperature and density of the ambient air. It should also be ascertained that the sides of the package are not in close proximity to some other equipment. This would seriously impair free convection.

▪ Forced Convection—maximum and minimum temperature and pressure of the cooling fluid or gas, and the available pressure drop across the package.

▪ Evaporation—amount of fluid available and the maximum and minimum ambient pressure.

▪ Radiation—maximum and minimum temperature of the surroundings and their emissivity.

Any of the above may change with time, sometimes very quickly. Such conditions must be carefully described to avoid designing for a situation that actually will not exist; for example, the skin of a missile reaches very high temperatures a few seconds after launch, but the equipment mounted to it on the inside, because of its thermal time constant, is able to operate for several minutes at relatively low temperatures.

MIL-E-5400D describes the standard environment for airborne military equipment and is often used in specifications in lieu of a detailed description of the thermal environment. Another possible source of information is the specification for testing of the equipment, which usually includes a test simulating the extremes of the expected thermal environment.

**Preliminary Thermal Design:** At this point, the general package layout, compatible with the selected means of cooling, is established. The various methods that have been used to remove the heat from the circuit modules are shown in Fig. 2. The designs are such that each circuit module has one or more sides in contact with a metallic foil or plate (called the "cooling foil") which is in turn connected to either the mounting structure or the side of a heat exchanger. The cooling foils are made of soft aluminum which deforms under the compressive load applied by the bolt and thereby provides a good thermal contact with the circuit module. Aluminum is used because it is the best heat conductor on a weight basis (copper and silver are better on a volumetric

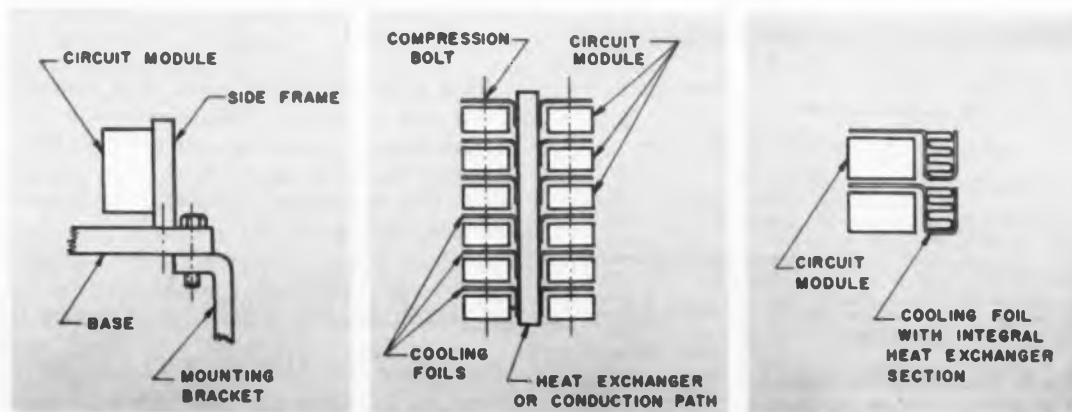


Fig. 2. Various methods of removing heat from a circuit module involve the transfer of heat through a plate or foil to a heat exchanger.



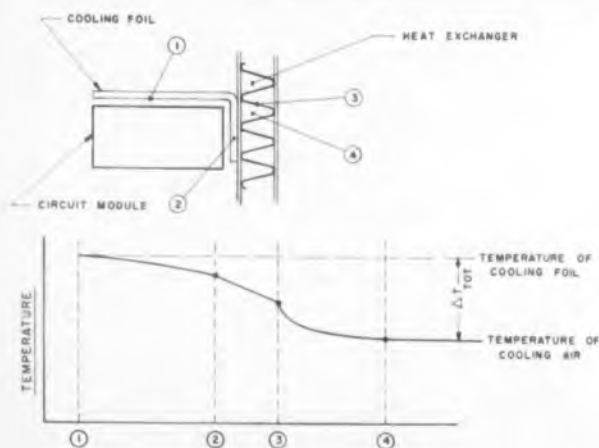


Fig. 3. Typical temperature gradient along a heat path.

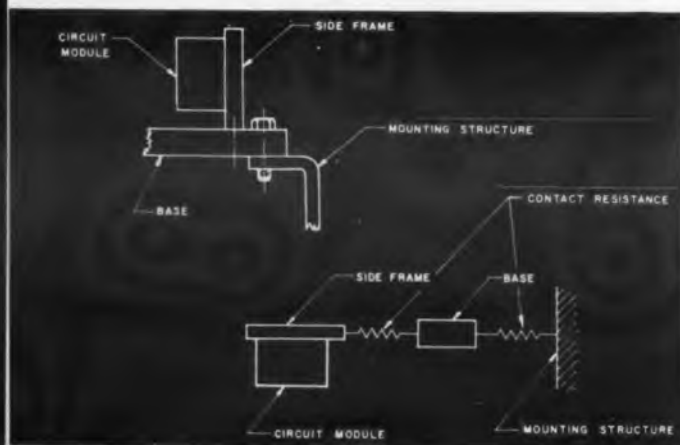


Fig. 4. Theoretical model and conduction path used in transient temperature calculations.

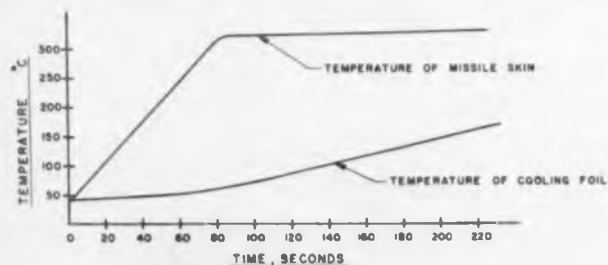


Fig. 5. Temperature-time response at the cooling fin of an assembly mounted to the inside of a missile skin.

basis). This statement is verified by the relationship of thermal conductivity and density for aluminum vs copper:

$$\frac{K_{al}}{d_{al}} = 0.795 \frac{\text{BTU-ft}^2}{\text{hr-F-lb}} > \frac{K_{cu}}{d_{cu}} = 0.402 \frac{\text{BTU-ft}^2}{\text{hr-F-lb}}$$

The thickness of the cooling foil is important because it determines the temperature gradient in the foil. For example, assume that a circuit module dissipates a total of 0.5 w and has a cooling foil 0.020 in. thick attached to one of its sides which has the dimensions of 2.5 x 1.5 sq in. The temperature distribution can be evaluated using the equation for a flat plate with uniformly distributed heat sources<sup>1</sup> which implies that the heat input from the circuit module is uniform. The maximum temperature difference along the length of the cooling foil is given by:

$$\Delta t_{max} = \frac{\dot{q}L^2}{2K}$$

where

- $\Delta t$  = max temperature difference along length of cooling foil
- $\dot{q}$  = heat dissipation per unit volume of cooling foil
- $L$  = length of cooling foil
- $K$  = thermal conductivity of aluminum, 100  $\frac{\text{BTU}}{\text{hr-ft}^2\text{-F/ft}}$

Substituting the given values and converting to a consistent set of units:

$$\Delta t_{max} = \frac{(3.413)(0.5)}{(2)(100)} \frac{(2.5)^2}{(12)} = 8.5 \text{ F}$$

This is an acceptable value. Now consider a different circuit module, dissipating 0.75 w and having a cooling foil 0.02 in. thick attached to one of its sides which is 3.5 x 1 sq in. The maximum temperature difference for this cooling foil is:

$$\Delta t_{max} = \frac{(3.413)(0.75)}{(2)(100)} \frac{(3.5)^2}{(12)} = 26.9 \text{ F}$$

This is probably too high and the thickness of the cooling foil must be increased or the dimensions of the circuit module changed.

The rest of the heat path is analyzed similarly. The resistance at the interfaces of metal parts can be estimated from available information on "contact coefficients"<sup>2</sup>. When this is done, the temperature gradients along the path are added to give the total temperature difference from the heat sink to the cooling foils (see Fig. 3).

The temperature of the cooling foil thus evaluated will be used to determine how the components should be distributed among the circuit modules.

To evaluate the temperature of the cooling foils under transient conditions, a theoretical model of the thermal path is drawn (see Fig. 4). Then, by either numerical or graphical methods, such as the Schmidt plot<sup>3</sup> the temperature vs time of the cooling foil can be obtained with a good accuracy. Fig. 5 shows the results for a package mounted to the inside of a missile skin.

To prevent excessive temperatures at the end of the required operating time, the package must have an adequate thermal capacity. The addition of mass for this purpose is not desirable, from the point of view of both weight and efficiency. The specific heat of most materials is about 0.25 BTU/lb-F, but the addition of a material which will change phase at a temperature below the maximum allowable component temperatures is a very good solution. One such material is a stearic acid compound<sup>4\*</sup> which melts at about 85 C. The heat of fusion of this compound is in the order of 70 BTU/lb. In one application, a small copper container was built and filled with such a compound. The components (mostly Zener diodes) were cemented to the container and the whole assembly encapsulated as a circuit module. The components will operate at 85 C as long as some of the compound is melting.

\*Available from the Armour Industrial Chemical Co. as "Armud C".

TABLE 1. Thermal Characteristics of Several Encapsulating Compounds

Materials	Specific Gravity	Thermal Conductivity BTU/hr/ ft <sup>2</sup> /F/in	Volume Resistivity ohm-cm <sup>3</sup>
Eccofoam			
Hi K 625D (1)	0.37	0.36	1 x 10 <sup>16</sup>
Stycast 1095 (1)	0.8	0.8	1 x 10 <sup>16</sup>
Stycast 1231 (1)	1.4	3.1	1 x 10 <sup>12</sup>
P33 (2)	2.5	12.3	1 x 10 <sup>14</sup>
Aluminum	2.8	1.100	2.8 x 10 <sup>-6</sup>

References:

1. Emerson & Cuming Tech. Bulletins Series 6-2 and 7-2.
2. Bacon Industries Tech. Data Sheet P33.

### Preparation of a List Containing Component Thermal Characteristics

Before an intelligent breakdown of the system into modules can be made, it is essential that each component be listed with its pertinent thermal characteristics:

1. The rating (maximum surface temperature vs dissipation) obtained from reliability considerations.
2. The maximum dissipation obtained from an analysis or test of the circuit.
3. The dimensions of the component, obtained from the manufacturer or by actual measurement.

While this type of information is normally collected for component specifications, this is generally so late as to preclude its effective use in design. Rigorous, persistent pursuit of this information before design commences is essential.

### Arrangement of Components For Optimum Thermal Design

The heat transfer inside an encapsulated circuit module occurs by conduction from the components and their leads to the encapsulating compound. The purpose of the thermal design is to provide a sufficient thermal path between each component and the cooling foil. To do this as efficiently as possible, components that require the same thermal path should be placed in the same circuit module. Naturally, other requirements, such as the electrical logic interconnections, often conflict with such an arrangement and a compromise must be selected.

The thermal path required by each component is calculated from the information already tabulated on the component lists. The equation which describes one-dimensional conduction is rearranged as follows:

$$\frac{Q}{(\Delta t)(A)} = \frac{K}{X}$$

where

- $Q$  = maximum dissipation of the component  
 $\Delta t$  = difference between the maximum allowable surface temperature of the component and the estimated temperature of the cooling foil  
 $A$  = cross-sectional area of the component perpendicular to its leads  
 $\frac{K}{X}$  = required thermal path

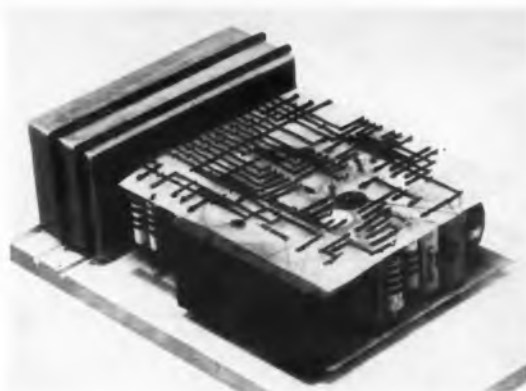


Fig. 6. Assembled circuit module (before potting) showing metallic heat conductor to transfer heat from high-dissipation components.

If components with the same value of  $K/X$  are placed in the same circuit module, they will operate at the same proportion of their maximum allowable surface temperature if no lateral heat transfer takes place. Lateral heat transfer will occur if there are temperature differences between adjacent components. Therefore, it is desirable to arrange the components in the circuit module in a way which minimizes the temperature difference between adjacent components. For example, the component which has the highest allowable surface temperature is placed at the center of the circuit module and the other components are arranged toward the outside of the module in order of decreasing allowable surface temperature.

The value of  $K/X$  for each component is tabulated on the component lists to give the layout designer a quick reference of the thermal requirements of each component.

After the components have been allocated to the various circuit modules, the type of cooling method for the whole circuit module is determined. There are two possible approaches for cooling modules:

1. Selection of encapsulating compound.
2. Use of metallic conductors.

For the first case, an encapsulating compound is chosen which has an adequate thermal conductivity. As seen from Table 1, the weight of the encapsulating compound increases with increased thermal conductivity, so that appreciable weight savings can be achieved by careful selection of the final compound.

The second option, metallic heat conductors, is usually employed when it is impossible to remove component heat by encapsulation in a potting compound having the

highest available thermal conductivity. Metallic heat conductors are also useful in the case where a component with a high thermal path requirement (high value of  $K/X$ ) must be placed in a circuit module having components with much lower thermal path requirements (see Fig. 6).

The actual operating component temperatures are evaluated after a preliminary layout of the circuit module has been made and an encapsulating compound has been chosen. Knowledge of the internal construction of a component helps in estimating the amount of heat which will be removed by the leads (usually about 50 per cent). The leads, being connected to metallic conductors in close proximity to the cooling foil, provide a low-resistance path from the point of attachment to the component. The remainder of the heat will be conducted in three dimensions by the surrounding encapsulant. An evaluation of the effective cross-sectional area in the axial direction is made according to the spacing shown by the preliminary layout. The temperature difference is then calculated using this area, the amount of heat not removed by the leads, the thermal conductivity of the encapsulant, and an average distance along the axis of the component.

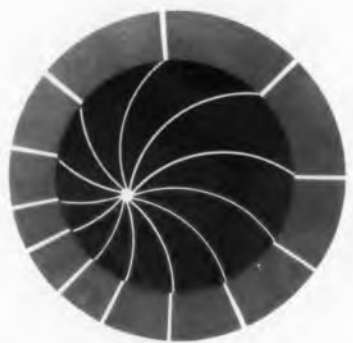
The results of this calculation will show whether or not the selected encapsulant is adequate. It may be found at this point that metallic heat conductors are preferable to a highly filled epoxy encapsulant, or that a rearrangement of the components results in a more satisfactory thermal design.

The final recheck of component temperatures is usually confined to those components whose location was a compromise due to other requirements and to those components whose performance was predicted to be marginal and thus subject to failure. ■ ■

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  4. "Cooling Electronic Equipment," ELECTRONIC DESIGN, Oct. 15, 1957.



# A Signal Level Monitor For Go-No-Go Testing

*Go-no-go testing, particularly when many different voltage levels must be monitored, can call for a lot of complicated and expensive equipment. In this article, authors Gile (left) and Newbigging describe a circuit which can be used in just about anyone's check-out equipment.*



William W. Gile and David F. Newbigging  
Seismological Laboratory  
California Institute of Technology  
Pasadena, Calif.

**I**DEALLY, electronic equipment used for go-no-go testing should be accurate, fast and inexpensive. In our work with such testing, we designed a monitoring circuit which, compared with commercially available units, could perform just as accurately, had a faster speed of response, and cost considerably (up to 90 per cent) less. The design, which we call the "reactron" circuit, may be applied to monitor any signal that can be transduced to a varying dc level.

Basically, the circuit acts as a high and low-level voltage comparator. That is, if the applied signal goes above or below any pre-selected levels for a duration of 0.1  $\mu$ sec or longer, the device will "trigger." This in turn may operate a relay, light a lamp, initiate a command function, etc.

Major specifications of the reactron are listed in the table. The circuit, Fig. 1, consists primarily of two complementary pnpnp monostable, highly regenerative, trigger circuits. In Fig. 2 the circuit is shown laid out on a modular plug-in card.

The primary factors that influenced the selection of the transistor types were:

1. High Beta. This was desired for high regeneration within the trigger circuit.
2. Low  $I_{cbo}$ . This characteristic allows the device an operating temperature gradient without excessive trigger-point level changes.
3. Conduction Hysteresis. Of the many types of transistors evaluated, several exhibited a nonrepeatable gain factor when going from cut-off to low conduction. Since the repeatability of

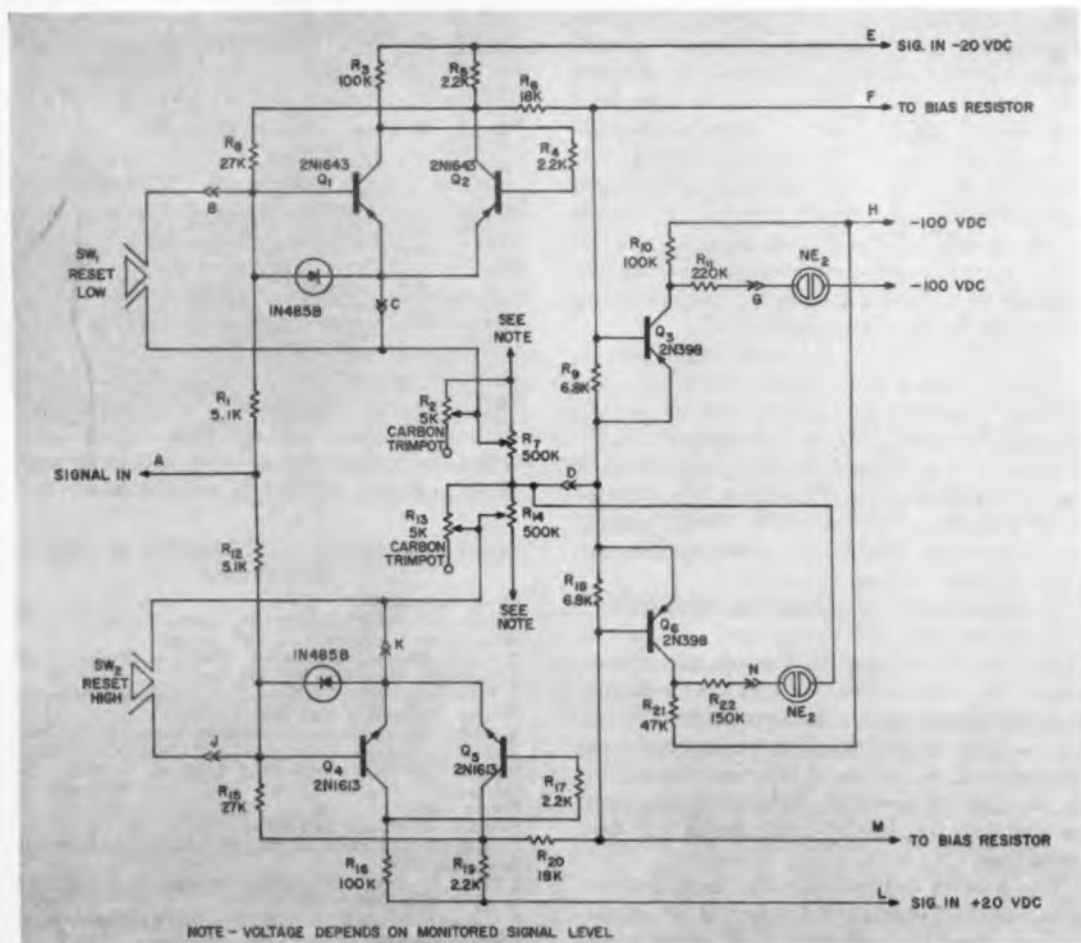


Fig. 1. Reactron monitoring circuit consists of two regenerative, complementary transistor trigger circuits.

**Table 1. Specifications for Reactron\*  
Monitoring Circuit.**

Trigger point accuracy . . .	That of the reference $\pm 35 \mu\text{V}$ .
Thermal drift . . . . .	Less than $30 \mu\text{V}$ per deg C.
Response . . . . .	Will trigger at any pulse, transient, or level change greater than the preset lim- its, that last longer than $100 \mu\text{sec}$ .
Stabilization time . . . .	10 min.
Input impedance (dc) . . .	Greater than 10 meg.
Input impedance (ac) . . .	Varies as a function of amplitude and fre- quency. Always great- er than 2.5 K.
Input trigger range (up- per and lower limits) . . .	Adjustable within $\pm 2.0 \text{ vdc}$ of the sig- nal to be monitored.
Input signal range . . . . .	No practical limits
Cost . . . . .	Under \$150.00

the trigger point is a function of the repeatability of the transistor gain factor, this had to be considered.

The operation of both the npn and pnp sections of the circuit is identical except for polarity. Thus, a description of the circuit's operation can be concerned mainly with the pnp side.

The input transistor *Q1* is biased to cut-off by feedback through resistor *R8*. The "reaction" transistor *Q2* is biased slightly into saturation via feedback through *R4*. The negative-going trigger point is selected by adjusting potentiometers *R2* and *R7*. Potentiometer *R7* acts as a coarse adjustment and is returned to the collector supply. This supply furnishes an emitter potential 0.5 v more positive than the desired negative-level trigger point. This gradient compensates for the emitter-base voltage drop across *Q1*.

#### Monitor Can Be Set To Trigger At Any Levels

Suppose that the desired voltage to be monitored was +10.000 vdc and the trigger points were to be +10.020 and +9.980. Pin "E", the collector supply for the negative sensing side, would be returned to a voltage supply that was 20.  $\pm 2$  vdc more negative than the input signal. This supply would then be -10.  $\pm 2$  vdc. The positive-sensing-

\*Initial development of the reactron was completed at Autonetics, a division of North American Aviation.

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- TOLERANCE  $\pm 1\%$
- TEMPERATURE COEFFICIENT 500 P.P.M. maximum
- FULL POWER to 70° C.

Write for Bulletin R-35 and  
handy cross reference file card







Fig. 2. Complete circuit can be laid out on etched-circuit, plug-in card.

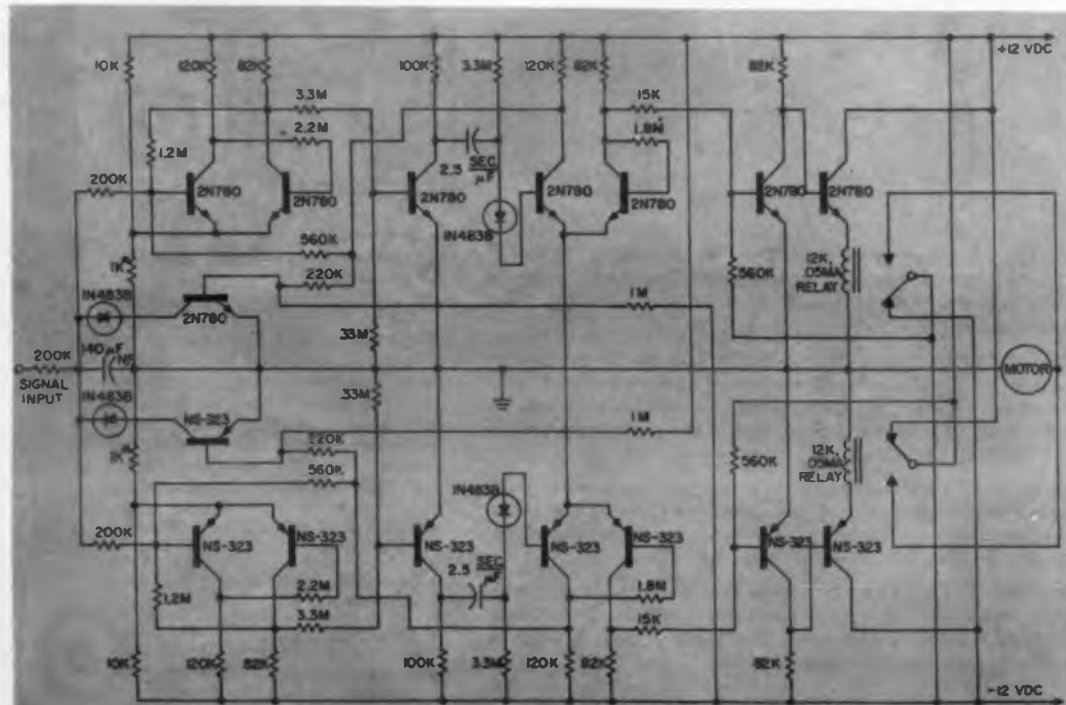


Fig. 3. Monitoring circuit for lunar seismometer leveling device is built around reactor but also provides input time constant delay, automatic discharge of the time constant, and automatic reset.

side collector supply pin, "L", would be returned to a supply that was  $20. \pm 2$  vdc more positive than the input signal, or, in this case,  $+30. \pm 2$  vdc.

Since the emitter potentials of  $Q1$  and  $Q2$  must be of approximately the same magnitude as the signal to be monitored, the returns of potentiometers  $R7$  and  $R14$  would be connected to the  $+30. \pm 2$  vdc supply (for monitoring the  $+10.0$  vdc level). Trigger-point adjustment would be made by connecting the desired trigger level potential to pin "A" and adjusting potentiometers  $R2$  and  $R7$ . The fine adjustment potentiometer  $R2$  is a 20-turn carbon trimpot. This was selected to provide infinite resolution.

The circuit is reset manually by  $SW-1$ . In the case of a high-speed transient that causes the circuit to "set", return of the signal voltage to the "normal" level will not reset the circuit. Reset is accomplished by selecting the ratio of resistors  $R5$  to  $R3$  and  $R8$  to  $R4$ . Transistors  $Q3$  and  $Q6$  are standard "normally off" and "normally on" light drivers. Since the collector voltages at points "E" and "L" are determined indirectly by the signal to be monitored, the light drivers must be biased off regardless of the voltage level feeding resistors  $R6$  and  $R20$ . This is

done by inserting bias resistors at points "F" and "M" and connecting them to positive or negative supplies determined by the respective collector-voltage swings.

Let us illustrate how these connections are made by again considering the  $+10.0$  vdc signal condition. The collector swing on  $Q2$  will be approximately from  $+10.0$  vdc during conduction to  $-10.0$  vdc during triggering. In this case, no external bias resistor on pin "F" would be needed. The "normal" state would reverse-bias  $Q3$  and the "triggered" state would cause sufficient current flow through  $R6$  for conduction.

On the positive-sensing side the collector swing of  $Q5$  would be from  $+10.0$  vdc to  $+30.0$  vdc. A resistor must be inserted at point "M" and returned to a negative supply to provide turn-on current for  $Q6$ .

If we were to return this resistor to the  $-10.0$  vdc supply, we could determine its value by making a Thevenin equivalent for the base of  $Q6$ . Thus we would find that the nonconducting state is represented by a voltage of  $+7.56$  vdc through a 5-K resistor. If a reverse bias of  $+1.0$  vdc rather than  $+7.56$  vdc is desired, the resistor to be connected to the  $-10.0$  vdc supply would be 8.40 K.

Making a Thevenin equivalent of the base of  $Q6$  during conduction yields a circuit which has  $-1.97$  vdc through 3.8 K, or a base current in  $Q6$  of 0.635 ma. This is sufficient to cause  $Q6$  to saturate. In actual practice the nearest standard resistor value is selected and used.

#### Current Feedback Produces High Dynamic Input Impedance

An interesting feature of the circuit is its extremely high dynamic input impedance. This is the result of current feedback through resistors  $R8$  and  $R15$ . Transistors  $Q2$  and  $Q5$  are biased at borderline saturation. Thus there exists a collector potential on both  $Q2$  and  $Q5$  when they are in the conducting state ( $V_{cc}$  sat). These opposite polarity potentials cancel when coupled through  $R1$  and  $R12$ , resulting in zero signal current flow at the optimum level. As the input signal shifts toward either of the trigger points, the reaction transistor ( $Q2$  or  $Q5$ ) senses that polarity shift and begins to come out of saturation. This results in feedback, through  $R8$  or  $R15$ , of a potential that is the same as the input swing. This feedback is not cancelled by the reaction transistor opposite to the input swing due to its relative position on the saturation curve. The

result is an almost infinite input impedance over limited signal swings.

The mathematics of design are primarily dependent upon the type of transistors used. They follow the normal "flip-flop" technique with but one exception. It has been found that if the collector resistors are kept to the approximate ratio of 50:1 and the biasing resistors approximately 12:1 (see  $R_3$ ,  $R_5$ , and  $R_4$ ,  $R_8$ ), extreme stability results. The normal procedure in design would be to select the collector load of the reaction transistor ( $Q_2$  or  $Q_5$ ) to be of optimum value for the current desired. Its value is then multiplied by 50 to find the load for  $Q_1$  or  $Q_4$ . The value of  $R_4$  or  $R_{17}$ , the base feedback resistors, would then be:  $R_4 = R_5 (\beta - 50)$  where beta is greater than 50. The opposite feedback resistor ( $R_8$  or  $R_{15}$ ) would then be  $R_8 = 12 (R_4)$  and  $R_{15} = 12 (R_{17})$ .

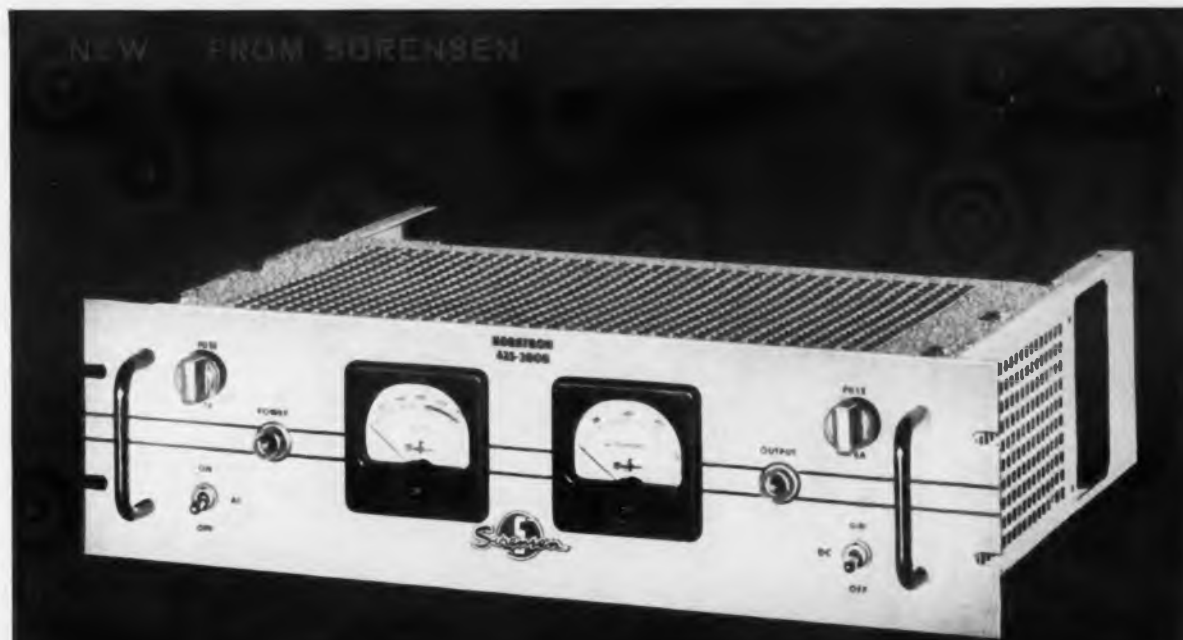
The above empirical description will satisfy the circuit condition for high-impedance loading (light drivers, etc.); for heavier loads the normal precautions must be taken. The emitter potentiometers must be small enough to stabilize the operating point. Normally, this condition will be met if:

$$R_7 = 0.25 (R_5) \text{ and } R_2 = 10 (R_7).$$

### Two Supplies Are Sufficient For Multiple Signal Monitoring

In making use of the reactron some choice is allowed in selecting the respective collector supplies. It has been found that many different signal levels may be monitored with the use of only two supplies. One console, designed for the Minuteman Missile monitored approximately 60 signals derived from a telemetry package during vibration testing. All of the input signals were within the 0 to  $\pm 5.0$  vdc range. Some signal limits were as close as  $\pm 10$  mv. Under these conditions it was possible to connect all 60 reactrons to only two supplies. (Also included within the console was circuitry for transducing frequencies, pulses, sine and square wave amplitudes, temperatures, etc. to dc voltages that can be monitored). This, of course, indicates the versatility of the circuit.

Another example of the reactron may be seen in Fig. 3. This circuit was designed for a lunar exploration seismometer levelling device presently being developed by the California Institute of Technology. The design is still based on reactron monitoring; however, this circuit provides an input time constant delay, automatic discharge of the time constant and automatic reset. ■ ■



Regulated, variable-output

## B SUPPLIES

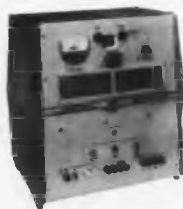
2 voltage ranges at 200, 400 and 800 MA

### TRANSISTORIZED SINE WAVE INVERTER -

The QISB, a rugged, low-cost, compact inverter, provides up to 60 VA of 115V AC at 60 or 400 cycles from a DC source. Output will not vary more than  $\pm 3\%$  with load variations. The QISB is easy to install and starts instantly. It has no moving parts and is not damaged by momentary overloads or output shorts.



### 3-PHASE FREQUENCY CHANGER - The FCR 3P300 variable frequency power source supplies 0-130 volts line to neutral; 300 VA 3-phase, 200 VA 2-phase, or 300



VA single phase with  $\pm 1\%$  regulation for both output frequency and voltage. Frequency may be varied from 45 to 2000 cps in two ranges. Suitable for many laboratory and industrial applications.

Close regulation, constant current output and provisions for external programming distinguish these versatile new B Supplies. Available with 125-325 VDC or 325-525 VDC output, they also provide 6.5 VAC for powering external tube filaments. Mechanically designed for easy access to tubes and circuits, all models are designed for standard 19" rack mounting and include front-panel output voltmeters and ammeters. These compact new plate and filament supplies are ideal for use in a broad variety of industrial and laboratory electronic equipment. Ask for complete specifications and literature.

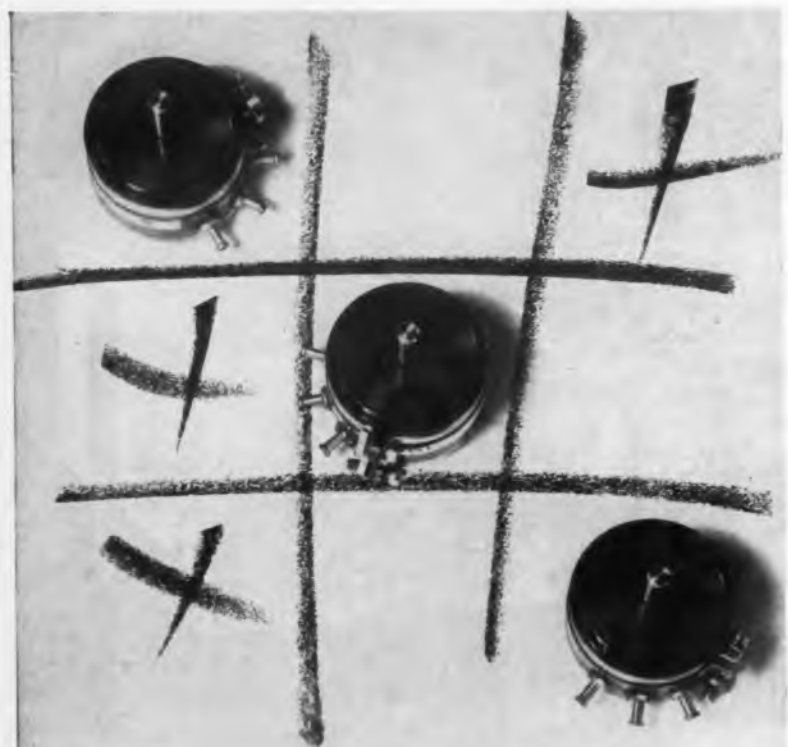
### SPECIFICATIONS

INPUT VOLTS:	105-125 volts AC 50-400 Cycles All Models
DC OUTPUT VOLTS:	125-325 V DC or 325-525 V DC
DC OUTPUT CURRENT (MA):	200, 400 or 800
LINE & LOAD REGULATION COMBINED:	$\pm (0.1\% \pm .05 V)$
RIPPLE:	3 millivolts RMS
AC OUTPUT VOLTS (unregulated):	0.8 V (at full load, 115 V AC input)

A UNIT OF RAYTHEON COMPANY

RICHARDS AVENUE • SOUTH NORWALK • CONNECTICUT  
CIRCLE 42 ON READER-SERVICE CARD





## WINNER!

It's not the game, it's winning that counts—and Duncan potentiometers score right down the line. Precision, quality and reliability (three in a row) offer a combination that thwarts competition. Simple? Only because Duncan has improved design and manufacturing techniques—become expert in potentiometer oneupmanship.

Our pots can fill that blank spot on your board. The next move is yours. Put your x on this advertisement (name and address will further clarify) and return it to us. We'll be pleased to send you a complete list of the Duncan winners.

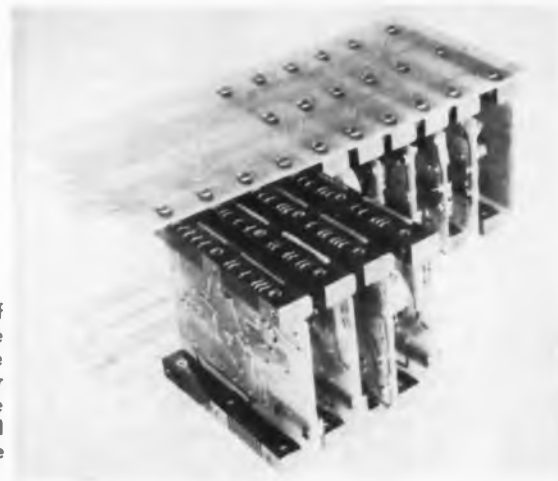
Exceptional vibration and shock performance (30g to 2,000 cps vibration and 50g shock) make Duncan's miniature  $\frac{1}{8}$ " single turn Model 1201 above, particularly suitable for military servo packages. Diallyl pthalate housing withstands shock and protects against fungus, acid and alkali attack. Operating temperatures to 150°C are available.

DUNCAN ELECTRONICS, INC.  
2865 FAIRVIEW ROAD • COSTA MESA, CALIFORNIA

CIRCLE 43 ON READER-SERVICE CARD

## PRODUCT FEATURE

**Army (ARGMA) application** of Becon connectors: In this case the connectors are screw fastened to the top and bottom boards but adapter strips permit the smaller boards to be plugged in. Only disadvantage noted by this user was the weight of the connectors.



## Board-to-Board Connector Creates Package Flexibility

**N**EW arrangements for assemblies of printed-circuit boards are permitted by a recently developed combined connector-mounting device. The "Becon" connector, which is being offered by the Brown Engineering Co., P. O. Box 917, Huntsville, Ala., was conceived at the National Aeronautics and Space Administration's Marshall Space Flight Center, also in Huntsville. The Becon has flown on a successful Juno-II satellite boost and is being used on the large Saturn rocket. However, a Marshall Center engineer cautioned *ELECTRONIC DESIGN* that time has not permitted reliability histories to be fully developed.

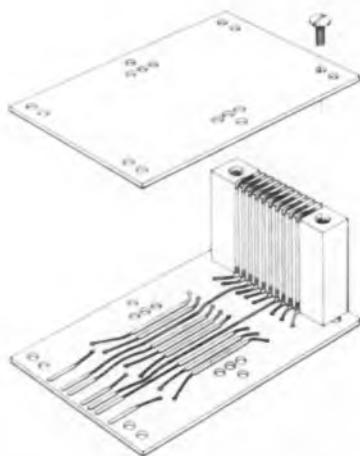
The manner in which this new connector increases a designer's freedom is symbolized on this issue's cover. As the cross sections indicate, the connector is but a block of diallyl pthalate plastic into which have been molded grooves to carry the contact fingers and tapped bushings for the hold-down screws. The contacts are springs of beryllium copper ribbons, gold plated.

When a printed-circuit board is screwed down onto this connector, the protruding contacts are compressed (with some wiping action) against the mating conductors on the boards. A virtue of this simple type of connection is that it can be placed anywhere on the board. The designer is not limited to inserting one end of the board into a connector or soldering board.

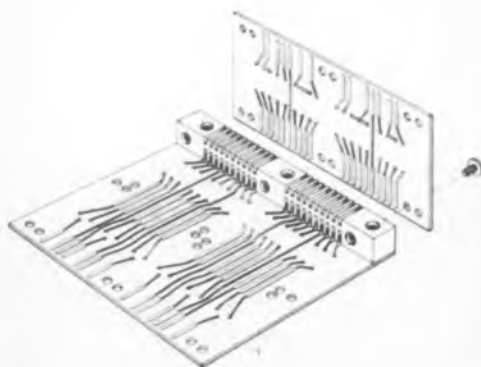
Thus the board arrangement patterns can be as regular as most conventional arrangements or very irregular, as long as the boards are either parallel or at right angles to each other. For example, the combined electrical and mechanical interconnection ability of the Becon could be used, first with the 180-



The 90-deg version of the Becon connector comes with 20 contacts (shown) or 10 contacts.



The 1.200-in. high by 1.600-in. wide 180-deg version can be used for stacking in parallel planes.



The 0.375-in. sq. 3.5-in. long 90-deg version is for joining boards at right angles.

deg types to stack the boards one on top of the other in parallel planes. Then the 90-deg types could be used to right-angle smaller boards off the main boards.

Prices for the connectors start at \$3.74 each for the 10-contact, 90-deg; \$5.46 for the 20-contact 90-deg; and \$7.38 for the 10-contact 180-deg. These are for sample quantities up to nine connectors and the prices have the usual decrease with quantity. Availability is from stock for quantities of fewer than 150 units and within 30 days for larger quantities.

For more information on these connectors turn to the Reader-Service Card and circle 250.

## INLAND d-c torque motors save critical weight in guidance systems



PLATFORM SHOWN 1/2 SIZE

Nordens Miniature All-Attitude Inertial Platform uses four Inland torque motors, one for each gimbal axis.

Nordens specifies these Inland d-c torque motors because of their compact pancake shape, low-power input and direct torquing. In addition to providing the obvious weight and space reduction, Inland's direct drive positioning eliminates gear train problems such as backlash.

Nordens engineers say, "The linearity of the Inland torquers is excellent over a wide range so that precession rates may be accurately established. The torquer fixed field is carefully stabilized so that the torquer gradients will be constant over long periods of time."

Inland d-c pancake torque motors with high torque-to-inertia ratios and linearity of output provide all the advantages of direct gearless servo positioning in a complete line over the full range of 0.1 to 3,000 pound-feet.

### COMPARE THESE TYPICAL INLAND TORQUER RATINGS

	T-1321-A	T-2136-A	T-2108-B
Peak torque, oz. in.	20.0	35.0	60.0
Volts at peak torque, stalled at 250°C	48.0	26.0	25.6
Amps at peak torque	1.21	1.6	1.24
Total friction, oz. in.	0.5	0.8	1.5
Rotor Inertia, oz. in. sec <sup>2</sup>	.001	.007	.011
Weight, oz.	5.0	9.0	14.0
Dimensions (inches):—O.D.	1.937	2.81	2.81
I.D.	.625	1.00	1.00
Thickness	.50	.63	1.00

For complete catalog with engineering data, outline drawings and specifications on these and other Inland d-c pancake torquers, write Inland Motor Corporation of Virginia, Northampton, Massachusetts, Dept. 3-8.



**INLAND MOTOR CORPORATION**  
OF VIRGINIA  
A SUBSIDIARY OF KOLLMORGEN CORPORATION

NORTHAMPTON, MASS.

CIRCLE 44 ON READER-SERVICE CARD



## ONE INTEGRATED SOURCE for Ceramic-to-Metal Seals



In all phases of planning for high-alumina ceramic-to-metal seals you can rely on Alite for the "know-how" and "do-how" required to produce highest quality for critical applications.

From design to finished part, every manufacturing step — including formulating, firing, metalizing and testing — is handled within our own plant and carefully supervised to assure strict adherence to specifications, utmost uniformity and reliability.

To simplify design problems and speed delivery, Alite terminals, feed-throughs and cable end seals are available in over 100 standard sizes.

### INSIDE LOOK AT ALITE—



Write today for Bulletin A-40R—Full technical data on standard and special Alite ceramic-to-metal seals.

ALITE DIVISION

**U. S. STONWARE**

CIRCLE 45 ON READER-SERVICE CARD

## PRODUCT FEATURE

### Photoconductive

**A**BOUT 1,000 times more light-sensitive than photovoltaic cells, these photoconductive cells are designed for light-dependent control applications. They are available in four basic sizes: a "Compactron" type; a 9-pin type in a conventional tube envelope; a medium size and a miniature type, each with flying leads.

The "Compactron" type and the two smaller cells are end-illuminated while the fourth is side-illuminated. The units, manufactured by the Receiving Tube Dept. of General Electric, Owensboro, Ky., are hermetically sealed to protect the photoconductive material from moisture.

The "Compactron" type Z-2946 and the conventional-tube envelope type 7427 are all-glass while the medium-size cell Z-2963 and the miniature Z-2755-1 are of metal-to-glass construction. All the cells operate over a range of 1,400 Å. The wavelength of maximum response is 5,500 Å which is the center of the visible light spectrum.

Both the "Compactron" type and the 7427 have essentially the same ratings. Power dissipation is about 100 mw; max current is 50 ma and max applied voltage is 350 V.

The "Compactron" envelope, because it is bottom-evacuated, lends itself to the end-illumination design. Its 12-pin feature provides extra tie points, socket adaptability and ruggedness. Seated height is less than 1 in. It can be used for street-lighting control and other area or residential-lighting applications. The seated height of the 7427 is 2.25 in.

The medium-size cell was developed for crt picture-brightness and contrast control. Its power dissipation is about 250 mw, max current is 20 ma and max applied voltage is 250 V. The outside diam is a little more

## Cells For Industrial Use

than 0.6 in. and height, excluding leads, is about 0.3 in.

The miniature cell is 0.37 in. in diam and 0.22 in. in height, excluding leads. Power dissipation is 50 mw; max current is 2 ma and max applied voltage is 3 V. Among the applications are camera-aperture controls and toys.

Factory life-test results for the units are impressive. During life-tests of 20 lots of 7427s, totaling 200 units and 100,000 hours of device operation, there were no failures. All 200 tubes were checked for dark current, light current and 350-v breakdown periodically during the test pe-

riods. Variations in these characteristics were negligible.

Among the uses for photoconductive cells are in anemometers, blood-pressure gages, card sorters, computer-logic circuits, radiation detectors and crt brightness controls.

Prices to original-equipment manufacturers are 85 cents for type Z-2963 and 80 cents for type Z-2755-1. Prices for the larger cells are in the \$1 to \$2 range. The 7427 is available from distributors, the other three are available in sample quantities. For more information on these photoconductive cells turn to the Reader-Service Card and circle 251.



ELECTRONIC DESIGN • November 8, 1961

## BALLANTINE True RMS VTVM model 350



Measures  
wide  
range of  
waveforms  
with  
**1/4% ACCURACY**

For highly accurate voltage measurements, the uncertainty introduced by waveform distortion limits the use of average and peak-responding instruments. The Model 350 is a 0.25% accurate, true rms-responding instrument designed to overcome this limitation. It provides the engineer with a rugged, reliable and easy-to-use laboratory or production line instrument. It will measure a periodic waveform in which the ratio of peak voltage to rms is not over 2.

The method of measurement with the Model 350 is similar to balancing a bridge: four knobs are set for minimum indication and the unknown voltage is read directly from a 4 to 5 digit NIXIE® in-line readout. The precision exceeds the stated accuracy by 5 to 10 times. Price: \$720.

### SPECIFICATIONS

Voltage Range..... 0.1 V to 1199.9 V	Frequency Range..... 50 cps to 20 kc
Accuracy: ¼%, 100 cps to 10 kc, 0.1 V to 300 V; ½% outside these limits	Max Crest Factor ..... 2 Input Impedance .... 2 MΩ shunted by 15 pF to 45 pF

Write for brochure giving many more details

— Since 1932 —



**BALLANTINE LABORATORIES INC.**

Boonton, New Jersey

CHECK WITH BALLANTINE FIRST FOR LABORATORY AC VACUUM TUBE VOLTMETERS. REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY OR WAVEFORM WE HAVE A LARGE LINE, WITH ADDITIONS EACH YEAR. ALSO AC DC AND DC AC INVERTERS, CALIBRATORS, CALIBRATED WIDE BAND AF AMPLIFIER, DIRECT READING CAPACITANCE METER, OTHER ACCESSORIES. ASK ABOUT OUR LABORATORY VOLTAGE STANDARDS TO 1,000 MC.

CIRCLE 46 ON READER-SERVICE CARD

# NEW PRODUCTS

Covering all new products generally specified by engineers designing electronic original equipment. Use the Reader-Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.

## SCR Trigger Provides High Stability Firing 255

Designed specifically for industrial controlled-rectifier firing circuits, the SCR trigger is a silicon transistor which exhibits a negative resistance characteristic when a predetermined emitter-to-base firing voltage is exceeded. This characteristic is stable over a temperature range of  $-65$  to  $+140$  C. Rated rms power dissipation is 250 mw; max rms emitter current is 50 ma. Permissible emitter reverse voltage is 30 v max and interbase voltage is 35 v max. Units are encased in a TO-18 package.

International Rectifier Corp., Dept. ED, 233 Kansas St., El Segundo, Calif.

P&A: \$3 ea, 1 to 99; from stock.



## Semiconductor Networks Measure 1/4 x 1/8 x 1/32 In. 257

The series 51 includes six different digital circuit modules which will handle 90% of the circuit functions of digital equipments, particularly for military computers, programmers and other information processing application functions. Each silicon network is contained in an hermetically sealed package measuring  $1/4 \times 1/8 \times 1/32$  in. Produced to meet the requirements of military applications, they have design compatibility with present-day digital circuitry and operate over a temperature range of  $-55$  to  $+125$  C. The SN 510 flip-flop and the SN 512 and 514 NOR/NAND gates have power drain of 2 mw while the power drain of the emitter-follower units SN 511 and 513 is about 8 mw for  $V_{cc}$  of 3 v.

Texas Instruments Inc., Dept. ED, 13500 N. Central Expressway, Dallas, Tex.

P&A: \$50 to \$65 for quantities of 1,000; immediate.

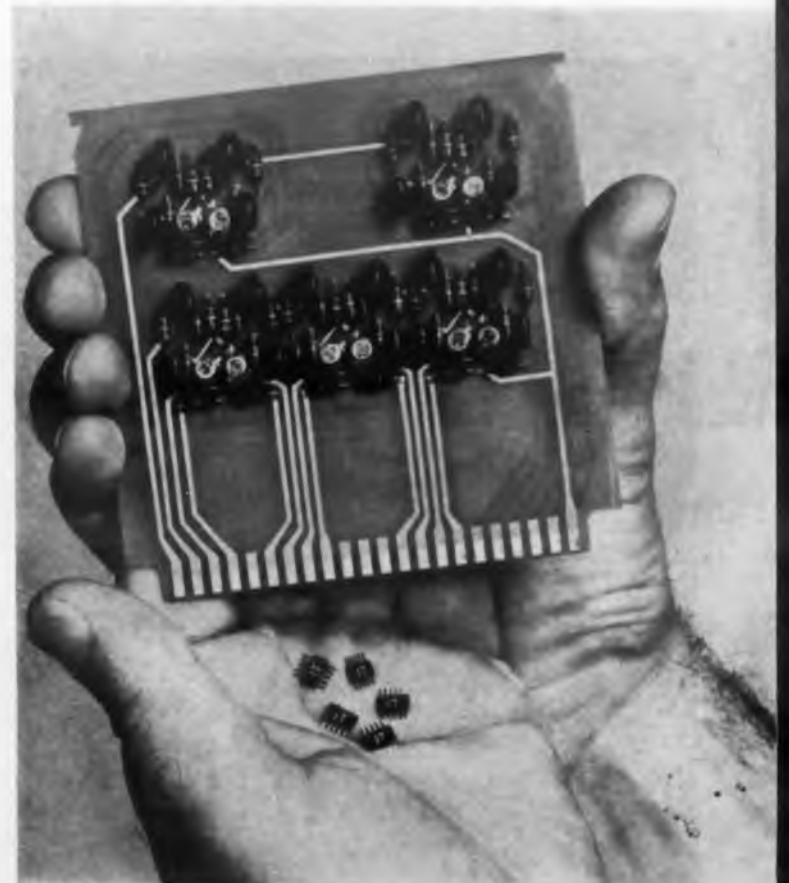


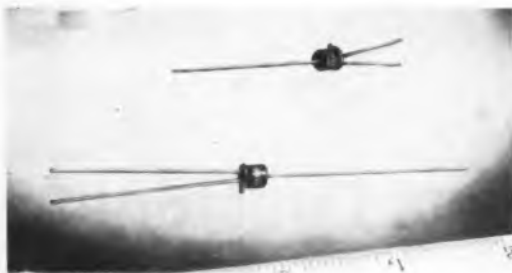
## Vaneaxial Blowers Have 2-In. Diameter 256

Up to 50 cfm at 2.1 H<sub>2</sub>O back pressure is produced by vaneaxial blowers designated VAX-2-MC. Maximum length of the unit is 1-1/2 in.; diameter is 2 in. The blower motor can be wound for 115 v ac, 1- or 3-phase, 400 cps or 200 v ac, 3-phase 400 cps. Maximum power for the 3-phase version is 45 w at 65 cfm free air delivery. The unit weighs 5 oz and is designed to meet appropriate MIL specifications for environmental protection.

Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton 4, Ohio.

P&A: factory quote; some from stock.





### Silicon Controlled Rectifiers Have In-Line Configuration 258

Newly developed packaging techniques allow miniaturization with no loss of sensitivity, cut-off characteristics or inherent reliability, in silicon controlled rectifiers types 3F15 through 3G200. Both conventional outline and new in-line configuration for welded modules and printed circuits are available with 2-ma triggering, dc ratings to 200 v and 350 ma with pulse capability to 10 amp.

Solid State Products, Inc., Dept. ED, 1 Pingree St., Salem, Mass.

*P&A: from \$3.50 ea in lots of 100; immediate.*



### Operational Amplifier Has No Choppers Or Modulators 259

A miniaturized plug-in, the P65 differential operational amplifier is designed primarily for instrumenting, controlling and computing. Containing no choppers or modulators, it has a direct-coupled input circuit with a differential input range of  $\pm 10$  v and a common-mode rejection of about 10,000 to 1. Output range is  $\pm 1.1$  ma at  $\pm 11$  v. High temperature characteristics of silicon transistors used in the P65 provide an operating range of  $-20$  to  $+85$  C.

George A. Philbrick Researches, Inc., Dept. ED, 127 Clarendon St., Boston, Mass.

*P&A: \$95; immediate delivery is possible for small quantities.*



## test-bench instrument



## or systems component



### KEPCO "ABC" POWER SUPPLY



MODEL ABC 30-0.3M

MODEL	DC OUTPUT RANGE		DIMENSIONS			PRICE
	VOLTS	CURRENT	H	W	D	
ABC 30-0.3	0-30	0-300ma.	4 1/4"	8 1/2"	5 5/8"	\$ 99.00
ABC 40-0.5	0-40	0-500ma.	4 1/4"	8 1/2"	9 5/8"	\$139.00
ABC 7.5-2	0-7.5	0-2 amp	4 1/4"	8 1/2"	9 5/8"	\$139.00
ABC 15-1	0-15	0-1 amp	4 1/4"	8 1/2"	9 5/8"	\$139.00

For meter: Add suffix "M" to Model No. and \$20.00 to price.  
Rack Adapter; Model RA-4 (for 2 units), RA-5 (for 1 unit) available at \$15.00 each.

WRITE FOR COMPLETE SPECIFICATIONS.

### KEPCO "ABC" POWER SUPPLY

Its small, lightweight design makes the Kepco "ABC" Power Supply equally at home on the test bench for R & D, rack-mounted as a system element, and chassis-mounted as a modular component.

Its precise, versatile capability makes it compatible with stringent and varied applications:

- Line/Load Regulation: 0.05% ■ Stability: 0.05% or 6mv, whichever is greater
- Ripple: 0.5mv RMS
- Input: 105-125v ac, 50-440 cps
- Constant Current operation
- Remote Programming at 1000 ohms per volt
- Remote error sensing: to maintain regulation at the load
- Automatic overload protection
- Adjustable current limiting.

Its Low Price is achieved by efficient design without sacrifice in quality and reliability.



131-36 SANFORD AVENUE • FLUSHING 52, N. Y.  
Area Code 212 IN 1-7309 • TWX # NY 4-5196

CIRCLE 47 ON READER-SERVICE CARD



SHOWN ACTUAL SIZE



## SIZE 5 COMPONENTS

### FOR SERVO SYSTEM MINIATURIZATION

A complete family of Size 5 components for every servo system function is now available from Kearfott. Stainless steel housings, shafts and bearings protect the units against environmental extremes and contribute to stability under shock, vibration, and temperature fluctuations. • Standard 26-v, 400-cps excitation. • Operating temperature range -55° to +125°C.

