

# ELECTRONIC DESIGN



*True rms of any waveform  
measured with this  
new broadband (10 cps-7 mc)  
vtvm . . . p 68*

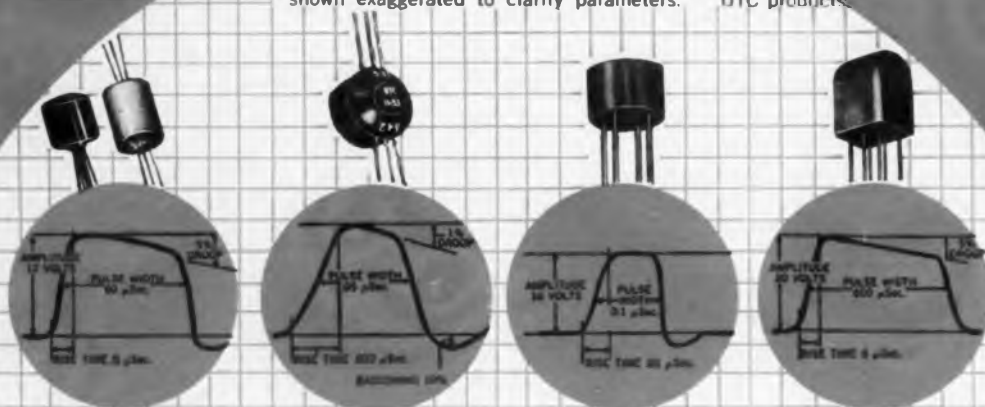




# SPECIAL PULSE TRANSFORMERS TO YOUR REQUIREMENTS

The pulse units illustrated below show a few of the thousands of special types designed and produced by UTC, to customers' requirements. Range covered on special pulse units is from a few microwatts to 10 megawatts. Rectangular pulse shapes are deliberately shown exaggerated to clarify parameters.

Almost thirty years of pioneering in the design and production of transformers plus exhaustive life testing programs and rigid quality control measures guarantee components of the highest reliability in the industry. . . . You can stake YOUR reputation on UTC products.

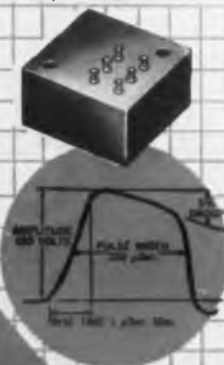


25 KC pulse transformer, DO-T or DI-T configuration. Pulse width 60  $\mu$ Sec. Rise time less than 0.5  $\mu$ Sec. Secondary C.T. balance each side to within 1% to ground. MIL-T-27A, GR 4. Size: DO-T,  $\frac{1}{2}$ " dia. x  $\frac{1}{8}$ " h., wt. 1/10 oz.; DI-T,  $\frac{1}{8}$ " dia. x  $\frac{1}{4}$ " h., wt. 1/20 oz.

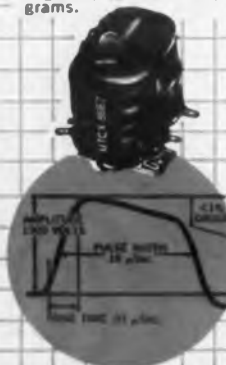
Special precision miniature pulse transformers. Designed in our standard stock mold to your specs. Checked and precisely adjusted in your tube or transistor blocking oscillator circuit. Sizes:  $\frac{1}{8}$ " dia. x  $\frac{1}{16}$ " h., 1 gram;  $\frac{1}{4}$ " dia. x  $\frac{1}{8}$ " h., 4 grams;  $\frac{1}{2}$ " dia. x  $\frac{1}{4}$ " h., 6 grams.

Ferrite core blocking oscillator transformer. 0.1  $\mu$ Sec.  $\pm 10\%$  @ 200 KC PPS. 2 windings, rise time .01  $\mu$ Sec. Epoxy case. MIL-T-27A;  $\frac{1}{8}$ " dia. x  $\frac{1}{4}$ " h., .07 oz.

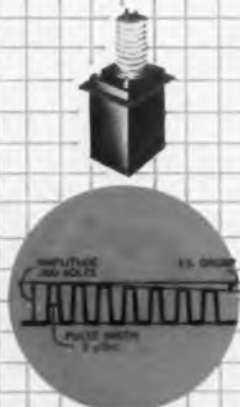
600  $\mu$ Sec. coupling transformer for printed circuit application. 3 windings.  $\mu$  metal case for extreme shielding. Z=20 K  $\Omega$ . 10 V. MIL-T-27A; standard UTC ML case;  $\frac{1}{2}$ " x  $\frac{1}{4}$ " x  $\frac{1}{8}$ " h., .2 oz.



Toroidal pulse transformer, 150 V, 200  $\mu$ Sec. @ 400 PPS. Molded in epoxy. 3 windings, low leakage, less than 1  $\mu$ Sec. rise time; -40 C. to +85 C.; output voltage within 1%. MIL-T-27A; 1 $\frac{1}{2}$ " sq. x  $\frac{1}{4}$ " h., 1.5 oz.



Output to 2142 magnetron. Input 1300 V-50 ohms. Output 6.5 KV to 1200 ohms and .6A. bilhar filament winding. .15  $\mu$ Sec., 1000 PPS. Trigger winding. MIL-T-27A GR 5; 1 $\frac{1}{2}$ " x 2 $\frac{1}{2}$ " x 2 $\frac{3}{4}$ ", 10 oz.



Output to Klystron, 5  $\mu$ Sec. pulses in groups of pulse trains at high rep rate. Droop 1% over pulse trains. 30 KV W.V., 43 KV hipot; -53 C. to +85 C.; MIL-T-27A; 4 $\frac{1}{4}$ " x 5" x 6 $\frac{1}{4}$ "; 11 $\frac{1}{2}$  lbs.



Sonar sine wave pulse output transformer. PP 4-65A's, 11-14 MC flat Pri. 11 KV; 28 KV hipot. Spark gap protected. Sec. 1500 V. @ 6000, 60 millisecon. duty cycle MIL-T-27A; -55 C. to +85 C.; 6" x 6" x 8 $\frac{1}{2}$ ", 13 lbs.

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over 1,000  
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High Reliability  
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distributor



Write for catalog

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COVER: Arrows contain waveforms equal in peak amplitude and varying in frequency. The true rms meter correctly indicates the difference in reading, which a peak reading meter could not do. The circle at the junction of the arrows represents meter input.

### Sidelights of This Issue

#### Reaching for the Moon

The world is indebted to the Russians and their photos of the far side of the moon for demolishing for all time an unscientific theory. While abundant holes exist on the "hidden" lunar surface, the photos showed, there is no noticeable evidence of cheese.

Another popular belief—that only the guileless would purchase a piece of real estate on the moon—may soon topple, too. Lockheed Aircraft of Marietta, Ga., is proposing a satellite that could map the lunar planet block by block. See p 8.

#### The Voters' Choice

ELECTRONIC DESIGN's fifth Most Valuable Idea of Issue Award of \$50 goes to H. W. McCord, engineer in the Electron Tube Div. of the Radio Corp. of America, Harrison, N. J. His design idea—"Ungrounded Shield Reduces Effective Cable Capacitance"—(April 26 issue)—won a plurality of your votes.

Why not join the voters and see if you can back a winner? It takes but a few minutes, and it doesn't cost a cent. Turn to the Ideas for Design section, starting on p 158, then cast your ballot on the Reader-Service Card.

◀ CIRCLE 1 ON READER-SERVICE CARD



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Measurement flexibility, moderate cost

# IN 4 NEW **SOLID STATE COUNTERS!**



Turn the page to learn about new measuring convenience, dependability from .

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Call your  engineering representative today for data demonstration of these time-saving, precision, advanced instruments

Your representative is your headquarters for sales, service and parts on the industry's most complete-coverage instrument array. (⊕) indicates factory-level field repair stations.

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a pleasure  
to measure  
with these...





⊕ 5532A, 1.2 MC




⊕ 5512A, 300 KC

# 4 NEW SOLID STATE

Measure frequency, period, ratio, with  
continuous display, no "blinking"...0.1  
...Unique low frequency accuracy...0.1

All the advantages of solid-state design are now yours in these new  solid state counters—offered at prices comparable to those of today's vacuum tube counters. And you get the *plus* advantages of greater readability, faster measurements, easier routine maintenance, rack-and-stack convenience of the new  universal module instrument cabinets.

Offered in four models, these new counters have maximum counting rates of 300 KC or 1.2 MC, with a choice of Nixie or columnar readouts. The high-intensity neon readouts are stacked in compact columns for faster, easier reading. On the in-line readouts, -pioneered standard incorporation of the new long-life, wide-viewing Nixies gives you many extra hours of lamp life and heretofore unknown readability even at extreme angles. Polarized screen provides maximum readout brilliance with freedom from reflections.

A unique display storage feature of these new counters produces a continuous visual readout of the most recent measurement, even while the instrument is making a new measurement. Only if the new count differs from the previous count will the display change, in which case it will shift directly to the new reading. The fatigue and error possibility of a "blinking" display is eliminated. The storage feature may be disabled with a rear panel switch.

The counter's "inactive time" (when not making a new measurement) is independent of gate time and adjustable from 0.2 to 5.0 seconds, thus permitting a higher sampling rate.

Counter	Max. Counting Rate	Registration	
5212A	300 KC	5 digits columnar	2 KC per to in
5512A	300 KC	5 digits Nixie	
5232A	1.2 MC	6 digits columnar	2 KC per to
5532A	1.2 MC	6 digits Nixie	

High sensitivity permits low level measurement without accessories, and multiple measurement (to 100,000 periods)



Note clean, compact, easy-to-service philosophy of new  solid-state counters.

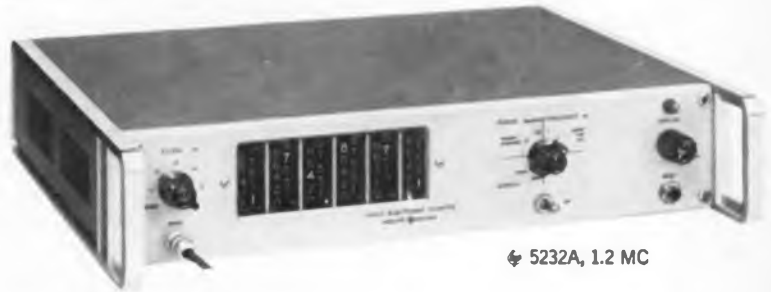
LIFT PAGE 



5212A, 300 KC



5212A, 300 KC



5232A, 1.2 MC

# NEW



# GATE COUNTERS!

...quickly, accurately ...Compact, easy-to-use instruments provide  
 ...0.1 volt sensitivity ...Solid-state dependability...Higher sampling rate  
 ...Operation -20° to +65° C...Prices comparable to vacuum tube counters!

Period Measurement				Frequency Measurement				Ratio Measurement			Price
Range	Accuracy	Reads in	Periods Averaged	Range	Accuracy	Reads In	Gate Time	Reads	Range	Accuracy	
2 cps to 10 KC in single period; up to 300 KC in multiple period average	$\pm 10 \mu s$ $\pm$ time base accuracy $\pm$ trigger error/periods averaged	Milliseconds with positioned decimal	1, 10, 10 <sup>2</sup> , 10 <sup>3</sup> , 10 <sup>4</sup> , 10 <sup>5</sup>	2 cps to 300 KC	$\pm 1$ count $\pm$ time base accuracy	KC with positioned decimal	10, 1, 0.1, 0.01 sec.	$(f_1/f_2) \times$ period multiplier	f <sub>1</sub> : 100 cps to 300 KC (1 v rms into 1,000 ohms) f <sub>2</sub> : same as period	$\pm 1$ count of f <sub>1</sub> $\pm$ trigger error of f <sub>2</sub>	\$ 975.00
2 cps to 10 KC in single period; up to 1 MC in multiple period average	$\pm 1 \mu s$ $\pm$ time base accuracy $\pm$ trigger error/periods averaged	Milli-seconds or microsec-onds with positioned decimal		2 cps to 1.2 MC						f <sub>1</sub> : 100 cps to 1.2 MC (1 v rms into 500 ohms) f <sub>2</sub> : same as period	
											1,300.00
											1,550.00

...low level measurement  
 ...multiple period average  
 ...modes) gives higher ac-



...physical arrangement of

...curacy in lower frequency ranges, even for noisy signals. Self-check is provided for both frequency and period measurement modes.

Only 3½" high, these counters are housed in the new modular cabinets ideal for both bench use and easy rack mounting. Routine maintenance is simple with snap-out decade readout units and circuit cards. Readout drive directly from photoconductors eliminates a complete stage of complex circuitry, to effect genuine cost and reliability advantages. Compact design and construction and servicing ease are illustrated at the left.

Solid state design and construction gives you the advantages of low heat dissipation with minor heating effect on adjacent equipment, fast warm-up, low power consumption and new standards of reliability.

The new counters include a four-line BCD code output. This output, with assigned weights of 1-2-2-4, is available for systems use or to operate devices such as the 562A Digital Recorder. Front panel controls include Input Attenuation, Display, Reset and Function.

Call or write your representative or call us today for information and a demonstration!

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



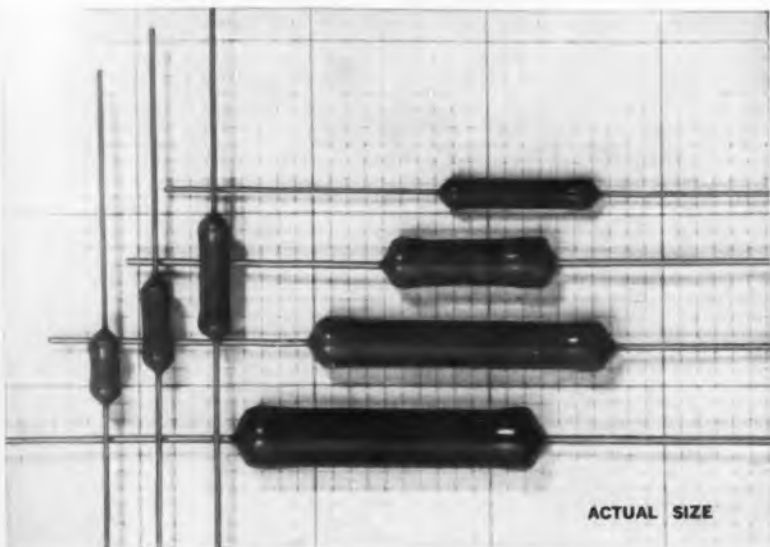
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## THESE "WIRE-WOUNDS" ARE CIRCUIT SHRINKERS . . . . . *newly* *expanded line lets AXIOHM® power resistors go into smaller circuits!*

Ward Leonard AXIOHM power resistors are now available in seven sizes—down to 2 watts, up to 12.5.

They're ideal for miniaturization in printed-circuits, industrial instrumentation and automation circuitry. But they're recommended for *any* electrical or electronic application where the highest stability and maximum overload capacity are required.

The seven AXIOHM sizes come in a

complete range of resistance values (see table) from 0.1 to as high as 75,000 ohms. Naturally, they feature the qualities Ward Leonard has made famous in power resistors:

Vitrohm vitreous enamel; Ward Leonard's specially made ceramic core; specially selected and matched resistance wire; and strong, permanent, low-resistance, spot-welded, lead-to-end-cap junctions. O. 9

SIZES AND RATINGS						
Rating (in watts)	Type	Resistances (ohms)		Dimensions (inches)		
		Min.	Max.	Length*	Diam.	
2	2X	0.1	5,000	$\frac{3}{8}$	$\frac{3}{16}$	
3	3X	0.1	10,000	$\frac{1}{2}$	$\frac{3}{16}$	
4	4X	0.1	15,000	$\frac{11}{16}$	$\frac{3}{16}$	
5	5XM	0.1	20,000	$\frac{15}{16}$	$\frac{3}{16}$	
7	7X	0.1	25,000	1	$\frac{3}{16}$	
10	10XM	0.1	50,000	$1\frac{1}{4}$	$\frac{3}{16}$	
12.5	12.5X	0.1	75,000	$1\frac{3}{4}$	$\frac{3}{8}$	

\*Less leads.

Get complete details in Supplement C to Catalog 15. Write for your copy and a list of stocking distributors today. Ward Leonard Electric Co., 77 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada, Ltd., Toronto.)



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CIRCLE 4 ON READER-SERVICE CARD



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# ELECTRONIC DESIGN

Hayden Publishing Company, Inc.  
850 Third Avenue, New York 22, N. Y.

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## Coming Next Issue

New design interest in surface-wave transmission lines is reported in the MicroWaves section of the August 2nd issue of ELECTRONIC DESIGN. This well-known, but little-used transmission method may be coming into its own for antenna lines and long-haul communications. Articles on design of magnetic radar modulators and selection of Doppler modulation systems are also featured. The latter article should be of particular importance to designers interested in the fast-growing Doppler field.



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NEW  
NEW  
NEW  
NEW  
NEW

# Rutherford



MODEL  
**B-10**

## TRANSISTORIZED / PORTABLE PULSE GENERATOR

A revolutionary new, highly versatile, general purpose, portable pulse generator for field and laboratory use. Featuring a self-contained rechargeable battery pack which allows independent operation "in-the-field" as well as from standard line voltages.

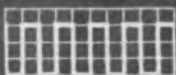
### SPECIFICATIONS:

- Main Pulse—plus or minus, 18 volts into 50 ohm amp.
- Repetition Rate from 20 CPS to 2 MCS in 5 ranges.
- Pulse Delay from 0.0 to 10,000 USEC in 5 ranges.
- Pulse Width from 0.05 USEC to 10,000 USEC in 5 ranges.
- Overshoot and undershoot—5% or less.
- Duty factor—60% max. at any rep. rate.
- Sync. Pulse Out—positive, 8 volts min., open circuit amplitude.
- Size: 8" wide x 8 $\frac{3}{4}$ " high x 12" deep.
- Also available as rack mounted unit.



**THE COMPLETE LINE OF RUTHERFORD PULSE GENERATORS AND SYSTEMS  
WILL BE ON DISPLAY—WESCON SHOW—BOOTH NOS. 1501 & 1502**

Write for complete catalog to Dept. ED7-19.



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ELECTRONICS CO.

8944 Lindblade Street • Culver City, California • TWK-CVR-CY-4133

*pulse generators / pulse systems / accurate time delay generators*

CIRCLE 5 ON READER-SERVICE CARD

# Advances Spur Thin-Film Computer Hopes

*Hughes Testing Complete DDA Using Films;*

*RCA Claims Field-Effect Deposited Transistor*

**Alan Comeretto**  
News Editor

**S**EVERAL recent developments indicate that designers are advancing in their drive to miniaturize computers via thin-films.

▪ At Hughes Aircraft Co., Culver City, Calif., tests are proceeding on a complete airborne computer in which thin-film capacitors and resistors operate in conjunction with conventional semiconductors of the smallest available type.

▪ Researchers at Radio Corp. of America, Princeton, N. J., claim development of a thin-film cadmium-sulfide transistor operating on field-effect principles but differently from other field-effect devices.

▪ General Electric's Light Military Electronics Dept., Utica, N. Y., has built thin-film logic circuits which it is proposing to the military services as replacements for conventional logic modules.

RCA reports it has deposited thin films of cadmium sulfide in strips so thin that electrodes can be spaced only 5 microns apart. The films are 1 micron thick. By using a source, drain, and gate configuration (corresponding to the emitter, collector and base nomenclature of conventional devices), RCA researchers have been able to make the combined cadmium-sulfide-insulation and metal-electrode structure act like a transistor.

To do this however, they have had to bias the gate positively so that the gate material, starting as an insulator, has electrons drawn into it, enhancing its conductivity. Enhancement current rather than depletion current is said to be the dominant factor in the device's operation. In field-effect devices such as the Shockley unipolar transistor the gate is biased negatively so that current passing through the device may be modulated by varying the amount picked off.

Because of the extremely narrow electrode

spacing, reports RCA, the insulation-like cadmium sulfide can be made to operate at high frequencies, overcoming the low carrier drift mobilities of the material. In laboratory transistors made so far, gain-bandwidth-products of about 5,000 have been measured, the company says. A transconductance of 5,000 was achieved at 10 ma and 10 v.

RCA says the device and the techniques it has developed appear very suitable for mass deposition of computer circuitry. However, its speed is limited to 1 mc at present. Because only a few milliwatts are required for operation, component densities of 10,000 per sq in. are expected.

**Experimental Hughes Thin-Film Computer Has 8,000 Components, Draws 30 W**

To demonstrate feasibility of thin-film circuitry for logical processing in an airborne computer, Hughes has built a digital differential analyzer based on the circuitry of the



**Thin-film digital differential analyzer** built by Hughes to demonstrate feasibility of techniques weighs 1 lb, occupies 20 cu in, contains more than 8,000 parts, yet draws only 30 w. Hinged wafers are of Fotoceram. Components along edges are micro-transistors and diodes in ultrasonically drilled holes. Thin-film components are in center of wafers.



**Logic board** for thin-film DDA contains 32 NOR circuits consisting of thin-film capacitors and resistors, and micro-semiconductors.



**Thin-film field-effect transistors** deposited on substrate are made of cadmium sulfide. Electrodes for individual transistors in development at RCA have been spaced as little as 5 microns apart to overcome some of the effects of using an insulator-like material for an active device. Substrate holds three transistors.

Mark II Polaris guidance computer. The unit is said to have more than 8,000 components. It weighs 1 lb, occupies 20 cu in. and requires 30 w of power. It has a core memory and logical circuitry made of thin-film capacitors and resistors deposited on top of one another and micro-transistors and diodes.

Resistors are formed by depositing a 250-A thick layer of Nichrome on a 40-mil Fotoceram wafer and covering this layer with an insulation of silicon monoxide. A layer of copper to form a capacitor plate is deposited on the silicon monoxide.

Either silicon monoxide or anodized aluminum is used as dielectric. Another layer of copper and insulation makes a capacitor.

Interconnections are formed by etching a network of horizontal and vertical conductors separated by a flexible insulator. In one 1-by-1-in. rectangle on the wafer, Hughes says, 44 horizontal wires cross 64 vertical wires with interconnections at each intersection. Reliability is said to be very great. In the circuit mentioned, more than a million on-off cycles have handled 1/4-amp with no failures, according to Hughes.

The computer is divided into 25 wafers, of which 17 logic wafers are nearly identical. For the 25 wafers only nine basic layouts are required, Hughes says. The wafers become unique when interconnections are selectively etched and when the semiconductors are added. These are inserted into holes ultrasonically drilled in the wafer. The wafers are hinged for accessibility so that the entire computer opens like a book.

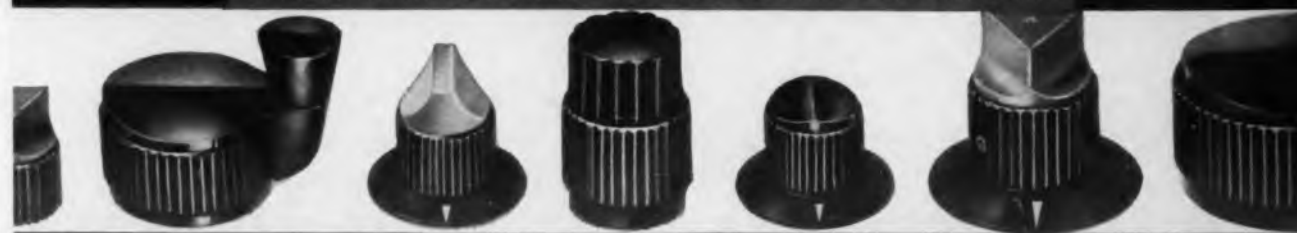
Hughes estimates that if the computer were to be produced in a production run, the semiconductors would make up about 70 per cent of the cost of the end product. Labor and materials would be 30 per cent. ■ ■



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## NEWS

### Sensing Network Is Planned in Gulf

#### Feasibility of Undersea Program To Undergo U.S.-Private Tests

Thomas E. Mount  
West Coast Editor

**T**HE FEASIBILITY phase of a wide-ranging oceanography project in the Gulf of Mexico is expected to be operational by mid-October. An underwater data-sensing system, linked to off-shore towers, will be used to tie together the instrumentation systems used in the project, according to Roy Gaul, program coordinator for the Dept. of Oceanography and Meteorology at Texas A & M.

The towers belong to the Navy's Mine Defense Laboratory in Panama City, Fla.; however, the project will be a joint effort of the Government, industry and educational institutions. Although the first phase of the Air-Sea Environmental Interaction Research program is directed only at showing feasibility, subsequent financing of the program should permit instrumentation of the entire Gulf.

While the sensing equipment to be established in the Gulf consists only of militarily innocuous oceanographic equipment, industry sources speculate that, after systems have been installed, ASW and sonar equipment may be attached.

Transducers used measure current speed, current direction, water temperature at three subsurface points. At one surface location, wind velocity and direction, air temperature and wave motion will be measured. The underwater sensors are all manufactured by Hytech Corp., Inglewood, Calif. Savonius rotors are used for measuring current velocity, while standard meteorological gear, such as anemometers, vanes, and barometric pressure devices are used for air measurements.

There is a need for better barometric pressure devices, Mr. Schlager said. "The trouble with strain gages calibrated from 5 to 15 psia is that we are working at the high end of the scale and the sensitivity is not great enough."

Thermistors, housed in 0.006 in. OD tubing, are used to measure temperature. Hytech is said to be building instruments with an error no greater than 0.05 C for all temperature measurements including air. Response of the thermistor device is only 1/2-sec but



Manufacturer: Trimpot® potentiometers; transducers for position, pressure, acceleration. Plants: Riverside, California; Ames, Iowa; and Toronto, Canada

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Underwater current speed transducers and some of the surface equipment is displayed by Roy Gaul, of Texas A & M, left, Henry Walker, vice president of Hytech Corp. and Don Crezler, president of Hytech, right. Current devices are Savonius rotors, standard velocity measuring device.

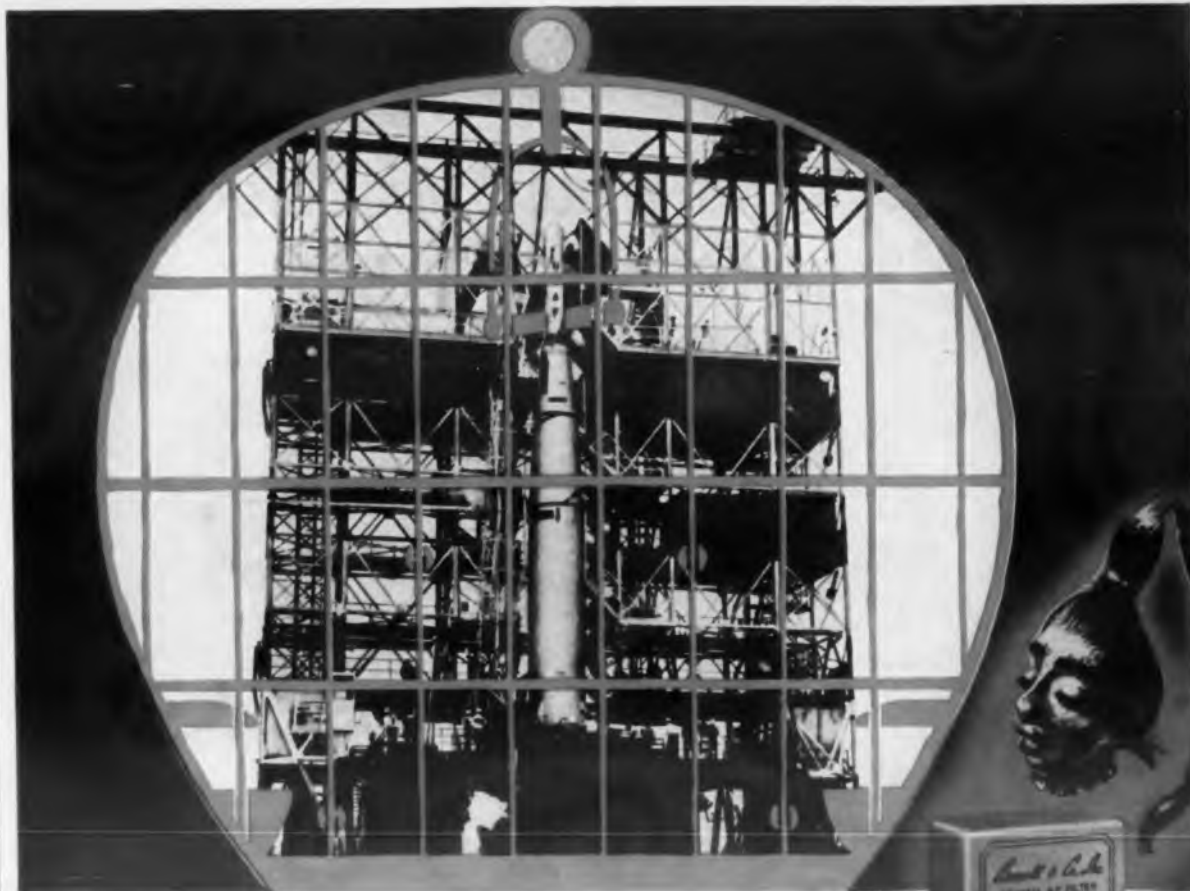
the slow-changing nature of the measurements makes this response adequate.

In the Gulf instrumentation set-up, buoys, used to house power supplies, conversion and transmitting equipment, would be linked to multiple underwater sensing stations. These would transmit data over webs to the buoy and the buoy would retransmit the data to equipment on an oil derrick or Texas Tower in the vicinity. In turn the information would be transmitted to shore site data reduction facilities by microwave link.

The power supply in the buoy would consist of standard wet cell batteries and a small diesel engine. When the batteries' charges reach a preset low the engine would turn on automatically to recharge them.

Telemetry equipment for the program is supplied by Telemetry Corp. of America, a subsidiary of Pacific Mercury Electronics, Sepulveda, Calif. A straightforward fm-fm telemetry system will be used, according to TCA's Vernon A. Dorrell, chief systems engineer. Frequencies used will be in the neighborhood of 135 mc in the vicinity of the Gulf missile range. In other areas of the Gulf, transmission frequencies used should be in the 225-260 mc band.

The program, thus far a patchwork of loosely-knit organizations, was sparked by Texas A & M's Roy Gaul. Mr. Gaul recently made a presentation to 30 or 40 different government organizations, including Office of Naval Research and National Science Foundation, who have expressed interest in the program. ■ ■



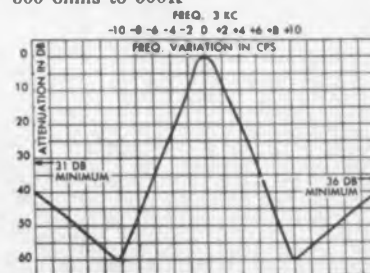
## Only a Bird In a Gilded Cage

As succeeding generations of missiles penetrate the curtain of space that separates Earth from other planets, the importance of electronic guidance, control and airborne telemetry systems becomes obvious. For, without new engineering design techniques to provide reliable communication and control, the most advanced missile is but a bird in a gilded and very expensive cage.

As typical examples of what can be accomplished to insure maximum performance in missile telemetry, communication, data processing and other applications, Burnell & Co. has developed two new filters—a miniature 3 kc crystal filter and, employing modern synthesis techniques, a miniature 500 kc LC toroidal filter possessing low transient distortion characteristics.

### TECHNICAL DATA 3 kc Crystal Filter

Attenuation—3 db B/W—2 cps  
Shape Factor—30/3—5:1  
Impedance—500K in and out  
Temp. Coeff.—.021 cps °C  
Size— $3\frac{1}{2}$  x  $2\frac{3}{16}$  x  $1\frac{1}{16}$   
Insertion Loss— $3\frac{1}{2}$  db  
Also available in any impedance from 500 ohms to 500K

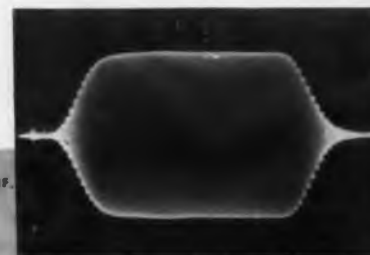


### TECHNICAL DATA 500 kc LC Toroidal Filter

Attenuation—B/W 40 kc at 3 db  
—200 kc at 50 db  
Impedance—50 ohms in and out  
Insertion Loss—4.5 db  
Over and undershoot—  
(for a step modulated  
500 kc carrier)—less than 1%  
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# Satellite System Would Map Moon With Erasable Tape

*Lockheed Design Calls for Electrostatic-Thermoplastic Recording  
Of Lunar Surface and High-Speed Transmission of Data to Earth*

Peter de Blanc  
News Editor

**E**LECTROSTATIC-thermoplastic tape recording, high-speed data transmission and an accurate earth-controlled guidance system are basic concepts of a lunar-mapping satellite design described at the AIEE Aerospace and Transportation Committee Technical Conference in Philadelphia.

The design was drawn up by the Lockheed Aircraft Corp., Marietta, Ga., prime contractor for the Samos (Satellite And Missile Observation System) vehicle. Company engineers said that the design considerations for the lunar satellite were similar to those for Project Samos. Thus far, however, Lockheed has no contract to develop its moon-mapping system.

The recording technique combined with the guidance system is said to make possible a final map of the moon with altitude markings accurate to 50 ft and linear-distance measurements accurate to 158 ft.

The Lockheed method would utilize a computer on earth for guidance and positioning of the satellite's attitude in flight, as

opposed to a pre-programmed computer in the satellite proper.

The time history of the satellite's altitude would be telemetered back to earth for computation of orbital parameters. Then thrust initiate and magnitude signals would be sent to the vehicle. Thrust direction information would probably not be necessary, as the inertial guidance system would position the vehicle properly. This system is said to permit a guidance accuracy of 50 miles inclination from the desired polar orbit.

The mapping camera to be used would employ electrostatic-thermoplastic film and have a focal length/format ratio of 1/3. Each frame would be a 30-by-30 mile segment of the moon's surface.

On exposure, static charges are arranged on a plastic tape corresponding to various levels of light. Images are recorded in 16 shades of gray, with a resolution inaccuracy of 158 ft in a 30-by-30 mile area at a distance of 30,000 ft. The tape can be read out directly. Readout is destructive, returning the tape to its original neutral electrical state. It may then be re-used.

Photographs of a 30-by-30-mile area with an overlap of 60 per cent will be taken every 10 sec for 1 hr during each 2 hr orbit. This requires a total of 360 frames. A film capacity of 1,000 frames will provide an adequate reserve.

## Data Link Would Transmit One Frame Every 12 Sec

Under the proposed system, data would be transmitted at a rate of  $3 \times 10^6$  bits per sec at a bandwidth of 750 kc. This speed would enable all of the information collected during the period of one orbit to be transmitted in a relatively short time. Picture elements themselves are resolved into 16 shades of gray, or 4 binary bits. The speed allows the transmission of one frame of data every 12 sec, a timing interval said to be an excellent compromise between readability and speed.

The star background over an area of the moon would be photographed concurrently with that area. The method devised for this would use an integrated technique of electrostatic-thermoplastic recording. The star background would be recorded on the mapping format itself and included on each frame, thereby eliminating the need of a separate recording system.

Scientists would be able to use the photo of the star background over a mapped area, along with accurate time measurements, to determine the nadir point location of each frame. Then instruments such as the Kelsh Plotter, automatic mosaicker and others, would be used to put together the final map.

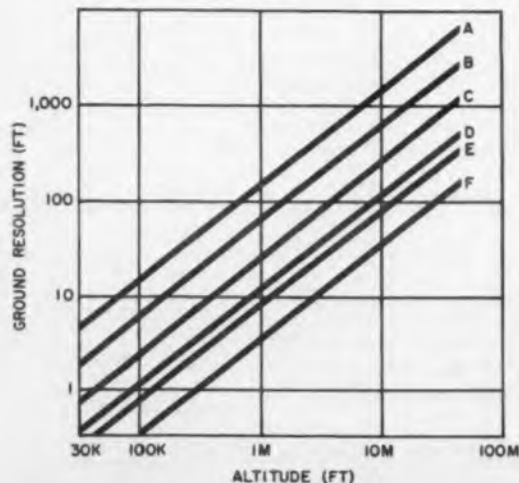
The navigation and control subsystem of the satellite would be composed of a programmer, including core storage, scalars and



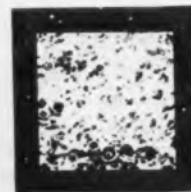
A. 6 in. FL 40 Lines/mm    D. 36 in. FL 100 Lines/mm  
B. 6 in. FL 100 Lines/mm    E. 120 in. FL 40 Lines/mm  
C. 36 in. FL 40 Lines/mm    F. 120 in. FL 100 Lines/mm

Figures were obtained in tests with available high-accuracy airborne mapping systems.

**Graphical relationship** of ground resolution to altitude of a mapping satellite.



**Lunar mapping satellite** as conceived by engineers of the Lockheed Aircraft Corp. Design problems are said to be similar to those of the Samos satellite.



Sample picture frame as it would appear when received from proposed satellite shows portion of the moon's surface with star background directly above it.



### Film for Moon: A Compromise

Electrostatic-thermoplastic tape recording—a merger of television and photography—was selected as the recording media for Lockheed's proposed moon-mapping satellite after careful consideration. The methods considered included:

**Radar:** Due to the low altitude of the proposed mapping vehicle and the lack of any attenuating or refracting atmosphere, a ppi-type radar originally exhibited considerable merit as a mapping technique. However, upon further examination, difficulties in the resolution of many successively overlapping ppi presentations and in the vertical and azimuth stabilization of a satellite carrying a rotating antenna ruled out this system.

**Television:** Resolution and linearity obtainable with present vidicon-type tubes would give only relatively coarse terrain data, hardly comparable with photographic capabilities. While being satisfactory for navigation use, the image obtained would not do for map makers.

**Infrared:** Basically similar to television, in that the image resolution obtained is not accurate enough for map-making.

**Conventional Photography:** A camera is figuratively the best choice for data-recording with the highest precision. But film in the quantities necessary to map the moon would weigh over a ton. Even if a suitable transport vehicle were devised, the film would have to be returned to earth for processing. And the sensitive film necessary for the job would undoubtedly be fogged by high-level cosmic radiation.

a timing clock with an accuracy of 1 part in  $10^7$ . Also in this package would be an inertial guidance system, radar altimeter and earth sensor.

Data transmission equipment would include the tape scanner and digitizers, a set of command receivers and transmitters, and the parabolic antenna.

Power would be supplied by solar cells and nickel-cadmium batteries.

The satellite itself would be cylindrically shaped. Around its perimeter four solar cell paddles would be spaced. At one end of the satellite would be a 5 ft parabolic antenna on a shaft, and at the other the main mapping camera. By means of an earth sensor, the antenna would be kept pointing continually toward the earth. Stabilization jets placed around the midsection of the vehicle would be used for control of unit orientation. Alongside the mapping camera, would be a sensor, used to maintain stabilization. ■ ■

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ABSOLUTE MAXIMUM RATINGS	
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Collector Voltage, $V_{CB}$	-20 volts
Collector Voltage, $V_{CE}$	-20 volts
Collector Voltage, $V_{CO}$	-15 volts
Collector Current, $I_C$	-100 ma
Total Device Dissipation @ 25°C	150 mw

### ELECTRICAL CHARACTERISTICS (@ 25°C)

Characteristics	Conditions	Min.	Max.	
Collector Cutoff Current, $I_{CBO}$	$V_{CB} = -5v$		3	$\mu A$
DC Current Amplification Factor, $h_{FE}$	$V_{CE} = -0.5v$ $I_C = -50 ma$	35		
DC Current Amplification Factor, $h_{FE}$	$V_{CE} = -0.5v$ $I_C = -10 ma$	50	300	
Collector Saturation Voltage, $V_{CE(SAT)}$	$I_C = -10 ma$ $I_B = -0.5 ma$	0.050	0.140	volt
Base Input Voltage, $V_{BE}$	$I_C = -10 ma$ $I_B = -0.5 ma$	0.25	0.35	volt
Hold Storage Factor, $K_1$ 's	$I_B = -2.5 ma$		100	nsec
Gain Bandwidth Product, $f_T$	$V_{CE} = -10v$ $I_C = -6 ma$	150		mc

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Characteristic Impedance .....	500 $\Omega \pm 5\%$
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with Input Rise Time .....	Step Function
Distortion .....	10%
with Input Rise Time .....	.02 $\mu$ sec
Attenuation .....	2 db Max.
Dielectric Strength .....	300 WVDC



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**NEWS**

**2.25-Gc Transmitter  
Is All Solid State**

*Tubeless 2-W RF Source Is Built  
Into S-Band Telemetry Equipment*

**A**N ALL-SOLID-STATE rf source said to be capable of supplying 2 w of power at 2.25 Gc has been incorporated in an S-band telemetry transmitter, according to Sylvania Electric Products, Inc., Buffalo, N. Y.

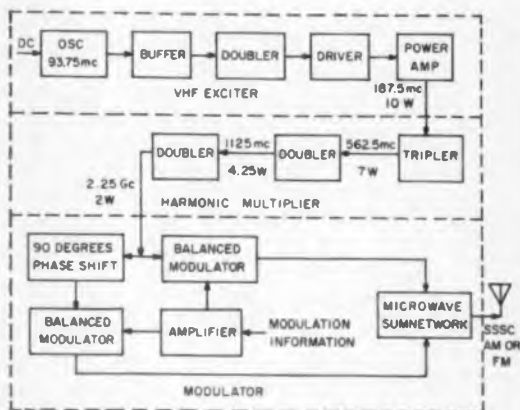
The source is an exciter—consisting of a 93.75-mc oscillator with high-gain buffer, varactor-doubler, driver and power-amplifier stages—driving a harmonic multiplier string. According to Sylvania, the use of solid state components gives the complete transmitter an estimated mean-time-to-failure of 14,000 hours. An engineering model built for Wright Air Development Div. occupies 41 cu in. and weighs 3 lb, including a 1-lb copper heat sink.