### CHARACTERISTICS

#### SYNCHROS

	VOLTAGE (400 cps)	T.R.	NULL (mv)	ERROR (min)
Transmitter CJO 0565 100	26	.454	34	10
Control Transformer Low Z-CJO 0555 100	11.8	1.765	34	10
High Z-CJO 0552 900	11.8	1.765	34	10
Differential CJO 0595 100	11.8	1.154	34	10
Resolver Low Z-CJO 0585 100	26	1.0	34	10
High Z-CJO 0589 100	26	1.0	34	10

#### SERVO MOTORS

	J126-06	J126-02	SYNCHRONOUS MOTOR CJO 0172 200
No-Load Speed	9800 rpm	9800 rpm	Pull-In Torque 0.06 in. oz
Stall Torque	0.10 in. oz	0.10 in. oz	Pull-Out Torque 0.10 in. oz
Rotor Moment of Inertia	0.175 gm cm <sup>2</sup>	0.175 gm cm <sup>2</sup>	Pull-Out Power 4 w
Voltage $\phi 1 / \phi 2$ (400 cps)	26 / 36-CT	26 / 26	
Power Input / Phase	1.7 w	1.7 w	

#### MOTOR GENERATORS

MOTOR	CJ4 0812001	CJO 0812 650	CJO 0813 200
Voltage $\phi 1 / \phi 2$ (400 cps)	26 / 36-CT	26 / 36-CT	26 / 26
Power / $\phi$	1.5 w	1.5 w	1.5 w
No-Load Speed	8000 rpm	8000 rpm	8000 rpm
Stall Torque	0.10 in. oz	0.10 in. oz	0.10 in. oz
GENERATOR			
Voltage (400 cps)	26 v	26 v	26 v
Volts / 1000 RPM	0.1 v	0.1 v	0.5 v
Null	1.3 mv	10 mv	6.7 mv

Size 5 gearheads range in reduction ratios from 20:1 to 1019:1 for servomotors and motor tachometers above. In addition to Size 5 clutches, brakes, and brake-clutches, Size 6 are available.

Write for complete data



**KEARFOTT DIVISION  
GENERAL PRECISION, INC.**

Little Falls, New Jersey

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tube, cathode-ray	86	390
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## KEARFOTT MICROWAVE ANTENNAS

- 1. X-BAND MONO PULSE ANTENNA** utilizes the principle of multiple modes in waveguide. It features extremely deep nulls (50 DB) and a very compact configuration.
- 2. PARABOLIC ANTENNAS** of conventional design for X-Band and KU-Band are also available in the Kearfott line.
- 3. HORN ANTENNA** This dielectric lense horn antenna is phase compensated to give optimum patterns and side lobe levels.
- 4. X-BAND PLANAR ARRAY ANTENNA** consists of a phased array of waveguide slot radiators. The pattern consists of two conical beams at a carefully controlled angle with respect to vertical.
- 5. Ka BAND CONICAL SCANNING ANTENNA** achieves a high rate of electrical scanning through use of a tri-slot device that gives 3 electrical scans for each mechanical scan. Compactly designed, it provides extremely close control (less than .1 DB) over the cross over.

Write for complete data



**KEARFOTT DIVISION  
GENERAL PRECISION, INC.**

Little Falls, New Jersey

CIRCLE 49 ON READER-SERVICE CARD

## MICROWAVE ASSOCIATES PROGRESS REPORT



# Microwave Power from Varactor Diodes

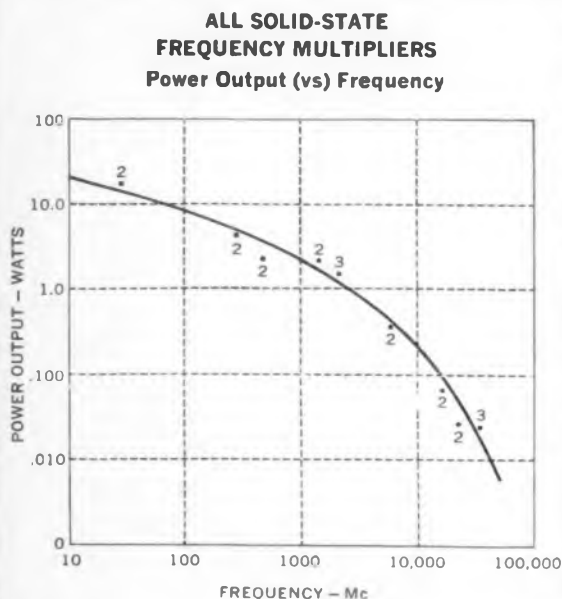
**E**fficient conversion of microwave power has been accomplished with a variety of new varactor frequency multipliers developed at the Waveguide Systems Division of Microwave Associates, Inc.

We have produced microwave power of several watts at UHF frequencies, several hundred milliwatts at X-band frequencies, and tens of milliwatts at Ka-band frequencies. The curve above indicates more accurately the power levels achieved by these Microwave Associates units. They employed doublers and triplers.

Efficiencies of these units range from 80 — 90% in the UHF region and from 20 — 30% at X-band. At present, the highest efficiencies are achieved at relatively narrow bandwidths (1%-2%). However, our capabilities are rapidly improving efficiencies for broader band operation. An example of a fixed-tuned broadband unit is a "tripler" which provides an output of 10 milliwatts over a 14% range at X-band.

Because of their efficiency and simplicity, these frequency multipliers are of considerable interest to systems engineers designing radar exciter circuits, low-power transmitters, stable local oscillator and paramp pump sources, and other circuits which require high frequency stability and exceptionally long life. These varactor multiplier circuits are generally passive, requiring neither tuning nor external bias voltage.

Our progress in producing efficient microwave



power with all-solid-state techniques is related to performance of the most advanced high-power epitaxial varactors with significantly lower losses. The capabilities of Microwave Associates' Semiconductor Division in producing such varactors is a most positive asset. As this article is being printed, the multiplier performances shown here have already been exceeded.

We are also developing chains of these frequency multipliers to provide moderate amounts of power when driven by transistor oscillators. Efficiencies of these multiplier chains (RF output/DC input) are as good or better than equivalent klystron sources. Compactness and all-solid-state reliability are equally important benefits.

If you have an application for efficient varactor frequency multiplication or would like to discuss the very latest capabilities of these units, please write to Mr. Herbert Cox, Waveguide Systems Division. We'll be pleased to send you a new article on Varactor Frequency Multiplication by Mr. M. E. Hines.



### MICROWAVE ASSOCIATES, INC. WAVEGUIDE SYSTEMS DIVISION

Burlington, Massachusetts • BRowning 2-3000  
Western Union Fax • TWX: Burlington, Mass. 942  
Export Sales: MICROWAVE INTERNATIONAL CORP.  
36 W. 44th Street, N.Y.C., N.Y., U.S.A., Cable MICROKEN

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## NEW PRODUCTS

### Tube Clamps

478



For subminiature T-3 envelopes, Series 7B is available with or without sockets for in-line and circular basing. The design is the open finger-sleeve which permits easy top insertion and/or withdrawal. The device conforms to irregularities of the envelope to provide greater contact and thus greater thermal conductivity. Lengths are 1-3/4 and 1-15/16 in.; widths 0.60 in.

The Birtcher Corp., Industrial Div., Dept. ED, 745 S. Monterey Pass Road, Monterey Park, Calif.

Availability: stock.

### Compressor Amplifier

523

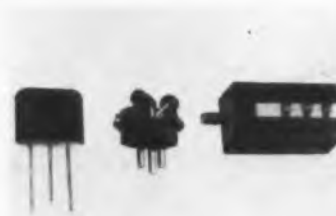
Model 666 compresses 40 db without increasing distortion, according to the manufacturer. The unit can be used as a line amplifier or pre-amplifier. Response is  $\pm 1$  db from 20 to 15 kc and output is +25 dbm with an input of -15 dbm. Inputs and outputs are 150, 300 or 600 ohms. Attack time is 40 msec; release time, 200 msec.

Fairchild Recording Equipment Corp., Professional Products Div., Dept. ED, 10-40 45th Ave., Long Island City 1, N. Y.

Price: \$495.

### Voltage Doublers

463



Ranging from 50 to 1,500 v piv at a current rating of 1.1 amp, three basic configurations of voltage doublers are available. Series DB features miniature size and high surge current rating. Series SC polarized plug-in type has a 3/4-in. diam. Series MB is available in molded blocks with mounting studs and is manufactured to meet all military specifications.

Solitron Devices, Inc., Dept. ED, 500 Livingston St., Norwood, N. J.

P&A: \$0.70 to \$4.00; stock.

## AC Power Supply

477



Output power is 160 va, 1 phase  $\pm 0.7$  power factor load, with output voltage of 0 to 130 v. Full power output voltage is 100-130 v and basic amplifier response is 45 to 5,000 cps. Regulation vs line is  $\pm 0.5\%$  for  $\pm 5\%$  line at full power and  $\pm 1\%$  for  $\pm 10\%$  line at 3/4 power. Recovery time is zero. Model 161A has input of 115 v ac, 1 phase, 60 cps.

Behlman-Invar Electronics Corp., Dept. ED, 1723 Cloverfield Blvd., Santa Monica, Calif.  
Price: \$420.00 job Santa Monica.

## Remote Control

492



For motor-driven variable autotransformers. Voltage on type 1590-A is indicated on a quasi-rms panel meter. Correction rate of the system depends upon the size of the driven autotransformer and can reach 60 v per sec for small units. Tracking accuracy is  $\pm 2\%$  of the line voltage.

General Radio Co., Dept. ED, West Concord, Mass.

Price: \$95.00 job West Concord.

## Push-Button Switch

475



Available with from one to ten stations. Model TP 8800 has snap-action contact with rating of 5 amp at 120-250 v ac (30 v dc rating, 3 amp inductive, 5 amp resistive). The switch has full interlock and lock out design which prevents the user from engaging more than one push-button at a time.

American Monarch Corp., Dept. ED, 2801 37th Ave. N.E., Minneapolis 18, Minn.

Price: \$50.00.



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Synkote<sup>®</sup> Silicone Rubber insulated wire and cable is the answer for extreme temperature applications. It combines some of the best physical and electrical properties of rubber and plastics in one insulation. Flexible even after long exposure to temperatures from  $-130^{\circ}\text{F}$  to  $+500^{\circ}\text{F}$ , ozone and corona resistant, non-flammable, high dielectric strength and insulation resistance, low dissipation factor and dielectric constant, good tensile strength and elongation. Can be manufactured in watertight constructions. Ideal for outstanding performance under difficult operating conditions—in aircraft, missiles, electronic equipment, motor and transformer leads, high tension ignition leads. Synkote<sup>®</sup> Silicone Rubber insulated wire and cable—a new twist you should know more about! Write today.

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**INSIDE  
GENERAL  
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TANTALUM**  
RELIABILITY THAT MEETS  
**MIL-C-26655A**  
FOR ALL 5 MAJOR RATINGS

Most sources for solid tantalum capacitors meet MIL spec requirements for one, two or possibly three major ratings. Only General Instrument satisfies all five major ratings, from 6 through 35 volts. ■ This proven ability to develop and produce advanced capacitors explains why General Instrument solid tantalums have gained unprecedented acceptance for military and industrial applications. It's also a good reason why General Instrument should be your source for tantalums, micas, films and electrolytics too. ■ Write for engineering bulletin and booklet "Inside General Instrument Capacitor." **General Instrument Corporation**, Dept. 200A, Darlington, South Carolina.

## NEW PRODUCTS

### Slip Clutch

537



Adjustable from 0 to 50 oz.-in. MCS series is designed to meet MIL-E-5272 C and is comprised of a stainless steel spur gear, Delrin bearing and clutch plate, steel spring and anodized aluminum hub and clamp. Axial position of the clamp sets the torque and locks unit to the shaft.

Northfield Precision Instrument Corp., Dept. ED, 4400 Austin Blvd., Island Park, N. Y.

P&A: \$22.00; stock.

### Time Delay Relay

516

Model 591 can be used as a delay timer, or a remote time adjustment. Weighing 9 oz., this 2 x 2-1/4 x 3-1/8 in. unit operates on 105 to 125 v ac, 60 to 1,200 cps, with dc units available. Time intervals range from 0.003 to 300 sec (factory set), with 5 amp contacts on this 3pdt relay.

G. C. Wilson & Co., Dept. ED, P. O. Box 5525, Huntington, W. Va.

### Cathode Ray Tube

531



Dual-gun, 12-in. ETC type M1030 tube provides tracking accuracy over a 10-in. diam useful area with a maximum error of 0.070 in. With additional electrodes providing further electrical correction, accuracy can be improved to approximately 0.050 in. max.

Electronic Tube and Instrument Div., General Atronics Corp., Dept. ED, 1200 E. Mermaid Lane, Philadelphia 18, Pa.

### VHF Variable Capacitors

533



Capacities are 1.3 pf min, 32.0 pf max. Standard, butterfly and differential capacitors are available with silicone-treated steatite bases, soldered nickel-plated brass rotor and stator assemblies, and lock-type bearing configurations for extreme shock conditions. These units, which test at 880 v rms, 60 cps, meet or exceed MIL specifications.

Hammarlund Manufacturing Co., Inc., Dept. ED, 460 W. 34th St., New York 1, N. Y.

Availability: stock.

### Gold-Tin Alloy

515

Eutectic, Acculoy 280C, a homogenous Au80-Sn20 alloy has automatically interspersed elements. Precision squares, rectangles, disks and washers up to 1.5 in. diam and 0.001 in. to 0.015 in. finished gage, have a melting point of 280 C. Alloy is suitable for electrode attachment in semiconductor devices.

Accurate Specialties Co., Inc., Dept. ED, 345 Lodi St., Hackensack, N. J.

### High-Capacity Switch

536



Rated at 22 amp at 125, 250 or 480 v ac, 1/4 hp at 125 v ac or 1/2 hp at 250 v ac, type BM-1R-A2 has spdt circuitry and is available with spst. The switch has 0.001 max differential travel and 0.005 min overtravel. The unit carries UL listing and CSA certification.

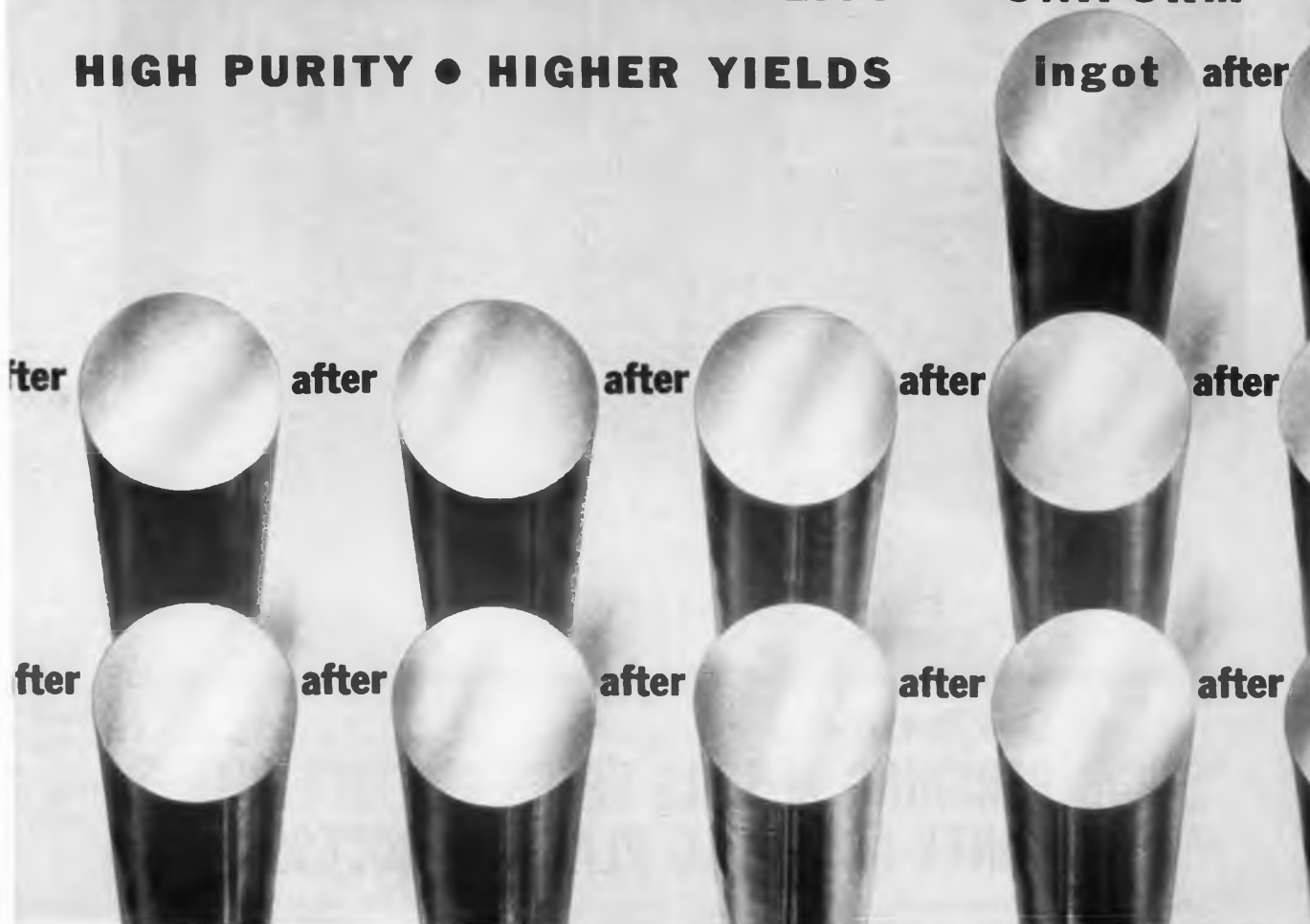
Minneapolis-Honeywell Regulator Co., Micro Switch Div., Dept. ED, Freeport, Ill.

Price: \$2 ea., 1 to 9.

CIRCLE 53 ON READER-SERVICE CARD

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HIGH PURITY • HIGHER YIELDS**



Single crystal MONSANTO SILICON — float-zone-refined with parameters *precision-tailored* to customers' specifications—assures these advantages:

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- Excellent crystal structure—no slippage or lineage
- Boron level in *n* type crystals less than 0.25 ppb—for minimum compensation effect
- Uniform radial and vertical dislocation density
- Low oxygen content—less than  $1 \times 10^{16}$  atoms per cc.
- Uniformly tight diameter control

Grow your own? Find out how Monsanto micropure polycrystalline silicon can help boost your ingot yield. Boron content guaranteed less than 0.25 parts per billion (typically less than 0.15 ppb).



and single crystal intermetallics. We cordially invite your inquiries.

MONSANTO SILICON is being produced in this modern multimillion-dollar plant—backed by a 60-year tradition of "tailoring" materials to critical specifications.

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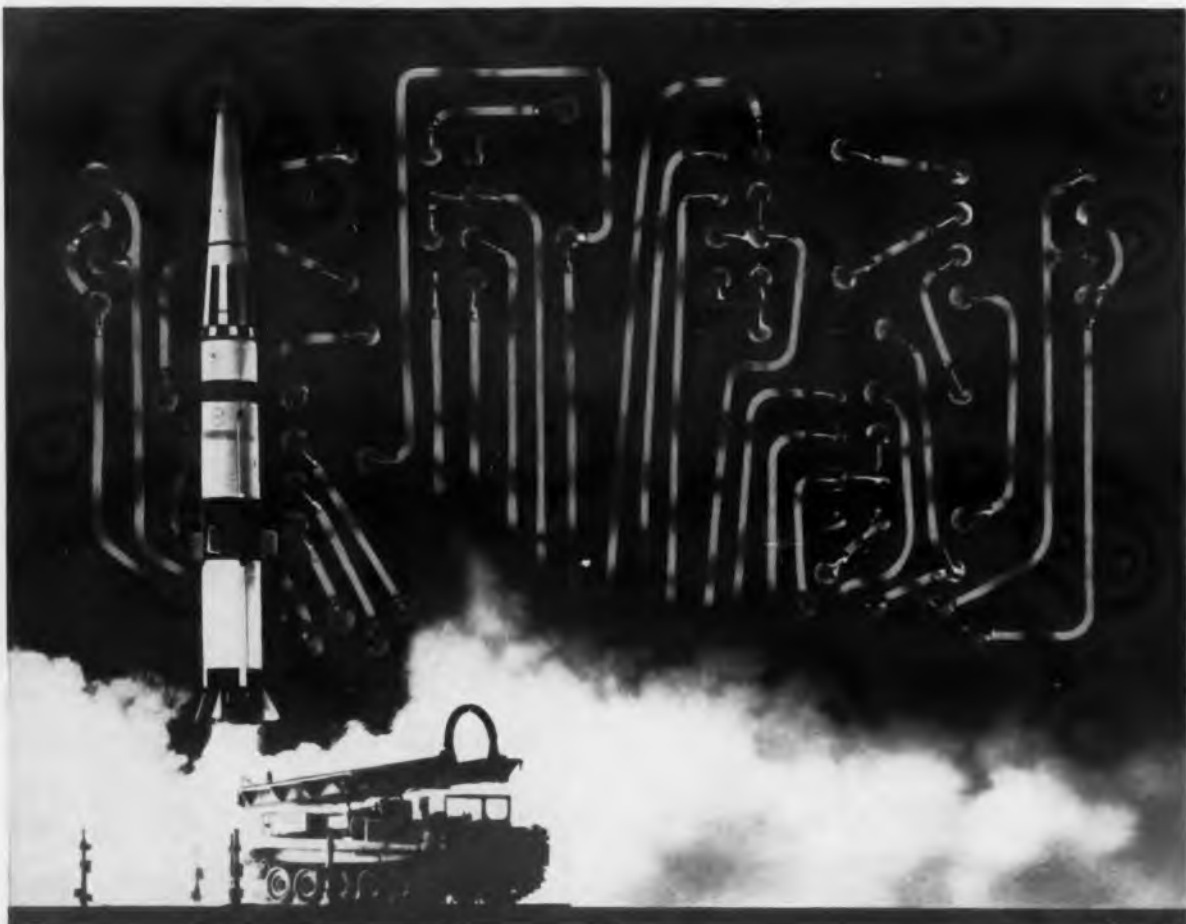
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*The highly reliable new Pershing Missile built by the Martin Company*

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## RIGID PERSHING MISSILE SPECS ARE MET WITH AUTRONEX ACID GOLD PLATING PROCESS\*

Dev Tek, Inc., Orlando, Florida, uses the patented Autronex Acid Gold Process to plate circuit conductors. According to Mr. A. F. Goldsby, Dev Tek President, Autronex Acid Gold permits compliance with the rigid ABMA-428 specifications for a hard bright coat of gold alloy 100-150 millionths thick covering all circuit conductors.

Dev Tek is one of the very few manufacturers of electronic components qualified to meet the ABMA Huntsville Specification ABMA-428 and PDS-1C for printed circuits and encapsulated assemblies, as used in the highly reliable new Pershing Missile. The specifications require close control over processes and raw material so that reliability is assured for each part that goes into the missile.

Dev Tek controls the gold bath closely which gives

an easy-to-solder-to surface which readily yields the desired ABMA PDS-1C solder joint characteristics of the exacting Pershing workmanship standard.

SEL-REX makes the world's largest selection of processes and systems which take the guesswork out of plating with precious metals. Baths are simply maintained with scientific precision by additions of pre-measured salts or solutions. Your assurance of consistent quality results from one batch to the next.

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*Patented processes for plating with Gold, Rhodium, Platinum, Palladium Silver, and to produce "custom alloys" for your particular requirements.*



\*Patented

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*The World's Largest Selling Precious Metal Plating Processes*

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## NEW PRODUCTS

### Inductance Substitution Box

582



Three decades of inductance, from 0.1 to 111 mh by toggle switch selection are featured in model SB-100. Low level contact and low stray capacity are claimed due to gold contact switches. Use of unit in an environmental chamber yields approximately +100 ppm per degree C.

Electronics Div., Bulova Watch Co., Inc., Dept. ED, 40-10 61st St., Woodside 77, N. Y. P&A: \$210.00; 3 weeks.

### Servo Phase Shifter

559



A completely solid-state instrument, model SRA is modular in construction and meets MIL-E-400B. It is a companion unit to the model VLA receiver phase comparator, which supplies 19 v dc operating power. Signal out is 3 v max into 100 ohms for recorder, with a digital readout in  $\mu$ sec.

Specific Products, Dept. ED, 21051 Costanso, Woodland Hills, Calif.

Price: \$1,485.00.

### Analog Converter

557



Transistorized unit has self contained power supply. Capcoder, model OC-2000, is an 8-bit, serial or parallel output, capacitive charge transfer analog to digital converter. Unit offers 0 to 210,000 encodings per sec, with a min of 4  $\mu$ sec between encodings.

Towson Laboratories, Inc., Dept. ED, 200 E. Joppa Road, Baltimore 4, Md.

P&A: \$8,000.00; 60 days.

## Binary Converter

561



Direct binary to BCD conversion of 23 bits to a 7 decade decimal output in 50  $\mu$ sec, with 1-2-4-8 BCD code. Other units can be furnished for any number of bits, with any standard code output. Size varies from 3-1/2 to 7 in. in a 19-in. rack, depending on the number of bits.

Wang Laboratories, Inc., Dept. ED, 12 Huron Drive, Natick, Mass.  
F&A: \$600 to \$6,000; 6 weeks.

## Epoxy Headers and Cases

560



Epoxy module packages plug into standard crystal can relay sockets. Friction fit between header and case prevents leakage during encapsulation. Unit will withstand continuous operating temperature of 400 F. Models are either 8 or 10 pin.

Epoxy Products Div., J. Waldman & Sons, Dept. ED, 137 Coit St., Irvington 11, N. J.  
P&A: \$0.50 to \$2.00 each; stock.

## Solid-State Delay

575



Time delay module is housed in a crystal case. This spst is normally open and can handle dc voltages up to 300 v. Operation is delay on make with a 1 amp rating and 26 v input. Units meet MIL-E-5400C and MIL-E-5272C. Two ranges are available; -55 to +85 C and -55 to +125 C.

Accutronics, Inc., Dept. ED, 403 N. Foothill Road, Beverly Hills, Calif.  
P&A: \$60.00 ea per 100; 2 weeks.

From the Indiana Steel Products Division of  
**INDIANA GENERAL CORPORATION**



## NEW INDOX<sup>®</sup> VI-A.... another ceramic magnet advance for microwave use

Developed by Indiana General's Indiana Steel Products Division, new INDOX VI-A has the highest coercive force of any commercially available magnetic material now in quantity production — plus better resistance to low temperatures, higher residual induction, higher peak energy product.

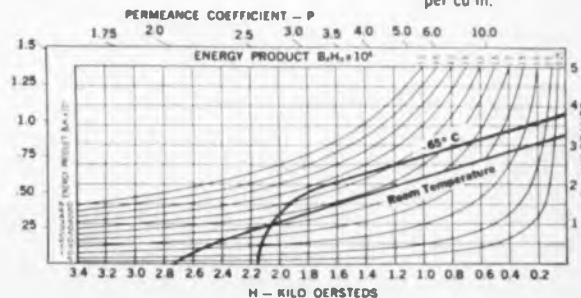
Indiana General's new INDOX VI-A is a highly oriented barium ferrite material that will effect substantial savings in both material and space in critical equipment such as periodic-focus traveling wave tubes.

One big advantage is that in many applications INDOX VI-A may be magnetized before assembly. Like INDOX V, INDOX VI-A is best suited for simple shapes: rings, discs, rectangles and squares. Magnet length (pressing direction) is limited to one inch or less; longer units can be built up from separate magnets.

Indiana design engineers worked closely with leading microwave manufacturers in the development of INDOX VI-A. The same characteristics that make this material outstanding for microwave application will open the door to other new applications and improve existing products.

New INDOX VI-A is another in a series of Indiana General's notable achievements in ceramic magnet design. For full details on this or other magnetic materials, write us or check your Indiana sales engineer.

	Room Temperature 20° C	-65° C
Residual Induction (B <sub>r</sub> ) gauss	3300	3830
Coercive Force (H <sub>c</sub> ) oersteds	2740	2140
Intrinsic Coercive Force (H <sub>cj</sub> ) oersteds	3000	2300
Peak Energy Product (B <sub>p</sub> H <sub>p</sub> ) max.	2.55 x 10 <sup>4</sup>	3.4 x 10 <sup>4</sup>
Reversible Permeability	1.06	
Reversible Temperature Coefficient (magnetic)	-.19%° C	
Magnetizing Field for Saturation, oersteds	10,000	
Chemical Composition	BaFe <sub>2</sub> O <sub>7</sub>	
Specific Gravity	4.5 or .162 lb per cu in.	



## INDIANA STEEL PRODUCTS

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VALPARAISO, INDIANA

INDIANA PERMANENT MAGNETS

CIRCLE 55 ON READER-SERVICE CARD



## NEW PRODUCTS



## 2 nanoseconds/cm: impossible to photograph until now

Polaroid has a new film that is so fast, it will reproduce scope traces that are almost invisible to the naked eye. The one above, a scintillation pulse, has never been photographed until now. Pulse duration was ten nanoseconds. Scope sweep speed was 2 nanoseconds/cm. *The new 10,000-speed Polaroid PolaScope Land film produced a finished usable print ten seconds after exposure.*

The maximum writing speed of the 10,000-speed film is about twice that of the Polaroid Land

3000-speed film, which is currently the standard for high speed photography. The new film not only gets "impossible" pictures, it also produces far better shots of slower pulses and steady state waveforms. Because of its high speed, less light is required; camera aperture and scope intensity can be reduced considerably, producing sharper pictures.

And besides oscillography, the PolaScope film opens up new possibilities in applications where light is at a premium, such as pho-

tomicrography and metallography. It is not suited, however, for pictorial work due to its high contrast and relatively coarse grain.

PolaScope film (designated Type 410) is packed twelve rolls to a carton. The price is actually lower than the 3000-speed film.

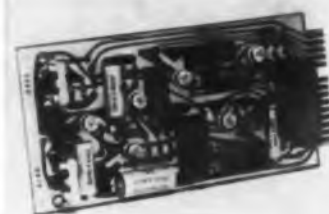
The film can be obtained through industrial photographic dealers. For the name of the dealer nearest you, write to Technical Sales Department, Polaroid Corporation, Cambridge 39, Massachusetts.

### New Polaroid Land 10,000-speed film for oscillography.

CIRCLE 56 ON READER-SERVICE CARD

### Chopper Amplifier

481



**Transistorized stabilizing amplifier** uses a 10,000-hr mechanical chopper. The unit features balanced input, single-ended output and may be used as an inverting or noninverting amplifier. With two output terminals to provide either internally filtered or unfiltered output, Series 200 may be driven from a source impedance up to 50,000 ohms.

C. E. S. Electronic Products, Dept. ED, 5026 Newport Ave., San Diego 7, Calif.

### Diode Tester

563



**High voltage constant current power supply** production test diodes. Supply features adjustable current levels (with less than 1 mv ripple). Output voltages from 400 to 800 v, with current ranges of 1 and 10 ma are available.

Wiley Electronics Co., Dept. ED, 2045 W. Cheryl Drive, Phoenix, Ariz.

Price: \$632.

### Temperature Control

462



**Temperature tolerances** can be as low as  $\pm 1/2$  F using this system. Temperature range is limited only by the capabilities of the thermocouple used. Switching of power current is done at 0 v and 0 amp using silicon controlled rectifiers.

Electronic Div., Product Management, Inc., Dept. ED, P. O. Box 6077, San Diego, Calif. P&A: \$135.00 for 650 w unit, fob San Diego; 2 weeks.

# Immediate delivery at factory prices . . . from Mallory industrial distributors



**TANTALUM CAPACITORS** Industry's broadest line. Microminiature to high capacity: 0.33 to 1300 mfd. Sintered wet slug, solid and foil types. Temperature ratings —55 to +200°C.



**SELECTOR SWITCHES** Push-button, lever action, rotary, wafer, multi-section. Phenolic or ceramic insulation.



**VITREOUS ENAMEL RESISTORS** Complete line of fixed and adjustable wire-wound resistors including MIL types. 5 to 200 watts, resistances to 100,000 ohms.



**CERAMIC DISC CAPACITORS** All standard temperature coefficients. Ratings from 50 volts general purpose to 6000 volts. Made by Radio Materials Company, a Mallory division.



**SUBMINIATURE SNAP-ACTION SWITCHES** Milli-Switch line of precision push-button switches; toggles and auxiliary actuators for slide or cam action. Temperature ratings to 300°F. Also hermetically sealed types.



**HIGH-CAPACITY, HEAVY-DUTY ELECTROLYTICS** High-capacity HC type and non-polarized NP type. Plastic case. Compact, leak-proof design. High ripple current rating, cool operation. From 3V, 6700 mfd. to 450V, 88 mfd.

Wherever you may be, a Mallory Industrial Distributor near you can supply you with Mallory original equipment parts from stock at factory prices. You'll profit by his prompt delivery on all your small-lot orders . . . for research, maintenance, or short production runs. Each of the organizations listed below specializes in industrial electronic supply. Call them for your rush orders . . . they're ready to serve you.

Distributor Division

Indianapolis 6, Indiana

PR MALLORY & CO. INC.  
**MALLORY**

## These Mallory industrial distributors stock the lines indicated by numerals:

Key: 1—Tantalum capacitors

2—Selector switches

3—Vitreous enamel resistors

4—Ceramic disc capacitors

5—Snap-action switches

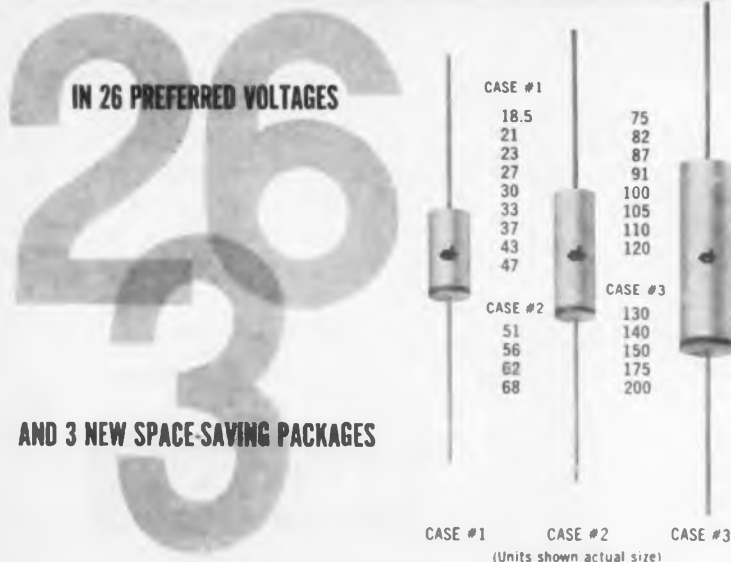
6—HC-NP capacitors

Standard Radio Parts	1	Tucson, Ariz.	Electronic Equipment	1	2	6	Miami, Fla.	Atlas Electronics	1	2	6	Perth Amboy, N. J.	Alled Supply	1	2	3	4	Dayton, Ohio
Newark Electronics	2	Inglewood, Calif.	East Coast Radio	1	4	6	Orlando, Fla.	Indisco, Inc.	2	3	4	Whippany, N. J.	Srepro, Inc.	1	2	3	4	Dayton, Ohio
California Electronics	1	2	Thurston Electronics	1	2	4	Tampa, Fla.	State Electronics	2	3	4	Albany, N.Y.	Servex Electronics	1	2	3	4	Marion, Ohio
Federated Purchaser	2	6	Allied Radio	1	2	4	Chicago, Ill.	Ft. Orange Radio	2	4	6	Binghamton, N. Y.	Trice Whistle Electronics	2	4	6	Okla. City, Okla.	
Kierulff Electronics	1	2	Chauncey's, Inc.	1	2	4	Chicago, Ill.	Federal Electronics	1	2	4	Brooklyn, N.Y.	Engineering Supply	1	2	4	Tulsa, Okla.	
Radio Product Sales	1	2	Newark Electronics	1	2	4	Oak Park, Ill.	GEM Electronics	2	4	6	Buffalo, N.Y.	Eoff Electric	1	2	4	Portland, Ore.	
Lynch Electronics	1	2	Meivyn Electronics	1	2	4	Springfield, Ill.	Radio Equipment	2	4	6	Buffalo, N.Y.	Television Parts	1	2	3	4	New Brighton, Pa.
Brill Electronics	1	2	Bruce Electronics	3	4	6	Indianapolis, Ind.	Standard Electronics, Inc.	2	4	6	Buffalo, N.Y.	Cameradio Co.	1	2	3	4	Pittsburgh, Pa.
Elmar Electronics	1	2	Graham Electronics	1	2	3	4	Summit Dist.	2	4	6	Buffalo, N.Y.	Radio Parts	1	2	3	4	Almo Radio
Zack Electronics	1	2	Radio Supply	1	2	3	4	Wentle Electronics	1	2	4	Buffalo, N.Y.	Almo Radio	1	2	3	4	Pittsburgh, Pa.
Elwyn W. Ley	1	2	P. I. Burks & Co.	2	4	6	Wichita, Kansas	Statewide Electronics	1	2	4	East Syracuse, N.Y.	Herbach & Rademan	1	2	3	4	Philadelphia, Pa.
Allied Radio of California	1	2	Louisville, Ky.	1	2	4	Louisville, Ky.	Lafayette Radio	2	4	6	Jamaica, N.Y.	Phila. Electronics	1	2	3	4	Philadelphia, Pa.
Shanks & Wright	1	2	D & H Distributing	1	2	4	Baltimore, Md.	Greylock Electric	2	4	6	Kingston, N.Y.	Radio Elec. Serv.	1	2	3	4	Philadelphia, Pa.
Penninsula Electronics	1	2	Kann-Ellert Electron	1	2	4	Baltimore, Md.	Peerless Radio	2	4	6	Lynbrook, L.I., N.Y.	Geo. D. Barbey Co.	1	2	3	4	Reading, Pa.
Denver Electronics	1	2	Radio Elec. Serv.	1	2	4	Baltimore, Md.	Bruno-New York	2	4	6	New York, N.Y.	West Chester Elec.	1	2	3	4	West Chester, Pa.
Westconn Electronics	1	2	Cramer Electronics	1	2	4	Boston, Mass.	Electronic Center	2	4	6	New York, N.Y.	Electra Distrib.	1	2	3	4	Nashville, Tenn.
Radio Appliance Co.	2	4	DeMambo Rad. Sup.	1	2	4	Boston, Mass.	Harrison Radio	1	2	3	New York, N.Y.	Engineering Supply	1	2	3	4	Dallas, Texas
Westchester Electronics	2	4	Lafayette Radio	1	2	3	Boston, Mass.	Harvey Radio	1	2	3	New York, N.Y.	McNicol, Inc.	1	2	3	4	El Paso, Texas
Capitol Radio	1	2	Radio Shark	2	4	6	Boston, Mass.	Lafayette Radio	1	2	3	New York, N.Y.	Harrison Equip.	1	2	3	4	Houston, Texas
Electronic Indus. Sales	1	2	Radio Specialties	2	4	6	Boston, Mass.	Milo Electronics	1	2	3	New York, N.Y.	Lenert Co.	1	2	3	4	Houston, Texas
			Northwest Radio	1	2	4	Detroit, Mich.	Terminal Hudson Elec.	1	2	3	New York, N.Y.	Rucker Electronic	1	2	3	4	Arlington, Va.
			Burstein-Applebee	2	4	6	Minneapolis, Minn.	Higgins & Sheer Elec.	1	2	3	New York, N.Y.	F. B. Connelly Co.	1	2	3	4	Seattle, Wash.
			Walters Radio	2	4	6	Minneapolis, Minn.	Morris Electronics	1	2	3	Syracuse, N.Y.	Radio Parts	1	2	3	4	Milwaukee, Wis.
			Interstate Indus. Elec.	1	2	4	Minneapolis, Minn.	Valley Indus. Elec.	2	4	6	Ulca, N.Y.	Canadian Elec. Sup.	1	2	3	4	Montreal, Que.
			Olive Electronics	1	2	4	St. Louis, Mo.	Westchester Electron	1	2	3	White Plains, N.Y.	Wackdo Radio	1	2	3	4	Ottawa, Ont.
			General Radio	2	4	6	St. Louis, Mo.	Dalton-Hoge Inc.	1	2	3	Winston-Salem, N.C.	Alpha Aracon Radio	1	2	3	4	Toronto, Ont.
			Eastern Radio	2	4	6	St. Louis, Mo.	Akron Electronic Sup.	1	2	3	Akron, Ohio	Electro Sonic Sup.	1	2	3	4	Toronto, Ont.
			Federated Purchaser	1	2	4	St. Louis, Mo.	United Radio	1	2	3	Cincinnati, Ohio	Wholesale Radio	1	2	3	4	Toronto, Ont.
			Aaron Lippman & Co.	1	2	4	St. Louis, Mo.	Pioneer Electronics	1	2	3	Cleveland, Ohio						
			Lafayette Radio	1	2	4	St. Louis, Mo.	Thompson Radio	2	3	4	Columbus, Ohio						
							Camden, N. J.	Whitenead Radio	2	3	4	Columbus, Ohio						

CIRCLE 57 ON READER-SERVICE CARD

# NEW

from **DICKSON**  
... THE INDUSTRY'S  
BROADEST LINE OF  
High Voltage, Temperature Compensated  
**ZENER REFERENCE DIODES**



AND 3 NEW SPACE-SAVING PACKAGES

TEMPERATURE COEFFICIENT : 0.005%/°C Max.

TEMPERATURE RANGES : 0° to +75°C; -55°C to +25°C to +100°C

V<sub>Z</sub> TOLERANCE : ±5% Max. Designed to Meet Requirements of MIL-S-19500B

New techniques developed by Dickson Electronics engineers for producing high voltage zener reference diodes result in a sophisticated combination of performance, small size, stability, ruggedness, reliability and value rarely, if ever, approached by any other semiconductor product. And Dickson's standardization of these hitherto special order devices results in ready availability.

Other series with voltages of 9.3 volts (1N2620-1N2624B) and 11.7 volts (Series 3/4T100A11.7-3/4T5C11.7) also available as standard items.

For prototype orders, complete technical information and prices, call your Dickson distributor or representative ... or write

**DICKSON**  
ELECTRONICS CORPORATION

248 WELLS FARGO AVENUE SCOTTSDALE, ARIZONA

CIRCLE 58 ON READER-SERVICE CARD



## NEW PRODUCTS

### Transistor Test Set

584



Small signal parameters for npn and pnp transistors can be measured with model 1803A transistor parameter test set. Grounded emitter or base connections are measured with 3% accuracy and collector leakage current can be read from less than 1 na to 1 ma.

Dynatran Electronics Corp., Dept. ED, 178 Herricks Road, Mineola, N. Y.

P&A: \$795.00; stock.

### Conical Helix Cable

574



Spectra-Flex extensible cable is suited for extension and retraction in vertical plane. Cables are custom built from No. 10 to No. 30 AWG and retract to a flat disk. Large numbers of conductors can be used.

Spectra-Strip Wire & Cable Corp., Dept. ED, P. O. Box 415, Garden Grove, Calif.

P&A: depending on specifications; 2 weeks.

### Precision Resistors

459



Micromodule, rectangular and dot resistor microelement, and microminiature ceramic printed circuits with printed resistors are available. Micromodule resistors range from 10 to 100,000 ohms for 4 resistors per wafer. Rectangular resistors rated at 1/10 w at 100 C range from 10 ohms to 1 megohm. Dot resistors have some rating and range from 10 ohms to 50 K.

Microelectron, Inc., Dept. ED, Santa Monica, Calif.

- the ultra  
new **YOKE!**



**Deflectron\***  
By **Celco**

MAJOR ADVANCE IN  
THE SCIENCE OF  
ELECTRON BEAM DEFLECTION!

**SPOT RECOVERY**

Fastest! to 1 μs

**SPOT SIZE**

Smallest - by 25%

**SPOT SWEEP**

Straightest.....

\* DEFLECTRONS for DISPLAYS

Where ordinary precision  
yokes **FAIL** to meet your  
requirements.

Write for NEW "DEFLECTRON"  
Data and Standard Yoke  
Catalog.

**Celco**

Constantine Engineering  
Laboratories Co.

Main Plant: MAHWAN, N. J. DAVIS 7-1123

PACIFIC DIV.-UPLAND, CALIF. YUKON 2-0215

CENTRAL DIV.-LANESBORO, PA. ULYSSES 3-3500

CIRCLE 59 ON READER-SERVICE CARD

## Static Relay

534



Maximum contact voltage is 28 v dc with resistive load, 25 v dc with inductive load; maximum contact current is 50 ma dc. Model DD-5 has nominal actuation voltage of 10 v at 4 ma, pull-in voltage of 10 v  $\pm 1$  v and frequency response of 1,000 cps. The dpst unit is epoxy encapsulated.

Kidde Electronics Laboratories, Walter Kidde & Co., Inc., Dept. ED, 675 Main St., Belleville 9, N. J.

Availability: 60 to 90 days.

## Ammeter Shunt

526

Accuracy is  $\pm 0.3\%$ . Series 8500 miniature, external ammeter shunt meets the operational requirements of MIL-S-61B. All units are individually calibrated by means of the Kelvin Comparison Bridge method. This shunt measures 5/8 x 1 x 13/16 in.

Janco Corp., Dept. ED, 3111 Winona Ave., Burbank, Calif.

P&A: \$7.00; stock.

## Voltage Reference

538

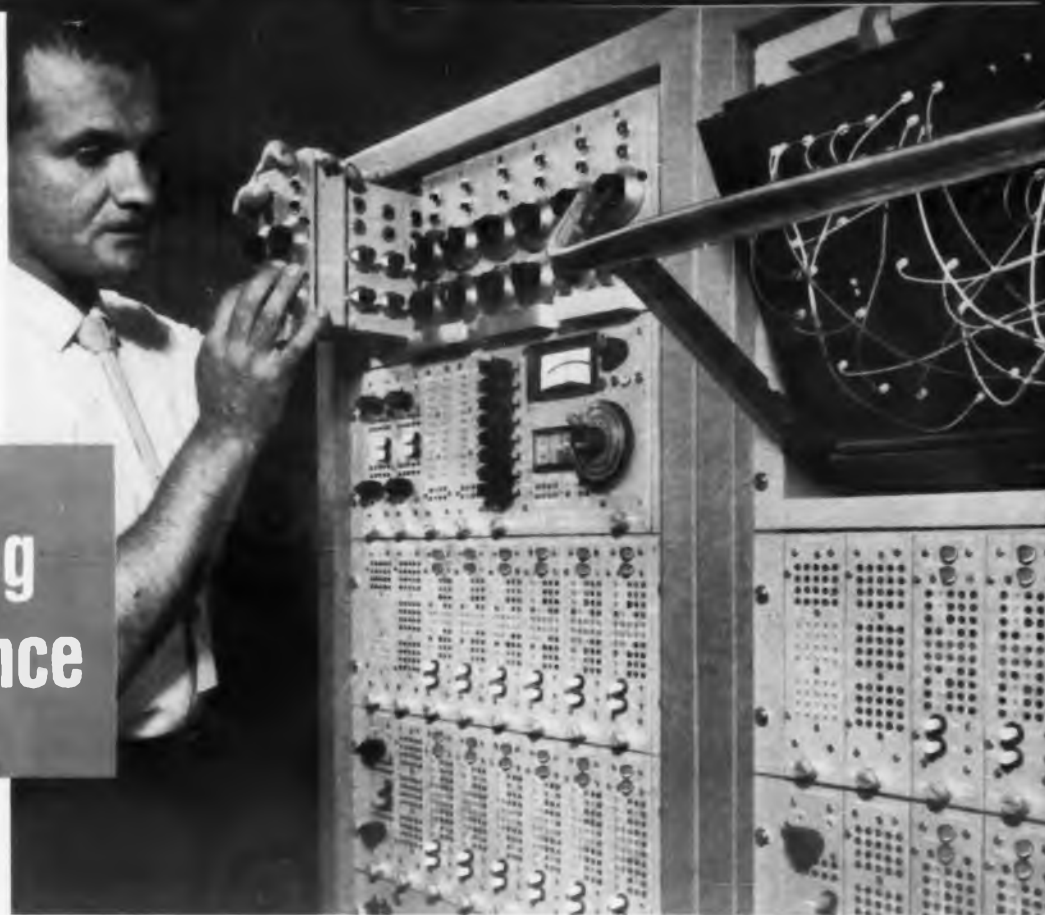


Isolation is 100 db. A solid-state device, designated type PR1, the voltage reference source is available in models to accept both 115 and 6.3 v inputs, from 50 to 400 cps. Outputs may be specified at 5.9, 8.6, 11.0, 14.5, 17.2 and 22.0 v, nominally. Temperature coefficient is 0.0005% per deg C.

CircuitDyne Corp., Dept. ED, 480 Mermaid St., Laguna Beach, Calif.

P&A: \$30.00 to \$130.00; 30 to 60 days.

# Analog Advance



## The all new 60 amplifier .01% Donner 3200 is the first computer designed from the ground up to use the new iterative technique

Every important assembly in the completely new Donner 3200 series iterative computer combines better performance and more features in less space than ever available before from any maker at any price.

The user can start with as few as 10 amplifiers and expand to 60 as necessary. Two or more 60 amplifier computers can be slaved to solve more complex problems. This flexibility is the product of a new packaging concept which emphasizes modularity and etched wiring. The plethora of cables usually associated with computers is gone but hardly grieved. Note these other unique features and specifications.

• **NEW AMPLIFIER** Bandwidth, 1 mc; drift, 20 microvolts per day; gain,  $10^8$ ; noise, 500 microvolts; output,  $\pm 100$  volts @ 20 milliamps. Three types of dual amplifiers are available — integrators, summers and inverters.

• **NEW DUAL MULTIPLIER** Solid state .05% quarter-square multiplier which can be programmed to function as multiplier, divider, or 2 squaring networks.

• **NEW FUNCTION GENERATOR WITH STORABLE PROGRAMS** Each module contains 2 independent 12-segment silicon diode function generators. Channels can be paralleled to provide 24 line segments. Programs can be stored by simply unplugging and removing the inexpensive potentiometer element from the function generator.

• **NEW POTENTIOMETER MODULE** Each compact module contains 20 fused precision potentiometers mounted on the smoothest drawer slides we've ever found. Eighty potentiometers take only 7" of panel height.

• **NEW CONTROL CENTER** Pushbuttons select these modes of operation: compute, hold, reset, automatic recycle, slave, audible overload indication, and automatic hold. A new reference potentiometer allows null voltage measurements accurate to 0.02%. Meter sensitivities which can be push-button chosen are 300, 100, 30, 10, 3 volts, zero centered.

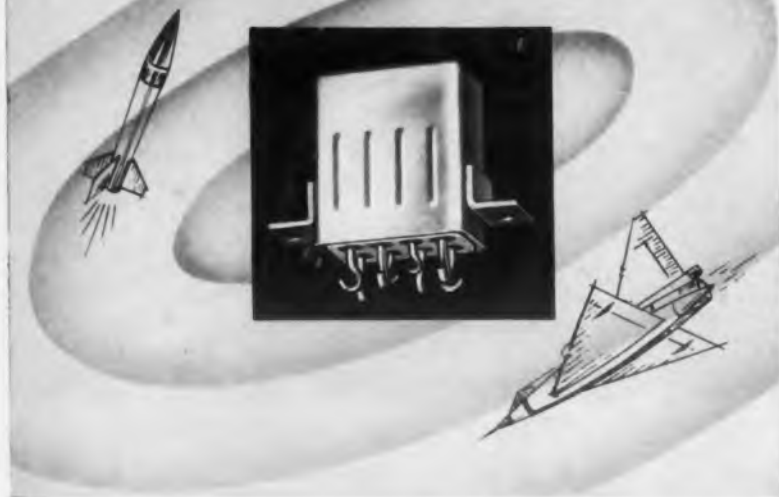
Forward and reverse relay logic is incorporated for either iterative or continuous operation.

**OTHER FEATURES** The novel amplifier construction incorporates a built-in jack field on every module which helps the user get a quality computer for minimum cost and later, when he adds the standard removable patch board, he can use the amplifier patching bay as a built-in simulation board. Several sizes of removable patch boards are available both shielded and unshielded. All critical computing components are mounted in a temperature controlled environment.

**DONNER** SCIENTIFIC  
DIVISION  
*SYSTRON-DONNER*  
CONCORD, CALIFORNIA



# POWER RELAY DEPENDABILITY IN A CRYSTAL CAN TYPE



Packed into this Struthers-Dunn FC-215 DP-DT relay is reliability heretofore unattained in a tiny sealed can unit for heavy duty power service under critical ground and air uses up to 125° C.

Designed to meet or exceed MIL-R-5757D, MIL-R-6106C and the super-seeded MIL-R-25018 requirements. Assembled under rigid environmental conditions. Laboratory checked and quality controlled throughout.

Contacts rated for 10 ampere DC operation. Standard coils rated 26.5 volts DC nominal with 400 ohms coil resistance. Others available. Hook or wire lead terminals available on 0.2 grid-spaced headers.

Write for Dunco Data Bulletin FC-215  
to Struthers-Dunn, Inc., Pitman, N. J.

## All-welded Internal Construction

... assures reliable operation  
under 30G vibration to 2000  
cycles and 50G shock.



# STRUTHERS-DUNN

PIONEERS OF SPACE AGE RELAY DEPENDABILITY

Sales Engineering Offices in: Atlanta • Boston • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Dallas  
Dayton • Denver • Detroit • High Point • Kansas City • Los Angeles • Montreal • New York • Orlando  
Pittsburgh • St. Louis • San Carlos • Seattle • Toronto • Export: Langguth-Olson Co., New York

CIRCLE 61 ON READER-SERVICE CARD

## NEW PRODUCTS

### Silicon Rectifiers

554



Micro-second switching speeds are featured in two series of silicon controlled rectifiers. Types 2N1842 through 2N1849 are rated at 10 amp with piv of 25 to 400 v between -40 C to +100 C. Rated at 16 amp, with the same piv over a range of -65 C to +125 C are types 16RC2 to 16RC40.

International Rectifier Corp., Dept. ED, 233  
Kansas St., El Segundo, Calif.

P&A: \$11.25 to \$75.00 each, 1 to 99; stock.

### Gold-Plated Connectors

519

Plated aluminum connectors are designed to retain the mechanical and electrical characteristics of gold-plated brass, while weighing approximately one-third that of the brass type.

Micon Electronics, Inc., Dept. ED, Roosevelt  
Field, Garden City, N. Y.

### Vertical TV Monitor

490



Three screen sizes are available; 14, 17 and 21 in. Unit operates with standard vidicon and image orthicon cameras in which the pick-up tube and deflection yoke have been rotated to provide a vertical signal. Size, focus and linearity controls are operated individually, and adjustment of one has no effect on the others.

General Electric Co., Dept. ED, P. O. Box  
4197, Lynchburg, Va.

**-100°F  
to  
+350°F  
test chamber  
for  
only \$285**



Model ELM-0.5 LC

Here it is — a quality temperature chamber at a previously unheard of budget price! The Econ-O-Line Mark II is designed specifically for components and small assemblies — gives you complete temperature test capability for production line, research or development lab. Ruggedly constructed for long, accurate service, its features include:

- Temperature control to  $\pm 2^\circ\text{F}$ .
- Liquid CO<sub>2</sub> refrigeration
- United Electric indicating controller
- 11" x 12" x 5" work area
- Rugged aluminum liner
- Fan circulation with external motor
- 1" port and plug for external connections

Delivery from stock. For complete data, write today for Bulletin C-19.

**A**ssociated

ASSOCIATED TESTING LABORATORIES, INC.  
(Manufacturing Division)  
190 ROUTE 46 • WAYNE, NEW JERSEY • CLIFORD 6-2800  
TEST LABORATORIES  
Wayne, N.J. • Winter Park, Fla. • Burlington, Mass.

CIRCLE 62 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

## Four-Element Meter 535



Ranges of dc millamperes, amperes, millivolts and volts are available. Type MDE-4 contains four self-shielded, coaxial meter movements that can be supplied with sensitivities as low as 100  $\mu$ a. Units can be supplied with or without lighting.

Minneapolis-Honeywell Regulator Co., Precision Meter Div., Dept. ED, Grenier Field, Manchester, N. H.

## Transistorized Instruments 509

The Designer series features a line of single instruments which are 4 x 8-1/2 x 10 in. All circuits contain transistors and use etched circuit boards. The series will include 25 different instruments. The linear amplifier and discriminator has a gain of 400 and rise time of 0.25  $\mu$ sec. Discriminator range is 0.1 to 10 v. Five other instruments are immediately available.

Radiation Instrument Development Laboratory, Inc., Dept. ED, 4501 W. North Ave., Melrose, Ill.

## Wound Motors 532



Type GJ wound field dc motors are 1-3/8 in. in diam and are available in two basic ratings: type GJA is 3 in. long and is rated 1/50 hp at 10,000 rpm; type GJY is 2-1/2 in. long and is rated 1/100 hp at 10,000 rpm. Both versions are normally available split series for three-wire reversibility with spdt switch.

Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton 4, Ohio.

CIRCLE 63 ON READER-SERVICE CARD



THE BEST

# \$10 POTS

YOU CAN BUY



**SPECTROL MODEL 860**  
1 1/4" diameter precision potentiometer  
Linearity Tolerance  $\pm 0.25\%$   
Standard Resistance Range  
50 $\Omega$  to 500K (to 1 Meg at extra cost)

**SPECTROL MODEL 510**  
7/8" diameter precision potentiometer  
Linearity Tolerance  $\pm 0.25\%$   
Standard Resistance Range  
15 $\Omega$  to 150K (to 250K at extra cost)

Stocked by 50  
Local Distributors  
Throughout the U.S. and  
Canada for Immediate  
Off-the-Shelf Delivery

These two Spectrol 10-turn precision pots are *not* specials in any way. They're standard production items in two popular sizes, tailor-made to fit almost all 10-turn requirements. Here's where Spectrol excels to give you the best pot for your 10-spot:

**END RESISTANCE** Spectrol's low end resistance is achieved by tap welding terminations to the turn of resistance wire nearest the mechanical stop. In addition, Spectrol provides an extra turn of helical resistance element beyond the stop insuring electrical continuity under all conditions.

**ROTOR MASS** Spectrol's lightweight rotor reduces inertia and starting torque, as well as minimizing the effects of shock and vibration.

**WIPER MASS** A wiper that's the lightest we've seen in any 10-turn pot allows lower contact force with resultant long life and superior performance under shock and vibration.

**SHAFT SUPPORT** Spectrol pot shafts are supported by bearings at both ends and have provision for rear shaft extension.

**STOPS** Spectrol uses 750 oz. in. stops on Model 860; 50 oz. in. on Model 510, the strongest you'll find.

**LIDS SECURED BY INTERNAL SNAP RING** Use of snap rings gives 360° lid support as opposed to other methods of attachment. Another exclusive feature: Remove or replace lids without damaging unit.

**POWER RATING** Model 860, 8 watts, and Model 510, 3 watts; at 40°C ambient.

**SPECIAL FEATURES AVAILABLE** Additional taps up to 111 on Model 860; up to 49 on Model 510. Special front shaft configurations and rear extensions. Special linearity and resistance tolerances.

**More Data Available** For complete electrical and mechanical specifications, and quantity discounts, contact your Spectrol representative or call or write the factory.

## SPECTROL

### ELECTRONICS CORPORATION

1704 South Del Mar Ave. • San Gabriel, Calif. • Phone: Atlantic 7-9761  
Adams Court • Plainview, Long Island, N.Y. • Phone: Wells 8-4000  
P.O. Box 130 • Brampton, Ontario, Canada

The World's Broadest Line of Precision Potentiometers

## NEW PRODUCTS

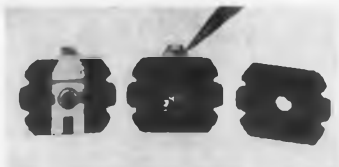
### Winding Compensated Resolver 491



Excitation voltage is 26 v and frequency is 400 cps. Model T980-003 size 15 operates from  $-54$  to  $+85$  C. Impedance of the primary is  $480+j2500$  ohms; of the secondary,  $440+j-2650$  ohms. This unit features 0.1% function error and maximum perpendicularity of 5 min.

Kearfott Div., General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

### Magnetic Material 551



High energy permanent magnet material for timing motors is called Lodex. Material has high torque output, good flux distribution from magnet to magnet; is resistant to stray fields, vibration and temperature. Small complex shapes can be produced.

General Electric Co., Dept. ED, 7852 Neff Road, Edmore, Mich.

### Multi-Station Indicators 469



Model LP-18 reads out up to 18 contour points and the variation from nominal "thickness" between any of the nine probes in the left-hand bank and any of the nine in the right-hand bank. Standard range is  $\pm 0.010$  in. and accuracy is within 0.0002 in. Unit requires 115 v, 60 cps current. Model LP-9 reads up to 9 contour points.

Winslow Manufacturing Co., Dept. ED, 1751 E. 23 St., Cleveland 14, Ohio.

# FROM MOTOROLA... POWER

NEW PNP GERMANIUM SERIES RATED AT

# 170 W. $P_d$

OPERATES UP TO

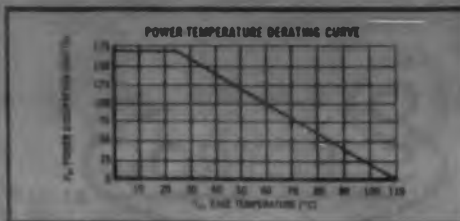
# 110°C. $T_j$

AVAILABLE WITH CERTIFIED RELIABILITY

# “MEG-A-LIFE”

## NEW 2N2075-82 SERIES OFFERS:

- 170 WATTS—93% greater power dissipation capability than conventional TO-36 power transistors.
- 110° C.  $T_j$  — Maximum junction temperature rating (15° higher than conventional TO-36 units) provides added operating temperature safeguard and also increases allowable power dissipation at any given case temperature. In over 3,000,000 device hours of storage life testing at temperatures up to 150°C. the failure rate was only 0.030%/1000 hrs.
- “MEG-A-LIFE”—a program offering industrial users certified reliability based upon complete electrical, mechanical, and environmental tests to military type specs. Lot acceptance data and test results available to purchasers of “MEG-A-LIFE” versions of these devices.



2N2075 SERIES, 15 AMP				
$h_{FE}$ @ 5A	$BV_{CES}$			
	40V	50V	70V	80V
20-40	2N2078	2N2077	2N2076	2N2075
35-70	2N2082	2N2081	2N2080	2N2079



# THE LEADER IN TRANSISTORS

Plus this most complete line of other TO-36 and TO-3 devices



3 AMP\*  $P_D = 90$  watts,  $T_j$  max = 100°C

$h_{FE}$ @ 5A	BV <sub>CES</sub>				
	30V	45V	60V	75V	90V
30-60	2N2137	2N2138	2N2139	2N2140	2N2141
50-100	2N2142	2N2143	2N2144	2N2145	2N2146

3 AMP\*  $P_D = 90$  watts,  $T_j$  max = 100°C

$h_{FE}$ @ 1A	BV <sub>CES</sub>			
	40V	60V	75V	100V
60-140	2N1360	2N618	2N1363	2N1365
35-90	2N1359	2N375	2N1362	2N1364

5 AMP\*  $P_D = 90$  watts,  $T_j$  max = 100°C

$h_{FE}$ @ 3A	BV <sub>CES</sub>				
	30V	45V	60V	75V	90V
75-150	2N1544	2N1545	2N1546	2N1547	2N1548
50-100	2N1539	2N1540	2N1541	2N1542	2N1543
35-70	2N1534	2N1535	2N1536	2N1537	2N1538
20-40	2N1529	2N1530	2N1531	2N1532	2N1533

10 AMP\*  $P_D = 90$  watts,  $T_j$  max = 100°C

$h_{FE}$ @ 10A	BV <sub>CES</sub>			
	30V	45V	60V	75V
10-30	2N627	2N628	2N629	2N630

15 AMP\*  $P_D = 150$  watts,  $T_j$  max = 100°C

$h_{FE}$ @ 5A	BV <sub>CES</sub>				
	40V	45V	50V	70V	80V
20-40	2N441	2N442	2N443	2N174	2N1100
35-70	2N277	2N278	2N173	2N1099	

15 AMP\*  $P_D = 90$  watts,  $T_j$  max = 100°C

$h_{FE}$ @ 10A	BV <sub>CES</sub>			
	30V	45V	60V	75V
50-100	2N1557	2N1558	2N1559	2N1560
30-60	2N1553	2N1554	2N1555	2N1556
10-30	2N1549	2N1550	2N1551	2N1552

25 AMP\*  $P_D = 90$  watts,  $T_j$  max = 100°C

$h_{FE}$ @ 25A	BV <sub>CES</sub>		
	35V	60V	75V
15-65	2N1162	2N1164	2N1166
	2N1163	2N1165	2N1167

MILITARY TYPES

	BV <sub>CBO</sub>	BV <sub>CES</sub>	$h_{FE}/I_C$
1AM 2N174	80V	70V	40-80/1.2A
2N297A (Sig C)	80V	50V	20 min/2A
2N297A	80V	50V	20 min/2A
2N1011 (Sig C)	80V	80V	30-75/3A
2N1011	80V	80V	30-75/3A
2N1120 (Sig C)	80V	70V	20-50/10A
2N1120	80V	70V	20-50/10A
2N1358 (Sig C)	80V	70V	25-50/5A
2N1358	80V	70V	25-50/5A
2N1412 (USM)	100V	80V	25-50/5A
2N1412	100V	80V	25-50/5A

\*Available in "Meg-A-Life" types



**POWER TRANSISTOR HANDBOOK**  
If you have not yet purchased this valuable reference book covering power transistor design considerations and applications, you may still obtain a copy from your Motorola distributor. Price is \$2.



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Semiconductor Products Inc.

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Dayton / Detroit / Glenside, Pa. / Hollywood / Minneapolis / Orlando,  
Fla. / Phoenix / Silver Spring, Md. / Syracuse / Toronto, Canada.

**IMMEDIATE LOCAL AVAILABILITY**—You may obtain sample or volume quantities of any of these devices by contacting your nearest Motorola distributor. Also be sure to ask for the complete Motorola Power Transistor Selection Chart, listing Motorola's new low prices.

**DISTRIBUTORS:**

**PACIFIC**  
LOS ANGELES: American Electric Supply Co., Inc.  
SAN FRANCISCO: Clear Electronics  
PALO ALTO: Hamilton Electro Sales, North  
SAN DIEGO: San Dolcar, Inc.  
SEATTLE: Almac Electronics Corp.  
**SOUTHWESTERN STATES**  
DENVER: Inter-State Radio & Supply Co.  
**MIDWESTERN**  
CEDAR RAPIDS: Deers, Inc.  
CHICAGO: Allied Radio Corp., Newark Electronics Corp., Semiconductor Distributor Specialists, Inc.  
**CLEVELAND**: Pioneer Electronics Supply Co.  
**DETROIT**: Radio Specialties Co., Inc.  
**MINNEAPOLIS**: Allied Electronic Corp.  
**SOUTHWESTERN**  
BIRMINGHAM: Ark Communications, Inc.  
MEMPHIS: Electronic Wholesalers, Inc.  
MIAMI: Ark Communications, Inc.  
**SOUTHWESTERN**  
DALLAS: Tekko, Inc.  
HOUSTON: Lowell Co.  
PHOENIX: Electronic Specialties Co.  
**NEW ENGLAND**  
BOSTON: Craner Electronics, Inc.  
**EASTERN**  
BUFFALO: Summit Distributors, Inc.  
CAMDEN: General Radio Supply Co., Inc.  
MINEOLA, L. I.: Schweber Electronics  
**NEW YORK**  
WASHINGTON: M'Grath Electronics, Inc.  
**MARYLAND & D.C.**  
BETHESDA: Electronic Wholesalers, Inc.  
**CHICAGO**: Wastark-Dwan Corp.

## Piston Capacitors

547



Solid dielectrics enable miniaturizing of piston trimmer capacitors. These capacitors range from less than 1 to 30 pf, with Q (MIL) specification of 500 and temperature range of -55 to +125 C. The temperature coefficient is 50 ppm per C, or less.

Voltronics, Inc., Dept. ED, 34-51 56th St., Woodside 77, N. Y.

P&A: \$2.35 to \$3.50; stock.

## Half-Wave Rectifier

558



Welded hat construction provides compact, 1-3/16 in. over all, rectifier series. Designated Trans-Sil type MA, twenty types are available with piv of 50 v to 800 v, in 50 v multiples. This double-diffused silicon junction unit has a max surge rating of 30 amp.

Trans-Sil Corp., Dept. ED, 55 Honeck St., Englewood, N. J.

Availability: 5 days.

## Lissajous Scale

572



Phase relationship can be read directly with the Pha-o-Scale. The scale, calibrated in degrees on the vertical axis, allows direct read-out of signal on X and Y axis.

Walker Pacific, Dept. ED, P. O. Box 2242, La Puente, Calif.

CIRCLE 64 ON READER-SERVICE CARD



It's easy to SEE why  
**McCoy** Glass Enclosed  
 Quartz Crystals  
 are "tops" from 5 points of view

**SIZE**  
 As small as .280" square by .110"  
 thick; please note dimensions below.

**WEIGHT**  
 One fifth (1/5) of an  
 ounce and lighter.

**STABILITY**  
 Frequency drift stabilities of  
 $\pm .0025\%$  over  $-55^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$

**VIBRATION**  
 Withstands 30 Gs from  
 10 to 2000 c.p.s.

**SHOCK**  
 Withstands 100 Gs for 11 milliseconds  
 duration in all planes

Their fabulous quality — which, heretofore, could only be enjoyed — can now be seen in the new McCoy G-1, G-20, G-21 and Micro-Module vacuum sealed ALL-GLASS Crystals.

Because they are sealed in vacuum, their performance CANNOT be affected by atmospheric pres-

sure changes or exposure to another vacuum.

This true "hard glass" seal results in lower resistance (higher Q), greatly increased long term stability plus ability to withstand extremes of shock and vibration, as well as, better control of crystal parameters.

**G-1**  
 (Military  
 HC-27/U)



Shown  
 actual  
 size

This vacuum sealed, hard glass crystal unit possesses all of the quality features for which the McCoy M-1 is so famous. It has long term frequency stability, approximately five times better than the conventional metal types. Available in frequencies from 2000 kc to 200 mc.

**G-20**  
 (Military  
 HC-26/U)



**G-21**  
 (Military  
 HC-29/U)



Shown  
 actual  
 size

This vacuum sealed, hard glass crystal unit meets the new CR-73/U and CR-74/U specifications. It has long term frequency stability approximately five times better than the conventional metal type. Available in frequencies from 5000 kc to 200 mc.

Shown  
 actual  
 size



**MICRO MODULE CRYSTALS-GLASS**

.28" square x .110" thick; frequency range 10.0 mc to 200 mc. Now available in limited quantities.

Write today for our free illustrated catalogs which include complete listing of military specifications. For specific needs, write, wire or phone us. Our research section is anxious to assist you.

**McCoy**

SUBSIDIARY OF OAK MANUFACTURING CO.

**ELECTRONICS  
 COMPANY**

Dept. ED-11  
 MT. HOLLY SPRINGS, PA.  
 Phone: HUinter 6-3411

CIRCLE 65 ON READER-SERVICE CARD

**NEW PRODUCTS**

**Telephone Click Reducer**

443



Solid-state telephone click reducer lasts over 200,000 hrs and operates from  $-65$  to  $+175^{\circ}\text{C}$ . Device, made to replace copper-oxide units, contains silicon rectifiers in a miniature hermetically-sealed package. Two eyelet leads are provided for mounting.

Soliton Devices, Inc., Dept. ED, 500 Livingstone St., Norwood, N. J.  
 P&A: \$0.40; immediate.

**Set-Reset Indicator**

550



Plug-in module, model (D9)G-104/N-1A is expressly designed for parallel transfer of 1-2-4-8 code to a remote NIXIE digital display. The unit has a diode matrix, measures 4-1/2 x 9 in. and operates up to 100 kc.

Electronic Control Products, Dept. ED, U.S. Rt. 22, Box 286, Dunellen, N. J.  
 P&A \$82.00 to \$103.00; 1 week.

**Test Clip**

555



Scissor action of "Monte-clip" test device gives high contact pressure on leads. Tapered throat guides leads to contact blades, which are individually adjustable. Blades are connected to banana plugs and show negligible fatigue at 10-million insertion cycles.

Monterey Engineering, Dept. ED, P.O. Box 3083, Granada Hills, Calif.

Price: \$11 a pair.



Bistable Amplifier for  
 static relay control



Richard B. Doorley, Mgr., New Products Div., Railway Maintenance Corp., Pittsburgh, Pa.

**"Norbatrol helped us cut  
 R&D time by 1 year with  
 this Bistable Amplifier"**

"Norbatrol's Bistable Amplifiers solved many control problems in redesigning our McWilliams Jack-and-Production Tamer from manual to reliable, automatic operation. Now this RMC railroad surface machine operates electronically—improves grade and cross level to accuracies never previously accomplished. And we got a bonus," Mr. Doorley continues, "these rugged, reliable static relays cost less than alternate systems."

You, too, can speed development and production time with the ultrasensitive Bistable Amplifier—it replaces mechanical relays in critical control and regulating applications. The Bistable incorporates silicon controlled rectifiers, magnetic amplifiers and attendant circuitry to give multiple inputs as low as  $5 \times 10^{-8}$  watts, fast response, high gain and a current output of 1 Amp at an  $85^{\circ}\text{C}$ . ambient.

GET THE FACTS on design  
 and application data—write for  
 technical bulletin CS60.

NE-1



**NORBATROL**  
 Electronics Corp.

DEPT. C 356 Collins Avenue  
 Pittsburgh 8, Pennsylvania

CIRCLE 66 ON READER-SERVICE CARD

## Voltage Comparator

383



A fail-safe alarm is provided by model VC670, transistorized voltage monitor. When the signal value exceeds the external reference limit the contacts open. Two sets of contacts indicate a go or no-go condition in this compact 10-oz unit. Input impedance is 2 meg, and sensitivity is 5 mv.

Verco, Inc., Dept. ED, 1430—130th N. E., Bellevue, Wash.

## Dip Soldering Device

654

For printed-circuit boards, the DIP-RAC soldering fixture is adjustable in widths from 1/4 to 10 in. and accommodates cards to 1 ft long. All parts are made of high-temperature-resistant materials. Card assemblies are held firmly in flat position through thermal cycling.

Defiance Printed Circuit Corp., Dept. ED, 144 Commercial St., Malden, Mass.

P&A: \$29.95; stock.

## Isolation Transformer

384



Portable voltage correcting transformer, for tools and lights comes in ratings of 1 through 5 kva and voltages through 600 v. Encapsulated core and coil are water and shock proof. Included are an output socket and a 15-ft cord and plug for input.

Westinghouse Electric Corp., Dept. ED, P. O. Box 2099, Pittsburgh 30, Pa.

CIRCLE 67 ON READER-SERVICE CARD ▶

# PACKAGING WITH COORS CERAMIC



VACUUM SWITCHES



VACUUM CAPACITATORS



VACUUM TUBES

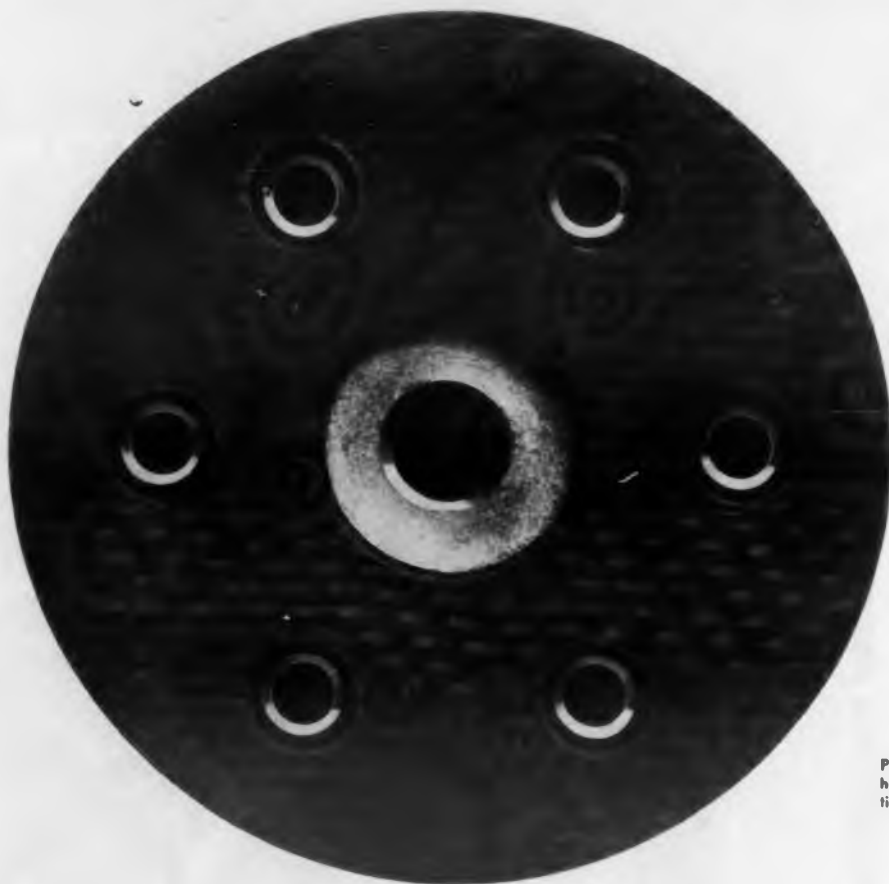
When your packaging application demands high strength and reliability — envelopes for vacuum switches, vacuum capacitors, vacuum tubes — use Coors high alumina ceramics. Outstanding properties include high dielectric characteristics at high frequencies, and high mechanical strength even at high temperatures. These materials can be metalized and subsequently brazed with bond strengths up to 15,000 psi. Coors has facilities for forming, for metalizing and for precision inspection of mass production quantities of dimensionally uniform envelopes. Small parts are dry-pressed . . . larger ones are isostatically formed. Write for "Ceramic Envelopes for Electronic Packaging," Data Sheet No. 7003, or call your nearest Coors regional sales manager: WEST COAST, William S. Smith, Jr., EM 6-8129, Redwood City, Calif.; MIDWEST, John E. Marozek, FR 2-7100, Chicago, Ill.; CENTRAL, Donald Dobbins, GL 4-9638, Canton, Ohio; EAST COAST, John J. McManus, MA 7-3996, Manhasset, N. Y.; NEW ENGLAND, Warren G. McDonald, FR 4-0663, Schenectady, N. Y.; SOUTHWEST, Kenneth R. Lundy, DA 7-5716, Dallas, Texas; SOUTHWEST, William H. Ramsey, UN 4-6369, Houston, Texas.

# Coors

## ALUMINA CERAMICS

Coors Porcelain Co., Golden, Colo.





PGAC electrical lead holder enlarged 2½ times actual size.

## AT 500 VOLTS... > 300°F.... 20,000 PSI, DOW EPOXY RESIN HOLDS 1000-MEGOHM RESISTIVITY!

Made of Dow epoxy resin, this electrical lead holder costs \$35.00 less to produce than a similar unit constructed of other materials. Yet it maintains a constant high resistivity of 1000 megohms at 500 volts under tremendous bottom hole pressures and temperatures which can reach 20,000 psi and more than 300° F.

Dow epoxy resin was selected for laminating this part because of its durability, chemical resistance, low water absorption, and excellent electrical characteristics. This same resin is also used in making other accurate PGAC down-hole instruments.

The Dow family of epoxy resins for electronics applications includes unusual brominated epoxies . . . casting and lami-



Part laminated with Dow epoxy resin holds high voltage leads inside this oil well instrument made by Pan Geo Atlas Corporation, Houston, Texas.

nating resins which offer self-extinguishing properties, and excellent electrical and other physical properties.

Dow offers designers the important advantage of uniform high purity and quality. Because Dow produces the raw materials required . . . and controls every step . . . in the production of epoxy resins, Dow can maintain absolute control over the purity and properties of its epoxies. This basic epoxy position assures a product you can depend on.

For information and data on the family of Dow epoxy resins, write us today in Midland, C/O Coatings Sales Department 1957BC11-8.

THE DOW CHEMICAL COMPANY

**DOW**

Midland, Michigan

CIRCLE 68 ON READER-SERVICE CARD

## NEW PRODUCTS

### Chopper Amplifier

472



Input dc is converted to ac at 94 cps with a mechanical spdt chopper. Ac is amplified in three stages, demodulated by the same chopper, and then filtered. The 94 cps is internally generated. Model C-2 features dc gain of over 10,000 and drift of less than 0.5  $\mu$ v per C over the range of 25 to 50 C. Filter time constant is 6 sec.

Ridgefield Instrument Group, Schlumberger Corp., Dept. ED, Ridgefield Conn.,  
P&A: \$195.00 fob Ridgefield; 30 days.

### Laboratory Power Supply

430

Providing 24 to 28 v power, dc and 60 and 400 cps ac, regulated to 1%, the model LPC-220 laboratory power center operates from 220 to 440 v, 60 cps, 3-phase power. Power is converted by a 3,500 rpm induction motor. Voltage regulators are solid-state. Self-contained unit is in a cabinet measuring 54 x 22 x 36 in.

Electric Specialty Co., Dept. ED, 211 South St., Stamford, Conn.

### Delay Lines

480



Nanolines are available in 10-nsec delay increments ranging from 20 to 100 nsec and are epoxy encapsulated. Delay to rise time ratio ranges from 5 to 1 for the 20-nsec units to greater than 10 to 1 for the 50- to 100-nsec lines. Impedance is 500 ohms  $\pm$ 10%. The lines meet or exceed environmental requirements of MIL-STD-202B.

Richard D. Brew and Co., Inc., Dept. ED, Concord, N. H.

Availability: samples from stock.

## Potentiometers

445



A stable composition resistance element in this line of potentiometers is temperature and humidity resistant. Resistance change from 20 to 105 C is  $\pm 3\%$  avg. Voltage coefficient is less than 0.01% resistance change per v. Life of 25,000 cycles has less than  $\pm 4\%$  resistance change. Tandem controls are matched in production. All standard tapers are available.

Stackpole Carbon Co., Dept. ED, St. Marys, Pa.

Availability: three weeks.

## Liquid Level Detector

423

Bellows or bourdon tube respond to pressure changes in the Chronoflo transmitter, model 231-10. Unit can measure liquid levels despite turbulences and ice formations. Information is telemetered with a pulsed code.

B-I-F Industries, Dept. ED, Providence, R. I.

## Sprayed-On Heaters

499

Custom "sprayed-on" elements are designed for use where stable temperature environment is mandatory. Conductive and insulating coatings combined are 0.015 in. thick. These elements may be applied to flat, cubicle or contoured surfaces of any kind or size.

Electrofilm, Inc., Dept. ED, 7116 N. Laurel Canyon Blvd., North Hollywood, Calif.

## Slip Clutches

455



Locking-type set screw adjusts torque transmission through a range of from 0 to 4 lb-in. Clutch parts are constructed of oil-impregnated sintered alloy and require no lubrication. Model K is designed to couple two shafts. Model M is supplied with a 1/4-in. bore on one end and 1/4-in. shaft on the other.

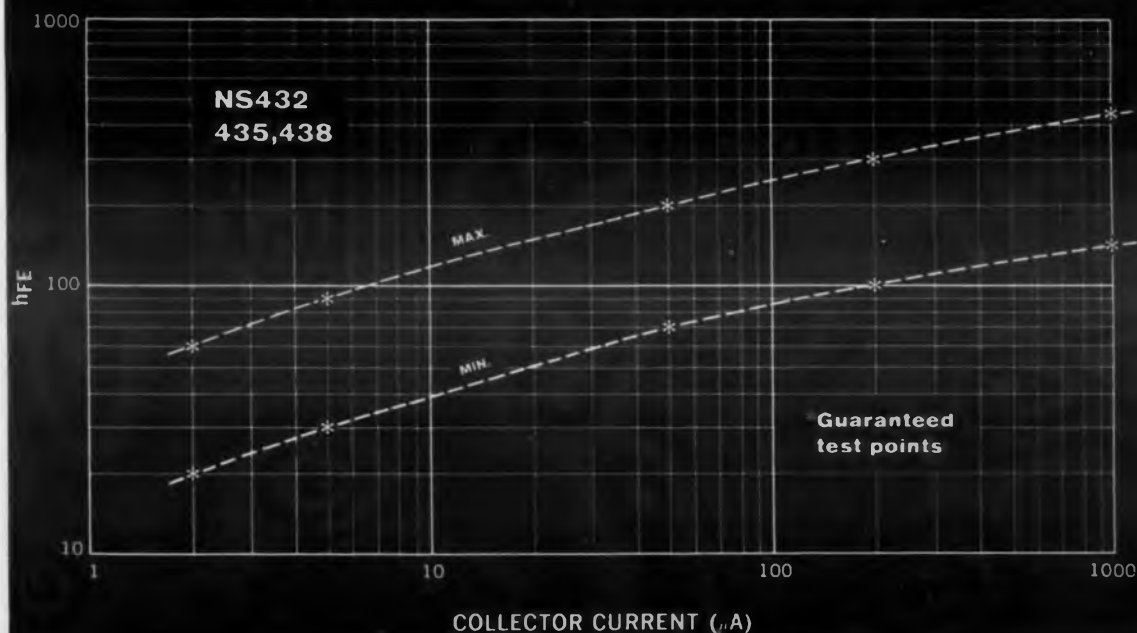
Precision Specialties, Inc., Dept. ED, Pitman, N. J.

ELECTRONIC DESIGN • November 8, 1961

# LOW LEVEL/LOW NOISE

## NS430 - 438 SILICON NPN TRANSISTORS

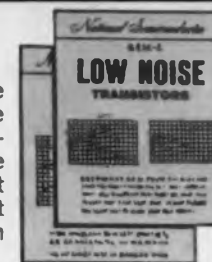
BETA MAX. 60  
MIN. 20 at 2 $\mu$ A COLLECTOR CURRENT



Equiv. Input Noise Voltage	.....	2 $\mu$ V max.
Equiv. Input Noise Current	.....	300 $\mu$ A max.
LVCEO	to .....	45V
Cob	.....	8 pfd max.
VCE (sat) (at 1mA)	.....	0.2V max.
f <sub>T</sub> (at 1mA)	.....	60 mc min.
Physical Package	.....	TO-18

### TWO NEW APPLICATION REPORTS AVAILABLE!

Two new papers on low noise transistor design, "Low Noise Transistors: A General Discussion," and "Calculating Noise Figure When Equivalent Input Noise Voltage and Noise Current are Known," are available from NSC.



For complete technical information on NS430 series transistors and new engineering papers, check key number below, or write:



*National Semiconductor* CORPORATION

Danbury, Conn. • Pioneer 3-7624 • TWX DANB 452-U

CIRCLE 69 ON READER-SERVICE CARD

61-8

77



## NEW PRODUCTS

### Impulse Counter

569



Automatic-reset impulse counter model 310-B requires a pulse of 50 msec duration. Standard ranges are: 1 to 40, 2 to 120, 5 to 480 and 10 to 960 counts at 500 counts per min. A 14-point terminal block permits wiring for all connections. Load ratings are 10 amp at 115 v ac, 5 amp at 230 v ac, 1/4 amp at 115 v dc.

Automatic Timing & Controls, Inc., Dept. ED, King of Prussia, Pa.

### Digital Voltmeter

656

Range is 1 mv to 1 kv. Model VR-2100 digital voltmeter reads dc voltages with an absolute accuracy of 0.01%, +1 digit. The input impedance is so high that the instrument can be standardized directly from standard cells. It withstands abnormal humidity, extreme shock and vibration, explosive atmospheres.

Cubic Corp., Dept. ED, 5575 Kearny Villa Road, San Diego 11, Calif.

Price: \$3,580.

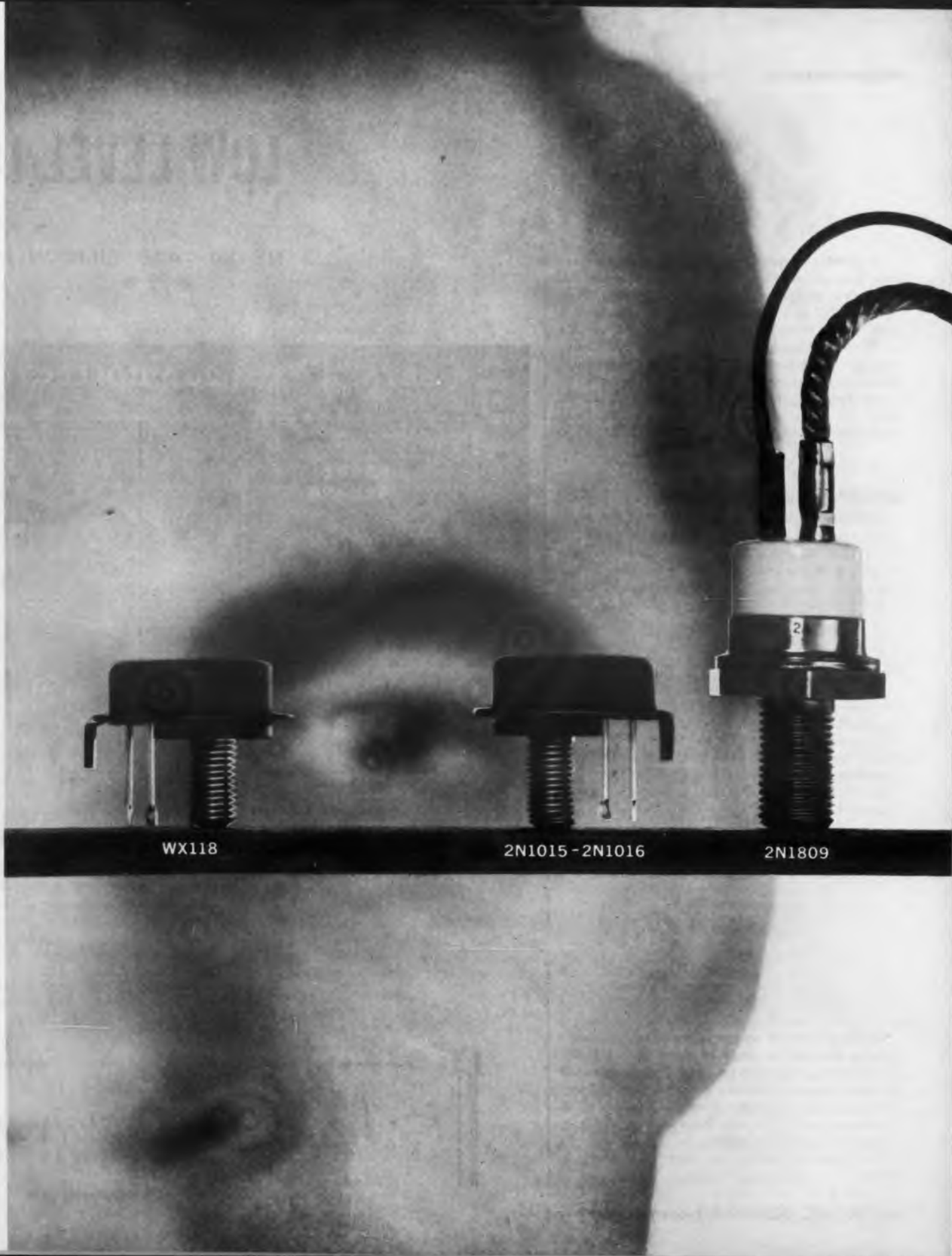
### Power Source

564



Output is 115 v dc at up to 3 amp. Model 10-C power source operates from an input of  $115 \pm 10$  v and  $230 \pm 20$  v, single phase, at 25 to 60 cps. It uses silicon rectifiers in full-wave configuration. It can be used as a power source for fractional horsepower dc motors, local relays and selector magnets.

H. O. Boehme, Inc., Dept. ED, 915 Broadway, New York 10, N.Y.



# Look to Westinghouse for Silicon Power Transistors with lowest saturation resistance

**LSR\* = .037** Lowest saturation resistance ratings in the industry enable design engineers to obtain three-fold increases in power-handling capability. Now—with these higher performance specifications you can replace germanium units and gain the silicon power transistor advantages of reduced heat sink size . . . higher allowable ambient . . . improved control range . . . and upgraded reliability in almost all circuits.

	I <sub>c</sub>	V <sub>ce</sub>	Typical R <sub>ce</sub> (SAT)
2N1809-2N2109 series	30 A	50-200V	.037
2N1015-2N1016 series	7.5 A	30-200V	.25
WX118 series	10 A	50-150V	.22

\*Lowest Saturation Resistance

**2N1809-2N2109 series. New 30-amp "Rock-Top" transistors . . . world's most powerful!** With 30-amp, 200-volt, 250-watt ratings these newest Westinghouse series 2N1809 and 2N2109 transistors are designed to meet the most exacting high power applications. Germanium-level saturation resistance (.037 ohms), and freedom from secondary breakdown mean highest efficiency and operating reliability.

**WX118 series. World's highest gain power transistors provide current gain of 400 at 10 amps!** New Westinghouse Type WX118 high-gain silicon transistors simplify circuitry, increase reliability, reduce cost of assembly. They're ideal for application in high power, high efficiency regulators, inverters and switching circuits. Saturation resistance is only 0.22 ohms.

**2N1015-2N1016 series. Highest reliability from production-proved 150 watt designs.** Get maximum circuit reliability at no extra cost by specifying the Westinghouse 2N1015-2N1016 series. These popular transistors have

been field-proven in thousands of operating equipments. They can replace lower rated transistors (2N1489-2N1490, 2N1069-2N1070, 2N389 and others), and give you up to twice-the-power derating margin. In addition to the exclusive rating characteristics of these transistors, you get greater assurance of performance reliability from:

- **True voltage ratings.** Westinghouse transistors can be operated continuously at their full published ratings into highly inductive loads. True Voltage Ratings are verified by 100% Power Testing.
- **100% Power Testing.** Each Westinghouse transistor is 100% Power Tested before leaving the plant. Tests are conducted over the full operating range—under all conditions of base bias and collector current at maximum rated dissipation.

For more information or technical assistance, see your nearest Westinghouse representative or write: Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Penna. You can be sure . . . if it's Westinghouse. SC-1054

2N2109

## For immediate "off-the-shelf" delivery, order from these Westinghouse Distributors:

**EASTERN**  
**ACK SEMICONDUCTOR, INC.** Birmingham 5, Ala./FA 2-0588  
**CAMERADIO** Pittsburgh, Pa./EX 1-0880  
**CRAMER ELECTRONICS, INC.** Boston, Mass./CO 7-4700  
**ELECTRONIC WHOLESALERS, INC.** Melbourne, Florida/PA 3-1441  
**GENERAL RADIO SUPPLY CO., INC.** Camden, N.J./WO 4-8560  
**GENESE RADIO PTS. CO.** Buffalo, N.Y./TR 3-9661  
**KANN ELLERT ELECTRONICS, INC.** Baltimore, Md./TU 9-4242  
**MILGRAY ELECTRONICS** New York, N.Y./RE 2-4400  
**RADIO & ELECTRONIC PTS. CORP.** Cleveland, O./UT 1-0080  
**SCHWEBER ELECTRONICS** Long Island, N.Y./PI 6-8520  
 Silver Spring, Md./JU 5-7023

**MIDWESTERN**  
**E.C.I. SEMICONDUCTORS, INC.** Kansas City, Mo./WE 1-0829

**ELECTRONIC COMPONENTS FOR INDUSTRY CO.** St. Louis, Mo./WO 2-9916  
**HALLMARK INSTRUMENTS CORP.** Dallas, Texas/RT 7-8933  
**INTER-STATE RADIO & SUPPLY CO.** Denver 4, Colo./TA 5-8257  
**LENERT CO.** Houston, Texas/CA 4-2663  
**MIDLAND SPECIALTY CO.** El Paso, Texas/EE 3-9535  
 Phoenix, Ariz./AL 8-8234  
**ARBUQUERQUE, N.M./CM 7-8236**  
**INDIANAPOLIS, IND./ME 7-5571**  
**RADIO DISTRIB. CO.** Chicago, Ill./MA 2-8860  
**SEMICONDUCTOR SPECIALISTS, INC.** Detroit, Mich./BR 3-2900  
**S. STERLING CO.** Cincinnati, O./MA 1-6530  
**UNITED RADIO, INC.**

**WESTERN**  
**ALMAC ELECTRONICS CORP.** Seattle, Wash./PA 3-7310  
**ELMAB ELECTRONICS** Oakland, Cal./TE 4-3311  
**HAMILTON ELECTRO SLS.** Los Angeles, Cal./BR 2-9154  
 Palo Alto, Cal./DA 1-7541  
**NEWARK ELECTRONICS CO.** Inglewood, Cal./OR 4-8440

## Telemetry Commutator 460

Life is 1,000 hr min at the highest sampling rate for the Datacel type 100 telemetry commutator. Sampling rates as high as 1,350 per sec are offered with a standard 90-channel unit. Contact noise is less than 5 v.

Datametrics, Inc., Dept. ED, 87 Beaver St., Waltham, Mass.

## DC Signal Amplifier 628

Low-level, dc signal amplifier model MA-100 is for measurements such as temperature or strain in industrial and military applications. Output is 0 to 5 v dc from 0 to 10 mv dc input. Input resistance is 10 ohms  $\pm 10\%$ ; output load is 1 to 100 K; frequency response is 0 to 2 cps; response time is 100 msec. Dc voltage gain is 500 v  $\pm 10\%$ .

Dynex Industries, Inc., Dept. ED, 170 Eileen Way, Syosset, N. Y.  
**Availability:** custom units, less than 8 weeks.

## Pulse-Height Discriminator 567



For electronic scalars with high speeds, model 2301 pulse-height discriminator provides an output pulse when the input signal is within a certain range. It resolves paired pulses spaced at 0.5  $\mu$ sec. Overload capacity is 120 v. It can be used in nuclear radiation or X-ray spectrum analyses.

Beckman Instruments, Inc., Berkeley Div., Dept. ED, 2200 Wright Ave., Richmond, Calif.  
**P&A:** \$895; 90 days.

## Transmitting Equipment 393

Am, 1,000, 500, 250-w transmitter type 20V-3 has pushbutton control of filament and plate power which may be extended to a remote position. Automatic sequencing of power-control circuits is used. Also offered is the matching 81M phasor with T-designed phase shifting networks.

Collins Radio Co., Dept. ED, P. O. Box 1891, Dallas 21, Tex.

◀ CIRCLE 70 ON READER-SERVICE CARD

# Westinghouse



# READ .0002 $\mu\mu\text{f}$



## PRECISION 3-TERMINAL (INSENSITIVE TO GROUNDED CAPACITANCE) CAPACITANCE BRIDGES

### MODEL 74C

- 100 KC Test Frequency
- 0.0002-11,000  $\mu\mu\text{f}$   
Generally 0.25%
- 1000 ohms to 1000 megohms  
Shunt Resistance
- 0.001 to 1000  $\mu\text{mhos}$   
Conductance

Price \$935

### MODEL 75A

- 1 Mc Test Frequency  
MIL SPEC. TESTING
- 0.0002 to 1000  $\mu\mu\text{f}$   
Generally 0.25%
- 1000 ohms to 100 megohms  
Shunt Resistance
- 0.01 to 1000  $\mu\text{mhos}$   
Conductance

Price \$990

### MODEL 74C-88 (Shown)

- With -5 to +100V DC Bias  
for Diode Testing

Price \$995

### MODEL 75A-88

- With -5 to +100 VDC Bias  
for Diode Testing

Price \$1050



**Boonton ELECTRONICS Corp.**

MORRIS PLAINS, N. J. • Phone JEFFERSON 9-4210

CIRCLE 71 ON READER-SERVICE CARD

## NEW PRODUCTS

### Telemetry Preamplifier

501

Noise figure is 4.25 db max. Model TPA-1 has a range from 215 to 260 mc. Ceramic tubes, hermetically sealed transformers and the elimination of blower motor and relay contribute to optimum performance under field conditions. Gain is 20 db min. The unit, which features type N connectors, operates from 117 v ac, 60 cps.

Defense Electronics, Inc., Dept. ED, 5455 Randolph Road, Rockville, Md.

Price: \$975.00

### Miniature Pressure Switches

495



Proof pressure is 750 psig. Switches can be factory adjusted to pressure settings from 10 to 500 psig. Type 1100 has an ambient temperature range from -65 to 250 F. This unit is available with or without pressure port and with options of solder terminals, potted leads or electrical connector for termination. Size without external port is 1-5/8 x 15/16 in. diam; weight is 0.75 to 2 oz.

Haydon Switch, Inc., Dept. ED, Waterbury, Conn.

### Silicon Rectifiers

500

Piv ranges from 200 to 1,000 v. Full cycle average leakage ratings for the three types are: type 10AL, 10  $\mu\text{a}$  max at 150 C; type 10AT, 150  $\mu\text{a}$  max at 150 C; and 10AG, 500  $\mu\text{a}$  max at 100 C. Double-diffused silicon junction is hermetically sealed in flangeless cylindrical case measuring 1/4 x 1/4 in.

Electronic Devices, Inc., Dept. ED, New Rochelle, N. Y.

P&A: \$0.50 to \$5.50; stock to 2 weeks.

### Accuracy Is Our Policy

The new product item appearing on p 118 of the Sept. 27 issue of ELECTRONIC DESIGN was in error. It should have read: the discharge of the "Hi-Jul" storage capacitors manufactured by Dearborn Electronic Laboratories, Inc., is as low as 0.1  $\mu\text{sec}$ .

## HIGH PURITY METALS AND ELECTRONIC MATERIALS

### METALS AND ALLOYS

ALUMINUM	ANTIMONY
ARSENIC	BISMUTH
CADMIUM	GOLD
INDIUM	LEAD
SILVER	TIN
	ZINC

High purity alloys are made from these metals to customer specifications.

### COMPOUND SEMICONDUCTORS

INDIUM ANTIMONIDE

Available as crystals, wafers, circles, rings and other shapes made to precise tolerances.

### STANDARD FORMS

INGOTS	SHEET
BAR	SHOT
RODS	POWDER
RIBBON	WIRE

### PREFORMS

Preforms are available in a range of sizes and shapes such as discs, dots, washers, squares and spheres. Enquiries are invited on our alloy preforms.

### CHEMICALS

SALTS SOLUTIONS

## COMINCO PRODUCTS INC.

Electronic Materials Department  
933 West Third Avenue  
Spokane, Washington  
Ph. RI 7-7103 TWX: SP 311

CIRCLE 72 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961



### Digital Voltmeter 655

Reed-relay digital voltmeter model V-70 has a range of  $\pm 0.000$  to  $\pm 999.9$  v dc with a sensitivity of 1 mv. Absolute accuracy is 0.01%,  $\pm 1$  digit; balance time is 500 msec max. Common mode rejection is 80 db at 60 cps and input impedance is 10 meg.

Cubic Corp., Dept. ED, 5575 Kearny Villa Road, San Diego 11, Calif.

Price: \$1180.

### FM Transmitter 395

Rated at 5,000 w, the 830E-1 fm transmitter uses the 830B-1 250-w driver and an amplifier. It is completely self contained with high-voltage transformer, directional couplers and filters mounted inside the cabinet. The amplifier power supply may use silicon rectifiers.

Collins Radio Co., Dept. ED, P. O. Box 1891, Dallas 21, Tex.

### Infrared Spectrometers 565



Two models offered. Model I-4S and I-4T infrared spectrometers have the following specs: ranges, 0.35 to 3.0 and 1 to 16 microns; resolution, 40  $\text{cm}^{-1}$  max; entrance aperture, 2.25  $\text{cm}^2$ ; angular acceptance, 15 deg; output impedance, 1,000 ohms resistive.

Block Associates, Inc., Dept. ED, 385 Putnam Ave., Cambridge 39, Mass.

Price: \$4,515 up.

### Power Supplies 589

Noise-free power supplies have precise voltage regulation for both line and load. Six Sorensen QIS 60-cps and six DQIS 400-cps models are transistorized, 115-v ac or dc, sine-wave inverters. Outputs are 20, 40 or 60 w, from 12 or 28 v dc. They are suitable for replacing vibrators.

Raytheon Co., Sorensen Products, Dept. ED, South Norwalk, Conn.

P&A: \$190 to \$200; stock.

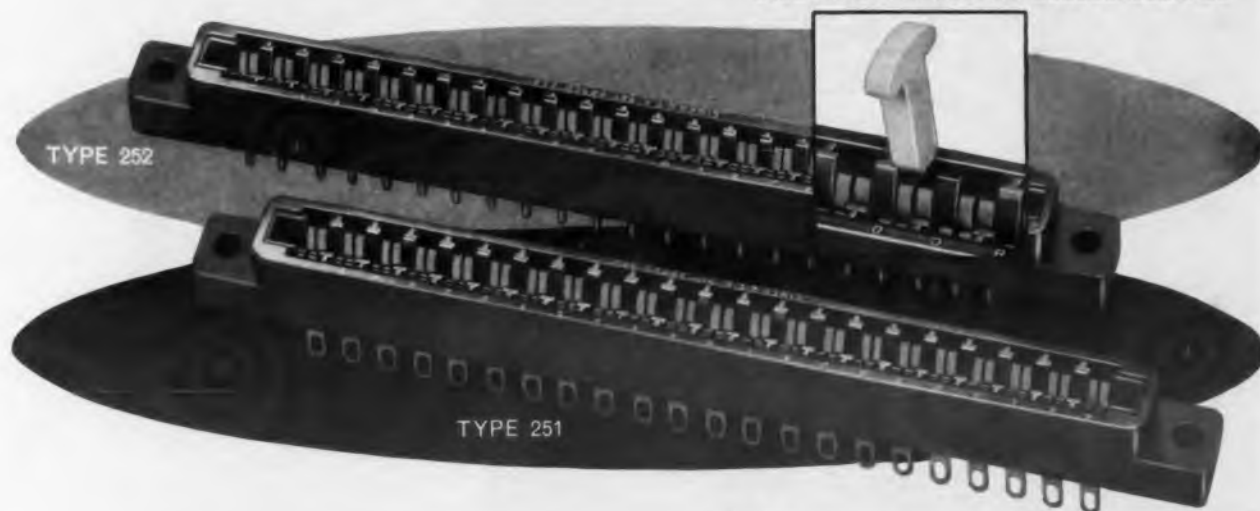
# NEW FROM CINCH...

# BIFURCATED

## Printed circuit

## board edge connectors

## to maintain positive contact!



**NOW AVAILABLE FOR IMMEDIATE DELIVERY!** Bifurcated Contact Connectors with two flexing surfaces instead of one to provide positive contact! . . . accommodate irregularities in Printed Circuit Boards.

**TWO TYPES**—conventional wiring tail (type 251) or dip solder (for .051 dia. hole) (type 252) . . . with 6 to 25 contact positions (12-50 contacts).

**INSULATION**—glass filled diallyl phthalate type GD1 30 per MIL-M-19833.

**POLARIZING KEYS**—can be supplied loose, or inserted in any position designated.

**FINISHES**—phosphor bronze or beryllium copper . . . .00003 Min. Sel-rex. gold plated.

**PART NUMBERS**—customer part numbers imprinted when required.

**MEETS MIL-C-2109A** (ships) specs for printed wiring board connectors

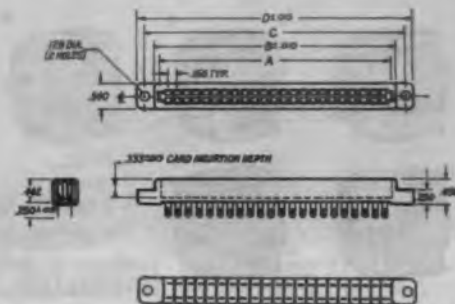
**WRITE FOR FULL INFORMATION TODAY!** Complete details and performance specifications on new Bifurcated Cinch Printed Circuit Board Edge Connectors are available for the asking. Write for full information now.



## CINCH MANUFACTURING COMPANY

1026 South Homan Avenue • Chicago 24, Illinois  
Division of United-Carr Fastener Corporation, Boston, Massachusetts

Centrally located plants at: Chicago, Illinois; Shelbyville, Indiana; City of Industry, California and St. Louis, Missouri



Contact* Positions	DIMENSIONS			
	A	B	C	D
6	1.098	1.239	1.531	1.785
7	1.254	1.395	1.687	1.941
8	1.411	1.552	1.844	2.098
9	1.567	1.708	2.000	2.254
10	1.723	1.864	2.156	2.410
11	1.879	2.020	2.312	2.566
12	2.036	2.177	2.469	2.723
13	2.192	2.333	2.625	2.879
14	2.348	2.489	2.781	3.035
15	2.504	2.645	2.937	3.191
16	2.661	2.802	3.094	3.348
17	2.817	2.958	3.250	3.504
18	2.973	3.114	3.406	3.660
19	3.129	3.270	3.562	3.816
20	3.286	3.427	3.719	3.973
21	3.442	3.583	3.875	4.129
22	3.598	3.739	4.031	4.285
23	3.754	3.895	4.187	4.441
24	3.911	4.052	4.344	4.598
25	4.067	4.208	4.500	4.754

\*Number of contacts equals contact positions times two.

CIRCLE 73 ON READER-SERVICE CARD ➤



RELIABILITY  
**EVERY**  
TIME



Another advance by M/M . . . QT17 stereo head tapered design to permit easy, foolproof insertion of cartridge tapes.



It's easy for head manufacturers to talk about the *theoretical* superiority of their particular designs . . . but the all-important proof is in the results achieved in actual *mass production*.

Michigan Magnetics' design is conventional yet efficient . . . it lends itself to modern production conditions and economies. No one has matched Michigan Magnetics' record for reliability. No one has a quality control and inspection system that can beat M/M . . . that's why you get 1000 reliable, dependable heads every time you order 1000 heads from M/M. Take the gamble out of head purchases . . . order only from the leading manufacturer of OEM heads for home tape recording equipment . . . always specify Michigan Magnetics!

THIS GUARANTEE TAG IS YOUR CUSTOMER'S ASSURANCE OF FIDELITY AND RELIABILITY.



**MICHIGAN MAGNETICS, INC.**

VERMONTVILLE, MICHIGAN

1-1

CIRCLE 74 ON READER-SERVICE CARD

## NEW PRODUCTS

### PDM to PCM Converter 426

Pdm data in 30 x 30 to 90 x 10 format is converted to pcm signal by this converter. Designated model 29309, the unit synchronizes conversion operation with the pdm frame rate, even when input momentarily drops out. Unit, self checking, allows either even or odd parity in output code. A portable input unit may be located up to 3 miles from other units.

Electronic Engineering Co., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

Price: \$17,500.

### Rack Cabinets 486



Custom built UNICABINET units include heavy 11-gage vertical posts in "arrowhead" configuration integrally welded both to its one-piece top and base. Panels and doors are available in both flush mounted and surface mounted stylings. The cabinet will meet most military specifications, and provisions have been made for rf shielding and metalizing as may be necessary.

Dahlstrom Manufacturing Corp., Dept. ED, Jamestown, N. Y.

### Eyeletting Machines 439

Feeds and sets as many as 12 eyelets automatically. Model F features easy change of raceways and setting tools to accommodate different sizes of eyelets. Model A permits conversion from hand-fed and foot-power operation to automatic feed and motor drive.

Fastener Div., United Shoe Machinery Corp., Dept. ED, Shelton, Conn.

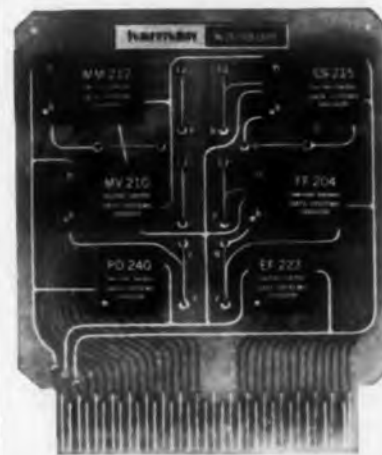
### Delay Lines 506

Signal-to-noise ratio is 7:1, and can be improved to 30:1. Input and output impedances of types ML and MT are supplied to accommodate driving and output circuitry. Type ML delays up to 100  $\mu$ sec; type MT delays up to 5,000  $\mu$ sec.

Computer Devices Corp., Dept. ED, 6 W. 18 St., Huntington Station, N. Y.



**You mix 'em!**



**We mount 'em!**

To your systems specifications

on **Flexi-Card**

**Harman-Kardon's new economical Digital Card Assembly**

Now, Harman-Kardon's new flexi-card circuit assemblies bring logical versatility to logical circuits. Each Flexi-card is factory-assembled to your specific requirement quickly, and at competitive prices, for any of the thousands of combinations of digital logic you require.

**...And two new series of Encapsulated Logic Modules**

Completely compatible modules now available at 125°C. • 5 MC. • 250 KC.

Send for complete details and...  
**FREE guide to Boolean Algebra!**



Data Systems Division

**harman kardon**

INCORPORATED, PLAINVIEW, L. I., N. Y.

CIRCLE 75 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

### Bias Oscillator 396

Output frequency is 100 kc. Output level of type RA-1668 is sufficient to provide bias current to drive six direct record channels. Normally encapsulated in polyurethane or modified epoxy resin, the unit requires  $24 \pm 1$  v dc at 50 ma. Temperature range is  $-30$  to  $+80$  C.

Westrex Co., Dept. ED, 335 N. Maple Drive, Beverly Hills, Calif.

### Planar Transistor 593

Triple-diffused planar transistor type 2N2102 offers the following ratings:  $BV_{CEO}$  of 120 v with  $I_C$  at 0.1 ma,  $V_{CE}$  of 0.5 v max at  $I_C$  of 150 ma,  $V_{BE}$  of 1.1 v max at  $I_C$  of 150 ma. Output capacitance is 15 pf, noise is 6 db max, switching speed is 30  $\mu$ sec max.

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, Somerville, N. J.

### Twin Tetrode 577



Warmup is 0.7 sec to full 3-db power output. Type 7983 twin tetrode can be used as a power-output amplifier, driver or frequency multiplier. It provides 16 w at 200 mc. Cathode voltage is 3.15 v. Rf performance is comparable to that of indirectly heated cathodes.

Amperex Electronics Corp., Power Tube Div., Dept. ED, 230 Duffy Ave., Hicksville, L. I., N. Y.

### Screen Press 392

For printed circuits. The unit features horizontal working action on rollers, registration and off-contact height adjustments, 3-way line adjustment, and positive taper pin automatic positioning of work frame. Planed registration plate is for drilled hole and pin holding.

Etchomatic, Inc., Dept. ED, P. O. Box 444, Waltham 54, Mass.  
Price: \$895.00.