The transmitter is single-sideband, suppressed-carrier modulated at a high level by phase discrimination. The modulator converts standard am or fm input to a sideband power of 320 mw. In the all-solid-state exciter of the transmitter, a fifth-overtone series crystal operating at 93.75 mc is used. This frequency is multiplied in a varactor



Developmental telemetry transmitter held by Sylvania project leader W. S. Maciag uses elaborate heat sinking and 3-0 microwave construction to operate at 2.25 Gc and 2 w with all-solid-state construction.

ELECTRONIC DESIGN • July 19, 1961



**S-band, 2-w transmitter** has rf source consisting of a vhf exciter driving a harmonic multiplier. The modulator supplies either am or fm single-sideband suppressed carrier modulation.

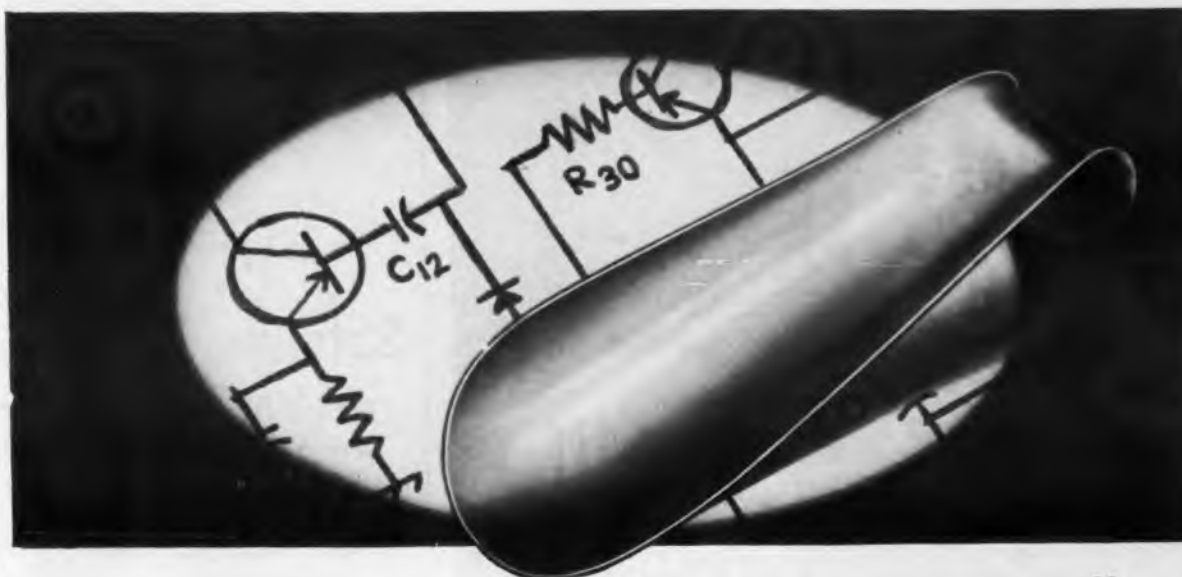
doubler that uses a PC-119-10 Varicap as the active element in a shunt-type circuit.

Operation is an environment of  $-20$  to  $+80$  was required by WADD. This called for a careful heat-sinking of the power amplifier. A nickel-plated beryllium-oxide disk is used in the sink for each of two TA2084 transistors employed.

The harmonic generator consists of a cascaded tripler and two doublers. It uses varactor diodes with breakdown voltages in the  $-100$ -range. This high voltage is said to keep peak currents low and provide reasonable varactor conversion efficiency. Total conversion efficiency is said to be 7 db in converting 10 w at 187.5 mc to 2 w at 2,025 Gc.


The configuration of the varactor was not conducive to high power dissipation. This required compensation in the microwave structure, where a bead-supported coaxial transmission line was used. Tuning stubs that match varactors individually and ease replacement are used as direct thermal paths. They are shorted half-wave transmission lines that provide metal-to-metal contact.

In the modulator, individual modulators each suppress the carrier frequency while generating both upper and lower sidebands. These are then directly combined to give only one sideband. This occurs when one of the balanced modulators shifts the phase of one of the sidebands 180 deg while maintaining the other at the reference, or input, phase. The balanced modulators, the phase shifter and the microwave sum network are strip transmission line 3-db directional couplers. This portion of the transmitter was built in a three-dimensional coordinate system. ■ ■



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**Winding Construction** — Extended foil (non-inductive) MYLAR Dielectric.

**Humidity Resistance** — Far exceeds requirements of EIA-Spec RS164 Para. 2, 3, 8.

**Tolerance** — Standard  $\pm 20\%$   $\pm 10\%$   $\pm 5\%$  thru  $\pm 1\%$ .

**Voltage Range** — 100, 200, 400, 600 and 1000 VDC.

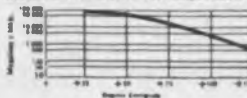
**MISC. SIZES (100 VDC)**

CAP.	D	L	CAP.	D	L
.001	.156	$\frac{1}{2}$	.1	.201	$\frac{3}{8}$
.01	.156	$\frac{1}{2}$	.22	.220	1
.022	.203	$\frac{5}{8}$	.47	.460	1 $\frac{1}{2}$
.047	.234	$\frac{3}{4}$	1.00	.502	1 $\frac{1}{2}$

**Capacitance Change vs. Temperature**



**Insulation Resistance vs. Temperature**



\* DuPont's trademark for polyester film.

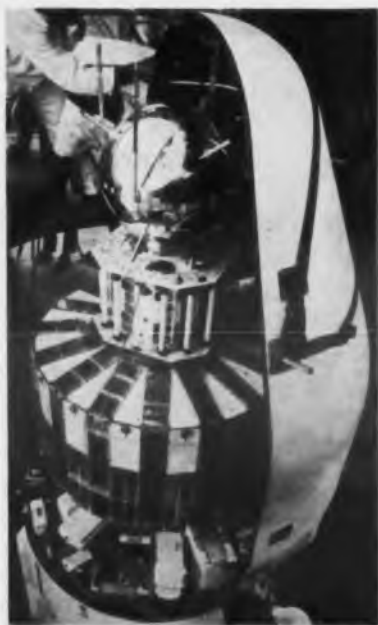
Write for Detailed Literature on Good-All  
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**GOOD-ALL ELECTRIC MFG. CO.** Ogallala, Nebr.

## Satellite Triplets Send Back Key Data

*Transit IV-A and 2 Smaller Vehicles Are Proving Worth of Multiple Launchings Despite Difficulties*



**Triple-play space shot** is readied as engineers check (from top to bottom): Greb III, solar radiation measuring satellite; Injun, cosmic ray Van Allen Belt monitor; and Transit IV-A, navigational satellite.

**T**HE FEASIBILITY of multiple satellite launchings has been established despite some difficulties in the recent triple-launching of Transit IV-A and two smaller orbiting vehicles, according to space officials.

The three satellites, riding a Thor-Able-Star from Cape Canaveral, were designed to be separated by a spring mechanism so that all would follow separate orbits. The two smaller vehicles, Greb III and Injun, failed to separate. Much of the data hoped for from these satellites is being obtained despite the separation failure, according to a Navy spokesman.

The multiple launching approach appears to be an ideal method of accomplishing several distinct space missions without the excessive costs of several individual launches.

The three satellites now in orbit are expected to accomplish the following:

- Transit IV-A, a navigational satellite, will signal from space on the energy provided by a small atomic battery atop the drum-shaped craft.
- Injun will investigate the radiation in the Van Allen belts and its relationship to the Northern Lights.

- Greb III will study X-ray radiation from the sun and its effects in causing ionospheric disturbances and radio blackouts on earth.

According to a Navy spokesman, Greb III is not rotating as rapidly as planned and is receiving only one-half of the data anticipated. A photometer installed in Injun, is blocked by Greb III, therefore preventing the instrument from making air glow observations. However, Transit IV-A is working successfully, according to the Navy spokesman.

This was the first time a triple-decker payload launch had been attempted. Two previous successful Transit satellites have



**Snap generator** is fastened to the base of Transit IV-A satellite by Martin Co. researchers. Fueled with plutonium-238, it is designed to provide continuous electrical energy for two of the four satellite transmitters. Additional power source is supplied by solar cells and two nickel-cadmium batteries.

carried single piggy-back satellites with them into orbit.

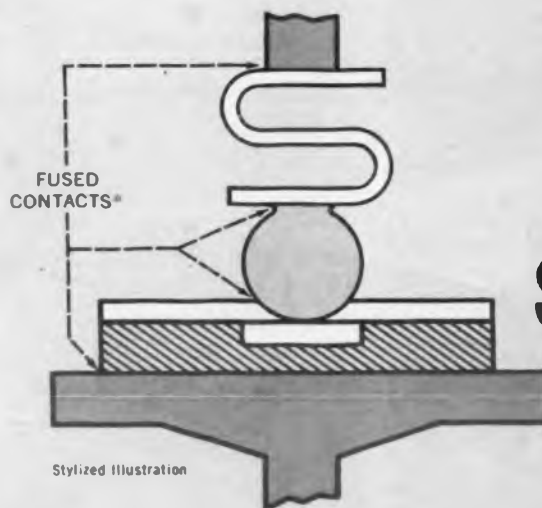
The tiny atomic power generator in the Transit IV-A satellite is one of a series of Snap (System for Nuclear Auxiliary Power) devices being developed by the Atomic Energy Commission for applications in space and on earth.

Inside the grapefruit-sized Snap device is a small amount of plutonium-238. As the radioactive material decays, it gives off heat. This heat is converted by thermocouples directly into electricity powering instrumentation and two of the four transmitters aboard the Transit satellite. The half life of the plutonium-238 isotope used is 89.6 yr. In addition to the 4.7-lb Snap generator, developed by the Martin Co., Baltimore, the satellite is powered by solar cells and carries two nickel-cadmium batteries.

Transit IV-A has an improved memory system (including an absolute time system) which will periodically receive orbital data from a ground injection station. The satellite will transmit these orbital data continuously until new data are received from the ground to replace the old. A single orbital passage of the satellite, will enable a properly equipped ground station to compute its own position from the orbital data and Doppler shift measurement.

The Injun satellite was designed and built by Dr. James Van Allen of the State University of Iowa as part of a program of research directed by him under contract with the Office of Naval Research. ■ ■

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## NEWS

# Single Radar to Aid All Ships in Harbor

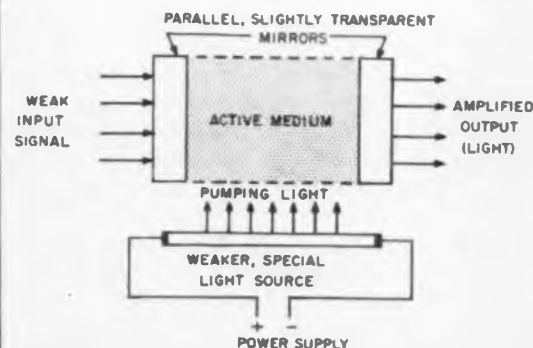
*Scan-Converted Display Is Sent To VHF Receivers on Vessels*

**T**HE COAST GUARD is about to test a navigation aid based on the broadcast of converted data from harbor surveillance radars to shipboard television receivers. In the tests, scheduled to begin shortly in New York Harbor, scan-converted data from a powerful radar will be transmitted omnidirectionally to adapted vhf receivers.

The system is designed to give large and small ships the ability to move about in a crowded harbor during low-visibility conditions without requiring a harbor surveillance radar aboard each craft. According to the Coast Guard, the only shipboard equipment required is an antenna and an ordinary TV set adapted for an additional channel.

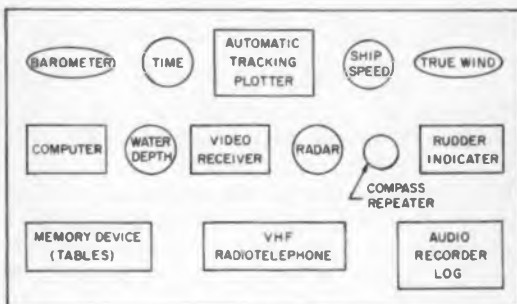
The Coast Guard's plans were described by Capt. L. E. Brunner at the 17th annual meeting of the Institute of Navigation held in Williamsburg, Va.

Captain Brunner reported that the data to be broadcast would be unedited by monitors and that no means of identifying in-



**Proposed as a space-navigation aid**, optical maser in receiver configuration would differ from transmitter unit mainly in use of slightly transparent mirrors. In the transmitter maser one mirror would be highly reflecting, and a powerful pumping light would be used. In the receiver, the pumping light would be bright enough to keep energy stored in atoms of an active medium but not so bright that noticeable transmitter maser action would begin. Received light from a companion transmitter would trigger the release of stored energy, which would emerge from a second mirror greatly amplified.

ELECTRONIC DESIGN • July 19, 1961



**Coast-Guard** conception of integrated display of navigation instruments on ship's bridge is being implemented in stages. In panel shown, which would permit one man to handle a sizable ship, the only equipments still undeveloped are a memory device, for display of navigational and other tables, and a video system to display ppi data broadcast from harbor surveillance radar. Scan-conversion video system is to be tested soon in New York Harbor.

dividual blips would be included in the system. In Europe, he said, similar systems are in use in which selected and otherwise processed data are broadcast.

It was learned at the meeting that General Precision, Inc., of Tarrytown, N. Y., has proposed a method of blip identification for use with the system but that the proposal has not been accepted. This technique would allow each ship to identify its own pip on the over-all harbor display. Called PLAN (Positive Locator Aid to Navigation), it would use a narrow rotating beam broadcast from an antenna mounted on the surveillance system transmitter. Each time this beam would be received by a ship in the harbor, the blip representing that ship on the harbor display would appear brighter than other blips.

Captain Brunner reported that development of the navigation aid was part of a continuing effort to develop a ship's bridge display of integrated instruments that would permit one man to navigate a sizable vessel.

#### Optical Maser Proposed as Aid To Space Ship Navigation

At the meeting, C. B. Ellis and I. A. Greenwood, GPL Div., General Precision, Inc., Pleasantville, N. Y., said that an optical maser appeared suitable as a space navigation aid, especially to determine distance. They reported on company studies indicating that a pulsed optical maser, operating at about 66 w average beam power, would permit measurement of the distance from one space ship to another at 160,000 km with an accuracy of one part in 100,000.

Such a maser might have 10 per cent power



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## NEWS

efficiency, and it would require only about 800 w during the period of measurement, according to Mr. Ellis and Mr. Greenwood. This figure includes power required by both timing and output-display circuitry. The pulse-repetition rate would be about 1 per sec. To surmount the difficult problem of target acquisition with an extremely narrow beam, they suggested use of an optical telescope for rough sighting. The maser and the telescope would share a 2-ft-diam reflecting mirror.

The optical maser was also said to be useful for precision altitude measurements and the measuring of velocity by Doppler shift.

### Design of Low-Powered Gyros Called Promising Area of Development

M. B. Trageser of the Massachusetts Institute of Technology, Instrumentation Laboratory, delivered a paper he authored jointly with C. S. Draper. The two stated that designers would do well to shift emphasis in gyroscope design from achieving improved accuracy to reducing power consumption. This is especially true for space applications, the authors stated, where reduced power requirements would permit reductions in temperature-control equipment, give longer gyroscope life because of the lower operating temperatures, provide greater gyroscopic reliability, and permit more stable calibration because of narrower temperature swings. ■ ■

### Test of Pay Television to Be Delayed Another Year by FCC

The Federal Communications Commission has set back the test date of a pay-TV test in Hartford, Conn., to July 1, 1962. The tests were originally scheduled to begin on August 23 of this year (*ED*, March 15, p.4).

The FCC said the delay was requested by RKO Phonevision, Hartford, Conn., sponsor of the tests. RKO Phonevision is a joint venture of RKO General, a unit of General Tire and Rubber Co., and Zenith Radio Corp. RKO Phonevision said the delay was necessary because more time was needed for production and delivery of equipment to be used.

A suit brought by a Connecticut group against the tests is said not to be responsible for the request.

## Flarescan-ILS System Allows Blind Landings

Blind aircraft landings have been accomplished with a new system combining an added scanning beam and present Instrument Landing System (ILS) equipment.

The Flarescan-ILS system, under development by Airborne Instruments Laboratory, division of Cutler-Hammer, Inc., Deer Park, N. Y., will soon be evaluated by the Federal Aviation Agency at its Atlantic City experimental facility.

The present ILS system, using equipment installed at hundreds of airports and in thousands of aircraft, allows a pilot to approach a runway on a 3-deg glide slope by following indications of instruments in the cockpit. Since this is too steep an angle for landing, the pilot must take over control before reaching 200 ft altitude, and flare the aircraft out for touchdown. The added Flarescan equipment will allow the pilot to make the complete landing, including flareout, by following glide slope indicators.

ILS provides both lateral and vertical guidance to an aircraft by means of transmitted beams picked up by an airborne receiver. Error signals generated when the plane is not in the center of the beams position indicators which show the pilot the proper direction to bring the aircraft back onto the glide slope.

An added microwave transmitter used in the Flarescan-ILS system is located some distance (2,500 ft in the experimental system) behind the ILS transmitter along the runway. This generates a fan-shaped microwave beam, about 20 deg wide and 1/2 deg high, which is mechanically scanned from the ground up to about 20 deg vertically 8 to 10 times a sec. Pulse coding of this beam at various angles allows a receiving system in the aircraft to determine its angular distance above the transmitter. The difference between this angle and the 3-deg ILS angle, along with the known baseline between the two transmitters, permits a geometric solution for aircraft altitude and horizontal distance from the transmitters.

The solution obtained allows the indicators in the aircraft to make his approach shallower at the proper time, decreasing to about 1/2 deg at touchdown. At 3,000 ft from the transmitters the system provides an accuracy within 5 ft in altitude and 200 ft in range, according to an AIL spokesman.



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MG-200	20-200	20	2	10	0.7	200	
MG-300	30-300	30	2	10	0.7	200	
MG-400	40-400	40	2	10	0.7	200	
MG-500	50-500	50	2	10	0.7	200	
MG-600	60-600	60	2	10	0.7	200	
MG-700	70-700	70	2	10	0.7	200	
MG-800	80-800	80	2	10	0.7	200	
MG-900	90-900	90	2	10	0.7	200	



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## NEWS

### New MM Waveguide Uses Plastic Lenses

*Signals Beamed in Concrete Pipe Could Supplant Circular Guide*

**A** BEAM waveguide said to achieve extremely low-loss transmission of millimeter waves is in development at the Army Signal Corps Laboratories, Fort Monmouth, N. J. The new guide consists of phase-correcting plastic lenses spaced at intervals within a large concrete or plastic pipe.

Signals are transmitted along the guide by free-space propagation and are guided by resetting the cross-sectional phase distributions at periodic intervals by means of the lenses.

Laboratory tests at 35 Gc have shown propagation losses of only 1.75 db per km, according to Dr. Georg Goubau, inventor of the guide. Construction of a 1-km-long guide for field tests is under way at Fort Monmouth.

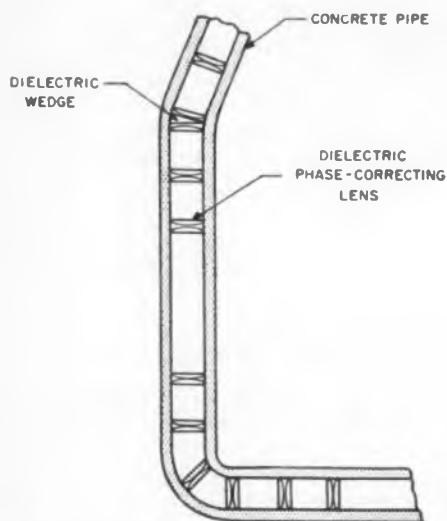
The dimensions of the guide are frequency-dependent, with the concept becoming increasingly practical at higher frequencies. A 50-Gc guide would consist of a pipe between 1 and 2 ft in diameter in which dielectric lenses would be spaced at about 150-ft intervals. Transmission characteristics improve at high frequencies, so the pipe can be made progressively smaller and the phase-correcting lenses can be spaced farther apart.

Calculations indicate that a 1-ft-diam pipe with lenses 47 m apart would have a propagation loss of only 5 db per mile at 100 Gc.

Alignment of the lenses is reportedly not critical, and the signal can be readily transmitted around corners by dielectric wedges. Furthermore the beam guide does not introduce any delay distortions when transmitting a broad spectrum of microwave energy. Signals of different polarizations can be transmitted simultaneously in opposite directions through the guide.

#### Beam Principle Avoids Use Of PCM Transmission

Proponents of the beam guide believe that these properties will make it an economical alternative to the circular metallic waveguide. "We can run our guide around corners



**Cross-section of new beam waveguide.** Microwaves are guided along the concrete pipe by dielectric phase-correcting lenses. Since lens alignment is not critical, the signal can be beamed around corners by a group of lenses or by a dielectric wedge. Actual guide would be between 1 and 2 ft in diameter.

without difficulty, and the absence of delay distortions means that we can avoid using pcm transmission," Dr. Theodore Hafner, president of Beam Guidance, Inc, New York, licensors for the guide, told ELECTRONIC DESIGN. "Concrete pipe, while expensive, doesn't begin to approach the cost of precision-machined metal guides."

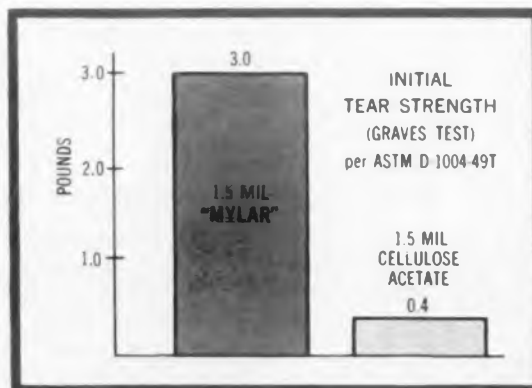
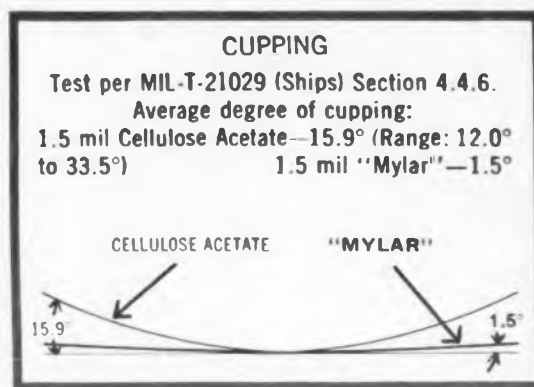
It was also pointed out that while rain would tend to degrade performance, open guides, consisting only of appropriately spaced lenses could prove feasible in certain less demanding applications.

The beam guide is being further developed by refinement of the phase-correcting elements. Multiple-layer dielectric lenses to reduce reflection are being tested. Doublet lenses, metal lenses and combination metal-plastic are among the devices under study.

The results reported by Dr. Goubau were of tests on a model guide in which long path distances were achieved by successive reflections over a 30-m path, as in an interferometer setup. Several lenses of 20-cm diameter were interposed at about 1-m intervals between the reflectors.

Test signals consisting of 70- $\mu$ sec, 35-Gc pulses were transmitted in this manner along a total path of 4.5 km. Radial field measurements revealed that the beam was almost completely contained within a cylindrical space of the diameter of the lenses and was not affected by metallic or nonmetallic obstacles outside this space. ■ ■

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Itek

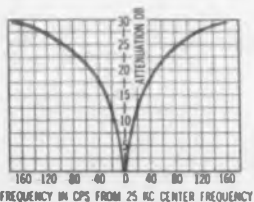
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CIRCLE 20 ON READER-SERVICE CARD

# WASHINGTON REPORT



**John J. Christie**  
Washington Editor

## DOD SPURS ACTIVITY IN QUANTUM ELECTRONICS

The Dept. of Defense will attempt to exploit as rapidly as possible the promising results of the last year's intensive R&D activity in optical and infrared masers.

A committee of DOD consultants and representatives of each military service will be formed shortly to review all Government and private R&D programs in maser technology. It will evaluate potential applications for extending the range of frequencies for radar and communications and also study prospects for use of coherent light in generation of power.

Prime purpose of the survey is to determine whether the scope of current R&D is adequate for military requirements and to pinpoint facets that may require more emphasis and increased Government financial support. The committee's findings also are expected to provide a time scale by which equipment and systems designers can anticipate the availability of practical devices.

By its effort to spur early development of practical quantum electronic devices, the Office of Defense Research and Engineering points up a policy matter of growing concern. This relates to the contention, particularly among officials responsible for development of advanced components, that applied research and component development in promising new areas of technology have lacked adequate support when not specifically designated for use in projected weapon system programs. These officials have advocated that such activities be managed and financed independent of weapon system projects.

## TOWARD SHIPBOARD AUTOMATION

The Maritime Administration has launched R&D programs that may lead eventually to the integration of all shipboard operating functions under automatic control systems. Its objectives are to improve safety at sea and to make U.S. shipping more competitive by saving manpower.

Sperry-Rand is under contract to develop a prototype bridge control system console that will centralize the outputs by which a watch officer performs his present functions. The unit will be composed of five sub-consoles relating to navigation, plotting, steering, radar and communications, and the ship's condition.

The console will incorporate such familiar elements as a weather facsimile recorder, an automatic direction finder, an adaptation of an X-Y recorder for plotting, the gyro-pilot and radar readouts. New elements will be a radar data computer and a ship-stability computer.

The Radar Data Computer, under development by Goodyear Aircraft, is an anti-collision device capable of tracking 10 targets with analog computing circuits and of sounding an alarm on the bridge

when a target crosses a track. It will be possible for the watch officer to put a trial correction of the course in the computer and then change to this course if it clears the alarm.

The ship-stability computer will be an adaptation of existing equipment under the Sperry contract. A combination analog-digital computer, it will automatically make computations to determine the stability of the ship, provide readouts on the vertical acceleration of the bow, and perform watertight door and smoke and fire control functions.

***More Advanced Control Techniques*** on the bridge, including engine-room monitoring and control, are planned for the next R&D stage. Already in the works is a course computer, for which Norden Division of United Aircraft is making an engineering study. This will compute an optimum course to a destination with automatic feed-in of correction data.

Since no previous attempt has been made to integrate control of a ship's steam power plant, the Maritime Administration has two parallel efforts underway to develop a system for controlling the whole operation from a console. Envisioned is a solid-state electronic servo system with hydraulic and pneumatic boosters. The console probably would contain automatic logging and computer programing. A similar effort will soon be launched for control of gas-turbine plants.

### ***A BOOST FOR HIGHWAY CONTROL SYSTEMS***

Commerce Secretary Luther M. Hodges is considering recommendations by his department's transportation policy group that would enable the Federal Government to provide a much-needed incentive for further development of electronic highway control systems.

Under one proposal the Bureau of Public Roads would provide a large-scale feasibility test of a system for automatic control of car steering, braking and acceleration on a limited access highway. A test strip of up to 100 miles is proposed.

The roads agency would name a prime contractor to serve as systems manager for the project. The contractor would assist the bureau in evaluating several proposed systems and handle the sub-contracting and over-all supervision.

RCA, Bendix, Thompson-Ramo-Wooldrige and Battelle Memorial Institute are considered the leaders in this field, and all have been consulted by the bureau in preliminary planning.

***The Urban Traffic Problem*** will receive attention under another proposed Bureau of Public Roads program to foster development of electronic systems that would anticipate snarls and automatically indicate corrective action.

Preliminary planning for this experimental project envisions use of imbedded inductive pick-up or transducer devices. The devices would measure traffic speed and density continuously for computer inputs. The computer would actuate control signals. Its readouts also would be used to relay instructions to motorists via radio or variable signs.

Such a system is considered particularly applicable to increasing the efficiency and capacity of urban expressways.

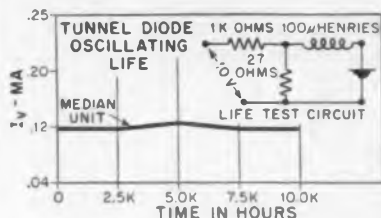


# semiconductor products news

## Service with a smile

As more and more G-E germanium tunnel diodes are being designed into low level switching circuits, it becomes increasingly apparent that many design engineers prefer to determine their own electrical specifications. Your wish is our command, and a section of our manufacturing line is now exclusively utilized to "tailor make" your tunnel diodes. Example: you can choose your own specs for peak current from .25 to 250 ma. and one other important parameter, such as capacitance or peak voltage.

While you're ordering your tunnel diodes, you might be interested in another little G-E gem of reliability data, compiled on our computer-general purpose line. Twelve units were subjected to 10,000 hours of life testing . . . with virtually no degradation of characteristics. One more example from over 3 million tunnel diode hours of life testing, with truly remarkable results.



Incidentally, you can also order "A" versions of these germanium tunnel diodes, specifically designed for your fastest switching applications. You'll get speed so fast that it pushes the capability of present sampling scopes. You also get extremely tight control of the three primary requirements for switching tunnel diodes; peak point, temperature stability and switching speed.

## Applications are bustin' out all over

A great deal has been written in recent months on tunnel diode usage, particularly in the UHF and microwave areas. Now that practical tunnel diode devices are available, the circuit designer has a real need for a comprehensive and authoritative survey of this information, along with a concentrated bibliography. If you'll pardon a modest bow of the head and downcast eyes, the job has been done.

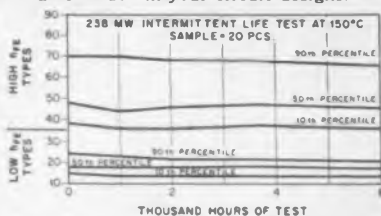
Erich Gottlieb, one of G-E's top tunnel diode application engineers, has covered the field of articles and papers published over the last year on tunnel diode usage at UHF and microwave frequencies. Over 90 pages of authoritative information, this survey is divided into four main sections: Amplifiers, Oscillators, Converters and General Information. Particular attention has been paid to noise figure and gain bandwidth, and how they relate to stability.

If you have a "need to know," drop us a line to Section 23G101 for your free copy.

Friend Erich has also recently finished an application note of his own called "Tunnel Diode Sinewave Oscillators" that we'll be glad to send to you. And Dr. C. S. Kim has finished a "Tunnel Diode Converter Analysis." For copies of either/both, write to Section 23G101.

## More proof positive . . .

. . . that our 2N497A-498A and 2N656A-657A medium power silicon mesa transistors are indeed the industry's most thoroughly characterized and tested! You have probably seen our published 1,000 hour life tests. May we modestly bow our head again while you look over the following 6,000 hour chart, and note the long term stability and reliability that can mean so much in your circuit designs?



Footnote to the above: the "A" versions are exclusive from General Electric, have higher power with cooler operation (cool transistors are reliable transistors), low input impedance (200 ohms vs. the usual 500 means more signal gets into the transistor and more current flows out), and lower saturation resistance (10 ohms vs. the usual 25 means less power loss when you turn the unit on). How can you go wrong?

## MIL types?

Can we put in a plug for USN 2N388? Phone your District Sales Manager, or buzz your G-E Semiconductor Distributor.

Semiconductor Products Department, Electronics Park, Syracuse, New York. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: International General Electric, 150 E. 42nd St., N.Y. 17, N.Y.



# GENERAL ELECTRIC



## Resistor Line Fully Automatic

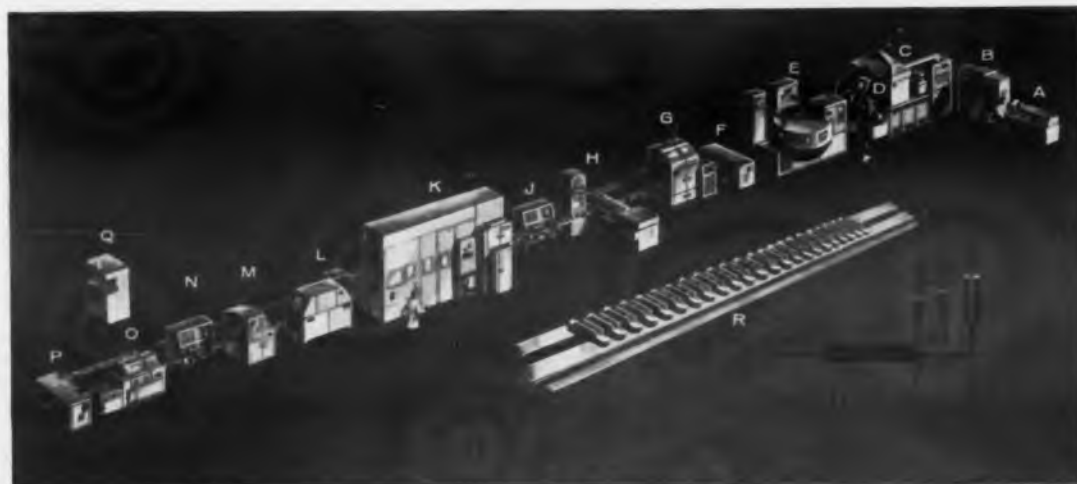
*A completely automatic computer-controlled production line for manufacturing deposited carbon resistors has been demonstrated at the Western Electric Co.'s North Carolina Works near Winston-Salem. The computer controlling the line can be programed to schedule a month's output. It will then issue suitable instructions to fabricating machines, capable of a continuous production of 1,200 finished resistors per hour. The final products are specified accurate to a tolerance of 1/2 of 1 per cent.*



**Bell jar** held by Western Electric engineer has a gold cathode, used to deposit a layer of gold on the ends of carbon-coated resistor cores passing through the line. The gold termination forms a contact on each end of the resistors, to which the next machine attaches wire leads and caps.



**End of the line** for the deposited carbon resistor is the packing machine, above. Here resistors are imbedded in styrofoam blocks, and loaded into a magazine. The magazines are then removed by an operator, who will prepare the blocks for shipment.



- |                                 |                               |                               |
|---------------------------------|-------------------------------|-------------------------------|
| A. Computer                     | F. Conveyor Control Equipment | M. Marking Station            |
| B. Output-Input Control Station | G. Capping Station            | N. Third Inspection Station   |
| C. Coating Station              | H. Helixing Station           | O. Packing Station            |
| D. First Inspection Station     | J. Second Inspection Station  | P. Conveyor Control Equipment |
| E. Terminating Station          | K. Encapsulating Station      | Q. Cap-Lead Welding Machine   |
|                                 | L. Leak Detector Station      | R. Detail of Conveyor Line    |

**The automatic production line** for making deposited carbon resistors is made up of eleven stations. The control computer, an LGP-30, runs the process completely, from raw materials to finished resistor. Until loading for shipment, the resistors are not handled by operators.



**Automatic inspection** and testing station of automatic line plots test record of every unit on a graph, and rejects defective resistors. The station also provides feedback control to the computer, resulting in line self-correction, if necessary to maintain standards.

(Advertisement)

## NEW PRODUCT

### High Density Miniature HYFEN with center jackscrew



Now available from the Burndy Corporation, Omaton Division is a new miniature HYFEN<sup>®</sup> connector with a center jackscrew which provides alignment and engaging force. This connector is presently designed in two configurations: 1) 104 contacts; and 2) six miniature coax contacts combined with 48 standard contacts. Contacts are crimp-type which snap-lock into and out of the connector body. Both inner and outer portions of the miniature coax contact are crimp-type. This connector may be designed to accommodate other combinations of coax, miniature coax, and standard contacts for particular applications.

Crimp-type contacts are installed by tools which are full-cycling, thereby guaranteeing a complete installation every time. These installation tools—hand, pneumatic or semi-automatic—provide a measurable crimp, facilitating quality control.

Connector bodies are molded of high heat-resistant, flame-proof diallyl phthalate with molded-in ferrules for contact retention. Jackscrews and guide pins and sockets are stainless steel. The connector can be easily polarized by varied placement of guide pins and sockets.

All contacts are gold plated with nickel plated beryllium copper locking springs. Quality materials throughout provide maximum reliable performance of this connector. This miniature HYFEN connector performs to the applicable sections of MIL-C-8384 and MIL-T-7928. Further information is available from

Burndy Corporation, Norwalk, Connect.

CIRCLE 22 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • July 19, 1961

# COAX HYFEN<sup>®</sup> CONTACTS

*reliable solderless contacts  
result in dramatic  
reduction of  
installation time*

*wide application—all with snap-locked removable contacts*



**Type MB-X**  
Coax in miniature rectangular configurations.



**AQUALOK<sup>™</sup>**  
Weather sealed round connector—either all coax or in combination with single conductors.



**Coax Bantam HYFEN**  
Connectors for standard and miniature coax—either all coax or in combination with single conductors.



**Coax Feed-Thru**  
Miniature and standard connector (above) and splice (below). All plastic shells—lightweight, durable, impact resistant.



**Coax MODULOK<sup>®</sup>**  
Modular terminal block with spring-loaded removable contacts.



**Type PD-X**  
Modular HYFEN inserts for all standard or miniature coax or in combination with inserts for single conductors.



**Type ME-X**  
Rack and panel HYFEN series—features one piece shell, one piece inserts.

Burndy's coax contacts, for both miniature and standard coax cable—feature crimped inner and outer contacts, which provide a more reliable connection, faster and easier. High speed production tooling results in low installed cost—crimps contacts in any circumferential position. Few parts simplify installation. No heat to damage insulation.

For further information write OMATON DIVISION

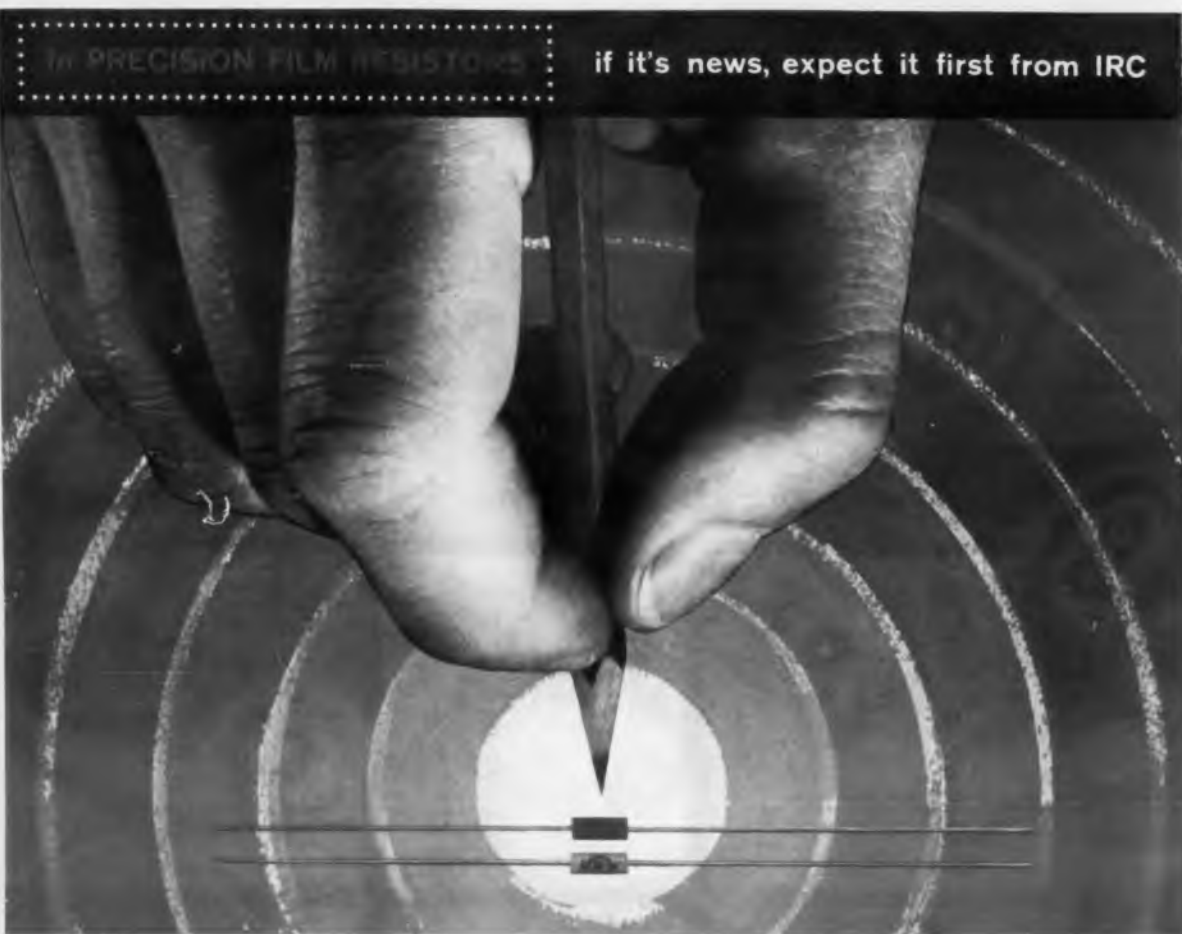
NORWALK, CONNECT.

BICC—BURNDY Ltd. Prescot, Lancs. England

In Europe Antwerp, Belgium

TORONTO, CANADA

CIRCLE 23 ON READER-SERVICE CARD



## Industry First... RN55 Precision Film Resistors in RC07 Size Replace Fixed Composition Resistors

Every critical circuit forced to attain smallness through use of RC07 style composition resistors can now be upgraded. To make this possible, IRC offers both metal film and deposited carbon precision resistors in a new subminiature size.

1. the first time a molded RN55 resistor is available completely interchangeable in physical size with the RC07
2. meets or exceeds performance of precision films (MIL-R-10509), which means lower noise, better TC, superior all-around stability than fixed composition RC07's (MIL-R-11)
3. surpass RC07's even when run at the MIL-R-11 rating of  $\frac{1}{4}$  watt @ 70° C
4. uniform, molded bodies just right for automated assembly . . . immune to damage by normal transit and handling

For top resistor performance without any space penalty, specify new IRC Type EM or DM units for every miniature circuit. Full details in a new 12-page bulletin. International Resistance Company, 401 North Broad St., Philadelphia 8, Pennsylvania.