CIRCLE 76 ON READER-SERVICE CARD ►



## General Instrument Silicon Planar Epitaxial Transistors

2N1613		
2N696 *	2N1711	2N1893
2N697 *	2N1252	2N1958
2N698	2N1253	2N1959
2N699	2N1410	2N1990

2N914	2N707	2N753
2N706 *	2N708	2N783
2N706A	2N743	2N784
2N706B	2N744	2N834

\*MILITARY TYPES AVAILABLE

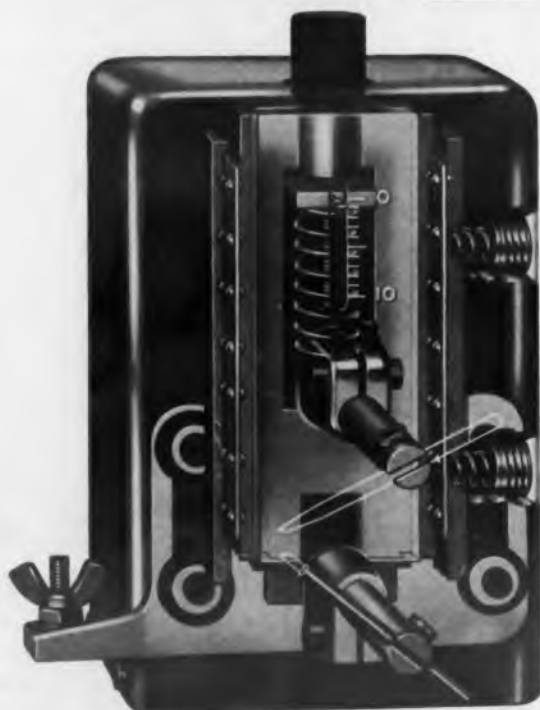
#### Source for Silicon Planar Epitaxial Transistors.

Get the benefits of both planar and epitaxial constructions in the transistors you specify for computer logic circuits. New General Instrument silicon transistors supply both. To the superior stability and freedom from contaminants our unique Molecular Shield™ planar-passivation process offers, we've added the high speed, low saturation resistance and high breakdown voltage of epitaxial devices.

Now, together they make possible faster switching, more usable current gain over a wider current range and lower costs due to higher production yields. ■ For complete technical data on silicon planar epitaxials and any other semiconductor in our complete line, call the General Instrument sales office or franchised distributor nearest you, or write today. General Instrument Semiconductor Division, 65 Gouverneur Street, Newark 4, New Jersey.

**GENERAL INSTRUMENT SEMICONDUCTOR DIVISION**  
**GENERAL INSTRUMENT CORPORATION**

**THIS WELDMATIC WELDING HEAD IS USED TO PRODUCE MORE MODULES THAN ALL OTHER MAKES combined**



**Here's why—**

**Fastest Follow-Up**

Model 1032 combines (1) near-zero inertia of lightweight electrode arm with (2) minimum friction (thanks to self-adjusting spring loaded linear raceways) and (3) low spring-rate driving force, to supply *ultimate* acceleration capability throughout the weld formation period. The vital combination of these 3 factors determines the resultant Weld-Schedule optimum "maximum-strength" area.

**Absolute Linear Electrode Movement**

Long linear ball-bearing raceways allow only perfect, non-wiping action—wiping action being a major contributor to mediocre welds.

**True Force Firing**

Patented, pure force-firing action is designed into the Model 1032. Weld energy is released to the electrodes only—and exactly—when the preset force is reached, regardless of setup configuration.

**Self-Adjusting Raceways**

Dual, linear ball-bearing raceways.

*For detailed specifications write:*

**WELDMATIC DIVISION / UNITEK**

950 ROYAL OAKS DRIVE, MONROVIA, CALIFORNIA

CIRCLE 77 ON READER-SERVICE CARD

spring loaded for full compliance, compensate for wear, thermal effects, and normal dirt and provide absolute, lowest constant friction over full electrode arm stroke.

**Minimum Movable Mass**

All parts moving during follow-up total less than 4 ozs. Die-cast electrode arm and holder, with electroplated high conductivity interfaces, offer highest welding efficiency yet lowest mass.

**Full Flexibility and Accessibility**

The head features full frontal 3-dimensional access with fully adjustable arm lengths. The head operates at any desired work position, either singly or in double head combinations.

**Full Line of Tailored Accessories Available**

Optimum production weld repeatability results through minimizing operator fatigue. Tailored accessories such as actuators, illuminator, magnifiers, riser assembly, horizontal adaptor, etc., provide these results.

**NEW PRODUCTS**

**DC Power Supply**

456



For thermoelectric coolers. All components are mounted on a base plate which acts as a heat sink or cooling surface for the rectifier. At maximum output, ripple content in the output voltage wave shape is limited to 10% of the dc level, according to the manufacturer. The unit is rated at 60 cps, 117 v input, 4 v at 30 amp output.

General Electric Co., Dept. ED, Schenectady 5, N. Y.

**Digital Voltmeter**

476



Exhibits 5-digit resolution on all readings by means of a front panel meter which verifies the null balance condition. Features of the model 2000 include  $\pm 1$  digit accuracy, floating operation, 0.001% resolution, transistorized circuitry and optional printout.

Auto-Data, Dept. ED, 943 Turquoise, San Diego, Calif.

**Crossbar Scanner**

496



Accommodates up to 100 one-wire channels, 60 two-wire channels, or 40 three-wire channels. Bounce is less than 400  $\mu$ sec, none on break. Model ST-1L handles 100 ma at 50 v dc and the breakdown voltage is not less than 1,000 v ac rms. Signal frequency range is dc to 10 mc.

James Cunningham, Son & Co., Inc., Dept. ED, 33 Litchfield St., Rochester, N. Y.

P&A: \$1,600 to \$1,800; 4-5 weeks.

**Now!  
Kidde "know-how"  
delivers  
pre-engineered  
static frequency  
changers with...**

- CUSTOM DESIGN
- LOW COST
- FAST DELIVERY



Kidde Electronics Laboratories now offer static frequency changers on a "custom" basis at lowest cost. Utilizing the extensive experience gained in the design and production of working units, Kidde static frequency changers employ any of the three principal design techniques—intermediate DC link; phase modulation, straight-through method; and switch modulation, straight-through method.

This background of experience with these techniques has resulted in circuits which are now available almost on an "off the shelf" basis, and can be used to produce custom static frequency changers in minimum time and at lowest cost. They are available from 10VA to 10 KVA and within the range of 50 cps to 3200 cps upward and downward. For more information write or call Kidde today.

Phone: GRegory 2-5000  
(Area Code 201)

**Kidde**  
**EL**ectronics  
Laboratories



WALTER KIDDE & COMPANY, INC.  
1174 Brighton Road, Clifton, N. J.

Static Frequency Changers, Static Inverters, Static Converters (DC to DC), Static Power Supplies.

CIRCLE 78 ON READER-SERVICE CARD

### Recording Amplifier 397

For airborne and missile environments. Temperature range of type RA-1667 is  $-30$  to  $+80$  C. Output signal is 2.5 ma rms. Input is adjustable from 35 mv rms to 4 v rms for output recording current of 1 ma rms. The unit requires  $24 \pm 1$  v dc at 15 ma. Bias frequency is 100 kc at 15 ma rms.

Westrex Co., Dept. ED, 335 N. Maple Drive, Beverly Hills, Calif.

### Dual Pressure Switch 578



Range is 1 to 10 in. Hg with a calibration accuracy of  $\pm 0.05$  in. The dual pressure switch, for spdt, normally closed operation, has contacts rated at 3-amp inductive load at 28 v dc. Maximum inrush is 15 amp. Switches meet MIL-S-8805, Class A-8, and environmental requirements of MIL-E-5272.

Assembly Engineers, Inc., Dept. ED, 3640 Holdrege Ave., Los Angeles, Calif.

### Silicon Rectifiers 592

Rated at 20 amp at 150 C case temperature, types USA-1N249B, 1N250B and 1N2135A silicon rectifiers have 100, 200 and 400 piv, respectively. They are designed in accordance with MIL-S-19500/134.

Radio Corp. of America, Semiconductors & Material Div., Dept. ED, Somerville, N. J.

### Tunnel Diodes 391

High current silicon tunnel diodes, HT-25, HT-26, and HT-27, have output voltages up to 0.8 v and typical switching time of 5 nsec. Peak current tolerances are  $\pm 10\%$  with a temperature coefficient of  $\pm 0.04\%$  per C. Operating and storage temperature range is  $-85$  to  $+200$  C.

Hoffman Semiconductor Div., Dept. ED, 1001 N. Arden Drive, El Monte, Calif.

P&A: \$25 to \$45; immediate.

CIRCLE 79 ON READER-SERVICE CARD >

## TYPE R THE OFFNER DYNOGRAPH

The most versatile and sensitive  
direct-writing unit available!

Ink, heat, electric recording media!

Handles all your recording requirements.



SILVER ANNIVERSARY



OFFNER DIRECT-WRITING  
OSCILLOGRAPHS

25 years ago Offner invented the world's first Direct-Writing Oscillograph.

This *one* high-speed direct writing assembly handles *all* your recording requirements. You change only the input coupler for thermocouples, strain gages, servo monitors; for industrial, scientific, and medical applications.

☆ From one microvolt, d-c to over 200 cps.

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**OFFNER DIVISION**

of Beckman Instruments, Inc.

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16 pages of facts, figures, and specifications on the Offner Type R Dynograph.

Write for your copy.



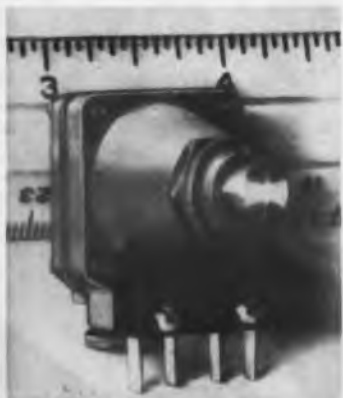
## NEW PRODUCTS

### Cathode-Ray Tube 390

For general purpose oscilloscopes in which two independent signals are displayed on a common time base. This double-gun helical tube, type 1000F, has 10 cm diam. and a window of 6.3 x 6.3 cm. Deflection sensitivity in the X direction is 24 v per cm and in the Y direction, 14 v per cm, with a gun voltage of 1.2 kv and a final anode potential of 4 kv.

The M-O Valve Co. Ltd., Dept. ED, Brook Green, London W. 6, England.

### Pneumatic Timer 566



Is 1.5 in. sq, weighs less than 1 oz. Model 90 pneumatic timer has an adjustable range of 0.2 to 15 sec and is built for 5 million cycles. Repeat accuracy is within  $\pm 10\%$  from 32 to 120 F. The switch is rated at 10 amp and is easily replaced.

Hagen Manufacturing Co. Div., E. W. Bliss Co., Dept. ED, 104 Walnut St., Baraboo, Wis.

### Precision Resolvers 388

Transformation ratios are  $\pm 0.5\%$  for size 8,  $\pm 0.2\%$  for size 11 and  $\pm 0.15\%$  for size 15 from room ambient value over  $-55$  to  $+125$  C temperature range. Size 8 has input of 26 v, output of 11.146 v, phase shift of 22 deg, accuracy of  $\pm 7$  min max, and total null voltage of 0.030.

John Oster Manufacturing Co., Avionic Div., Dept. ED, Racine, Wis.

Availability: 60-90 days.



A full line of capacities from 10 to 52 points. Capable of millions of steps without adjustment.

# Fast "Off-The-Shelf" delivery

## Overnight delivery on many items at factory prices

When standard CLARE relays or switches meet your needs, distributor service saves you time, costs you no more.

### Top quality

—the same fine design and long life you get in CLARE custom-built relays and switches.

### Easy purchasing

—you can order CLARE relays at the same time you purchase other components...have them delivered together.

### Engineering assistance

—always available from CLARE field engineers who work in close cooperation with CLARE distributors.



### NOW AVAILABLE

... mercury-wetted contact relay modules for mounting on your own printed circuit board

Type HGM relay module (left) with cut-away (right) showing mercury-wetted switch capsule and coil potted in steel enclosure.

Your nearby CLARE distributor can now supply you with the new CLARE mercury-wetted relays, steel enclosed and ready for mounting. They combine the famous CLARE billion-operation reliability with unusual ease of handling and application. You can choose either the standard CLARE HG relay module or the HGS, super-fast and super-sensitive. Each module contains the CLARE mercury-wetted contact switch capsule with contacts continually wetted by capillary action. They never bounce, never get dirty, never weld and never wear out.



**TYPE J RELAY**

A compact telephone type relay of unequaled long life and superior performance.

**SEALED CONTACT REED RELAY**

A highly reliable switching device for single or multiple circuit control... wide mounting versatility.

**MERCURY-WETTED CONTACT RELAY**

Single or multiple switch capsules potted in steel container. Gives billions of operations with no maintenance.

**TYPE F RELAY**

A crystal can relay with unusual flexibility and a variety of mounting styles.

## of top-quality Clare relays

### From these distributors

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Tel: Davenport 3-9431
2. Bell Electronic Corporation  
305 E. Alondra  
Gardena, California  
Tel: Faculty 1-5802
2. Bell Electronic Corporation  
8072 Engineers Road  
San Diego 12, California  
Tel: Browning 8-4350

#### SOUTHWEST

3. Radio Specialties Co., Inc.  
6323 Acoma Road, S.E.  
Albuquerque, New Mexico  
Tel: Amherst 8-3801
2. Radio Specialties Co., Inc.  
209 Penn Avenue  
Alamogordo, New Mexico  
Tel: Hemlock 7-0370
4. Engineering Supply Co.  
8000 Denton Drive  
Dallas 35, Texas  
Tel: Fleetwood 7-8121



5. Harrison Equipment Co., Inc.  
1422 San Jacinto St.  
P. O. Box 1506  
Houston 1, Texas  
Tel: Capitol 4-9131
6. Engineering Supply Co.  
1124 East Fourth Street  
Tulsa 20, Oklahoma  
Tel: Luther 2-8121

#### CENTRAL

10. Relay Sales, Inc.  
P. O. Box 106  
West Chicago, Illinois  
Tel: 231-1100
11. Srapco, Inc.  
314 Leo Street  
Dayton 4, Ohio  
Tel: Baldwin 8-2546

#### EAST

7. R & D Supply, Inc.  
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Needham 92, Mass.  
Tel: Hillcrest 4-4500
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Westbury, L.I., New York  
Tel: Edgewood 3-5800
9. Electronic Wholesalers, Inc.  
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Melbourne, Florida  
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12. Pioneer Electronics Supply Co.  
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les Clayes-sous-Bois (S.et O.), France.



**C. P. CLARE & CO.**

Relays and related control components

### Gear Transmission

576



Multispeed, direct coupled gear transmission changes speeds while rotating. Offered in several sizes for different torque requirements, it is for use in power transmissions for industrial-process controls and instrumentation of computers, data-reduction equipment, and film and tape-drive mechanisms.

Analog General Corp., Dept. ED,  
7-11 Main St., East Rockaway,  
L. I., N. Y.

P&A: from \$200; stock.

### Silicone Compound

387

Compound oil resistance with low temperature flexibility. Rubber-base compound has a useful temperature range of -120 to +450 F. Volume swell in fluids is equivalent to that of dimethyl silicone rubber compounds which have brittle point of -80 F. Type KW-1920 is designed for vital parts for military aircraft and missiles.

Silicones Div., Union Carbide Corp., Dept. ED, 270 Park Ave., New York 17, N. Y.

### Differential Transformers

568



Electromechanical transducers, the Atcotran differential transformers convert linear displacement into a proportional ac mv signal. They can be used with motion from bellows, diaphragms, Bourdon tubes, flow meters and levers. The electrical signal can be transmitted several miles over wire.

Automatic Timing & Controls, Inc., Dept. ED, King of Prussia, Pa.

◀ CIRCLE 80 ON READER-SERVICE CARD

# SELECTIVE TONE SIGNALING

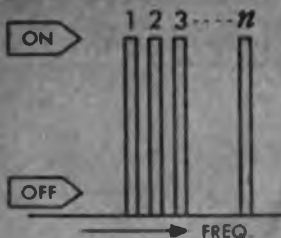
OSCILLATOR  
STABILIZER

RESONANT  
RELAY

TRANSMIT  
ENCODE



FREQUENCIES 60-1000 CPS



RECEIVE  
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THOUSANDS OF FUNCTIONS PER CHANNEL

FOR RELIABLE

- Selective Calling
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Please write  
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CIRCLE 81 ON READER-SERVICE CARD

## NEW PRODUCTS

### Saturable Reactor

479



Power-O-Matic 60 includes control, saturable power reactor, voltmeter and circuit breaker plus heavy gage polished aluminum ventilated housing. Three ranges are  $-20$  to  $+650$  F and sizes are 2 to 10 kva.

Blue M Electric Co., Dept. ED, 138th & Chatham St., Blue Island, Ill.

### Brushless Fan

471



Cabinet fan meets the temperature requirements of MIL-E-5272-C ( $-65$  to  $160$  F). Elimination of the brushes increases the life expectancy of the unit. The device uses a shade pole motor.

Rotronics of California, Dept. ED, 11168 Santa Monica Blvd., Los Angeles 25, Calif.

### Digital Switch

451



Thumbwheel switches can be stacked up to 15 sections in a panel slot  $8 \times 1-9/16$  in. Deca-switch sections are available in single-pole 10-position, single-pole 11-position, plus/minus, binary and 2-pole, 5-position models. Switch contacts are gold plated and are said to feature low resistance.

Hallamore Electronics Div., The Siegler Corp., Dept. ED, 714 N. Brookhurst St., Anaheim, Calif.



## NEW-COMPACT 8695 TEMPERATURE POTENTIOMETER

Here in one space-saving instrument (only  $7'' \times 6'' \times 5''$ ), you'll find a self-contained portable potentiometer made with L&N's top-quality craftsmanship. If you're checking thermocouples, recorders or controllers in industry—or measuring temperatures in research work—you can choose, from 15 different ranges, the 8695 Double-Range Potentiometer which meets your needs (an 8694 Single-Range instrument is also available). For information on ranges, write for Data Sheet E-33(5).

LIMIT OF ERROR— $\pm 0.3\%$  of range.

FUNCTION SWITCH—Six-position switch provides following internal connections: (1) "OUTPUT" A (2) "STD" A (3) "MEAS" A (4) "MEAS" B (5) "STD" B (6) "OUTPUT" B.

CASE—Metal with handle,  $7'' \times 6'' \times 5''$ . Wt.:  $4\frac{1}{2}$  lbs.

PRICE—8695: \$240.00. 8694: \$200.00 F.O.B. Phila. or North Wales, Pa. (Price subject to change without notice). Specify List Number 8694 or 8695 with desired range suffix numbers, obtainable from your nearest L&N Office or 4908 Stenton Ave., Phila. 44.



**LEEDS & NORTHRUP**

Pioneers in Precision

CIRCLE 82 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961



### Precision Potentiometer 570



Low-noise, 10-turn precision potentiometer has the following specs: resistances, 25 ohms to 200-K, 0.03% linearity; 0.007% resolution; power rating, 3 w at 40 C; temperature range, -55 to +110 C; life of 2 million revolutions. Dimensions are 1-in. in diam by 1-53/64 in. long.

Arcon Electronics, Dept. ED, Box 31, Los Alamitos, Calif.  
Availability: 1 to 2 weeks.

### Pneumatic Instrumentation 389

Instruments feature automatic switching with no matching of any pressures, accessible zero and damping adjustments, 4-in. charts with rectilinear recording, calibrated control adjustments and optional front-set control adjustments. Available are S1004-1 indicators and recorders, S1004-2 recording and indicating control stations, and S1004-3 recording and indicating control stations for cascade control.

Minneapolis-Honeywell Regulator Co., Industrial Div., Dept. ED, Wayne and Windrim Aves., Philadelphia 44, Pa.

### Sequence Timer 493



Battery-powered timer is accurate to  $\pm 10$  sec per day over a temperature range of 30 to 140 F. A 4.5-v "A" battery will power the unit for 8-12 months. Cams are available with 1, 2, 3, 4 or 6 lobes, enabling the spdt switch to be cycled as many times in a 1- or 12-hr period.

Geodyne Corp., Dept. ED, 180 Bear Hill Road, Waltham 54, Mass.

CIRCLE 83 ON READER-SERVICE CARD

# REDUCE Circuit Board SHRINKAGE



National Germanium Gold Bonded Diode  
Surpass All Others in these vital tests  
which determine reliability and ruggedness.  
Result: Fewer Opens and Shorts —  
Reduced Circuit Board Shrinkage.

Actual Size NATIONAL Subminiature Diode	CENTRIFUGE (stress)	SHOCK (deceleration)	HERMETIC SEAL
<b>National</b>	<b>50,000 G's</b>	<b>3,000 G's</b>	<b>150 psi</b>
Nearest Competitor	30,000 G's	1,500 G's	100 psi
Mil-S-19500	20,000 G's	1,500 G's	not required

Send Today for  
CATALOG A101 ED

# NATIONAL

NATIONAL TRANSISTOR MFG., INC.

500 Broadway, Lawrence, Massachusetts

RELIABILITY BY DESIGN — NOT BY CHANCE



# FRONT END PLUG IN VERSATILITY



THE ONLY SOLID STATE  
10 MC COUNTER-TIMERS  
THAT PROVIDE COMPLETE  
FRONT END FLEXIBILITY.  
ALL MODELS ARE READILY  
CONVERTIBLE TO UNIVERSAL COUNTER-  
TIMERS BY USE OF PLUG-IN UNITS.



• 1039TL  
Time Interval Meter \$2,325.00



• 1039T  
Time Interval Meter \$2,475.00



• 1039FL  
Frequency Counter \$2,475.00



• 1039UL  
Universal Counter-Timer \$2,525.00



• 1039F  
Frequency Counter \$2,550.00



• 1039U  
Universal Counter-Timer \$2,750.00

The 1039 Series equipment represents a significant engineering design contribution to user convenience; ease of operation, performance, flexibility and modular solid state reliability are achieved.

## PICK A PLUG-IN FOR YOUR SIGNAL

### Universal Amplifier AC-DC Coupled

Sensitivity: 0.1vrms 0 to 11 mc  
Impedance: 1m $\Omega$  50 pf  
Attenuator: 1, 3, 10, 30, 100  
with Trigger Level Control

### Low Impedance Unit — DC Coupled

Sensitivity: 0.25vrms at 10 mc  
Impedance: 93 $\Omega$  or 50 $\Omega$   
Trigger Level:  $\pm$  1 volt

These instruments, depending upon the model desired, are priced between \$2,325.00 and \$2,750.00

Let us send you complete specifications of the Model 1039 Series.

**SYSTRON**  
DIVISION OF **SYSTRON-DONNER**  
Corporation  
950 GALINDO STREET  
CONCORD, CALIFORNIA  
CIRCLE 84 ON READER-SERVICE CARD

## NEW PRODUCTS

### Tantalum Capacitors

489



For filter, by-pass, coupling, blocking, RC differentiating and integrating circuits, phase shifting and vacuum tube grid circuits. Available in MIL case sizes A, B, C, and D, to MIL CS 12 or CS 13, these capacitors range from 1.0 to 330  $\mu$ f with tolerances of  $\pm$ 5%,  $\pm$ 10% or  $\pm$ 20% and working voltages of 6, 10, 15, 20 and 35 v. The units operate from  $-80$  to  $+85$  C at full rated voltage or to  $+125$  C at derated voltage.

Erie Resistor Corp., Dept. ED, 644 W. 12th St., Erie, Pa.

P&A: \$0.87 to \$4.53; 3 to 4 weeks.

### Dielectric Material

505

High-K 707 is available in dielectrics of 6, 9 and 12 as rods, bars and sheets. The range of dielectric constants is from 3 to 18 and the material can be manufactured for the customer to a tolerance of  $\pm$ 0.1 at microwave frequencies. The high-temperature (500 F continuous operation) material is also available as a casting compound in a 1-lb containers.

Custom Materials, Inc., Dept. ED, 279 Billerica Road, Chelmsford, Mass.

Price: on request.

### Gaging Console

466



Reads- and prints-out up to 24 gage points in 1 min. Digital read-out windows give the gaging position and variation in lighted numeral 1 in. high. Readings are accurate to 0.0002 in. Range is  $\pm$  0.010 in. Model CS-24 uses 110-120 v, 60 cps ac and consumes 350 w.

Winslow Manufacturing Co., Dept. ED, 1751 E. 23 St., Cleveland 14, Ohio.



# WHAT ELSE CAN YOU ASK FOR IN HOOK-UP WIRE?

WHEN YOU CAN get wire in sizes from No. 24 to No. 6 from Rome Cable

WHEN YOU CAN specify either rubber or thermoplastic insulation from Rome Cable

WHEN YOU CAN order wire to meet either commercial or military specs from Rome Cable

WHEN YOU CAN select outer covers of nylon, cotton, rayon or glass from Rome Cable

WHEN YOU CAN be sure of fast delivery from Rome Cable, why look elsewhere for hook-up wire?

Whatever your requirements, Rome Cable can fill them. For the full story on types, sizes and specs, write for Bulletin TR-3. Direct inquiries to Rome Cable Division of Alcoa, Department 11-111, Rome, New York.

**ALCOA**  
**ROME CABLE**  
DIVISION

CIRCLE 85 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

## Pulse Generator

398



Transistorized 10-mc pulse generator has rise time of 10 nsec. Extended performance capabilities of model 4550A include: pulse train generation to 10 mc, coherent double pulse rate generation, multiple-channel pulse generation and dc biased pulse generation.

Servo Corp. of America, Dept. ED, 111 New South Road, Hicksville, N. Y.  
P&A: \$18.75; 30 days.

## Electronic Timer

473



Two adjustments for predetermined time intervals are featured in the "Protectal" timer: on—from 1/16 to 5 sec; off—from 1/16 to 30 sec. Step switch consecutively energizes up to 24 external circuits. Incorporating a single electronic tube, the device operates from 115 v, 60 cps.

Protection Controls, Inc., Dept. ED, 7317 N. Lawndale Ave., Skokie, Ill.

## Temperature Chamber

483



Tests 150 component parts simultaneously. Range is from -100 to +350 F. Model SU-100-10-HC, 10-cu ft chamber, has a thermal capacity of 400 BTU per hr at -80 F. The unit is 30 x 24 x 24 in. and is equipped with fin coil evaporator on the rear wall, 1,000-w heaters and air baffle.

Cincinnati Sub Zero Products, Dept. ED, 3932 Reading Road, Cincinnati 29, Ohio.



## Slip Rings?

To provide excellent electrical properties and long equipment life for slip rings, we manufacture and supply fine and coin silver in the form, size, finish and degree of hardness most convenient for the manufacturer and least productive of scrap.

Photo courtesy of Breeze Corporations, Inc., Union, New Jersey



## Adjustable Contacts?

The Handy & Harman Bimet shown here is used as an adjustable contact in a Rimset thermostat for control of residential heating, cooling and air conditioning. It is made of fine silver for optimum conductivity and reliability, and clad with bronze to give a more machinable, easily threaded surface. Handy & Harman bimetal give you uniformly clad precious metal just where you need it, with no excess. Available in gold and silver and their alloys in strip, overlays, inlays, edge lays and throlays.

Photo courtesy of Penn Controls, Inc., Goshen, Indiana



## Rotary Switches?

Low contact resistance and ability to withstand corrosion make silver ideal for switch parts. The stationary contacts of this rotary switch are made of fine silver...the multiple leaf brushes are of durable silver alloy. Life tests of one million operations, representing several years of normal use, show that "Zero" resistance of 0.001 ohm through the switch body changes by less than 0.0005 ohm.

Photo courtesy of Leeds & Northrup Company, Philadelphia, Pa.

*If What You're Doing  
Involves Precious Metals\**

# HANDY & HARMAN CAN HELP YOU DO IT

Gold and silver...and their alloys...possess a combination of characteristics that offers unique advantages to the electronics and electrical industries. Their excellent electrical and thermal conductivity makes them ideal for a vast range of applications, particularly in subminiature components. Their ability to resist corrosion imparts long service life and dependability to critical control items. The fact, too, that they can be obtained in so many convenient forms...wire, strip, sheet, powder, bimetal, flakes and plating anodes...lends them unusual versatility.

These are only a few examples of the ways in which Handy & Harman precious metals are used in the electronics and electrical fields. Perhaps they will suggest some ideas to help you apply them advantageously in your own products or operations. Our technical staff invites your inquiries. No obligation.

\* BOLD & GOLD ALLOYS • SILVER AND SILVER ALLOYS  
BIMETALS • SILVER PAINTS • POWDERS AND FLAKE

Your No. 1 Source of Supply and Authority on Precious Metals

# HH

## HANDY & HARMAN

General Offices: 850 Third Avenue, New York 22, N. Y.

Offices and Plants: Bridgeport, Conn. • Chicago, Ill. • Cleveland, Ohio  
Dallas, Texas • Detroit, Mich. • Los Angeles, Calif. • Providence, R. I.

Toronto, Ontario • Montreal, Quebec

CIRCLE 86 ON READER-SERVICE CARD

## NEW PRODUCTS

Materials Tester

494



Measures the B-H hysteresis loop of small samples of material. Model 750T is designed to evaluate samples of magnetic films as thin as 10  $\mu$ in., as well as wire and other bulk material. The unit, which operates from 110 v, 60 cps at 5 amp, is capable of developing magnetic fields up to 1,000 oersteds.

Halex, Inc., Dept. ED, 310 E. Imperial Highway, El Segundo, Calif.

P&A: \$5,230; 60 days.

### Voltage Regulator Tubes

428

Microminiature voltage regulator tubes are gas-filled cold-cathode diodes. Designated types TD-9A and TD-19, the tubes measure about 1.1 in. long and 0.13 in. in diam. Regulation voltage is 150 and 115 v respectively, at 75 to 400  $\mu$ a operating current. Typical regulation is within 1.7 v dc. Temperature range is -55 to +125 ambient; shock and vibration characteristics meet MIL-E-1.

Bendix Corp., Red Bank Div., Electron Tube Products, Dept. ED, Eatontown, N. J.

### Humidity Indicator

485



Measures true relative humidity. Readings of wet and dry bulb can easily be taken in close proximity to critical manufacturing processes. Accurate measurements may be made with the instrument in any position. Two standard flashlight batteries power a fan of low current drain to provide proper air circulation and evaporation. Dimensions are 2-3/4 x 5-1/2 x 7 in. and weight is 1-1/2 lb.

Better Fabrics Testing Bureau, Inc., Dept. ED, 101 W. 31 St., New York 1, N. Y.

P&A: \$63.50; stock.

# The First Major Variable Resistor



In load life, freedom from resistance change under mechanical wear and aging, Stackpole Controls with new STABILITE\* Elements surpass any general purpose variable resistors produced since the early days of radio!

By achieving far greater variable resistor stability—at no increase in cost—the new Stackpole STABILITE elements provide greater circuit design freedom while assuring maximum dependability for the equipment in which they are used.

Available in all Stackpole Control



\*Trademark, Stackpole Carbon Co.

# Advance in STABILITY in Years

types. STABILITE elements handle higher loads with an absolute minimum of derating. And they maintain their tolerance through years of hard use!

STABILITE elements result from entirely new techniques in applying carbon dispersions to a specially-developed base material. The accompanying data tells its own story of truly remarkable performance under pertinent conditions of normal use.

For complete details and engineering samples, call your local Stackpole sales engineer or write on company letterhead to: Electronic Components Division, Stackpole Carbon Company, St. Marys, Pennsylvania.

## STACKPOLE VARIABLE composition RESISTORS

Fixed Composition Resistors • Slide & Snap Switches • Ceramag®  
Ferrite Cores • Fixed Composition Capacitors • Ceramagnet®  
Ceramic Magnets • Electrical Contacts • Brushes for all Rotating  
Electrical Equipment • Graphite Bearings, Seal Rings, Anodes  
Hundreds of Related Carbon & Graphite Products

CIRCLE 17 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961



Compare this performance  
with any controls you've  
ever used before!

### PERFORMANCE TEST

#### LOAD LIFE @ 25°C, 1000 hours

500 volts, dc. .... ¾ to 1 watt } depending  
750 volts, dc. .... ½ watt, Min. } on value.

#### LOAD LIFE @ 70°C, 1000 hours

500 volts, dc. .... ½ to ¾ watt } depending  
750 volts, dc. .... ½ watt, Min. } on value.

SHELF LIFE ..... Unlimited

NOISE ..... 3 to 8 millivolts, values  
below 500,000 ohms.  
8 to 12 millivolts, values  
above 500,000 ohms.

#### Average Percent Resistance Change

ZERO LOAD @ 100°C for 1000 hours  
±4%, values to 100k; ±2%, values above 100k.

VOLTAGE COEFFICIENT  
Less than ±0.01% per volt. (±0.005% per volt, avg.)

TEMPERATURE CHARACTERISTIC  
±3% from 20°C to 105°C

HUMIDITY: 95% RH @ 40°C for 240 hours  
±4% to ±5%, values to 250k; ±6% to ±9%, values  
above 250k.

MECHANICAL LIFE: 25,000 cycles... Less than ±4%

### Control "Mechanics" Have Been Improved Too!

- New rear bearings assure wobble-free shaft operation.
- 70% less backlash on "ordinary" tandem controls. Zero backlash on tandems for stereo.
- Close-tracking or matched element controls available for stereo.
- Full line of switches for most types—rotary, push-push, pull-push.
- Built-in solder flux guards on switches of miniature, ¼" diameter types.

## Silicon-Controlled Rectifiers

497



Types 3RC5A—3RC40A, the 3-amp rated series, and types 5RC2A—5RC40A, the 5-amp rated series, have a prv range from 25 to 400 v. All types enable rapid firing with 2.5 ma at 125 C. Units measure approximately 1.18 in. over-all length.

International Rectifier Corp., Dept. ED, 233 Kansas St., El Segundo, Calif.

P&A: \$7.46 to \$53.25 each, (1-99); stock.

## Paper Phenolic Laminate

504

Dilecto 160 is a warm punch laminate meeting NEMA X and XP requirements. Perpendicular short time dielectric strength is 500 v per mil. At 1 mc, dissipation factor is 0.666 and dielectric constant is 5.7. In 1/32-in. thickness, it is punched at 170 F.

Continental-Diamond Fibre Corp., Dept. ED, Newark, Del.

## Ionic Crystals

498

Twenty-two crystal types, including masers and lasers, are available in disk, plate and boule shapes. These crystals span a wide range of metallic halogens, including sodium, calcium, lithium, cadmium, lead, potassium and magnesium.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N. J.

## Resistor Kit

484



Experimental kit contains seven micro-miniature solid cermet fixed resistors, each with a different resistance value within the range of 250 ohms to 12-K. CERADOTS are designed for insertion into printed circuit boards. Each is 0.050 in. diam x 0.030 in. thick and is without leads.

CTS Corp., Dept. ED, Elkhart, Ind.  
P&A: \$7.00; stock.

93





Laboratory demonstration shows Du Pont Resistor Composition being applied to a ceramic base by stencil screen and squeegee (left). When stencil is removed from ceramic base, resistor is ready for firing (right).

## New Du Pont Resistor Compositions are easy to apply... permit you to vary resistance values by blending the compositions

One major advantage of Du Pont Resistor Composition is its ease of application on ceramic or glass substrates. Just a simple screen-print, dip, brush or spray application, and the resistor is ready for firing under normal atmospheric conditions in the range of 1100-1400°F.

Du Pont resistor compositions allow you to vary resistance values by changing the composition of the resistor without altering its geometric form. You are no longer limited by the physical shape of conventional resistor materials. These compositions give you greater design flexibility, essential for miniaturized circuits. They are available at three approximate resistance values: 500, 3,500 and 10,000 ohms/sq. per mil thickness, and they can be blended to give a range of intermediate values.

Electrical properties are reproducible. Laboratory tests show that fired printed patterns and coated rods have abrasion and impact resistance similar to fired silver coatings.

Fired samples are available for your own evaluation. Request them on your letterhead. For more technical information, write: Du Pont, Electrochemicals Department, Ceramic Products Div., Wilmington 98, Del. Please indicate the application you are considering. Du Pont does not manufacture resistors... only resistor compositions.

BETTER THINGS FOR BETTER LIVING  
... THROUGH CHEMISTRY



### Perhaps you can also profit from these Du Pont Products for the Electronics Industry

**Conductive Coatings**—Specially compounded silver, gold, palladium and platinum compositions that are used to produce capacitor electrodes, ceramic-to-metal hermetic seals, electrical shields and surfaces of high conductivity on non-conductive materials.

**Conductive Cements**—Silver and gold compositions consisting of finely divided metallic particles dispersed in a resin system; Du Pont conductive cements may be used to replace solder as lead attachments for transistors, diodes, resistors and as a base for electroplating.

CIRCLE 88 ON READER-SERVICE CARD

## NEW PRODUCTS

### Digital Multimeter

487

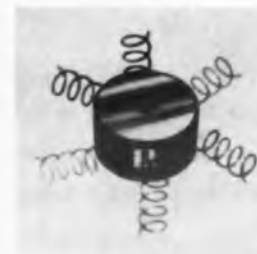


Measures dc volts, dc ratios, ac volts and resistance. Dc voltage and ratio range and ac voltage range are 0.0001 to 999.9; resistance range is 0.0001 K to 999.9 K. Input impedance (dc) is 1,000 to 10 megohms. Model 851 has provision for directly driving a digital printer.

Electro Instruments, Inc., Dept. ED, 8611 Balboa Ave., San Diego 11, Calif.

### Power Transformer

461



Triaxial 30 kc output power transformer has a 2,000 v dielectric breakdown rating. Potted in flameproof epoxy resin, it meets all applicable military specifications for flammability and thermal shock.

PCA Electronics, Inc., Dept. ED, 16799 Schoenborn St., Sepulveda, Calif.

Price: \$25.00 to \$35.00.

### One-Station Indicator

470



Standard range is  $\pm 0.010$  in. with accuracy of 0.0002 in. for model IN-27 Electro-chek. Optional ranges are  $\pm 0.020$ ,  $\pm 0.005$ ,  $\pm 0.003$ ,  $\pm 0.001$  in. Scale length is 4 in. The unit requires 20 w of 115 v, 60 cps regulated power. A knife-edge pointer minimizes reading errors due to parallax.

Winslow Manufacturing Co., Dept. ED, 1751 E. 23 St., Cleveland 14, Ohio.

### Telemetry Receiver-Recorder 429

Signals from fluid-flow transmitters made by the firm are received, totalized, indicated, and recorded by this receiver. Unit includes a modular circuit pre-wired to handle 16 control switches. Three recording pens on a circular graph are provided.

B-I-F Industries, Dept. ED, Providence, R. I.

### Insulating Coating 436

Designed for high temperature applications, type 1C40 is recommended for continuous operation up to 300 C. The manufacturer claims that the single-component coating has good weathering resistance and excellent adhesion. The compound is made to meet MIL-E-005272B.

Columbia Technical Corp., Dept. ED, Woodside 77, N. Y.

### Relay Module 465



Uses dry-reed switch contactor. The unit consists of a spat normally open reed switch rated at 12 va up to 250 v ac resistive load. Up to 12 switches can be operated by the same coil. Operating time is from 1.5 to 3 msec at coil power of 0.1 to 0.4 w. Coils are available for operations at 6, 12, 24, 32, or 48 v dc.

D. Randall Co., Dept. ED, 6 Pawcatuck Ave., Westerly, R. I.

### Molding Compound 438

Designed for use in apparatus operating at 130 C continuous. Components produced with grade 1703-A have a dielectric strength of more than 400 v per mil, good thermal stability and high corona starting voltages, according to the manufacturer.

The Glastic Corp., Molding Materials Div., Dept. ED, 4321 Glenridge Road, Cleveland 21, Ohio.

### Accuracy Is Our Policy

Model 5000 analog to digital converter, manufactured by Non-Linear Systems, Inc., Del Mar, Calif., has an overall accuracy of  $\pm 0.01\%$  plus 1 digit. In the Sept. 27 issue on p 78, ELECTRONIC DESIGN incorrectly reported the accuracy as being  $\pm 1\%$  plus 1 digit.



You can  
**FEEL**  
the Difference  
in an Ohmite  
Rheostat

Sm-o-o-o-th Operation Prolongs Life...Aids in Close Control

**TRY IT YOURSELF!** Note the smooth, silent glide of the contact over the windings . . . and of the contact moving off and on the terminal bands. There's absolutely no raspy grinding to cause premature wear . . . no aggravating "jerk" points that make you hunt for a setting.

The smooth, close control of Ohmite rheostats doesn't just happen. It's the result of special production operations that eliminate roughness. All 11 sizes of Ohmite rheostats from 12½ to 1000 watts bring you this plus value . . . a refinement that pays dividends in your equipment, whether the rheostat is to be hand operated or motor driven.

Write on Company Letterhead for Catalog 58.

Terminal lug band is adjusted to wire diameter...no bump up or down for the contact.



Rounded pivot gives metal-graphite contact brush flush-floating contact with wire.

Smooth, welded transitions between the different wire sizes of tapered windings.

SMOOTHNESS FROM ATTENTION TO DETAIL



**OHMITE MANUFACTURING COMPANY**  
3643 Howard Street, Skokie, Illinois

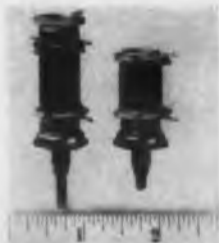
Rheostats Power Resistors Precision Resistors  
Variable Transformers Tantalum Capacitors  
Tap Switches Relays R.F. Chokes  
Germanium Diodes Micromodules

CIRCLE 89 ON READER-SERVICE CARD

## NEW PRODUCTS

### Amateur-Band Coils

482



Operating in the 3.5- to 28-mc bands, coil series 2419 consists of five coils used as a set. Coil no. 2546 enables obtaining a wide variety of inductances by shorting different sections of the coil. The amateur bands of 80 through 10 meters may be covered by presetting the entire coil to tune at 4 mc with 37 pf of shunt capacity.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

*P&A: \$1.50 to \$2.00; stock.*

### Regulated Power Supplies

432

Rated up to 3,500 v dc, continuously variable, this line of power supplies offers 0.4 amp at high voltage and up to 50 amp on low-voltage models. The line includes narrow-band models variable over  $\pm 10\%$  of nominal output, rated from 6 to 60 v dc. Line and load regulation is from 0.1% to 0.005%, with long-term chopper stability of 0.01%.

Davenport Manufacturing Div., Duncan Electric Co., Dept. ED, 2530 N. Elston Ave., Chicago 47, Ill.

### Heat-Sink Kits

596



For evaluation purposes, four heat-sink kits are available. Kit A contains three TO-3, two TO-5, one TO-8 and two TO-18 heat sinks; kit B contains one TO-3, two TO-5, four TO-8 and two TO-18 types; kit C contains one TO-3, six TO-5, one TO-8 and two TO-18; kit D contains one TO-3, two TO-5, one TO-8 and seven TO-18 types.

National Beryllia Corp., Dept. ED, First & Haskell Ave., Haskell, N. J.

*Price: \$18.*

## The Porter Alloyist delivers the right alloy IN THE SPOTS THAT COUNT





There can be no compromise for instant, reliable communication when disaster strikes. That's why the Porter Alloyist recommends phosphor bronze and other special alloys for telephone and switchboard components. Contact springs and other vital parts made from these alloys deliver high electrical conductivity and resist deformation after repeated use.

### THE PORTER ALLOYIST IS A SPECIALIST IN A WIDE RANGE OF SPECIAL METALS

Porter's Riverside-Alloy Metal Division is your single reliable source for specialty alloys in 8 basic groups of wire, rod and strip . . . phosphor bronze, nickel silver, cupro nickel, brass, stainless steel, nickel, Monel and Inconel.

Ask for a free copy of "Alloys for Industry" describing our wide range of specialty alloys. Write H. K. Porter Company, Inc., Riverside-Alloy Metal Division, Riverside, N. J. Or contact our sales offices in Hartford, Chicago, East Orange, Atlanta, Cleveland, Detroit, Cincinnati, Los Angeles, and Rochester.



PORTER supplies stainless steel, "K" Monel and Inconel "X" wire for many types of springs.

PORTER carbon steel wire reinforces and lengthens the life of a wide range of industrial hose.

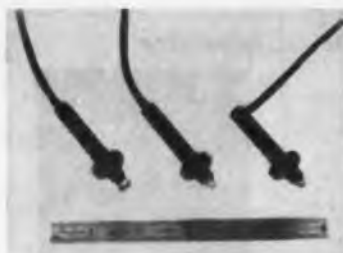
# PORTER

RIVERSIDE-ALLOY METAL DIVISION  
H. K. PORTER COMPANY, INC.  
CIRCLE 91 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

### Gaging Probe

468



A transducer of the inductive type. Gaging range is 0.040 in. and total plunger travel is 0.080 in. Linearity is 0.1% over 0.020 in.; 0.25% over the full 0.040-in. range. Output is 5 mv per 0.00 in. with 6 v excitation. Units are designed for 60 cps operation. Sensitivity of model S reaches 0.00001 in.

Winslow Manufacturing Co., Dept. ED, 1751 E. 23 St., Cleveland 14, Ohio.

### Simulators and Converters

474



Repeated serial data words up to 120 bits in length are provided by the 600-series digital data simulators. Bit rates from 1,000 to 500,000 per sec are available. Up to 8 parallel channels are provided. C-series binary to decimal converters accept 10-bit binary data, either serial or parallel, and convert data to 12-bit binary-coded decimal.

Howard Instrument Co., Dept. ED, Red Bank, N. J.

### Ceramic Capacitors

595



In values up to 0.2  $\mu$ f, miniature 20-v Ultra-Kap ceramic capacitors can be substituted for paper capacitors in semiconductor circuits. They are stable at temperatures from -55 to +85 C. The basic construction principles of previous lower voltage Ultra-Kaps is employed.

Globe-Union Inc., Centralab Div., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.  
P&A: \$50 to \$100; 3 to 4 weeks.



## COUCH RUGGED ROTARY RELAYS

### SPECIFICATIONS

CONTACTS — 4 PDT (4 form C) 5 A @ 30 VDC

SIZE — 1 $\frac{3}{32}$ " D. x 1 $\frac{1}{2}$ " H.

WEIGHT — 3.2 oz.

PULL-IN-POWER —  $\frac{1}{2}$  watt

VIBRATION — 50 G, 10 to 3,000 CPS

SHOCK, Electrical — 100 G minimum

TYPE — CVE with patented rotary armature

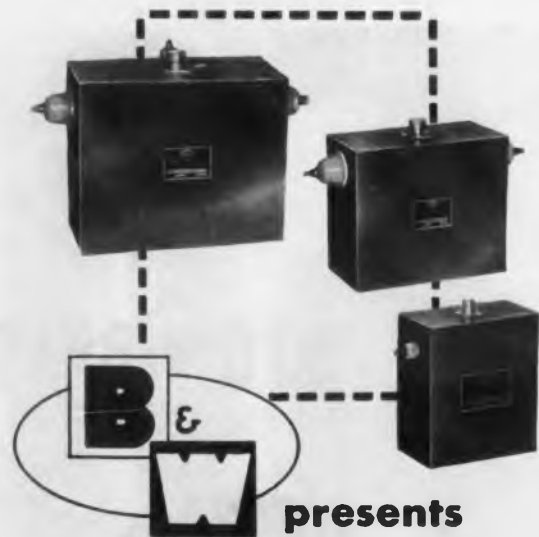
WRITE FOR DATA SHEET 7



**COUCH ORDNANCE, INC.**

A subsidiary of S. H. Couch Company, Inc.  
3 ARLINGTON STREET, NORTH QUINCY, MASS.  
CIRCLE 92 ON READER-SERVICE CARD





**presents**  
**a Series of Broadband**  
**High-Frequency Matching**  
**Transformers**

Frequency range 2 to 30 mc . . . low insertion loss . . . low SWR . . . good balance.

Power ratings: 1KW, 5KW and 20KW.

These high frequency transformers are ideal for matching unbalanced radio transmitter outputs to balanced amplifiers and balanced antennas. Standard impedance transformations: 50 to 70 ohms unbalanced to 150, 300 or 600 ohms balanced as required. Other impedance ratios available on special order.

Pioneers in the development of baluns and unique RF coupling devices B&W again sets a standard.

Drop us a card requesting Spec Sheet.



**Barker & Williamson, Inc.**

Canal St. and Beaver Dam Rd., Bristol, Pa.

Specialists in designing and building equipment to operating specifications

A few other B&W products: I. P. TRANSFORMERS • COMMUNICATIONS EQUIPMENT • AUDIO PHASE SHIFT NETWORKS • TEST EQUIPMENT • and many types of standard and special electronic components and equipment.

CIRCLE 93 ON READER-SERVICE CARD

## NEW PRODUCTS

### Harmonic Generator

599



Wide-range harmonic generator model CDH-0.1 uses three tubes and two crystal diodes. Accuracy of the crystal is  $\pm 0.005\%$ . Several of the units can be used at one time with a sweep generator. It can be furnished with crystals ranging from 0.1 to 100 mc.

Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.

Price: \$55 to \$75.

### Mobile Data Acquisition System 431

With 48 channels of instrumentation, this data acquisition system is designed as a mobile device. Called Mobidac, it measures 36 x 24 x 20 in. and weighs 175 lb. Magnetic tapes produced by the device are suitable for direct input into computers. Digital logic is contained on five different standard circuit cards. Nixie output is provided.

Systems Engineering Laboratories, Inc., Dept. ED, P. O. Box 9148, Fort Lauderdale, Fla.

### Secondary Frequency Standard 488



Checks and sets operating frequencies of mobile communications systems. ZEROBEAT will produce signals from 5 kc to 500 mc with an accuracy of  $\pm 0.0002\%$  as a primary standard in the field or  $\pm 0.00003\%$  as a secondary standard in the laboratory. The unit can also be operated in the field from a 6- or 12-v inverter, weighs 21 lb, and is 19-7/8 x 11-1/8 x 6-1/4 in.

Eltec Laboratories, Inc., Dept. ED, Middletown, Conn.

Price: \$550.00

WHEN QUALITY  
 IS A MUST  
**Stromberg-Carlson®**  
 TELEPHONE-TYPE  
 COMPONENTS



RELAYS: Wide range, for electro-mechanical switching. Send for Bulletin T-5800R2.



KEYS: Cam-type and push-button. Send for Bulletin T-5002R.



STEPPING SWITCHES. Fast and dependable. Bulletin T-5001R.



JACKS & PLUGS: For many electrical and electronic uses. Send for Bulletin T-5003.



TELEPHONE HANDSETS: Standard or with switch assemblies. Send for Bulletin T-5017-R.

For bulletins and more information contact the nearest Sales Branch office: Atlanta—750 Ponce de Leon Place N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Avenue; San Francisco—1805 Rollins Road.

GENERAL DYNAMICS  
 TELECOMMUNICATION

CIRCLE 94 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

## Light Source

366



Gives 50-ft scanning range with omni-directional mounting. Type LS-3 light source includes a low-voltage lamp and a step-down transformer for connection to any 115-v ac circuit. Housed in aluminum, it is sealed against moisture and dirt. Dimensions are 6-1/16 x 5-7/8 x 3-15/16 in.

Farmer Electric Products Co., Inc., Dept. ED, 2300 Washington St., Newton Lower Falls, Mass.

## Pulse Switch

464

One-shot pushbutton switches, series 1PB3000, produce one square-wave, msec-length pulse with each operation. Eight circuits are available to produce lengths from 0.030 to 0.5 sec at amplitudes of 6 to 20 v and 20 to 55 v. Characteristics are: operating force, 30 oz; total travel, 0.105 in.; pretravel, 0.040 in. min; differential travel, 0.050 in. max.

Minneapolis-Honeywell Regulator Co., Micro-Switch Div., Dept. ED, Freeport, Ill.

P&A: from \$26.40 to \$28; immediate.

## Servo Assembly

645



Integrated servo assembly is designed to provide remote transmission of angular positions. It contains a size 5 motor, a size 5 synchro and precision gearing with gear ratios of up to 875 to 1. The output shaft is geared 1 to 1 with a size 5 control transformer. The complete assembly is integrally housed in a size 11 configuration.

Daystrom, Inc., Transicoil Div., Dept. ED, Worcester, Pa.

CIRCLE 95 ON READER-SERVICE CARD



## STILL OPERATIVE!

TI GROWN-JUNCTION TRANSISTORS in satellite survive torture treatment: The satellite fell from atop a missile carrier and bounced across a launching pad into a LOX- and kerosene-filled ditch. The fuel in the ditch ignited and the satellite burned for several hours. Result — TI transistors are still operative... dramatic proof of the high reliability of TI units under extreme conditions.

# Here's Long-term Proof of TI Grown-Junction Transistor Reliability

● Only Texas Instruments offers life-test data from lots that have been continuously on operating life test for over five years — showing an extremely low average failure rate of less than  $5 \times 10^{-6}$ . More than six-million life-test hours give you the industry's greatest source of reliability data for predicting TI transistor performance.

● Successful applications in thousands of circuits over the years testify to the consistent reliability of these TI units.

● Independent Quality and Reliability Assurance department augments TI's own production and testing know-how... independently measuring device reliability at every manufacturing stage. Approximately one-million life-test hours monthly offer continuous verification of TI grown-junction reliability.

● Low cost of TI grown-junction transistors is made possible through industry's wide acceptance and usage of these units in many applications, enabling TI to provide fast, cost-saving production in large quantities. Added savings in time and money too, through one-source purchasing from TI's complete line of military and industrial grown-junction types.

Take advantage of the predictable reliability of these devices in your low frequency and switching designs. Call your local TI sales office or TI distributor now for immediate delivery in sample or production quantities.

Write on your company letterhead for TI grown-junction reliability data, application notes, data sheets or engineering assistance.



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PRODUCTS  
DIVISION



TEXAS INSTRUMENTS  
INCORPORATED  
13500 N. CENTRAL EXPRESSWAY  
P. O. BOX 5012 • DALLAS 22, TEXAS

## NEW PRODUCTS

### Signal Integrator

362



Integrates amplified signals from various transducing elements. Model J101B can be used with current and voltage indicators, recorders or any instrument that supplies a full-scale output of 1 ma from 10 to 100 v. Accuracy is 1%. Drift is less than 0.01% per hr. Information is indicated by a 6 decimal digit counter and a 2-1/2 in. meter.

Elcor, Inc., Dept. ED, 1225 W. Broad St., Falls Church, Va.

P&A: \$795.00; 4 weeks.

### Stack Switch

377



Telephone relay type. Switch features tempered nickel-silver springs, ranging in thickness from 0.0063 to 0.016 in.; type XXXP paper-base phenolic spacers in thicknesses of 1/32, 3/64, and 1/16 in. Silver or welded cross-bar palladium contacts are used and tubing is polystyrene or bakelite.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

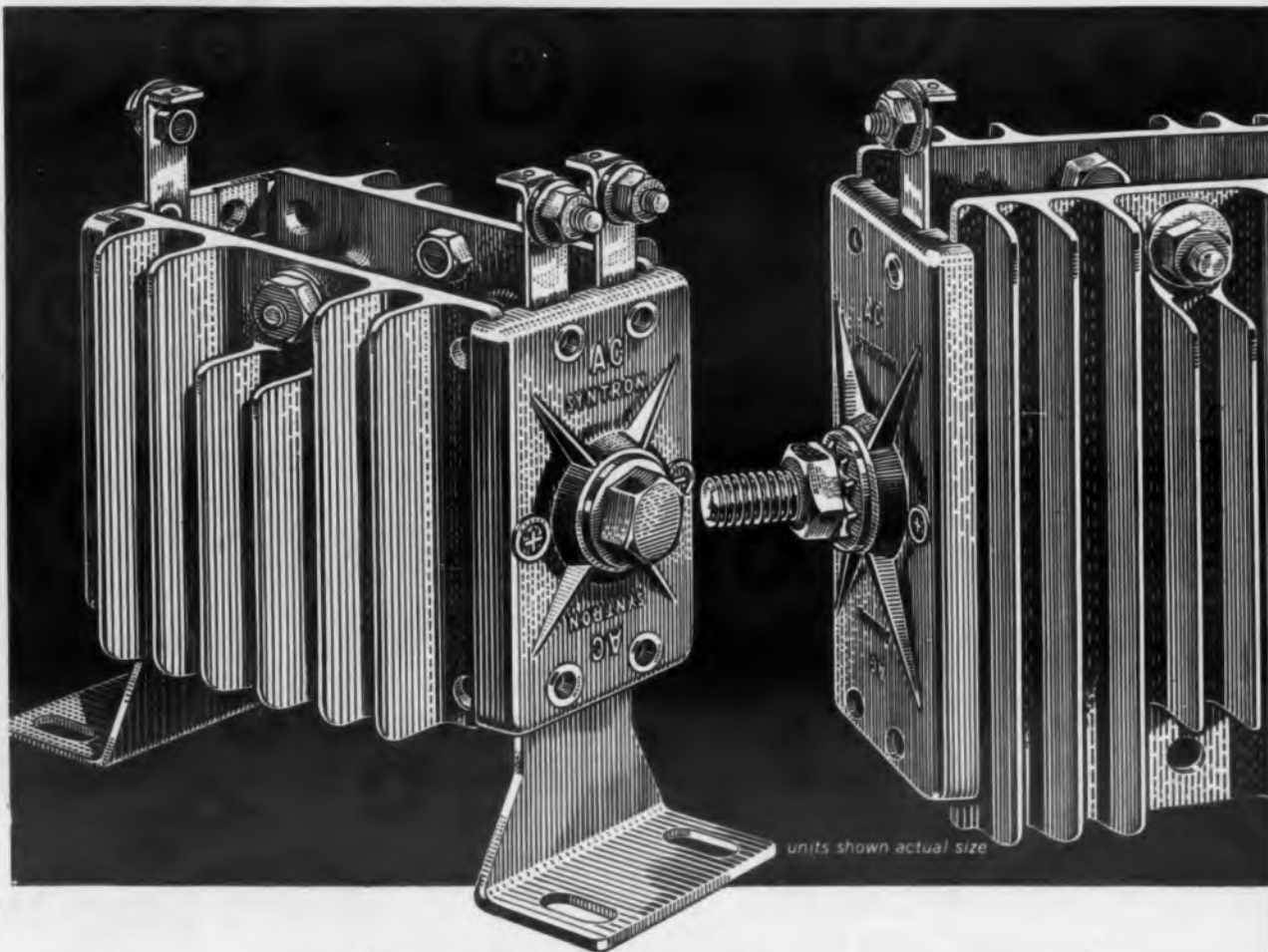
### Pulse Transformer

356



The PIP series of nine pulse transformers are completely metal cased. Measurements are 5/16 in. diam x 3/16 in. high, weight is 1/20 oz. Units meet MIL-T-21038 and MIL-TP6RX-4410CZ. Parameter ranges are: 0.05 to 10.0  $\mu$ sec pulse width; 0.018 to 0.4  $\mu$ sec rise time; 50 to 200 ohms impedance (in, out).

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N. Y.



# New SYNTRON Power Point Delivers up to 22 KW

Plagued by the lack of space for your power rectifier circuits?

Looking for more delivered d-c power?

Like to reduce the costs of the rectifier assemblies you're using by 30% or more? Want certified and guaranteed\* performance? You'll want the new Syntron Power Point\*\*, the new component you mount right at the point of use, right where you need the d-c. It's a single unit replacing the usual complicated assembly of silicon rectifiers, heat sinks, cooling fins, terminal posts and mounting lugs, spacers, etc.

It's a compact unit that supplies a lot of power. Example: a force cooled heavy duty model, measuring only 4 $\frac{5}{16}$  by 3 $\frac{1}{8}$  by 4 inches, can deliver 22 kw at the d-c terminals. If you prefer to use the smaller of the two available models, you can get as much as 17 kw d-c. This little fellow is only 4 by 2 $\frac{9}{16}$  by 2 $\frac{1}{2}$  inches.

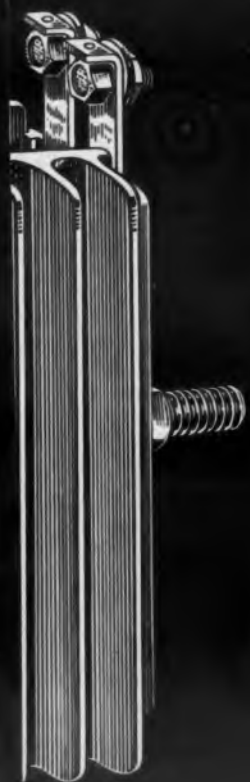
You can get either of these two sizes for single phase or

three phase operation . . . current range from 3-25 amps (75 amps on force cooled units).

What about cost? . . . Depending on the number you need, you'll find that the Power Point costs from 30% to 50% less than any comparable silicon rectifier assembly. If you want a firm dollar quote, let us know your requirements and the quantity desired. We'll tell you exact prices along with delivery dates. Usually, delivery is 15 days or less after you order. (We can make it fast because the Power Point is in stock NOW and it's available direct from Syntron or from selected distributors throughout the country.)

Want a quote or more information? A complete data sheet showing performance curves, dimensions, operational characteristics is yours by completing the coupon or by writing Syntron Company, Semiconductor Division, Homer City, Pa. In Canada: Syntron Company Ltd., Stony Creek, Ontario.

\*\*Syntron Trade Mark



# Replaces Bridge Assemblies in 50% less space, 30% less cost

## WHERE TO USE THE POWER POINT

- on clutches, computers, for cathodic protection
- business machines, and burglar alarms, and battery chargers
- on magnetic chucks and amplifiers and magnetic reactors
- on motors and brakes and to close circuit breakers
- in circuits with telephones, telegraph and other equipment, such as vibrators and relays and traffic control
- power supplies for autos and airplanes and electro-plating
- in short: almost anywhere you need d-c power close to the Point of use

# SYNTRON

certified SEMICONDUCTORS

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**\* SYNTRON CERTIFIED SEMICONDUCTORS**

All Syntron semiconductors have been tested and inspected to AQL level of 1.0, Inspection Level II, and are so certified. Electrical and mechanical tests include:

- Inspection to the appropriate JEDEC outline drawing.
- Stated PRV for specific current ratings over a range of diode or cell temperatures.
- Forward drop at rated current and a diode or cell temperature of 25°C.
- Testing of all rectifier assemblies at rated load conditions.

We guarantee that our semiconductors will meet their certified AQL performance levels for up to 18 months after manufacture provided they are not misused or misapplied. All Syntron semiconductors found to be defective in materials or workmanship will be replaced at no charge upon return to our plant.

SYNTRON CO., Semiconductor Div., Homer City, Pa. ED-11

Please send me more information on Syntron Power Point.

Please have a Syntron representative call.

name	title
company	
address	
city	state

## Thermoelectric Coolers

376



Using 3.0 amp max, these 2 and 3 stage cascade coolers will reach -95 C from a sink temperature of +20 C. The 2 stage model 615-5 has a maximum delta T in open air of 65 C; in vacuum, 86 C. The 3 stage model 615-5-1 specifications are 75 and 115 C, respectively. Both units have a maximum active heat pumping capacity of 20 mw.

Jepson Thermoelectrics, Inc., Dept. ED, 139 Nevada St., El Segundo, Calif.

P&A: model 615-5, \$309, model 615-5-1, \$349; 30 days.

## Digital Control Equipment

373



Digital transducers and a sampling multiplexer are available to operate over range -40 to +158 F ambient. Higher ranges are available. Components are capable of operating individually or collectively with any digital controller or data recorder.

Diginamics Corp., Dept. ED, 2525 E. Franklin Ave., Minneapolis 6, Minn.

## Vibration Isolator

358



Based on the principle of seismic motion, this shock and vibration isolation system is designed to protect supported mass in all altitudes, even in combination with high steady-state G-loads. Featuring all-metal construction, the isolator is unaffected by temperatures from -100 to +500 F; meets MIL-E-5272C and exceeds performance requirements of MIL-C-172.

Aeroflex Laboratories, Inc., Dept. ED, 48-25 36th St., Long Island City 1, N. Y.

P&A: \$4 to \$50; stock to 60 days.





## ... sign here!

If you want top-quality pots when you need them, you could make your own! Of course, you'll need Swiss screw machinery to produce the cases necessary to complete the job. So plunge right in — sign up for those highly precision screw machines . . . and hang the cost!

But before you deplete the family exchequer with a grand flourish of the pen, come to Ace! We've already taken the plunge, and it's paid off. These machines automatically deliver, at high speed, cases with mechanical tolerances closer than .0002. This also means the most flexible production operation in the industry. No sub-contracted parts to wait for — we design our own cams to any special size and shape, and we run the cases ourselves, on a 24-hour day basis! So for dependable delivery, see your ACErep!

Here's one of our automatic-production cases, on a servo mount A.I.A. size 1-1/16" ACEPOT®. In-plant production on cases up to 6".



**ACE** ELECTRONICS ASSOCIATES, INC.  
99 Dover Street, Somerville 44, Mass.  
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Accept® Acotrim® Acecot® Aceohm® \*Reg. Appl. for  
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## NEW PRODUCTS

### Silicon Transistors

370



Power dissipation is 85 w. Types 2N1212 and 2N1208 are diffused junction npn high power transistors designed to operate from -65 to +200 C.  $V_{ce}$  is 60 v,  $V_{cb}$  is 60 v,  $V_{eb}$  is 10 v, and  $I_c$  is 5 amp. These transistors meet the environmental requirements of MIL-S-19500B.

Silicon Transistor Corp., Dept. ED, 150 Glen Cove Road, Carle Place, L. I., N. Y.

### Ultrasonic Cleaner

378



Features 5 gal capacity. The system 320 has a generator rated at 320 w average power, 1,280 w at peak power output. Fused for 7 amp, the generator operates from 117 v, 50 to 60 cycle line current. A 220 v, 50 to 60 cycle export model is also available. Broad-band frequency modulation is used to prevent overloading of transducers.

Ultrasonic Industries, Inc., Dept. ED, Engineers Hill, Plainview, L.I., N. Y.

P&A: \$499.95; immediate.

### Pressure Switch

360



Trips at 50 psi; resets at 30 psi. Model 65M291 is designed for a wide range of environmental conditions and operates from -65 to +300 F at altitudes from sea level to 800,000 ft. Featuring explosion proof construction, the unit measures 1-in. sq by 1-1/2 in. overall length. Captive Seal Corp., Dept. ED, Caldwell, N. J.

## DESIGNED TO MEET THE CHALLENGE OF ENVIRONMENT



### Connectors

Strength . . . Endurance . . . Survivability . . . The Albatross is well equipped to live at sea and in the air almost continually. Airborne missiles, too, are designed for capable operation under rigorous environmental conditions. That is why Anton Series S-20 Miniature Connectors by Lionel are specified whenever utmost reliability is essential for plug-in type sub-assemblies.

- Positive alignment & polarization
- Minimum mated depth
- Extended insertion/withdrawal life
- 4 sizes: 13 to 41 high voltage contacts, 2 & 4 coaxial contacts & combinations
- Meet applicable MIL Specs

(Special materials and modifications to meet specific requirements)



Delivery time slashed for Anton "special" connectors! New Lionel tooling practices provide rapid delivery of "specials" for unusual applications... within 6-8 weeks\* of order date!

\*"Standard" catalog units are in-stock items.

Write Dept. 111-W for Series S-20 Technical Literature.



**LIONEL**  
Electronic Laboratories

FORMERLY ANTON ELECTRONIC LABORATORIES  
1226 Flushing Ave., Brooklyn 37, N. Y.

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ELECTRONIC DESIGN • November 8, 1961

## UHF Filters

372



Three-terminal, high-frequency, low-pass filters are designed to eliminate parallel resonance peaks in the uhf range of 100 to 2,000 mc. At 500 mc the transfer impedance of the filter is below 0.01 ohms; effective filtering continues to above 1 Gc. Temperature ranges are up to 125 C.

Erie Resistor Corp., Dept. ED, 644 W. 12th St., Erie, Pa.

P&A: from \$0.60 to \$12.50 each in lots of 1M to 10M; immediate.

## Contact Blocks

657

For push button and selector switches. Type H and HO melamine contact blocks can be supplied for panel mounting with 1 NO or 1 NC contact and 2 NO or 2 NC contacts for base or panel mounting. They are rated at 6 amp, 110 to 125 v; 3 amp, 220 to 250 v; 1.5 amp at 440 to 480 v; 1.2 amp at 550 to 600 v.

Clark Controller Co., Dept. ED, 1146 E. 152nd St., Cleveland 10, Ohio.

## Welding Tool

630



A pressure sensing, pencil-probe type welding handpiece, the VTA-43, has been designed to facilitate small, pin-point welds entirely from one side of a work surface. The probe is adjustable to fire and weld energy at preset pressures ranging from 1/2 to 5 lb. The unit weighs 6 oz with cables.

Hughes Aircraft Co., Dept. ED, 2020 Short St., Oceanside, Calif.

P&A: \$75 each; from stock.

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**DAVEN/GENERAL MILLS**  
Blazing new trails in component reliability!

5

*extra features*

*at no extra cost!*

### Daven metal film resistors

- True glass-to-metal seal plus epoxy encapsulation
- 25 PPM/°C. temperature coefficient over normal operating temperatures at no surcharge
- Weldable leads, which are readily solderable, are standard on all units at no surcharge
- Exceeds MIL-R-10509D, Characteristic C specs
- Off-the-shelf delivery from your Daven distributor

Write for full details on Types DA 2 and DA 4



**THE DAVEN COMPANY, Livingston, New Jersey**

General  
Mills

RESISTORS

TODAY, MORE THAN EVER, THE DAVEN © STANDS FOR DEPENDABILITY

# SAMS

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YOU'LL ALWAYS WANT AT HAND



## Industrial Electronics Measurement & Control

Ed Bukstein's up-to-date volume describes the electronic devices most commonly used for industrial measurement and control. Nine chapters cover techniques and devices for measuring: pressure; illumination and color; temperature; humidity; liquid level; time and speed; frequency; dimensions; rate of flow, etc. Seven additional chapters describe methods for electronically controlling: time delay; temperature; motor speed; weld current; positioning; illumination; tension, etc. Covers devices such as Bourdon tubes, servomanometers, radiation pyrometers, binary counters, ratemeters, radioactivity gauges, anemometers, etc. Components, circuits, and applications are adequately described to provide a ready reference source for engineers, technicians, and maintenance personnel. 192 pages, 5 1/2 x 8 1/2". No. IND-1. Only . . . . . \$3.95

## Electronics Math Simplified

A solid background in basic electronics requires at least a working knowledge of advanced arithmetic, algebra, and trigonometry. Here is a simplified approach to the understanding of these subjects, specifically tied into and based on electronics theory. Includes dozens of step-by-step examples relating to problems concerned with resistance, capacitance, inductance, wire measurements, frequency, vacuum tube characteristics, transformers, modulation, meters, antennas, etc. Practical exercises are included, with answers in a special Appendix. Especially helpful for use with texts or courses leading to second and first class FCC phone licenses. Ideal for home study or classroom use. 224 pages, 5 x 8". No. MAT-1. Only . . . . . \$4.95



## ABC's of Ultrasonics

Alan Andrews provides a basic overview of ultrasonics. Covers the nature and behavior of sound waves, the maintenance and testing of ultrasonics equipment, transducers, typical circuitry, cavitation. Describes commercial ultrasonics equipment used for various applications. Brings you right up to date on this fascinating subject. 96 pages; 5 1/2 x 8 1/2". No. ULT-1. Only . . . . . \$1.95

## Transistor Substitution Handbook, 2nd Edition

Latest volume; contains only DIRECT substitutions. Now includes 7500 substitutions (1000 more than in prior volume). Includes biasing diagrams, polarity identifications and manufacturers for over 3100 transistor types. Special section covers over 700 American replacements for Japanese transistors, plus a semiconductor diode and rectifier cross-reference directory (over 600 substitutions shown). Text explains when substitution is appropriate and when not; what precautions to take when substituting. Covers all transistor types, U.S. and foreign, for home entertainment, industrial and military use. 96 pages. 5 1/2 x 8 1/2". No. SSM-2. Only . . . . . \$1.50

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## NEW PRODUCTS

### Data System

371



Density and pressure can be digitized and recorded on Mobidac for later computer analysis of standard deviation, variance, quantities, mean values, etc. This unit accepts 48 input data channels directly from transducers at full scale levels at low mv. Inputs are multiplexed and digitized into binary or binary-coded decimal codes and recorded on magnetic tape.

Systems Engineering Laboratories, Inc., Dept. ED, 4066 N. E. Fifth Ave., Fort Lauderdale, Fla.

P&A: \$50,000 to \$60,000; 90 days.

### Power Transistor

357

Silicon power transistor has a current gain of 1,000 at 2 amp and a 0.35 ohm saturation resistance. This 10 amp device, designated WX-118, has voltage ratings up to 150 v and a power rating of 150 w. The low saturation resistance of this device improves efficiency and reduces cooling problems in power switching circuits.

Westinghouse Electric Corp., Dept. ED, 2519 Wilkins Ave., Baltimore 3, Md.

### Optical Oscillograph

368



Featuring direct readout, the 8-channel unit has 0 to 500 cps response with standard galvanometers. The model 658 T system uses an 8-in. wide chart, has 9 chart speeds from 1,000 to 2.5 mm per sec, timing lines at 0.1 and 1.0 sec intervals, and a beam interrupter for trace identification. Amplitude lines are "written," and may be eliminated from 1/4, 1/2, 3/4 or the entire width of the band.

Sanborn Co., Medical Div., Dept. ED, 175 Wyman St., Waltham 54, Mass.

# HOW TO SAVE TIME WHEN YOU NEED CORNING COMPONENTS IN A HURRY

Check this list for the Corning Electronic Components distributor located nearest to you . . . Clip and save.

You can get *immediate delivery* from him at factory prices on virtually the full line of top-reliability Corning components . . . tin oxide resistors, from the 6¢ C line through the environment-proof NF type; capacitors, axial lead and wafer types; shock- and vibration-resistant precision trimmers; rugged, high stability inductors and inductor kits, and printed circuit grid boards and grid board kits.

All you need: your distributor's name, a telephone and a purchase order. Your distributor will do the rest . . . quickly.

## CORNING ELECTRONIC COMPONENTS DISTRIBUTORS

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**CORNING ELECTRONIC COMPONENTS**

CORNING GLASS WORKS, BRADFORD, PA.

CIRCLE 101 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • November 8, 1961



# New

## CORNING CYFM CAPACITOR has reliability you can see

You get total protection against environment for less money than ever before

The new Corning CYFM capacitor gives you reliability at a markedly lower cost than that of any like capacitor.

The CYFM goes far beyond MIL-C-11272B specs. It has proved its performance through more than 3,000,000 hours of testing. It took a 50-day MIL moisture test and a 96-hour salt spray test with no measurable effects. We stopped testing only when it became evident that no more significant data could be developed. The CYFM went through other tests, with solvents, fluxes, boiling salt, and steam, to make sure it is the most completely sealed capacitor you can buy.

You'll see why the CYFM can take such torture when you check its design. We stack alternate layers of stable ribbon glass and aluminum foil. Then we weld the foils to the bead-terminal assembly, which has a glass bead sealed to the Dumet wire lead. With heat and pressure, the entire capacitive element is frozen in glass for complete protection against environment and for struc-

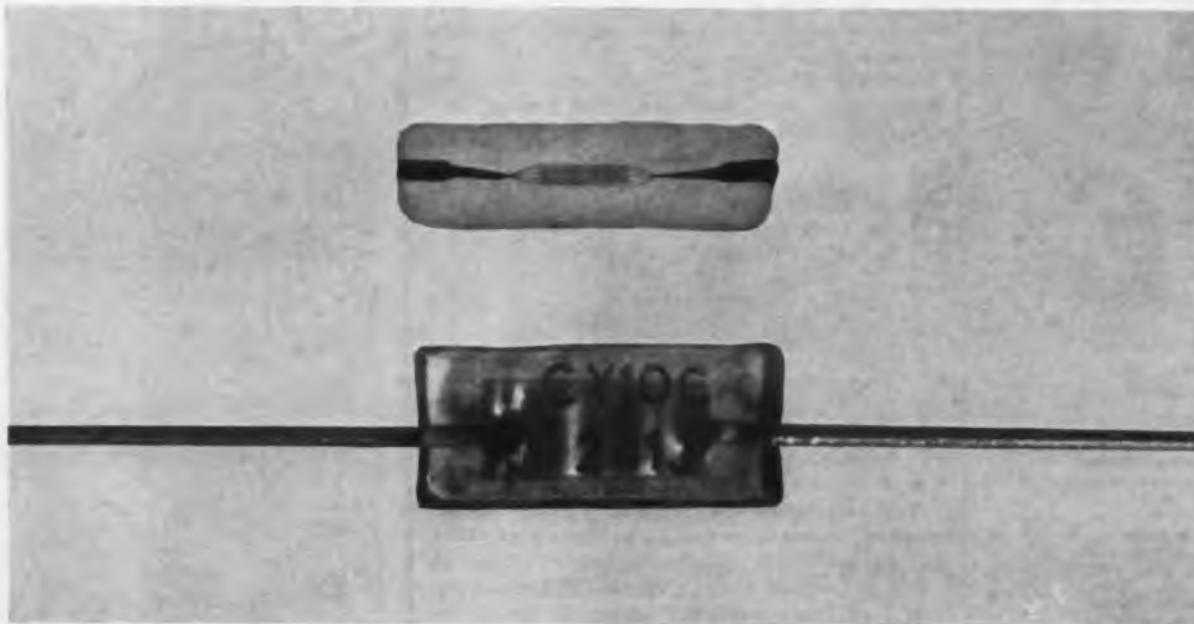
tured protection against physical shock.

True glass-to-metal seals at the weld area and along the leads bar moisture. The seal of the leads to the glass shifts stresses from the leads to the entire monolithic unit, guarding the capacitance area. Of course, you get electrical performance to match this environmental stability, since the CYFM has our glass-foil capacitor construction.

The CYFM is machine made . . . each capacitor is the same as every other, to give you uniformity which hand production cannot match.

You can get immediate delivery on the CYFM in four types. The CYFM-10 gives capacitance values from 0.5 to 300 pf; the CYFM-15, from 220 to 1200 pf; the CYFM-20, from 560 to 5100 pf, and the CYFM-30, from 3600 to 10000 pf.

For the rest of the story on this capacitor, send for our data sheet. Write to Corning Glass Works, 540 High St., Bradford, Pa.



This is the CYFM capacitor. 6 times actual size. The dark areas between the ends of the glass and the capacitance element are your visual proof of the complete glass-to-metal seal.



### CORNING ELECTRONIC COMPONENTS

CORNING GLASS WORKS, BRADFORD, PA.

CIRCLE 102 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

### Fixed Span Recorder

353



With 24 plug-in modules, this unit operates as a strain gage or a potentiometer-following recorder. No rewiring is needed to change from one module to another. Tape sizes are either 5 or 11 in., with single or dual pen and multipoint models.

Westronics, Inc., Dept. ED, 3605 McCary, Fort Worth 10, Tex.

### Frequency Changer

364



Maintains  $\pm 0.25\%$  frequency stability. This 400 cycle sine wave frequency changer has input of 105 to 130 v, 47 to 1,000 cps, 2.5 amp max. Regulation of the adjustable 105 to 130 v single phase output is said to be  $\pm 1\%$  from full load or over 105 to 130 v line change. The solid-state 100 va converter is packaged for bench or rack-mounted applications.

Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

### Logic Module

363



Available in two package styles, this module contains three gate circuits and a flip-flop which is capable of being set, cleared and complemented at a 10 mc. Model 1012 is designed for basic test equipment and prototype system design applications. Model 2012 is intended for use in final systems.

Harvey-Wells Electronics, Inc., Dept. ED, 14 Huron Drive, Natick, Mass.

P&A: \$140; from stock.

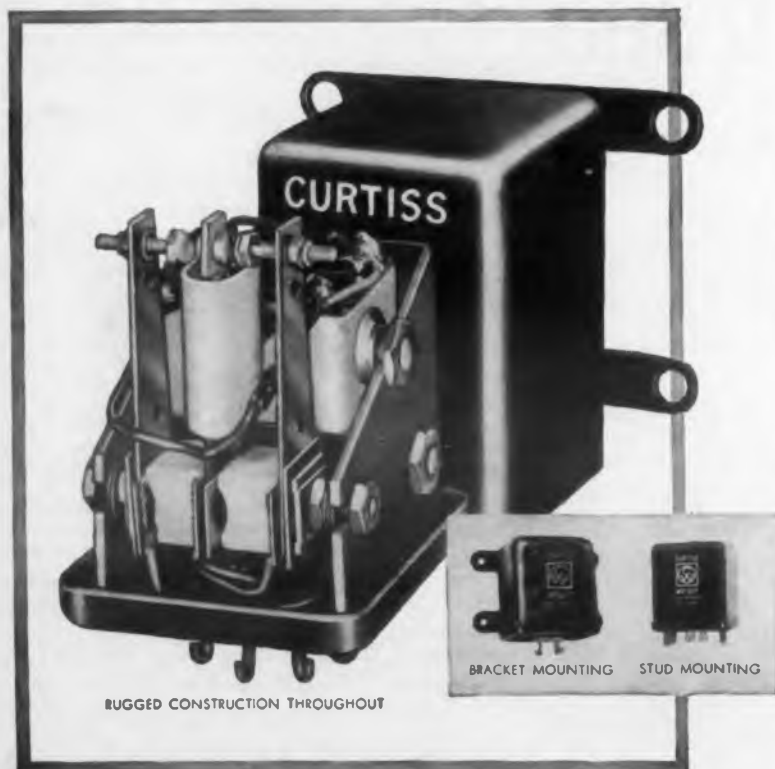
105





## NEW Time Delay Relays

### INSTANTANEOUS RESET... VOLTAGE-TEMPERATURE COMPENSATED



Designed with an instantaneous reset feature, these relays provide the same time delay for a series of cycles when temperature and voltage vary.

They are pre-set from 3 to 180 seconds, are chatter-free and will withstand severe shock and vibration. Because of this unique combination of features, these relays are now being used in such new circuit applications as:

Sequential timing for missiles • Automatic reset on digital readout equipment • Oscillator stabilization • Overload protection  
Computer sequencing



#### "DM" SERIES STEPPING MOTORS

Curtiss-Wright Stepping Motors convert digital pulses into mechanical work or motion. Units are bi-directional with high starting torque.

Write for complete Components Catalog 260 to help you select Curtiss-Wright electronic components for use where dependability is of prime importance.

COMPONENTS DEPARTMENT • ELECTRONICS DIVISION

**CURTISS**  **WRIGHT**

CORPORATION • EAST PATERSON, N. J.  
CIRCLE 103 ON READER-SERVICE CARD

## NEW PRODUCTS

### Radiation Meter

375



Little larger than a pack of cigarettes, this device weighs less than 8-1/2 oz and operates on power from ordinary penlight batteries or mercury cells. In normal use, the mercury cells are said to power the unit for more than a year. The meter is accurate at any temperature from -20 to +140 F, according to the manufacturer.

Gelman Instrument Co., Dept. ED, Chelsea, Mich.

### Production Machine Programmer 421

Card programmer, model 1600, allows machine tool systems, automatic check-out equipment, and circuit testers to be programmed from standard computer cards. Unit includes a series of memory bands, each containing 960 normally open latching relays. Relays remain closed according to instructions until program is erased.

Embree Electronics Corp., Dept. ED, 993 Farmington Ave., West Hartford, Conn.  
Price: less than \$6 per connection.

### Power Source

417



For emergency operation of critical equipment. The unit supplies up to 750 va at 115 v ac, 60 cps from reserve battery sources of 120, 130 or 140 v dc. Capable of picking up full load from standstill within 50 msec, the equipment maintains an output power frequency of 60 ± 1/2 cycle regardless of battery condition or load.

Cornell-Dubilier Electronics Div., Dept. ED, 118 E. Jones St., Fuquay Springs, N. C.



# yes

**Gamewell made  
a sector pot  
with .0006"  
wire**

This subminiature sector pot is wound with .0006" wire at over 1000 turns per inch. Required winding length tolerance is only .005".

Here's one example of the hundreds of "special" pot design requests that Gamewell is answering with an unqualified YES.

Find out what Gamewell YES service — Your Engineered Specials service — can do for you. Write for the facts.

\*  
**your  
Engineered  
Specials service**



THE GAMEWELL COMPANY, POTENTIOMETER DIVISION,  
1427 CHESTNUT STREET, NEWTON UPPER FALLS 64,  
MASS. A SUBSIDIARY OF E. W. BLISS COMPANY.

CIRCLE 104 ON READER-SERVICE CARD

## Environmental Tester 638



Combination vibration and shock-testing instrument ST300 has a 250-force-pound air-bearing exciter. The instrument allows shock testing to over 5,000 g and vibration testing over a useful frequency range from 5 to 30,000 cps. The first major resonance is above 6,000 cps.

International Telephone and Telegraph Corp., Industrial Products Div., Dept. ED, 320 Park Ave., New York 22, N. Y.

## Electron Gun 608

Produces 10,000-deg Kelvin at the smallest spot size. The electron gun and transport mechanism is designed for mass production of thin-film microcircuit elements. A pulsed triode, it operates at 55 kv peak with a beam current of 1 to 10 ma. Spot size is 0.010 to 0.125 in. Hole-punching rate is 60 or 120 per sec.

Rescon Electronics Corp., Dept. ED, 151 Bear Hill Road, Waltham, Mass.

## Magnetic Core Memories 647



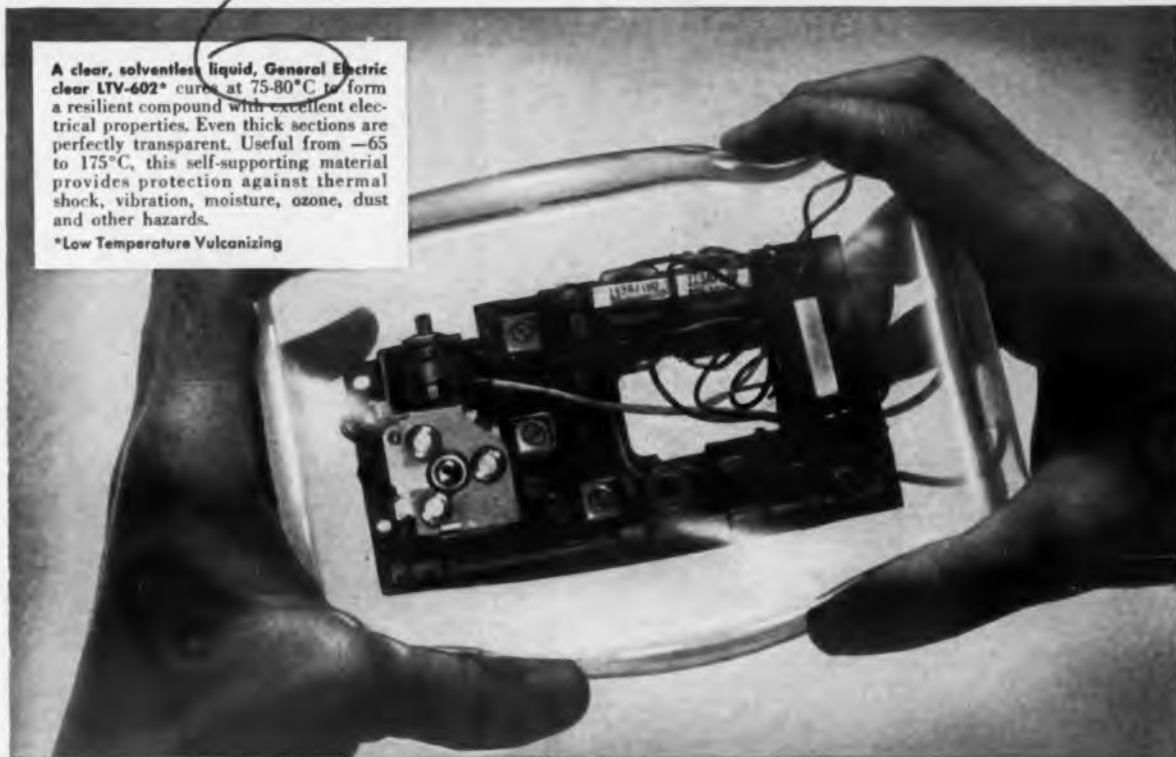
For use in the design of data conversion and data processing systems, the EECO 8-level series has a capacity of 128 to 2,048 characters. The series has three models: random access; sequential access; sequential interlace. Self-checking features provide automatic test of the entire memory at the 200 kc rate or a manual step-by-step test can be made.

Electronic Engineering Co. of California, Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif. P&A: \$10,000 to \$15,000; 60 to 90 days.

**NOW CURES FAST AT ROOM TEMPERATURE TOO!  
(OR 2 HOURS WITH HEAT)**

A clear, solventless liquid, General Electric clear LTV-602\* cures at 75-80°C to form a resilient compound with excellent electrical properties. Even thick sections are perfectly transparent. Useful from -65 to 175°C, this self-supporting material provides protection against thermal shock, vibration, moisture, ozone, dust and other hazards.

\*Low Temperature Vulcanizing



## General Electric clear LTV silicone compound for potting and embedding

*Transparent, resilient, self-supporting and easy to repair*



LTV-602 is easily applied, flows freely in-and-around complicated parts. Having a low viscosity in the uncured state, 800-1500 centipoise, LTV is ideal for potting and embedding of electronic assemblies. Unlike "gel-like" potting materials, LTV-602 cures to a hard, solid. Oven cure is overnight, or from 6 to 8 hours at 75 to 80°C.



LTV-602 is easy to work with and easy to repair. To repair parts embedded in LTV, merely cut out and remove section of material, repair or replace defective part, pour fresh LTV into opening and cure. Pot life, with catalyst added, is approximately 8 hours and may be extended with refrigeration. When desirable, LTV may also be cured at room temperature.



Resiliency offers excellent shock resistance. LTV-602 easily meets thermal shock tests described in MIL-STD-202A test condition B which specifies five temperature cycles from -65 to 125°C. Tests indicate that LTV retains protective properties even after 1800 hours aging at 175°C. Other tests confirm LTV's resistance to moisture and water immersion.

**NOW CURES IN  
2 HOURS - CAN  
EVEN USE HEAT  
LAMP!**

LTV-602 is the newest addition to the broad line of G-E silicone potting and encapsulating materials which also include the RTV silicone rubbers. For more information, write to General Electric Company, Silicone Products Department, Section L1063, Waterford, New York.

**3 TIMES FASTER  
THAN BEFORE**

**GENERAL  ELECTRIC**

**SEND FOR DATA  
ON NEW FAST CURE**

# NEW! WYLE

## Miniature Temperature Chamber

For Small Parts and Black Boxes



Wyle Model C-106 Miniature Chamber

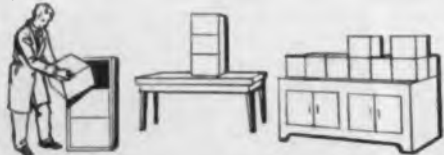
Offering You...

- CLOSER TEMPERATURE CONTROL
- COOLER OUTSIDE SKIN
- BETTER OPERATING ECONOMY
- GREATER FLEXIBILITY
- FASTER HEATING & COOLING RATES

**Revolutionary NEW "Sensor"** The new Wyle liquid CO<sub>2</sub>-cooled Model C-106 Miniature Temperature Chamber is the first to use a revolutionary new type electronic resistance bulb controller that "anticipates" temperature changes and thus effects minimum variation over the full range.

Extra thick layers of new, improved insulation retard flow of heat to outside skin... skin stays cooler. Interchangeable plug-in doors, with various provisions for specimen mounting, instrumentation, specimen operation, and observation, assure minimum downtime. All features lead to greater economy of operation.

### RACK...STACK...OR SIDE-BY-SIDE MOUNTING



Fits standard 19" racks... Flush top & bottom... Flush sides

640 Cu. In. Capacity ● -100°F to +500°F Range ● 8" x 8" x 10" Test Volume Dimensions ● Weight... Approx. 55 Lbs. ● Heating & Cooling Rates... Up to 100°F per Minute

**Write TODAY for Full Information!**

DEPARTMENT MIN

# WYLE

## LABORATORIES

MANUFACTURING DIVISION

128 MARYLAND STREET, EL SEGUNDO, CALIFORNIA  
OTHER FACILITIES AT WESTBURY, NEW YORK...NEW HYDE PARK, NEW YORK...AND AT NORCO, CALIF.  
CIRCLE 106 ON READER-SERVICE CARD

## NEW PRODUCTS

### Semiconductor Component Kits 369



Contains spheres, washers, rings, pellets, base tabs and foils of various alloys, claddings and combinations. Nine different kits of spheres, four different kits of specialized stampings and three kits of foils and clad metals are available, along with special kits for microwave devices and tunnel diodes.

Semi-Alloys, Inc., Dept. ED, 20 N. Mac-Questen Parkway, Mount Vernon, N. Y.

Price: \$18.50 to \$47.50.

### Brushless DC Motor-Fan 359



Capacity is 270 cfm free air delivery. Operates at 28 v dc and requires 50 w of power. Designated model 3301, the fan has sealed ball bearings for adverse environmental conditions and is housed in a black anodized aluminum frame per MIL-A-8625, type II. Featuring stainless steel shaft and hardware, the unit is designed for operation in ambient from -55 to +55 C.

Astro Dynamics, Inc., Dept. ED, Northwest Industrial Park, Burlington, Mass.

P&A: \$75 to \$150; 2 weeks.

### Accuracy Is Our Policy

Volt-ohmmeter model 21A, manufactured by J-Omega Co., Los Altos, Calif., was erroneously described, on p 76 of the Sept. 13 issue of ELECTRONIC DESIGN, as having an accuracy of  $\pm 15\%$  of full scale. The accuracy is actually  $\pm 0.15\%$  of full scale.

## HIGH-VOLTAGE BRIDGE RECTIFIERS



### Typical Unit

- 7,000 Watts (1.0 amp @ 7000 vdc)
- Silicon Diffused Junction Diodes
- Matched Thermal Coefficient of Expansion
- 2.25 Cubic Inches
- Packaging to Customer's Requirements

### Applications

- Klystron Power Supplies
- High Voltage D-C Power Supplies
- Plate Power Supplies for Transmitters
- D-C Power Supply for Traveling-Wave-Tubes

For Additional Information write or phone



# VARO Inc

SPECIAL PRODUCTS DIVISION

2201 Walnut St., Garland, Texas ● Phone BRoadway 6-6141

CIRCLE 107 ON READER-SERVICE CARD



**unisec** measures angles accurately in missile controlling submarines.  
**unisec** measures angular precision of radar antennas.



**unisec** positions precise guidance equipment in missiles prior to launching.  
**unisec** is used to measure azimuth in the newest surveying equipment.

**unisec** optical system reading angles to one second of arc... is made in several sizes by  
W & L E GURLEY, TROY, N. Y.  
525 Fulton Street  
Write for further information

ELECTRONIC DESIGN • November 8, 1961



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\$ **MILLION** \$  
\$ In Electronic Engineering? \$

Not likely. Only a few have done it. However, most electronics engineers realize that above average earnings can be theirs in the electronics market. For the man who wants challenging work & earnings reflecting his capabilities, we are retained by over 500 top electronics firms (both "giants" and "comers").

**FREE—MONTHLY OPPORTUNITIES BULLETIN**

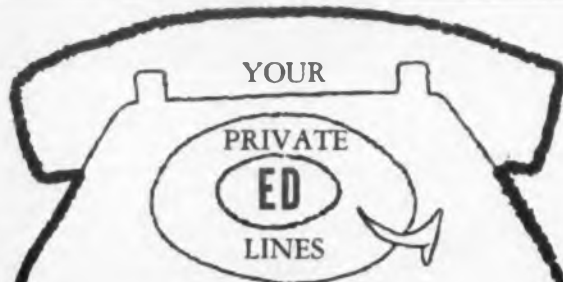
If you wish to receive a monthly bulletin of the finest available electronic opportunities, simply send us your name and home address (and if you wish, a review of your qualifications)—Our services are without cost to you through our Chicago office and our Los Angeles subsidiary, Lon Barton Associates.



Lon D. Barton, President  
Cadillac Associates, Inc.\*  
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\* "Where More Electronic Executives Find Their Positions Than Anywhere Else in the World."

CIRCLE 888 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*.

CIRCLE 109 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

Relays and Contactors

415



For noninductive loads. The four units available are contact rated at 30 amp, 250 v ac and may be applied continuously up to their full rating, open or enclosed, with conservative temperature rises.

Automatic Switch Co., Dept. ED, Florham Park, N. J.

Price: \$27.00 to \$35.00.

Six-Channel Oscilloscope

414



Features upper 5-in. memory tube and lower 5-in. square five gun tube. Range of sensitivities is 100 v per cm to 0.1 v per cm. Rise time is 40 nsec. Sweep speeds are available between 5 sec per cm and 0.1  $\mu$ sec per cm in 23 calibrated steps. A 1-kc oscillator acts as the driving source of a square wave generator to provide calibrating voltages and time intervals.

Clifton Technical Physics, Dept. ED, 3329 Doris Ave., Wanamassa, N. J.

Price: \$8,500.

Instrument Rectifier

416



Redesigned model 500 has 0.5-in. cell size and 0.125-in. active cell area. The device has a 6-32 stud mounting and is available in five standard types. Terminal ends clamp on to lead wires in a vise-like hold.

Conant Laboratories, Dept. ED, Box 3997, Bethany Station, Lincoln, Neb.

when reliability is  
designed into a component,  
it costs no more!



*Aladdin* **DURA-CLAD**  
and other standard Aladdin  
**TRANSFORMERS**

for applications in

- Data Processing Equipment
- Missile Guidance
- Automatic Controls
- Multiplex Telephone Systems
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Aladdin DURA-CLADS are designed for reliability and made on automatic machinery.

The DURA-CLADS and other Aladdin transformers are used at frequencies from 20 CYCLES to 30 MEGACYCLES.

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CIRCLE 249 ON READER-SERVICE CARD



# MEET

## BIG PROTECTION IN SMALL PACKAGES

CAMBION® Standard Wound Chokes give long lasting new strength to your inductance factor! And with good reason. These durable components are always quality-controlled, tested and guaranteed — and meet, and even exceed, applicable MIL SPECS.

Both the No. 2950 and the No. 2960 exemplify the trouble-free reliability of the whole broad line of CAMBION chokes. They're epoxy-encapsulated and provide a secure seal against moisture as well as solid protection against mechanical breakage. Definite advancements over the old-style alkyd varieties, these rugged chokes are temperature-cycled, from  $-50^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  . . . repeatedly cycled in sodium chloride solution . . . rechecked electrically and physically . . . tested for terminal twist and drill . . . and checked for dielectric strength at simulated altitudes up to 80,000 feet. They're color-coded for preferential values.

Choke No. 2950 offers an inductance range from 1.1  $\mu\text{h}$  to 120.0  $\mu\text{h}$  and conforms to MS-91189, while choke No. 2960 has an inductance range from 0.15  $\mu\text{h}$  to 27.0  $\mu\text{h}$  and meets MIL-C-15305B (Grade 1).

The broad CAMBION line includes plugs and jacks, solder terminals, insulated terminals, terminal boards, capacitors, shielded coils, coil forms, panel hardware, digital computer components, and they're all guaranteed. For a catalog, for design assistance or for both, write to Cambridge Thermionic Corporation, 457 Concord Avenue, Cambridge 38, Massachusetts.

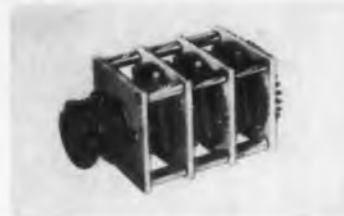
CAMBRIDGE THERMIONIC CORPORATION  
**CAMBION**   
The guaranteed electronic components

CIRCLE 111 ON READER-SERVICE CARD

## NEW PRODUCTS

### Adjustable Stop Switches

404



Permit an increase or decrease of positions as circuit requirements dictate. Built in square configuration in 1-3/4 and 2-1/4-in. sizes, these units are said to be constructed of corrosion resistant metals and heat resistant plastics. They meet MIL-S-3786 and MIL-E-5272.

The Daven Co., Dept. ED, Livingston, N. J.  
*Availability: immediate, from distributors.*

### Compression Amplifier

412



Bridging type, 12,000-ohm, balanced 3-terminal input is featured on model WSC515. Power output is 3.8 v on 600 ohm or +13.8 dbm average at full compression. Attack time is 35 msec; recovery time, 1 sec. Frequency response is within audio range. The three-tube unit has 110-120-v, 60-cps, 0.16-amp power supply.

Webster Electric Co., Dept. ED, Racine, Wis.

### Component Heater

408



For bench-top temperature testing. Probe tips fit the component to be heated and are controlled at the temperature set within  $\pm 3^{\circ}\text{C}$ . Temperature stability is  $\pm 0.5^{\circ}\text{C}$ . A 35-w heater probe is interchangeable with one of 9 w. Tips supplied fit TO-3 and TO-5 transistor cases.

Kennedy Co., Dept. ED, 2029 N. Lake Ave., Altadena, Calif.

*P&A: \$150.00; 2 weeks.*

## POWER, CONTROL, SIGNAL CIRCUITS...



... all in one  
**ROYAL  
CABLE!**

ROYAL MULTI-CONDUCTOR CABLES are designed, manufactured and quality-controlled to your exact specifications . . . for a myriad of uses . . . for simple or complex applications. Cable elements and materials may be combined to include signal, control and power circuits into one construction and within one jacket. Royal is equipped and experienced to provide a finished cable that will assure predictable, dependable on-the-job performance. And remember, Royal is ready . . . to quote . . . to supply . . . to satisfy.

Write for new Catalog No. 4C-61 . . . (includes charts on Royal RG and special application cables, physical characteristics, test procedures, engineering tables, etc.)

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(Quebec) Ltd., Pointe Claire, Quebec

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ELECTRIC   
... an associate of

CIRCLE 112 ON READER-SERVICE CARD

### Shaft Angle Translator 648



Visual display and BCD data outputs derived from the translation of shaft encoded input signals are produced by the EECO 780 shaft angle translator. It is possible for angles to be read instantly and with resolution of 0.01 deg. Translation speed is approximately 75 msec after interrogation command.

Electronic Engineering Co. of California, Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif. P&A: \$4,150 fob Santa Ana; 60 to 90 days.

### Regulated Power Supply 467

A static magnetic power supply, the Sola CVDR is modified by the addition of a saturable reactor to regulate the output voltage for load variations. Regulation is  $\pm 2\%$  overall for both line and load changes. Ripple is 1% peak-to-peak. Units are available in 4 types from 6 v, 10 amp to 24 v, 5 amp ranges.

Sola Electric Co., Dept. ED, Elk Grove Village, Ill.

### Precision Thermostat 386



Precise temperature control within narrow limits is accomplished by the M2 thermostat. Suggested uses are for warning devices in missiles, heating blankets and similar devices. The unit is designed to fit small spaces and can be supplied to open or close on temperature rise. All-welded construction eliminates use of organic substances.

Metals & Controls Inc., Dept. ED, 34 Forest St. Attleboro, Mass. P&A: \$3 to \$10 depending on quantity; 3 weeks.

CIRCLE 113 ON READER-SERVICE CARD

Another CMC First...

# 100 mc SOLID STATE Universal Counter-Timer



WEIGHT 25 LBS.

#### KEY SPECIFICATIONS

##### FREQUENCY

0 cps to 100 mc

##### TIME INTERVAL

0.02  $\mu$ sec to  $10^3$  sec

##### PERIOD

0 cps to 10 mc

##### INPUT SENSITIVITY

1.0v rms

##### GATE TIMES (FREQUENCY)

1  $\mu$ sec to 10 sec in 8 decade steps or external. Reads in cps, kc, mc.

##### FREQUENCY OUTPUTS

0.1 cps to 1 mc output in decade steps

##### ACCURACY

$\pm 1$  count  $\pm$  stability  
 $\pm 10$  nanosecond  $\pm$  stability

##### STABILITY

Short term:  $\pm 1$  part in  $10^6$   
Long term: within 5 parts in  $10^6$

##### PRICE, F.O.B. FACTORY

\$3,950; inline readout \$200 extra

\* SEVEN BASIC FUNCTIONS, including dc to 100 mc frequency measurements without heterodyning techniques\* Time interval measurements with 10 nanosecond resolution\* Straight or totalizing counting\* Frequency ratio measurement\* Period measurement\* Sensitivity better than 1.0v rms\* Power consumption 50 watts\* Decade count-down time base (no adjustments necessary)\* Two year free service warranty\* No vacuum tubes\* Connector on rear providing standard 1-2-4-8 BCD output for operating printer, punch, etc.

Model 728B is a production unit, not a showpiece prototype. Demonstrators are now in the hands of CMC engineering reps. Call, wire or write to arrange a demonstration. Complete technical data plus a copy of our new 20 page short form catalog is yours for the asking.

CMC

9  
8  
7  
6  
5  
4  
3  
2  
1  
0

**Computer  
Measurements  
Company**

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EMPIRE 7-2161

## New Revolutionary Concept In Pushbutton Switch Design

The newly designed IEE Cue Indicator Switch has the capacity to display twelve different messages on its viewing screen, which is also the "push-button" of the switch. Messages are displayed by the use of a rear-projection display system.

### CUE INDICATOR

### SWITCH

OFFERS 12 INTERCHANGEABLE MESSAGES

Ability to reduce overall panel space by 1200% may be achieved by combining twelve different messages into one Cue Indicator Switch, resulting in ten Cue Indicator Switches doing the job of 120 conventional switches. Switches with readout communication capabilities employing words, color, numbers, and symbols herald a new era in control applications.

Write today for prices and complete detailed specifications. Representatives in principal cities.

**INDUSTRIAL ELECTRONIC ENGINEERS**  
5528 Vineland Avenue • North Hollywood, Calif.

CIRCLE 114 ON READER-SERVICE CARD



**MODEL DC-200AR**

Accuracy . . . . . 0.01% +5  $\mu$ v of reading  
Ranges . . . . . 0-1000v DC  
Long Term Stability . . . . . Better than 0.03%  
Reference Stability . . . . . 2 ppm/°C  
Price . . . . . \$985\*



**MODEL DC-100A**

Accuracy . . . . . 0.05% +5  $\mu$ v of reading  
Long Term Stability . . . . . Better than 0.1%  
Reference Stability . . . . . 5 ppm/°C  
Price . . . . . \$475\*

**0.01% ACCURACY**

# CALIBRATION > STANDARDS

## Self Calibrating DC Voltmeters

Now, in the Model DC-200AR Voltmeter, fine accuracy Voltage measurements with a 6 digit readout. Completely transistorized. This instrument and its companion DC-100A use ultra-stable Zener references. The stability, inherent in both these Voltmeters, make them essential to reliable laboratory and production testing. Only 3 watts of power at 117 VAC required. DC-100A available as a DC-100AR in rack mounting. Write for detailed specifications or contact your local CSC representative.

LOS ANGELES, SMITH-DISTRICH SALES COMPANY • SEATTLE-PALO ALTO, STANLEY ENTERPRISES • DENVER-SALT LAKE CITY, EMP ASSOCIATES • CHICAGO, LOREN F. GREEN & ASSOCIATES • WICHITA, LAWRENCE L. HILL • WALTHAM, MASSACHUSETTS, REG. WESTENHOFER & ASSOCIATES • SCHENECTADY, CHARLES A. WINICK COMPANY • NEW YORK CITY (MT. VERNON), GEO. ELECTRONIC SALES, INCORPORATED • PHILADELPHIA (LANSDOWNE), HOLDSWORTH & COMPANY • ARLINGTON, VIRGINIA, THE JAY COMPANY • ATLANTA-COCOA BEACH, SPECIALIZED EQUIPMENT COMPANY • CLEVELAND-DAYTON-DETROIT, ELECTRO SALES ASSOCIATES • EXPORT, FRAZER & HANSEN, LTD.

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P. O. B. ALHAMBRA, CALIF. PRICES SUBJECT TO CHANGE WITHOUT NOTICE

CIRCLE 115 ON READER-SERVICE CARD

## NEW PRODUCTS

### Logic Card Systems

374



Made of 1/16-in. glass bonded epoxy, the standard card is 7-1/2 x 6 in. Connector is a 47 pin hermaphrodite design with card contacts staked and soldered to the etched circuit. Power supply voltages required are +12 v, -6 v, and -24 v regulated within  $\pm 3\%$ . Temperature range is 0 to 55 C. All outputs are clamped. Output signals are 0 v and -6 v.

Drexel Dynamics Corp., Dept. ED, Horsham, Pa.

### Carrier Amplifier

403

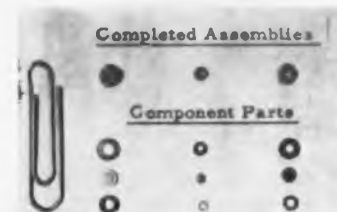


Transistorized, single-channel model 8300 is available in 3 or 10 kc, with line regulation of better than 0.1% and a temperature coefficient of less than 0.01% per F. A 10-turn precision potentiometer is provided to form one-half of a bridge circuit when a two-element sensor is employed.

Crescent Engineering & Research Co., Dept. ED, 5440 N. Peck Road, El Monte, Calif.

### Ceramic-to-Metal Housings

400



For tunnel diodes. The housings, which are as small as 0.090 in. diam. and 0.030 in. overall height, are constructed to withstand temperature in excess of 1,500 F. Mechanical strength is 15-20,000 psi tension.

Advanced Vacuum Products, Inc., Dept. ED, 430 Fairfield Ave., Stamford, Conn.

P&A: \$0.10 to \$1.00; 4-5 weeks.

## Round Plug

352



Suitable for relay and miniature plug-in circuits, the K1-14, a 14-pin plug, can mate with TS1405P01 sockets. It has phosphor-bronze-cadmium plated 0.040 in. diam pins, gold flashed pins and higher temperatures are also available. Model R14, a matching 14-pin socket, has saddle mounts.

Vector Electronic Co., Inc., Dept. ED, 1100 Flower St., Glendale 1, Calif.

P&A: \$0.53 ea. in lots of 100; stock.

## Phase Checker

410



Determines correct phasing of loudspeakers in stereo, hi-fi, and public address systems. The sound-powered device, designated WG-360A, may be used with any conventional volt-ohm-milliammeter, vtvm, or cathode-ray oscilloscope. The effective frequency range of each of the two receptor units is 40 to 4,000 cps. Resonant frequency is 180 cps, approximately.

Radio Corp. of America, Electron Tube Div., Dept. ED, Harrison, N. J.

P&A: \$14.95; immediate.

## Instrument Motor

354



Six positive, repeatable speed ratios, which can be changed while the motor is running, are incorporated in this gear motor. Built to NEMA size 25 frame, the gearhead can be adapted to motors from 1 to 600 rpm. Speed ratios are from 1 to 1, to 50 to 1; others can be suited to requirements. Operation is 115 v ac, 60 cps.

Insc Co., Dept. ED, Hollis St., Groton, Mass.

## ENGINEERED COMPONENTS

for the Electronics Industry



As close at hand as your nearest authorized Garlock distributor—  
CHEMELEC® Insulators, Subminiature Tube and Transistor Sockets, Connectors.

Availability as well as reliability are two reasons why it is smart to specify Garlock when buying components.

Through a new organization of authorized distributors, Garlock now offers immediate delivery of CHEMELEC Stand-off and Feed-Thru Insulators, Subminiature Tube and Transistor Sockets, Connectors, and other standard components.

As near as the telephone, your authorized Garlock Electronic Products Distributor offers prompt, courteous service. Call him at the nearest of these locations:

<b>CALIF.</b> NEWARK ELECTRONICS CO. 4747 W. Century Blvd. Inglewood, Calif. SCHAD ELECTRONICS 499 S. Market St. San Jose, Calif. WESCO ELECTRONICS 1715 E. Colorado Blvd. Pasadena, Calif.	<b>MASS.</b> DE MAMBRO RADIO SUPPLY CO. INC. 1095 Commonwealth Ave. Boston 15, Mass.
<b>COLORADO</b> INTER-STATE RADIO & SUPPLY CORP. 1200 Stout Street Denver, Colorado	<b>NEW YORK</b> ELECTRONIC CENTER INC. 160 5th Avenue New York 10, New York HARRISON RADIO CORP. 225 Greenwich St. New York 7, New York
<b>ILLINOIS</b> NEWARK ELECTRONICS CO. 223 West Madison St. Chicago 6, Illinois	<b>ONTARIO</b> LAKE ENGINEERING CO. LTD. 767 Warden Ave. Scarborough, Ontario, Canada
<b>MARYLAND</b> ELECTRONIC ENTERPRISES, INC. 4902 Snader Avenue Baltimore 15, Md.	<b>N. CAROLINA</b> DALTON-HEGE, INC. 938 Burke St. Winston-Salem, N. C.

Take advantage of on-the-spot availability—specify these skillfully engineered Garlock electronic components. Reliable under the most severe conditions, they are ideal for high temperature, high voltage, high frequency service on missile guidance, fire control, tracking, and radar systems. Garlock has the technical personnel and modern facilities to produce components of all materials—Teflon† TFE and FEP, Nylon, Delrin‡, C.T.F.E.‡—and a range of sizes, designs, and tolerances to fit your exact needs. At your disposal, too, for development of new electronic products, Garlock maintains complete electrical, chemical and physical laboratories staffed by top-flight engineers.

Remember, too, the newest of the Garlock electronic products—Flexible Printed Circuitry of Teflon FEP. For complete details on what Garlock has to offer, write for Catalogs AD-169, 171, and 188. Garlock Electronic Products, Garlock Inc., Camden 1, New Jersey.

# GARLOCK

## ELECTRONIC PRODUCTS

Canadian Div.: Garlock of Canada Ltd.  
Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

\*Registered Trademark  
†DuPont Trademark

‡polychlorotrifluoroethylene

CIRCLE 116 ON READER-SERVICE CARD





## 15 Mw Modulator Power 3.0 Mw R-F Power **ML-7560** Ceramic Triode

Coaxial terminal, thoriated-tungsten cathode ML-7560 provides:  
15 Mw Pulsed Modulator Power Capability at 1% duty . . .

DC Plate Voltage Max 50 kv

Pulse Cathode Current Max 550 amps

3.0 Mw R-F Pulsed Power capability at 5% duty . . .

Peak Plate Pulse Supply Voltage Max 40kv

Pulse Cathode Current, Max 550 amps

Send for 74 page brochure, "Hard Pulse Modulator Tubes", containing useful information for Radar Design Engineers and others.

**MACHLETT**

The Machlett Laboratories, Inc.  
Division of Raytheon  
Springdale, Connecticut

CIRCLE 117 ON READER-SERVICE CARD

## NEW PRODUCTS

### Connector Devices

351



Only the required number of contacts are mounted on Edge-Bord and In-Bord pin and cup receptacles. Round 0.040-in. diam pins project 1/4 in. beyond the board edge. Cup receptacles accommodate boards with 10, 15, or 20 pins installed. Connector pins allow the boards to be stacked in a piggy-back arrangement.

Vector Electronic Co., Inc., Dept. ED, 1100 Flower St., Glendale 1, Calif.

*P&A: pins, \$0.015 ea. in lots of 10,000, cup receptacles, \$0.06 ea. in lots of 10,000; stock.*

### Ultrasonic Pulser

424

Sound from 30 kc to 1 mc is generated in low-frequency pulses by the model 101 ultrasonic pulser. Pulse amplitude is variable to 1,000 v, and a simultaneous 0 to 700 v dc output is provided. Device can be used with all standard crystal and ceramic transducers, including polarizable units.