CIRCLE 24 ON READER-SERVICE CARD

### CAPSULE SPECIFICATIONS

	Metal Film	Deposited Carbon
Wattage	1/10 watt @ 125 C derated @ Zero load @ 175 C	1/10 watt @ 125 C 1/4 watt @ 70 C derated @ Zero load @ 165 C
Temperature coefficient	± 25 PPM (°E Char.) ± 50 PPM (°C Char.) ± 100 PPM ± 150 PPM	+200 — 500 PPM (°D Char.)
Resistance	50 ohms min. 100K ohms max.	10 ohms min. 301K ohms max.
Standard tolerance	± 1%	± 1%
MIL-R-10509D	RN55 Characteristic E and C	RN55 Characteristic D
Size	250" ± .031" x .093" ± .005" dia.	250" ± .031" x 093" ± .005" dia.
IRC designation	EM	DM

## NEWS

# Digital Communication Modules Developed

*Prototypes Can Be Combined to Form  
Systems or Used to Adapt Data Units*

**P**ROTOTYPE modules that can be combined to form complete digital communication systems have been constructed.

The modules can also be used to adapt data communication equipment for special needs. In use they adapt teletypewriter, data transceivers, facsimile machines, tape equipment and other devices for compatible operation.

The prototype series is made up of input-output multiplex equipment, modulator-demodulator units (modems) and special devices, such as parallel-to-serial and serial-to-parallel converters.

This concept of modularization at the functional level is a development of ACF Electronics Div., Riverdale, Md., under its ACF Building Block Communications Devices program (ABCD). Wherever possible, according to the company, standard solid-state circuits on plug-in cards are used throughout the series of functional blocks. This is said to permit the equipment to be sold at relatively low prices. Many of the cards are interchangeable, as are the modules within each type.

### Modem to Process 4,800 Bits Per Sec Is Among the Blocks Built So Far

The following have been built so far: a modulator said to be capable of operation at 4,800 bits per sec for use with either radio or telephone links; a demodulator with an unusual equalizer; a stable clock with phase corrector; five multiplexer blocks for such equipment as facsimile systems and IBM transceivers; five demultiplexer blocks; serial-to-parallel and parallel-to-serial converters, and an encryption control.

The multiplexer equipment operates at up to 4,800 bits per sec, a limit imposed by telephone-system channels. ACF says the circuits in the time-division system are capable of rates as high as 50 kc. From two to 16 channels can be multiplexed and demultiplexed. These may be either from asynchronous equipment, like teletypewriters;



**Communications system** consisting of modular functional blocks is designed for flexibility in handling digital data from a variety of sources. The block being examined provides a multiplex input channel for tele-type equipment.

quasi synchronous equipment, such as facsimile; or synchronous systems, such as an IBM card reader.

Logic levels in the multiplexing building-block circuits are 0 and  $-12$  v nominal, and supply voltages,  $-12$  and  $+12$  v. All circuits operate at the nominal maximum frequency of 50 kc. The levels of terminal devices are changed to ABCD voltage levels by buffer circuitry when necessary.

#### Terminal Devices of Varying Bit Rate Reduce Effective Transmission Time

In the multiplex system, terminal devices with more than eight information bits per character must be accommodated by two or more channels of the multiplex cycle, because each channel is limited to eight bits. Another disadvantage, ACF admits, is that when terminal devices of greatly different bit rates are used, the multiplexer transmits no information for much of the time.

The modem blocks use four-level am, suppressed-carrier, vestigial-sideband transmission. Am was chosen, the company says, because of cost, size and complexity benefits. Four-level, suppressed-carrier techniques are said to give the same signal-to-noise ratio at 4,800 bits per sec as two-level un-sup-

*Hughes TWT capability offers you*

## New solutions for tube and systems problems

A continuing program of applied research by Hughes has resulted in the development of outstanding operating features such as those illustrated in the accompanying cutaway of a high-powered TWT.

When you have a requirement for an advanced microwave tube—CW or pulsed—consider TWT's, and Hughes. Perhaps the solution to your problem is already in development, or *production*, at Hughes.

For a more complete rundown on what Hughes can offer you, contact your nearest District Office today, or write for your copy of the Hughes short form catalogue.

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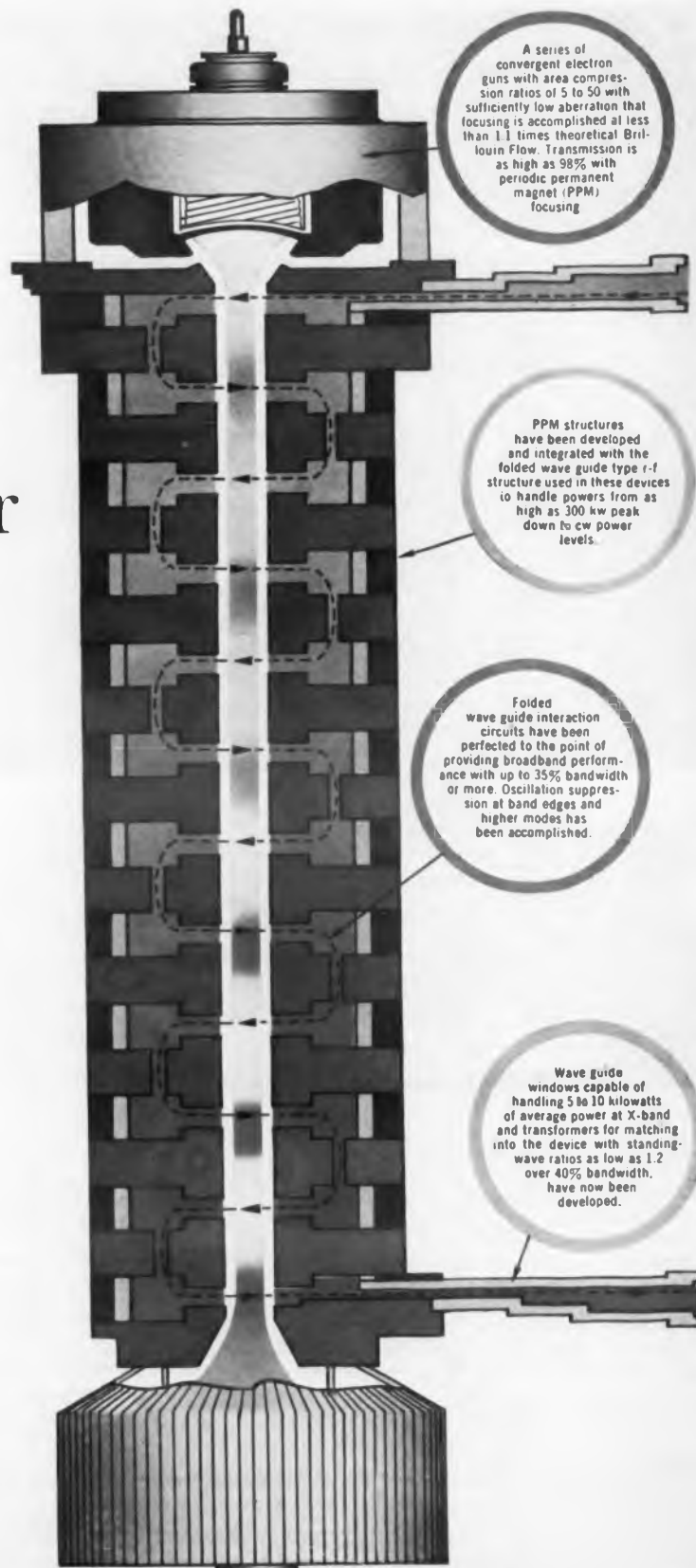
**EASTERN** 2000 "K" Street, N.W., Washington 6, D. C. FEderal 7-6760  
13 Lloyd Avenue, West Long Branch, N. J. CApital 2-1111

**WESTERN** 11105 South La Cienega Blvd., Los Angeles 45, Calif. SPring 6-1515

CREATING A NEW WORLD WITH ELECTRONICS

**HUGHES**

HUGHES AIRCRAFT COMPANY  
MICROWAVE TUBE DIVISION



A series of convergent electron guns with area compression ratios of 5 to 50 with sufficiently low aberration that focusing is accomplished at less than 1.1 times theoretical Brillouin Flow. Transmission is as high as 98% with periodic permanent magnet (PPM) focusing

PPM structures have been developed and integrated with the folded wave guide type *r-f* structure used in these devices to handle powers from as high as 300 kw peak down to cw power levels.

Folded wave guide interaction circuits have been perfected to the point of providing broadband performance with up to 35% bandwidth or more. Oscillation suppression at band edges and higher modes has been accomplished.

Wave guide windows capable of handling 5 to 10 kilowatts of average power at X-band and transformers for matching into the device with standing-wave ratios as low as 1.2 over 40% bandwidth, have now been developed.

...here's a little 'scope for BIG JOBS



TYPE  310A

HINGED CHASSIS AFFORDS EASY ACCESSIBILITY  
TO ALL TUBES AND COMPONENTS



Measuring deviations to quantify parts-per-million in similar units under test.

Instrumentation includes a Tektronix Type 310A Oscilloscope and the new *Electro Scientific Industries* precision-measurement console—which measures resistance, capacitance, and voltage ratio over wide ranges with direct traceability of accuracy to three reference standards certifiable by the National Bureau of Standards.

Photographed at Electro Scientific Industries, Portland, Oregon.

Need a precision-measurement tool in the dc-to-4 mc range?

A small-size, light-weight, semi-ruggedized instrument that operates almost anywhere from 50-to-800 cycles line frequency?

One that combines stability in performance, simplicity of operation, accessibility for maintenance?

Then consider a Tektronix Type 310A Oscilloscope.

For size, convenience, presentation of trace display—a Type 310A ideally suits precision-measurement applications at point-of-use . . . such as quality-control checks in production testing . . . or maintenance and calibration of complex electronic equipment in the laboratory or in the field.

Call your Tektronix Field Engineer for a demonstration.

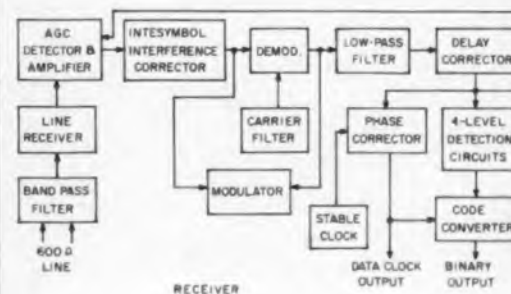
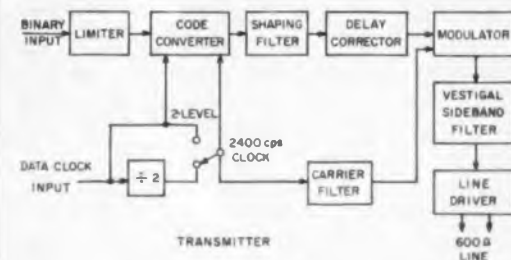
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**TEKTRONIX ENGINEERING REPRESENTATIVES:** Mosthorno Electronics, Portland, Oregon • Seattle, Washington. Tektronix is represented in twenty overseas countries by qualified engineering organizations. In Europe please contact Tektronix International A.G., Terrassenweg 1A, Zug, Switzerland, Phone (042) 4-91-92, for the address of the Tektronix Representative in your country.

CIRCLE 26 ON READER-SERVICE CARD

## NEWS



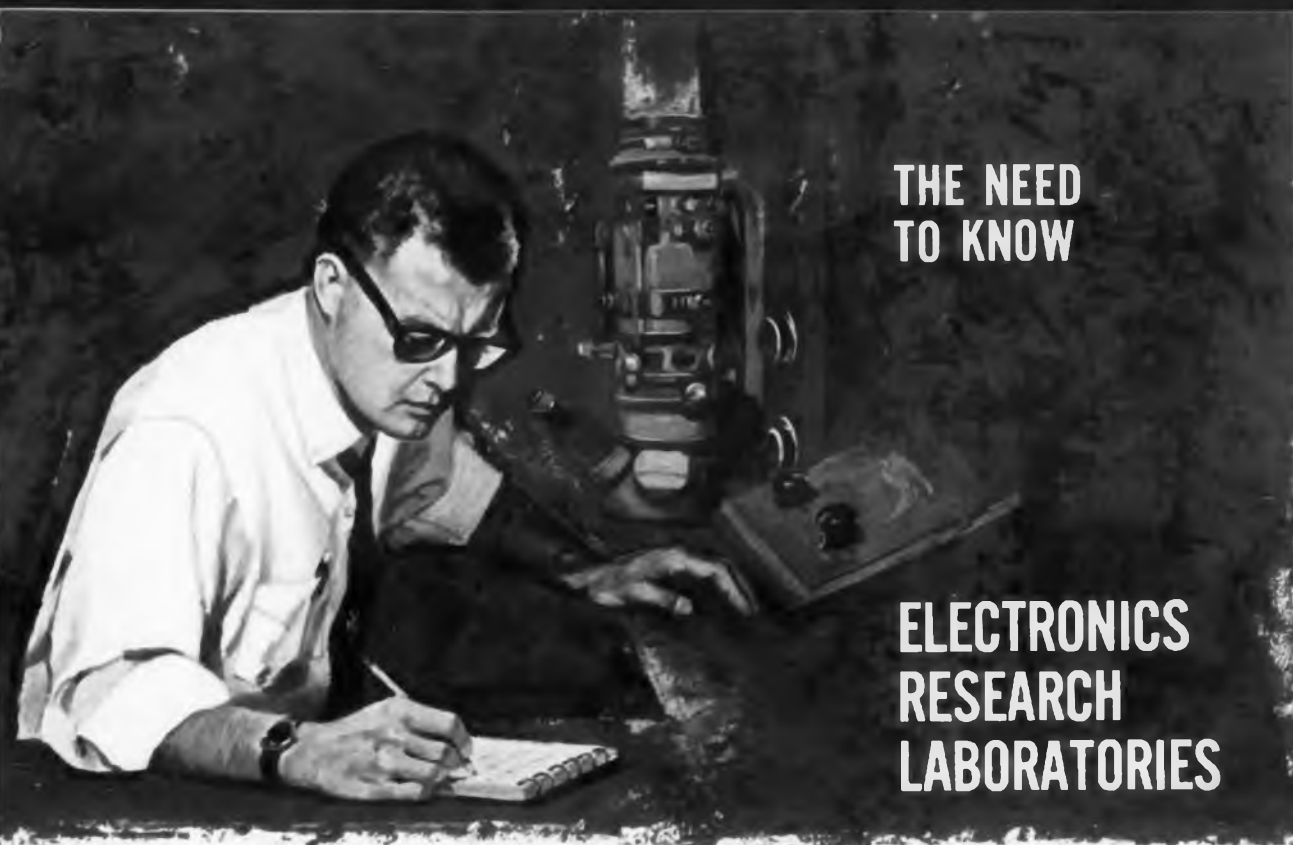
Modem processes up to 4,800 bits per sec using four-level am, suppressed-carrier, vestigial-sideband techniques. Binary data at 4,800 bits are transmitted as four-level, 2,400-bit data. An intersymbol interference corrector in the receiver compensates simultaneously for delay and amplitude distortion.

pressed carrier systems operating at 2,400 bits per sec. Vestigial-sideband modulation permits double the information rate of a double-sideband system. For communication at 4,800 bits per sec the data stream is changed to a four-level stream of 2,400 bits per sec by converters, which are switched out for rates of 2,000 bits or less.

An unusual type of distortion compensation is used in the modem. It is said to correct simultaneously both amplitude and delay distortion. The compensator is reported useful as an equalizer of digital or analog transmission systems, a highly adjustable filter, or an instrument for obtaining any amplitude-vs-frequency curve or differential-delay-vs-frequency curve.

The compensator consists of a string of time-delay stages, an adjustable adder network and inverters. Data pass serially through the delays, the outputs of which are continually summed. When the adder network is properly adjusted—after an oscilloscope “eye” pattern of received data is observed—the output of the network is compensated for the distortion. The delay stages are designed to introduce a minimum of distortion of their own, ACF says. ■ ■

CIRCLE 910 ON CAREER INQUIRY FORM, PAGE 177 ➤



THE NEED  
TO KNOW

ELECTRONICS  
RESEARCH  
LABORATORIES

There is a continuing *need to know* more about the nature of space and its complex environment. Only through fundamental research and scientific inquiry can this need be met.

At Convair Astronautics Electronics Research Laboratories, our task is to meet this need: to explore the space sciences; to advance the state of the space technology arts. Here, company-funded research in space electronics and space physics is in progress, motivated by the need to develop instruments and electronic techniques vital to the progress of space flight and exploration.

The men selected to staff these laboratories must be of high academic caliber. They must possess the sort of professional background which demonstrates interest and achievement in solving the broad spectrum of problems associated with space technology.

Senior and staff positions are available now for electronic scientists and physicists with advanced degrees. Specific areas of research are detailed on the back of this page. If they meet your interest, we invite your investigation. A convenient inquiry card is attached which you may mail in complete confidence. It will be promptly reviewed by a member of the Electronics Research Laboratories staff.

*If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Industrial Relations Administrator-Engineering, Mail Zone 130-90, Convair/Astronautics, 5676 Kearny Villa Road, San Diego 12, California. (If you live in the New York area, please contact Mr. T. Cozine, manager of our New York placement office, Circle 5-5034.)*

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Engineers and Scientists for

## ELECTRONICS RESEARCH LABORATORIES

The Electronics Research Laboratories at Convair/Astronautics offer fine facilities and a professional atmosphere, plus a distinguished staff of associates, to scientists and engineers with an interest in fundamental research.

A free exchange of ideas is actively pursued through attendance at scientific meetings, and since a great deal of the research conducted here is unclassified, publishing of papers is also encouraged.

An added advantage is the location of the Laboratories. San Diego, California, boasts an ideal climate, fine living conditions, excellent schools, vigorous cultural attractions, and constantly expanding facilities for advanced education.



### SENIOR AND STAFF POSITIONS ARE AVAILABLE NOW TO ELECTRONIC SCIENTISTS AND PHYSICISTS TO CONDUCT RESEARCH IN THE FOLLOWING AREAS:

Solid State and Thin Film Research for application to micro-electronics using sputtering, vacuum evaporation-deposition, decomposition-sublimation, and advanced electron beam graphics.

Surface physics studies of film kinetics and structures by electron microscopy including the study of epitaxy and nucleation from the vapor phase "in situ."

Materials research and synthesis of inorganic semi-conductors for active components in molecular electronics and solar energy conversion applications.

Theoretical and experimental studies of thin magnetic films for computer applications. The mechanism of orientation, domain nucleation and wall motion, and the mechanisms of nanosecond flux reversal.

Study of geo-astrophysical phenomena including the development of instrumentation to study weather-indicating phenomena, cosmic radiations, magnetic and gravity field measurements of planetary bodies by means of space probes.

Space Electronics Research for application to tracking, communication and data processing systems and special purpose devices and instruments for use in satellite payloads.

Statistical Communication Theory studies of narrow banding, correlation and rate controlled sampling and quantization techniques for threshold improvement of long range tracking, communication and real-time digital control and data processing systems.

Special purpose instrumentation for sensing and controlling attitude and velocity of space vehicles with heretofore unattainable sensitivities and precision including microgram thrust rockets, gravity field differential torquing, and radiation pressure sensing.

*If you desire more information, may we urge your prompt inquiry on the attached card. If it has been removed, or if you wish to furnish more details about your background, please write to Mr. R. M. Smith, Industrial Relations Administrator-Engineering, Mail Zone 130-90, Convair/Astronautics, 5676 Kearny Villa Road, San Diego, California. (Men living in the New York area are invited to contact Mr. T. Cozine, manager of our New York placement office, CIrcle 5-5034.)*

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DIVISION OF GENERAL DYNAMICS

*This card may be folded and sealed or stapled and mailed in complete confidence. It will enable the professional staff at Convair/Astronautics to make a preliminary evaluation of your background. A personal interview can be arranged in your city by appointment. Every completed inquiry will be acknowledged.*

### ENGINEERING PLACEMENT INQUIRY

NAME \_\_\_\_\_

STREET ADDRESS \_\_\_\_\_

CITY & STATE \_\_\_\_\_

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DEGREE \_\_\_\_\_

THESES TOPIC \_\_\_\_\_

AREA OF RESEARCH INTEREST \_\_\_\_\_

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YEAR OBTAINED \_\_\_\_\_

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TITLES OF PUBLISHED PAPERS, ETC. \_\_\_\_\_

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## Electronic Manufacturer Contracts For Servicing of Its Computers

Clary Corp. of San Gabriel, Calif., has contracted with Federal Electric Corp. to provide nationwide service for its computers.

This is a departure from traditional servicing methods, but it will enable the company to sell in areas previously beyond its servicing capabilities.

Federal Electric, service associate of International Telephone & Telegraph Corp., with headquarters in Paramus, N. J., said it will supply the full range of service normally received from a factory service arm, including maintenance.

## Information-Hunting Computer Has a 8,192-Word Memory

A mechanized information-retrieval system with an 8,192-word, magnetic-core memory of 20-bit words is in operation at Western Reserve University for the American Society of Metals.

The system, developed over the last four years by the university, is built around a GE 225 computer, programed for literature searches. The memory is said to enable the computer to search through 100,000 indexed abstracts, patent reports, technical articles and the like in an hour. Western Reserve indexing and tape language are compatible with most existing data processing installations.

Able to utilize either magnetic-tape or punched-card input, the General Electric computer features a 15,000-character-per-sec transfer rate.



Control console of GE 225 information searching computer, installed at Western Reserve University for the American Society of Metals.

# Linde *materials & Coatings* News

LINDE COMPANY, DIVISION OF UNION CARBIDE CORPORATION

## Crystal tungsten opens up a new era for the metal in electronics



Typical electronic shapes fabricated from crystal tungsten (l. to r.): target emitter; zero-porosity tungsten anode for high-powered electron tubes with fluid cooling; high-power vacuum switch contact of zero-porosity tungsten mounted to copper.

A new method of consolidating tungsten powder into tungsten ingot has been created by LINDE'S Crystal Products Department. This new material—in crystal form—changes the whole approach to use of tungsten in electronic applications.

Compared to metallurgically prepared (PM) tungsten, crystal tungsten offers 5 to 15 per cent higher electrical conductivity. Thermal conductivity is about 20 per cent higher at 500° F., resulting in improved heat dissipation. These properties can be advantageous in electronic design.

### Useful in vacuum devices

The high purity and zero porosity of the crystal tungsten also suggest its use not only in electrical contact points, but also in vacuum switches, electrical leads in vacuum tubes, and applications where outgassing or leakage is a problem. Their purity and lack of grain boundaries provide more even electron emission, making them valuable in several high pressure vacuum or open air switches. Other uses include: flexible sheet in electronic tubes; x-ray and anti-cathode targets.

LINDE crystal tungsten is considerably more ductile than undoped PM

tungsten. It can be drawn into wire as fine as 1 mil, giving greater yield of finished product from the starting ingot. Although undoped crystal tungsten has a lower recrystallization temperature, it does have a yield point at about 150° F.

### Material easily worked

Significant is the fact that it can be easily worked and at temperatures 800° F. lower than working temperature for powder metallurgy or vacuum-arc cast tungsten—making it useful for a wide range of non-electronic applications. Present shapes include swaged rods from 1/10 to 3/8-inch diameter, as grown ingots up to 3/4-inch diameter in production, and even larger diameters in development.

For more details on this new material, check the coupon below.

## Super-hot process metal-coats and fabricates intricate parts

Dense, high-purity metal coatings for certain base materials, and the fabrication of odd shapes, are accomplished with "Plasmaplate," a super-hot plasma stream process developed by LINDE'S Flame-Plating Department.

In operation, a high-current torch uses temperatures up to 30,000° F. to produce a supersonic stream of ionized gas—melt and accelerate to high velocity particles of any inorganic material that melts without decomposition.

High-purity coating materials—such as tungsten or other refractory metals—are thus permanently fused to the surfaces of materials such as graphite, brass, copper, steel, molybdenum, titanium, aluminum and others.

Parts of intricate configuration can be fabricated by depositing the coating material on a mandrel machined to the desired internal shape of the finished part. After the desired thickness is obtained, the mandrel is dissolved out by chemical means.



Tungsten grid cage—one of many complex shapes made by LINDE'S "Plasmaplate" Process.

Thin coatings of tungsten carbide and other hard materials can also be applied to base metals by the LINDE oxyacetylene Flame-Plating "gun" process, to increase surface wear as many as 40 times.

For details on either of these LINDE processes, check the coupon below.

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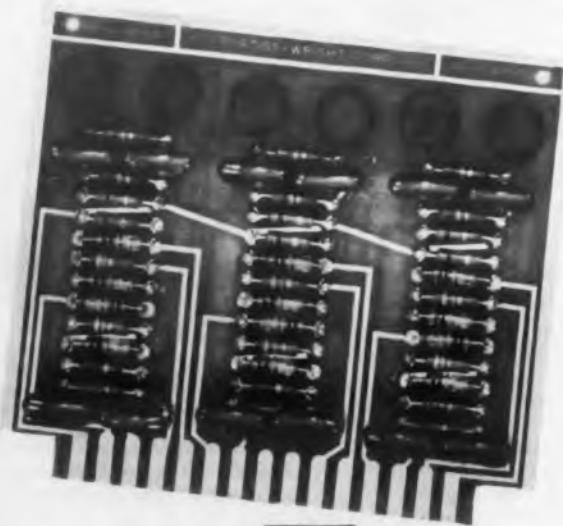
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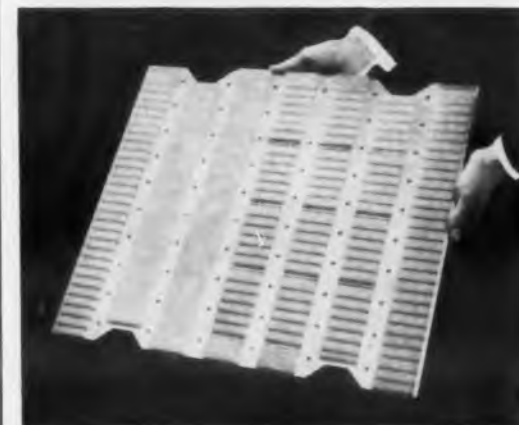
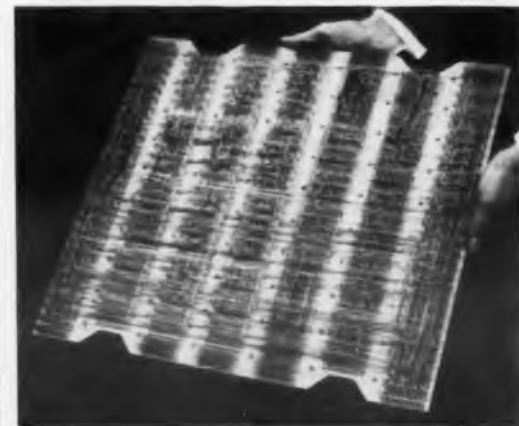
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## NEWS

### Solderless Wirewraps Have Low Failure Rate

Solderless wirewrap connection techniques now gaining wide use in industry are averaging only 1 failure per 200,000 connections according to production engineers.

Speaking at the recent IRE Production Engineering Conference in Philadelphia, A. H. Wenner of IBM's Federal Systems Div., Kingston, N. Y., said that IBM is now making solderless wirewrap connections at the rate of 100 million per year with the 1 in 200,000 failure rate. Following the presentation of the paper a representative from West-



**Wirewrap panels** for computer in Polaris submarine are wired by General Electric Co. with a numerically controlled wiring machine. Top: A Gardner Denver Co. wiring machine is programmed to take one end of a wire, wrap it around one terminal, follow a predetermined path among the terminals to a second terminal, then wrap the other end of the wire to that terminal. Bottom: Malco Manufacturing Co. aluminum wirewrap terminal boards use nylon bushings around the terminals to achieve a 10,000-terminal density in a 24-in. sq area.

ern Electric Co. said that his firm was experiencing a similar failure rate on wirewrap connections made at the rate of 6 million per year.

The failure rate figures apply to the number of substandard wraps discovered during inspection. Very few failures ever occur beyond this point, the production engineers indicated. Mr. Wenner said that operator variations were the main cause of poor connections. He and others at the meeting agreed that new numerically controlled automatic wirewrapping machines being produced by Gardner Denver Co. should increase the yield of good connections.

Cost of the conventional manual connections using a hand wirewrap tool is about half that of conventional solder joints, according to Mr. Wenner.

Wirewrap techniques have also proved surprisingly good for low production and even breadboarding. Isaac Auerbach of Auerbach Electronics Corp., Philadelphia, said that when his firm was forced to use the technique for a prototype item because of customer specifications, the technicians discovered it was both easier to use the first time and easier to modify.



### Automatic Data Reduction System To Assist Oceanographic Studies

An automatic data-reduction system will be used by Woods Hole Oceanographic Institution, Woods Hole, Mass., to convert analog data gathered for ocean wave studies.

Called the Addressor System, by its developers Tele-Dynamics, a division of American Bosch Arma Corp., Philadelphia, the system can also be used for:

- Investigations of thermal microstructure in a thermocline.
- Studies of transfer of momentum, heat, and water vapor across the ocean-atmosphere interface.
- Studies of bottom friction of oceanic and tidal currents.

The Addressor comprises a two- or four-track tape playback system, 12-fm demultiplexers, and an analog-to-digital converter. It includes such features as tape error compensation using any channel as reference, reference detection for computer control, and a specially designed flexible patchboard. The outputs permit on-line entry of data to existing high speed digital computers. Direct analog outputs will also be available.

## Immediate Minuteman and Dyna-Soar openings for Electronic and Electrical Engineers

Electronics is one of the fastest growing areas of engineering at Boeing. Electronic and electrical engineers interested in the advancement of space-age technologies will find challenging and deeply rewarding opportunities in advanced Boeing programs, including the Dyna-Soar manned space glider and the solid-fuel Minuteman ICBM. Assignments exist in your particular area of interest and at the level you require for career satisfaction and advancement. For your convenience, a professional application form appears at the right, and continues on the following page.



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1.		
Position & Duties		
2.		
Position & Duties		
3.		
Position & Duties		
4.		
Position & Duties		

REFERENCES. Give full names, occupations and addresses. Professional (previous supervisor preferred):

- 1.
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## LIST TYPE OF WORK PREFERRED UPON EMPLOYMENT:

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Have you ever been cleared for classified military information? \_\_\_\_\_ If yes, give date, level and company.

May we contact your former and present employer prior to completion of employment negotiations? Yes \_\_\_\_\_ No \_\_\_\_\_  
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## NEWS

### Single-Channel, 3-D TV Speeds Atomic Assembly

Three-dimensional television now available as an industrial aid uses only a single vidicon and one channel instead of the two vidicons and two channels needed with former stereoscopic techniques.

The new closed-circuit sets are being used to monitor the manipulation of component parts and the assembly of radioactive isotope power sources at Atomics International Corp., Div. of North American Aviation, Inc., Los Angeles.

In the past, single-plane TV techniques for nuclear assembly proved lengthy and arduous. To simplify the job, atomic developers painted the radiation chambers and "hot" cells with easily spotted reference lines of different colors.

#### 3-D Television Kits Being Used For Nuclear Power Source Program

Atomics International purchased the unusual 3-D television kits to speed work for the SNAP program (Systems for Nuclear Auxiliary Power).

Made by Stereotronics Corp., 1717 N. Highland St., Los Angeles, the television system works as follows:

A mirror system, screwed onto a standard 16-mm industrial TV camera lens, doubles the image. The pair of half-size images is then transmitted to the TV monitor, where they are presented side by side on the viewing screen.

By replacing the standard safety screen with polarized filters and then viewing the



Image picked up by a single vidicon in Stereotronics Corp.'s new 3-D TV system is doubled by a mirror system and presented (above) side by side on the monitor's viewing screen. When the two images appear to converge through polarized glasses, a three-dimensional presentation appears.

screen through converging polarized lenses, one sees a 3-D image.

Instead of glasses, a viewing hood may be used. No electronic modifications are necessary to adapt a closed-circuit TV system to three dimensions. The cost is on the order of \$900.

#### Many Other Military, Industrial Uses Foreseen For Stereo-Viewing Kit

Other uses for the Stereotronics 3-D TV kit include viewing screens for tanks, underwater manipulation, stereo microscopes and commercial TV, according to the company president, James F. Butterfield.

Stereotronics Corp. is preparing the kit for commercial TV. Temporary stereo glasses would be wrapped in colored cellophane. The unwrapped cellophane would fit over the TV screen and serve as the polarizing medium. Instead of field polarization, color polarization—with suitably colored convergence lenses in the glasses—would be used.

#### Automated Storage System to Use Digital and Analog Techniques

An automated storage system, combining digital and analog techniques, will automatically stack and store heavy aircraft engine parts.

The storage system, to be developed by Electro Nuclear Systems Corp., Minneapolis, Minn., will be installed at Alameda Naval Air Station, Calif.

#### Loads of Up to 500 Lb Automatically Placed in Compartments

The storage system will move pallets holding loads of up to 500 lb and deposit them in any one of more than a thousand storage compartments. By using automatic controls the stackers will be able to move in both vertical and horizontal directions simultaneously, thus reducing time and increasing the efficiency of the operations. The system will also be able to withdraw the loads, which measure more than one yard in each dimension, from the compartments and return them to a central conveying point.

According to specifications, the stacking system will accomplish about 185 stacking operations per hour or about three per min. In operation, the automatic stacker removes a loaded pallet from a conventional conveyor. The operator at a control console directs the load to its destination by depressing keys on the addresser.

# QUIET PLEASE



## NEW SOLID-STATE DIGITAL VOLTMETER AT WORK!

As reliable as they are quiet, the EAI Series 5000 Transistorized Digital Voltmeters combine a unique "Full-Time" high input impedance circuit with outstandingly accurate, high speed performance.

- EAI Series 5000 features include —
- Full-time input impedance to 1000 megohms
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  - Fully transistorized
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Versatile as well as economical, these voltmeters provide decimal and binary-coded decimal electrical outputs for driving a full range of accessory equipment. Brilliant, easy-to-read projection displays eliminate "glow-through" ambiguity while providing wide angle reading — even under adverse ambient lighting conditions.



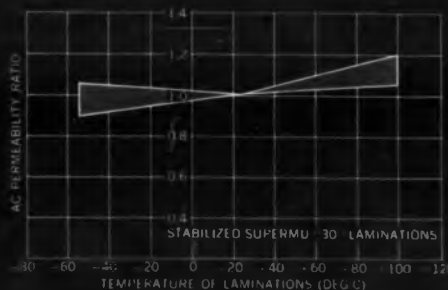
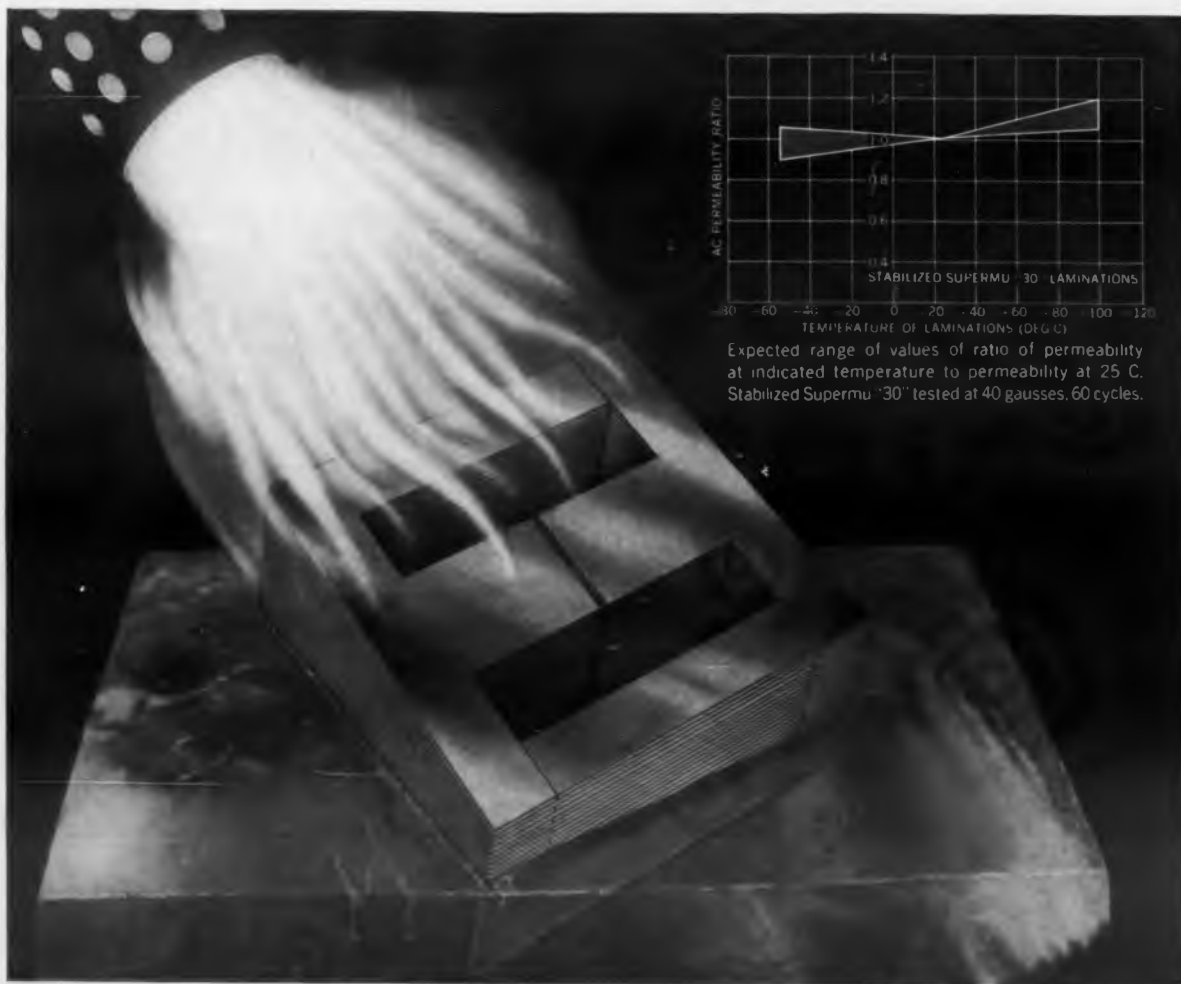
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## NEWS

### 'Dunking Duck' Is Invented With Transistor Oscillator

An all-electronic version of the toy "dunking duck" has been invented by Dr. H. E. Stockman, Professor of Electrical Engineering at Lowell (Mass.) Technological Institute.

The usual version of the toy consists of a model duck so mounted on a pivot that once set in operation the head dips repeatedly, without any immediately apparent mechanical stimulus. The electronic unit, made in the shape of a duck or a bee, depends for its operation on a transistor oscillator.

A tapped inductor forms a cavity. A small Alnico magnet, attached to the duck's head, dips into the cavity. The 3,000-to-5,000-turn inductor is connected to the transistor in a common-emitter configuration. The bottom winding is connected to the base, and the top winding is connected through a 1.5-v battery to the collector.

### Ultrasonic or High Audio Frequency Oscillation Results From High Mutual Inductance

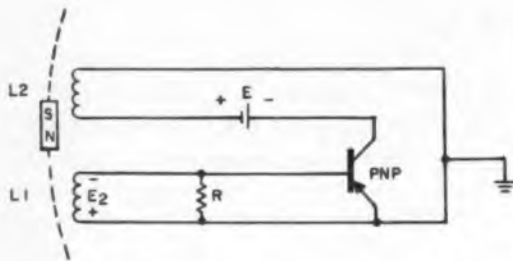
Because of the high value of mutual inductance, the system oscillates at a high audio or ultrasonic frequency. This results in a dc collector current of several milliamperes. However, because this oscillation is damped by a resistor connected between the base and ground, if mechanical oscillations are not allowed to take place, the electrical oscillations vanish also.

Once the unit has been started, and mechanical oscillations have begun, mutual inductance in the circuit increases during each down-dip, so that the oscillation limit  $\beta A = 1$  is exceeded. With a short rise time, the device then works itself into a "spike" of ultrasonic oscillations of high-average current value and short duration, causing the down motion of the magnet to become forcefully enhanced.

### Duck's Head Begins to Rise As Collector-Current Pulse Dies

Associated with the increase in mutual inductance is a secondary electromotive force. This biases the base of the transistor until a point of diminishing return is reached, whereupon the driving collector-current pulse vanishes, and the duck begins to raise its head again.

Mechanical oscillations are determined by



**Schematic of the toy** shows that it is a simple transistor oscillator with a movable magnetic core. E2 is a secondary electromotive force generated by mechanical motion of the magnet.

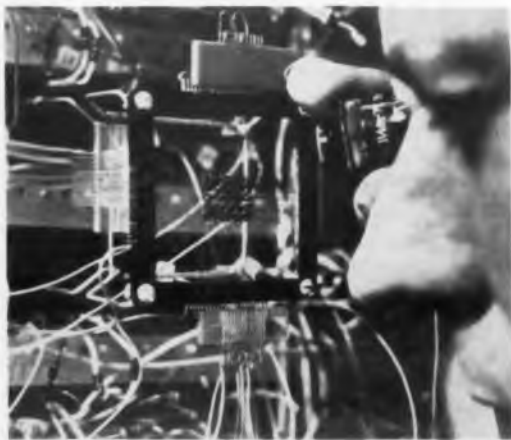
the natural frequency of the oscillation—in this case on the order of 1 cps.

Because the magnet serves as a quenching agent and the ultrasonic oscillation pertains to system resonance, the phenomenon resembles super-regeneration; on an oscilloscope the ensuing wave-train looks very much like that obtained from a transistor super-regenerative device.

The unit is said to consume so little power that the battery used should last for several months.

Produced by Sine-Serco of Waltham, Mass., it sells for \$11.

### Tiny Ferrite Cores Form Memory



Miniature ferrite cores, above, form the memory of a data-processing system that will be used in the first Orbiting Astronomical Observatory of the National Aeronautics and Space Administration (ED, Jan. 4, p 12). The advanced memory system, developed by International Business Machine's Federal Systems Div., Rockville, Md., uses quadruple-component and triple-modular redundancy. Asynchronous operation simplifies tie-in to external equipment. Nondestructive readout permits multiple readout of the entire memory while the satellite is in range of a receiving station. The memory's storage capacity is 102,400 bits, redundant, and 204,000 bits, nonredundant.