Elion Instruments, Inc., Dept. ED, 430 Buckley St., Bristol, Pa.

*Price: about \$900.*

### Feed-Thru Capacitors

419



For chassis-wall mounting. Solid tantalum, hermetically sealed type STAF capacitor ranges from 4.7 to 1.0  $\mu$ f for use on 6 to 35 wdc max under 8 to 46 surge volts max. They have current ratings ranging from 1.0 amp at 25 C to 0.4 amp at 125 C with working voltages at ambients above 85 C requiring 67% linear derating to 125 C.

Rectifier-Capacitor Div., Fansteel Metallurgical Corp., Dept. ED, North Chicago, Ill.



**NYLON TIP JACK**  
Available in all nylon body or as a metal-clad type to meet military specifications. Completely insulated—no auxiliary mounting hardware needed.

**NYLON BANANA PLUG**  
Rugged, high voltage insulated plug for a wide variety of applications.

**NYLON BANANA JACK**  
Molded nylon body provides voltage breakdown of 12,500 volts DC.

**NYLON BINDING POST**  
Compact, completely insulated, pre-assembled 5-way binding post.

**NYLON TIP PLUG**  
Designed for solderless connection—fits all standard tip jacks.

# NYLON CONNECTORS

Voltage breakdowns up to 12,500 volts DC!

These rugged Johnson connectors are molded of tough, low-loss shock-proof nylon—and will not chip or crack, even when subjected to extreme temperature changes or severe mechanical stress. Nylon provides high voltage insulation, with voltage breakdowns up to 12,500 volts DC. Metal clad tip jack meets MIL specifications (full specifications available on request). All connectors are designed for fast, easy mounting—and are available in 13 bright colors for coded applications.

**OTHER CONNECTORS**—Johnson also manufactures a complete line of standard connectors in addition to the nylon line described above. For complete information, write for our newest components catalog shown below.



**NEW**

**DUAL BANANA PLUG**  
Extremely versatile—provides variety of application possibilities. Solderless design—tough shock resistant nylon body retains strength and low-loss characteristics over a wide range of temperature and high relative humidity conditions. Available in 13 permanent colors.

*New Catalog*

Write today for our newest electronic components catalog—complete specifications, engineering prints and current prices on:

• CAPACITORS • TUBE SOCKETS • CONNECTORS • PILOT LIGHTS  
• INSULATORS • KNOBS, DIALS • INDUCTORS • HARDWARE



**E. F. JOHNSON CO.**

2916 Tenth Avenue S.W. • Waseca, Minnesota

CIRCLE 118 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

## Transistorized Gaussmeter

381



Direct reading of flux densities, from 0.3 gauss full scale to 30,000 gauss is accurate to  $\pm 2.5\%$ . Gaussmeter model 900, operates from self-contained batteries or ac supply, has eleven switch selected ranges and can be extended to 100,000 gauss.

Dyna-Empire, Inc., Dept. ED, 1075 Stewart Ave., Garden City, N. Y.

P&A: \$475.00; 2 weeks.

## Copper Coating

394

For plated thru-holes in printed circuits. The material is applied by dipping, removing excess, oven-drying, light sanding and copper strike. Laboratory controls are not required.

Etchomatic, Inc., Dept. ED, 182 Newton St., Waltham 54, Mass.

Price: 6-oz sample kit, \$5.95.

## Ionospheric Sounding System

379



Mobile ionospheric sounding system is fully automatic and compatible with existing systems. Sounder transmitter and receiver units weigh 600 lbs each and measure 42 in. wide x 52 in. high. Frequency range is 1 to 25 mc and power output is 10 to 20 kw, with a 25- $\mu$ sec Gaussian pulse width. Receiving terminal is designated RM548A; transmitting terminals model RM547A.

Phillips Electronics Industries Ltd., Dept. ED, 116 Vanderhoof Ave., Toronto 17, Ont.

CIRCLE 119 ON READER-SERVICE CARD



ELECTROLYTIC CAPACITORS—Reliability is our first ingredient



NEW G-E FOIL TANTALYTIC CAPACITOR  
"A CASE" (POLAR)

SOLID TANTALUM CAPACITOR

NEW G-E FOIL TANTALYTIC CAPACITOR  
"A CASE" (NON-POLAR)

## NEW smaller size foil Tantalytic\* capacitors pack foil advantages in near solid dimensions

No longer can limited space prevent your specifying a foil capacitor with its superior characteristics. General Electric now offers an 85C Tantalytic "A Case" capacitor .131" diam., .47" long—almost as small as the smallest solid!

The General Electric foil "A Case" is available at higher voltages, and is inherently more reliable than solids

\* Reg. Trade-mark of General Electric Co.

when operated at rated voltages. It is available in non-polar as well as polar ratings. Further, it matches solids for volumetric efficiency.

But there's no compromise on electrical characteristics. The lower leakage currents of the "A Case" actually decrease during operation, while leakage currents in solids normally increase.

The "A Case" comes in single-end, .47"-long, .131"-diam., polar type; or double-end, .54"-long, .131"-diam., polar or non-polar types—rated 6v (12uf) to 50v (1.4 uf) and to higher voltages.

For data, call your G-E Sales Engineer. Or write for Bulletin GEA-7226, General Electric Co., Schenectady, N. Y., Capacitor Department, Irmo, S. C.

4M-07

Progress Is Our Most Important Product

GENERAL  ELECTRIC

Now up to  
100-volt  
ratings

General Electric also offers these reliable Tantalytic capacitors

HIGH-RELIABILITY  
OIL AND SOLID  
CAPACITORS

Bulletin  
GEA-7227

POROUS-AMODE  
TANTALYTIC  
CAPACITORS

Bulletin  
GEA-7008

125C KSR\*  
TANTALYTIC  
CAPACITORS

Bulletin  
GEA-6766

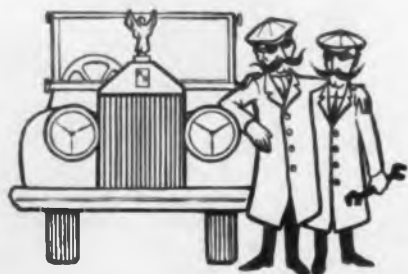
HIGH-VOLTAGE  
TANTALYTIC  
CAPACITORS

Bulletin  
GEA-7065

125C CYLINDRICAL  
TANTALYTIC  
CAPACITORS

Bulletin  
GEA-7085

**Behlman-Invar**  
*is to*  
**electronic power**  
*as Rolls*  
*is to Royce*



And to determine what Behlman-Invar means to you, BJI has a complete catalog of AC and DC power supplies which is yours for the asking. Ask!



**BEHLMAN-INVAR ELECTRONICS CORP.**  
 1723 CLOVERFIELD BLVD., SANTA MONICA, CALIFORNIA

CIRCLE 120 ON READER-SERVICE CARD

**5**  
**MEGACYCLES**  
**5th**  
**OVERTONE**

**JK**  
 PRODUCTS

Primarily for Frequency Standard Use Under Rigorous Environmental Conditions.

**Aging:**  $1 \times 10^{-9}$ /day. **Frequency Change:** Less than  $1 \times 10^{-8}$  under vibration of 10 to 200 cps at 10 G, and under 100 G shock when tested per MIL-STD 202A Method 202A. **Frequency Range:** From 4.966 mc to 6.133 mc. Write for literature to James Knights Company, Sandwich, Illinois

CIRCLE 121 ON READER-SERVICE CARD

## NEW PRODUCTS

### Mica Capacitors

405



**Flag-type terminal.** Available in stand-off and feed-thru styles, models 2922 and 2921, these capacitors range from 15 pf through 2,500 pf, with tolerances of  $\pm 2\%$  or  $\pm 1$  pf,  $\pm 5\%$ ,  $\pm 10\%$  or  $\pm 20\%$ . They operate from  $-55$  to  $+200$  C, at which point they exceed life test and temperature cycling requirements of MIL-C-10950.

Erie Resistor Corp., Dept. ED, 644 W. 12 St., Erie, Pa.

P&A: \$.785 to \$2.49; 3 to 4 weeks.

### Pressure Valve

420

**Regulates pressure** in the compartment to  $\pm 0.25$  psi from sea level standard to space at a constant nominal flow of 8 cfm. Flow capacity of model P/N 26100 is 6 to 9 cfm; inlet pressure is 16 to 17 psia and outlet pressure is 0 to 14.7 psia. The unit may be mounted in any position and can operate in the ambient range of  $-40$  to  $+185$  F.

Aerodyne Controls Corp., Dept. ED, 90 Gazza Blvd., Farmingdale, N. Y.

### Materials Tester

402

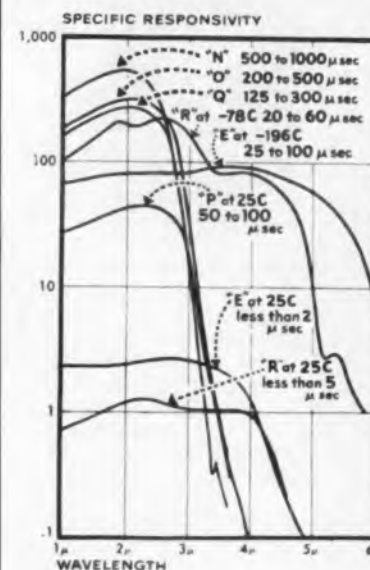


**For insulating materials.** Model 4712 determines dielectric strength of insulating liquids, solids and sheets at potentials to 60 kv. The dc test potential is continuously variable from 0 to 60 kv, with maximum output rated at 2 kva. Overload breakers and safety interlocks are provided.

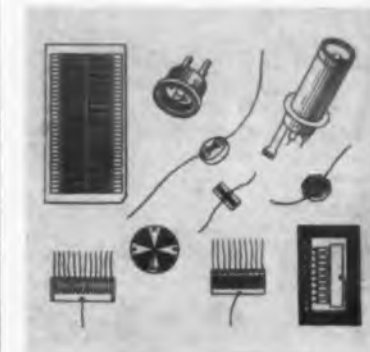
Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

## KODAK EKTRON DETECTORS

-for the  $1\mu$  to  $6\mu$  infrared



a wide-open choice in spectral responsivity and time constant



a wide-open choice of physical forms—large, small, complex shapes, multiple arrays, "immersed," Dewar-housed—ingenuity is the only limit, almost

For more precise explanations and a price list of off-the-shelf Kodak Ektron Detectors (or to see if we can build a complete infrared system for you), write—

## EASTMAN KODAK COMPANY

*Apparatus and Optical Division*

**Rochester 4,  
 N.Y.**

Kodak  
 TRADE MARK

CIRCLE 122 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

## Protective Packaging

365



Constructed of foamed plastic in two halves, this package may be sealed with pressure-sensitive tapes and shipped in any shipping container. Weight is approximately 8 oz. Shock loads are distributed equally to all sides of the container. The units have a slow-controlled rate of rebound, are non-hygroscopic, and are said to be unaffected by heat, humidity or altitude. They can be fabricated in a variety of shapes and sizes.

Pac-Tron, Inc., Dept. ED, 225 Crescent St., Waltham, Mass.

## Flow Transmitter

422

Differential pressure caused by fluid flow is measured, and the information is transmitted by model 231-01 Chronoflo telemetering transmitter. Unit sends a pulsed code, the rapidity of pulses indicating the rate of flow. Water differential capacities from 20 to 320 in. are interchangeable. Case is weatherproof.

B-I-F Industries, Dept. ED, Providence, R. I.

## Frequency Standard

418



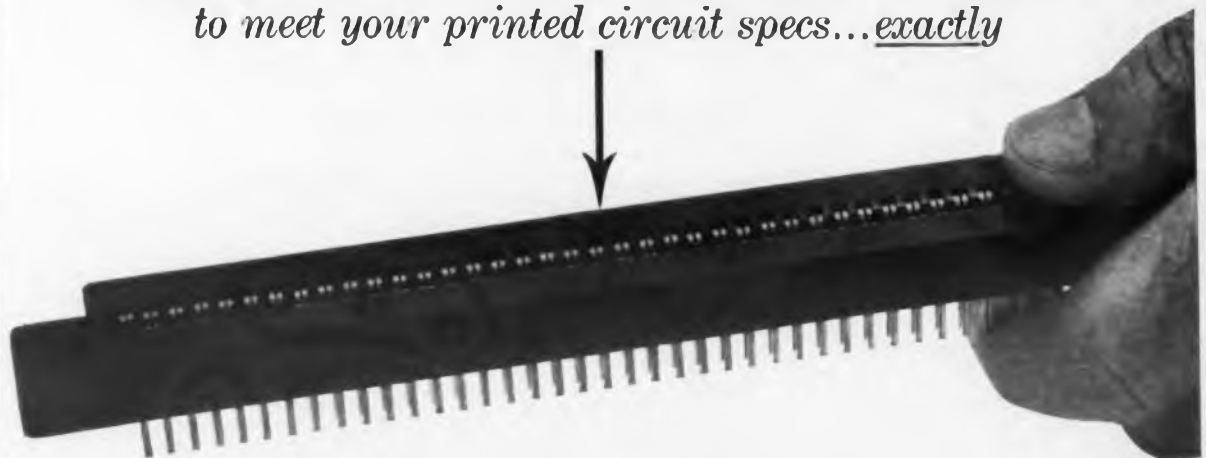
Incorporates silicon transistors with built-in buffer amplifier. Output frequency is 1 mc or any frequency output from 500 kc to 20 mc. Models RFS 16000 and RFS 17000 have 24 to 28 v dc and 6.3 v ac input. Sine-wave output is 1 v min into 1,000 ohm load. The unit is 1-1/2-in. in diameter and 2-1/2-in. high and meets military specifications.

Greenray Industries, Inc., Dept. ED, 5281 E. Simpson Road, Mechanicsburg, Pa.  
P&A: \$189.00; 2 to 6 weeks.



# AND 67 SIZES IN BETWEEN

*to meet your printed circuit specs...exactly*



Continental's line of PC connectors include nearly seventy sizes and types. Name your requirement—and the chances are Continental has a standard production type that meets it *exactly*.

These service-proven connectors are available with up to 210 contacts, for 1/32, 3/64, 3/32, 1/16 and 1/8" PC boards, in both single- and double-row construction. Wiring styles include eyelet lug, wire wrap lug, taper tab and contacts for dip soldering. Continental's patented Bellowform contacts permit use of undersized or oversized boards while maintaining low contact resistance.

New PC connector designs are constantly under development. Our Engineering Department will be pleased to assist you in solving special connector problems. Simply call or write, stating your requirements.



### DESIGNERS' DATA FILE

If you're designing around printed circuits you'll want to have Continental's Con-Dex File PC, compiled to help you select and specify the PC connectors best suited to your needs. For your copy, please write to: Electronic Sales Division, DeJur-Amsco Corporation, Northern Boulevard at 45th St., Long Island City 1, New York (Exclusive Sales Agent) RAvenswood 1-8000.

MICRO-MINIATURE • SUB-MINIATURE • MINIATURE • PRINTED CIRCUIT • RIGHT ANGLE PIN & SOCKET • CENTER SCREWLOCK

# CONTINENTAL CONNECTORS



CONTINENTAL CONNECTOR CORPORATION • WOODSIDE 77, NEW YORK  
CIRCLE 123 ON READER-SERVICE CARD



Itek

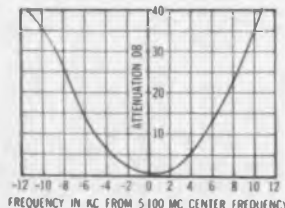
## Crystal Filters do Wonderful Things



A toast to Itek for a wonderful thing . . . Itek Crystal Filter 968B, with a near-Gaussian attenuation characteristic makes possible a 10,000 channel receiver! In antenna circuits, this 5 MC Filter optimizes pulse response, minimizes overshoot, and eliminates adjacent channel interference.

Perhaps you don't need a Gaussian crystal filter. But could you use the ingenuity that built one? Could Itek technical leadership help you?

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**Itek Electro-Products Company**  
75 CAMBRIDGE PARKWAY, CAMBRIDGE 42, MASS. A DIVISION OF

Itek

CIRCLE 124 ON READER-SERVICE CARD

## NEW PRODUCTS

### Trimmer Capacitors

413



Designed for vertical mounting on printed-circuit boards, these piston-type capacitors are available up to 12 pf in three standard ranges: 8.5, 10, and 12 pf. Featuring linear tuning and gold-plated parts, the units are made to meet or exceed the requirements of MIL-C-14409A.

Atlee Corp., Dept. ED, 2 Lowell Ave., Winchester, Mass.

Availability: 2 to 3 weeks.

### Delay Line

355



Eleven standard nsec delay lines, called Nanalines, have time delays of 5 to 100 nsec. The 10 nsec unit has a bandwidth of 100 mc; rise time for a 100 nsec delay line is 9 nsec. Suitable for fast pulse computer applications, some models are tapped for circuit trimming. Units are epoxy potted.

Bel Fuse Inc., Dept. ED, 198 Van Vorst St., Jersey City, N. J.

P&A: small quantities, \$4.50 to \$10.00 ea.; 2 weeks.

### RF Voltmeter

411



Thermocouple type has 1% accuracy from dc to 100 mc per sec. Ranges available from a low of 0 to 1 v and to a high range of 0 to 100 v. Units may be calibrated against an accurate dc standard and may be certified by the National Bureau of Standards.

Rawson Electrical Instrument Co., Dept. ED, 110 Potter St., Cambridge 42, Mass.



# WHY

## MAJOR C. R. TUBE MFGRS. RECOMMEND SYNTRONIC YOKES

Syntronic yoke procedure originated the industry standard for specification correlation between yoke, c. r. tube and circuitry. For a helpful, time-saving checklist covering all physical and electrical yoke parameters and their determining conditions, request ELECTRONICS reprint #12-59. Thorough correlation enables Syntronic to guarantee accepted specifications.

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## syntronic

INSTRUMENTS, INC.

100 Industrial Road, Addison, Illinois  
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The industry's broadest yoke line . . . already tooled for quantity production. Or, yokes can be custom designed to your precise requirement.



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ELECTRONIC DESIGN • November 8, 1961

## Static Inverter

385



Programmed control of switching elements is controlled by oscillator pulses. No moving parts are incorporated in this module; operation under extreme conditions is dependable. Model R143 meet MS 25096 and uses silicon-controlled rectifiers for positive reliability.

Western Branch, Pesco Products Div., Dept. ED, Burbank, Calif.

## DC Amplifier

658

Floating, differential dc amplifier model 114C is for thermocouple and strain-gage measurements where transducer, amplifier and output are separately grounded. Ratings include: 180-db dc, 130-db, 60-cps common mode rejection with up to 1,000 ohms unbalance at either input. Drift is within  $\pm 2 \mu\text{V}$  for 40 hr.

Cohu Electronics, Inc., Kintel Div., Dept. ED, Box 623, San Diego 12, Calif.

Price: \$875.

## Tuning Fork Oscillator

382



Transistorized tuning fork oscillator model DFO-81 is available in any frequency from 50 to 400 cps. Frequency tolerance is  $\pm 0.15\%$  from 0 to 60 C and  $\pm 0.05\%$  at room temperature. With a supply voltage of +26 v it will provide 3 v rms into a nominal load of 10 K.

Delta-f, Inc., Dept. ED, 113 E. State St., Geneva, Ill.

P&A: \$63.50 to \$99.50; stock.

High-energy density electron-beam welding techniques, recently developed by the Zeiss Foundation of West Germany and the Hamilton-Standard Division of United Aircraft, markedly improved packaging density and production methods in the field of microelectronics.

In microcircuitry, for example, packaged circuits no bigger than a thumbnail can now be reliably produced. Electron-beam equipment now welds microelectronic components into circuits with pinpoint precision, making intra- and inter-circuit connection, and hermetically encapsulating the completed micromodule.

Only electron-beam welding, performed in a high vacuum, can offer these significant advantages for the field of microelectronics: virtual elimination of contamination; a close control of penetration; low thermal distortion; and close dimensional control. The upper illustration shows weldments of 0.002" thick copper leads to 0.002" thick nickel-plated ceramic substrate. In the field of thin films difficult welds are possible with this revolutionary new equipment such as 0.002" gold tabs to chromium-gold films 3000-A\* thick.

Another important use of electron-beam equipment is the welding of ceramics used in vacuum tubes which

**Electronic  
Giants  
no bigger  
than your  
thumbnail...  
now  
through  
electron-beam  
welding**

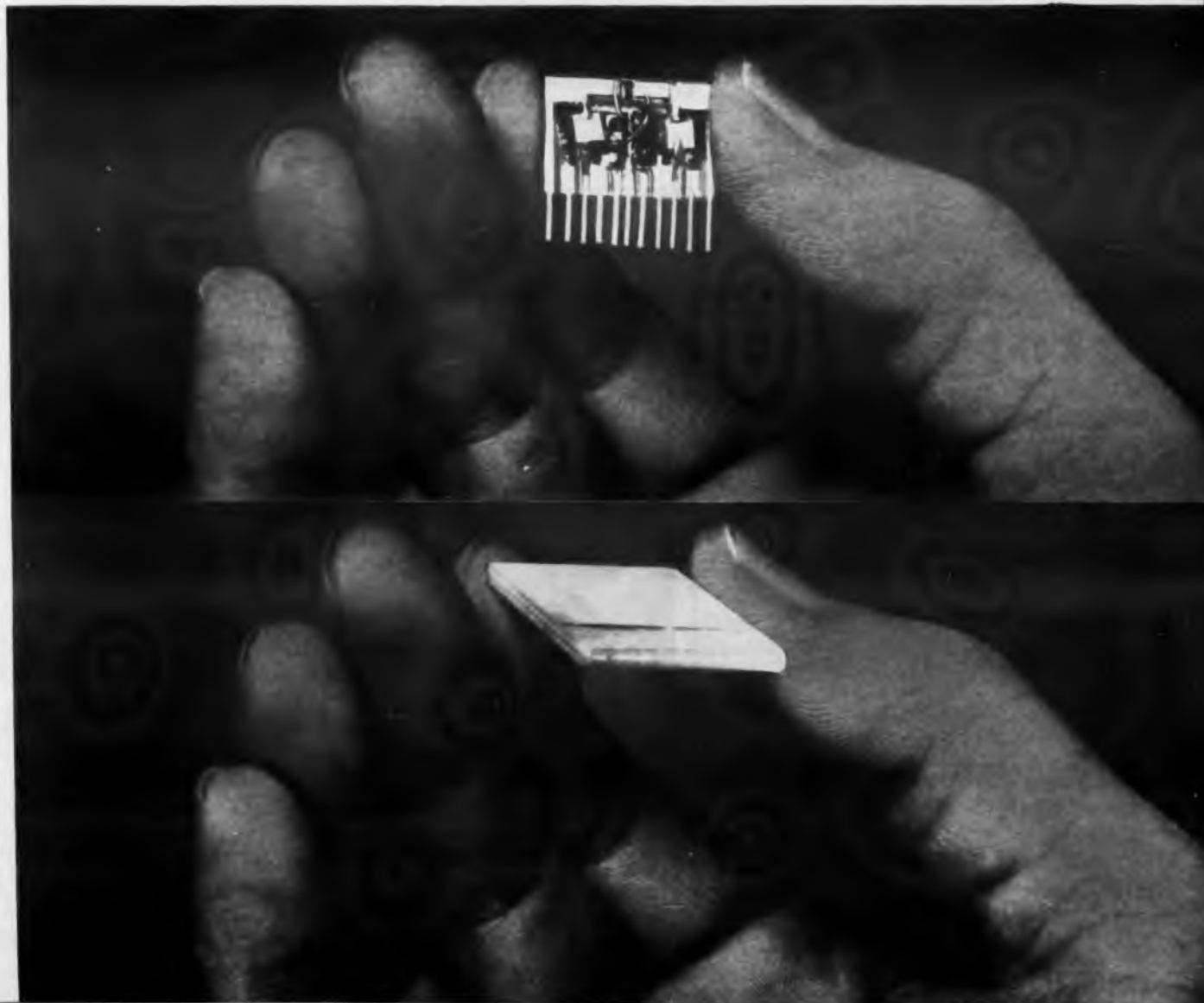


**HAMILTON-ELECTRONA, INC.**

TIME-LIFE BUILDING, ROCKEFELLER CENTER, NEW YORK 20, N. Y.

require extremely high temperature performance. For these procedures, tight ceramic-to-ceramic bonds are necessary — bonds available only through high-energy density electron-beam welding. The lower illustration is a 2 X magnification of two aluminum oxide ceramic wafers  $\frac{1}{2}$ " x  $\frac{3}{4}$ " x .010" thick edge-welded by deflecting the high energy density beam of a Hamilton-Zeiss electron beam welder across the edge surface.

Hamilton-Standard, with over twenty years of metallurgical experience and meeting rigid government specifications, has exhaustively tested the welds produced with Hamilton-Zeiss equipment. The data, which are available for your inspection, demonstrate conclusively that the Hamilton-Zeiss method produces welds in miniature workpieces that are as strong as the original materials themselves. Such results are possible only by the use of high energy density and precision focusing by the Zeiss magnetic lens system which are exclusive features of the Hamilton-Zeiss equipment. Find out what this revolutionary equipment can mean in your business. For full information call Hamilton-Electrona, Inc., exclusive marketing agent for Hamilton-Zeiss equipment in the United States and Canada.



## NEW PRODUCTS

### VHF-UHF Noise Generator

367



Measures receiver and amplifier noise factors in the vhf-uhf range from 30 to 1,000 mc. Power requirements are 60 w at 115 v, 60 cps. The noise figures between 0 and 20 db can be read directly on the front panel meter. Additional calculations permit the user to obtain measurements beyond 20 db. Model 904-A features a continuously variable output signal-level control knob and a type N output connector.

PRD Electronics, Inc., Dept. ED, 202 Tillary St., Brooklyn 1, N. Y.

### Punched Tape Reader

425

For tape duplicating systems, the model TP-522 punched tape reader operates with 8-level, 1-in. punched paper or mylar tape. Unit reads 10 lines per sec. Read heads, designed to resist vibration, have two contacts. Contact life is rated over 10 million operations. Tape can be quickly loaded and unloaded.

Electronic Engineering Co., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

Price: \$465.

### Tachometer Tester

401



Accommodates four at a time. Evaluates operating characteristics of both integrating and damping tachometers at a temperature range of -60 to +220 F. The equipment is available with two system requirements to accommodate both the component user and the component manufacturer.

American Electronics, Inc., Instrument Div., Dept. ED, 9503 W. Jefferson Blvd., Culver City, Calif.

# G-E LEXAN® POLYCARB



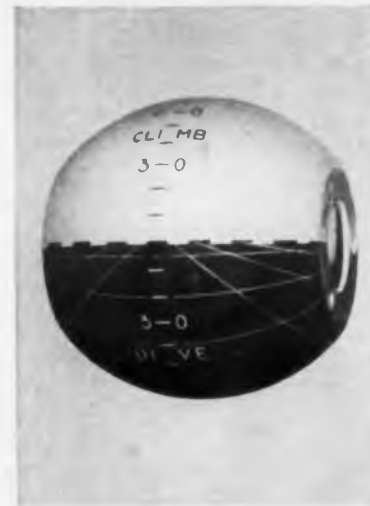
**STABLE ELECTRICALS.** Binding posts made of LEXAN resin retain electricals even under moist, hot conditions. They do not loosen, are molded in six attractive LEXAN colors for coding. Other features are: low loss and power factor, low dielectric constant, high voltage insulation, non-sink surfaces.

(Superior Electric)



**HEAT RESISTANCE.** Beautiful handles of LEXAN polycarbonate resin are used in rugged service on U.L. approved soldering irons. They resist the impact, heat and abrasion of daily bench work. The hard, glossy handles are light in weight. Molded in three pastel colors, they provide toughness and sales appeal.

(Ungar Electric Tools)



**DIMENSIONAL STABILITY.** Maximum allowable change in this 5-inch aircraft instrument part is only 5 mills over a temperature range of -65° to 300°F! And it must maintain this tolerance under high humidity. Part is injection molded of LEXAN resin as half spheres which are solvent cemented, lathe-turned and painted. (Lear, Inc.)

**Applied Research inc**  
76 South Bayles Avenue, Port Washington, N. Y.

**ATTENUATORS  
TERMINATIONS  
IMPEDANCE  
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**TYPICAL  
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Model HFA-50  
52.5 ohm - BNC  
Max vswt, 12:1 1000 mc  
9 standard values  
f.o.b. plant \$10.50 each

BNC DC to 1000 mc \$2.50 7910 9710  
TNC DC to 1000 mc \$3.50 7910 9710  
F DC to 500 mc \$2.50 7910  
C DC to 200 mc \$2.50

Applied Research, Inc. - 76 S. Bayles Avenue - Port Washington, N.Y. PORT Washington 7-8707 - Integrated RF Components and Sub-Assemblies, VLF thru C Band, Octave Amplifiers to 1100 mc; band pass filters; Low noise Amplifiers; Frequency Multipliers.

--- Some areas still open for representation ---

CIRCLE 127 ON READER-SERVICE CARD

YOUR  
PRIVATE  
**ED**  
LINES

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**.

# ONATE RESIN GOOD DIELECTRIC— AND MUCH MORE!



**TRANSPARENCY** of LEXAN resin is important in chart guide for recorder. LEXAN resin is the only transparent plastic able to withstand heat generated by internal lights. It is distortion-free at temperatures up to 270°F and self-extinguishing. Its extremely high impact strength eliminates cracking of guides. (The Foxboro Co.)



**TOUGHNESS.** Press-fitted into metal gear used in an electric drill, bushing of LEXAN polycarbonate resin provides safety from electric shock . . . helps eliminate need for additional grounding. Strength and creep resistance of LEXAN resin enables bushing to withstand torque and load requirements of drill. (Millers Falls Co.)

## ARE YOU LOOKING FOR A PLASTIC THAT CAN REALLY TAKE IT?

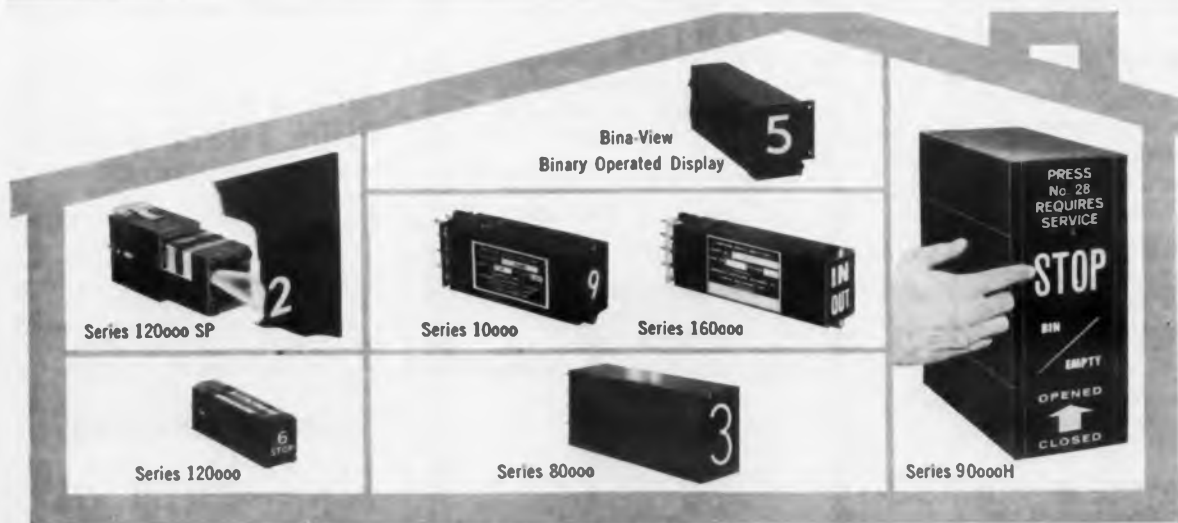
To demonstrate the toughness of LEXAN resin, salesmen will sometimes slam and hammer a product made of the material. LEXAN has the highest impact strength of any plastic—amounting to 12-16 foot-pounds per inch of notch—and it usually emerges unscathed from encounters with such “merchandising stresses”. It is a high-performance material, likewise, with regard to high-temperature behavior and dimensional stability.

Its many other advantages make it a priority material for thorough investigation by all designers, engineers and molders. We will be pleased to supply you with information on the properties, processing and end-uses of LEXAN resin. Don't hesitate to write to us. General Electric, Chemical Materials Department, Section ED-61, Pittsfield, Mass.

**LEXAN®**  
Polycarbonate Resin

**GENERAL ELECTRIC**

CIRCLE 128 ON READER-SERVICE CARD



## READOUTS THAT DO MORE THAN DISPLAY NUMBERS

I.E.E.'s complete line of rear-projection readouts display words, numbers, symbols, and color. The alpha-numeric Bina-View readout is self-decoding and operates direct from binary output. And all can satisfy human factors requirements!

The engineering staff and facilities of Industrial Electronic Engineers, Inc. have approached the problem of readouts as one of visual communications, the case in point being that

complete!  
under  
the  
EE  
roof

numbers are only one form in a host of methods in visual communications. The engineering talent at I.E.E. work under the formula that the more forms of visual communications that are available the less chance there is for communication breakdown. *In a word; complete.*

Your inquiry to complete readout visual communications is invited.



**INDUSTRIAL ELECTRONIC ENGINEERS, Inc.**  
5528 Vineland Avenue, North Hollywood, California

CIRCLE 129 ON READER-SERVICE CARD

## Tape Transport

407



Recording on 600 ft of 1/4-in. magnetic tape, contained in standard cartridge, model M101 starts and stops for each character up to 60 characters per sec. Density of 300 bits per in. allows 350,000 binary coded decimal characters to be recorded on one cartridge. Five-to-eight-level codes can be accepted either as contact closures or pulses.

Kennedy Co., Dept. ED, 2029 N. Lake Ave., Altadena, Calif.

## Programmable Power Supply

361



Dc output voltage is programmable over the range of 100 v to 3,000 v by connecting an external resistor across a pair of terminals. Output current range is 0 to 10 ma with a current limiting circuit which operates at 12.5 to 15 ma. Output ripple is below 5 mv rms and the response time is 25 v per msec. Model 1516 power supply measures 8-3/4 x 19 x 4-1/2 in.

Carad Corp., Dept. ED, 3381 Junipero Serra Blvd., Palo Alto, Calif.  
Price: under \$1,000.

## Custom Modules

409

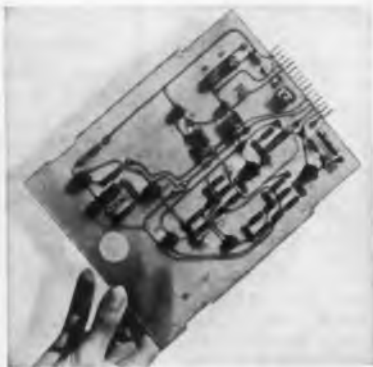


Completely assembled epoxy encapsulated modules of resistance-inductance-capacitance networks to fit within given size and shape factors are available with this service. Manufacturers can procure various packaged networks meeting their exact electrical and physical specification.

Key Resistor Corp., Dept. ED, 321 W. Rondo Beach Blvd., Gardena, Calif.  
Availability: 30 to 45 days.



## Taylor glass-base laminates pop right out as design materials in many applications



There are good reasons for investigating Taylor glass-base laminated plastics as high-strength-to-weight materials in your design. They offer light weight, corrosion resistance, electrical and thermal insulation, and ease of fabrication.

For example, glass-fabric-base laminates have the highest mechanical strength of all laminated plastic materials. They have been successfully used in the fabrication of critical parts, including aircraft parts and bases for printed circuits. They are most valuable where extremely low moisture absorption, increased heat resistance and superior electrical properties are required.

Taylor Fibre produces a number



of different glass-base grades in sheet, rod and tubular form, and copper-clad. Those with phenolic resin are recommended for mechanical and electrical applications requiring heat resistance. Those with melamine are characterized by their excellent resistance to arcing and tracking in electrical applications. They also have good resistance to flame, heat and moderate concentrations of alkalis and most solvents. Those with silicone exhibit very high heat resistance, combined with good mechanical and electrical properties. They also have highest arc resistance. Those with epoxy offer extremely high mechanical strength, excellent chemical resistance, low moisture absorption, and high strength retention at elevated temperatures.

Technical data about these and other Taylor laminated plastics are available. Ask for your copy of the Taylor Laminated Plastics Selection Guide. Taylor Fibre Co., Norristown 48, Pa.

**Taylor**  
LAMINATED PLASTICS VULCANIZED FIBRE

CIRCLE 130 ON READER-SERVICE CARD

## NEW PRODUCTS

### Sunlight Integrator

440



Portable, battery-powered sunlight integrator measures 6-1/2 x 8 x 8 in. and weighs less than 8 lb. Instrument employs a solion tetrode as the integrating element and records directly in calories per sq cm. Accuracy is within 2% over periods of a few minutes to several days. Unit is complete with sensor and hook-up cable.

Texas Research and Electronic Corp., Dept. ED, Meadows Bldg., Dallas, Tex.  
P&A: \$575; from stock.

### Dynamic Load

427

For testing power supplies. The model 705 dynamic load measures internal ac impedance of dc power supplies operating up to 32 v. Unit operates at frequencies from 20 cps to 1 mc, and at dc supply currents from 50 ma to 2.5 amp. Meters indicate power supply ac output current, dc output current, and dc output voltage. Connections for external signal generator, ac voltmeter, and oscilloscope are provided.

Electronic Engineering Co., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.  
Price: \$950.

### Double Pulse Generator

399



With modular construction, series 2100 double pulse generator provides many separate or mixed output signals. Rise time is 0.02  $\mu$ sec; repetition rate is provided to 100 kc, and accuracy is 0.5%. Standard cables adapt the equipment to advanced pulse and pulse pair operation.

Servo Corp. of America, Dept. ED, 111 New South Road, Hicksville, L. I., N. Y.



## VITREOSIL<sup>®</sup> PURE FUSED QUARTZ

**IDEAL FOR ALL SEMI-CONDUCTOR METALS**  
Our unique process enables us to supply semi-conductor quality VITREOSIL to close tolerances in crucibles and special fabricated shapes. Now available Quartz to Metal Seals. Write us about your requirements. See our ad in *Chemical Engineering*, *Electronic Engineers' Master* and *Electronic Designers' Catalogues*.

## SPECTROSIL<sup>®</sup> FOR HYPER-PURITY IN SEMI-CONDUCTOR WORK

**PURITY** — purest form of fused silica  
**TRANSPARENCY** — unique optical properties  
**HOMOGENEITY** — completely homogeneous and free from granularity  
**AVAILABILITY** — block material for lenses, prisms, etc; rod, fiber, wool; hollow ware as tubing, crucibles, and special apparatus.

Write for complete, illustrated catalog.

THERMAL AMERICAN  
FUSED QUARTZ CO., INC.  
18-20 Salem St., Dover, N. J.

CIRCLE 131 ON READER-SERVICE CARD



Designed for compression and tension service model 344 force transducer guarantees an accuracy of  $\pm 0.10\%$  and is available in ranges from 50 to 1,000,000 lb. Materials used are chosen for temperature compensation, low hysteresis and minimum linearity error.

Allegany Instrument Co., Dept. ED, 1091 Wills Mountain, Cumberland, Md.

## Power Supply

653

Strain-gage power supply model 1120 has an output of 3 to 30 v at 0 to 100 ma. Ripple is less than 1 mv, peak to peak; regulation is 0.01% for load and line; drift is 0.01% for 10 days at constant ambient temperature; temperature coefficient is less than 20 ppm per deg C from 0 to 50 C.

Cubic Corp., Dept. ED, 5575 Kearny Villa Road, San Diego 11, Calif.

Price: \$430.

## Solid State Amplifier

646



Ultra-high impedance solid-state amplifier, model 514, operates without dc power supply, transistors or negative resistance devices. Characteristics are: frequency response, 5 cps to 100 kc within 1 db, 3 cps to 200 kc, within 3 db; input impedance, 20,000 meg min shunted by 1 to 1.5 pf; output impedance, 1 meg shunted by 3 to 10 pf; voltage gain, 0.2 to 0.5; power gain, 30 to 40 db.

Denro Lab, Dept. ED, 2801 15th St., N.W., Washington 9, D. C.

Price: \$87 ea.

CIRCLE 132 ON READER-SERVICE CARD ►

# MATCHED CHOPPERS



## SILICON CHOPPERS

From 1 mV "on"  
to 80 V "off"

NOW IN TO-18  
and  
TO-5 CASES

# SPERRY

SEMICONDUCTOR

DIVISION OF  
SPERRY RAND CORPORATION  
NORWALK, CONNECTICUT

### SINK YOUR TEETH INTO THESE FACTS ...

- High breakdown ratings — 50 to 80 volts
- Two point control of current/voltage offset parameters
- Matched pairs to standard tolerance of 100  $\mu\text{v}$
- 10 million-to-1 minimum "off" to "on" resistance ratio
- Typically 30,000 megohms reverse resistance
- Typically 50 ohms forward resistance
- High temperature stability
- Unlimited quantities available
- Available from local Sperry Authorized Distributors

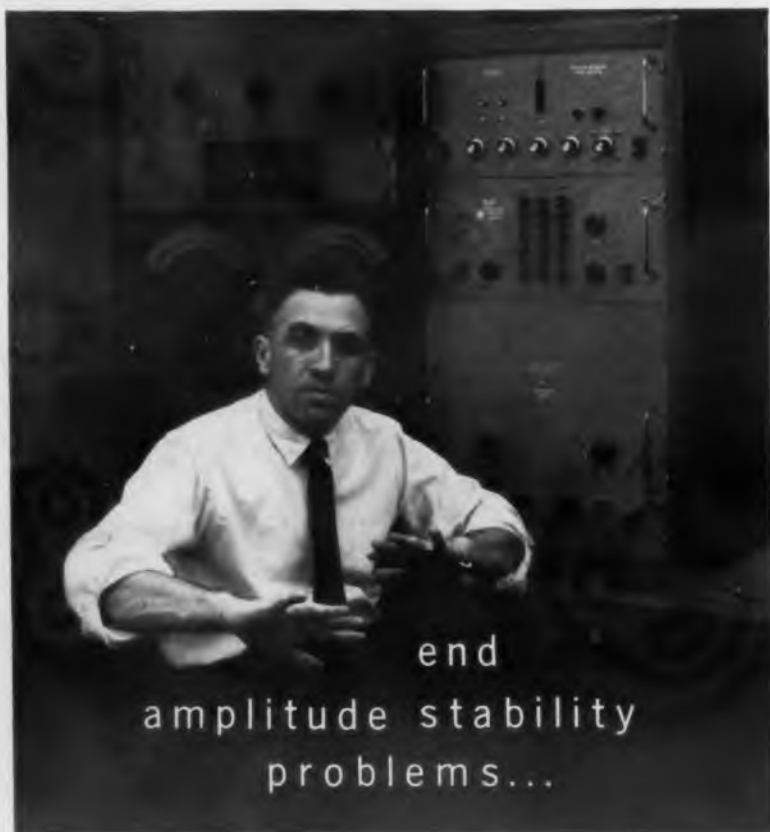
Don't gamble — you put your experience on the line when specifying for analog computers, D.C. amplifiers, electronic commutators and multiplex equipment.

Sperry now offers you a complete series of silicon transistors for single use or matched pairs that have the best combination of chopper characteristics — plus an extra margin of safety which provides true design flexibility.

Type Number TO-18	Type Number TO-5	$BV_{CEO}$ (Volts)	$BV_{CES}$ (Volts)	$BV_{ES0}$ (Volts)	$V_{CE}$ (max) Offset Voltage (mV)	$I_{CE}$ (max) Offset Current (mA)	The Bite 1 — 99	The Bite 100 — 999
2N941	2N1917	-8	-25	-25	1.0	1.0	\$ 9.75	\$7.50
2N942	2N1918	-8	-25	-25	3.0	3.0	7.80	6.00
2N943	2N1919	-18	-40	-40	2.0	1.0	12.35	9.50
2N944	2N1920	-18	-40	-40	3.0	1.5	8.77	6.75
2N945	2N1921	-50	-50	-50	4.0	2.0	5.20	4.00
2N946	2N1922	-80	-80	-80	4.0	2.0	6.50	5.00

Write for 16 page Technical Application Bulletin #2107 and new Chopper transistor data sheets on types 2N1917 through 2N1922 and 2N941 through 2N946.

SEMICONDUCTOR IS OUR MIDDLE NAME . . . SEMICONDUCTOR INTEGRATED NETWORKS (SEMI-NETS\*), TUNNEL DIODES, MESA AND ALLOY SILICON TRANSISTORS AND DIODES  
SALES OFFICES: CHICAGO, ILLINOIS; LOS ANGELES, CALIFORNIA; OAKLAND, NEW JERSEY; MEDFORD, MASSACHUSETTS; SYKESVILLE, MARYLAND; FOREST HILLS, NEW YORK.  
SEMICONDUCTOR OPPORTUNITIES AVAILABLE TO QUALIFIED ENGINEERS  
\*Trade Mark, Sperry Rand Corporation



with this new low-distortion  
ac power source!

New from Krohn-Hite: this variable-frequency, 50 watt ac power source, with the long-desired specifications of less than 0.01% amplitude stability and 0.1% harmonic distortion! The LDS-1500 offers a continuously variable wide range of voltage and current — up to 1500 volts, and up to 12 amps, at any frequency from 20 cps to 20 kc.

The short-term stability and low distortion now makes it possible for you to calibrate conventional indicating ac voltmeters and ammeters, and digital meters to lab standards, yourself!

As a general-purpose variable frequency source of distortion-free, highly stable power, the LDS-1500 has many applications. Distortion measurements at high power levels of precision resolvers, inductors, gyro motors and other electro-magnetic components can now be made with greater accuracy and ease.

The 50 watt power output of the LDS-1500 is ample to supply test benches, for quality control testing at unusual frequencies.

Investigate this unusual ac power source. Its unsurpassed stability and distortion characteristics, its convenience of continuously variable frequency, voltage and current — make it a basic instrument of the industry. Send for complete technical specifications.



**KROHN-HITE CORPORATION**  
580 Massachusetts Avenue • Cambridge 39, Mass.  
Pioneering in Quality Electronic Instruments

CIRCLE 133 ON READER-SERVICE CARD

## NEW PRODUCTS

### Video Telemetry System

450



For real-time television transmission over a mobile link, this video telemetry system consists of a wide-band fm, uhf transmitter and receiver. Carrier frequency is 882 mc, and video response is flat from 30 cps to 4.5 mc. The transmitter, illustrated, has a pressurized enclosure, withstands shock and vibration, can be mounted in aircraft, missile, or satellite vehicles, and provides 20-w power. The receiver provides a satisfactory picture with 10  $\mu$ v input.

Tapco Div., Thompson Ramo Wooldridge Inc., Dept. ED, 23555 Euclid Ave., Cleveland 17, Ohio.

### Counter Modules

508

Model M 10 has five identical flip-flops which operate as a counter at rates up to 2 mc. With model M 11 interstage delay module, it forms a parallel-entry adder which will complete a 5 bit addition 4  $\mu$ sec max.

Navigation Computer Corp., Dept. ED, Valley Forge Industrial Park, Norristown, Pa.

### General Purpose Integrator

449



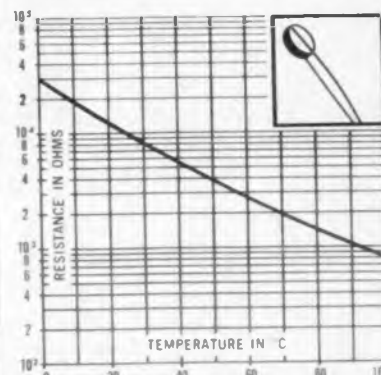
Battery-powered and portable, the model GPI-100 general purpose integrator weighs 5-1/2 lb and measures 6-1/2 x 8 x 8 in. The instrument uses a solion tetrode as the integrating element. Accurate to 1%, the unit has an input impedance of 10 K, a frequency response from dc to 10 kc, and accepts inputs to 1 v. Input amplifier, time averaging, and digital readout are optional.

Texas Research and Electronic Corp., Dept. ED, Meadows Bldg., Dallas, Tex.  
P&A: \$475; 30 days.

# NOW

## A family of Precise Thermistors

YSI produces a family of precise thermistors which match standard Resistance-temperature curves within  $\pm 1\%$ .



Resistance Temperature Characteristics — Partial Range—YSI 44006 Thermistors (10K).

You can now use stock YSI thermistors interchangeably as components in any temperature transducer or compensator circuit without individual padding or balancing.

### DATA

Base resistances at 25° C. of:		
100 $\Omega$	1 K	10 K
300 $\Omega$	3 K	30 K
		100 K

- Each family follows the same RT curve within  $\pm 1\%$  accuracy from  $-40^\circ$  to  $+150^\circ$  C.
- Cost under \$5.00 each, with substantial discounts on quantity orders.
- Quantities under 100 available from stock at YSI now.
- YSI can produce precise thermistors with different base resistances and beta's where design requirements and quantities warrant.

For complete specifications and details write:



CIRCLE 134 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961



## Gyro Power Supply

458



Voltage regulation system is contained in this 3-phase, 400-cps unit. The equipment delivers 30 v rms, with an accuracy of  $\pm 1\%$  line to line. It operates at  $27 \pm 3$  v dc, at 1.5 amp max, delivering 7.5 va per phase max and 3.3 va per phase normal.

M. Ten Bosch, Inc., Dept. ED, 80 Wheeler Ave., Pleasantville, N. Y.

## Heating Device

457



To prepare thermoplastic sheets for bending. The unit consists of two rectangular aluminum heating bars, electrically heated by metal-encased elements. Each bar has two insulated handles, 10 ft of two wire electrical cord and plug. Two models are available for 36-in. and 54-in. wide sheets.

Kamweld Products Co., Dept. ED, 932R Washington St., Norwood, Mass.

## Regulators and Controls

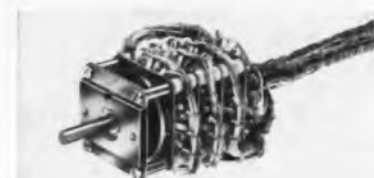
452



Generator voltage regulators and motor generator set controls designed around silicon controls rectifiers are available in sizes from 100 to 3,000 w dc regular output and up to 40 kw on special order. Voltage regulation is  $1/2\%$  no load to full load. Power to regulator is 120 or 220 v ac, 60 to 10,000 cps.

Auto Marine Laboratories, Dept. ED, 6 E. Main St., Ramsey, N. J.

## Standard 'Specials' in Shallcross Miniature Switches



PRE-WIRED & HARNESED SWITCHES — Decks pre-wired before ganging to reduce your production costs and time.



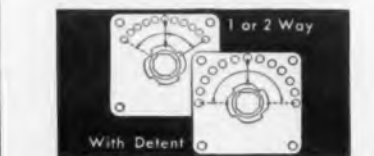
GOLD PLATED CONTACTS & TERMINALS—for the ultimate in maintaining low, stable contact resistance under corrosive conditions.



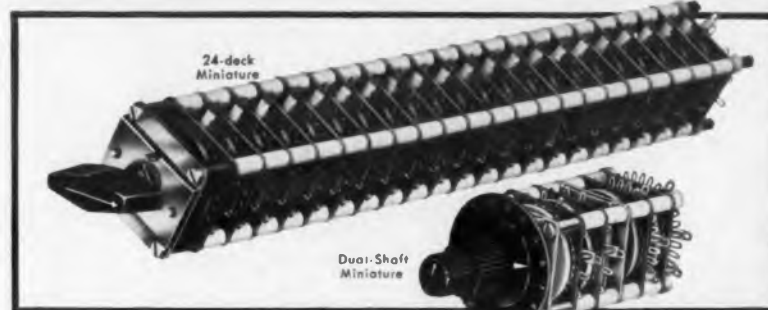
PRINTED CIRCUIT TERMINALS—available on single-deck or last deck of multi-deck switches.



CLUSTER ARM ROTORS—for progressive shorting or progressive-making circuits.



SPRING RETURN ROTORS—on either or both directions of rotor travel.



## MAXIMUM CIRCUIT SWITCHING IN MINIMUM SPACE

Here's a positive approach to miniaturization—a way to handle more circuits per cubic inch! Conservatively estimated, over 650 circuits may be switched in only 38 cubic inches by a Shallcross Miniature Series switch . . . and with the quality and reliability only a button-contact, multi-leaf wiper arm switch can provide. In one recent application, the single 24-deck Shallcross Miniature switch shown above replaced four "subminiature" units.

Equally impressive space advantages are possible with dual concentric shaft versions of the Shallcross Miniature Series. Either shaft may

operate up to five of a total of ten decks. The inner shaft may also control a rheostat, variable capacitor, or other device.

If, in addition to size, switch quality is also your concern, the following highlights substantiate why Shallcross Miniature Switch users repeatedly specify these switches, and no others, for critical airborne, missile control, and computer applications.

**Low initial contact resistance**—less than 0.002 ohm.

**Stable contact resistance**—0.5 milliohm for 10,000 operations.

**Highly immune to vibration damage**—exceeds MIL-S-3786 requirements.

**Uncompromised material quality**—silver button contacts; silver alloy, multi-leaf, self-cleaning wipers; diallyl phthalate rotors; epoxy-laminate decks (filament woven with glass fiber).

**Designed to applicable MIL-S-3786 Specifications.**

**Minimum thermocouple effects**—similar materials for all current-carrying parts.

**Excellent RF characteristics.**

**Minimum depth**—1" first deck,  $5/8$ " each additional deck.

**Maximum Versatility**—up to 32 positions, 1 to 4 poles, shorting or non-shorting in the same switch, 1 to 24 decks, ball detents, many special modifications.

For complete details, write for Shallcross Switch Bulletin

## Solenoid-Operated Switches



For indirect switching of complex circuits, or to avoid "over stepping" positions in critical circuits, most Shallcross Miniature Switches can be furnished with solenoid operation. Outline your circuit requirements for a prompt recommendation by Shallcross engineers.

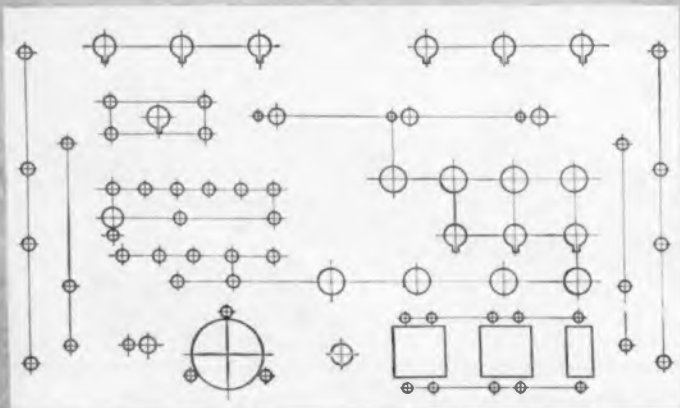
**Shallcross Manufacturing Co.** Selma, North Carolina

Precision wirewound resistors, Switches, Instruments, D. ay lines, Resistance networks, Audio attenuators.

CIRCLE 135 ON READER-SERVICE CARD



## RAYTHEON PANEL COMPONENTS FIT RIGHT INTO YOUR DESIGNS



for equipment that deserves  
the precision-engineered look

### PANEL BRACKETS

Provide rigid support under shock or vibration  
• Mount single or double panels • Meet military specifications • Cold-rolled carbon steel, cadmium plated.

### KNOB LOCKS

Prevent control movement by shock or vibration or accidental movement • No slippage • Replace potentiometer mounting hardware • Match standard Raytheon knobs • Available in Mirror or Matte finish.

### SHAFT LOCKS

For use with screwdriver-adjusted controls • Constant friction drag prevents accidental rotation • Provide seal against dirt and moisture • Replace standard mounting hardware • Under knob and standard types available.

### CAPTIVE HARDWARE

Stainless steel construction • Wide assortment of matching stock sizes and styles • Meet military specifications • Neoprene gasket provides dirt and moisture seal.

### WRITE FOR DATA

Complete technical data and specifications are available on Raytheon's full line of quality panel hardware and control knobs. Please write to: Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Mass.



Raytheon Panel Components Available From Local Franchised  
Raytheon Distributors

**RAYTHEON**

**RAYTHEON COMPANY**

Industrial Components Division

CIRCLE 136 ON READER-SERVICE CARD

## NEW PRODUCTS

### Variable Transformer

446



Rated at 50-amp, 0 to 140 v with 120-v input, the model T501U variable transformer is said to have very fine resolution. Designed for either panel or bench mounting, the unit has a square aluminum base providing heat transfer from the coil. Balanced rotor snaps on and off. Transformer measures 13-5/8 x 12-1/2 x 5-1/2 in.

Standard Electrical Products Co., Dept. ED, 2240 E. Third St., Dayton, Ohio.

### AC Line Voltage Regulator

433

With 5-kva capacity, the ac line voltage regulator is a buck-boost, servo type which is said to introduce no wave-form distortion into the ac output. Two models are available; output on one is adjustable  $\pm 10\%$  from a nominal 115 v and another variable from 0 to 135 v. Regulation is better than 0.2% for line and load changes. Made for 19-in. rack mounting, fixed model is 5-1/4 in. high and variable model is 21-in. high.

Davenport Manufacturing Div., Duncan Electric Co., Dept. ED, 2530 N. Elston Ave., Chicago 47, Ill.