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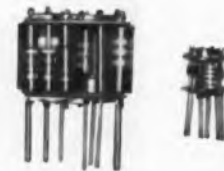
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**H** Military Products Group engineers at Minneapolis-Honeywell, St. Petersburg, Florida, use welding for maximum density—encapsulation for maximum strength—to achieve uniform, reliable results in the production of rugged but inexpensive modules. Shown above is Minneapolis-Honeywell module using build-on welded technique.



**C** The Cubic Corporation, San Diego, California, welds presently available, standard components to achieve flexible design of computer logic modules. (above left) 10 mc flip-flop circuit using conventional components, water board point-to-point assembly. (right) NAND gate produced to fit TO-5 transistor case using micro components, insulative wafers, point-to-point wiring.



**T** Design engineers at Texas Instruments, Incorporated, Dallas, Texas, face difficult microminiaturization problems. They find that electronic welding produces inexpensive, lightweight, shockproof modules of outstanding reliability. Shown above are modules employing point-to-point welded wiring. (left) Set and reset generator; (right) Oscillator amplifier, dual controlled.



**TO THE ENGINEER**

## who needs the magic of mercury

If you're stymied by switching problems in data processing, automatic control or high-speed keying, then consider the unusual attributes of AE's Series V51 mercury-wetted contact relay.

This fleet switcher can be driven at speeds up to 100 operations per second, completely free from contact bounce. It requires no maintenance within its life of over a billion transfers. The contacts can switch dry circuits or handle loads up to 250 volt-amperes. Operate and release time is approximately 3 milliseconds.

Contact and armature assemblies of the V51 are hermetically sealed in a glass capsule with a high-pressure hydrogen atmosphere. Mercury wetting continuously renews the contacts, eliminates wear, erosion, welding and sticking. Operating sensitivity is 250 milliwatts, minimum.

AE engineers will be glad to aid in applying the V51 to your designs. Ask for Circular 1988 covering full specs on the V51. Write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

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## NEWS

### Digital Computers To Be Used For Process Control Computation

Four digital computers will be used for process control computation in an ethylene and ethylene co-products plant currently under construction.

The computers and other electronic instrumentation are being furnished by Minneapolis-Honeywell Regulator Co.'s Special Systems Div. of Pottstown, Pa., for the Monsanto Chemical Co., Chocolate Bayou, Tex.

The plant will operate initially on an open loop with the computers continually monitoring process conditions, making calculations, and furnishing printed instructions to operating personnel who will make necessary process changes.

Cost of the computer control system was not disclosed.

### Ballistic Camera Sync System Times Shutters Within 0.1 Msec

A ballistic three-camera synchronization system, which can keep the timing of rotating shutters within 0.1 msec of each other at distances up to 200 miles away, has been accepted by the Army Ordnance Ballistic Research Laboratories.

Developed and manufactured by the Electronic Engineering Co. of Santa Ana, Calif., the system will be used for tracking space vehicles or capsules.

The entire system is housed in three trailer vans. The vans contain one central camera control and two remote-control timing stations. The cameras are interconnected by radio or telephone circuits.

In operation the system provides shutter-synchronizing control from a central point for phototheodolites, used in the tracking of rockets or satellites.

Sine-wave signals sent from the central control station may be phase-shifted to vary the shutter opening time. At the remote station the shutter opening is detected, and a shutter-opening signal is transmitted back to the central camera control station as a precise time mark. These return time marks are compared with other time marks delayed from a real-time reference. Either a 1-pps local range timing signal or a 1-pps time signal from WWV may be used as the real-time reference.

To synchronize the camera shutters, an unusual method of detection is employed to time the incident of maximum shutter opening.

A shutter disk drive incorporates two aluminum wheels with small iron slug inserts, which are geared to the input shafts of the two rotating disk shutters. Reluctance pickups are accurately positioned with respect to the aluminum wheel to sense the open position of the disk shutter.

The ballistic camera synchronization system also includes equipment for the measurement of time delays in transmitting shutter-open pulses through the modulation and demodulation circuits, as well as time delays in the communications circuits.

### Fiber-Glass Instrument Carrier Built for Underwater Research

A new submarine instrument carrier, called the V-Fin (Vehicle For Instrumentation), has been developed by the Braincon Corp. of Marion, Mass. The molded fiber-glass vehicle is useful for such projects as seismic investigation, temperature and pressure studies, echo-sounding and high-speed sampling at constant, predetermined undersea depths.

The V-Fin, because of its precise hydrodynamic design, is said to be completely stable at speeds up to 20 mph, remaining at the desired depth regardless of fluctuations in the speed of the towing ship.

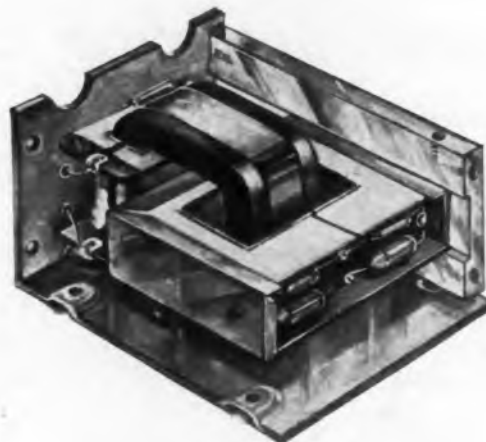
The instrument compartment of the V-Fin is 12 in. long, 2-1/2 in. wide and 1-1/8 in. deep. It can be sealed; components placed in it may be individually potted. Information is transmitted to the towing ship over a coaxial towing cable.

A hydrophone and impedance-matching transistorized preamplifier is available for use in the V-Fin, the company reports.



**V-Fin underwater** instrument carrier for marine researchers and commercial fishermen is said to be stable at speeds up to 20 mph.

## Unique construction of Elcor ISOFORMER® makes efficient isolated power supplies practical



The drawing shows the unique construction of the Isoformer (isolation transformer). This is the key element in new Elcor isolated power supplies... called ISOPLYS.

Significant features of the Isoformer are: (A) Tape-wound magnetic core (B) Shielded primary winding (C) Shielded secondary winding separated from core by air gap.

Results? Distributed capacitance between ground and shield of secondary winding is reduced to the order of 15 to 40 pf, depending on transformer power rating. And in spite of the air gap there is good magnetic coupling between primary and secondary winding. Efficiency is of the order of 90%. When used in D-C power supply, such as the Isoply, rectifiers are enclosed in same shield as secondary winding. With Isoplys you can now create simpler, less costly, and in many cases, better performing circuit designs in applications never before possible.



Write for full information: **ELCOR Incorporated**

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## New Laboratories Going Up As Research Spending Rises

*Total electronic research expenditures have climbed over \$2 billion a year, estimates the Commerce Department's Bureau of Defense Services Administration. Military R&D alone in 1960 hit over \$1.8 billion—a 10 per cent jump over 1959. To keep pace with these expanded research needs, new laboratories have been springing up throughout the industry. Shown here are examples of some of the projects being carried on in the many new facilities.*



**Developments** such as this miniature all-attitude inertial platform (above), weighing less than 20 lb, are being handled by United Aircraft Corp.'s new Norden Div. research laboratory in Norwalk, Conn. This platform will be used in a new navigational system.



**Sealed chamber** (right) with controlled atmosphere allows Philco Corp. researcher to assemble semiconductor devices under carefully controlled atmosphere. Rubber gloves built into the sealed chamber permit the worker to manipulate minuscule parts without breaking the seal. Philco's new research center is located in Blue Bell, Pa.

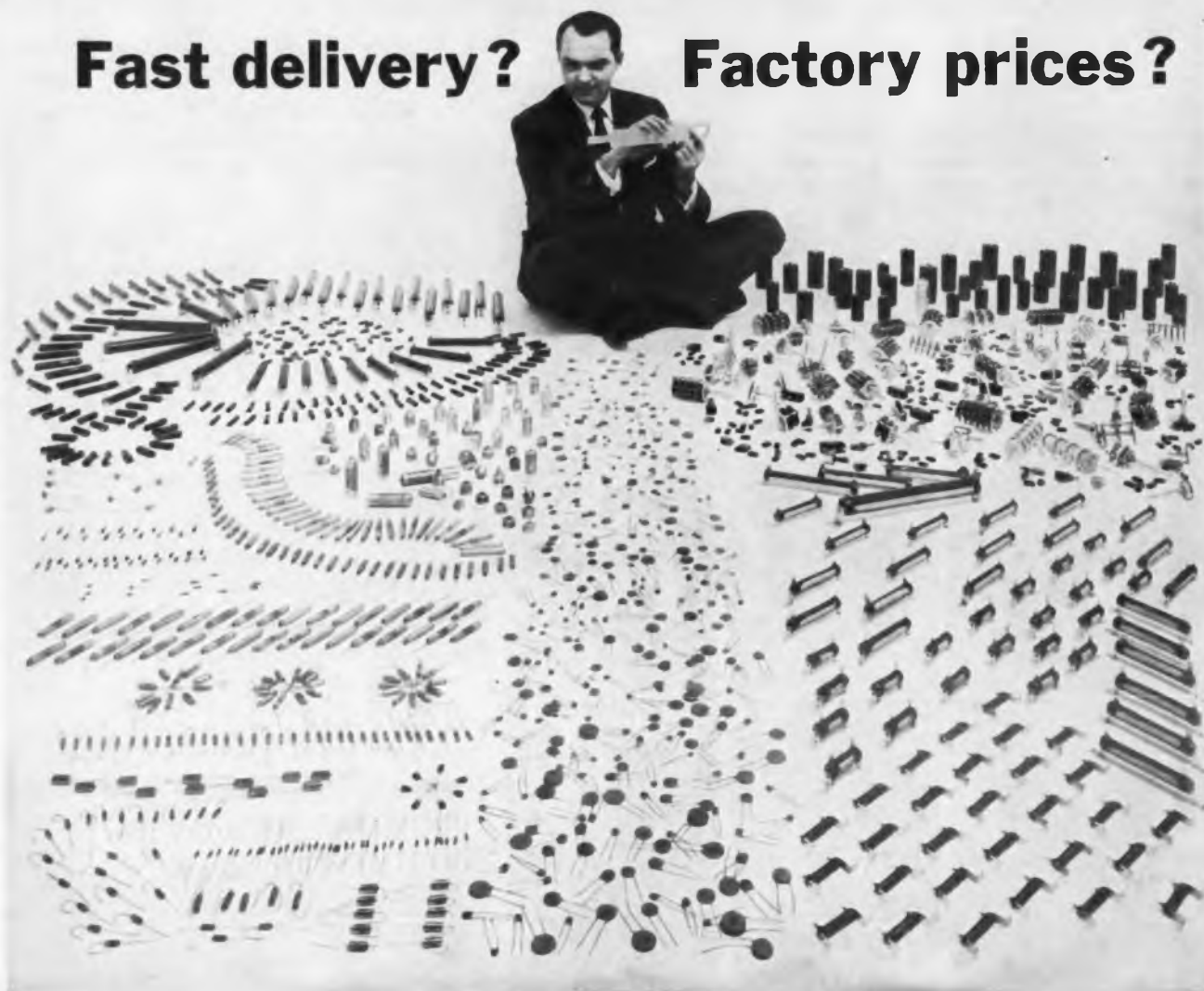


**Photodetectors for space** using semiconductors and liquid electrolytes are under development at International Business Machines Corp.'s Thomas J. Watson Research Center in Yorktown Heights, N. Y. The photodetector above is sensitive enough to detect weak signals from the moon, but rugged enough to withstand intense direct sunlight. It is expected to operate for several years with a 1.36-v battery. In normal solar cells light must pass through a thin silicon layer to reach the junction where energy conversion takes place. In the IBM device the surface layer is a sulphuric acid electrolyte which absorbs very little light. Sensitivity is  $740 \mu\text{a}/\text{cm}^2$  measured at 0.9 micron at a light level of  $24 \mu\text{a}/\text{cm}^2$ , according to IBM. High sensitivity to ultraviolet is used in ultraviolet detector using similar principle, below.



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Kierulff Electronics	1	2	4	5		6
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Brill Electronics	1	2	3	4		6
Zack Electronics	1	2	3	4		6
Eimar Electronics	1	2	3	4		6
Elwyn W. Ley	1	2	3	4		6
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Peninsula Electronics	1	2	3	4		6
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Westconn Electronics	1	2	3	4		6
Radio Appliance Co.	1	2	3	4		6
Capitol Radio	1	2	3	4		6

Electronic Indus. Sales	1	2				6
Electronic Equipment	1	2	3	4		6
East Coast Radio	1	2	3	4		6
Thurow Distributors	1	2	3	4		6
Allied Radio	1	2	3	4		6
Chauncey's, Inc.	1	2	3	4		6
Newark Electronics	1	2	3	4		6
Melvin Electronics	1	2	3	4		6
Bruce Electronics	1	2	3	4		6
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Radio Supply	1	2	3	4	5	6
P. I. Burks & Co.	1	2	3	4	5	6
D & H Distributing	1	2	3	4	5	6
Kann-Elliott Electron.	1	2	3	4	5	6
Radio Elec. Serv.	1	2	3	4	5	6
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DeMambo Rad. Sup.	1	2	3	4	5	6
Lafayette Radio	1	2	3	4	5	6
Radio Shack	1	2	3	4	5	6
Radio Specialties	1	2	3	4	5	6
Northwest Radio	1	2	3	4	5	6
Burstein-Applebee	1	2	3	4	5	6
Walters Radio	1	2	3	4	5	6
Interstate Indus. Elec.	1	2	3	4	5	6
Olive Electronics	1	2	3	4	5	6
General Radio	1	2	3	4	5	6
Allied Radio	1	2	3	4	5	6

Atlas Electronics	1	2				6
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Aaron Lippman & Co.	1	2				6
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Peerless Radio	1	2	3	4		6
Bruno-New York	1	2	3	4		6
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Milo Electronics	1	2	3	4		6
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Whitehead Radio	1	2	3	4		6
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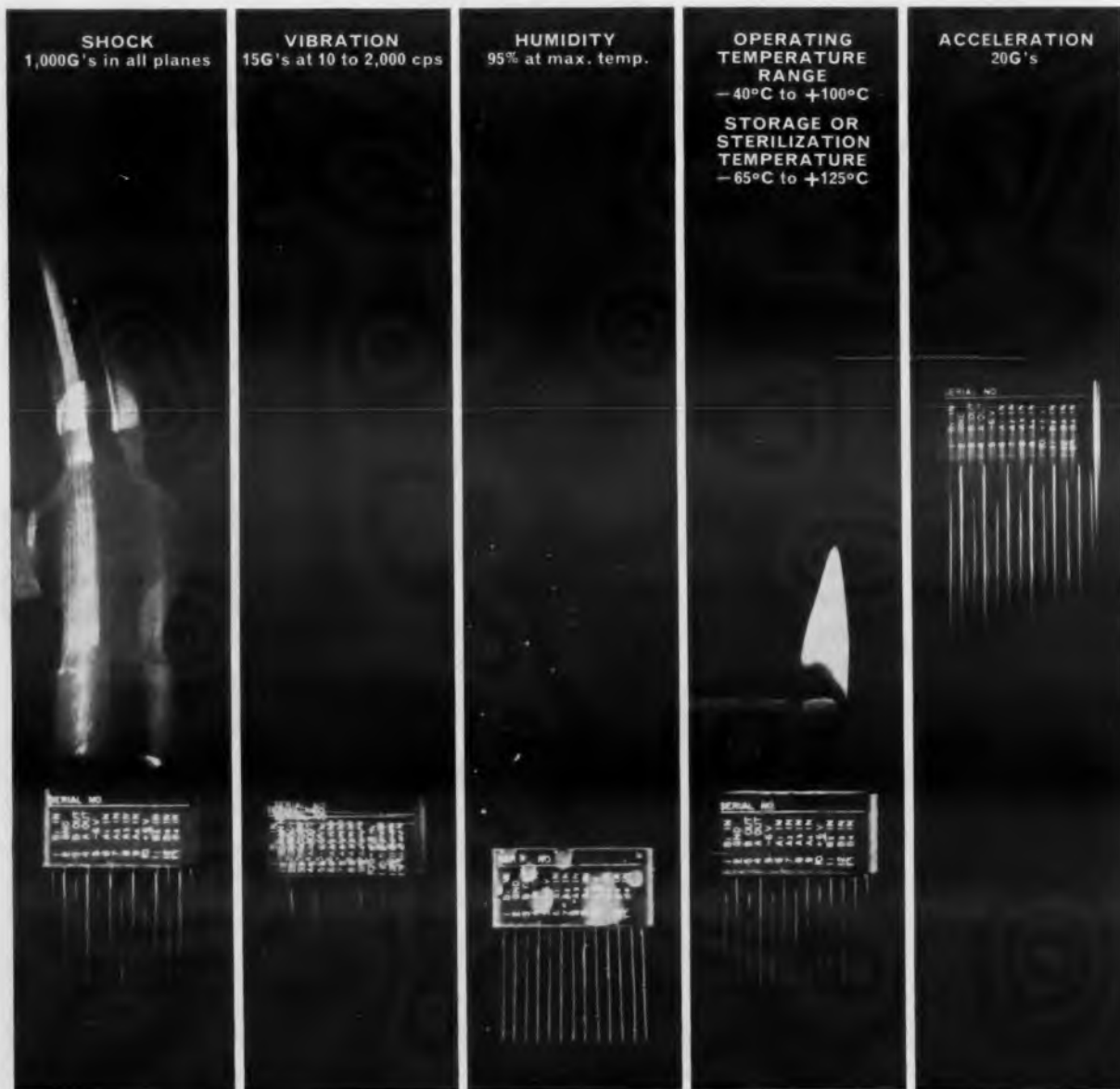
Srepco, Inc.	1	2	3	4		6
Servex Electronics	1	2	3	4		6
Trice Whistle Electronics	1	2	3	4		6
Engineering Supply	1	2	3	4		6
Eoff Electric	1	2	3	4		6
Television Parts	1	2	3	4	5	6
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Radio Parts	1	2	3	4	5	6
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Phila. Electronics	1	2	3	4	5	6
Radio Elec. Serv.	1	2	3	4	5	6
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West Chester Elec.	1	2	3	4	5	6
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Sweco Inc.	1	2	3	4	5	6
Harrison Equip.	1	2	3	4	5	6
Lerner Co.	1	2	3	4	5	6
Rucher Electronic	1	2	3	4	5	6
F. B. Connelly Co.	1	2	3	4	5	6
Radio Parts	1	2	3	4	5	6
Canadian Elec. Sup.	1	2	3	4	5	6
Wackid Radio	1	2	3	4	5	6
Alpha Aracon Radio	1	2	3	4	5	6
Electro Sonic Sup.	1	2	3	4	5	6
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## NEWS

### Analog-Digital Recording Systems To Be Developed For the Navy

Two identical high-speed digital data recording systems, to be designed for shipboard installations, will use both digital and analog inputs.

The system, to be developed by Monitor Systems, Inc. of Fort Washington, Pa., will handle up to 25 inputs, 10 in analog voltage form and 15 in digital form. In its normal mode of operation, each system will sample all data channels within 20 msec followed by a quiescent interval for the remainder of the sampling period.

Frame rate will be adjusted by the operator to 0.1, 0.2, 0.5, 1, 2, 4, 8, 16, 32, or 64 seconds as desired. The operator will be able to select any one channel for high-speed sampling at a rate of 800 samples per sec. All data will be recorded on magnetic tape in compatible format for IBM 650 or 704 computer processing.

The systems will be developed under a \$250,000 Navy contract.

### Optical Sensor Designed to Help Blind 'See' Approaching Objects

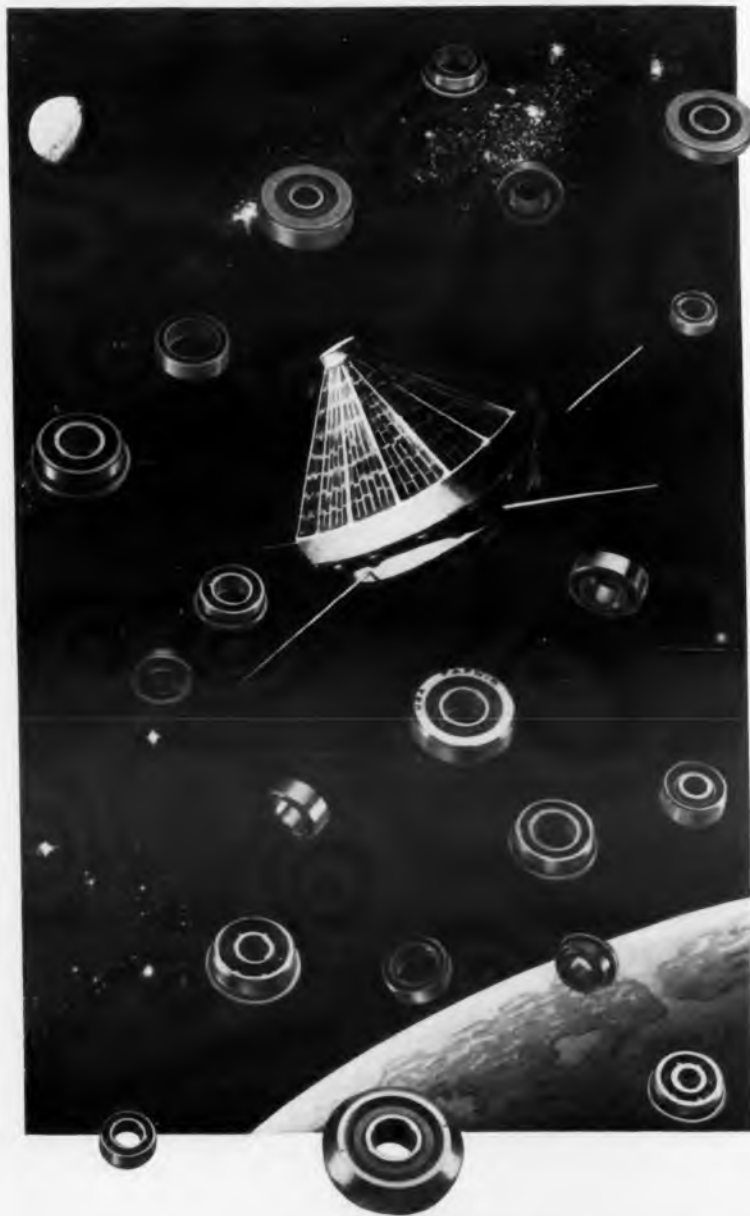
An optical range finder is being developed to help blind people sense the distance of approaching objects by means of vibrations applied to their fingers.

The device is essentially a zoom lens operating in conjunction with a photomultiplier, which converts the light variations of an approaching object into mechanical vibrations.

The detector is being incorporated into a briefcase that has a handle with four metal membranes, arranged so they touch the fingers of the holder. The membranes are set for fixed-distance ranges—1 to 3 ft, 3 to 9 ft, 9 to 30 ft, and beyond 30 ft. A blind person would sense approaching objects—an auto, say—through successive activation of the membranes, while using his thumb to change the angle of the lens.

The device is being developed by Dr. Bertil Jacobsen of Karolinska Hospital, Stockholm, Sweden. He is also the inventor of the endoradiosonde, a tiny transistor radio transmitter that can be swallowed by a patient to supply data to a receiver outside his body.

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Get the highest available accuracy in this piston type attenuator.

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**TYPE 132**—Precision Test Receiver  
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TYPE 90

TYPE 71

TYPE 133

TYPE 70

TYPE 70

TYPE 74

tory tool. Calibrate R-F attenuators and couplers. Measure noise figure and selectivity. **FEATURES:** Incorporates Type 30 attenuator. 30 and 60 Mc standard frequencies. Noise figure 1.6 db at 30 Mc; 2.4 db at 60 Mc. Prices \$1,350 and \$1,400. Circle publication No. 786.

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**TYPE 71—Power Supply**  
Provides Power for all nine Type 70 argon discharge noise generators when used manually. Price \$165. Circle publication No. 788.

**TYPE 74—Automatic Noise Figure Indicator**  
Widest frequency coverage is yours with this equipment. Plus maximum flexibility. Exclusive tunable I-F amplifier available. **FEATURES:** R-F range 10 Mc to 40 Kmc with Type 70 noise generators. I-F range—30, 60

and 40 to 180 Mc. Noise figure ranges—0 to 25 db,  $\pm$  0.5 db; 23 to 36 db,  $\pm$  1.0 db. Prices \$765 and \$830. Circle publication No. 789.

**Type 113030 (not illustrated)—Radar Performance Monitor.** Transistorized. Measures noise figure, checks mixer crystals; checks transmitted and reflected power. Circle publication No. 790.

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## Radar Augmenter Enlarges Target On Radars of Tracking Planes

An active radar augmenter has been developed to make small Air Force drone or target aircraft appear as large "enemy" planes on the radars of tracking planes.

The 14-lb augmenter, developed and now being produced by Lockheed Electronics Co. of Plainfield, N. J., electronically simulates the radar-echo characteristics of target vehicles. The typical augmenter gain is about 70 db at 9 Gc. The unit receives a radar-transmitted signal and transmits an amplified signal back to the tracking missile-carrying aircraft.

### Simulated Enlarged Target Area Can Be Varied With Attenuator

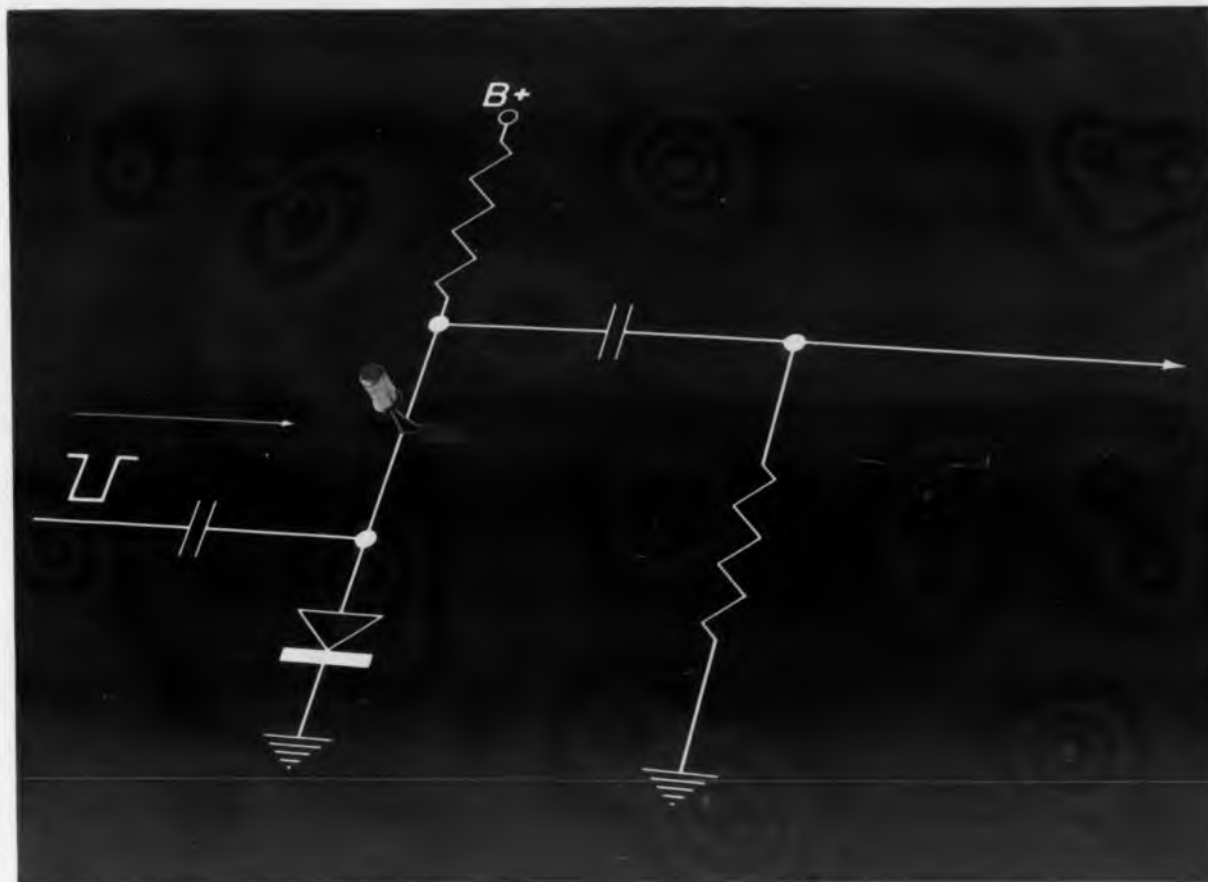
Assuming the transmitter and receiver line losses are equal to the antenna gains and that the antenna isolation obtainable is greater than 70 db, the simulated target area is 850 sq m. Target areas may be varied by a variable attenuator in the antenna output line.

The C/X-band unit uses a traveling-wave-tube amplifier, transistorized power supplies and matched receiving and transmitting antennas. The frequency range is 5 to 11 Gc. Output power is 1 w minimum, although more than 3 w are transmitted over a major portion of the band. Signal gain over the major portion of the frequency range is greater than 65 db and as high as 72 db. Input and output impedance is 50 ohms nominal. Input power (dc) is 100 w with a voltage rating of 25 to 29 vdc. Regulation is 1 per cent.

The augmenter can be used at rated specifications in an environment of  $-54^{\circ}\text{C}$  to  $71^{\circ}\text{C}$  and at altitudes up to 70,000 ft.



**Twt radar augmenter**, which provides a gain of 70 db at 9,000 Gc, is intended for installation in drone or target aircraft to reinforce radar tracking by missile-carrying aircraft.



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# EDITORIAL

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## Getting Obsolete?

Is experience the best teacher? Will you be worth more as an engineer 10 years from now because of your experience?

Dr. Thomas Stetson, Head of the Department of Civil Engineering at Carnegie Institute of Technology expresses some provocative ideas on the value of experience in an article titled "Education for Oblivion?" (*Carnegie Alumnus*, April 1961).

He points out that starting salaries for engineering graduates have risen far more rapidly than those of experienced employees with the same basic training. This situation, he says, is claimed to be caused by a temporary maladjustment caused by an expanding technology combined with a shortage of engineers.

Commenting on this, Dr. Stetson says:

" . . . There is considerable evidence to indicate that the situation is not temporary, but will continue and may even become more pronounced. Such a trend implies that a new engineering graduate is near the peak of value to his employer and society, and that several years of experience may only add slightly to his professional stature. . . "

He goes on to view the problem quantitatively.

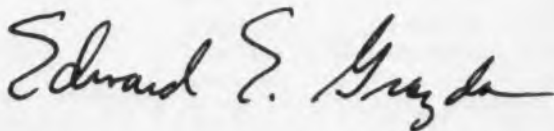
" . . . Unless a graduate of 10 years ago has systematically spent about 10 per cent of his time extending his knowledge beyond the level of development achieved in his collegiate training he will not have value in excess of a new graduate. This . . . assumes that he has retained all of his previous training, which is probably far from realistic.

"If an estimate of decay from neglect or disuse is also 10 per cent per year, an engineer is faced with the task of growing in new knowledge at the rate of about 20 per cent per year to remain of equal value to his employer and society. To increase in value at a significant rate he should probably devote about one-third of his productive hours to self-education and improvement. . . ."

In other words, you have got to keep with your field or become obsolete. How can you keep up? One way is to learn how to read effectively—and use this skill to regularly absorb the carefully compiled, edited, and detailed account of the advances in your field that appears in every issue of technical magazines like *ELECTRONIC DESIGN*.

Employers would also do well to act on this problem. Technical management should not merely expect engineers to keep up with the advances in their field, it should insist on and require this as part of each man's job. One of the best ways to do this is to encourage and make time available for technical reading—right on the job.

If a man is to spend one-third of his time to grow in his field, surely one hour of his working day, set aside for technical reading, is not asking too much. Certainly he will supplement this one hour with many more on his own, encouraged by the knowledge that management is really interested in his growth.



# NEW

## MODEL 700 CAPACITANCE MEASURING SYSTEM...



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Calibration of two or three-terminal variable air capacitor secondary standards.

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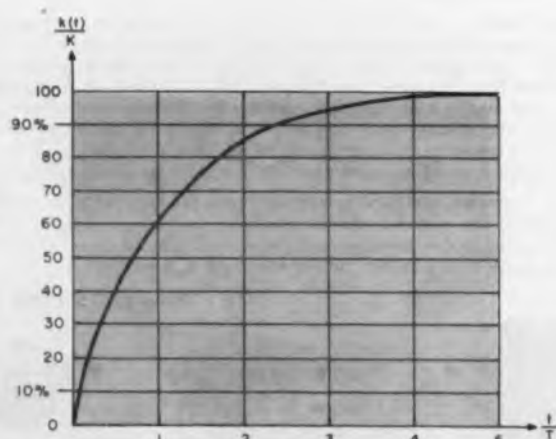
# Transistor and Switching-Circuit Measurements



**Charles Askanas**  
Engineering Project Manager  
Lumatron Electronics, Inc.  
New Hyde Park, N. Y.

LACK of correlation and repeatability in switching speed measurements plague manufacturers and users of fast transistors for computer circuits. Among the many factors which compound this problem is the lack of uniformity in circuit construction and layout resulting in nonrepeatable differences in the distributed reactances critical at high frequencies.

The lack of correlation is partially due to



t/T	0	1	2	3	4	5	6
INCOMPLETED TRANSIENTS	1.000	0.368	0.1353	0.0498	0.0183	0.0067	0.0025

Fig. 1. Plot of a normalized exponential.

At present, rise and fall time measurements for switching transistors are taken at the 10 and 90 per cent points of the device excursion. Although this approach is acceptable for an exponential function, the 10 and 90 per cent levels are difficult to determine for transistors having a delayed exponential due to high frequency loading; capacitive feedthrough and ringing also limit the accuracy of locating the 10 and 90 per cent points. Response measurement using 20 to 80 per cent levels, author Charles Askanas argues, is equally valid and avoids the above problems.

the persistent use of a definition which was originally intended for use with somewhat classic exponentials. That is, the definition of rise time and fall time between 10 and 90 per cent, and turn-on delay time and storage time between 10 per cent of an input pulse and 10 per cent of an output pulse. The advantage and validity of measuring switching times between 20 and 80 per cent is given.

## The Exponential Related to Switching-Speed Characteristics

**Review of Definitions:** The dimensionless exponential response of a network is:

$$\frac{k(t)}{K_0} = e^{-t/T} \quad (1)$$

$K_0$  is the initial current or voltage at time  $t = 0$ .  $T$  is the time constant of the system.

A tabulation of  $t/T$  is shown in Fig. 1, together with a plot of the normalized exponential. It can be seen that the exponential will reach a steady state in five time constants.

**Relationship between Exponential Rise Time and Frequency Response:** Since shunt (distributed and lumped) capacitance determines high-frequency response, consider the rise time of the integrating network (low-pass filter) shown in Fig. 2.

The rise time, defined as the time interval between 10 and 90 per cent of the total excursion is:

$$t_r = 2.3 RC - 0.1 RC = 2.2 RC$$

The cut-off frequency of the network is:

$$f_c = \frac{1}{2\pi RC} \quad \therefore t_r = \frac{2.2}{2\pi f_c} = \frac{0.22}{f_c}$$

and  $t_r f_c = 0.35$

If the rise times were defined as the time interval required for voltage output to go from 20 to 80 per cent of its final value  $t_r = 1.6 RC - 0.22 RC = 1.38 RC \approx 1.4 RC$

$$t_r f_c = 0.22 \quad t_r = \frac{1.4}{2\pi f_c} = \frac{0.22}{f_c}$$

Since the exponential becomes asymptotic to its final value in five time constants, the selection of the 10 and 90 per cent points on the waveform is straightforward. However, it can also be seen that selecting the time between 20 and 80 per cent is as valid for indication of the frequency response as the 10 and 90 per cent points—one just deals with a different constant. However, defining switching times between 20 and 80 per cent must still be justified.

## Switching Response of A Grounded-Emitter Transistor

The most accepted form of the saturating grounded-emitter transistor response is the exponential:

$$t = \frac{1}{f_1(\omega_c) - f_2(\omega_c \alpha)} \ln f_1 \frac{(i_1 i_2)}{f_1(i_1 \alpha)} \quad (1)$$

$\omega_c$  = the common-base current gain cut-off radian frequency.



Fig. 2. Simple RC low-pass filter circuit.

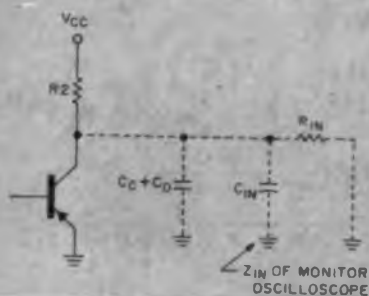


Fig. 3. In the transistor output circuit shown,  $C_d$  represents the distributed circuit capacity and  $C_{in}$ ,  $R_{in}$  the oscilloscope input impedance.

$\alpha$  = the common-base current gain  
 $i_c$  = collector current  
 $i_b$  = "on" or "off" base current

These equations, valid to determine an approximate response or a direction for design, are accurate within 20 per cent; the following are assumed:

1. The transistor switch input is from an idealized constant-current source. Actually, most of the switching circuits are voltage driven from source impedances between 50 and 100 ohms.

2. The transistor is considered essentially nonloaded, i.e., the load resistance is assumed small enough so that the short-circuit current gain can be used, and the only load capacitance considered is that of the collector capacitance which is nominally in the order of 1.0 to 30 pf.

Analytically, the nonloading assumption is:

$$R_L C_{p\omega c} \ll 1$$

(continued on p 44)

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Noise:	Less than 0.05%
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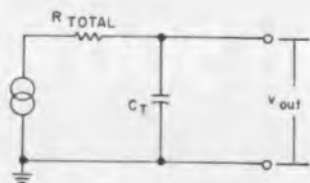


Fig. 4. The equivalent transistor output developed from Fig. 3.

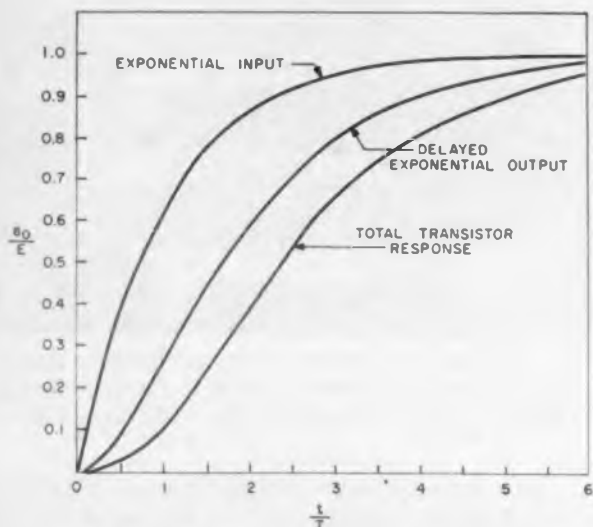


Fig. 7. The effect of loading on the transistor rise time response.

To determine the validity of the nonloading assumption, consider a typical high-frequency switching circuit:

The alpha cut-off frequency = 100 mc

$$\omega_c = 2\pi f = 2\pi \times 10^8 \text{ rad/sec}$$

$$C_c = 10 \text{ pf}$$

$R_L = 500$  ohms which is fairly small load resistor

$$\omega_c C_c R_L = 2\pi \times 10^8 \times 10 \times 10^{-12} \times 5 \times 10^2$$

$$= \pi$$

$$\therefore R_L C_c \omega_c > 1$$

Thus, the loading effect cannot be ignored. Furthermore, this is neglecting the effect of distributed circuit capacitance due to layout and wiring and the capacitive input of most oscilloscopes or probes used to monitor fast switching times.

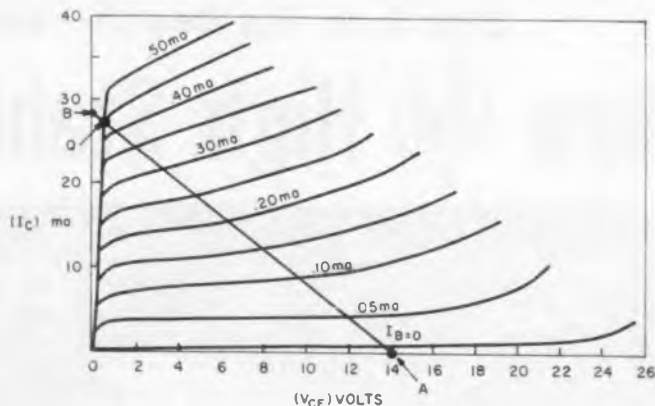


Fig. 5. Characteristic curve of a transistor with a load line drawn from "off" (point A) to "on" (point B).

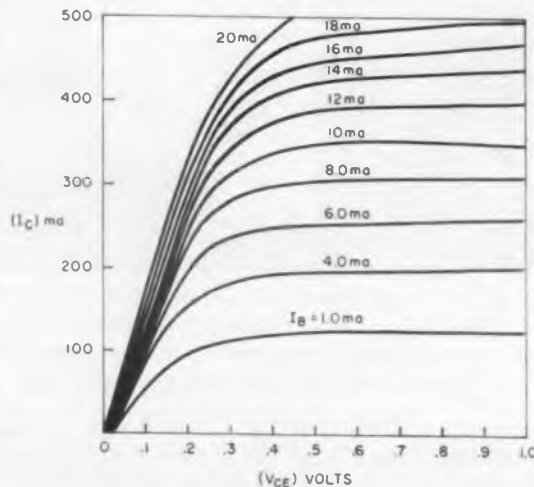


Fig. 6. Common emitter collector saturation characteristics.

Consider the switching circuit output shown in Fig. 3.

$C_{in}$  and  $R_{in}$  are the input impedance to the monitor oscilloscope (if its input is capacitive, as well as resistive.)

$C_c$  is the collector capacitance.

$C_d$  is the distributed circuit capacitance.

Consider the transistor as a function generator whose output is the idealized exponential. In the equivalent circuit,  $R_{total}$  includes the transistor output impedance and its shunt load resistance  $R_L$  (which is at ac ground) and  $C_T = C_{in} + C_d + C_c$  as shown in Fig. 4.

As shown, for high-frequency operation:  $RC_T \omega_c > 1$  and  $C_T > C_c$

$$\therefore \omega_c \gg \frac{1}{RC} \text{ and } RC \gg \frac{1}{\omega_c}$$

As shown, it is RC which determines the response and not  $\omega_c$ .

Rewriting Eq. 1 as:

$$t = -K \ln g \quad \text{when } g = \frac{f_2(i_c, i_b)}{f_1(i_c, i_b, \alpha)} \quad (2)$$

$$K = \frac{1}{f_1(\omega_c) - f_2(\omega_c, \alpha)}$$

$K$  is a constant for a given transistor.  $g = e^{-t/K}$  which is the assumed exponential feeding the integrating network.

Using transform theory:

$$\mathcal{L}(e^{-t/K}) = \frac{1}{(S + 1/K)}$$

The transfer function of the equivalent low-pass filter is:

$$\frac{V_2(S)}{V_1(S)} = \frac{\frac{1}{CS}}{R + \frac{1}{CS}} = \frac{1}{1 + CSR}$$

$$\begin{aligned} \therefore V_2(s) &= \frac{V_1(S)}{1 + CSR} \\ &= \frac{1}{(s + 1/K)(CSR + 1)} \\ &= \frac{1}{CR} \left[ \frac{1}{(s + 1/K)(s + 1/RC)} \right] \end{aligned}$$

By residues: (4)

$$V_2(S) = \frac{1}{CR} \left[ \frac{A_1}{s + 1/K} + \frac{A_2}{s + 1/RC} \right]$$

$R$  in the above treatment has been assumed as constant. However,  $R$  includes the output impedance of the transistor which varies by many orders of magnitude as the transistor switches from "on" to "off."

The slope of the  $V_{ce}-I_c$  characteristic curves of the grounded emitter transistor is a good approximation of the transistor output impedance. The characteristic curve of a "typical" transistor is considered in Fig. 5.

Some small change in the transistor output impedance is seen as it switches from point A to point B. A rapid change in impedance is seen as the transistor reaches the saturation point, Q. However, if the voltage axis is increased by a factor of at least 10, a more realistic view of the transistor saturation characteristic is obtained as shown in Fig. 6.

In Fig. 6 the output impedance of the transistor is seen to vary markedly as the transistor is driven further into saturation. The transistor output impedance, which is a function of  $I_c$ ,  $V_{ce}$ , and  $I_b$ , can be approximated by linear increments which are functions of time. Thus in the frequency domain,

$R(S)$  can be expressed as a finite series.  
 $R(S) = R_1(S_1), R_2(S_2), R_3(S_3), \dots, R_n(S_n)$  (5)  
 Rewriting Eq. 4:

$$V_2(S) = \frac{1}{CR(S)} \left[ \frac{A_1}{(s + 1/K)} + \frac{A_2}{s + \frac{1}{CR(S)}} \right] \quad (6)$$

$$A_1 = \frac{1}{CR(S)} \left[ \frac{1}{s + \frac{1}{CR(S)}} \right]_{s = -1/K}$$

$$= \frac{1}{CR(S)} \left[ \frac{1}{+CR(S) - 1/K} \right] = \frac{K}{K - CR(S)}$$

$$A_2 = \frac{1}{CR(S)} \left[ \frac{1}{s + 1/K} \right]_{s = -\frac{1}{CR(S)}}$$

$$= \frac{1}{CR(S)} \left[ \frac{1}{-\frac{1}{CR(S)} + 1/K} \right] = \frac{K}{CR(S) - K}$$

$$V_2(S) = \frac{K}{K - CR(S)} \left( \frac{1}{s + 1/K} \right) + \frac{K}{CR(S) - K} \left( \frac{1}{s + \frac{1}{CR(S)}} \right)$$

and substituting Eq. 5.

$$V_2(S) = \frac{K}{K - C[R_1(S_1), R_2(S_2), \dots, R_n(S_n)]} \left( \frac{1}{s + \frac{1}{K}} \right) + \frac{K}{C[R_1(S_1), R_2(S_2), \dots, R_n(S_n)] - K} \left[ \frac{1}{s + \frac{1}{C[R_1(S_1), R_2(S_2), \dots, R_n(S_n)]}} \right] \quad (7)$$

Writing the  $n^{\text{th}}$  turn of  $K/K - CR(S)$  in the time domain  $k_{1n} = K/K - CR(t_n)$  which is a constant in each time increment. Similarly  $k_{2n} = K/CR(t_n) - K$

$$\therefore \mathcal{L}^{-1} V_2(S) = v(t) = k_{1n}e^{t/K} +$$

$$(k_{21}e^{-t_1/CR_1(t)}, k_{22}e^{-t_2/CR_2(t)}, \dots, k_{2n}e^{-t_n/CR_n(t)})$$

$$\text{or } v_2(t) = k_1e^{t/K} + [k_{21}f_1(t, R_1, C)],$$

$$[k_{22}f_2(t, R_2, C)], \dots [k_{2n}f_n(t, R_n, C)]$$

(continued on pp 46)

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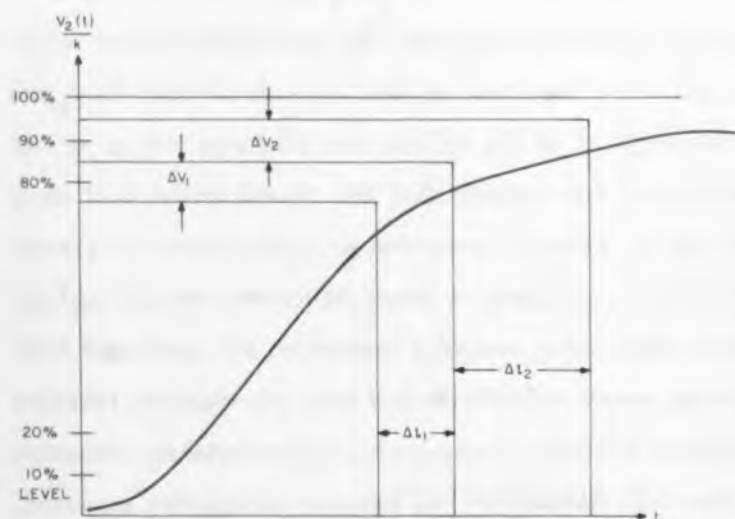


Fig. 9. Normalized total transistor response.

Thus, the transistor response is the delayed exponential which would be expected when driving an RC network with an exponential. However, the resultant output rise time of the delayed exponential is altered by the shift in  $R(t)$ , i.e.,  $R$  changes during the transistor excursion.

The theoretically predicted resultant delayed exponential including the effect of the transistor loading is shown in Fig. 7. In order to verify the appearance of the delayed exponential, the output of the circuit shown in Fig. 8a was monitored.

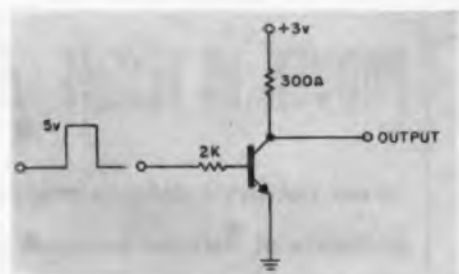
The transistor has the following specified characteristics:

$$\begin{aligned} h_{fe} &= 20 \text{ at } I_c = 10 \text{ ma, } V_{ce} = 1 \text{ v} \\ C_c &= 4.5 \text{ pf} \\ h_{fe} &= 2 \text{ at } V_{ce} = 15 \text{ v dc,} \\ I_c &= 10 \text{ ma, and } f = 100 \text{ mc.} \end{aligned}$$

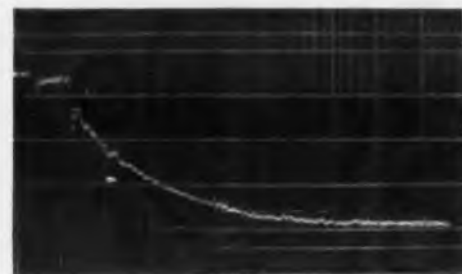
It can be seen that the transistor is being sufficiently overdriven to assure saturation.

The response oscillogram of the circuit appears in Fig. 8b. The delayed exponential characteristic can be observed in Fig. 8b, i.e., the waveform continues to increase in magnitude after the steady state appears to have been reached. If one changes the sweep speed to 50 nsec per cm in order to view the entire characteristic, the delayed response is not as evident. Response characteristic at a sweep speed of 50 nsec/cm is shown in Fig. 8c.

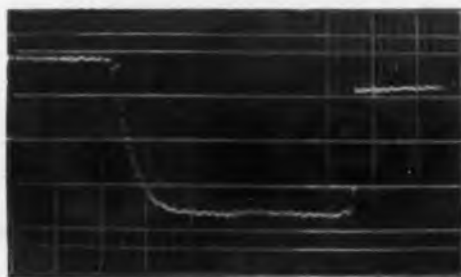
In Fig. 8d one can see an oscilloscope dis-



(a)



(b)



(c)



(d)

Fig. 8. (a) Test circuit used to verify the delayed exponential response. In (b) is shown the circuit response using a sweep speed of 10 nsec/cm; in (c) the speed has been changed to 50 nsec/cm. In (d) the delayed exponential is shown as displayed on a Tektronix 541A at a 20 nsec/cm rate.

play of the response characteristics on a Tektronix 541A. Again the delayed exponential characteristic can be seen.

#### Errors in Selecting 10 and 90 Per Cent Points

The high frequency delayed transistor response appears in Fig. 8. The curve shown in Fig. 8 is so nonlinear around the 90 per cent region that a small error in the selection of the 90 per cent point yields a very large error in time. The 80 per cent point is approximately the first easily selected linear portion of the curve and a small error in the selection of the 80 per cent point corresponds to correspondingly small error in time.

As can be seen graphically:

$$\Delta V_1 = \Delta V_2 \text{ but } \Delta t_2 \gg \Delta t_1$$

Aside from the delayed transistor response

the faster switch has anomalies in the response characteristic such as capacitive feed through, reflection due to improperly terminated inputs, and ringing. Each of these may have peaks which are over 10 per cent of the total transistor swing.

It is desirable to have test limits which are easily selected regardless of a change in waveform and are not disturbed by the above described anomalies. But, most of all, it is desired to have test limits which encompass, as completely as necessary, the waveform being observed.

The 20 per cent level can be justified as the lower test limit since it is high enough on the curve to be independent of the reflections and feed through.

The 80 per cent upper test limit is the highest point of the linear portion of the re-

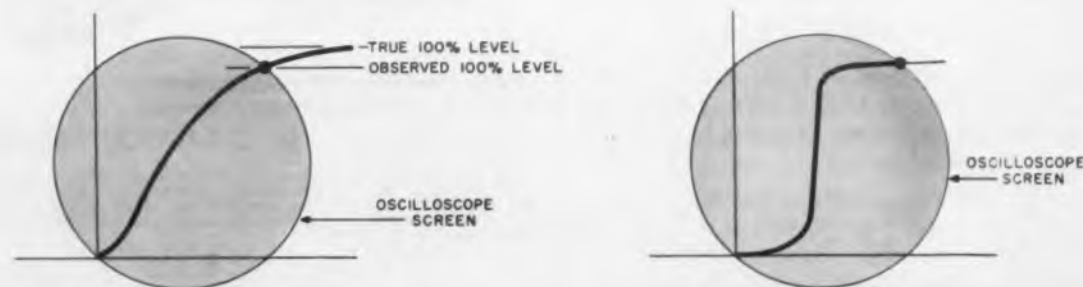


Fig. 10. (a) Oscilloscope pattern showing transistor response with maximum resolution. (b) Same pattern reduced in resolution in order to observe total response.



sponse characteristics which is easily determined. As shown graphically in Fig. 9, a small error in the selection of 80 per cent means a correspondingly small error on the time axis. The exponential delay can be further increased without seriously effecting the 80 per cent limit; however, the error in selecting 90 per cent would increase proportionately with an increase in exponential delay.

However, 20 per cent as the lower limit and 80 per cent as the upper limit are not the only optimum test limits. Specific requirements may result in other limits. The limits are selected as being optimum in order to present the most general case.

#### Instrumentation Errors Due to Sweep Speed Choice

Further justification of the nominal 20 and 80 per cent points as the lower and upper test percentage points can be made from an instrumentation point of view.

If one wants to determine switching times accurately with an oscilloscope, the sweep speed must be such that the waveform may be viewed over a large a time as possible. This increased resolution results in the measuring error illustrated graphically in Fig. 10. If the resolution is decreased in order to see the entire response, it may appear as shown in Fig. 10b. In Fig. 10b, the entire waveform is reduced at levels which are less than 50 per cent is reduced, but the entire measurement is correspondingly reduced in accuracy.

The users of transistor switches are rarely concerned with the upper portion of the leading edge of a drive or trigger pulse. Circuit designers are primarily concerned with transfer and delay time between logic elements. Both are functions of the level at which a logic element triggers.

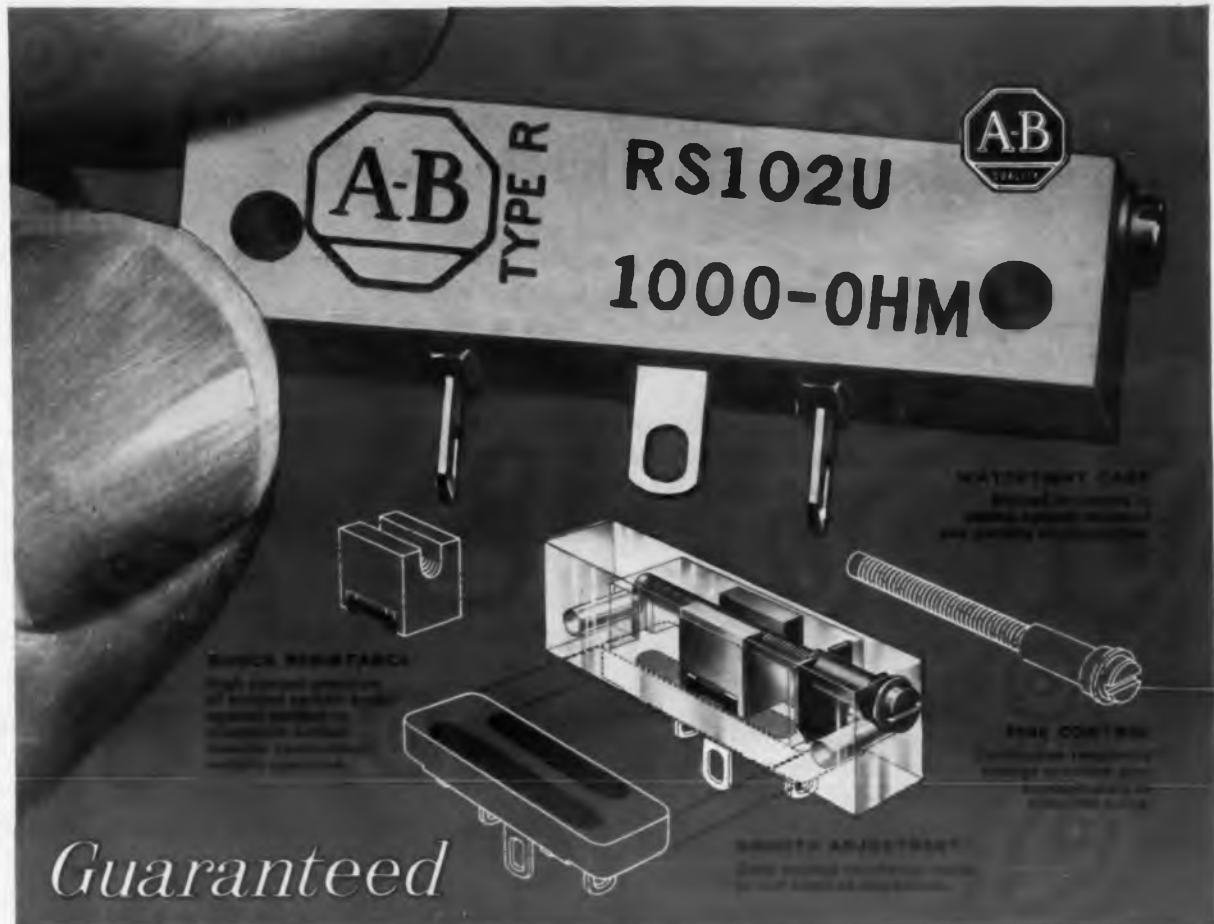
In most designs, logic circuits are triggered at levels which are less than 50 per cent of the input pulse, in order to reduce turn on delay times. Furthermore, delays between successive stages are usually computed from 50 per cent points. Thus, the above 80 per cent nonlinear portion of the delayed exponential rise usually yields no useful information to the logic designer. ■ ■

#### Acknowledgments

The author expresses appreciation to Philip Emile and Paul Schwartz of Lumatron Electronics for their many helpful comments and enlightening suggestions and to Lawrence May for his drawings.

#### Reference

1. Ebers, J. J., and Moll, J. L., Large Signal Behavior of Junction Transistors. *Proc. IRE*, Vol. 42, pp 1761-1772, December 1954.



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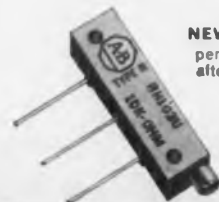
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\*Test Report #71801, Sept. 1960, United States Testing Company, Inc.



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# Precision Potentiometers Need Better Specifications

*One would think that after all these years virtually everyone should know how to specify a precision potentiometer. But it just isn't so, according to Robert Hennessy. Mr. Hennessy, who's been designing precision pots for more than nine years points out that even pot manufacturers don't agree on basic electrical definitions. (This is one of the problems that the new Precision Potentiometer Manufacturers' Association will try to solve.) In an effort to eliminate the most pressing ambiguities he offers this article.*

**Robert Hennessy**  
Carter Manufacturing Corp.  
Hudson, Mass.

**E**LECTRICAL specifications for precision potentiometers are too ambiguous. They were developed solely for specifying the shaft-voltage relationship of precision potentiometers. Presently used specifications have, in practice, created situations where the manufacturer is not clear as to the customer's requirements and the customer often receives a unit that meets the letter of his specifications and then finds his specifications do not reflect his requirements. Since manufacturers often disagree among themselves on the precise meanings of various specifications, it seems that the problem is not merely one of customer education.

Further proof of this lies in the fact that requirements exist that cannot be covered by the existing definitions. Thus, the customer or designer may be expert in the field of precision potentiometers and find he cannot specify the requirements and consequently must buy a unit that is over specified.

## Accuracy Definitions Cause Most Trouble

Accuracy definitions are the most troublesome. There is some disagreement in the industry on the precise meaning of resolution, electrical angle, etc., but these are minor and they do not often cause severe difficulty.

Basically, a precision potentiometer generates a voltage output as its shaft is rotated. This relationship is specified by an equation, a table of output values corresponding to shaft angle, or a graph. In each case, the function to be generated is easily understood but difficulties arise as to tolerances.

Through custom, the accuracy is based on the maximum deviation from a theoretical master function of zero error. In practice, the accuracy of a precision potentiometer (once manufacturing is complete) can be altered in any one of three ways (or a combination of them).

1. By using an angle that varies somewhat from the prescribed 100 per cent rotation angle. (This is done presently under "independent linearity.")

2. By phasing the potentiometer to the system so that the actual output varies its relationship to the absolute shaft position.

3. By varying the actual voltage across the potentiometer whereby the output range is greater or less than the 100 per cent reference voltage. (This is also done, at present, under "independent linearity" and also "independent conformity.") External circuitry is generally needed for this adjustment.

## Specifications Should Show Which Allowances Are Permitted

Accuracy definitions are needed to indicate whether any of these allowances are permissible and, where they are, the tolerances of the adjustments and of the accuracy with the adjustments.

When the system designer has a precision-potentiometer requirement, he knows the following:

1. The function to be generated by the potentiometer (linear, square law, logarithmic, etc.).

2. The shaft angle over which this function is to be generated.

3. Whether this total shaft angle is absolute or can be varied.

4. Whether external circuitry can be made



available or is desirable by means of which the voltage at the low-voltage-end terminal of the potentiometer may be adjusted.

5. Whether the high-voltage end may be similarly adjusted.

6. If it is necessary that the first indication of voltage (or voltage change) must be the beginning of the function.

7. What accuracy is required in the shaft-position-to-voltage-output relationship.

If a table or a check-off list is now made, the potentiometer can be specified completely. For example:

- |                               |                                                              |
|-------------------------------|--------------------------------------------------------------|
| (1) Function                  | $E_o = \text{---}$                                           |
| (2) Reference Angle           | $\text{--- deg}$                                             |
| (3) Reference Angle Tolerance | $\pm \text{--- deg}$                                         |
| (4) Low-Voltage End           | <input type="checkbox"/> Independent                         |
|                               | <input type="checkbox"/> Terminal                            |
| (5) High-Voltage End          | <input type="checkbox"/> Independent                         |
|                               | <input type="checkbox"/> Terminal                            |
| (6) Index                     | <input type="checkbox"/> Zero Base                           |
|                               | <input type="checkbox"/> $\text{--- \%}$ at $\text{--- deg}$ |
| (7) Conformity                | $\pm \text{--- \%}$ of $E_{10}$                              |

If the function is defined by a graph or a

table, the first block can refer to a print. The terms used in (4) and (5) are similar to their present use.

*Independent* indicates that adjustment of the particular end of the potentiometer is allowable. The proper use of this term permits that end to be adjusted only within the conformity tolerance.

*Terminal* derives its name from the fact that no external adjustments are allowed and the source is connected directly to the terminal of the potentiometer.

*Zero Base* in (6) is retained for the special case where it is desirable that the first jump-off or voltage change is phased for zero degrees. Also in (6) the figure per cent at \_\_\_ deg defines the angle at which the designer prefers the manufacturer to specify the output voltage in order that the designer may phase the potentiometer identically with the manufacturer's test. This figure should be given with all end adjustments on the output removed. Of course, if *Zero Base* is used, this is unnecessary.

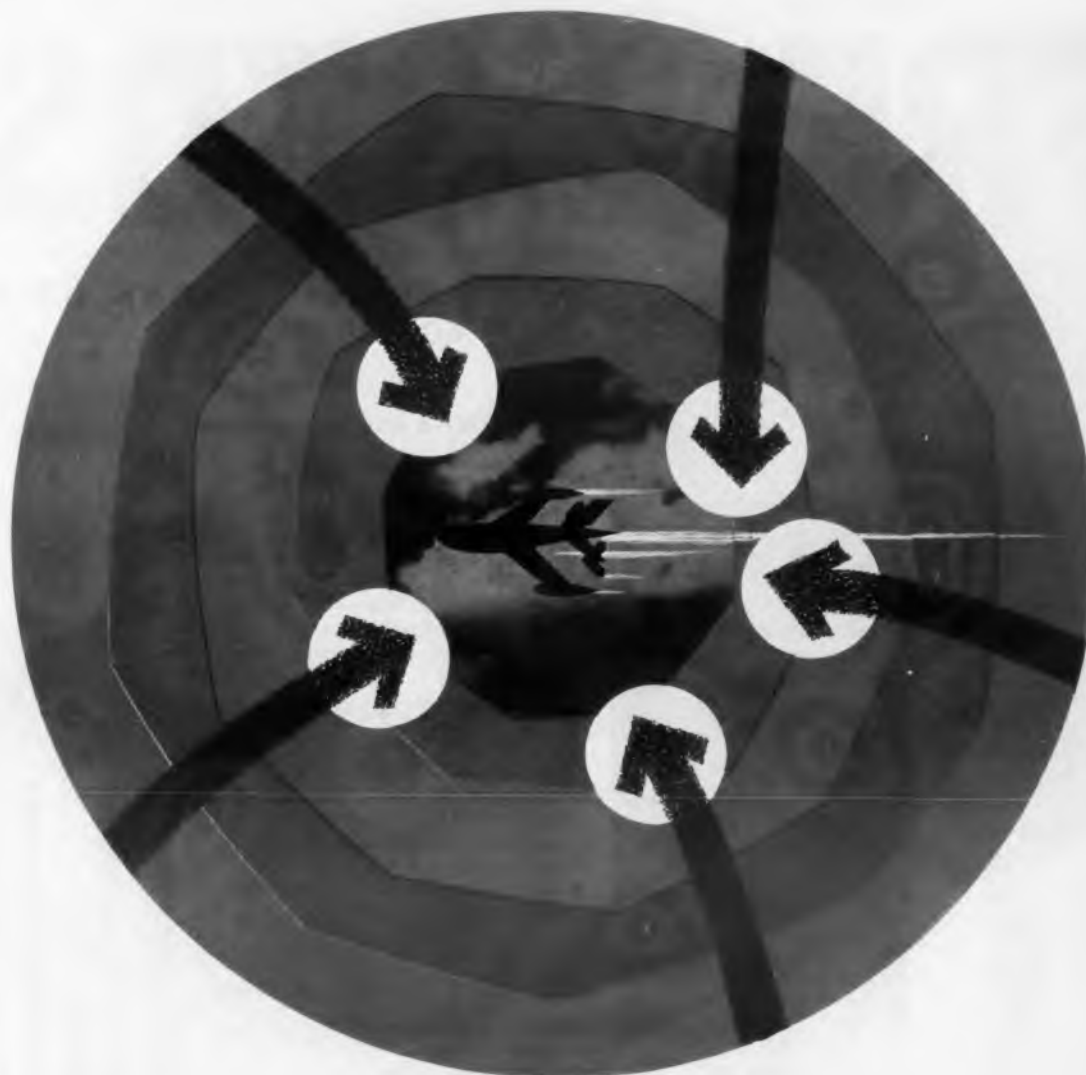
*Conformity* is the term used here for all accuracy designations whether the function be linear or nonlinear.

As an example of how this table is used, consider a square-law potentiometer that is to be turned against a dial. The dial is calibrated to 330 deg. The circuit designer wants the potentiometer to be grounded in its zero position but he can adjust the high voltage end slightly. The conformity of the output is to be within 0.5 per cent. The designer's table could then read:

(1) Function	Square Law
(2) Reference Angle	330 deg
(3) Reference Angle Tolerance	$\pm 0$ deg
(4) Low-Voltage End	<input type="checkbox"/> Independent <input checked="" type="checkbox"/> Terminal
(5) High-Voltage End	<input checked="" type="checkbox"/> Independent <input type="checkbox"/> Terminal
(6) Index	<input type="checkbox"/> Zero Base <input checked="" type="checkbox"/> % at 297 deg*
(7) Conformity	$\pm 0.5\%$

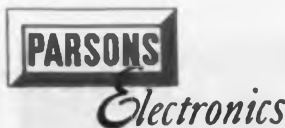
Since the dial is already calibrated, no tolerance is allowed on the reference angle. On the other hand, if the dial is to be calibrated to the potentiometer output a toler-

\*Manufacturer would indicate output per cent of input voltage at the specified rotation angle for the specific potentiometer.



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#### 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

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Frequencies: 200 to 3000 cycles

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For use with tubes or transistors.

ance of a few degrees should be allowed on the total angle.

### Two Main Differences Distinguish Specifications

There are two main differences between these proposed definitions and the existing ones. The first is the separation of the independent and dependent variable. Presently used "independent linearity" envelops both variables since the output (dependent variable) is defined as being adjustable and the angle (independent variable) also is defined as having a finite tolerance. In fact, all the accepted definitions define simultaneously the independent and dependent variables.

A void exists any time a requirement calls for the independent-variable characteristics of one definition and the dependent-variable characteristics of another. The table shown separates the two variables. The independent variable is defined distinct from any requirement on the dependent variable. Once the angle is specified, the output can be defined properly.

The other main difference is in specifying the possible adjustment of one end of the potentiometer output and not the other. Under the present specifications, both ends must be defined as adjustable or not adjustable. Thus, if the system (as in the example) allows freedom of adjustment on the high-voltage end of the potentiometer but not on the low-voltage end, the only possibility with conventional terminology is to go to a terminal linearity (which now is identical with terminal conformity) and sacrifice the adjustment on the high-voltage end. The result will be an increase in price for the same conformity.

The phasing or indexing of the potentiometer should in no way be interpreted as a variable, either independent or dependent. Rather, it is supplementary. It is an added requirement in the case of "zero base" and it only restricts any increase in conformity that could be obtained by phasing the potentiometer to its most desirable conformity condition for this case.

### Circuit Designer's Needs Should Dictate Specification

Technically, the proper attack on this problem is to consider exactly what is being



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specified by the designer. When he specifies a total function angle and the corresponding output, he is defining the ideal potentiometer (or master) for his application. If the system can tolerate an angular deviation—if he sees that 329 deg as well as 330 deg total angle can be tolerated, he is in effect saying his master or ideal potentiometer can have a total angle of 329 deg and the manufacturer is, therefore, allowed this range for his reference angle.

Theoretically, there is no connection between this angle and the actual total electrical angle as the potentiometer is manufactured. If the manufacturer can meet the conformity requirements with a winding angle of 325 deg, the specifications are met. Indeed, something of this nature is usually done when a potentiometer with a function that includes a zero derivative is being manufactured.

Applying the same attack to the output, the designer, by saying one or both ends are adjustable, specifies that the ideal 100 per cent output voltage can vary from the total potentiometer voltage. The current independent-linearity definition is often described as "the best straight-line fit." This "best straight-line fit" is again a master potentiometer defined as having an input (or total angle) that may vary within a few degrees and an output whose total range also may vary slightly. It is up to the manufacturer to select the best master within these ranges. The proposed table further permits this output to be varied on only one end while the other end is predetermined.

The table can be further improved by removing all terms that need defining. It would then look like this.

- |                                 |                                                                                                     |
|---------------------------------|-----------------------------------------------------------------------------------------------------|
| (1) Function                    | _____                                                                                               |
| (2) Total Function Rotation     | _____ deg                                                                                           |
| (3) Function Rotation Tolerance | ± _____ deg                                                                                         |
| (4) Low-Voltage End             | <input type="checkbox"/> Adjustable<br><input type="checkbox"/> Nonadjustable                       |
| (5) High-Voltage End            | <input type="checkbox"/> Adjustable<br><input type="checkbox"/> Nonadjustable                       |
| (6) Index                       | <input type="checkbox"/> Zero deg jump-off                                                          |
| (7) Conformity                  | <input type="checkbox"/> _____ % at _____ deg<br><input type="checkbox"/> ± _____ % of $E_{in}$ ■ ■ |



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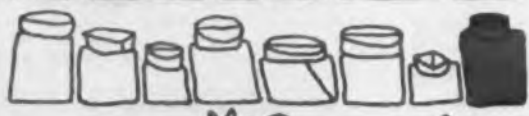
## How to Choose



## A Curing Agent



## For Epoxy



*In the first article of this series (May 10, issue), author Charles H. Harper described how the many curing agents used by epoxy packagers made for the vast varieties of epoxies available to the designer. In this article, he outlines the more important classifications among the curing agents and relates them to the properties they produce in the final hardened resin.*

**Charles A. Harper**  
Air Arm Div.,  
Westinghouse Electric Corp.  
Baltimore, Md.

**F**OUR TERMS are used to describe materials capable of reacting with epoxy resin polymers: *curing agent*, *converter*, *hardener* and *catalyst*.

The first three terms are actually interchangeable and describe materials which react with the resin to become part of the end product. But the last term, *catalyst*, is only correct when describing a material which causes epoxy resin polymer units to react with one another, with the catalyst not being part of the cured product. This is similar, then, to the curing of polyester resins. (Polyesters were compared with epoxies in the first article of this series in the May 10 issue). Some examples of catalysts for epoxy resins are given in Table 1. The amines included in this table represent a common type of epoxy curing agent. They can usually be identified by their pungent, fishy odor.

### Curing Agent-Terminology Helps Reduce Confusion

Sub-terms often used to describe curing agent types are *aliphatic* and *aromatic*. Other sub-terms are *primary*, *secondary*, or *tertiary*. The latter group of terms deals with the number and locations of the nitrogen or amine ( $-NH_2$ ) groups on the molecule in the case of amines (in other chemicals these terms may refer to different groups). The term *aromatic* identifies any organic chemical built up of a basic chemical building block employing the benzene ring structure ( $C_6H_6$ ) often structurally shown as:



*Aliphatic* describes any organic chemical not using the benzene ring in the basic skeleton of the molecule. Generally speaking, aromatic amines are more difficult to process than aliphatic amines, since most aromatic amines are solid, while aliphatic amines are generally liquid. Aromatic amines give considerably better thermal aging properties, though.

### Acid Anhydrides: Good for High Temperatures

A second class of curing agents often used with epoxy resins is the class known as acid anhydrides. The main advantage of acid anhydride curing agents over amine curing

**Table 1. Curing Agents for Epoxy Resins**

**A — Catalytic Curing Agents for Epoxy Resins**

Curing Agent	phr*	Gel Time **	Curing Schedule	Comments
Epi-Cure 83	15	24 hr	16 hr/165 F	Slow cure, low exotherm. Recommended for large castings.
Epi-Cure 86	10	6 hr	1 hr/212 F	Good mechanical and electrical properties. Recommended for electrical potting.
Piperidine	6	8 hr	3 hr/212 F	Used for casting and potting applications.
Benzyl Dimethylamine	5-10	4-8 hr	2-4 hr/200 F	Used at 0.1-1.0 per cent as an accelerator for anhydride curing agents.
Diethylamino-propylamine	6-10	3-5 hr	Several days at room temperature.	Has been used in room temperature cure adhesives.
Dimethylamino/methylphenol (DMP-10)	—	—	—	Used at 0.1-1.0 per cent as an accelerator or at 10 phr with LP-3 polysulfide.
2, 4, 6 - Tri (dimethylamino-ethyl) phenol (DMP-30)	6-10	1/2-1 hr	1 hr/200 F	Main use is same as DMP-10 except that it is more active.
BF <sub>3</sub> - Ethylamine complex	2-5	Months	1 hr/200 F 4 hr/300 F	Cured resins are quite brittle. Recommended for B-stage systems.

agents is the superior high temperature properties of the resulting acid anhydride-cured epoxy system.

Until recently, the acid anhydrides used were all solid materials. The more common solid acid anhydrides used are phthalic anhydride, hexahydrophthalic anhydride, pyromellitic dianhydride and chlorendic anhydride. They melt at 128 C, 35 C, 286 C and 239 C respectively, and give heat distortion temperatures ranging from 135 to 260 C. With the exception of hexahydrophthalic anhydride, certain practical difficulties in the use of these materials have been an unfortunate detriment to their wider usage. Not only are their melting points high but it is difficult to get the anhydrides into solution with the epoxies. Even when they are put in solution the pot lives are relatively short.

The liquid and low melting temperature acid anhydrides commonly used are dodecyl succinic anhydride, hexahydrophthalic anhydride, and Nadic methyl anhydride.



## B — Aliphatic Polyamine Curing Agents for use with Epoxy Resins

Curing Agent	phr*	Gel Time **	Curing Schedule	Comments
Diethylene triamine (DETA)	10	30 min	Overnight at room temperature. Several days for full cure.	Good general purpose room temperature curing agent, but fairly toxic.
Triethylene tetramine (TETA)	12	30 min	Overnight at room temperature. Several days for full cure.	Usually preferred over DETA and TEPA.
Tetraethylene pentamine (TEPA)	13.8	30 min	Overnight at room temperature. Several days for full cure.	Recommended in protective coating applications.
Iminobispropylamine	13	30 min	Overnight at room temperature. Several days for full cure.	About the same as (TETA) but higher cost.
Xylylene diamine	18	20 min	Room temperature. Several days for full cure.	Exceptionally good color. Forms carbonates with CO <sub>2</sub> of atmosphere.
Methane diamine	22	8 hr	1 hr/200 F 3 hr/350 F	Good color. Similar to aromatic amines in curing schedule and properties.
Armine AL-1	22	15-20 min	1 hr/212 F	Very exothermic but requires heat cure for maximum properties.
Aminoethyl piperazine (AEP)	22	20 min	1 hr/212 F	Short pot life, high exotherm. Requires heat cure. Cured resin has excellent impact strength and heat distortion temperature of 105-110 C.

## C — Aromatic Polyamine Curing Agents for Epoxy Resins

Epi-Cure 841	22.5	8-10 hr	1 hr/200 F 2 hr/400 F	Liquid mixture.
M-phenylene diamine (MPDA)	14	6-8 hr	1 hr/200 F 2 hr/400 F	Solid melting at 62 C.
Methylene-dianiline (MDA)	26	30 min	1 hr/200 F 2 hr/400 F	Solid melting at 90 C.
Tonox-PL	28	8-10 hr	1 hr/200 F 2 hr/400 F	Waxy solid melting at 80 F. Can be cooled before addition to resin without solidifying.
Diaminodiphenyl sulfone (DDS)	32	1 hr at 250 F	1 hr/300 F 3 hr/425 F	Solid melting at 175 C. Forms B-stage resins with excellent stability. Cure may be accelerated with 1 phr of BF <sub>3</sub> ethylamine complex.

\* Parts by weight per 100 parts of Epi-Res 510-(Jones-Dabney) or equivalent.

\*\* For a 1-lb batch at an ambient temperature of 77 F.

(For larger batch size the gel time may be considerably less.)





### Selection Guide for Choosing Epoxy-Curing Agent Systems

Want	Use	Comments
Room temp. cure	1. Aliphatic polyamine	Generally have short pot life.
Moderate high operating temp. (125 C)	1. Aromatic polyamine 2. Acid anhydride	Liquid and low temperature melting acid anhydrides offer handling convenience over solid curing agents and retain properties up to 180 C. They can be cured at moderate temperatures.
High temperature	1. Cycloaliphatic diepoxides 2. Epoxy novolacs 3. Epoxidized polyolefins (As well as bisphenol epoxies.)	Cycloaliphatic diepoxides resist ultraviolet light. Epoxy novolacs offer improved chemical resistance and adhesion. Epoxidized polyolefins allow low-temperature curing with acid anhydride agents.
Long pot life	1. BF <sub>3</sub>	Good from several days to "weeks."
Lowest cost	1. Phthalic anhydride	
Crack and shock resistance, flexibility	---	Use flexible resin system and special fillers (to be discussed in final article of series.)

Also, what has been termed a liquid eutectic anhydride mixture is available as a mixture of hexahydrophthalic anhydride and chloroendic anhydride.

Table 2 shows heat resistant properties of the various commonly used curing agents. The heat distortion temperature referred to in the table is the temperature at which a flat sample under a standard load will deflect a given amount. For rigid resins, high heat distortion compounds are usually better in over-all thermal aging properties. Semi-rigid and flexible resins naturally have lower heat distortion temperatures since they deflect faster under load. Other thermal properties of semi-rigid and flexible resins are governed primarily by the curing agent and the modifiers used.

#### Still Other Epoxy Resins For Exotic Uses

In addition to the bisphenol type epoxies which have been discussed thus far, there are several other epoxy molecular modifications

which are used. Three of these will be briefly discussed to round out the total epoxy picture: Cycloaliphatic diepoxides, epoxy novolacs and epoxidized polyolefins.

Cycloaliphatic diepoxide resins represent a class of epoxy materials which do not contain the phenolic rings associated with most of the commercially available epoxy resins. Therefore, these diepoxides are virtually unaffected by ultraviolet light and in addition have excellent resistance to thermal degradation and air oxidization. Some heat distortion point comparisons are shown in Table 3. These materials have been developed by the Union Carbide Chemicals Co. and are identified as Epoxide 201, Epoxide 207 (dicyclopentadiene dioxide) and vinyl cyclohexene dioxide. For comparison with a conventional bisphenol epoxy resin the structural formulas of these diepoxides are shown in Fig. 1. The shorter distance between reactive groups means compounds made from these diepoxides are more highly cross-lined. Thus, higher heat distortion temperatures

Table 2. Heat Distortion Temperatures of a Standard Epoxy Resin with Various Curing Agents

Curing Agent Type	Curing Agent	Approx. Heat Distortion Temperature C
Aliphatic Amines	Ethylene diamine	90
	Diethylene triamine	120
	Triethylene tetramine	125
	Piperidine	100
	DMP-30	115
	Shell D	95
Aromatic Amines	M-Phenylene diamine (Shell Catalyst CL)	155
	p,p-Methylene diamine	155
	p,p-Diaminodiphenyl sulfone	175
Acid Anhydrides	Phthalic anhydride	150
	Nadic Methyl anhydride (NMA)	185
	Chlorendic anhydride (HET)	190
	Pyromellitic dianhydride	260

Table 3. Comparison of Heat Distortion for Bisphenol and Cycloaliphatic Diepoxides

Resin	Hardener	Heat Distortion Temperature C
Epoxide 201	Phthalic Anhydride	220
Epoxide 201	Chlorendic Anhydride	250
Dicyclopentadiene Dioxide	Maleic Anhydride/Polyol	300
Vinylcyclohexene Dioxide	Chlorendic Anhydride	250
Epon 828	Diethylene Triamine	100
Epon 828	Methylene Dianiline	170
Epon 828	Chlorendic Anhydride	195
Epon 828	Phthalic Anhydride	130
Epon 828	Pyromellitic Dianhydride	280

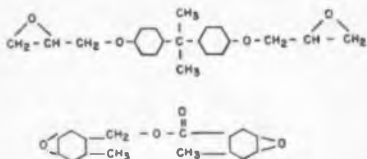
can be obtained with many of the same hardeners used for bisphenol epoxies.

#### Epoxy Novolacs For Highest Temperature Applications

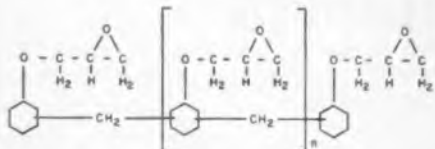
An epoxy resin system known for its superior temperature resistance is epoxy novolac. Epoxy novolac resins contain more of the benzene ring or phenolic resin type structure in the molecule; thus they combine the excellent thermal stability of the phenolic structures with the reactivity of the bisphenol epoxies, see Fig. 2.

Hardeners or curing agents used with conventional bisphenol-A epoxy resins can also be used with epoxy novolacs, since the curing reaction is through the epoxy groups of the molecule. Postcuring is usually necessary to develop the maximum properties of the epoxy novolac resins.