### Signal Generator

406



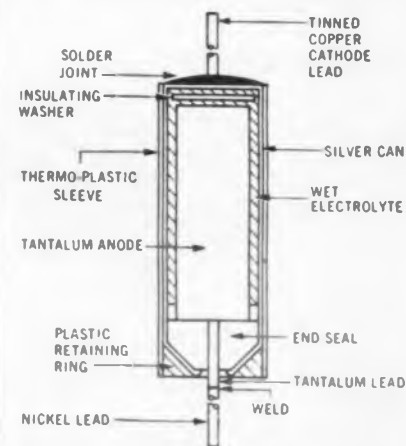
Features 6-band extended frequency range. Model N-2 operates from 115-v line and produces an output of 0 to 10 v rms. Distortion is 0.1% from 100 cps to 350 kc, 0.25% from 10 to 100 cps, 1% from 1 to 10 cps. Line voltage changes from 105 to 125 v ac do not affect the accuracy of its output.

Hathaway Denver, Dept. ED, 5800 E. Jewell Ave., Denver 22, Colo.

# NEW STRAIGHT WALL TANTALUM CAPACITOR CAN'T LEAK

Meets MIL C 3965-B. Style CL-64, CL-65.

A new space-saving approach to the design of wet tantalum capacitors ends mounting problems encountered with flanged types and yet will not leak.



ITT's compact, sintered slug tantalum capacitor features a wedge-shaped seal held under compression by an epoxy retainer ring formulated for thermal characteristics inverse to those of silver. Ordinary, straight-wall capacitors leak along the lead when elastomer compression is reduced as the silver can expands. Not so with the new ITT design!

This new, compact capacitor conforms to specifications MIL C 3965-B, Style CL-64, CL-65 and provides both the compactness and rugged reliability required in missile, airborne and mobile equipment. For details, write today requesting Bulletin No. 610.



**CAPACITOR DEPARTMENT  
COMPONENTS DIVISION**

INTERNATIONAL TELEPHONE AND TELEGRAPH  
CORPORATION, PALO ALTO, CALIFORNIA

CIRCLE 137 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

## Vacuum Gages

627



Self-contained, miniaturized circuitry is attached directly to the rear of the indicating meter on this line of compact vacuum gages. The complete gage mounts in any panel, requiring only a standard meter panel cutout. Three ranges are offered from 0.2 micron Hg through 20 mm Hg. Up to 5 positions can be monitored with one instrument.

Hastings-Raydist, Inc., Dept. ED, Hampton, Va.

P&A: \$110 each; immediate.

## Insulating Varnishes 597

Diallyl phthalate and diallyl isophthalate insulating resins, RAM-23-X4 and RAM 23-X5 are for coating sealing and encapsulating uses. The X4 formulation functions at 150 C, continuous; the X5, at 180 C. They have unusual resistance to moisture, chemicals, corrosion and weathering.

RAM Chemicals, Inc., Dept. ED, P. O. Box 192, 210 E. Alondra Blvd., Gardena, Calif.

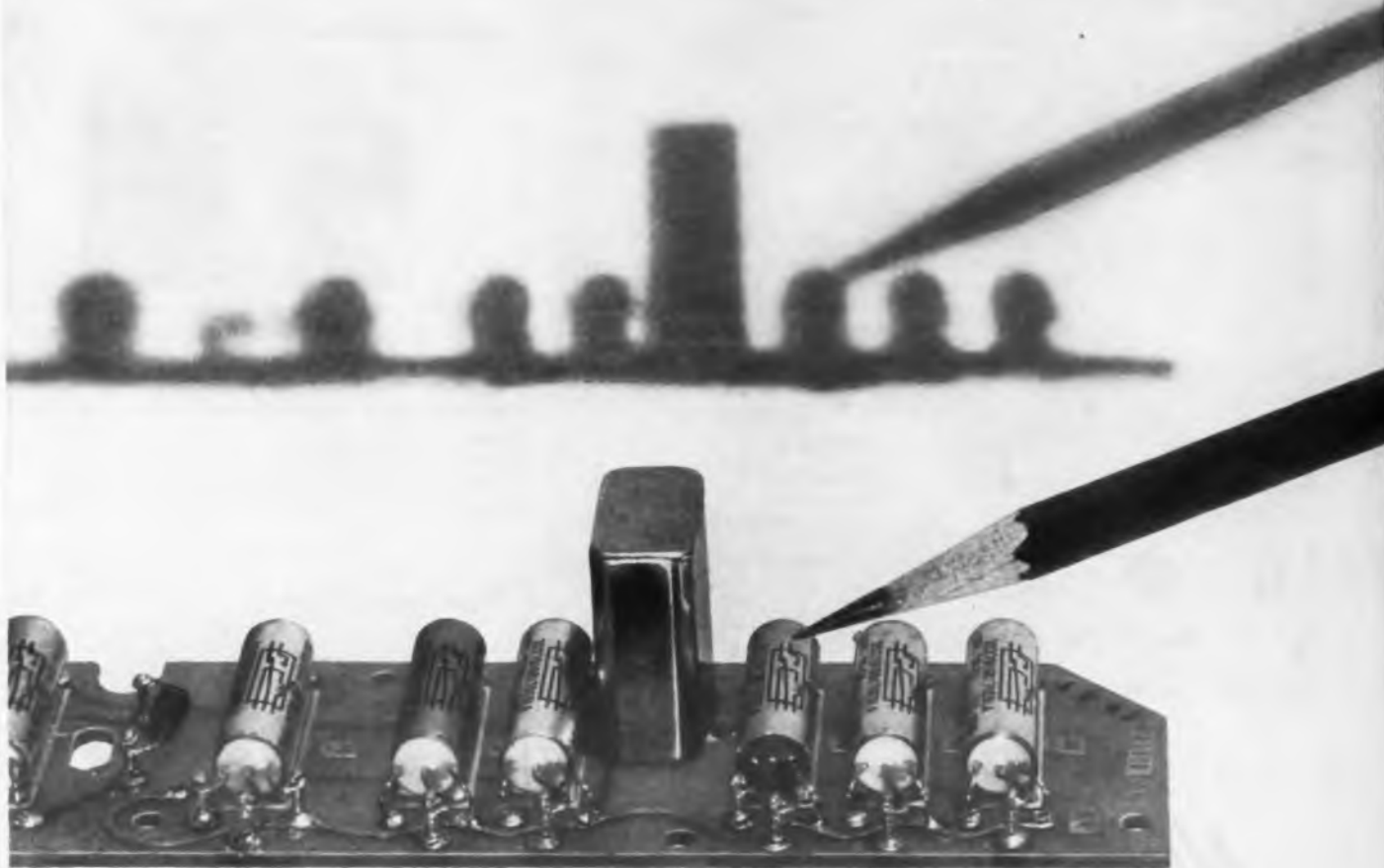
## Tantalum Capacitors 380



Polar and nonpolar, solid tantalum capacitors have insulated, hermetically sealed cases. The STA polar series has ten ratings of 300 to 4,000  $\mu$ f and the STAN series of ten nonpolar capacitors range from 150 to 2,000  $\mu$ f. All ratings are for 6 to 35 max vdc, at ambients of -55 C to +125 C, with linear deratings above 85 C, to 67% at +125 C.

Fansteel Metallurgical Corp., Dept. ED, Rectifier-Capacitor Div., North Chicago, Ill.

## GENERAL ELECTRIC SEALED RELAYS — UNMATCHED FOR RELIABILITY



### New Unimite relays are only $\frac{1}{3}$ rd the height of crystal cans, make boards "wafer" thin

With new General Electric Unimite relays, you can lay out a switching circuit .374" thin, including mounting! Mount Unimites on their .900" side, and they stand only .320" off the board— $\frac{1}{3}$ rd the height of "stand-up" crystal-can types.

And there's no performance compromise! Rated one amp, 28vdc, spdt, Unimites switch in a fast 1.5 milliseconds. They weigh only .105 ounce.

In addition, Unimites offer characteristic G-E

high reliability. General Electric's exclusive all-welded construction eliminates solder- and flux-caused malfunctions. Internal contamination is eliminated by isolating the contact chamber, and by using chemically inert materials.

Best of all, Unimites are available now! Call your G-E Sales Engineer. Or, write for Bulletin GEA-6822, to General Electric Co., Schenectady, New York. Specialty Control Department, Waynesboro, Va. 792-20

*Progress Is Our Most Important Product*

GENERAL  ELECTRIC

## WHAT'S YOUR TRANSISTOR COOLING PROBLEM?

Whatever it is, you can probably find the solution with a Birtcher Radiator. Available in sizes and designs to most efficiently cool all popularly used (and many special) transistors. Test reports show up to 27% more transistor efficiency!

AVAILABLE FROM AUTHORIZED BIRTCHER DISTRIBUTORS



**NEW!**  
TRANSISTOR  
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CATALOG 1-HR

*Just off the press - write for it*

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**THE BIRTCHER CORPORATION**

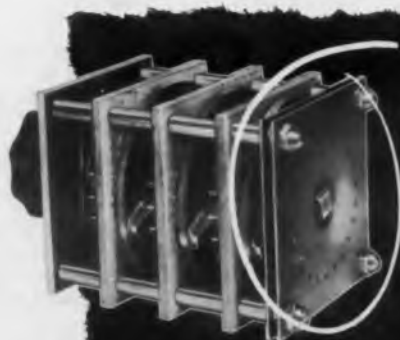
INDUSTRIAL DIVISION

745 S. MONTEREY PASS ROAD, MONTEREY PARK, CALIFORNIA

CIRCLE 139 ON READER-SERVICE CARD

## NEW FROM **Langevin**

PRECISION INSTRUMENT SWITCHES  
WITH **Adjustable Stops!**



Adjustable  
Stop Mechanism

1. Stops can be set after switch is mounted
2. Adjustment to contacts in any position on contact array
3. Use **only** a socket wrench for quick, easy change

Langevin offers a free 24 page "Guide to Choosing Precision Instrument Switches" to those requesting it.



**Langevin**



A Division of  
Sonotec  
Incorporated

503 SOUTH GRAND AVENUE • SANTA ANA, CALIFORNIA

CIRCLE 140 ON READER-SERVICE CARD

## NEW PRODUCTS

### Nylon-Insulated Slide Switch 444



Clearance of only 1/2 in. is required by the series SS-37 slide switch. Switch is nylon-insulated and rated at 6 amp. Unit, excluding trigger, measures 1-5/8 x 1/2 x 1/2 in. Terminals, silver-plated, accept soldered or solderless connections.

Stackpole Carbon Co., Electronic Components Div., Dept. ED, St. Marys, Pa.

P&A: \$0.10 ea for 10,000; 3 weeks.

### High-Speed Counter 453



Model T276 is available in five models from a seven digit 500 per sec 166 hour test time model to a ten digit 100,000 per sec 277 hour test time model. The unit may be used with a contact switch, photoelectric cell or motion sensing device. No preamplifier is required.

Avtron Manufacturing, Inc., Dept. ED, 10409 Meech Ave., Cleveland 5, Ohio.

Price: from \$245.00.

### Hysteresis Clutch 442



Fractional horsepower hysteresis clutch delivers controllable torque through a range of speeds and loads. Unit illustrated is rated at 1/20 hp, 1,800 rpm and measures 2-1/2 in. OD. Devices are capable of synchronous driving or continuous slip with negligible torque variation at any slip differential.

Scanner Corp. of America, Dept. ED, 30595 W. Eight Mile Road, Livonia, Mich.

Let us show  
you how to  
**KEEP  
COMPONENT  
COSTS  
DOWN!**

**PRECISION  
WIRE FORMS**



Send a sample or blue print  
for estimates.

Art Wire specializes in wire forms designed for today's automatic production lines . . . manufactured with the precision and uniformity that assure the economy of an uninterrupted work flow. Reduced down-time, and the lower costs made possible by Art Wire's modern production methods mean greater savings to you, and greater profit in your operations.

**ART WIRE AND STAMPING CO.**

17 Boyden Place, Newark 2, N. J.

CIRCLE 141 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

# SPEED UP TECHNICIAN TRAINING WITH NEW **ERECTRONIC**<sup>®</sup> SYSTEM KIT BE-7 AND EIA MANUAL



New ERECTRONIC Kit provides all components mounted on plastic bases with patented jiffy connectors for pegboard breadboarding of thirty-nine experiments.

Used with "Industrial Electronics" manual developed by EIA (Electronic Industries Association), the student quickly gains an understanding of basic circuits and their application.

## The "Industrial Electronics" course covers:

- Computers
- Thyratrons and Thyatron Control
- Time Constants
- Vacuum Tube and Transistor Time-Delay Relays
- Photo-Electric Control
- Phototransistor Relays
- Saturable Reactor
- Peaking Transformer
- Motor Control
- Regulated Power Supplies
- Radio and Tone Control Systems
- Gaseous Rectifiers
- Synchros
- Servo-mechanisms

Write for Technical Data on the new ERECTRONIC Kit BE-7

## SCIENCE ELECTRONICS, INC.

195 Massachusetts Avenue, Cambridge 39, Mass.

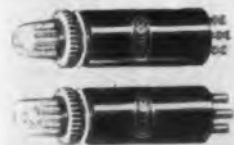
a subsidiary of

GENERAL ELECTRONIC LABORATORIES, INC.

CIRCLE 142 ON READER-SERVICE CARD

## Indicator Lights

454



STI-series subminiature transistorized neon-lights measure 1-15/16-in. in over-all length and mount in a 3/8-in. clearance hole from back of the panel. Socket, lamp, and all connections are well-insulated from the mounting bushing. The units accommodate NE-2E or NE-2V neon lamps and meet applicable military specifications.

Dialight Corp., Dept. ED, 60 Stewart Ave., Brooklyn 37, N. Y.

Price: \$4 to \$11.

## Variable Potentiometer

441



Infinite-resolution potentiometer pick-off converts linear wiper motion into linear or non-linear voltage. Designated model 10111, the unit is linear to 0.05% per in., and is compensated for electrical loading. Resistances from 500 ohms to 100-K per in. are available. Nonmetal thin-film resistance element is noninductive and has a guaranteed life of more than 10 million cycles. Ganged units are available.

Computer Instruments Corp., Dept. ED, 92 Madison Ave., Hempstead, L. I., N. Y.

## Electronic Control Stations

448



Made for 24-v and 1-v systems, these electronic control stations have a manual power supply and are designed for compact panel mounting. Series 701K station provides process indication meters; series 701N is non-indicating. Chassis may be partially removed from panel while in operation. Mode can be switched from automatic to manual.

Taylor Instrument Co., Dept. ED, 95 Ames St., Rochester 1, N. Y.

CIRCLE 143 ON READER-SERVICE CARD ➤

## Cary Vibrating Reed ELECTROMETERS...



### MODEL 31

Detects currents to 10  $\mu\mu$  amps, voltages to 20  $\mu$ v. Ten ranges, separate input preamplifier, and special features offer exceptional versatility.



### MODEL 32

Provides excellent performance, similar to Model 31, at lower cost. Primarily designed for radiation studies. Four ranges, built-in preamplifier unit.



### MODEL 36

Offers exceptional response, DC to 10 cps, sensitivity and stability for small currents to 10<sup>-15</sup> ampere originating in a high impedance source.

For details regarding the various applications, specifications and

accessories for all Cary Electrometers...ask for Data File M 30-111

...outstanding instruments for precise, reliable measurement of extremely small charges, currents and voltages. Several models along with many accessories serve a variety of applications including radioisotope assays, ion current measurements, pH determinations, and solid-state studies. Inquiries regarding special problems are invited.

APPLIED PHYSICS CORPORATION  
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INSTRUMENTS

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## How to find laminations when you need them fast!

High permeability lamination stock list goes out to purchasing agents and engineers semimonthly

A stock list, mailed every other week, pinpoints the quantities and sizes of our high permeability laminations that are immediately available from stock. It's sent to purchasing agents and interested engineers throughout the country. To get your regular copy, just address a request to Magnetics Inc., Department ED-94, Butler, Pa.

*What makes the stock list important?* Depleted inventories or stepped-up production means that when laminations are needed, they're needed fast—and in perfect condition. Magnetics Inc. stock list shows what types are available for immediate shipment. In addition, the stock list contains information on the new higher permeability "E" grade laminations. What's more, stocks listed reinforce those maintained at regional outlets on the east and west coast (all connected by teletype to assure fast delivery).

What makes Magnetics Inc. high permeability lamina-

tions special is the fact that they are the heart of high performance audio transformers, chokes and countless other fast response magnetic devices. They're burr-free, precision-sized and flat (thanks in part to a standardized 9" long carton that keeps the laminations undistorted during shipment and stocking). For more information, write to Magnetics Inc., Dept. ED-94, Butler, Pa.

*Magnetics Inc. also publishes a bi-weekly stock list on tape wound cores and permalloy powder cores. It's available to you along with the laminations stock list. Ask for it.*

**MAGNETICS inc.**

CIRCLE 179 ON READER-SERVICE CARD

## PRODUCTION PRODUCTS

### Toroidal Coil-Winding Head

260

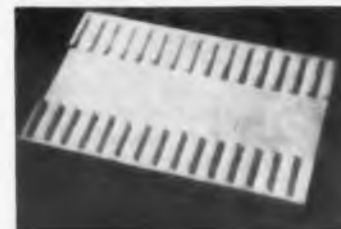


For heavy wire build-up. Type 601 toroidal coil winding-head assembly has a two-piece magazine which opens in half for easy insertion of cores. Six magazines can be furnished for winding coils with inside diameters of 5/8 to 1-1/4 in. Wire sizes 20 to 28 AWG can be accommodated.

Waltham Precision Instrument Co., Inc., Boesch Manufacturing Div., Dept. ED, 45 River St., Danbury, Conn.

### Production Trays

261



Form-fitting production trays are custom-molded of foamed plastic to protect delicate parts in assembly. Units are reusable. Plastic is not affected by water, oil, gasoline, or alcohol, and does not scratch.

Pac-Tron, Inc., Dept. ED, 225 Crescent St., Waltham, Mass.

### Vibratory Parts Feeder

262



Electromagnetic drive operates at the rate of 3,600 vibrations per min. Model 251 vibratory parts feeder is designed to feed parts up to 4 in. long into a 24-in., cast-aluminum bowl. A spirally inclined 1-1/4 in. track is built around the inside perimeter of the bowl. Rate of feed is adjustable by means of a rheostat control.

Elk Engineering Works, Dept. ED, St. Marys, Pa.

## Miniature-Parts Header

263



Variable-speed drive permits instantaneous speed adjustment while the machine is in operation. Fly-wheel speed can be adjusted from 150 to 300 rpm. Model 00 miniature-parts header has a wire diameter range of 0.012 to 0.07 in.

REM Sales Inc., Dept. ED, P. O. Box 41, West Hartford, Conn.

## Machine Tool Position Display

264



For partial automation, these position displays indicate numerically the position of machine tools. Machines are rated at 20,000 counts per sec. Model PD5 has five decades; model PD6 has six decades. Magnitude and direction of motion are indicated, and machine zero is displayed. Typical resolution is 0.0001 in.

Rheem Manufacturing Co., Electronics Div., Dept. ED, 5200 W. 104th St., Los Angeles, Calif.

Price: \$1,350 and \$1,495.

## Soldering-Gun Attachment

265



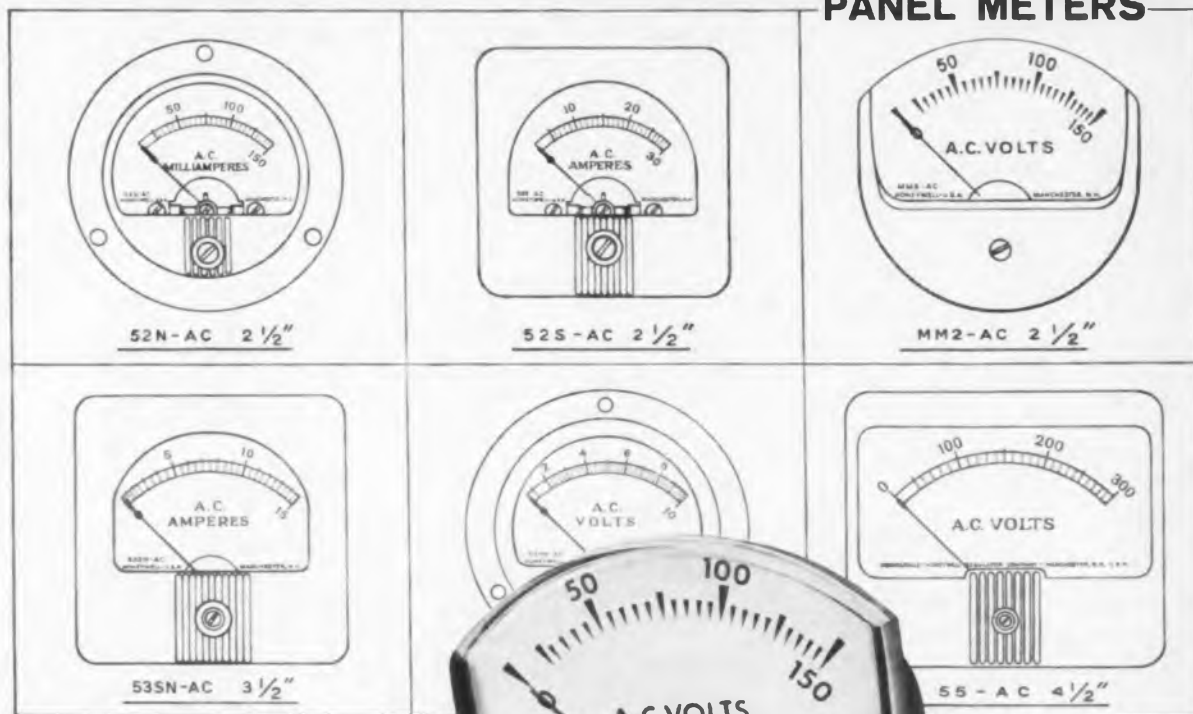
For printed-circuit soldering. Attachment sucks excess melted solder from printed-circuit boards into a porcelain cup. Device includes a special replacement tip, on which is mounted the porcelain cup to receive excess solder, and an attached plastic hose and squeeze-type rubber suction bulb.

Cyclops Manufacturing Co., Dept. ED, 20839 Fenkell, Detroit 23, Mich.

Price: \$7.95 each.

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These meters are available in a wide selection of case styles and colors. Dials can be custom designed with your company name, trade-mark or other data. For full information, contact our representative in your area — he's listed in your classified telephone directory. Or us: Precision Meter Division,


Minneapolis-Honeywell Regulator Co., Manchester, N. H., U. S. A.

In Canada, Honeywell Controls Limited, Toronto 17, Ontario

and around the world: HONEYWELL INTERNATIONAL — Sales and service offices in all principal cities of the world.

CIRCLE 180 ON READER-SERVICE CARD

## Honeywell

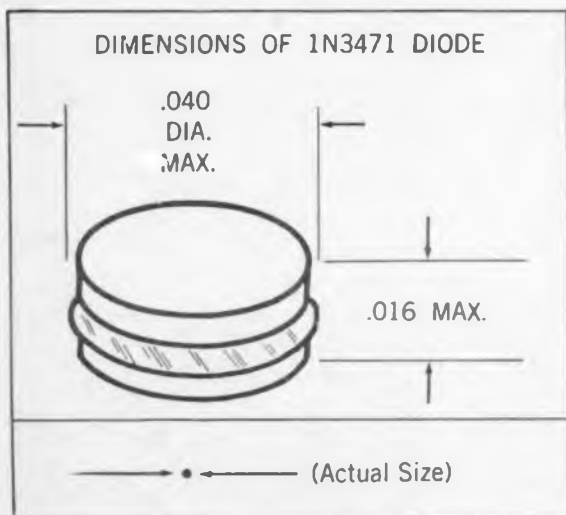
 Precision Meters

To Contractors and Subcontractors on U. S. Government Projects

## THE 1N3471 "PINHEAD"

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Microminiature Switching Diode  
from Laureldale

The 1N3471 is a diffused silicon microminiature switching diode designed for high-speed operation. The size and construction of this pinhead diode suit it for high-density packaging. Controlled manufacturing conditions assure the circuit designer of uniform lot-to-lot diode characteristics with exceptional performance and reliability. (A leaded version of the 1N3471 diode is also available.)



### MAXIMUM RATINGS

(Mounting Surface Temp. 100° C)

BV	40 Min.
Power dissipation	0.5 Watt
Tstg	-65° C to +250° C
I <sub>F</sub>	120 mA dc

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#### FOR ELECTRICAL CHARACTERIZATION

trr (I <sub>F</sub> = I <sub>R</sub> = 10 mA dc)	2 nsec max.
V <sub>f</sub> (I <sub>F</sub> = 10 mA dc)	1 Volt dc
I <sub>s</sub> (V <sub>R</sub> = 20 V dc)	20 nA dc
C (V <sub>R</sub> = 0; f <sub>0</sub> = 100 kc)	3 pf
BV (I <sub>R</sub> = 5 μA dc)	40 V dc

The 1N3471 microminiature switching diode can be purchased in quantity from Western Electric's Laureldale Plant. For technical information, price, and delivery, please address your request to: Sales Department, Room 103, Western Electric Company, Incorporated, Laureldale Plant, Laureldale, Pa. Telephone—Area Code 215—Walker 9-9411.

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## DESIGN DECISIONS

Featuring the clever and unusual in packaging, appearance design, and circuitry in electronic equipment.

### Reversed Weld Nut Makes Low-Cost Detent

Standard, commercial weld nuts, used backwards, provide an unusual low-cost detent in an inexpensive citizen's-band transceiver.

The weld nuts, manufactured by Ohio Weld-Nut Co., have three dimples which are Co. of 33-00 Northern Blvd., Long Island City, N. Y., welds the reverse surfaces of used as weld points. Electronic Instrument



Standard weld nut, with reverse side welded to instrument case, exposes three dimples. Dimples hold detent plate in place.



Detent plate is secured by standard thumb screw and lock washer through carrying handle.

ELECTRONIC DESIGN • November 8, 1961



Carrying handle can be rotated in 30-deg increments to form support bracket.

these nuts to the sides of the instrument case of the transceiver.

The dimples position a steel stamping that serves as a detent plate. The very simple and inexpensive arrangement allows the carrying handle to be positioned around the case in 30-deg increments so it can serve as a handle or support bracket.

Commenting on his design, project engineer Vincent Proc points out that when an inexpensive, standard, commercial part can do a job well, it is always to be preferred over a "special."

### Rubber Cores in Eyelets Speed Circuit Breadboarding

Anyone who has used a breadboard knows the problems inherent in the usual spring-type contacts. They work quite well when leads of equal diameter are inserted. But if it is necessary to join two or more leads of different diameters—like the leads of a small diode and a 2-w resistor—the contacts usually are quite unsatisfactory. The larger wire eases the contact's grip on the smaller one and the small component tends to lose contact.

A novel approach to this problem appears in the "Circuit Builder," manufactured by Circuit Structures Laboratory of Laguna Beach, Calif. This breadboard, conceived by Edmund L. Van Deusen, vice president of the company, uses rubber cores in gold-plated



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**J. W. MILLER COMPANY • 5917 So. Main St., Los Angeles 3, Calif.**

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## DESIGN DECISIONS



Rubber cores in gold-plated eyelets make it easy to connect leads of different diameters in this breadboard.

eyelets to secure component leads at tie points.

A slight tug at one of the rubber cores makes it easy to insert additional component leads into a tie point without dislodging any other leads.

## Round Lights Cut Cost, Improve Panel Appearance

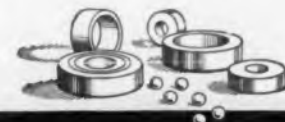
A switch from square panel-light lenses to round ones helped engineers at General Electric's Computer Dept. to cut the cost and improve the appearance of panels in the GE 3100 Status Monitor.

The original concept in designing the panel lights was that square lenses would look neater and more attractive than other shapes. But in the Status Monitor, 20 panels are stacked in a vertical array. To avoid a lopsided appearance of the panel lights, it was necessary to maintain a 1-mil tolerance in the positions of the four sides of the square holes that retain the lenses.

Any slight misalignment or lack of parallelism would have been exaggerated by the



Slight lack of parallelism in square panel-light lenses is exaggerated by viewer.



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ELECTRONIC DESIGN • November 8, 1961

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ELECTRONIC DESIGN • November 8, 1961



Change to round lenses eliminates appearance of misalignment.

eye and would have given an appearance of careless workmanship.

The change to round lenses eased the hole tolerances by a factor of about 10, according to Henry H. Bluhm, industrial designer.

**Watch Crowns Crown Efforts To Waterproof Shaft Seals**

Commercially available waterproof watch crowns make excellent seals for precision instruments that must be both adjustable and waterproof. They must meet the Federal Trade Commission standard that defines

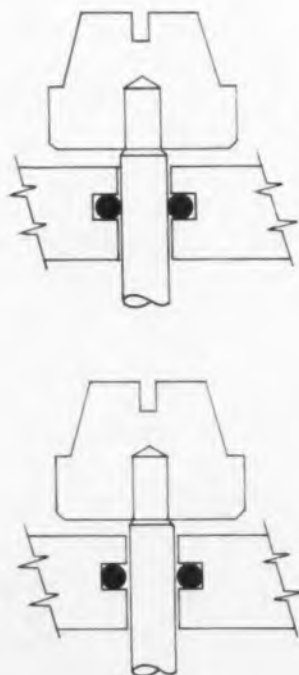


Fig. 1. Conventional "O" ring seal makes good dust seal, but water pressure can force the ring to periphery of oversized slot, making for leaks.

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50 CONTACTS



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## DESIGN DECISIONS

"waterproof" as the ability to withstand 35 psi without leaking.

The same waterproofing techniques that watchmakers use so successfully have been used in designing sealing knobs for precision electronic equipment, potentiometers, and other adjustable devices. These knobs, designed by Joseph Waldman & Sons of Irvington, N. J., withstand 72 psi. With modifications, they can be built to take more than 100 psi.

The problem with electronic equipment is that a low torque is often required for precise adjustments and this often conflicts with waterproofing requirements. The conventional seal has a circular retaining slot cut into the wall of the case to hold a sealing ring. As shown in Fig. 1, the slot must have a slightly larger OD than the ring to allow the ring to get into it.

This makes for an adequate dust seal, but water pressure can force the sealing ring out of shape and back into the retaining slot. The ring pulls away from the adjustment shaft and leaks result.

The seal in Fig. 2 overcomes this problem. The recess for the "O" ring seal is slightly smaller than the ring so the ring always maintains positive pressure at four separate points. This is possible because the ring is held in place by a retaining washer so it does not need extra space for insertion.

In this case, water pressure increases the pressure at all four contact points and actually improves the seal. The positive pressure also makes for good vibration resistance. Because only a small tangent edge of the sealing ring contacts the case, the shaft requires very low torque, only 0.3 in. oz.

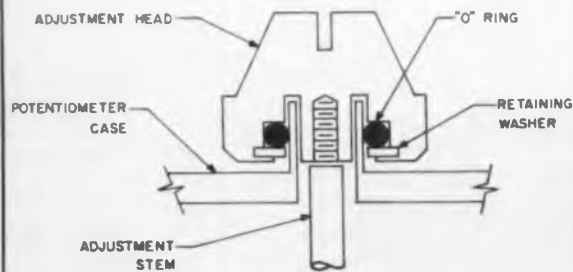


Fig. 2. "O" ring retained, as in watch crown, actually improves seal under pressure.

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ELECTRONIC DESIGN • November 8, 1961

DESIGN

ENGINEERING DATA

# Simplified Design Procedure For Tuned Class-B Power Amplifiers

There's nothing particularly complex about designing tuned class-B power amplifiers. But the design usually involves a good deal of drudgery which paves the way for errors. In this article, author Everett Moore gives a design procedure that obviates the drudgery.

**H. Everett Moore**  
Government Electronics Div.  
Admiral Corp.  
Chicago, Ill.

THE cumbersome calculations normally required in designing tuned class-B amplifiers can be avoided. A simplified technique, along with a graphical plot, give a rapid, precise solution for the resonant, plate-load resistance,  $R_o$ .

To design for the optimum condition ( $e_{b \text{ min}} = e_{c \text{ max}}$ ) in tuned class-B power am-

plifiers, one normally has to solve the rather messy equation

$$R_o^2 + \left[ \frac{4r_p}{\mu+1} - \frac{E_{bb}^2}{P_p} \left( \frac{2}{\pi} - \frac{1}{2} \right) \right] R_o + \left[ \frac{4r_p^2}{(\mu+1)^2} - \frac{E_{bb}^2}{P_p} \frac{4}{\pi} \frac{r_p}{\mu+1} \right] = 0 \quad (1)$$

where

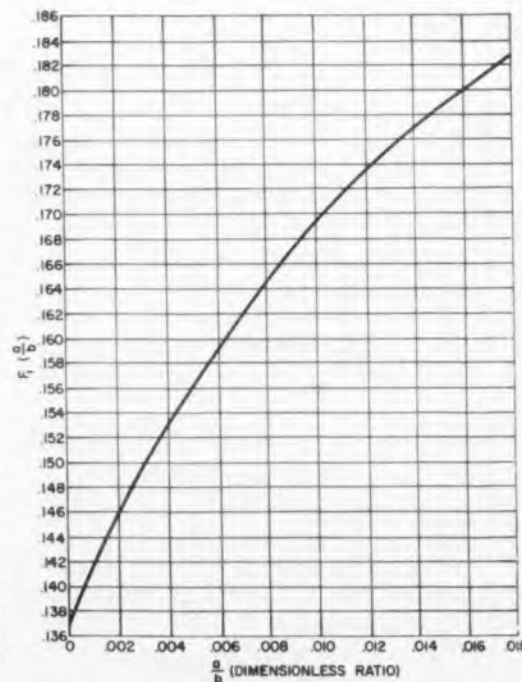
- $E_{bb}$  = plate-supply voltage
- $P_p$  = plate dissipation
- $e_{b \text{ min}}$  = instantaneous plate-voltage minimum swing
- $e_{c \text{ max}}$  = instantaneous control-grid voltage maximum swing
- $r_p$  = dynamic plate resistance
- $\mu$  = tube amplification factor
- $R_o = L/RC$  = tuned resistance of parallel-tuned plate-load

For a given tube, with a given dc plate supply and a given plate dissipation (not necessarily the maximum rating for the tube), Eq. 1 gives the necessary  $R_o$  for maximum power output. If  $n$  is defined as equal to  $e_{b \text{ min}}/e_{c \text{ max}}$ , then Eq. 1 can be rewritten as

$$R_o^2 + \left[ \frac{4nr_p}{\mu+n} - \frac{E_{bb}^2}{P_p} \left( \frac{2}{\pi} - \frac{1}{2} \right) \right] R_o + \left[ \frac{4n^2r_p^2}{(\mu+n)^2} - \frac{E_{bb}^2}{P_p} \frac{4}{\pi} \frac{nr_p}{\mu+n} \right] = 0 \quad (2)$$

But both Eqs. 1 and 2 are cumbersome; neither is especially suitable for quick, easy, and accurate slide-rule calculations, nor for evaluating the significance of any given parameter in a design.

Fortunately, we can reduce the calculation of  $R_o$  to a simpler form involving fewer



Graph for solving for tuned resistance of plate-load tank in class-B power amplifiers.





Photo: Stelma, Inc., Stamford, Conn.  
Electronic Communications Systems

## Becco Ammonium Persulfate etches cleanly!

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9. Equipment corrosion is minimized.
10. Cost of etching solution is low.
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## ENGINEERING DATA

steps. We can define two new parameters (having the units of resistance) and express  $R_o$  as a function of the new parameters  $a$  and  $b$ . We can then use a graphical plot of the function  $F_1(a/b)$  vs  $a/b$  for a very rapid, precise determination of  $R_o$ .

We start by defining the parameters  $a$  and  $b$  and a constant  $c$ .

$$a \equiv \frac{nr_p}{\mu + n} \quad b \equiv \frac{E_{bb}^2}{P_p} \quad c \equiv \frac{2}{\pi} - \frac{1}{2}$$

With insertion of parameters, Eq. 2 becomes

$$R_o^2 + (4a - bc)R_o + 4\left(a^2 - \frac{ab}{\pi}\right) = 0 \quad (3)$$

which, after solution of the quadratic and rearrangement, takes the final form

$$R_o = \frac{c}{2}b \left[ \left(1 - \frac{4}{c} \frac{a}{b}\right) + \sqrt{1 + \frac{4}{c^2} \frac{a}{b}} \right] \quad (4)$$

After the constants are inserted, the relationship plotted in the graph becomes

$$F_1\left(\frac{a}{b}\right) = 0.06831 \left[ \left(1 - 29.28 \frac{a}{b}\right) + \sqrt{1 + 214.3 \frac{a}{b}} \right] \quad (5)$$

### Design Procedure

**Given:**  $e_{b \min}/e_{c \max}, \mu, r_p, E_{bb}, P_p$

- Step 1.** (a) Compute  $n = e_{b \min}/e_{c \max}$  OR (b) Set  $n = 1$  for optimum case.
- Step 2.** Compute  $a = nr_p/(\mu + n)$ ,  $b = E_{bb}^2/P_p$ , and  $a/b$ .
- Step 3.** From the graph, read  $F_1(a/b)$  for the computed value of  $a/b$ .
- Step 4.** Compute  $R_o = bF_1(a/b)$ .

### Sample Calculations

**Given:** An 833A triode with  $\mu = 35$  and  $r_p = 2,215$  ohms.  $E_{bb} = 4,000$  v and  $P_p = 400$  w.

- Step 1.** Set  $n = 1$  for maximum power output
- Step 2.**  $a = (1)(2,215)/(35 + 1) = 61.53$   
 $b = 16(10)^6/400 = 40,000$   $a/b = 0.00154$
- Step 3.** From the graph, for  $a/b = 0.00154$ ,  $F_1(a/b) = 0.1440$
- Step 4.**  $R_o = 40,000 \times 0.1440 = 5,760$  ohms. ■ ■

### Acknowledgment

The author wishes to acknowledge the work of Nicholas T. Neapolitakis of the Department of Electrical Engineering at Illinois Institute of Technology. Mr. Neapolitakis derived equations leading to Eq. 2 in this article.

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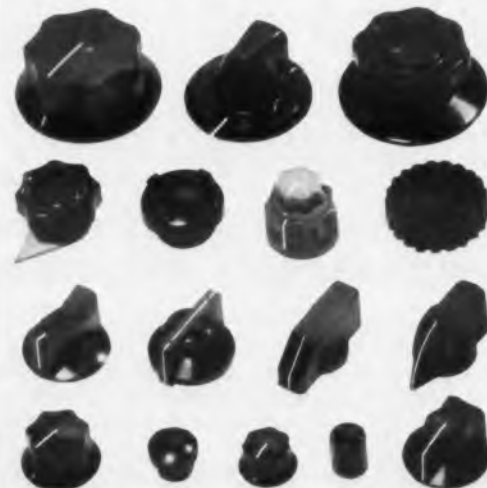
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## NEW LITERATURE

### Digital Circuitry 266

"Digital Application Notes" is a new 68-page handbook covering applications of digital circuitry. It contains chapters on basic logic design principles, graphic symbols, logic modules and circuit configurations. Boolean algebra and the analysis of logical processes are also covered. Interstate Electronics Corp., 707 E. Vermont Ave., Anaheim, Calif.

### Inductive Devices 267

A complete 48-page catalog on molded rf chokes, if transformers, adjustable coils wound on stable ceramic and resinite materials, and exact replacement coils includes specifications, schematics and prices. J. W. Miller Co., 5917 S. Main St., Los Angeles, Calif.

### Electronic Components 268

Products covered in this 6-page catalog include the firm's complete line of tip plugs and jacks, as well as banana plugs and jacks. Meter type banana and tip plugs, test prods, binding posts, alligator clips, nylon tip jacks, two and three conductor phone jacks and plugs are included. A separate section carries 11 types of molded push-button terminal blocks. National Tel-Tronics Corp., 52 St. Casimir Ave., Yonkers, N. Y.

### Transistor Noise Analysis 269

"A Practical Approach to Transistor Noise" is a technical report which deals with the origin and nature of the various types of electrical noise generated in transistors. In addition, specific methods for the quantitative analyses of transistor noise are treated in detail. Quan-Tech Laboratories, Inc., Boonton, N.J.

### Solid-State Power Packs 270

The firm's complete line of high current, miniaturized regulated solid-state power packs is contained in bulletin No. 23-561. Full technical information is given on miniaturized units with outputs ranging from 5 to 32 v dc and current ratings up to 8 amp. Specification data, circuit information, operational data and physical characteristics are included. Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J.

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## NEW LITERATURE

### Torch Brazing

271

Use of low-temperature silver brazing alloys in torch brazing is discussed in this data file, "An Outline of Operations for Successful Torch Brazing with Silvaloy". Joint design, preparation for brazing, fluxing and assembling, heating and making the braze, cooling, flux removal, and inspection are discussed. Engelhard Industries, Inc., 75 Austin St., Newark 2, N. J.

### Plastic Film

272

Physical and electrical properties of Lexan polycarbonate films are outlined in this 13-page technical report, CDC-396. Curves describe strength and dielectric constant as a function of film thickness and temperature. Tables give other properties, chemical, electrical, and physical, for the film in both cast and extruded forms. General Electric Co., Chemical Materials Dept., 1 Plastics Ave., Pittsfield, Mass.

### Defense Products

273

"Facilities and Capabilities" of this firm's Defense Products Div. are described in a 28-page brochure. Major sections cover reconnaissance and mapping systems; data processing, display and interpretation systems; communication and special radar systems; optics; ordnance and numerous other products. Defense Products Div., Fairchild Camera and Instrument Corp., 300 Robbins Lane, Syosset, L. I., N. Y.

### Sensitive Test Instruments

274

Electrometers, electrometer amplifiers, linear and logarithmic microammeters, microvoltmeters, megohmmeters and bridges, voltage supplies and similar instruments are listed in this 32-page catalog. Illustrations, descriptions, specifications, and application suggestions are included. Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, Ohio.



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## Feedback Control Units 275

Brief descriptions of unique, high-performance feedback control hardware are provided in this six-page brochure. Included are: test equipment, sliderules, pressure transmitters and receivers, actuators, programmers and computers. Boonshaft and Fuchs, Inc., Hatboro Industrial Park, Hatboro, Pa.

## Audio Devices 276

Earphones, microphones, switches, plugs, jacks, sockets, and related devices for audio applications are described in 16-page catalog No. 1000. Illustrations, ratings, and dimensional drawings are included. Rye Sound Corp., 145 Elm St., Mamaroneck, N. Y.

## Electronic Template

Symbols on the No. 316 missile and space electronic template conform to MIL-STD 70327 specifications. Designed for precision drawing of electronic circuits used in guidance and

control systems of military hardware in space, the template is made of 0.03-in. matte finish plastic. Over-all size is 7 x 5 in. Send \$4.50 to Rapidesign, Inc., Dept. ED, P. O. Box 429, Burbank, Calif.

## Power Supplies 277

A wide variety of regulated, transistorized power supplies is described and illustrated in four-page Short Form Catalog 1961. Also included are three two-page bulletins on 10 amp, 25 amp, and 75-160 v supplies. Harrison Laboratories, Inc., 45 Industrial Road, Berkley Heights, N. J.

## Optical Products 278

A 16-page brochure covers the facilities and products of the Photo-Optical Div. of this firm. It describes the military camera, photo instrumentation and optical production capabilities as well as other related activities. Consolidated Systems Corp., Photo-Optical Div., 1725 S. Peck Road, Monrovia, Calif.



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## NEW LITERATURE

### Silicon Varactors 279

Described in this 4-page folder are 220 new epitaxial silicon high power varactors. It provides specific pointers on how to choose the appropriate varactor for best circuit performance. Also included are pointers for calculating the best diode choice for harmonic generator or modulator applications. Microwave Associates, Inc., Dept. HE, South Ave., Burlington, Mass.

### Digital Data Acquisition 280

A technical introduction to Micro-SADIC, an integrated, high-speed, general-purpose solid-state system capable of sampling several channels of analog data at up to 15,000 samples per sec is provided in 16-page bulletin 3047. A functional description of all the system's major components and detailed system specifications are included. Consolidated Systems Corp., 1500 S. Shamrock Ave., Monrovia, Calif.

### Closed-Circuit TV 281

A 10-page brochure describes how closed-circuit TV can be used for surveillance, transportation and dispatching, cost reduction and quality control, observation of hazardous locations and for other uses. Also described is the Mini-Camera, able to observe the interior of a 3-in. pipe. Electronics Div., Fairbanks, Morse & Co., 100 Electra Lane, Yonkers, N. Y.

### Mathematical Handbook 282

This 64-page pocketsize handbook contains powers and roots, logarithms, decimal equivalents, circular arc tables, mensuration formula, weights and measures, conversion factors, etc. Also included are business formulas such as profit and loss, markup, discount, etc. In addition it provides general arithmetical rules and formulas. Curta Co., 14436 Sherman Way, Van Nuys, Calif.

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### Digital Delay Lines 283

Three series of ultrasonic lines, for commercial or military systems, use glass or fused silica as delay media. They are described in a six-page designer's booklet, which includes operating data, as well as characteristics, for each series. Corning Electronic Components, Corning Glass Works, Bradford, Pa.

### Circuit Modules 284

A full line of encapsulated circuit modules designed to meet any specific application in military and industrial electronics, as well as special products fields, is described and illustrated in six-page bulletin CC-1. General Instrument Corp., Semiconductor Div., 65 Gouverneur St., Newark 4, N. J.

### Proximity Limit Switch 285

The CR115D proximity limit switch, for detection of ferrous and non-ferrous materials without physical contact, is covered in four-page

bulletin GEA-7318. Typical applications, including sorting, counting, inspection and limiting machine travel, are shown. Characteristic curves and other data are included. General Electric Co., Schenectady 5, N. Y.

### Foam Products 286

Two color charts with many illustrative photos show the properties and uses of a variety of standard foam products. In addition, a tabulation of dielectric and physical properties of artificial and adjusted dielectric constant foams is presented. Emerson & Cuming, Inc., Canton, Mass.

### Closed-Circuit TV 287

General applications of closed-circuit TV systems are presented in this eight-page catalog (6-205). A number of typical system configurations are shown, with applicable equipment types delineated. Kin Tel Div., Cohu Electronics, Inc., 5725 Kearny Villa Road, San Diego, 12, Calif.

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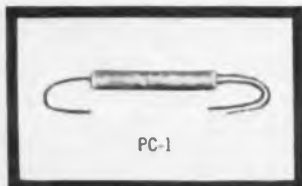
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## NEW LITERATURE

### Trimmer Capacitor 288

The firm's entire line of variable trimmer piston capacitors is covered in catalog C-61, 24-pages. Complete electrical and physical data of standard, split bushing, miniature, MAX-C, Sealcap, split-stator and differential trimmers in panel mount and printed circuit types is contained. A chart describes and illustrates standard modifications that are optional. JFD Electronic Corp., 6101 16th Ave., Brooklyn 4, N. Y.

### Dry-Film Lubricants 289

Lubricants for extreme environmental conditions are the subject of two publications. Special print 461, titled "Inorganic Solid-Film Lubricants" describes the results of tests of inorganic, solid-film lubricant performance in liquid oxygen service and at pressures approaching a complete vacuum. Bulletin 242 presents characteristics, performance reports and application instructions for Molykote X-15, an inorganic-bonded dry-film lubricant for extreme environmental service. Alpha-Molykote Corp., 65 Harvard Ave., Stamford, Conn.

### Motor Capacitors 290

The 16-page, easy-to-use catalog MS61-10 features complete listings of motor-start, motor-run capacitors. Capacities and physical dimensions are clearly shown for all types. Engineering data and a section covering the Capacitor Selector and the Emergency Capacitor are included. Hardware and terminal variations are illustrated. Aerovox Corp., New Bedford, Mass.

### Synchronous Motors 291

The construction and operation of 385 different types and models of the company's synchronous motors are described in this 20-page catalog. Included are speed-torque curves, dimensional drawings, wiring diagrams, and performance characteristics. Bodine Electric Co., 2500 W. Bradley Place, Chicago 18, Ill.

### Time Meters 292

Applications, features, specifications, standard ratings and schematics of the company's type 236 Elapsed Time Meter are given in the four-page bulletin GEZ-3354. General Electric Co., Schenectady 5, N.Y.



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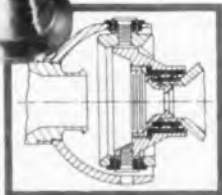
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FREE LITERATURE

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BLUE ISLAND, ILLINOIS

DIVISION: BLUE M ENGINEERING COMPANY  
2312 So. Main Street, Los Angeles 7, California

CIRCLE 176 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

## Relays and Timers

293

Catalog 861A provides illustrated technical data for the company's complete line of electromagnetic relays and motor-driven timers. Sequence, manual reset, automatic reset, cycle, delay and interval timers are among the types presented. Telex/Aemco, 24 State St., Mankato, Minn.

## Television Manual

294

A technical manual on 3-D TV describes the operation of the system which optically converts closed-circuit television to three dimensional pictures. Installation, operation and service are covered. Stereotronics Corp., 1717 N. Highland Ave., Los Angeles 28, Calif.

## PCM Telemetry System

295

An "off-the-shelf" pcm telemetry system is described in this 8-page illustrated brochure. The model 1323 system description includes information on reliability, bi-level programming, inputs for processing, inputs for control and synchronization and outputs. Radiation Inc., Melbourne, Fla.

## Numerical Positioning Controls

296

A control block diagram and step-by-step explanation of automatic numerical positioning controls for machine tools are included in a 12-page brochure. Control specifications, tape programming and position display are discussed. Rheem Manufacturing Co., Electronics Div., 5200 W. 104th St., Los Angeles, Calif.

## Adjustment Potentiometers

297

A four-page summary brochure on the company's adjustment potentiometers is designed for quick reference. Key information on 20 basic models is summarized. Resistances, terminal types, power ratings, operating temperatures, dimensions and prices are included. Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

## DC Power Supplies

298

A 12-page picture brochure describes the firm's line of dc power supplies. Production techniques employed in the manufacture of the units are presented along with new facilities available. Jordan Electronics, 121 S. Palm Ave., P. O. Box 2047, Alhambra, Calif.

# ALL Your Needs in Laminated Plastic Tubes



## An Example of Synthane You-shaped Versatility

At Synthane we have the versatility to give you just about everything you want in laminated plastic tubing or parts. Over 25 standard grades including those complying with governmental specifications. Sizes  $\frac{3}{32}$ " ID up to  $26\frac{1}{4}$ " OD. Lengths 18" to 96". Wide range of wall thicknesses. Selection of colors and finishes. Molded and rolled tubing. Variety of cross sections—round, oval, square, polygonal, etc. Our excellent fabrication facilities provide you with finished parts to your specifications.

*You-shaped Versatility makes Synthane a Better Buy in Laminates*

**SYNTHANE**  
CORPORATION **S** OAKS, PENNA.

Synthane Corporation, 42 River Road, Oaks, Pa.

Gentlemen:

Please send me information about Synthane as a source for laminated plastic tubes and parts fabricated from tubes.

Name \_\_\_\_\_

Address \_\_\_\_\_

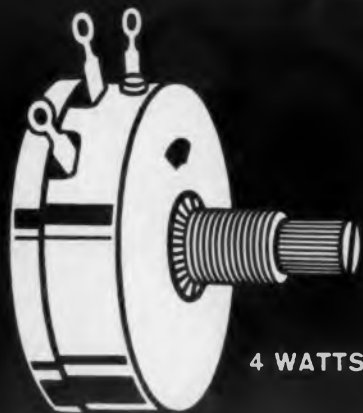
City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 177 ON READER-SERVICE CARD



No job is too tough  
for Mallory

4



4 WATTS

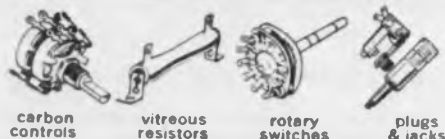
wire-wound controls



Take the 4-watt Type M control, for instance. Can't be beat for long life and dependability. It's constructed to take severe shock and vibration and still maintain positive contact. "Off" position for rheostat type eliminates need for separate switch.

Whatever you need in wire-wound controls, Mallory has it . . . 2 watts, 4 watts, 7 watts . . . in a big assortment of resistance values, tapers, shafts, mounting arrangements and tandem constructions. We build specials, too, to your specifications. Mallory Controls Company, Frankfort, Indiana.

P. R. MALLORY & CO. Inc.  
**MALLORY**



carbon controls

vitreous resistors

rotary switches

plugs & jacks

CIRCLE 178 ON READER-SERVICE CARD

## NEW LITERATURE

### Batteries 299

Complete details on a line of lead-calcium grid communication batteries are provided in a 14-page catalog, T-532. Weights, cell dimensions, electrical characteristics, discharge curves and rack data are provided. C & D Batteries Div., The Electric Autolite Co., Conshohocken, Pa.

### Anechoic Chambers 300

An eight-page catalog and four-page price list present illustrated data in detail on physical and electrical characteristics of Eccosorb anechoic chambers, both shielded and unshielded, and of Eccoshield rf shielded chambers. Emerson & Cuming, Inc., Canton, Mass.

### Metallized Ceramics 301

A 16-page bulletin describes the high and low temperature metallizing processes, proves a wide variety of information on design and installation of ceramic-metal assemblies, and

catalogs numerous hermetic terminals available from stock. American Lava Corp., Chattanooga 5, Tenn.

### Power Supplies 302

Nineteen models of plug-in transistorized power supplies are described in detail in a four-page bulletin, No. 6. Specifications, voltage and current ratings, and performance charts are included. Acopian Technical Co., Easton, Pa.

### Ground Support Equipment 303

The GEPAC "100" Programmable Automatic Comparator, a portable unit for use in shop, factory or flight line, is described in 24-page bulletin LMEJ 4837. It is used for automatic checkout of electronic and electro-mechanical systems. General Electric Co., Light Military Electronics Dept., Armament and Control Section, 600 Main St., Johnson City, N. Y.



**JANSKY &  
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A Division of Atlantic Research Corporation

**Electronic Engineers**

#### ANTENNA DESIGN

For Research and Engineering Department: one, to head up group dealing with shipboard antenna problems; the other to perform theoretical and practical calculations for high frequency antenna systems design. Experience in model measurements, antenna impedance, broad band HF and VHF antenna design, and matching network design. B.S., M.S., physics or electrical engineering.

#### ELECTROMAGNETIC THEORY

To investigate radiation phenomena, theoretical calculations on antenna design and performance, wave propagation over frequency range LF to UHF, and application of electromagnetic field theory to practice. M.S. in E.E. or physics, 3-5 years experience.

#### INSTRUMENTATION—ROCKET TEST

For ARC's rocket production and test facility to maintain and develop instrumentation for firing bay measuring devices and propellant processing. Familiarity with general measuring circuitry, pressure transducers, strain gages, multiple-point temperature recorders, electronic process instrumentation. B.S. engineering, 3 years practical experience.

For local interviews, send a resume of your technical

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Professional Personnel Recruitment

**ATLANTIC RESEARCH CORPORATION**

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CIRCLE 901 ON CAREER INQUIRY FORM, PAGE 163

ELECTRONIC DESIGN • November 8, 1961

### Data Acquisition System 305

A 10-channel analog-to-pulse duration system (APD) is described in detail in a four-page bulletin. The system permits direct digital conversion of analog input from dc sensing devices. Genisco, Inc., 2233 Federal Ave., Los Angeles 64, Calif.

### Waveguide Adapters 306

Mechanical data on a variety of types of sidewall and topwall waveguide adapters, covering EIA waveguide sizes from WR28 to WR187, are provided in 20-page catalog JS-61A. Dimensions are tabulated with and without flanges. Microwave Development Laboratories, Inc., Natick Industrial Centre, Natick, Mass.

### Polymers 307

Basic information on nine major grades of Cyclocac brand polymers is provided in eight-page catalog 10240. Shown are end products particularly representative of the major processing techniques: molding, vacuum

forming and extruding. A large chart provides data on properties of the various material grades. Marbon Chemical Div., Borg-Warner Corp., Washington, W. Va.

### Rectifier Stacks

A 6-page catalog (SR-170) covers thousands of possible selenium rectifier stack variations, including standard and high voltage types and new double and triple density cell types. Write on company letterhead to International Rectifier Corp., Dept. ED, 233 Kansas St., El Segundo, Calif.

### R-C Networks 308

Relay contact protection by resistance capacitance networks is discussed in this five-page reprint of an article from Bell Laboratories Record. Theory and application information is presented, with curves and circuits. Characteristics of the firm's line of such units are given. Presin Co., Inc., 2014 Broadway, Santa Monica, Calif.

## *Wassco* GLO-MELT RESISTANCE SOLDERING



... for Perfect  
lead-to-pin joints  
on All sizes of A/N  
and similar connections

*Wassco* GLO-MELT  
... for Fast-Efficient  
Accurate-Permanent  
connections.

239-B  
POWER UNITS • HANDPIECES • ACCESSORIES  
for all jobs from Micro-Miniature to Heavy-Current connectors  
WRITE FOR DESCRIPTIVE LITERATURE, PRICES AND NEAREST DISTRIBUTOR

*Wassco* GLO-MELT DIVISION  
AMERICAN ELECTRICAL HEATER COMPANY  
DETROIT 2, MICHIGAN

CIRCLE 181 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

## SAVE 1/4 INCH WITH THIS NEW TINIEST GENERAL ELECTRIC GLOW LAMP



Here's an indicator light that's only two-thirds the size of glow lamps previously available. Yet it lasts as long and has equal brightness. It's available as a high brightness lamp (A1B) and a standard brightness lamp (A1C).