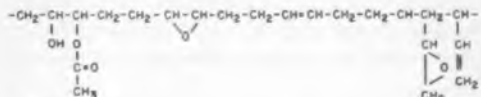
Another group of epoxy resins are the epoxidized polyolefins. These polyfunctional epoxies contain epoxy groups, hydroxyl groups (-OH) and double bonds [vinyl type *functionality*, (C =)]. It will be



**Fig. 1.** The shorter distance between reactive groups in the cycloaliphatic diepoxides (bottom) compared to common bisphenol-A epoxies (top) allows the diepoxides to be more highly cross-linked.



**Fig. 2.** The greater number of benzene rings or phenolic type structure found in epoxy novolacs accounts for their thermal stability.



**Fig. 3.** Epoxidized polyolefins have some of the double bonds found in polyesters.

remembered from the discussion of polyesters that this double bond arrangement is typical in a polyester resin. Thus, as with polyester resins, epoxidized polyolefins are capable of reacting with the peroxide catalysts which are conventionally used with polyester resins. Also, since epoxidized polyolefins contain the reaction points common to epoxy resins, these resins can be reacted with amine and acid-curing agents.

The simplified structure of an epoxidized polyolefin is compared to the structural formula for a bisphenol-epichlorohydrin, Fig. 3.

The epoxidized polyolefins are liquids of various viscosities at room temperature. The uncured resin is about 20 per cent lighter than conventional epoxy resins. Electrical properties are comparable to those of conventional epoxies while exotherm curves are flatter. Epoxidized polyolefins offer excellent high-temperature performance.

In this and the previous article in this series on epoxies, we have covered the main degrees of freedom possible for the designer merely by the choice of the particular resin and particular catalyst to be used in the resin-catalyst system. In the final article, the one remaining degree of freedom, the modifier, will be discussed. ■ ■



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# How To Select Miniature Lamps For Electronic Equipment

L. W. Curtis  
Manager of Engineering  
Lamp Div.  
Tung-Sol Electric, Inc.  
Newark, N. J.

*Selecting a miniature lamp for use in mass-production electronic equipment isn't always a matter of picking up a catalog and ordering the first type that will work. Author Curtis, who has worked with miniature lamps for 25 years, tells what the engineer should worry about.*

**S**ELECTING miniature lamps for use in electronic equipment requires more thought than is usually realized. This is especially true when the lamp is to go into mass produced gear where it must function reliably for long periods of time.

To select the best lamp type for his equipment, the engineer should consider not only its electrical performance and the circuit in

which it will be used, but also the testing procedures it will undergo on the assembly line. The lamp's physical strength can be just as important as its inherent noise characteristics.

The need for ruggedness was demonstrated by an auto radio manufacturer who checked his sets for loose connections by tapping them with a rubber mallet. As a result of this test-

Table 1. Low-Voltage Miniature Lamp Types

Type	Design Voltage	Design Current	Rated Avg. Lab. Life —Hr at Design Volts	Inherent Strength	Inherent "Noise"
43	2.5 v	0.50 amp	3,000 hr	High	Low
45	3.2	0.35	3,000	High	Low
47	6.3	0.150	3,000	High	Low
44	6.3	0.250	3,000	High	Low
1847	6.3	0.150	Indef. Long	High	Low
1866	6.3	0.250	Indef. Long	High	Low

Table 3. Common 28.0-v Miniature Lamp Types

Type	Design Voltage	Design Current	Rated Avg. Lab. Life —Hr at Design Volts	Inherent Strength	Inherent "Noise"
313	28.0 v	0.170 amp	500 hr	Low	High
327	28.0	0.040	1,000	Low	High
336	28.0	0.040	1,000	Low	High

Table 2. Common 12.0-v Miniature Lamp Types

Type	Design Voltage	Design Current	Rated Avg. Lab. Life —Hr at Design Volts	Inherent Strength	Inherent "Noise"
1815	14.0 v	0.20 amp	3,000 hr	Low	Medium
1816	13.0	0.33	1,000	Medium	Medium
1891	14.0	0.24	500	Medium	High
1892	14.4	0.10	1,000	Low	High
57X	14.0	0.24	500	Medium	High
1895	14.0	0.27	1,500	High	High
1893	14.0	0.33	Indef. Long	High	High
1898	14.0	0.24	500	High	Low

Table 4. "Baseless" and Wedge Lamp Types

Type	Design Voltage	Design Current	Rated Avg. Lab. Life —Hr at Design Volts	Configuration
10	2.5 v	0.50 amp	3,000 hr	2-pin
12	6.3	0.15	Indef. Long	2-pin
15	7.0	0.40	500	2-pin
19	14.4	0.10	1,000	2-pin
20	14.0	0.23	500	2-pin
29	10.0	0.10	3,000	2-pin
158	14.0	0.24	500	Wedge
159	6.3	0.15	Indef. Long	Wedge

ing method, many of his lamps failed. Substitution of an inherently stronger lamp with the same outer physical dimensions eliminated the problem.

Then there were the manufacturers of 12-v auto radios who found intolerable speaker noises when the production line sets were tested. The pilot lamps were found to be the culprits. They became noise sources because the relatively long 12-v filaments were supported by twin anchors, looped around the coiled, incandescent section. Under impact, the filament moved around the inside of the anchor loops. This caused the resistances to vary slightly which, in combination with the particular circuitry in the radios, resulted in the high level of noise.

#### To Select A Lamp Type Questions Should Be Asked

Some of the questions the engineer should consider when choosing a lamp type are:

1. Will the lamp undergo tumbling or excessive shock during the equipment's manufacture?
2. Will the impact or vibration tests to which the equipment is exposed occur while the filament is lighted or not?
3. Will the lamp be subjected to intermittent or prolonged cycling during its expected life?
4. Will there be any momentary overload?
5. Will there be any ambient temperature extremes?
6. Will the lamp be subjected to sudden temperature changes?
7. Will the lamp be exposed to shock or vibration while the equipment is in normal use?
8. Will the lamp be difficult to replace; if so, should indefinitely long life be specified or should there be some provision in the equipment for easy replacement?
9. Will there be a possibility that "noise" can be generated in the circuit as a result of varying resistance within the lamp?

There are numerous types of panel bulbs to choose from. However, the catalog information is usually limited to listing the design voltage and current, the life, the candlepower and the physical size and configuration of the bulb and its base.

#### Several Facts Help Answer the Questions

Here are a few general facts that should guide the selection of a lamp type:

1. Panel bulbs designed for 2.5 v, 3.2 v

\* ACTUAL SIZE



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CIRCLE 53 ON READER-SERVICE CARD

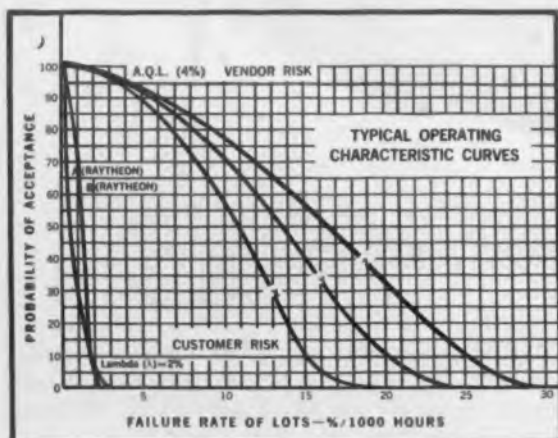
# How Raytheon can offer you 10 times better Semiconductor Reliability Assurance



By: R. E. PRATT  
Reliability Engineering Manager  
Semiconductor Division  
Raytheon Company

Most of the commonly used quality control procedures for semiconductors follow MIL Std. 105 and normally result in a wide spread of customer risk, directly dependent on the quantities purchased. (See curves X, Y, and Z below for risk points.) Now, Raytheon offers reliability protection (under MIL-S-19500B, Method B — defining the Lambda [ $\lambda$ ] concept), which specifically limits customer risk. This means that for the first time, you, the customer, can specify reliability assurance at a fixed confidence level, to a fixed low value, in terms of a lambda number.

To explain further, reliability assurance is generated by the manufacturer's life test procedures. These life test procedures, or plans, are best described by operating characteristic curves (see below), which describe the ability of each particular plan to discriminate between good and unacceptable product.



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or 6.3 v are inherently stronger than those designed for 12.0 v or 28.0 v because the filaments are shorter and heavier.

- If noise is a problem, the 2.5-v, 3.2-v or 6.3-v panel bulbs are less likely to exaggerate the condition than the 12.0-v or 28.0-v types. This is because the filaments in the lower voltage lamps require no supports along the incandescent section of the coil.
- Inherent-noise in a lamp is not necessarily troublesome unless the circuit in which it is used is very sensitive to minute changes of current.
- The lamps having an indefinite "long life" (greater than 5,000 hr) rating have a better chance to survive shock than those of the normal life rating, all other factors being the same.

## Tables List Common Lamp Types

Table 1 lists the low-voltage lamps that have proved themselves rugged and highly reliable in many of the older circuits. Their use has been curtailed however by the trend toward 12.0 v automotive circuits and 28.0 v aviation circuits.

The group of 12.0 v panel lamps shows considerably wider performance levels from one lamp type to another. Table 2 lists the more common 12.0-v types. It should be pointed out that a lamp such as the 1898 does not use the twin anchor supports mentioned in connection with noisy auto radio performance. Instead the lamp uses two similar filaments in series, neither of which require supports.

In most cases it is advisable, if possible, to avoid the 28.0-v lamps. In these types the filaments are longer and of finer wire. This leads to a low inherent strength and a high inherent noise, although in certain circuits the noise may not be a problem.

## Who Takes The Risk?

Under most current procedures, the A.Q.L. (Acceptable Quality Level) and Lot Size determine the operating characteristic curves. Typical of such curves are X, Y, and Z. Note how the customer risk point shifts.

In contrast, curves A and B are typical of the new plan now in operation at Raytheon. Note that not only is the customer risk point fixed, but fixed at industry's lowest specified failure rate.

The first transistor types offered by Raytheon incorporating this new method are the Raytheon 2N404 and Raytheon 2N428 germanium PNP switching transistors. These products, now available in quantity, carry a reliability assurance of lambda ( $\lambda$ ) = 2%/1000 hours; equivalent to 0.02 failures/1000 hours.

## Here's The Difference

The essential difference is that a reliability specification, under the older system, carried implied customer risk failure rates varying from 15 to 25%/1000 hours, depending on lot size. The lambda ( $\lambda$ ) = 2%/1000 hours quality assurance (customer risk failure rate), now offered by Raytheon, averages a 10 fold reduction in failure rate. Stated positively, you can be 10 times more sure of getting good product. A truly important advance in product quality.

Ask your local Raytheon sales engineer about this program.

A new nomograph, relating lambda ( $\lambda$ ) to sample size and accept number, as well as process average requirement, is now available. For this, along with the paper "A.Q.L. — What Is It?", by J. M. Gilbey, write or call your local Raytheon Semiconductor Sales Office.

For extreme acceleration or impact it is sometimes possible to improve the performance by shock mounting the socket.

Table 3 lists some of the 28-v types that are available.

#### "Baseless" and Wedge Types Can Also Be Used

"Baseless" lamps will survive higher ambient temperatures than the conventional lamps because there is no cement used in the construction that can soften or fume. The two-pin miniatures and the wedge types fall in the "baseless" category. They are also designed to withstand rapid changes in temperature.

Some of the two-pin miniatures have found applications in electronic organs where stability is especially important. They should also find many useful applications in printed circuits. In places where loading is particularly difficult, the "baseless" lamps lend themselves nicely to "rear" loading.

Some automotive panels use rear loading lamps. The lamp is inserted in a socket that adapts to a printed circuit panel. In position, the lamp is on the opposite side of the panel from where it was inserted.

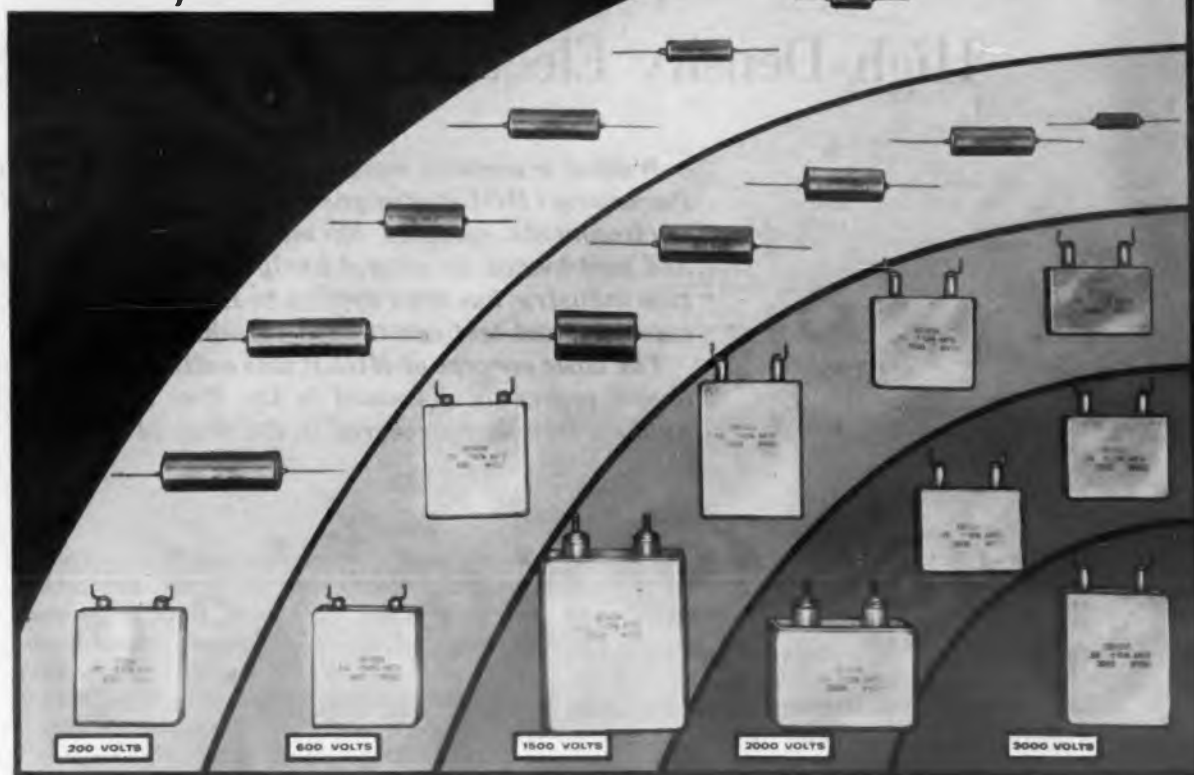
A list of "2-pin baseless" and wedge lamps is given in Table 4.

The up-to-date lamp manufacturer has the facilities for evaluating his products for known conditions of use. In many instances, however, he is not familiar with the environment the lamp is expected to survive. Communication between the electronic engineer and the lamp engineer can be extremely important.

The following points should be considered when a lamp must be selected:

1. In general, where the circuit permits, use 2.5- to 6.3-v lamps for maximum ruggedness.
2. The choice of the lamp type should always be based on the environmental conditions to be survived before active service as well as after.
3. Some lamp types are inherently noisy while others are relatively quiet. The importance of the noise depends on the electronic circuitry. If the lamp and its switch are directly connected across the power source, noise is seldom generated. The fact that this is not always practical makes noise a definite consideration.
4. It is wise to contact the lamp manufacturer when a special condition requires a special characteristic. ■ ■

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## High-Density Electronic Packaging — Structural Design

*Welded assemblies constructed from High-Density Electronic Packaging (HDEP) designs must endure the rugged mechanical environments specified by military requirements. Reinforced and post-loaded structural analysis, derived from the construction industry, has been applied to HDEP; the mathematical calculations and test results are presented.*

*The basic concept of HDEP was outlined in the April 12 issue, layout procedure discussed in the May 10 issue and resistance welding techniques covered in the May 24 issue.*

**Courtland B. Converse, Paul N. James**  
The Sippican Corp.  
Marion, Mass.

**T**HE INHERENT compressive strength of encapsulated components can be used to achieve a reliable structural assembly for a High-Density Electronic Package. Reinforced and postloaded structural design analysis, applied to HDEP assemblies, has resulted in rugged units which have passed the stringent military requirements for shock, vibration and temperature cycling.

Although a single encapsulated module may be capable of withstanding compressive forces in the order of tons, a unified structure is required to brace groups of modules as well as cooling devices, connectors and cabling. Internal loads must be kept to a minimum and, under vibration stresses, amplifications must be low.

### Postloading As Applied To Electronic Assemblies

*Circuit Module Compression Techniques:* One of the problems concerning present day specifications is that the required frequency range in vibration is so wide (from 5 to as high as 3,000 cps) that it is almost impossible to avoid resonances in structural members. If a highly loaded member operates continuously in a resonant range, this member usually must be quite heavy in order to keep the alternating stress levels below the endurance limits of the material being used.

Although a potting compound serves as an adequate means of uniformly supporting each electronic component, the encapsulated circuit module presents some complex problems because of the widely divergent properties of its composite materials. The qualitative properties of potting compounds are:

1. High compressive strength.
2. High coefficient of thermal expansion.
3. Low Young's modulus (which is the modulus of elasticity).
4. Low tensile strength.
5. Relatively high damping factor under vibratory conditions.

Experience indicates that the most serious problems exist in environments exhibiting large changes in temperature. When many modules are postloaded by a bolt having a low coefficient of thermal expansion, an increase in temperature will cause the bolt tension to increase because of the expansion of the modules.

Low coefficient of thermal expansion is an attribute of all materials having high tensile strengths, the property necessary to minimize the bolt diameter, which in turn influences the arrangement of circuitry within the module. The bolt must be capable of exerting enough compression on the module stack at the lowest environmental temperature to maintain the structural integrity of the module stack as a beam under vibratory load conditions, but not exceed elastic limit at the highest environmental temperature.

To keep the change in tension on the bolt to a minimum throughout the temperature range, components such as Bellville washers and springs can be used. In most cases, however, a wide range of bolt tensions can be accepted, because it can be shown that a high bending load has to be put on the module stack in order to separate the modules on the tension side of the beam. The exception to this is when heavy modules, resulting from the use of a high specific gravity potting compound, are operating at a high acceleration level.

*Postload Methods:* High-Density Electronic Packages lend themselves particularly well to the reinforced and postloaded structural technique. Because most of the epoxy potting compounds in use today exhibit high compressive strength, electronic subassemblies such as circuit modules can be postloaded in "stacks" to produce a homogeneous structural beam (Fig. 1). The module stacks, held in compression by a tensioning bolt and appropriate hardware, are clamped against structural webs. These webs, usually fabricated of aluminum or magnesium, are inserted at calculated locations in the module stacks and serve to transmit the loads from the electronics to a point where the total loads may be carried by a vehicle. These parts are shown by Fig. 2. A case or frame assembly usually surrounds an array of circuit module stacks and serves to support the wiring module.

**Table 1. Definition of Abbreviations**

A	Area
B	Subscript, Bolt
C	Subscript, Circuit Module
E	Young's modulus of elasticity, psi
$F_b$	Bending stress
f	Frequency, cps
$f_n$	Natural frequency
g	Gravity, $1g = 32.2 \text{ ft/sec/sec}$ or $386 \text{ in/sec}^2$
I	Moment of inertia, in. <sup>4</sup>
L	Length
$\Delta L$	Axial strain
$\Delta t$	Temperature change
M	Bending moment
P	Applied load, allowable load, post-load force
Q	Amplification factor (dimensionless)
w	Weight/unit length
W	Total weight
y	Deflection due to bending of beam
c	Distance from neutral axis to outer fiber
$\alpha$	Coefficient of thermal expansion

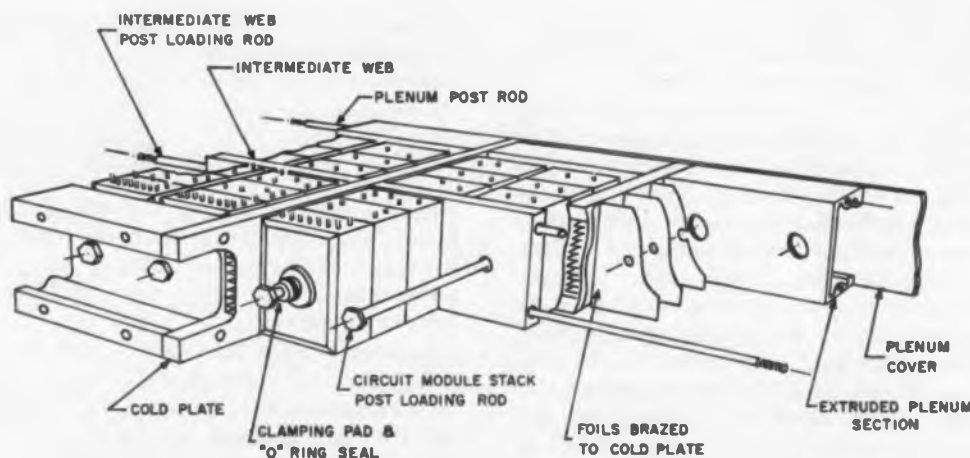
Another means of placing a circuit module assembly in compression, also based on the postload concept, is shown by Fig. 3. In this method, the individual circuit modules are cemented to cold plates by a thin layer of epoxy (0.0005 to 0.001 in. thick). In some designs, a module will be cemented to each side of a cold plate. The units thus formed are strung together by tension bolts through the cold plates. Intermediate webs may be used where compression of a large assembly of circuit modules is required.

Tensioning bolts are also used to tie the assembly together in the side-to-side dimension, these bolts being located through the longitudinal axis of the end-frames and intermediate webs.

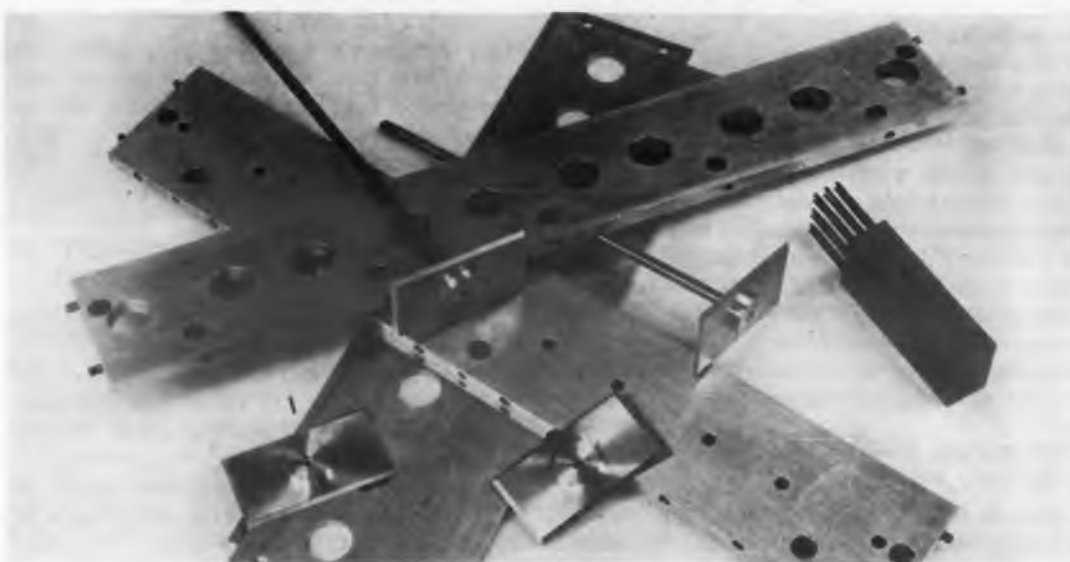
This method results in an assembly of circuit modules and cold plates which is held in compression in two dimensions.

**Wiring Module Structural Requirements:** The many layers of film and ribbon in a wiring module tend to produce a good reinforced structure. Tests show that the many wire-wrap connections between the circuit modules and wiring module (from 12 to 24 per circuit module) cause the circuit module stacks to become structurally part of the wiring module. In other words, the deflection curve of the wiring module will look just like that of the circuit module beams.

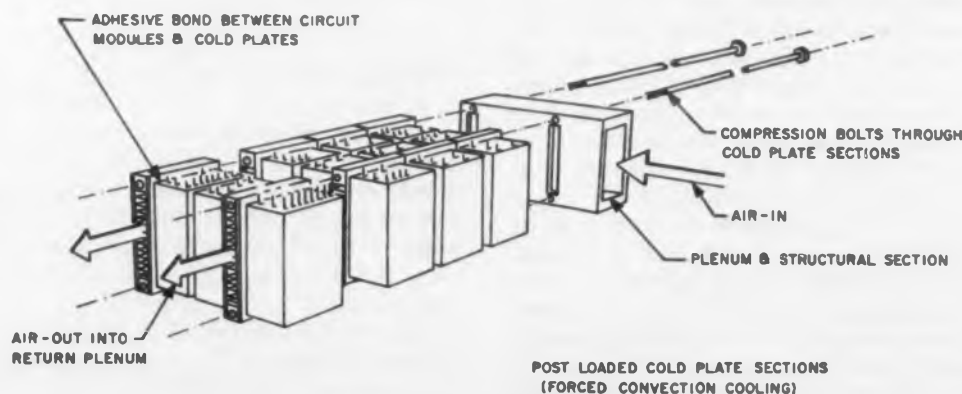
In one way this is troublesome since structural loads are transmitted through the wire-wrap connections. On the other hand, there



**Fig. 1.** Circuit modules postloaded in stacks to form a homogeneous structural beam.



**Fig. 2.** Mechanical components used for structural beam assembly.



**Fig. 3.** Circuit modules are cemented to cold plates and compressed in two dimensions.



are usually so many connections per module that each connection is loaded well below the ultimate tensile strength of 5 lb each.

To evaluate this connection qualitatively, a small wiring module, wire-wrapped to four individual elements of 0.05 lb each, was run through an environment of 30 to 3,000 cps sinusoidal vibration at a level of 30 g. The mounting consisted of clamping the wiring module to a horizontal shake table. The elements were not bolted together, but were supported only by the wire-wrap terminals. It is noted that there was no instrumentation such as strain gages on the terminals, so that the stress levels encountered are unknown. The wiring module had a circuit in series with each one of the circuit module terminals, and continuity was not interrupted at any time. The same specimen was subjected to a 100-g half-sine shock of 9.5 msec duration.

The above evaluation does not mean that the wire-wrap connections are adequate without the postloading bolt through the middle of the circuit modules, because on larger wiring modules, sizable, if not ultimate, forces would be imparted to the wiring module especially in the bending modes. Also, in the plane tested, the alternating flexural stresses in the wire-wrap terminals would present a serious fatigue condition in the more severe environments. This type of mounting may be considered, when supported by test data, for smaller machines.

#### Mathematical Analysis of Structural Characteristics

*Circuit Module Beam Bending:* In dealing with any structural system, one of the most important parameters is Young's modulus, or modulus of elasticity. In the case of most epoxies, the modulus in compression is nonlinear in the range of stresses under normal bolt loads. Fig. 4 is a plot of compressive load vs strain for a common epoxy used in encapsulation. If it is assumed that the base is 1.38 in. and the height 1.65 in., this works out to a surface area in compression of 2.29 sq in. If the bolt down the middle is an aluminum number 10-32, the highest load, based on the bolt diameter, that can safely be put on it is about 800 lb. Since  $S = P/A$ , the compressive stress is  $800/2.29$  or 350 psi. Looking at the slope of the load-strain curve in the region of this load, it is apparent that a slight increase in bolt load could appreciably change the modulus of elasticity. Factors of safety must be applied to accommodate this increase.

Unfortunately, any formula for natural frequency of a beam contains  $E$  (Young's modulus) to the following extent. The natural frequency is:

$$f_n = 2.45 \sqrt{\frac{gEI}{wL^4}} \quad (1)$$

where  $w$  is the weight per unit length of beam. The effect of a nonlinear modulus is to change the natural frequency in a varying temperature environment where the bolt postload is changing.

Inconsistencies have also been found in analyzing pre-stressed structures in vibratory environments. Information is available on the pre-stressed theory of construction, but most of the data unfortunately deal only with the well known and tested properties of concrete. In the time that Sippican has been dealing with this type of structural support, a full evaluation of the different potting compounds has been impossible. Difficulty has been encountered in obtaining correlation between theoretical analysis and experimental results. However, there is an empirical method that can be used to determine the natural frequencies in bending.

If the shape of the static deflection curve is known, it is possible to calculate the natural frequency from the Stodola formula:

$$f_n = \frac{1}{2\pi} \left( \frac{g \sum W y}{\sum W y^2} \right)^{1/2} \quad (2)$$

To simplify the simple static test that must be performed to obtain various values of  $y$ , beam can be loaded to about 20 times its weight and the deflections measured at different points. Since the deflection is a linear function of weight, the deflections are divided by 20 to obtain  $y$  under static loading.

To further simplify the above analysis, the maximum deflection can be measured and a second formula employed:

$$f_n = \frac{1}{2\pi} \sqrt{\frac{g}{y}} \quad (3)$$

This last method gives a more inaccurate result, but is adequate for preliminary design.

Also important is the fact that the deflection or natural frequency varies with the postload force on the circuit module stack. Therefore, the static deflections should be found for each condition of the bolt postload expected over the temperature environment spectrum.

*Effect of Wiring Module on Circuit Module Stack Bending:* There are two approaches that can be taken to find the effect of the wiring module on the circuit module stacks.

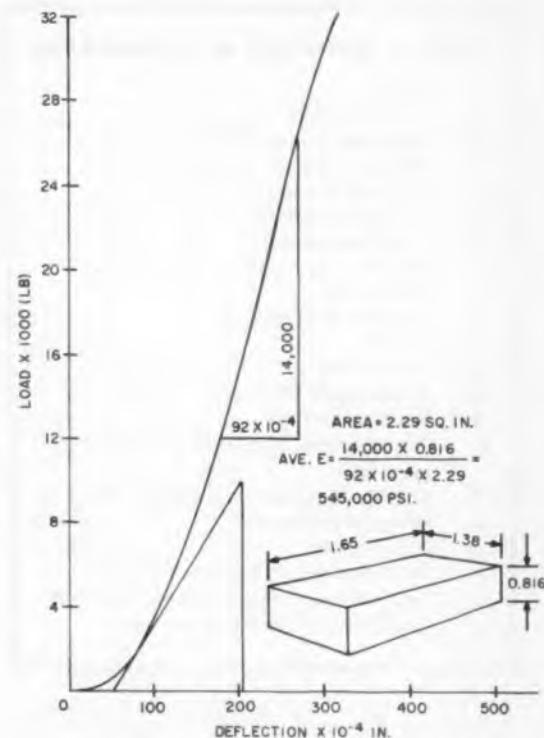


Fig. 4. Compressive load vs strain characteristics for a typical epoxy.

If preliminary static tests show that the natural frequency is greater than the frequency limit outlined in a given specification, it can be assumed that the presence of the wiring module will make the entire system stiffer or will have the effect of raising the natural frequency in the plane of wiring module bending. However, conventional designs have shown that this plane of bending is not the most critical, because the moment of inertia of the circuit module stack is greater than in the other bending plane.

In the plane parallel to the wiring module, the wire-wrap terminals behave as relatively flexible cantilevers. Because these terminals are long and slender, so as to pass through the wiring module, the only effect that they have shown in recent tests is damping. There does not seem to be enough of a structural connection to alter the natural frequency significantly.

*Amplification Factors:* In a complex post-loaded system, such as the one that has been discussed above, calculation of the magnification factor,  $Q$ , is nearly impossible. However, some general information was gathered during recent tests on two representative models.

The first model tested was a 12-circuit module stack mounted in a jig with supports. An "O" ring at the end support served the



Fig. 5. Typical vibration test setup, showing circuit module assembly, compression webs, structural frame parts, tensioning bolts, and cold plates (corrugated metal parts).

purpose of eliminating close tolerances between the boss of the pressure pad and the hole in the case. If the pressure pad was allowed to be loose in this hole, there would be a ringing at resonance, and a serious fatigue condition would exist. This model was vibrated in the two bending planes at two different postloads. The following summations can be made:

1. Increased postloads give higher natural frequencies and lower transmissibilities.

2. Low postloads give lower natural frequencies but higher transmissibilities. Knowledge of these factors permits the design of structures which have low amplification factors. The actual values of amplification depend on the stiffness of the case and wiring module connection, but values of  $Q$  from 3 to 7 are common.

The second model tested was an entire machine. This machine, which was designed with amplifications of 10 for the aluminum parts and 5 for the epoxy structure, was vibrated in all three planes from 5 to 3,000 cps up to levels of 30 g. In addition, a factor of safety of 1.5 was used in the design. The only instance of actual stresses higher than design loads was in bending of the end plate about its low moment of inertia axis. This was due to the long span with no support and the presence of a large number of holes.

Fig. 5 shows a typical vibration test setup.

**Bolt Postload:** In determining the proper postload to put on the bolt, two basic conditions, thermal stresses and bolt load increase due to bending, must be considered.

In calculating thermal stresses in the bolt, the general assumption can be made that, for equilibrium to exist, the compressive load in the circuit modules must be the same as the tension load in the bolt. Thus the load in the bolt can be equated with the load in the circuit module stack:

$$\alpha_B L \Delta t + \frac{P_B L}{A_B E_B} = \alpha_C L \Delta t - \frac{P_C L}{A_C E_C} \quad (4)$$

where the subscripts  $B$  and  $C$  are the bolt and circuit module, respectively. If the lengths are the same and the changes in temperature are equal, the above equation can be reduced to:

$$\Delta P = \frac{\Delta t (\alpha_C - \alpha_B) (A_B E_B) (A_C E_C)}{A_B E_B + A_C E_C} \quad (5)$$

The average value of  $\alpha$  for most epoxy potting compounds lies in the region of  $18 \times 10^{-6}$  in./in./F, while that of heat-treated stainless steel is  $5.5 \times 10^{-6}$  in./in./F. These values indicate the problems involved, e.g., for a large change in temperature, there will be a large change in bolt tension. Because the potting compound has such a high value of ultimate compressive strength, it is not a

problem at the higher temperatures. However, in order to maintain bolt tension at the lower temperatures, but not yield tension at the higher temperatures, a balance between the area of the bolt and the area of the circuit module must be achieved. This balance is achieved by use of Eq. 4.

This problem, coupled with that of electronic layout, structural strength, natural frequency and weight, implies a close working relationship between the electronic engineer, thermal engineer and the structural designer. That the problems are not insurmountable becomes apparent with the use of the calculation methods presented, and the advantages gained from the properties of the completed structure are substantial. If it turns out that the temperature extremes are too great, such schemes as Bellville washers or springs may be adopted.

The other factor affecting the size of the bolt concerns the reaction of the bolt to various modes and deflections in bending. Axial accelerations of the structure also influence the stress in the bolt.

The centerline of the bolt should go through the neutral axis of the circuit module stack. If an accurate value of the modulus of elasticity were known, the load required to cause separation of the modules could be calculated by letting the ultimate bending stress equal the postload stress along the face of the circuit modules. This bending stress can be calculated using the formula:

$$F_b = Mc/I \quad (6)$$

where  $c$  is the distance from the neutral axis to the outermost fibres on the surface of the tension side of the stack. This calculation is usually only significant at the low values of postload where module separation takes place at relatively low bending stresses. The weakest point will be the shear loads imposed on the bolt at the end of the module stack.

Axial loads down the circuit module stack, imposed by vibration or shock, can cause an increase in the bolt tension depending on the relative rigidity between the bolt and the potting compound. If the mass of the bolt is neglected, this change in postload will be

$$\Delta P = \frac{Q}{\frac{(AE)_B}{(AE)_C} + 1} \quad (7)$$

where  $Q$  is equal to the added axial load imposed by the circuit modules. This value could be equal to their weight times the  $g$  forces in a shock test. Tests on completed modules have substantiated design steps. ■ ■

\*McClure, James G., "The Prestressed Bolt." *Machine Design*, Sept. 15, 1960.

## Potentiometers: 2 Sides to Reliability

***Are manufacturers bending efforts to make potentiometers more reliable? They are indeed, report a cross-section of specialists in the field. The manufacturers made their views known in response to an editorial in the May 24, 1961, issue of ELECTRONIC DESIGN, calling for better potentiometers. Users were blamed in part by the makers for performance difficulties. One unfortunate inference drawn by some manufacturers from the editorial was that systems companies can produce a more reliable potentiometer. This the editorial did not wish to convey. Nor did it wish to suggest that potentiometers are notoriously unreliable. Following are letters from manufacturers on the subject:***

**Not all pots are alike . . .**

Your Editorial on p 31 of your May 24 issue calling for a gold-plate special potentiometer is certainly subject to dispute. As division manager of the Helipot Div. of Beckman Instruments, Inc., and also as president of the Precision Potentiometer Manufacturers Association I feel I cannot leave the remarks unchallenged.

Your Editorial tars all potentiometers with the same brush. This is highly unfair. Many manufacturers have been supplying highly reliable trimming potentiometers for years. The potentiometers used by the industrial and commercial instrument manufacturers have also been highly satisfactory over many years because these people have used the product most nearly as it should be used. Other types of pots have operated well into the millions of revolutions area.

None realizes more than the pot manufacturers themselves that the potentiometer, by its very construction, is a critical item under many conditions. What then makes pots un-

reliable? Acknowledging the nature of the product and its limitations, we believe the customer himself aggravates the problem. Some of these causes, as we see them, are:

- 1) Pot selection is too often relegated to a junior engineer. . .
- 2) Requirements demand poor pot design. As only one example, we find that resolutions and/or linearity requirements demand wires as small as 0.0005 in. in diameter. How long can you rub this wire with a brush before the wire breaks?
- 3) The demand that the pot compensate for most or all of the errors in the system. This requires accuracies that are at best marginal. When the pot will not hold these unrealistic accuracies beyond the first few thousand revolutions the system no longer performs to requirements so the pots fail.
- 4) Inadequate servo system design causes the pot to dither. This concentrates all the wear at a small point and early failure results.
- 5) Actual physical mistreatment of pots. For example, we see pots where the shaft was shortened by sawing half-way through the shaft and breaking off the rest of the way. Why be surprised when bearings fail or the pot doesn't perform because of a bent shaft?
- 6) Purchase on price alone without regard to value analysis. The constant pressure to reduce price and meet ever stronger specifications drives the manufacturer to short cuts or "tongue-in-cheek" acceptance of orders. I think we manufacturers know how to build pots of far better reliability but our customers will either not pay the price or they will not accept the performance level necessary.

Your Editorial intimates that the pot manufacturers are not doing anything to upgrade the reliability of our product. To this I strenuously object. Most of the manufac-

turers have spent, are spending, and will spend substantial amounts of money to upgrade our products and also to explore new areas. Perhaps we have not communicated well enough to the industry the efforts we are making. Speaking for my company, here is just a partial list of things we have done:

- 1) Tried every new material or lubricant that has shown any promise to try for greater reliability.
- 2) Worked with vendors to improve the quality of wire, housings, contacts, bearings, plating, etc.
- 3) Developed all sorts of no-rubbing contact pots such as photo-electric, variable impedance, magnetorestrictive, variable pressure, etc. Unfortunately the users will not accept the linearity, temperature coefficient or accuracy limitations these units possess so we are forced back to the conventional type potentiometer.
- 4) Have spent substantial sums of money in the development of cermet type potentiometers for ultra high reliability.  
D. C. McNeely, Division Manager  
Beckman Instruments, Inc.  
Helipot Div.  
Fullerton, Calif.

► *ED supports intensive research like this to improve performance.*

**Reliable pots are here . . .**

I am amazed that any reputable magazine would print an editorial such as that appearing in your May 24th issue, indicting an entire industry without taking the trouble to make any investigation whatever of the facts.

Reliable precision potentiometers can be made, and are being made every day by reputable potentiometer manufacturers, and we at Fairchild have the data to back up this statement as far as our own products are concerned. Fairchild alone has spent over half a million dollars in just the last five years in research and development on new

approaches to the problem of making potentiometers better and more reliable. In addition we have spent many hundreds of thousands of dollars on projects undertaken for specific customers, many of them at only a fraction of the total cost required to meet the almost impossible conditions requested by the customer, so that in effect far more was spent on improving performance and reliability than is indicated by the R&D figures alone. I am sure other major manufacturers of precision potentiometers have spent comparable amounts.

Briefly, the problem is that everyone *talks* reliability but almost everyone *buys* only price. Unfortunately, almost anyone with a lathe can get into the potentiometer business and there are probably a hundred or more, who have an engineer or technician and a few assemblers, who claim to make precision potentiometers—and their prices are much lower than manufacturers who maintain a large engineering staff and complete quality control department with facilities for all environmental tests and continuous surveillance of production units to assure the performance and reliability ordered by the customer. Then when these “bargain” units fail, your “engineer” and his “visitor” say “Potentiometers are no damn good.”

. . . Reliable precision potentiometers are available if the user is willing to pay for them, and if he will call in one of the major potentiometer manufacturers before all the rest of the design is frozen and the combination of requirements left over for the potentiometers becomes impossible.

H. E. Hale

Vice President & General Manager  
Fairchild Controls Corp.  
Hicksville, L. I., N. Y.

► Fairchild Controls Corp.'s efforts in achieving reliability are well known in the industry. Some of its precision potentiometers are described in the ad on p 45.

#### Use manufacturer's know-how . . .

Your Editorial in the May 24, 1961, issue of *ELECTRONIC DESIGN*, which makes reference to the need for a “Gold-Plate Special Pot,” serves to stimulate thought, relating to the ever increasing demand for high reliability components to satisfy the need of our infinitely expanding systems.

Perhaps we have been guilty of attempting to satisfy all needs at one time in one unit. Our direct experience . . . with the military and systems engineers . . . [indicates] that

## NO SACRIFICE REQUIRED



...If you choose the new

**SMITH-FLORENCE**

## Potentiometric Voltmeter

A number of differential voltmeters are available from sources other than Smith-Florence. Some have this feature, some have that. (*We have compared them all.*) But you won't have to sacrifice one feature for another if you choose the new Smith-Florence 851. In the medium voltage range, it has more useful features than any other voltmeter. Here they are:

- \* Solid State Reliability (and compactness)
- \* 0 to 10 vdc Precision Source in 10  $\mu$ V Steps
- \* Unique 5-Dial Inline Readout
- \* Wide Range (1 mv to 1 kv full scale)
- \* Working Zener Reference Backed up by Built-in Standard Cell (only with S-F instruments)
- \* Polarity Reversal (only with S-F instruments) you can read negative voltages with same accuracy as positive voltages
- \* Recorder Output (1 v gives f.s. deflection)
- \* Input Impedance Above 10 v, 10 Megohms (best available)
- \* Automatically Positioned Decimal Point
- \* Lightweight, rugged, portable weighs 15 lbs.

This is not to say that *only* Smith-Florence produces a good voltmeter—just the only one with all these features.

#### OTHER DATA

Absolute accuracy better than  $\pm .05\%$ . Most sensitive null range 1 mv (f.s.). Infinite input impedance from 0 to 10 vdc—10 megohms to 1 kv. (Only available in S-F 851.) Size (cabinet) 7 $\frac{1}{4}$ " x 11" x 10 $\frac{1}{2}$ ". Weight 15 lbs. Cabinet or rack price, \$550.00.

#### MORE DATA AVAILABLE

Please request Model 851 data sheet. Contact your Smith-Florence engineering representative or write us directly.

#### TRY IT YOURSELF

Your Smith-Florence engineering representative can give you a demonstration now. Call our nearest rep at your convenience, or drop us a line at the factory and we'll make the arrangements.



**SMITH-FLORENCE, INC.**

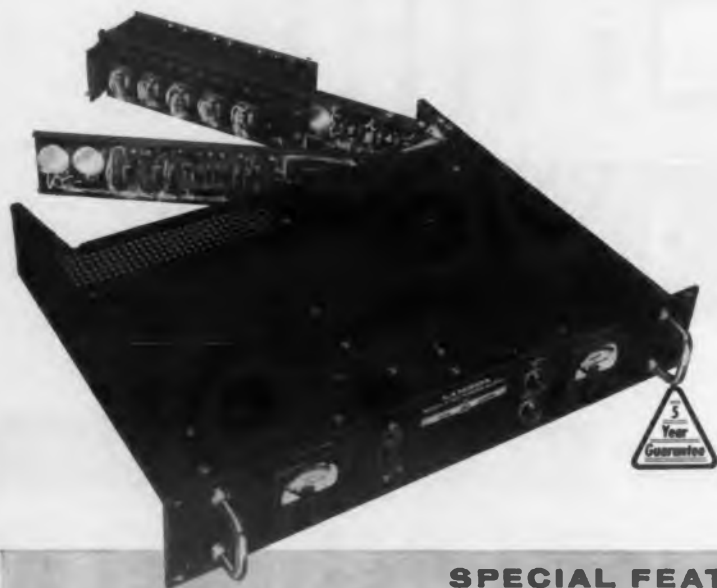
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CIRCLE 56 ON READER-SERVICE CARD

# LAMBDA

## Convection Cooled

### Transistorized Regulated Power Supplies



#### LA SERIES

0- 34 VDC	5 AMP
0- 34 VDC	10 AMP
0- 34 VDC	20 AMP
20- 105 VDC	2 AMP
20- 105 VDC	4 AMP
20- 105 VDC	8 AMP
75-330 VDC	0.8 AMP
75-330 VDC	1.5 AMP
75-330 VDC	3 AMP

#### SPECIAL FEATURES

- Convection Cooled—No internal blowers or filters—maintenance free
- Ambient 50°C
- No Voltage Spikes or overshoot on "turn on, turn off," or power failure
- Short Circuit Proof
- Remote programming over Vernier band
- Hermetically-sealed transformer designed to MIL-T-27A
- Easy Service Access
- Constant Current Operation—Consult Factory
- Guaranteed 5 years

#### CONDENSED DATA

##### DC OUTPUT (Regulated for line and load)

Model	Voltage Range (1)	Vernier Band (2)	Current Range (3)	Price (4)
LA 50-03A	0- 34 VDC	4 V	0- 5 AMP	\$ 395
LA100-03A	0- 34 VDC	4 V	0-10 AMP	510
LA200-03A	0- 34 VDC	4 V	0-20 AMP	795
LA 20-05B	20-105 VDC	10 V	0- 2 AMP	350
LA 40-05B	20-105 VDC	10 V	0- 4 AMP	495
LA 80-05B	20-105 VDC	10 V	0- 8 AMP	780
LA 8-08B	75-330 VDC	30 V	0- 0.8 AMP	395
LA 15-08B	75-330 VDC	30 V	0- 1.5 AMP	560
LA 30-08B	75-330 VDC	30 V	0- 3 AMP	860

Regulation (line) . . . . . Less than 0.05 per cent or 8 millivolts (whichever is greater). For input variations from 105-140<sup>(5)</sup> VAC.

Regulation (load) . . . . . Less than 0.10 per cent or 15 millivolts (whichever is greater). For load variations from 0 to full load.

Ripple and Noise . . . . . Less than 1 millivolt rms with either terminal grounded.

##### Temperature

Coefficient . . . . . Less than 0.025%/°C.

(1) The DC output voltage for each model is completely covered by four selector switches plus vernier range.

(2) Center of vernier band may be set at any of 16 points throughout voltage range.

(3) Current rating applies over entire voltage range.

(4) Prices are for un-metered models. For metered models add the suffix "M" and add \$30.00 to the price.

(5) Except for LA50-03A, LA100-03A, LA200-03A which have AC input voltage of 100-130 VAC. 105-140 VAC available upon request at moderate surcharge.

##### AC INPUT

105-140 VAC, 60<sup>(5)</sup> ± 0.3 cycle<sup>(6)</sup>

(6) This frequency band amply covers standard commercial power line tolerances in the United States and Canada. For operation over wider frequency band, consult factory.

##### Size

LA 50-03A, LA20-05B, LA 8-08B 3½" H x 19" W x 14½" D  
 LA100-03A, LA40-05B, LA15-08B 7" H x 19" W x 14½" D  
 LA200-03A, LA80-05B, LA30-08B 10½" H x 19" W x 16½" D

Send for new Lambda Catalog 61

emphasis on reliability contributes the most to reducing the highest attainable level of reliability while pushing costs beyond the point of diminishing return on the dollar invested. It seems . . . that a component must be engineered to the *n<sup>th</sup>* degree of the various states of the art to satisfy a non-directional compilation of the most stringent specifications rather than the demands of a specific application. Yet, if we examine procurement specifications for our aircraft, missiles, control systems, etc. we too often find this condition prevails.

A simple approach to reducing the magnitude of this problem as well as holding costs down, in these times of close profit margins, might well be the full utilization of the component manufacturer's engineering know-how. . .

Robert P. Zupa, Fenimore Fisher  
 Analogue Controls, Inc.  
 Hicksville, L. I., N. Y.

► If we stimulated thought, our editorial was not in vain.

#### Autotransformer pot is the answer . . .

It is my hope that the many readers of your Editorial "Wanted—A Gold-Plate Special Pot" (ELECTRONIC DESIGN, May 24, 1961) murmured to themselves "Vernistat." On the chance that none of these readers were prompted to take pen in hand, I feel obligated to do so.

Perkin-Elmer did "rise to the challenge" several years ago. Our approach was not to perfect the commonly used resistance potentiometer, but to analyze its shortcomings and design a component which would avoid them. This design process began by recognizing that a tapped toroidal autotransformer has the following characteristics:

- 1) Precise voltage division
- 2) High input impedance
- 3) Low output impedance (for low-loading error)
- 4) Low phase shift (quadrature)
- 5) Low power dissipation

Each of these characteristics is desirable in a potentiometer; to obtain them simultaneously would be to approach what one might call "an ideal potentiometer." The one remaining requisite of a precision potentiometer, resolution, is obtained in the Vernistat with a resistance potentiometer which interpolates between the several taps of the multi-section autotransformer.

The result of this "marrying" process is the Vernistat ac potentiometer, a component



LAMBDA ELECTRONICS CORP.

515 BROAD HOLLOW ROAD, HUNTINGTON, L. I., NEW YORK 516 MYRTLE 4-4200

CIRCLE 57 ON READER-SERVICE CARD

which is currently operational in many important military programs. In several of these programs it is the only potentiometer used. Our approach has truly produced *reliability by design* in that:

- 1) Transformer taps, which are the fundamental source of accuracy, cannot change with time, use, or environment.
- 2) The design permits use of larger potentiometer wire for a given resolution and input impedance than do conventional potentiometers.
- 3) Limited rotational usage is not detrimental to life (e.g. ground speed output in airborne navigational system.)
- 4) Noise and pick-up are low, due to the low-impedance circuitry possible with the component.

While your Editorial is timely as far as conventional potentiometers are concerned, we wonder if the industry is not "beating a dead horse". For years engineers have vainly tried to get reliability from potentiometers, and certainly some progress has been made. However, there is only one sure way to get reliability, whether it be in a system or a component, and that is *by design*.

Lionel Robbins  
Sales Manager  
Perkin-Elmer Corp.  
Norwalk, Conn.

► *Perhaps we need better system design.*

#### Conductive plastic pot is the answer . . .

We've been overlooked! Overlooked by ELECTRONIC DESIGN's May 24 Editorial . . . We must have been by-passed! We, who've been performing successfully in all types of critical installations where *reliability* is the *prime requisite*!

To cite just one example of reliability that now exists, a group of our rotary conductive plastic pots run over 200 million revolutions at 600 rpm, and . . .

- Showed an average resistance increase of only 0.035% per million rev.
- Stayed within the original 0.5% linearity requirement for that same span;
- Maintained a noise level below the original value for over 100 million rev.

Some were tested under 70-g vibration at 5-2,000 cps, 100-g shock, 100-g acceleration in all axes, without discontinuity.

Morris Tarragano  
Markite Corp.  
New York, N.Y.

► *There has certainly been a great deal of progress in pot design. Continued efforts by manufacturers are to be applauded.*

**Mr. Design Engineer...  
BELDEN Has It**

*Every electronic and electrical wire you need—from the finest drawn magnet wire to the most complex multi-conductor cable.*

There is a Belden wire or cable in every insulation and shielding to meet your design and application requirements. Here is just part of this complete line. Available from stock.

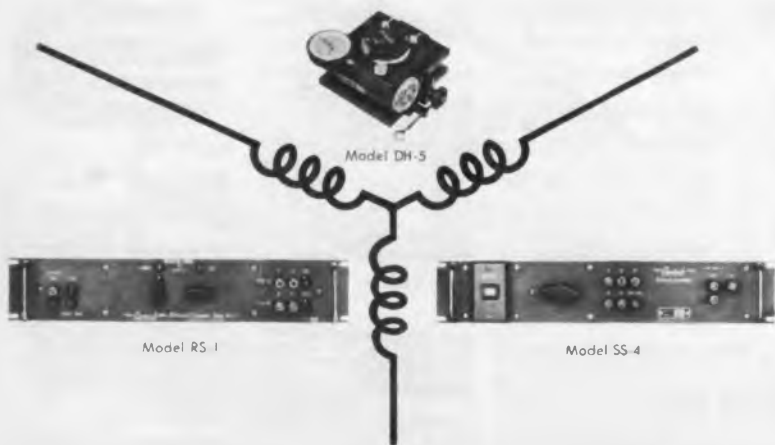
**Belden**  
WIREMAKER FOR INDUSTRY  
SINCE 1902 — CHICAGO

One Wire Source for Everything Electronic and Electrical

• electronic wire • magnet wire • lead wire • power supply cords  
• cord sets • portable cordage

Labels for various cables shown:  
Shielded Power Supply Cables—Rubber  
Plastic Microphone Cables  
Shielded Interconnecting Cables  
Cathode Ray Tube Lead  
Duplex Connector Extension Cords  
Low Impedance Lines  
Miniaturized Cables  
Grid Wires  
Unpaired Intercom Cables  
Control Cables  
Audio Cables  
Shielded Control Cables  
Magnet Wire  
Automotion Cable  
Individually Shielded Intercom Cables  
RG/U Transmission Line Cables  
Coiled Test Prod Wire  
RC/U Cables  
3-Conductor Power Cords  
Control Cables  
Rubber Microphone Cables  
Hook-Up Wires  
Miniature Audio Cables  
Duplex Primary Wires  
Strain Gauge Cables  
Call System Cables  
Test Prod Wires  
Broadcast Audio Cables  
PA System Cables  
2 & 3 Conductor Extension Cords  
TV Eye Camera Cable  
Sound & Alarm System Cables  
Mil-Spec Wires  
Color, Studio, Closed Circuit Camera Cables  
75-Ohm Video Cable  
Industrial Intercom Wires  
Lamp Cordage  
Teflon® Wires  
\*DuPont trademark  
Portable Cordage  
Coiled Cords  
Shielding & Bonding Cable  
Special Sound Cables  
Multiple Pair Cables  
2-Conductor Power Cords

CIRCLE 58 ON READER-SERVICE CARD



# now...high accuracy synchro and resolver testing

## — GERTSCH STANDARDS REPLACE COSTLY ELECTRO-MECHANICAL METHODS

**Gertsch Synchro Standards** simulate the output of a master Synchro Transmitter (CX), with better than 2 seconds of arc accuracy. Ideal for checking Synchro Control Transformers (CTs), or complete systems. Units feature a low effective unbalance impedance which permits loading the output without introducing stator output errors.

When driven by a suitable signal source, unit provides stator outputs  $S_1$ ,  $S_2$  and  $S_3$ , corresponding to the outputs of a master Synchro Transmitter as the shaft is rotated in  $5^\circ$  increments. Quadrant switching simulates operation over a full  $360^\circ$ . Series SS.

**Gertsch Resolver Standards** simulate the output of a master Resolver Transmitter (RX). Checks Resolver Control Transformer (RCT). Unit features low effective unbalance impedance, hence negligible loading error.

Driven by a suitable signal source, unit produces 2 isolated output voltages corresponding to the sine and cosine output voltages of a master Resolver Transmitter as the shaft is rotated in  $5^\circ$  increments. Full  $360^\circ$  operation. Series RS.

Synchro and Resolver Standards rotate throughout a full  $360^\circ$ , in  $5^\circ$  increments. Accuracy is better than 2 seconds of arc. Both single-switch and 2-switch models are available to cover all standard voltages and frequencies. Bulletins SS and RS on request.

**Gertsch Divider Heads**—for checking angular measurements on all types of rotary components. Accuracy is  $\pm 15$  seconds. Repeatability:  $\pm 5$  seconds. Large dial indicator provides direct readings with 3-second resolution. Unit rotates in  $5^\circ$  steps through a full  $360^\circ$  in either direction . . . is quickly set up, easy to operate, and fully portable. Bulletin DH-5.

  
**GERTSCH PRODUCTS, Inc.,**

3211 South La Cienega Boulevard, Los Angeles 16, California / UPTon 0-2761 - VERmont 9-2201

CIRCLE 59 ON READER-SERVICE CARD

## PRODUCT FEATURE



# True Rms Voltmeter Covers 7-Mc Bandwidth

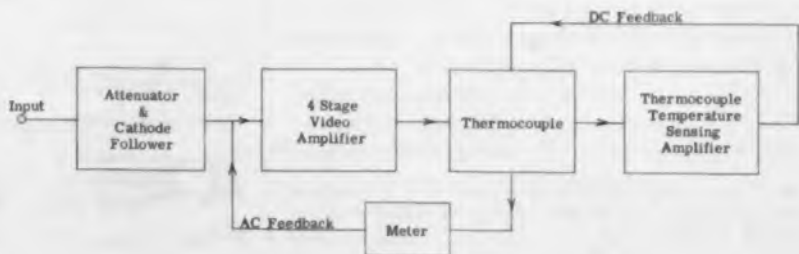
**R**EGARDLESS of duty cycle or amplitude characteristics, the true rms value of any waveform from 10 cps to 7 mc can be measured with a new meter that functions over a range of 100  $\mu$ v to 300 v. The bandwidth of 7 mc is at least an order of magnitude greater than that of any other rms responding voltmeter available at the present time.

The model 910A true rms voltmeter, manufactured by the John Fluke Manufacturing Co., Inc., Seattle, Wash., has a sensitivity of 1 mv full scale and an accuracy of 1 per cent. Its applications include distortion measurements, double-power noise measurements and transformer copper loss measurements.

Model 910A accomplishes the direct conversion of the input ac voltage to a dc voltage, proportional to the effective heating

(rms) value of the input voltage, by means of a low-impedance thermocouple. This thermocouple, situated in the feedback loop of a sensitive dc amplifier is chopper stabilized to operate at a constant level. Because the thermocouple is operated at this constant temperature level, the meter responds very rapidly to a change in input voltage and also maintains its calibration accuracy over long periods of time.

Other voltmeters with comparable bandwidth and sensitivity normally employ an indirect means to convert from ac to dc. The most popular methods are peak detection and diode rectification. In meters which use diode rectification, the average dc value is multiplied in the voltmeter by the form factor of 1.11 and the unit will indicate correctly the rms value of a pure sine wave. However,





should any distortion appear in the waveform to be measured, the meter will interject this error into the rms indication.

Using thermal techniques to sense the rms value of input waveforms, the model 910A is designed to eliminate many of the problems normally associated with instruments which employ thermocouples. Constant temperature ovens are not required.

The use of an input amplifier provides high sensitivity while isolating the thermocouple from the input terminals. By combining the thermocouple in the feedback loop of a sensitive dc amplifier which maintains a constant input power to the thermocouple, the unit achieves fast response and accurate calibration.

The thermocouple temperature-sensing amplifier is shown in the block diagram. With 0 v ac at the input terminals to the instrument, this amplifier provides a current into the thermocouple and through the meter. Net current in the meter is then 0; there is no deflection. When an ac signal is applied to the thermocouple from the four-stage amplifier, dc through the thermocouple is reduced to keep its temperature constant. The reduction in dc is indicated on the meter. Since it is a thermal device, the thermocouple automatically responds only to the heating or rms value of the waveform.

At full scale the 910A will indicate the rms value of any pulse train or other complex waveform which has a crest factor of 3 or less. For readings less than full scale, it will accept crest factors as large as three divided by the fraction of full scale reading.

Model 910A true rms voltmeter is available in a cabinet model for \$545 and a rack model for \$565.

For more information on this instrument turn to the Reader-Service Card and Circle 251.

## SPECTROL SOLVES EQUATIONS LIKE THIS...

$$\Theta = \text{ATAN}^{-1} B \left[ (1 + 0.2 \left[ C + D \frac{e_0}{E_1} \right]^2)^{7/2} - 1 \right]$$

**to design non-linear  
potentiometers  
-faster, more accurately**



*The above equation is the mathematical expression for the non-linear function required of a precision pot to relate voltage ratio  $\frac{e_0}{E_1}$  to potentiometer shaft position  $\Theta$ .*

This is a typical non-linear problem applied to Spectrol's new IBM 1620 digital computer... equipment which eliminates days of design time, provides error-free results and makes it possible for Spectrol to issue quotations a day or two after receiving your request. For the past three years Spectrol—and only Spectrol—has used this technique.

Basically, it works this way: Computer input data is in the form of programmed equations or tabulated X and Y coordinates. Previously programmed tapes with general equations for non-linear applications (on file at Spectrol) operate on the data, to compute output in terms of winding equipment settings, cam angles

AM	FPN-8,01,10	03366 11 03129 00001
TF	**18,KOUNT4	03378 26 03396 03952
TFM	,70,10	03390 16 00000 00070
B	NEGK	03402 49 03318 00000
EQUALK	AM KOUNT4,02,10	03414 11 03952 00002
TF	**18,KOUNT4	03426 26 03444 03952
TFM	,70,10	03438 16 00000 00070
TF	**30,KOUNT4	03450 26 03480 03952
TF	**23,KOUNT5	03462 26 03485 03957
TD	.	03474 25 00000 00000
AM	KOUNT5,01,10	03486 11 03957 00001
CH	KOUNT5,FPN,7	03498 14 03957 03137
BNH	EQUALK	03510 47 03414 01100
FLAGK	BNF **24,FPN	03522 44 03546 03137
TDM	DECK+21,2,10	03534 15 03876 00002
BB		03546 42 00000 00000
POSK	HM FPN-8,02,10	03558 13 03129 00002
S	KOUNT4,99	03570 22 03952 00099
TF	**18 KOUNT4	03582 26 03600 03952
		03594 16 00000 00070
	30,KOUNT4	03606 26 03636 03952
	23,KOUNT5	03618 26 03641 03957
		03630 25 00000 00000
	4,02,10	03642 11 03952 00002
	KOUNT5,01,10	03654 11 03957 00001
	KOUNT5,FPN,7	03666 14 03957 03137
BNH	**36	03678 47 03774 01100
CH	KOUNT4,DECK,7	03690 14 03952 03855



and radii. An electric typewriter prints out this information on a form such as that shown above, which is sent directly to production, eliminating delays and potential transcription errors.

Speaking of production, Spectrol has precision equipment for winding non-linear resistance elements at its plants in New York and Toronto to supplement its California facilities. Using the computer in California, Spectrol can TWX winding instructions to either plant... another reason you can expect results sooner.

One more thought: Call us if you're in a bind. Letters take time.

To assist engineers who have applications for non-linear pots, Spectrol has prepared a detailed specifications brochure. For your copy, contact your Spectrol engineering representative or the factory.



**ELECTRONICS CORPORATION**  
1704 South Del Mar Ave. • San Gabriel, Calif. • Atlantic 7-9761  
Adams Court • Plainview, L. I., New York • WElls 8-4000  
TORONTO, ONTARIO, CANADA



## reliability

Because it never varies from birth to death, a fingerprint is the most reliable method of personal identification.

NAE silicon devices have fingerprint reliability because they never vary in performance, even under extreme conditions of temperature, shock or humidity. Test our semi-conductor devices. You can count on them to perform with reliability

These hermetically sealed, corrosion resistant units perform at full capacity for the life of the equipment. Wherever reliability is important specify NAE.

Here, at North American Electronics, Inc., we manufacture Silicon Rectifiers, Controlled Rectifiers and Voltage Regulators to exclusive specifications. These give them the finest characteristics available. In process, reliability is further assured by 100% testing to all specified parameters. Get acquainted with NAE devices. Write for specifications, data and details.

*nae "first in reliability"*

**NORTH AMERICAN ELECTRONICS, INC.**

71 Linden Street, West Lynn, Mass.

FWX Lynn, Mass. 01951

AFFILIATE OF



CIRCLE 61 ON READER-SERVICE CARD

## PRODUCT FEATURE



# Permanently Tuned, Ceramic, IF Transformer Is Temperature Stable

**A** PERMANENTLY tuned, small, ceramic filter may well replace the bulky if cans in commercial broadcast receivers. Though not intended as a direct substitute for if transformers in existing equipment, the device can drastically cut the size of newly designed receivers while obviating if-strip alignment.

Manufactured by U. S. Sonics Corp., 63 Rogers St., Cambridge, Mass., the hermetically sealed, ceramic, if transformer provides a temperature stability of 10 ppm per deg C from  $-20$  to  $+80$  C. Insulated for 500 wvdc, the filter can take an input voltage of 10 v rms. It can pass 100 g shock levels and 2.5 g vibration levels at any normal frequency.

Made of a lead-zirconate, lead-titanate compound, the filter does not require the metal shielding that takes up so much of the space around conventional wound transformers.

Further, since it does not require tuning, it can be mounted in any convenient part of a chassis. The filter is only 5/16-in. long and 5/16-in. in diameter.

Typical power loss for the filter, a mere 1 db, compares with up to 12 db for conventional if transformers. The filter's low loss is due, in part, to its high tolerance to impedance mismatch. A typical unit can be used with output impedances ranging from 500 ohms to 5 K without much change in resonant frequency.

The ceramic in the new filter vibrates in a fundamental mode rather than a harmonic mode so it has only one spurious response—and that isn't related harmonically to the center frequency. For example, the spurious response for a 455-kc filter is about 100 kc.

One of the unique characteristics of this filter is that it acts as a symmetrical transformer: it can be wired into the

Just *Plug it in*

any computer and...

- multiply
- divide
- square
- extract square root

circuitry with either of its leads as input. Axial-lead construction of the device lends itself well to economical automatic assembly techniques.

The shell serves as the rf ground connection. It has no dc connection, so separate provisions would be necessary for biasing tubes or transistors.

Two models of the filter are now available, both tuned to 455 kc  $\pm 1$  kc. One model, type A10019C, suitable for transistor circuitry, has a 10-K input impedance and a 1-K output impedance. The other version, type A25H4C, suitable for vacuum-tube circuits, has a 25-K input impedance and a 200-K output impedance.

In large quantities, over 10,000 units, the filter is available, on 15-day delivery, at 31 cents per unit. This cost is competitive with the cost of conventional, magnetic, or transformers. But, of course, one would also require an inexpensive choke (for dc return), and a capacitor.

In addition to their applications, these ceramic filters are also available for other frequencies and bandwidths. Center frequencies can range from 100 kc to 1 mc and 6-db bandwidths can range from 1 per cent of center frequency to 20 per cent. Input and output impedances can range from 50 ohms to 15 K.

For more information on these small ceramic filters, turn to the Reader-Service Card and circle 252.

Donner's new all solid state electronic multiplier plugs into any analog computer problem board with  $\frac{3}{4}$ " terminal spacing — all Donner models, all Heathkit models, Boeing (BEAC), Goodyear L3-N3 series, and so forth.

Designed on the quarter-square principle, this compact, single channel multiplier offers four modes of operation selected by a switch:

- Four-quadrant multiplication (output =  $-0.01XY$ ), with static accuracy of 0.3% of full scale voltage (200 volts).
- Two-quadrant division (output =  $-100X/Y$ ).
- Two-channel squaring (outputs of  $-0.01X^2$  and  $+0.01Y^2$ ).
- Two-channel square root operation.

As inputs, the Model 3732 accepts  $+X$ ,  $-X$ ,  $+Y$ ,  $-Y$ , and generates an output current to the summing junction of an external amplifier.

To satisfy your particular needs, Donner furnishes the multiplier in a variety of packages besides the plug-in version shown.



Model 3732 electronic multiplier is available without enclosure for panel mounting or as a single printed card for inclusion in your system. The unit is also available with up to three solid state multipliers on a  $3\frac{1}{2}$ " x 19" panel for rack mounting.

Price of the Model 3732P is \$350; delivery 30 days. Other prices, detailed specifications and demonstrations available from all Donner representatives or just drop us a line at the factory. Please address Dept. 36.

**DONNER**  
SCIENTIFIC COMPANY

A SUBSIDIARY OF **SYSTRON-DONNER**  
Corporation

CONCORD, CALIFORNIA

# 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.



## Silicon Rectifiers Rated to 1 Kv Piv

254

Double-diffused silicon rectifiers IN3289 through IN3295 have piv ratings from 200 to 1,000 v. Current rating is 100 amp; transient voltage rating of the 1-kv unit is 1,300 v. Hard solder construction enables the devices to perform reliably in applications where large temperature excursions are encountered.

General Electric Co., Rectifier Components Dept., Dept. ED, W. Genesee St., Auburn, N. Y.  
Price: \$9.50 to \$44.00 ea, OEM quantities.

## Ceramic Diodes Operate at 400 C

255

Designed for high-temperature applications, these ceramic diodes withstand 400 C continuously, up to 500 C intermittently. Type Z-5437 ratings are: piv, 200; current, 10 amp; filament, 2.5 v, 85 w, and peak cathode current, 125 amp. The 2-amp Z-5434 is rated at 750 v piv. Type Z-5365 is a small unit with anode piv of 1 kv. Filament operates at 1 v, 10 w. The rectifiers withstand 50 g for 11 msec, 20 g at 2 kc.

General Electric Co., Power Tube Dept., Dept. ED, Schenectady, 5, N. Y.  
P&A: \$146 to \$315 ea; samples from stock.



## Piezoelectric Transducer In Rigid Mounting

256

A variable piezoelectric transducer, the Variducer has a rigid mounting and positive electrical contact for accurate, low-noise measurement of shock velocity, blast pressure, compression and expansion wave durations, force, and other parameters. Pressure range is 0 to 1,000 psi, rise time 1  $\mu$ sec, and voltage sensitivity 30 mv per 1 psi. Operating temperature is 300 C max. Type V-1 uses barium titanate sensor, type V-2 lead zirconate.

Mirax Chemical Products Corp., Dept. ED, St. Louis, Mo.  
P&A: \$100 up; 30 days.



### Servo Galvanometer Is Accurate to 0.25%

258

Galvanometer servometers provide full-scale accuracy of 25% in any position, under shock, vibration, and varying temperatures. There are no magnetically induced errors, and no damage occurs under 1,000% overload. Full-scale response time is 50 msec max. Power required 1.5 w max.

Computer Instruments Corp., Dept. ED, 92 Madison Ave., Hempstead, L. I., N. Y.  
P&A: \$275 up; 30 to 45 days.



### Low-Noise Amplifier Uses GaSb Tunnel Diode

257

Noise figures of 2.5 to 3.5 db have been achieved in stable, high gain, circulator-coupled amplifiers for use at uhf and L bands. The compact, all solid-state unit has very low power requirements. Noise constant of the GaSb diodes is about 0.7 as compared to 1.35 for Ge. Cut-off frequency is between 2 and 4 Gc. Peak-to-valley ratio is about 20:1.

Micro State Electronics Corp., Dept. ED, Murray Hill, N. J.

**kepco**  
Inc.

# makes power supply news for '61

with a design for general purpose, continuous duty applications:

MODEL	DC OUTPUT RANGE		RIPPLE % rms	DIMENSIONS			PRICE
	VOLTS	AMPS		H"	W"	D"	
PR 15-10M	0-15	0-10	4	3½	19	13¾	\$345.00
PR 38-5M	0-38	0-5	2	3½	19	13¾	\$325.00
PR 80-2.5M	0-80	0-2.5	1.5	3½	19	13¾	\$325.00
PR 155-1M	0-155	0-1	1	3½	19	13¾	\$325.00
PR 310-0.6M	0-310	0-0.6	0.5	3½	19	13¾	\$345.00
PR 15-30M	0-15	0-30	4	7	19	13¾	\$495.00
PR 38-15M	0-38	0-15	2	7	19	13¾	\$475.00
PR 80-8M	0-80	0-8	1.5	7	19	13¾	\$450.00
PR 155-4M	0-155	0-4	1	7	19	13¾	\$430.00
PR 310-2M	0-310	0-2	0.5	7	19	13¾	\$430.00

#### REGULATION:

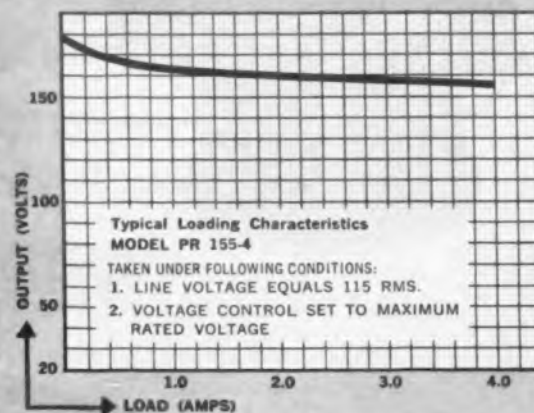
**LINE:**  $\pm 1\%$  for 115  $\pm 10$  v ac line change at any output voltage within specified range.

**LOAD — at maximum output voltage:**

Less than 2% output voltage change for 50-100% load change (3% for PR 15-10M and PR 15-30M).

Less than 4% output voltage change for 25-100% load change (6% for PR 15-10M and PR 15-30M).

(See Graph below for typical load characteristics)



### NEW 32 PAGE POWER SUPPLY CATALOG!

#### Featuring:

- 11 Kepco design groups including new "SM", "HB", and "PR" models.
- Separate listing and description of programmable current/voltage regulated models.
- Special nomograph of voltage drop vs. wire size and supply current.
- *Dual index to all models:*  
by DESIGN GROUP (inside front cover);  
by OUTPUT VOLTAGE (inside rear cover).



Model PR 15-10M



Model PR 15-30M

### PR GROUP FEATURES:

#### "FLUX-O-TRAN"

**CONSTANT VOLTAGE TRANSFORMER:** Delivers regulated square-wave voltage to rectifier, improving rectifier utilization, and reducing output ripple.

**ADJUSTABLE WIDE-RANGE OUTPUT:** Continuously variable voltage control permits output settings from 0 to maximum rating.

#### OVERLOAD PROTECTION:

Special "Flux-O-Tran" transformer and DC overload circuit breaker allow output to be shorted without damage to unit. Ideal for lighting lamps and charging capacitive loads.

#### SILICON RECTIFIERS:

Reliable, efficient, full-wave rectification.

#### CAPACITIVE FILTERING:

Provides excellent ripple reduction and minimizes transient response characteristics.

#### NO VOLTAGE OVERSHOOT:

No output voltage overshoot from turn-on, turn-off or power failure.



**kepco**  
Inc.

131-36 SANFORD AVENUE • FLUSHING 52, N. Y. • IN 1-7000 • TWX # NY 4-5196

CIRCLE 63 ON READER-SERVICE CARD

## NEW PRODUCTS

### Thermoelectric Module

422



Cooling and heating of electronic systems are provided by the Coron thermoelectric module. Units are available in one, two, four and eight couple modules, in encapsulated and non-encapsulated form.

Sela Electronics Co., Dept. ED, 545 West End Ave., New York 24, N. Y.

P&A: \$19.00 to \$24.00; from stock.

### Cleaning Chemicals

456

For electronic components. Made for processing semiconductors and other components, cleaning chemicals include de-scaling solutions, bright dips, carbon removers, special paint removers, and epoxy strippers.

Fidelity Chemical Products Corp., Electronic Chemicals Div., Dept. ED, Newark, N. J.

### Adjustable Pot Cores

455

Operating to 3 mc, Ferrokkor adjustable pot cores have final adjustment accuracy of better than 0.02%. Each core size is available in three standard effective permeabilities. Made to close tolerances, the units are easily assembled.

Ferroxcube Corp. of America, Dept. ED, Saugerties, N. Y.

### Humidity Chamber

433



Automatically controlled humidity chamber H-104 provides humidity time cycles in conformance with MIL-E-5272C. It will attain a relative humidity of 95 per cent at a dry-bulb temperature of 160 F. Fail-safe control system and variable thermostat are incorporated. Interior is stainless steel.

Wyle Laboratories, Manufacturing Div., Dept. ED, El Segundo, Calif.

P&A: \$1,290; 30 days.

Standardize with this multi-purpose film wire success!

Phelps  
Dodge

# POLY-Therm



Has replaced as many  
as six standard wires  
in these important  
applications!

Motors

Poly-Thermaleze®—Patent applied for.

# Maleze®

- Best balance of overall properties without sacrifice of any one property!
- High dielectric for thermal protection at operating temperatures (Class F 155C)!
- Cost reduction benefits through standardizing inventory to one wire for most applications!

Any time your problem is magnet wire, consult Phelps Dodge for the quickest, surest answer!



**PHELPS DODGE COPPER PRODUCTS**  
CORPORATION  
**INCA MANUFACTURING DIVISION**  
FORT WAYNE, INDIANA

## Coils

## Dry-type Transformers

### Oscillograph

418



**Two-channel pen-and-ink oscillograph** measures 11-1/4 x 4-3/16 x 5-7/8 in. and weighs 12-1/2 lb. Galvanometer resistance is 1,500 ohms; sensitivity is 1 mm/v, down 3 db at 60 cps. Recording width is 4 cm per channel. Paper speed is 1 or 10 cm per sec, and can be changed while paper is running.

Keystone Development Corp., Dept. ED, 2813 Westheimer Road, Houston 6, Tex.

### Check-Out System

454

**Universal automatic check-out system** model 301 ATE will locate single faulty components or circuits in large systems. The programmer selects test stimuli and routes them to test points, commands performance of a function, and connects system response to detectors. Accuracy is one part per 1,000 at a rate of 1,200 unique tests per min. Operator can select one of six functional modes. The system is assembled from stock to meet user needs.

Radiation Inc., Dept. ED, Melbourne, Fla.

### Phosphor

446

**Improved picture brightness** up to 10 per cent is claimed for the CR408 phosphor, made for television picture tubes. The phosphor can be produced in the varying colors and particle sizes required by manufacturers.

Sylvania Electric Products Inc., Dept. ED, 730 Third Ave., New York 17, N. Y.

### Signal Amplifier

427



**High-gain airborne dc-to-dc signal amplifier** SA9-0 provides 0 to 5 v output from 0 to 10 mv input. Gain is continuously variable from 50 to 500; operating temperature range is -65 to +165 F. Power required is 30 ma at 28 v dc  $\pm 10\%$ . Weight is 8 oz, volume less than 8 cu in.

Statham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.



## NEW PRODUCTS

### Heater



Ceramic film heating elements in this heater will not glow, support combustion, or emit odor. System dissipates 8.7 kw, operates from 120/208-v, three-phase power, and weighs less than 4 lb. Requirements of MIL-E-5272C are met.

Therm-O-Lab Corp., Dept. ED, 6940 Farmdale Ave., North Hollywood, Calif.

### Radioisotope Unit

Portable radioisotope unit, called the Pipeliner, offers 10, 20, and 30 curie power. Radiation source is Iridium 192 housed in a tungsten alloy. Unit weighs 60 lb, including controls. Device can be operated remotely, and AEC-recommended radiation levels are maintained.

Picker X-Ray Corp., Dept. ED, 1275 Mamaroneck Ave., White Plains, N. Y.

**P&A:** Unit, \$1,505; IR source, \$250 to \$350; 2 weeks.

### Transformer

For laboratory testing. Called Lab-Pac, this transformer furnishes three phases for any output voltage from 100 to 640 v, 30 to 60 amp ac. Tap switches are changed on three phases simultaneously. An ac voltmeter is provided.

Strong Electric Corp., Dept. ED, 464 City Park Ave., Toledo 1, Ohio.

### Variable Transformer



This 20-amp variable transformer, model VT20, replaces other transformers of comparable size. Shaft can extend from either side of transformer, and has a collet-type lock to permit repositioning.

Ohmite Manufacturing Co., Dept. ED, 3665 Howard St., Skokie, Ill.

429

### Multi-Range Standards



Accurate to 1/2% of full scale, dc voltmeter model 1700 and dc milliammeter model 1702 each provide 10 ranges from 0 to 1.5 to 1,500. Meter is compensated from 15 to 35 C. Mirror scale length is 5.5 in. Deep core magnet movement has spring-mounted sapphire jewels and hardened steel pivots.

Simpson Electric Co., Dept. ED, 5200 W. Kinzie St., Chicago 44, Ill.

**Price:** Model 1700, \$160; model 1702, \$135.

### Switching Transistors

Silicon npn planar switching transistors, available in production quantities, include types 2N706, 2N706A, 2N706B, 2N707, and the highly reliable 2N708. Units are sealed in a TO-5 case. Life tests indicate little degradation at high temperatures.

General Instrument Semiconductor Div., Dept. ED, 65 Gouverneur St., Newark 4, N. J.

### Power Supply

Silicon power supply operates from 115 v ac, 50 to 60 cps, and provides 24 v dc at 1 amp with low ripple and good regulation. Protection against incorrect polarization is provided. Military requirements are met.

Gates Electronic Co., Dept. ED, 2243 White Plains Road, New York, N. Y.

**Price:** \$49.

### Switch



Subminiature switch, model B-2, requires an operating force of 3 oz max. Movement differential is 0.0002 max and operating force differential is 1/2 oz max. The switch is supplied with either turret or solder-type terminals.

Milli-Switch Corp., Dept. ED, 105 Town Center Road, King of Prussia, Pa.

426

### Timer Motor



Synchronous timer motor has all moving parts sealed in oil for dependable, noiseless operation. Package OD is 1-11/16 in. A spring-loaded packing gland prevents the oil from working out of the housing when motor is operating.

Controls Co. of America, Lake City, Inc., Dept. ED, 110 W. Woodstock, Crystal Lake, Ill.

### Ceramic Insulators

Miniature dense alumina wafers 0.014 in. thick are available in 0.03, 0.05, and 0.07 in. squares. Wafers are metalized and gold plated on both sides with no overlap on thin edges. They can be soldered to transistor bases and components.

Ceramics International Corp., Dept. ED, 39 Siding Place, Mahwah, N. J.

**Price:** \$0.75 each for small quantities.

### Selenium Rectifier

High-current rectifier, called Hi-I, is available in ratings from 200 ma convection-cooled to 33 amp forced-air cooled, half-wave. Stacks rated at up to 5,000 amp are available. Cells, rated at 33 v ac, can be stacked in series for higher voltage ratings. Applications include electroplating, anodizing, battery charging, welding, and dynamic braking.

Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

### Radiation Monitor



Fountain-pen size personal radiation monitor clips onto the wearer's clothing. It emits high-pitched chirps and flashes a neon light to warn of exposure to radiation. Designated model ORNL, the device uses a mercury cell which gives about 30 days of uninterrupted operation.

Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

419

424

## Wirewound Resistor

434



Molded wirewound resistor type BWH is made in  $\pm 5\%$  and  $\pm 10\%$  tolerances, with resistance range of 0.24 to 1,000 ohms. Performance requirements of MIL-R-11C are met or exceeded. In RC-32 size, rating is 2 w at 70 C, 1/2 w at 137 C.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

Availability: Two weeks.

## Glass-Epoxy Laminates

450

Slit coils and fabricated parts can be made from continuous glass-epoxy laminates with Mylar facing. The material is said to have excellent electrical properties and chemical resistance, and a high strength-to-weight ratio. It meets AIEE Class F temperature rating and MIL-P-18177B specifications. Thicknesses from 0.007 to 1/16 in. are available.

Spaulding Fibre Co., Inc., Dept. ED, 310 Wheeler St., Tonawanda, N. Y.

## Vacuum Evaporation Unit

416



Automatic control of vacuum system valves and pumps is provided by this vacuum evaporation unit. It evacuates a 10-in. bell jar to 0.1 micron in 2 min, and reaches an ultimate pressure of 0.001 micron. Two pairs of insulated electrodes are on a 16-in. base plate, and six spare feedthroughs are provided.