This new General Electric glow lamp packs 5 mm electrodes into an M.O.L. of 1/2". Its maximum diameter is .244". It operates on standard line voltage, and because it uses a higher value resistor than a conventional glow lamp, it runs on half the current. This 1/2" long lamp, therefore, has a reduced total light output but because its brightness is not reduced, it is just as effective an indicator as other glow lamps in most applications.

You can get this new glow lamp for less than 5¢ each in lots of 25,000. (Slightly more with a resistor attached.)

For complete information write: General Electric Co., Miniature Lamp Dept. M-151, Nela Park, Cleveland 12, Ohio. Ask for Bulletin No. 3-1504.

*Progress Is Our Most Important Product*

GENERAL  ELECTRIC

CIRCLE 182 ON READER-SERVICE CARD

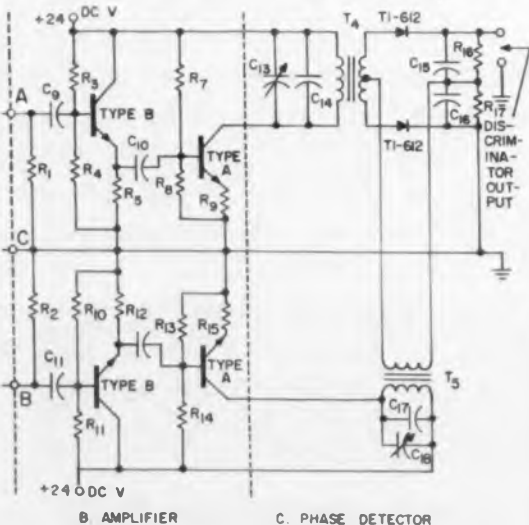
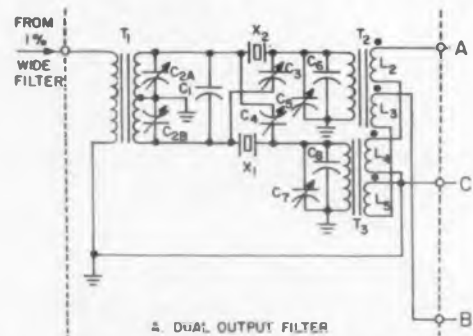
# IDEAS FOR DESIGN

## Dual Filter, Phase Detector 742 From Frequency Discriminator

Connecting a dual-output filter to a phase detector results in a frequency discriminator with several useful characteristics. The combination of the filter and detector is shown; its advantages are enumerated below.

First, the circuit allows both the reference channel and the signal channel to the phase detector to be virtually as narrow in bandwidth as the system-signal requirements allow. This reduces noise output from the phase detector to a minimum.

Second, the problem of relative drift between the two channels, which leads to noise bias, is eliminated. This occurs since both channels use the same pair of crystals, and



Dual-output filter (A), connected to phase detector (C) through an amplifier (B) at points indicated, forms useful frequency discriminator.

drift in frequency by the same amount.

Third, the circuit uses fewer components because only a single dual-output filter is required to do the job that would normally require two single-output, half-lattice filters.

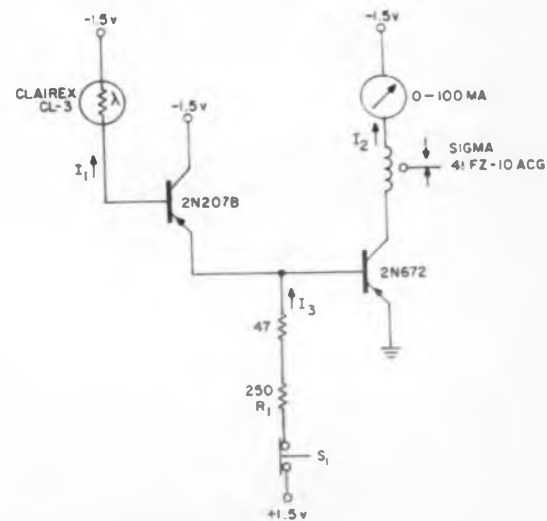
Donald M. Lauderdale, research engineer, Defense Research Laboratory, University of Texas, Austin, Tex.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 742.

## Photoelectric Circuit Operates 745 With High Light Resolution

In many applications of photoelectric controls, it is desirable to obtain a change in output current for a very small percentage change in light at the detector. These applications might include burglar alarm systems and industrial proximity controls. The circuit shown affords a direct and inexpensive method for obtaining this type of action.

The circuit is designed so that a change of output current  $I_2$  approaches the change in photocell current  $I_1$  times the product of the  $\beta$ 's for the two transistors. However, biasing current,  $I_3$ , allows quiescent current,  $I_3$ , to be set at some nominal, below-saturation level even in the presence of a relatively high ambient light level at the photocell.



High-resolution photo detector circuit does not require more elaborate differential amplifier techniques.

A type of "suppressed-zero" operation is obtained, giving high light resolution without a more elaborate differential amplifier.

For burglar alarm type of operation  $R_1$  is decreased so that  $I_2$  is just sufficient to hold the relay in. A very small decrease in light input then will drop out the relay (fraction of a foot-candle change causes 20-ma change in  $I_2$ ). By momentarily depressing  $S_1$  the relay is again pulled-in, resetting the system. The actual relay used in the low voltage dc circuit was a 6-v ac unit. Pull-in current is 80 ma; drop-out current is 15-20 ma.

E. S. Gordon, Research Engineer, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 745.

### Vote for Ideas Valuable to You

Vote for the Ideas which are valuable to you. Other engineers will vote for the Ideas which are most valuable to them. The Idea which receives the most "Valuable" votes will be judged "Most Valuable of Issue." Its author will receive a \$50 award.

Choose the Ideas which suggest a solution to a problem of your own or stimulate your thinking or which you think are clever.

And if you have any Ideas of your own, why not send them in? Remember, to be eligible for the 1961 Seventh Anniversary Awards Program your Idea should be received no later than November 15.

## SEVENTH ANNIVERSARY AWARDS

# ***IDEAS-FOR-DESIGN***

*Entry Blank*

### How You Can Participate

#### Rules For Awards

Here's how you can participate in Ideas for Design's Seventh Anniversary Awards: All engineer readers of **ELECTRONIC DESIGN** are eligible.

Entries must be accompanied by filled-out Official Entry Blank or facsimile. Ideas submitted must be original with the author, and must not have been previously published (publication in internal company magazines and literature excepted).

Ideas suitable for publication should deal with:

1. new circuits or circuit modifications
2. new design techniques
3. designs for new production methods
4. clever use of new materials or new components in design
5. design or drafting aids
6. new methods of packaging
7. design short cuts
8. cost saving tips

#### Awards:

1. Each Idea published will receive an honorarium of \$20.
2. The Idea selected as the most valuable in the issue in which it appears will receive \$50.
3. The Idea selected as the Idea of the Year will receive a Grand Prize of \$1,000 in cash.

The Idea of the Year will be selected from those entries chosen Most Valuable of the Issue.

Most Valuable of the Issue and Idea of the Year selections will be made by the readers of **ELECTRONIC DESIGN**. The readers will select the outstanding Ideas by circling keyed numbers on the Reader-Service cards. Payment will be made eight weeks after Ideas are published.

Exclusive publishing rights for all Ideas will remain with the Hayden Publishing Co.

Ideas-for-Design Editor  
**ELECTRONIC DESIGN**  
850 Third Ave.  
New York 22, N. Y.

**Idea** (State the problem and then give your solution. Include sketches or photos that will help get the idea across.)

*(Use separate sheet if necessary)*

I submit my Idea for Design for publication in **ELECTRONIC DESIGN**. I understand it will be eligible for the Seventh Anniversary Awards—\$20 if published, \$50 if chosen Most Valuable of Issue, \$1,000 if chosen Idea of the Year.

I have not submitted my Idea for Design for publication elsewhere. It is entirely original with me and does not violate or infringe any copyrights, patents or trademarks or the property rights of any other person, firm or corporation.  
Hayden Publishing Company, Inc. shall have the exclusive publication rights to these Ideas for Design selected for publication in **ELECTRONIC DESIGN**. This right extends to the subsequent use of the Idea for Design by Hayden in any of its other publications. Honorariums, if any, for subsequent publication shall be solely in the discretion of Hayden Publishing Company, Inc.

Name \_\_\_\_\_ Title \_\_\_\_\_

Company Name \_\_\_\_\_

Address \_\_\_\_\_

For Additional Entry Blanks, circle 750 on Reader-Service Card.





*Bendix Craftsmanship at work for you*



#### AVAILABLE TYPES Solenoid Focused

Type TWO-88 with frequency range of 30 Gc to 40 Gc  
 Type TWO-75 with frequency range of 40 Gc to 50 Gc  
 Type TWO-67 with frequency range of 49 Gc to 59 Gc  
 Type TWO-82 with frequency range of 50 Gc to 60 Gc  
 Type TWO-66 with frequency range of 61 Gc to 71 Gc  
 Type TWO-83 with frequency range of 65 Gc to 75 Gc  
 Type TWO-85 with frequency range of 70 Gc to 85 Gc  
 Type TWO-87 with frequency range of 85 Gc to 100 Gc  
 Type TWO-90 with frequency range of 100 Gc to 120 Gc  
 Type TWO-93 with frequency range of 120 Gc to 140 Gc

Available now permanent magnet focused type TWO-89  
 with frequency range up to 180 Gc

**LARGEST LINE OF MILLIMETER WAVE LENGTH BWO** Bendix® BWO tubes for higher frequency transmission. These Backward-Wave Oscillator Tubes—exclusive with Bendix—generate microwave energy over the largest continuous frequency range. Ideal for advanced multichannel telephone and television systems, microwave spectroscopy, high definition short range radar, highly directive communications, and many other applications needing low power, voltage-tuned millimeter wave length radio frequency energy. Write today for complete information. Electron Tube Products, The Bendix Corporation, Eatontown, New Jersey.

#### ELECTRICAL DATA

Frequency Range..... 30 Gc-180 Gc (see specific type)  
 Anode Voltage..... 1000-4000 volts  
 Power Output..... Up to 20 mw average (depending on frequency)  
 Beam Current..... 10 MA  
 Magnetic Field..... 2000 gauss  
 Heater Voltage..... 6.3 ±10%

#### MECHANICAL DATA

Output Flange..... Special adapter to RG-98/U (50-75 Gc)  
 Maximum Diameter..... 0.625"  
 Length..... 8"  
 Mounting Position..... Any  
 Weight..... 5 oz.\*  
 \*Without magnet (tube only). Magnets are available.

**Red Bank Division**



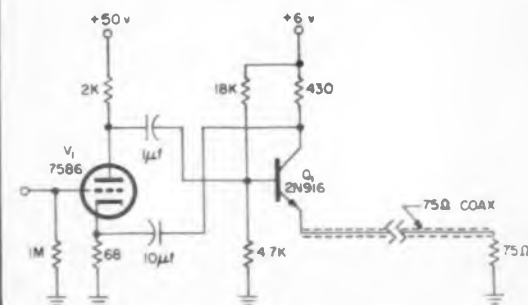
CIRCLE 103 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

### Small Test Probe Uses Hybrid Isolation Amplifier 749

A small test probe needed an isolation amplifier with high input impedance and unity gain. The amplifier had to have a gain deviation of no more than  $\pm 1$  per cent over a 25-mc bandwidth, with the gain remaining stable within  $\pm 2$  per cent over long periods.

The problem was solved by designing a hybrid amplifier combining the high input impedance of a vacuum tube and the low output impedance on a transistor. A nuvistor triode, having the advantages of both small physical size and high input impedance, was used at the input. Thus, the input impedance of the circuit, shown in the figure, is about 1 meg in parallel with 10 pf.



Hybrid isolation amplifier uses nuvistor and transistor to achieve high input impedance, unity gain.

The output at the plate of the monitor,  $V_1$ , is coupled to the base of  $Q_1$ . The transistor output, taken from the emitter, is then fed through a length of coaxial cable terminated in its characteristic impedance.

High gain stability is achieved by providing negative feedback from the collector of  $Q_1$  to the cathode of  $V_1$ . This results in an overall gain of unity. Measurements have shown that the overall voltage gain remained within 1 per cent of its initial value for a 30 per cent reduction in  $g_m$  of  $V_1$ . The frequency response (1 db down) is 10 cps to 55 mc. The collector supply voltage was also used to operate the filament of  $V_1$ . The maximum input level is limited to about 0.2 v which was satisfactory for our application.

*Owen B. Laug, Electronic Engineer, National Bureau of Standards, Washington, D. C.*

If this Idea is valuable to you, give it a vote by circling Reader-Service number 749.

## Single Potentiometer Adjusts 746 Range of Simple VFO

Here are the design equations for a variable-frequency, phase-shift oscillator that will operate over a frequency range of 5:1 to 20:1. The frequency of the circuit, which uses noncritical components, can be varied by a potentiometer adjustment.

Referring to the circuit, if:

$$R' = R_3 + \text{input resistance of } T_1$$

then the circuit's frequency of oscillation is:

$$f_o = \frac{1}{2\pi C \sqrt{3RR_L + R'R_L + 3R^2 + 3R'R}}$$

For this oscillating frequency the required transistor  $\beta$  is:

$$\beta_{req} = 11 +$$

$$\frac{10R'}{R} + \frac{3R_L}{R} + \frac{R'R_L}{R^2} + \frac{9R}{R_L} + \frac{14R'}{R_L} + \frac{2R^2}{R^2} + \frac{6R^2}{RRL}$$

These equations can be simplified somewhat by making the substitutions:

$$M = \frac{R_L}{R} \text{ and } K = \frac{R'}{R}$$

Thus, the required  $\beta$  is:

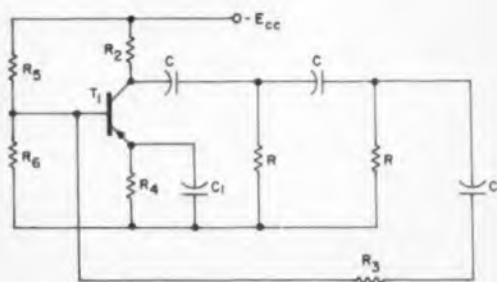
$$\beta_{req} =$$

$$2K^2 + 10K + 11 + M(3 + K) + \frac{1}{M}(9 + 14K + 6K)$$

and the frequency of oscillation is:

$$f_o = \frac{1}{2\pi CR \sqrt{K(M+3) + 3(M+1)}}$$

Frequency is varied by adjusting  $R'$ .



Variable frequency oscillator is variable over range of 5:1 to 20:1.

David R. Olsen, Engineer, Western Development Laboratories, Philco Corp., Palo Alto, Calif.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 746.

## Some Ideas

Frankly, we hope you're a fusspot. If you are fussy about the way you work, and proud of it, we think you'll enjoy knowing about these K&E items...

### A Real "Gingling Vine"

Some of our more meticulous K&E people have been known to walk out of a drafting room in a cold sweat at the way the drafting boards were covered. Its those ripples, wrinkles and bends that cause all the anxiety. "How," mutters our loyal agent, "can you expect to draw a straight line on a wavy surface?"

And it's all so easy if you just take the right K&E product and mount it in the right way. The product in this case is LAMINENE® N70 Board Surface Material. This is a product unique with K&E. We hold a patent on the process that laminates a thin acetate film to a tough paper base—quite a bit different than simply coating a paper with plastic. And the results are different too.

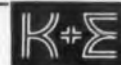
It's rather a dramatic show of force that LAMINENE stages on a board. The secret is in the irresistible urge of a natural product to return to its normal state. In this case, when you wet the back of LAMINENE you expand it ever so slightly. When tacked or taped under the edges of the board, it begins to dry and shrink. The paper backing builds tension on the surface as it dries,



finally reaching a smooth taut state... with enough tension left over to keep it permanently wrinkle-free. No matter what the temperature or humidity, LAMINENE stays with the board as if cemented there.

Add to this a fine, springy quality, and a variety of other features—grid lines, green color, washability—and you can see why LAMINENE rates at the top in popularity for a semi-permanent board covering.

Would you like a sample? It's yours for the asking. See your K&E dealer or return the coupon at the right.



for your file of practical information on drafting and reproduction from

— KEUFFEL & ESSER CO. —

### Time Saving Stickers

Want to eliminate a time-consuming chore? You can cut down on tedious repetitive lettering by having title blocks, specifications, and other symbols or legends printed—clearly and sharply—on DULSEAL™ (74). This tissue-thin film has a delayed-action adhesive on the back, and a dull-finish face for easy writing or printing.



Stickers made of DULSEAL can be firmly positioned—and re-positioned hours later, just as firmly. The adhesive takes 24 hours to set. Once it does set, a permanent bond is formed with the paper or cloth beneath. DULSEAL is chemically stable, and the adhesive will not bleed, even in hot copying machines.

Repeated erasures on DULSEAL will not affect its "take." Produced by an exclusive

process, the "tooth" is built into the surface. Transparent and low in reflectivity, DULSEAL stickers will not affect the transparency or printing speed of your drafting medium. K&E supplies DULSEAL in sheets, rolls (printed to your specifications if you wish), and as a mending tape in a handy dispenser. Try a sample, on us!

### 3 To Keep Clean

Best way to keep your tracings clean: don't let them get dirty. A mighty easy way to achieve this is to sprinkle the tracing lightly with gum eraser particles, while working. Then, triangles, T-squares, and scales stay clean, and clean the surface automatically, as they are moved back and forth. The particles will not dry out or harden—they contain no grit or abrasives. They'll actually improve the ink taking qualities of your drafting surface.



For this purpose, K&E supplies cleaning particles put up in three different ways. We think the new plastic squeeze-bottle (3036C) is the handiest of all. The shaker-top can (3036) has also been a drafting-room favorite for some time. And, for double-duty cleaning, we suggest the ABC DRY-CLEAN PAD™ (3037) or DRY-CLEAN JR.™ (3037J)—a smaller version—which hold slightly coarser granules that sift through soft mesh. The ABC Pad also comes in handy for wiping a complete tracing after it is finished, or for preparing certain surfaces for ink work. Or for an overall pre-cleaning, since the best way to insure clean tracings is never to let soil build up.

The proverbial ounce of prevention is worth the traditional pound of cure!

These K&E products, and others that can make life easier for you, are available from your nearby K&E dealer. See him soon... or send us the coupon below for further information and samples.

KEUFFEL & ESSER CO., Dept. ED-11 Hoboken, N. J.

Please send me samples and information on LAMINENE® Drawing Board Surface Material, and DULSEAL™ Tape... plus information on K&E cleaning powders.

Name & Title \_\_\_\_\_

Company & Address \_\_\_\_\_

4259-9

CIRCLE 184 ON READER-SERVICE CARD



In 184 words or less, write to Sigma saying why you intend, without hesitation, to use a new Sigma Series 46 instead of almost any other AC or DC DPDT octal plug-in relay. This contest isn't limited just to your exciting new designs — the products you've been making every day are also eligible. (See helpful hints below.) All entries will be judged on the basis of ingenuity, originality and Sales Dept. records of purchases made by the entrant. (Entries by Sigma competitors will be given special consideration.)

First prize will be one (1) magnificently dented left front fender from the Sigma Sales Manager's Lily-White Sportscar, removed after recent spirited trip by owner. Second prize will be a genuine memento of the Advertising Manager's European Tour; 3rd through 10th prize will be a Series 46 relay in winner's choice of type, adjustment and contact material.

All entries must be received by Nov. 30th, 1961 and indicate that entrant knows what a Sigma Series 46 Relay is (for). Judges will include various qualified Sigma personnel, such as the engineer who designed the Series 46, Head Shipper and Chief Dietician. Suitable final arrangements will be made for all entries.

some hints on preparing winning entries

- rated to switch 5 amps at 28 VDC, 1 amp at 120 VDC; on AC, 1200 volt-amperes per pole with 240-volt and 10-amp maximums
- outlasts other things: works 10 million times on 1-amp loads, half a million times on 10-amp loads
- trips on as little as 200 milliwatts (DC types) or 0.2 v-a (AC types)
- fits octal sockets wired for conventional DPDT relays
- big contacts and "motor" visible to all who enjoy watching relays operate
- Mack truck construction with Rolls-Royce touches
- very competitive (price- and appeal-wise)
- available off the shelf at your friendly neighborhood Sigma Distributor (if you don't have a nearby Sigma Distributor, you're not living in a friendly neighborhood)

This is serious. Equipment designers, industry and The Public shouldn't go another day without the benefits of Sigma Series 46 relays. Enter this glorious, rewarding quest now!



SIGMA

SIGMA INSTRUMENTS, INC.  
91 PEARL ST., SO. BRAintree 85, MASS.  
CIRCLE 185 ON READER-SERVICE CARD



## BOOKS

### Radio Transmitters

Lawrence F. Gray and Richard Graham, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 480 pp, \$12.50.

Practical analysis of transmitter operation including data on transmitter test measurements and maintenance.

### Transmission of Information

Robert M. Fano, MIT Press and John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 389 pp, \$7.50.

Graduate level discussion of the foundations and major results of information theory.

### ABC's Of Computers

Allan Lytel, Howard W. Sams & Co., Inc., 1720 E. 38 St., Indianapolis 6, Ind., 128 pp, \$1.95 (paperbound).

Basic, "self-teaching" introduction to electronic computers.

### Analytical Techniques For Non-Linear Control Systems

John C. West, D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 225 pp, \$5.75.

Deals with methods for analyzing feedback control system behavior when amplitude nonlinear elements dominate the performance. A minimum amount of linear servomechanism theory is used.

### Foundation For Electric Network Theory

Myril B. Reed, Prentice-Hall, Inc., Englewood Cliffs, N. J., 354 pp, \$13.

Stresses the topology of network systems. Using resistive networks only, the presentation is based on linear graphs and matrices.

### Transformers

Alexander Schure, Editor; John F. Rider Publisher, Inc., 116 W. 14 St., New York, N. Y., 88 pp, \$2.

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**The 1961 Aerospace Year Book**  
*Aerospace Industries Association, Inc., American Aviation Publications, 1001 Vermont Ave., N. W., Washington 5, D. C., 486 pp, \$10.*

**Progress In Dielectrics, Vol. III**  
*J. B. Birks and J. Hart, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 295 pp, \$10.*

**An Introduction To The Theory and Practice Of Transistors**  
*J. R. Tillman and F. F. Roberts, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 340 pp, \$8.*

**NAB Engineering Handbook**  
*A. Prose Walker, Editor; McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 1005 pp, \$27.50.*

**Elements of Nuclear Engineering**  
*Glenn Murphy, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 215 pp, \$7.50.*

**A Treatise on the Differential Geometry of Curves and Surfaces**  
*Luther Pfahler Eisenhart, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 500 pp, \$2.75 (paperbound).*

**High Frequency Applications of Ferrites**  
*J. Roberts, D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 166 pp, \$4.85.*

**Wave Propagation In A Turbulent Medium**  
*V. I. Tatarski, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 285 pp, \$9.75.*

**Principles of Illumination**  
*H. Cotton, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 530 pp, \$12.*

**Optimum Use of Engineering Talent**  
*American Management Association, 1515 Broadway, New York 36, N. Y., 420 pp, \$9. (AMA members: \$6.)*

Thirty one executives describe their management techniques and their solutions for the problems of managing technical personnel.

**Numerical Methods For Science and Engineering**  
*Ralph G. Stanton, Prentice-Hall, Inc., Englewood Cliffs, N. J., 288 pp, \$9.*

Numerical methods are discussed and then applied to the solution of practical problems.



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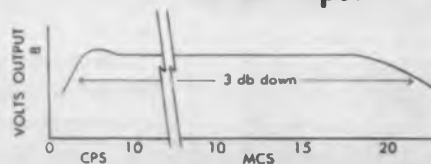
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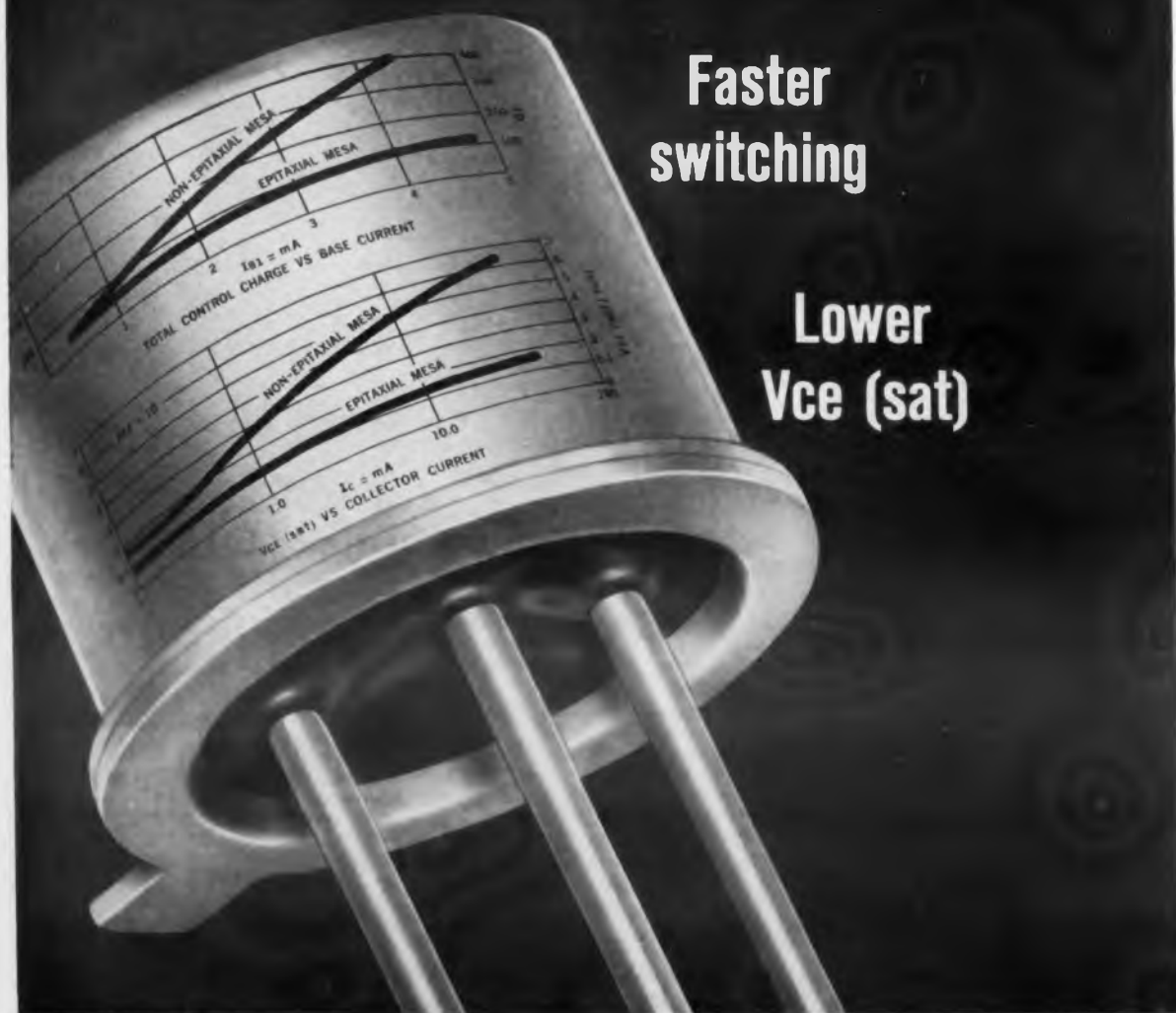
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## GERMAN ABSTRACTS

E. Brenner

## Frequency of Tunnel

THE UPPER frequency limit of tunnel diodes, based on the physics of the tunneling effect, has been estimated as  $10^{13}$  cps. Practically, however, frequencies of the order of 10 Gc can hardly be exceeded, or even reached. This conclusion is based on an analysis of the tunnel diode equivalent circuit, Fig. 1, together with geometrical considerations of the size of the semiconductor.

The tunnel diode is represented by the negative incremental resistance  $-R$ , the capacitance  $C$ , the internal inductance  $L_s$  and the series (positive) resistance  $R_s$ . A tuning element, represented by  $R_v - L_a$ , and a load,  $R_L$ , are also included. The negative incremental resistance,  $-R$ , corresponds to the largest value of the negative slope of the diode volt-ampere curve. In the microwave region, it is about  $-1$  ohm and is virtually independent of the semiconductor material or of the frequency.

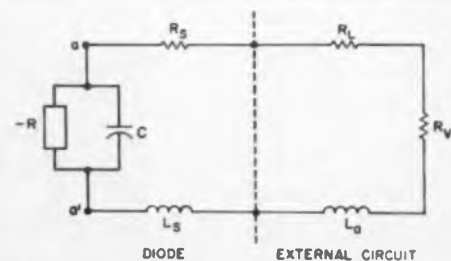


Fig. 1. Equivalent circuit of tunnel diode with tuning element represented by  $R_v$  and  $L_a$ .

## Limitations

## Diodes

The net admittance of the circuit of Fig. 1 at the terminals  $a-a'$ , is zero if:

$$L_e = R R_e C \quad (1)$$

and

$$\omega_0 = \frac{1}{RC} \sqrt{\frac{R}{R_e} - 1} \quad (2)$$

where

$$R_e = R_s + R_L + R_T \text{ and } L_e = L_s + L_A$$

The upper frequency limit is approached when  $R_L$  is made to approach zero in Eq. 2, provided, of course, that  $R_e < R$  (which is necessary for oscillations). Thus, if  $-R = -1$  ohm,  $f_o = 320$  mc for  $C = 1$  nf and  $R_e = 0.2$  ohm; and  $f_o = 10$  Gc for  $C = 15$  pf and  $R_e = 0.5$  ohm.

The capacitance of the tunnel diode is given, for germanium, by:

$$C = 0.045 r^2 \text{ (nf)} \quad (3)$$

where  $r$  is the semiconductor disk radius, Fig. 2, in millimeters. For  $r = 0.1$  mm,  $C = 450$  pf; for  $r = 0.015$  mm,  $C = 10$  pf.

Most of the series resistance,  $R_s$ , stems from the semiconductor material. Therefore, its bulk should be minimized. The external circuit inductance, produced by a coaxial cable, together with contact resistance accounts for resistance of the order 0.05 to 0.1 ohm.

Considering current density  $J$  and semiconductor geometry ( $h$  and  $r$ , Fig. 2) as

# Electronic Products **NEWS**

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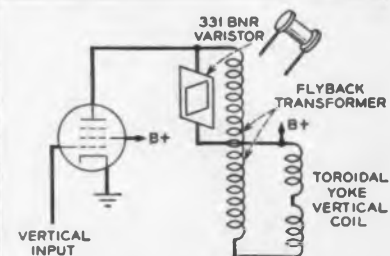
## Critical Hermetic Sealing Problems Solved with metal-bonded CERAMIC-TO-METAL ASSEMBLIES and METAL-BONDED CERAMICS

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Helpful suggestions in solving a variety of difficult sealing problems are offered in our bulletin "Metal-Bonded Ceramic-to-Metal Assemblies and Metal-Bonded Ceramics." For your copy, or for evaluation or quotations covering your particular application, write Dept. EDC-111, Latrobe Plant, Refractories Div., Carborundum Co., Latrobe, Pa.



## Flyback Transformer Voltage controlled by Carborundum Varistors

Under some operating conditions such as high line voltage, the output from the flyback transformer in a TV vertical circuit can reach 2500 volts. This far exceeds the voltage needed for normal operation and can puncture winding insulation, cause flashover at tube pins, and can damage other components.

A simple solution is the installation of a Carborundum Type 331 BNR Varistor. The voltage-sensitive resistance characteristic of the Varistor holds the flyback output to a safe 1500 volts.

Data Sheet on the reduction of induced transients using Carborundum Varistors and Bulletin GR-2 giving characteristics will be sent on request. Write Dept. EDV-111, Global Plant, Refractories Div., Carborundum Co., Niagara Falls, N. Y.



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External power of 1.4 volts at 6 microamperes powers the unit.

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### TYPE 2001-2

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For over 20 years we have made frequency standards and precision fork units for applications where consistent accuracy and rugged dependability are vital. Shown are just a few typical examples.

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Size, 1 1/2" dia., x 3 1/2" H., Wt., 7 oz.  
Frequencies: 360 to 1000 cy.

#### Accuracies:

2007-6  $\pm 0.2\%$  ( $-50^\circ$  to  $+85^\circ\text{C}$ )

R2007-6  $\pm .002\%$  ( $+15^\circ$  to  $+35^\circ\text{C}$ )

W2007-6  $\pm .005\%$  ( $-65^\circ$  to  $+85^\circ\text{C}$ )

Input: 10 to 30V DC at 6 ma.

Output: Multitap, 75 to 100,000 ohms

### TYPE 2001-2 FREQUENCY STANDARD

Size, 3 3/4" x 4 1/2" x 6" H., Wt., 26 oz.  
Frequencies: 200 to 3000 cycles  
Accuracy:  $\pm .001\%$  at  $+20^\circ$  to  $+30^\circ\text{C}$   
Output: 5V at 250,000 ohms  
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B voltage, 100 to 300 V, at 5 to 10 ma.  
Accessory Modular units are available to divide, multiply, amplify and power this unit.

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Weight, 1 1/2 lbs.  
Frequency: 400 cycles  
Accuracy: .03%,  $-55^\circ$  to  $+71^\circ\text{C}$   
Input: 28V DC  $\pm 10\%$   
Output: 400 cy. approx. sq. wave  
at 115V into 4000 ohm load (approx. 4W)

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Size, 3/8" dia. x 2 3/16"  
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## GERMAN ABSTRACTS

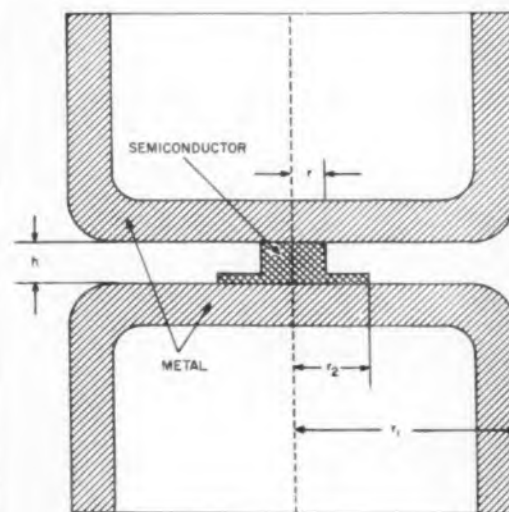


Fig. 2. Construction of a microwave tunnel diode.

## Analog Output Circuit For A Decimal Decade

Electronic counters occasionally require analog output circuits for single decades. A suitable resistance matrix is shown in the figure. It is assumed that the resistance of the indicator,  $R_i$ , is large compared to the resistances of the matrix ( $R_1$  through  $R_n$ ). Also, the resistances of the conducting tubes or transistors are negligible compared to the matrix resistances. The equation for the output voltage  $E$  has the same form as that of a decade consisting of four flip-flops. This equation is:

$$E = E_1 - [A_1 (E_1 - E_0) + A_2 (E_2 - E_1) + A_3 (E_3 - E_2) + A_4 (E_4 - E_3)]$$

variables, the optimum current density for maximum  $f_o$  is given by:

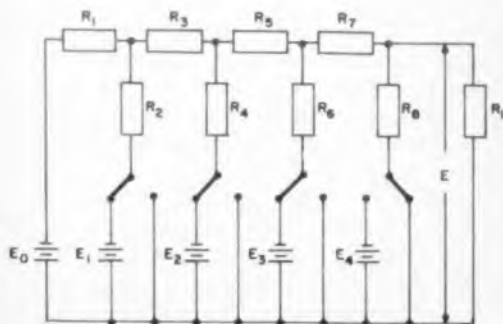
$$J_{opt} = 11 f_o \text{ amp/mm}^2 \quad (4)$$

where  $f_o$  is in gigacycles. Thus, for  $f_o = 10$  Gc the current sensitivity is 110 amp/mm<sup>2</sup>. It can also be shown that semiconductor disk height for germanium is related to the limiting frequency,  $f_o$ , (assuming  $h = 2r$ ) by:

$$h = 0.0316 \left[ \sqrt{(34.5/f_o) + 1} - 1 \right] \text{ mm} \quad (5)$$

Consequently a 10-Gc upper frequency limit corresponds to  $h = 0.035$  mm, the smallest size which appears to be practical.

*Abstracted from an article by M. Muller, Nachrichtentechnische Zeitschrift, Vol. 14, No. 4, April 1961, pp 165-169.*



Circuit of the resistance matrix.

where the values  $A_1, A_2, A_3,$  and  $A_4$  are determined by the matrix resistance values. For a decade counter:

$$A_1 = 0.1 \quad A_2 = 0.2 \quad A_3 = 0.4 \quad A_4 = 0.6$$

By straightforward application of circuit equations, the resistance network has the same  $A$ -values of the decade, if

$$R_1 = R_2 = R_3 = R_4 = R; \quad R_5 = R_6 = R/2 \\ R_7 = 2R, \quad R_8 = 0$$

*Abstracted from an article by H. Wachholz, Elektronische Rundschau, Vol. 15, No. 1, January 1 1961, pp 25-26.*



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## REPORT BRIEFS

### Parametric Limiters

Both theoretical and numerical analyses are presented to describe phase-distortionless, passive parametric limiters. Leakage-spike energy, a troublesome problem when a limiter is used as a protecting device, is small in varactor diode versions, and large in ferrite versions. The analytical result which predicts the behavior of the leakage spikes may be used to control the leakage energy by adjusting certain parameters. *Passive Phase-Distortionless Parametric Limiters*, I. T. Ho, Stanford Electronics Laboratories, Stanford University, Calif., April 1961, 134 pp, \$11. Order AD-256775 from OTS, Washington 25, D. C.

### Ferromagnetic Materials

Nonlinear effects on the microwave properties of ferrites and ferrimagnetic-garnet materials were studied. Two millimeter-wave generation experiments using nickel-zinc ferrite and Ferroplans type hexagonal single crystals are described. An analysis of a longitudinally pumped ferrite amplifier is given. Expressions for gain, bandwidth, gain-bandwidth product and noise temperature are derived. *Investigation Of Microwave Nonlinear Effects Utilizing Ferromagnetic Materials*, Roy W. Roberts, Melabs, Palo Alto, Calif., April 1961, 20 pp, \$2.60. Order AD-256716 from OTS, Washington 25, D. C.

### RFI

In predicting interference the calculation of the frequencies where interference will occur and their magnitudes are of interest. A device used to show this pictorially is the mutual interference chart or mutual interference matrix. The processing of a mutual interference matrix for sets of noninterfering frequencies was separated into two cases. The first case was concerned with symmetric mutual interference matrices with no distinction between the transmitter or receiver frequencies. The second case was applicable to a general mutual interference matrix with the distinction between transmitter and receiver frequencies preserved. *Directory of Electronic Equipment Characteristics, Non-Radar Types*, I. E. Perlin and C. E. Blakely, Georgia Institute of Technology Engineering Experiment Station, Atlanta, Ga., Sept. 1959, 100 pp, \$9.10. Order AD-256545 from OTS, Washington, D. C.

## Tunnel Diode Circuits

Tunnel-diode circuits were theoretically investigated as a source of high-speed current pulses capable of switching thin film memories in the order of tens of millimicroseconds. Break-point models of the characteristic curve are constructed and piecewise linear analysis is used to predict and extrapolate experimental results. Three basic circuits were chosen as drivers for various load forms and levels. These were tried in the laboratory and results are given. *Tunnel Diode Circuits For Switching Thin Film Memories*, Paul C. Davis, *Electronic Systems Laboratory, Massachusetts Institute of Technology, Cambridge, Mass., June 6, 1961, \$8.10. Order AD257015 from OTS, Washington 25, D. C.*

## Ferrite Devices

Troughline isolator design problems are discussed. A stripline isolator is described which provides greater than 25-db isolation and under 1.2-db insertion loss for 4-8 kmc. Also described are phase-shift studies carried out on an axially magnetized, ferrite-loaded stripline bandpass filter. *Ferrite Devices for Receiving Systems*, R. A. Henschke, D. A. Parkes and S. S. Shapiro, *Melabs, Palo Alto, Calif., May 3, 1961, 35 pp., \$3.60. Order AD-260382 from OTS, Washington 25, D. C.*

## Switches and Lines

Results are presented of a program to investigate (1) the application of crystal switches to the scanning of receiving antennas and (2) the properties of a multiwave transmission line. The crystal switch study was concerned with the characteristics of single and multithrow switches to determine their effectiveness as an antenna scanning device. Measurements on insertion loss, switching ratio, switching speed and noise figure were made. The multiwave transmission line study was concerned with a transmission line consisting of two unbalanced TEM lines whose outer form was a rectangular or ridged waveguide. Major points of investigation were the attenuation of TEM modes, the cross coupling of the TEM modes, the effect of center conductors on the cut-off frequency of the dominant waveguide mode, and the construction of an experimental mode launcher. *Multiwave Transmission Line and Semiconductor Switching Elements Studies*, James D. Kellett, *Sylvania Electric Products, Inc., Waltham, Mass., Feb. 1961, 43 pp., \$6.60. Order AD-256421 from OTS, Washington 25, D. C.*

# Linde *materials & Coatings* News

LINDE COMPANY, DIVISION OF UNION CARBIDE CORPORATION

## Polish semiconductors scratch-free with 99.98% pure alumina powders

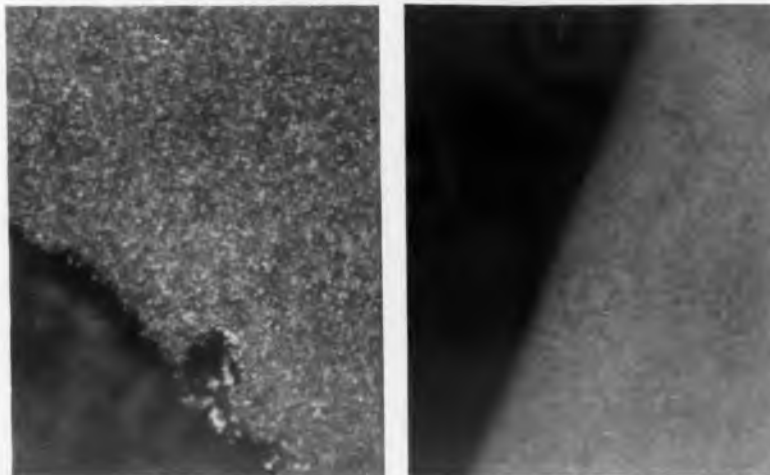


Photo at left: A typical as lapped silicon wafer, showing edge chip, prior to finishing. (Magnified 42X). Right: Complete polishing with LINDE alumina abrasives leaves edge of silicon and wafer scratch-free. (Magnified 144X).

The surfaces of the semiconducting wafers used in the new high-speed mesa switching transistors and planar diodes must have a superior surface finish, flatness, and parallelism—prior to final etching and diffusion. This effect is now being achieved in full production with high-purity alumina abrasives produced by LINDE.

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Formula	Al <sub>2</sub> O <sub>3</sub> (Alpha)	Al <sub>2</sub> O <sub>3</sub> (Gamma)	Al <sub>2</sub> O <sub>3</sub> (Alpha)
Crystal System	Hex.	Cubic	Hex.
Hardness, MOHS'	9	8	9
Size, Microns	0.3	0.05	1.0

Type 1.0C is used to remove stock from surfaces that are rougher than 6 micro-inches rms; Type 0.3A for preliminary polishing, and Type 0.05B for final polishing of the wafers.

In the initial stages of junction transistor or diode production, the powders can be used for preparing metallographic cross-sections of the assemblies according to standard methods on a horizontal polishing wheel. For semiconductors, LINDE has developed several adaptations of standard techniques.

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## Flame-Plated tungsten carbide coatings precision-finished

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Most frequently used precision grinding equipment is diamond wheels, resulting in lowest overall cost on ordinary cylindrical and flat work. On many contour grinding jobs, special grades of silicon carbide wheels will do the job, eliminating the high cost and lack of precision associated with shaped diamond wheels. Diamond-abrasive lapping techniques give high finishes.

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## Plasma-Plate process applies thin dielectric coatings

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The new EDC makes it easier than ever before to locate and obtain information about recently released electronic products. Improvements suggested by readers include:

- **Simplified code and reference numbers, for new products.**
- **Bold category heads on each page make it easier to find products listed in the locator.**
- **Improved cross references.**
- **An entirely new section—"Index to New Products by Manufacturer." Use it to scan a given company's new product activity.**

EDC is Electronic Design's 27th Issue.

## REPORT BRIEFS

### Phase Shifters

Two general phase-shifting techniques employing semiconductor elements were investigated. The first technique uses a step or incremental phase-shifting device that provides for discrete changes in phase. The second phase-shifting device is continuously variable and provides for a greater flexibility in phase control. Phase shifters were built for L-band which, for the incremental type, can handle peak powers in excess of 10 kw, and for the continuous type can handle 1 kw peak power. *Phase Shifters Study Program, Kenneth E. Mortenson and Charles Howell, Microwave Associates, Inc., Burlington, Mass., Aug. 1, 1961, 52 pp., \$5.60. Order AD 260092 from OTS, Washington 25, D. C.*

### Radar Clutter

Radar pulse coding (or pulse comprehension) techniques to improve detection of targets in clutter is discussed. Assuming a simple clutter model and an appropriately optimized receiver, an expression is derived for the single-pulse detection capability of a radar operating in the presence of both clutter and additive white receiver noise. From the expression it is seen that detection performance is simply related to the spectrum of the transmitted signal. Generally speaking, it improves as the bandwidth of the transmitted signal is increased. *The Use of Pulse Coding to Discriminate Against Clutter, Roger Manasse, Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Mass., June 7, 1961, 16 pp., \$1.60. Order AD-260230 from OTS, Washington 25, D. C.*

### Low-Noise Antennas

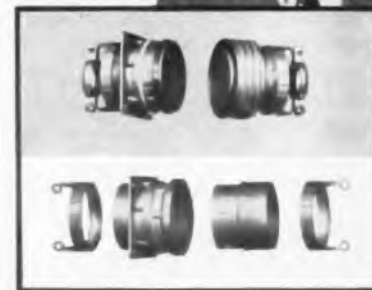
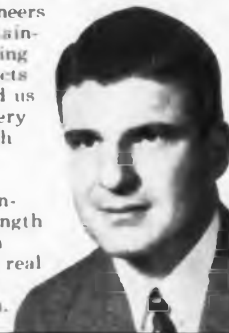
Principal sources of antenna noise are discussed, together with their effects on antenna performance. The concept of antenna gain-temperature ratio and a mathematical method for handling it as a single design parameter are introduced. Limitations of very large continuous apertures are considered and a multielement system proposed for increasing the useful size of large antennas. Some experiments to determine the feasibility of such a system and its optimum size are described. *Some Principles of Low-Noise Antenna Design, Ross Caldecott, Antenna Laboratory, Ohio State University Research Foundation, Columbus, Ohio, Dec. 1, 1960, 45 pp., \$4.60. Order AD-260112 from OTS, Washington 25, D. C.*

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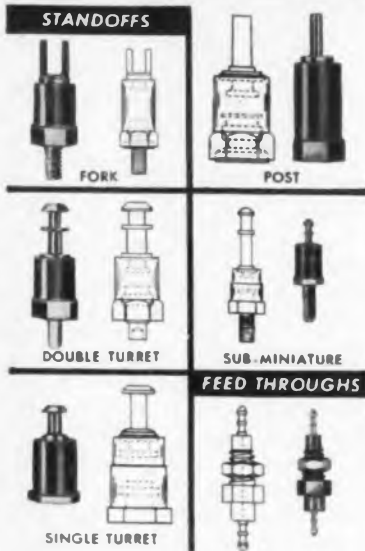
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### Tunnel Diodes

Research was concerned with the theory and applications of tunnel diodes. Effort was also devoted to developing a better understanding of the behavior of negative resistance devices. Most of the known essential elements of tunnel diode theory are summarized. *Tunnel Diode Theory and Applications*, Rajendra Nanavati and W. Howard Card, Syracuse University, College of Engineering, Syracuse, N. Y., April 10, 1961, 135 pp., \$10.50. Order AD-260776 from OTS, Washington 25, D. C.

### Antenna Matching

Techniques for using the Smith Chart when developing matching networks for broadband antennas are presented. The Chart is used for the matching of broadband as well as single frequency antennas. *Practical Matching Techniques on the Smith Chart*, Ove Simonsen, Navy Electronics Laboratory, San Diego, Calif., March 31, 1961, 29 pp., \$2.60. Order AD-260292 from OTS, Washington 25, D. C.

### Analog Circuitry

The results obtained by the application of redundancy to various types of analog circuitry are summarized. Comparisons are made between passive and active switching redundancy. Formulas are derived enabling the designer to determine the actual reliability improvements that may be expected. *An Improvement in the Reliability of Analog Circuitry Through the Application of Redundancy*, A. A. Sorensen, Space Technology Laboratories, Inc., Los Angeles, Calif., May 1961, 39 pp., \$4.60. Order AD-260459 from OTS, Washington 25, D. C.

### Reconnaissance Antennas

Research was continued on broadband, low-noise amplifier and mixer circuits to be integrated into an antenna to form a unified system. A broadband, low-noise, hybrid-coupled parametric amplifier is described. Research was also continued on the use of rf circuitry and nonlinear elements as integral parts of an antenna configuration to perform functions such as mixing, phase-shifting, amplifying, and tuning. *Research On Electronic Reconnaissance Antennas*, Interim Engineering Report, Antenna Laboratory, Ohio State University Research Foundation, Columbus, Ohio, June 5, 1961, 8 pp., \$1.60. Order AD256924 from OTS, Washington 25, D. C.

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Hughes Space Systems Division has immediate openings for Electronic Engineers, Mechanical Engineers, Physicists and Aeronautical Engineers to work on Project Surveyor—a spacecraft which will soft land on the moon. Once there, Surveyor instruments will perform a variety of scientific tests: drills will pierce and analyze the moon's surface; high quality television pictures will be transmitted to earth; other instruments will measure the moon's magnetic and radiation characteristics. ■ To accomplish this step into space, Project Surveyor requires the talents of imaginative junior and senior engineers and scientists to augment its outstanding staff. Experience is preferred but not required. A few of the openings include:

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## circuit designers

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## systems analysts

To consider basic problems such as: the requirements of manned space flight; automatic target recognition requirements for unmanned satellites or high speed strike reconnaissance systems; IR systems requirements for ballistic missile defense.

## infrared

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## YOUR CAREER

### IBM Systems Engineers Briefed at Symposium

Systems engineers of International Business Machines, Inc., recently attended the company's First Systems-Engineering Symposium. They heard reports on advanced computer techniques and received instruction on the new solid-state 1410 data-processing system.

More than 70 technical papers were presented, describing systems ranging from automatic methods of information retrieval to the programming of nuclear-reactor design problems.

A process-control system for the paper-making industry, simulated on a solid-state IBM 1620 computer, was demonstrated. It consists of an IBM 1710 process-control unit that monitors production on one or two paper-making machines. A 1711 data converter translates instrument readings from the paper-making machine into computer language and the solid-state 1620 data-processing system. The system stores, analyzes, and reports this converted data in visual form to technicians who control the paper-making process.



Instructor Shirley Daniels demonstrates the IBM solid-state 1410 data-processing system to IBM systems engineers.

### Industry Wage Pattern Shows Wide Fluctuation

The average minimum hourly wage for the electronic-equipment industry is \$1.41, according to the Bureau of Labor Statistics and the Electronic Industries Association. However, there are wide variations in minimum wages, dependent upon size of establishment and location.

The lowest rate in median establishments

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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.

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- 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.

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Position Desired \_\_\_\_\_

Educational History				
College	Dates	Degree	Major	Honors

Recent Special Training \_\_\_\_\_

\_\_\_\_\_

Employment History				
Company	City and State	Dates	Title	Engineering Specialty

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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.

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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

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  - Display and storage devices
  - Design of VHF & UHF FM communications in portable or subminiature development
  - Microwave field engineers
  - Transistor switching circuit design
  - Logic circuit design
  - T.V. circuit design engineering
  - Home radio design
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CIRCLE 903 ON CAREER-INQUIRY FORM

ELECTRONIC DESIGN • November 8, 1961

## YOUR CAREER

was said to be \$1.60, but the regional rates varied as follows: New England region, \$1.34; Middle Atlantic, \$1.75; South, \$1.48; Middle West, \$1.56; and Far West, \$1.57.

S. Herbert Unterberger, wage consultant to the industry association, said wages in the electronics industry in the six-state New England region have been consistently lower than those in other regions of the country. He also pointed out significant differences in wages between small and large electronics companies, minimum wages being substantially lower in small plants.

**The University of Rhode Island** and Raytheon Co.'s anti-submarine and undersea warfare center at Portsmouth have joined in a plan to bridge Narragansett Bay with a TV-relay link, thus eliminating lengthy trips by professors and graduate students.

Raytheon will install cameras in the university's new engineering building. When on-campus graduate students receive instruction, another group of students will receive the same courses across the bay at Raytheon, through closed-circuit television.

Two water towers, at the university and at Raytheon in Portsmouth, hold TV relay-link antennas, which carry video and audio signals between the university and Raytheon classrooms.

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**Careers Inc., New York**, says it is incorporating teletype links in the "career centers," which it has been holding during the larger technical conventions.

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Also, Careers Inc. is going to make available teletype links to the home plants of the participating companies (as well as to companies that are not participating). The advantage of these remote lines, says Careers, is that the home office of a company also can screen the new applicants as they register and can alert the recruiting team if a man looks good to it.

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\*Manufacturers' catalog appears in 1960-1961  
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ELECTRONICS ENGINEERS • PHYSICISTS

CAREERS

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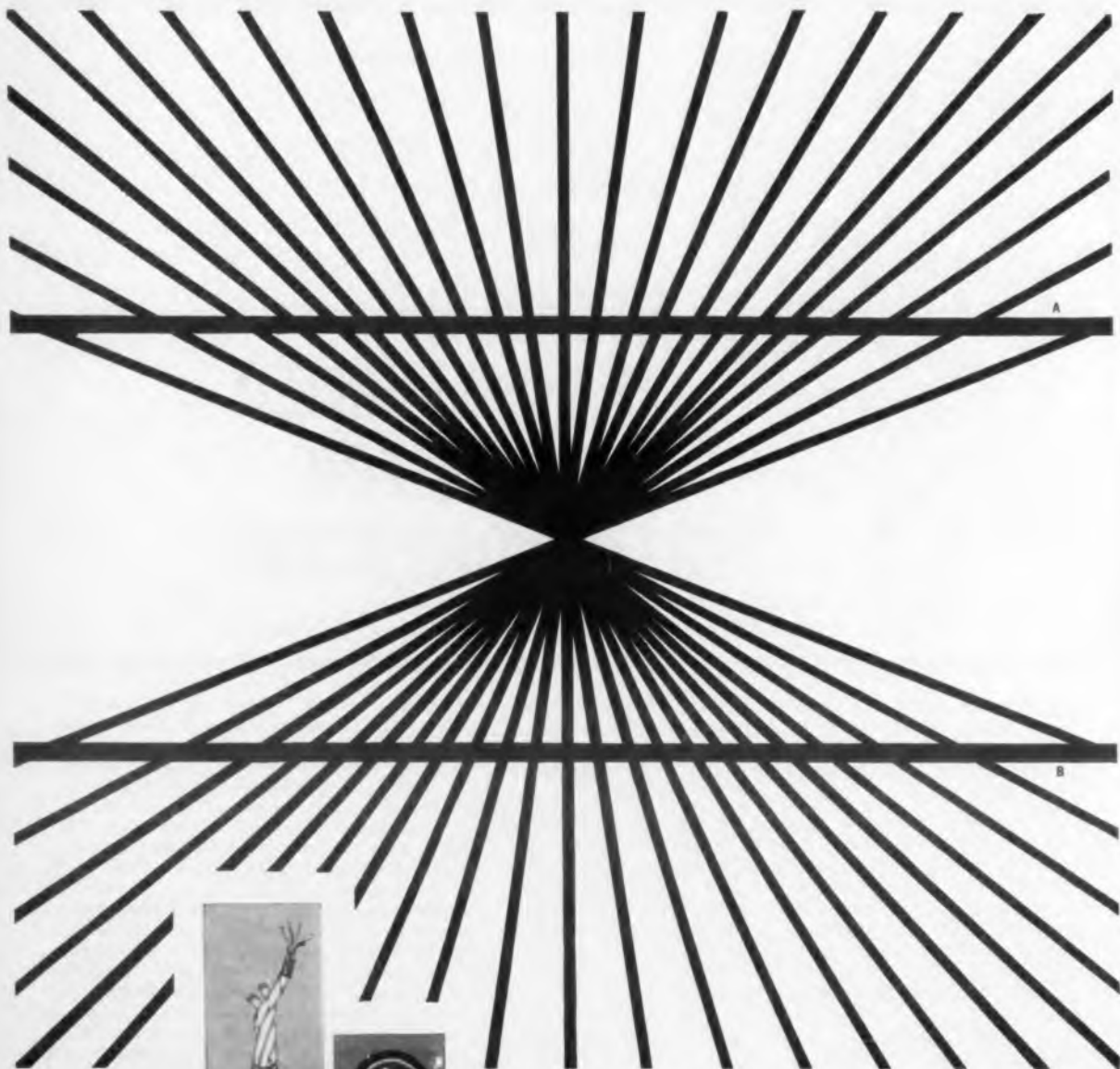
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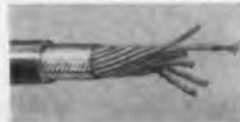
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