Mikros, Inc., Dept. ED, 7620 S. W. Macadam Ave., Portland 19, Ore.

P&A: \$2,250 to \$2,750; 15 days.

# NEW MIL RESISTORS... from OHMITE



## "INSULATED" MIL-R-26C RESISTORS

### Wire-wound, Sealed in Silicone-Ceramic

**NEW MIL-R-26C AMENDMENT 2 IN BRIEF:** By means of this new amendment, specification MIL-R-26C is extended to include three sizes of *insulated, wire-wound* resistors with axial leads. The new insulated resistors meet all requirements of MIL-R-26C including a dielectric strength test (1000-volt, V-block) and an insulation resistance test (100-volt, V-block). Currently, tolerance is specified as 5% and maximum ambient temperature rating as 275°C.

**INSULATED RESISTOR CONSTRUCTION:** A single layer of resistance alloy wire is wound on a ceramic core. Metal end caps, with axial leads attached by welding, are then fitted snugly over each end of the core. A molded jacket of silicone-ceramic material completes the unit by sealing the entire assembly.

*Through research and advanced production know-how, Ohmite is able to introduce this advanced product line to meet the demanding new requirements of its Military and Industrial customers.*

Mil Des.	Char.	Watts	Resist. Range*	Length $\pm .020$	Dia. $\pm .020$
RW67	V G	6.5 5.0	0.10 to 3600 ohms	0.917	0.323
RW68	V G	11.0 8.0	0.10 to 8200 ohms	1.823	0.343
RW69	V G	3.0 2.5	0.10 to 910 ohms	0.542	0.230

\*MIL-R-26C limit for single-layer winding.

RESISTORS SHOWN TWICE SIZE



**Anticipating  
Industry's Needs  
In Quality  
Components**

*All Sizes and Values Available From  
Distributor or Factory Stock—  
Write for Bulletin.*

**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

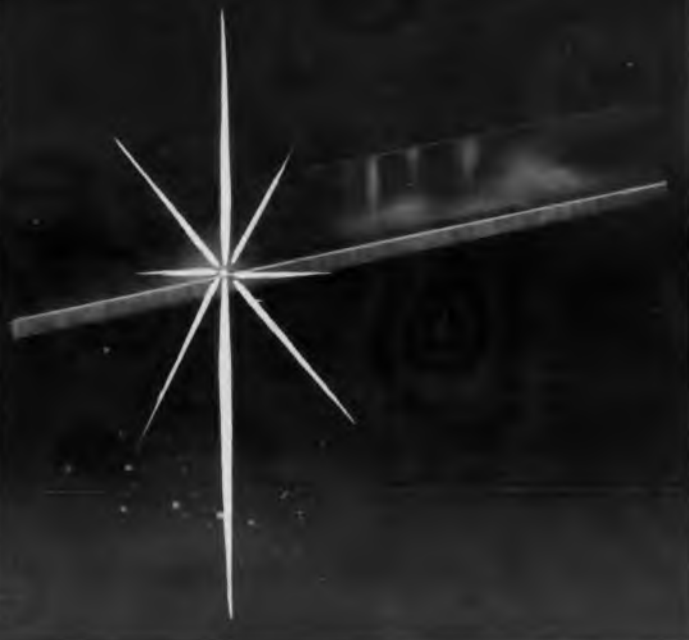
CIRCLE 65 ON READER-SERVICE CARD



# Textolite®/reliability

GE Textolite® 11571

## RADIO and TELEVISION'S newest STAR



The General Electric TV Receiver Department is one of the major manufacturers of television sets sold in the United States. Contributing to this high volume has been the quality achieved through rigid manufacturing procedures. Part of the strict specifications call for Textolite 11571 XXX PC Copper-Clad laminate for use as circuit boards in all of their TV home receivers.

According to a TV Department spokesman, 11571 was selected because of its excellent insulation resistance under humid conditions. It has superior punching characteristics, stands up well in soldering and has good peel strength. Mr. W. W. Ward, Supervisor, Components, TV Receiver Department, said, "Since changing to 11571, production quality has been materially improved. It is the best laminate we've ever used."

Especially designed for use in television and radio receivers, G-E Textolite 11571 reliably meets UL testing standards, MIL-P 13949B and MIL-P 3115, type PBE-P specifications as well as NEMA XXX PC requirements. If you manufacture TV or radio equipment, you probably have an application in which 11571 would assure added reliability at a low cost. We will be happy to supply you complete information and samples. Write: Laminated Products Department, Section ED-71, General Electric Co., Coshocton, Ohio.

WESCON Show • Booth 4811



MILITARY



COMMUNICATIONS



ELECTRONICS

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

## NEW PRODUCTS

### Size-5 Synchros

491



Miniature line of size 5 synchros has 1/2 in. diameter case. Stainless steel housing protects against environment and temperature change. Frequency is 400 cps; excitation is 49 ma at 10.2 v. Temperature range is -55 to +95 C. Accuracy is  $\pm 10$  min. MIL-E-5272 application requirements are met.

Daystrom, Inc., Transicoil Div., Dept. ED, Worcester, Pa.

### Power Supplies

492



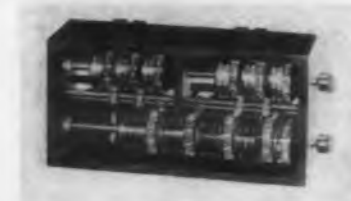
For missiles and instrumentation. Model PS-100 power supply has a 20 v dc, 1-amp output from 24 to 32 v input. Regulation is 0.5%; ripple is 20 mv rms max; efficiency is 90 to 95%. Components meet MIL specs, are rigidly mounted and encapsulated. Unit is hermetically sealed and meets MIL-E-5272 environmental specifications.

Dynex Industries, Inc., Dept. ED, 170 Eileen Way, Syosset, N. Y.

Availability: Eight weeks.

### Multiple Counter

461



With eight or more switches. Multiple programmer counter is made for applications requiring a number of switch contacts at pre-determined numbers. Double-deck, end-drive unit will close from one to eight or more switches. Four basic designs are available, with variations to user order.

Durant Manufacturing Co., Dept. ED, Milwaukee 1, Wis.

## Cabinet Racks

473



Open side walls provide access for rack-to-rack wiring when several racks are arranged side by side in a row. Series PR racks have rear doors only, and series FR racks have both front and rear doors. Standard fittings and accessories are available. Heights range from 48-1/8 to 83-1/8 in.

Par-Metal Products Corp., Dept. ED, 32-62 49th St., Long Island City 3, N. Y.

P&A: \$80.60 to \$257.20; from stock.

## Potentiometer

488



Molded carbon potentiometer series 63M, is 1/2 in. in diameter, and is rated at 1/2 w at 70 C, derated to 120 C. Unit is made for instrumentation and airborne equipment. MIL-R-94B, style RV-6 specifications are met. Resistance values range from 100 ohms to 5 meg  $\pm 10\%$ , with linear tapers.

Clarostat Manufacturing Co., Dept. ED, Dover, N. H.

## Thermionic Test Cell

482



A research tool for performing parametric studies in thermionic energy conversion, model B103 thermionic test cell has a replaceable emitter and collector, variable interelectrode spacing, and temperature controls and monitors. Unit has an electron-bombardment heat source. Inert gas is used for controlled cooling.

Thermo Electron Engineering Corp., Dept. ED, 85 First Ave., Waltham 54, Mass.

Availability: 120 to 150 days.

# MIL-TYPE

## SEMICONDUCTORS

for the military equipment designer looking for  
a complete, single source of reliable,  
field-proven transistors, rectifiers, and diodes

With its line of Mil-type semiconductor devices continually expanding, Motorola now offers 84 high reliability devices of the "preferred" types as well as many "guidance" types listed by the Department of Defense. This comprehensive selection includes power transistors, milliwatt transistors, rectifiers and zener diodes. In addition to the quality proven by their ability to meet stringent military tests, many of these devices have proven their reliability in such major missile systems as the Minuteman, Polaris, Atlas, Nike-Zeus and others. Also, Motorola is the first to offer military users components that were developed to meet the high reliability requirements of the Minuteman program. These are the 101 and 201 Mesa switch and amplifier types. If you are working on military equipment, we suggest you call your local Motorola representative for further information on the types listed below as well as other types that are presently being tested to the appropriate military specifications.

### LISTED BELOW ARE SOME OF THE MORE POPULAR LINES OF MOTOROLA MIL-TYPE TRANSISTORS, RECTIFIERS AND SILICON ZENER DIODES.

#### POWER TRANSISTORS

2N174 (JAN)	2N1011 (SIG. C)	2N1358 (SIG. C)
2N297A (SIG. C)	2N1120 (SIG. C)	2N1412 (USN)

#### MILLIWATT TRANSISTORS

2N331 (JAN)	2N465 (SIG. C)	2N467 (SIG. C)
2N461 (USAF)	2N466 (JAN)	

#### MESA TRANSISTORS

2N700A (SIG. C)	2N705 (USN)
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#### SILICON RECTIFIERS (JAN)

1N253	1N256	1N540
1N254	1N538	1N547
1N255		

#### SILICON ZENER DIODES (SIG. C)

1N2970B	1N2985B	1N3001B
1N2971B	1N2986B	1N3002B
1N2972B	1N2988B	1N3003B
1N2973B	1N2989B	1N3004B
1N2974B	1N2990B	1N3005B
1N2975B	1N2991B	1N3007B
1N2976B	1N2992B	1N3008B
1N2977B	1N2993B	1N3009B
1N2979B	1N2995B	1N3011B
1N2980B	1N2997B	1N3012B
1N2982B	1N2999B	1N3014B
1N2984B	1N3000B	1N3015B

Reverse polarities (suffix RB) are available in all zener diodes listed.

**ANNOUNCING another superior Motorola Mil-type semiconductor - The 2N1412 (USN)**



Motorola's new 2N1412 (USN), produced to the requirements of MIL-S-19500/76A, is the first Mil-type power transistor offering a collector voltage of 100 volts. This husky Motorola unit dissipates a full 150 watts, and its thermal resistance (0.5°C/W max) enables it to run cooler for increased circuit reliability and longer life.

In addition, the Motorola 2N1412 (USN) is rated for 100°C continuous junction operation and its "low silhouette" TO-36 case requires far less headroom than conventional TO-36 packages. It's ideal for application in high-power, high-efficiency amplifier and switching circuits, and in most cases will replace the commercial 2N1100.

### MOTOROLA IS YOUR MOST COMPLETE SOURCE FOR HIGH-RELIABILITY MIL-TYPE SEMICONDUCTORS

For complete technical information on any of Motorola's Mil-type units, phone your Motorola Semiconductor District Office:

Bolton, Mass., (Vanhoe 4-5070/Burlingame, Cal., Diamond 2-3228  
Chicago, Ill., Avenue 2-4300/Clifton, N. J., Gregory 2-5300  
Dallas, Tex., Lakeside 6-8931/Dayton, Ohio, Axminster 3-4164  
Detroit, Mich., Broadway 3-7171/Glenside, Pa., Turner 7-7020  
Hollywood, Cal., Hollywood 2-0821/Minneapolis, Minn., Liberty 5-2198  
New York, N. Y., Wisconsin 7-2980/Philadelphia, Pa., Waverly 7-6144  
Phoenix, Ariz., 273-6364/Silver Springs, Md., Juniper 5-4485  
Syracuse, N. Y., Granite 4-3321/Winter Park, Fla., Midway 7-2507  
Toronto, Ont., Plymouth 9-2222

VISIT WESCON BOOTH #914-916



**MOTOROLA**  
Semiconductor Products Inc.

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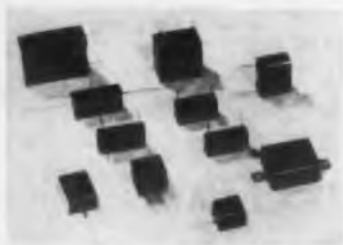
5005 EAST McDOWELL ROAD • PHOENIX 8, ARIZONA

CIRCLE 67 ON READER-SERVICE CARD

## NEW PRODUCTS

### Mica Capacitors

490



Custom-molded capacitors, type RE, have silvered-mica dielectrics and epoxy encapsulation. Expendable flexible molds formed to any desired contour without tooling or dies permit shaping single or multiple capacitors to customer's requirements. Units meet MIL-C-5 specifications. Tolerances of  $\pm 0.1\%$  are available.

Federal Pacific Electric Co., Cornell-Dubilier Electronics Div., Dept. ED, 50 Paris St., Newark, N. J.

### Power Supplies

468



Rack-mounting modules and power supplies are made in a wide range of ratings and sizes. Ripple is less than 1 mv rms; regulation is  $\pm 0.05\%$  or  $\pm 0.5\%$ , line and load. Input is 105 to 125 v, 40 to 400 cps. Output is adjustable over a 10% range.

Technipower, Inc., Dept. ED, 18 Marshall St., South Norwalk, Conn.

*P&A: \$50 up; two weeks.*

### Photoconductive Cell

470



For low light levels and low voltages, type NSL-33 cadmium-sulfide photoconductive cell has a spectral response resembling that of the human eye. Recommended illumination range is 0.01 to 1,000 ft-c. Device, intended for photometric applications, is tubular and hermetically sealed. Diameter is 0.378 in., length is 1.25 in.

National Semiconductors Ltd., Dept. ED, 230 Authier St., Montreal 9, Canada.

### Magnetic Rectifier Control

493



Silicon controlled rectifiers can be fired by model MRC-6203 magnetic rectifier control. Unit is full wave, isolated, with no common connections between the SCR load and the control windings. A high, narrow 3-msec output pulse of 9 v, 1 amp is generated. Module measures 4-9/16 x 3-1/16 x 3-5/8 in.

Fairfield Controls, Inc., Dept. ED, 114 Manhattan St., Stamford, Conn.

### Instrument Counter

462



High-speed digital readings provided by instrument counter model D indicate tool movements within 0.001 in. Maximum speed is 1,500 rpm, giving up to 150,000 increments per minute. Counter is applicable to navigational and tracking instruments.

Durant Manufacturing Co., Dept. ED, Milwaukee 1, Wis.

### Cable Identification Tapes

498



Coded identification tapes called Identitape can be used to mark cables in assembly procedures. Markers are supplied on cards from which they are easily removed. A range of materials and colors, as well as shrink-on type, is available. Military specifications are met. Tapes are made to reduce time and guesswork at assembly.

Manger Electric Co., Inc., Dept. ED, Miller St., Stamford, Conn.

*Availability: Two days.*

### Millivolt Source

464



Calibration, linearity and drift measurements are easily made with millivolt source model 205. Linearity, step attenuator accuracy, and stability are 0.1% each. Full-scale outputs are 1,000, 100, and 10 mv. Mercury battery supplies power for 1,000 hr of operation.

Monroe Electronic Laboratories, Inc., Dept. ED, 21 Vernon St., Middleport, N. Y.

### Vane-Axial Fans

463



Produce 50 to 500 cfm. Series 60 vane-axial fans operate at 3,400 rpm on 115-v, single-phase, 60-cps current. They provide from 50 to 500 cfm at static pressures ranging from 1/3 in. through 1 in. of water static pressure. There are 10 standard models.

Joy Manufacturing Co., Dept. ED, Henry W. Oliver Bldg., Pittsburgh 22, Pa.

### Power Transistors

487



Industrial power transistors, types 2N538 through 2N540A, have a maximum dissipation of 30 w at a base-mounting temperature of 25 C. Each transistor weighs less than 6 g and requires 1/3 sq in. of chassis space. Units are made for servo motor controls, power amplifiers, converters, regulated power supplies, and low-speed power switches.

CBS Electronics, Dept. ED, 100 Endicott St., Danvers, Mass.



For rocket and satellite sun trackers, photoelectric sensors have various angular characteristics for servo control, spin detection, and aspect determination. Type EA-3 amplifier conditions sensor signals for servo or telemetering applications, providing a 5-v output. Weight of sensor assemblies is about 10 g, of amplifier, about 30 g.

Ball Brothers Research Corp., Dept. ED, Boulder Industrial Park, Boulder, Colo.

### Digital Recording Head

448

Photographs and digital data can be recorded simultaneously on the same film with this digital recording head. The device converts transducer signals to code suitable for digital photo recording. Codes can be recorded at rates up to 300 frames per sec. A code scanning unit types out data recorded on all frames. Any number of code bits can be accommodated.

FMA, Inc., Dept. ED, 142 Nevada St., El Segundo, Calif.

### Heat-Resistant Coating

489



Temperatures over 4,000 F are withstood by PyroShield 21 coating. Furnished in powder form and mixed with water, it is applied by brush, spray, or dip. Coating withstands 2,000 F for more than an hour, while protected surface remains under 350 F. Coating can be washed away after a fire, or, for permanent protection, can be covered with paint or enamel.

Columbia Technical Corp., Dept. ED, Woodside 77, N. Y.

## HAMILTON STANDARD ANNOUNCES...

# 4 new static inverters specifically designed for aircraft and missiles



Hamilton Standard has developed a new line of 100-VA and 500-VA inverters that establishes an important increase in inverter reliability and performance. The units are specifically designed for airborne use. They possess extremely high overload and short circuit capacity and offer wide operating ambient temperature ranges. The basic design is modular and utilizes silicon transistors throughout. The packages are small, compact and deliver high over-all power-to-weight ratios.

AS MAIN OR STANDBY AC POWER SOURCE, these new inverters can now replace much of the rotary equipment presently in use on aircraft and missiles for supplying power to:

- Gyros
- Radar
- Telemetry
- Instrumentation
- De-icing and other heating equipment
- Warning and emergency devices
- Communication equipment
- Guidance systems

#### CHARACTERISTICS OF 100-VA and 500-VA STATIC INVERTERS

RATING PART NO.	100 va 555546	100 va 566480	100 va 566470	500 va 570250
Output Voltage (Nom.)	115 v	115 or 200 v	115 v	115 or 200 v
Frequency	400 ± 0.25%	400 ± 1%	400 ± 1%	400 ± 0.25%
Phases	Three	Single or three	Single	Single or three
Transient Protection	Yes	Yes	Yes	Yes
Temp. Ranges	-55°C to 125°C	-55°C to 85°C	-55°C to 71°C	-55°C to 125°C
Input Voltage (Range)	18-29v dc	20-29v dc	20-29v dc	14-29v dc

SEND FOR YOUR COPY of this illustrated Static Power Conversion Guide. Clip coupon and mail to:  
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Section 71, Broad Brook, Connecticut.

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UNITED AIRCRAFT CORPORATION  
HAMILTON STANDARD DIVISION

ELECTRONICS

CIRCLE 68 ON READER-SERVICE CARD

## NEW PRODUCTS

### Antenna Multi-Coupler 414



Made for vlf, lf, and mf bands, the type NV-2 multi-coupler feeds up to six independent receivers. Input and output impedance is 60 ohms, gain is 3-db max, and interaction between outputs is 35 db below signal level. Unit weighs 16-1/2 lb and mounts on a 19-in. rack.

Rohde and Schwartz Sales Co., Inc., 111 Lexington Ave., Passaic, N. J.

### AC Millivoltmeter 701

Accuracy is 1%. Model VT-3A ac millivoltmeter, for measurements as low as 10 mv, has a response of 20 cps to 600 kc, at 1% accuracy, or 1/2 cps to 5 mc. It has a total of 12 voltage ranges; input impedance is 22 meg max on all ranges. Weight is 3-1/2 lb; dimensions are 6 x 9 x 5 in. It is portable.

Electronic Applications Co., Dept. ED, 10916 Basye St., El Monte, Calif.

**Price: \$295.**

### Time Delay Relay 412



Miniature, hermetically sealed time delay relay has ranges from 15 sec to over 30 min with 2% accuracy. Contacts are rated for 3 amp at 125 v ac, 30 v dc; lifetime is 50,000 operations min. Units measure 1 x 2 x 4 in., have flange or bracket mountings, and meet MIL specs.

Giannini Controls Corp., Cramer Div., Dept. ED, Centerbrook, Conn.





# Now! 100% power testing of 1N536-1N561 series rectifier cells gives greater reliability ...at no extra cost!

Now you can get Westinghouse power semiconductor quality in this popular, low-current rectifier series. Complete in-service reliability is assured by 100% Power Testing. Each and every one of these rectifiers is tested under full-load conditions—which simulate actual field operation. This exclusive Westinghouse procedure, developed through years of experience in high-power silicon rectifiers, has resulted in high reliability standards.

Each cell is completely tested under the severest combination of current, voltage, and temperature. Westinghouse gives this assurance of extra reliability, yet the Westinghouse 1N536-1N561 series rectifiers cost no more than other makes.

Features Include: ■ New fused, double-diffused construction ■ Ambient operating temperature minus 65°C to plus 165°C ■ Typical forward drop at 1 amp instantaneous at 25°C—.95 volts ■ Hermetically sealed encapsulation.

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Westinghouse Electric Corp., Semiconductor Dept., Youngwood, Pa.

# Westinghouse



## Portable Meters 509

Taut-band suspension mechanisms are used in a series of portable ac and dc ammeters and voltmeters. Scale lengths are 6 and 10-1/2 in., with arcs of 100 and 240 deg. Accuracy is within 1/2%.

Westinghouse Electric Corp., Dept. ED, P. O. Box 2099, Pittsburgh 30, Pa.

## Electron Beam Power Supply 716



Output of 6 kw is provided by this electron beam power supply, model A2632, made for welding, cutting, vacuum melting, and metal purification. Bias, focus, over-voltage trip and overcurrent trip are adjustable. Input power is 208 v, 30 amp, 3 phase.

Del Electronics Corp., Dept. ED, 521 Homestead Ave., Mount Vernon, N. Y.

## Missile Battery 627

Activates in 1 sec, automatically. Model 79 24-v missile battery has a discharge time of 0.83 min when discharged at 10 amp, a capacity of 0.14 amp-hr and an output of 3.06 w-hr per lb and 0.19 w-hr per cu in. It performs at an altitude of 50,000 ft. Weight is 1.1 lb.

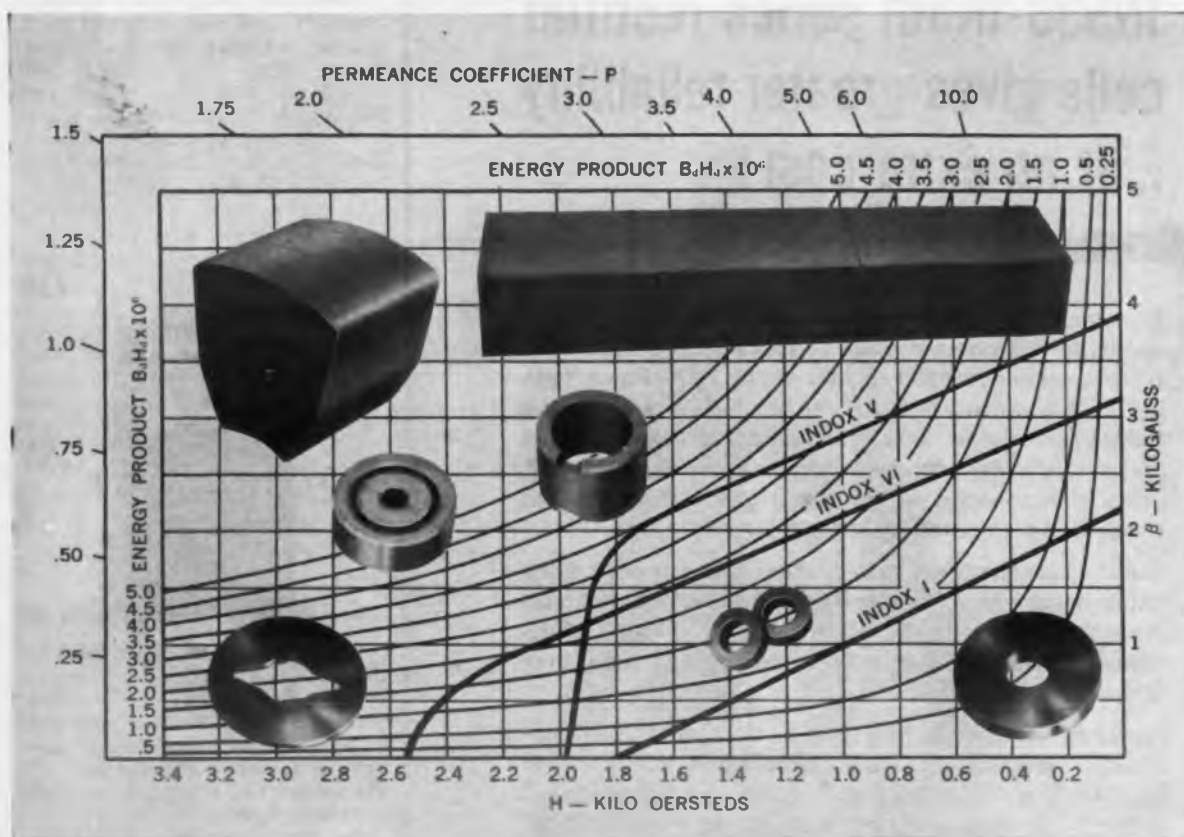
Electric Storage Battery Co., Missile Battery Div., Dept. ED, P. O. Box 11301, Raleigh, N. C.

## Solenoid Valves 625

Seven sizes: 3/8, 1/2, 3/4, 1, 1-1/4, 1-1/2 and 2 in. are offered. Types Q and Q-1 solenoid valves are UL listed. General purpose type Q is for air and water at 5 to 400 psi, temperatures to 250 F and steam pressure to 15 psi. Type Q-1 handles steam only from 5 to 150 psi and temperatures to 365 F.

J. D. Gould Co., Dept. ED, 4707 Massachusetts Ave., Indianapolis 18, Ind.

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## NEW PRODUCTS

### Power Supply

465



Dynamic regulation of  $\pm 0.1\%$  line and  $\pm 0.5$  v load is maintained by dc power supply MTR28-30 over its output range of 24 to 32 v dc, 30 amp. A transistor series regulator eliminates transients; a magnetic amplifier provides static regulation of  $\pm 0.1\%$  line and load. Ripple is 5 mv, dynamic impedance 30 milliohms max from 0 to 20 kc.

Perkin Electronics Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

### Tape Cartridges

423



Continuous-loop tape cartridges, models M-4, M-6, and M-8A, accommodate tape lengths from 6-1/2 ft to 1,700 ft, and, using double-oxide tape in a moebius loop, play from 10 sec to 128 min at 3-3/4 ips. Lock automatically secures tape during shipping and handling.

Viking of Minneapolis, Inc., Dept. ED, 9600 Aldrich Ave., S. Minneapolis 20, Minn.

### Capacitor Retaining Clamp

486



For plug-in capacitors. Clamps are open-loop type with a built-in tension loop, and are available for several case diameters. Cam-action locking clips are said to hold capacitors securely against vibration and to permit fast closure and removal. Design conforms to MIL-C-8603 (ASG) specifications.

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

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NEW MEXICO: Electronics Parts Co., Inc., 222 Truman St., N. E., Albuquerque; Midland Specialty Co., 1712 Lomas Bl. N. E., Albuquerque; Radio Specialties Co., Inc., 209 Penn Ave., Alamogordo.

NEW YORK: Arrow Elect. Inc., 525 Jericho Turnpike, Mineola, L. I.; Electronic Center, Inc., 160-5th Ave., N. Y.; Harvey Radio Co., Inc., 103 W. 43rd St., N. Y. 36; Lafayette Radio Elect. Corp., 100 Sixth Ave., N. Y. 13; Stack Industrial Elect. Inc., 45 Washington St., Binghamton; Terminal-Wadson Elect. Inc., 236 W. 17th St., N. Y. 17.

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• Five case sizes in working voltages and ranges:

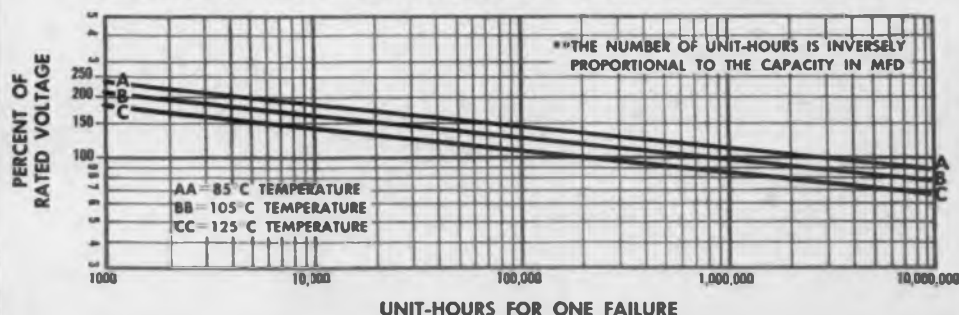
200 WVDC —	.018 to .3 MFD
400 WVDC —	.0053 to .33 MFD
600 WVDC —	.0048 to .33 MFD
1000 WVDC —	.005 to .1 MFD
1600 WVDC —	.005 to .05 MFD

**SPECIFICATIONS**

- TOLERANCES: 10% and 20%. Closer tolerances available on request.
- INSULATION: Durez phenolic, epoxy vacuum impregnated.
- LEADS: No. 20 B & S (.032") annealed copper clad steel wire crimped leads for printed circuit application.
- DIELECTRIC STRENGTH: 2 or 2½ times rated voltage, depending upon working voltage.
- INSULATION RESISTANCE AT 25°C: For .05MFD or less, 100,000 megohms minimum. Greater than .05MFD, 5000 megohm-microfarads.
- INSULATION RESISTANCE AT 105°C: For .05MFD or less, 1400 megohms minimum. Greater than .05MFD, 70 megohm-microfarads.
- POWER FACTOR AT 25°C: 1.0% maximum at 1 KC

These capacitors will exceed all the electrical requirements of E. I. A. specification RS-164 and Military specifications MIL-C-91B and MIL-C-25C.  
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**NEW PRODUCTS**

**Film Resistors**

484



Microminiature film resistors are 0.135 in. in diameter and 0.05 in. long. They are rated at 1/8 w, 250 v at 100 C, and are derated to 150 C. The resistance range from 25 ohms to 110 K is covered with 1% and 2% tolerances. The noble metal film resists oxidation and moisture, and is not affected by low temperatures.

American Components, Inc., Dept. ED, 8th Ave. and Harry St., Conshohocken, Pa.

P&A: \$4.00 to \$1.00; from stock.

**Infrared Equipment**

458

Produces up to 3,000 F. High-intensity infrared equipment uses fluid cooling to obtain the maximum capabilities of quartz lamp sources. Product temperatures up to 3,000 F can be produced in continuous operation. The equipment can be readily adapted to custom designs.

Fostoria Corp., Engineered Products Div., Dept. ED, Fostoria, Ohio.

**Solenoid Valves**

483



Miniature three-way, brass solenoid valves, series BM-300, handle differential pressures up to 200 psi. ON, NC, directional, and free-venting types are available. Valves weigh 15 oz, measure 3-47/64 in. over-all. Liquids and gases from -45 to +150 F are handled. Operating time is 8 to 12 msec. Special models rated at 500 psi and -60 to +350 F are available.

Allied Control Co., Inc., Dept. ED, 2 East End Ave., New York 21, N. Y.

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	2N706A	2N1837A	2N1711	2N1337		
	2N706B	PT850	2N1893	2N1338		
	2N708	PT850A	<b>GENERAL PURPOSE SWITCHING TRANSISTORS</b>	2N1342		
	2N753	<b>STANDARD SWITCHING TRANSISTORS</b>		2N1505		
	2N834			2N1506		
	2N835			2N1709		
	2N919			2N1710		
	2N920			PT530A		
	2N921			PT531		
2N922	PT612					
2N1252	PT613					
2N1253	PT720			<b>SPECIAL PURPOSE SWITCHING TRANSISTORS</b>	<b>RF HI POWER TRANSISTORS</b>	
<b>PREMIUM SWITCHING TRANSISTORS</b>	2N497		2N1336			2N1899
	2N498	2N1339	2N1900			
	2N656	2N1344	2N1901			
	2N657	2N1838	2N1902			
	2N696	2N1839	2N1903			
	2N697	2N1840	2N1904			
	2N698	<b>COMMUNICATION TRANSISTORS</b>	PT900			
	2N699		2N1340			PT900-1
	2N717		PT600			
	2N717A		PT601			
2N718						
2N718A						
2N719						
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2N720A	2N707					
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| <input type="checkbox"/> 2N697  | <input type="checkbox"/> 2N1409  | <input type="checkbox"/> 2N1710  | <input type="checkbox"/> PT600   |
| <input type="checkbox"/> 2N706  | <input type="checkbox"/> 2N1410  | <input type="checkbox"/> 2N1837  | <input type="checkbox"/> PT601   |
| <input type="checkbox"/> 2N706A | <input type="checkbox"/> 2N1410A | <input type="checkbox"/> 2N1837A | <input type="checkbox"/> PT850   |
| <input type="checkbox"/> 2N1336 | <input type="checkbox"/> 2N1420  | <input type="checkbox"/> 2N1838  | <input type="checkbox"/> PT850A  |
| <input type="checkbox"/> 2N1338 | <input type="checkbox"/> 2N1505  | <input type="checkbox"/> 2N1839  | <input type="checkbox"/> PT900   |
| <input type="checkbox"/> 2N1340 | <input type="checkbox"/> 2N1506  | <input type="checkbox"/> 2N1840  | <input type="checkbox"/> PT900-1 |

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## PSI TRANSISTOR TO-51 PACKAGE



### 2N958 • 2N959

#### HIGH PERFORMANCE COMPUTER LOGIC SWITCHES

$T_s < 25 \text{ ns}$  •  $V_{CE}(\text{sat}) < .2\text{V}$  • 250mW Dissipation @ 25°C

SPECIFICATIONS		Min.	Max.
$V_{CE}$ .....	25 volts		
$V_{CE}$ (R=10 ohms) .....	20 volts		
$V_{CE}$ .....	15 volts		
$V_{BE}$ .....	5 volts		
Power Dissipation @ 25°C .....	.250 watts		
$I_{CBO}$ @ $V_{CE}$ .....			0.5 $\mu$ A
$h_{FE}$ $V_{CE}=1\text{V}$ (2N958) .....	20	60	
$h_{FE}$ $I_C=10\text{mA}$ (2N959) .....	40	120	
$V_{CE}(\text{sat})$ $I_C=10\text{mA}$ , $I_B=1\text{mA}$ .....	0.75V	0.85V	
$V_{CE}(\text{sat})$ $I_C=10\text{mA}$ , $I_B=1\text{mA}$ .....	0.20V		
$h_{FE}$ $V_{CE}=10\text{V}$ , $I_C=10\text{mA}$ , $f=100 \text{ mc}$ .....		2.0	
$C_{V_{CE}=5\text{V}}$ .....		7.0 pf	
$T_s$ $I_C=10\text{mA}$ , $I_{B1}=I_{B2}=10\text{mA}$			25 ns
$R_c=1000 \text{ ohms}$ .....			

#### DIMENSIONS



#### THE THREE STANDARD MICRO PACKAGES NOW AVAILABLE FROM PSI



**NEW TO-51 PACKAGE**  
for standardization in "swiss cheese" and other advanced methods of component assembly.



**PSI MICRO PACKAGE**  
ideally suited for "cord-wood" approach to micro-miniaturization.



**PSI PICO PACKAGE** this unit offers the ultimate for microminiaturized component assembly.

All illustrations shown in actual size.

There's a PSI Micro-Transistor for every design requirement and every assembly technique.

If you're planning a new and original computer design

let us hear from you. Just call

Bill Eckess, OSborne 9-2281,

TWX: HAW CAL 4270 or write

PSI Micro-Electronics Division.

Ask for your copy of the new up-to-the-minute "Micro-Electronics Catalog" and "PSI Micro-Diode Reliability Report"

Available at PSI Distributors coast-to-coast



## Pacific Semiconductors, Inc.

A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.

12955 Chadron Avenue, Hawthorne, Calif. • Cable: PSISOCAL

CIRCLE 75 ON READER-SERVICE CARD

#### Narrow-Band Crystal Filters

538



Bandwidths of 2 kc to 30 kc at 6 db with a center frequency at 10.7 mc are provided by a series of six crystal filters. Designated series FB, the units are hermetically sealed. Insertion loss is 4 db max; in-band ripple, 0.8 db max; ultimate rejection, 105 db min. Units occupy less than 2.5 cu in. and operate from -55 to +90 C.

Midland Manufacturing Co., Dept. ED, 3155 Fiberglas Road, Kansas City 15, Kan.

Availability: From stock.

#### DC Driver

687



Flip-flop fan-out capabilities are extended to 64 AND or OR gate loads per output with the T-163 dc driver. Standard T-series container measures 7/8 in. diameter by 2-3/16 in. seated height, with 9-pin plug-in base.

Engineered Electronics Co., Dept. ED, 1441 E. Chestnut Ave., Santa Ana, Calif.

P&A: \$32.50 ea; stock.

#### Digital Readout

677



Four-unit digital readout assembly 20000P features quick disconnect and plug-in. Entire assembly may be removed from panel front, or lamp and terminal assembly may be disconnected from the rear. Assembly may be potted to specification.

Industrial Electronic Engineers, Inc., Dept. ED, 5528 Vineland Ave., North Hollywood, Calif.

P&A: \$129.50; 30 days.

## NEW PRODUCTS

### Heat Dissipators

496



One-piece aluminum heat sinks, made in three basic package sizes with configurations for mounting JEDEC transistors and diodes, contain no welded or brazed joints. Cooling fins are radially arranged. Low profile makes the dissipators suitable for circuit card uses.

U. S. Heat Sink, Dept. ED, 637 S. Isis Ave., Inglewood, Calif.

### Pot Tapping Kit

526

Snap taps to simulate nonlinear or special functions in the RVBC2 and RVC2 precision pot may be inserted with this portable tapping kit. Goniometer and chuck assembly, insertion tool, and necessary accessories are included.

Technology Instrument Corp., Dept. ED, 531 Main St., Acton, Mass.

### Delay Line

495



Delay time of 24.65  $\mu\text{sec}$  is provided by delay line model 332. Designed for aircraft transponder use, the line is hermetically sealed for operation to 60,000 ft; temperature range is  $-65$  to  $+105$  C. Weight is 14 oz, size 1.625 x 2.45 x 3.3. Output rise time is 0.60  $\mu\text{sec}$ . Ten taps with tolerances of 0.1  $\mu\text{sec}$  are provided. Attenuation is 4 db.

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

## Concerned about these radiation



NEW YORK—Pulse nuclear radiation which could temporarily disable avionics controls in a weapon system and thus jeopardize the success of the weapon's mission is becoming the subject of serious military and industry concern.

The extremely brief, but very high intensity pulses of radiation that occur immediately following a nuclear explosion can produce disrupting transients or erratic operation of avionic equipment at distances from the detonation point that were once considered to be safe for equipment.

AVIATION WEEK, 8/8/60, Page 58

Increasing use of nuclear energy in propulsion systems and weapons, as well as the exposure of space systems to Van Allen and cosmic radiation, is causing growing interest in the effects of nuclear radiation on complex electronic systems. One of the more significant phenomena that occur under high-level nuclear radiation is the transient effect, leading to circuit malfunction as opposed to permanent damage. . . . shields or protective covers that surround typical electronic systems are almost completely transparent to these radiations.

ELECTRONICS, 2/10/61, Page 62



## G. E. OFFERS THREE ANSWERS TO

### 1. G-E 5-STAR TUBES



Special heavy-duty construction, highest quality materials, and low boron-content glass envelopes give G-E 5-Star tubes an increased tolerance to steady-state radiation and provide faster recovery time to pulsed gamma radiation. Integrated gamma dosage up to  $10^9$  roentgens and approximately  $10^{18}$  integrated fast neutron flux (NVT) can be sustained without permanent damage. For temperatures up to  $220^\circ\text{C}$ ., G-E 5-Star tubes offer the ultimate in high-output performance and reliability under the most adverse conditions of vibration and shock.

### 2. CERAMIC TUBES



Microminiature ceramic tubes, when adapted to your present circuitry, can increase steady-state radiation tolerance to as high as  $10^{11}$  roentgens and  $10^{19}$  NVT. In addition, the effects of pulse radiation are reduced considerably if the tubes are operated at higher temperatures. These reductions are proportionately greater as the tube operating temperature is increased to its maximum, up to  $500^\circ\text{C}$ .

Rigid, compact construction of ceramic tubes makes them extremely resistant to shock and vibration and provides the smallest equipment package using standard circuitry components.

# problems in the news?

 **ELECTRONICS**



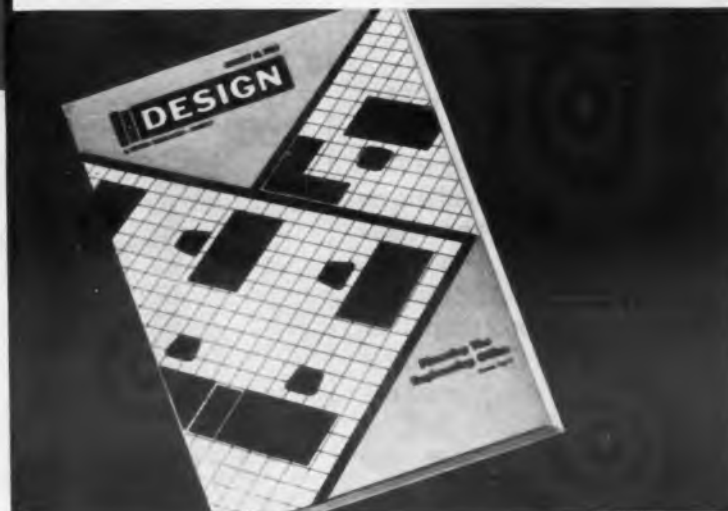
Frequently it is desirable to operate in a high radiation area and protect equipment by shielding. . . preliminary considerations seem to rule out protection by shielding for present payloads. The range of a 100-mev proton is about 1.5 cm in lead; since about half of the damage is produced by the protons above 100 mev, it is clear that several cm of lead will be required to increase semiconductor lifetime significantly.

. . . cascade products are forward scattered in addition to other less preferentially radiated products, it appears that the use of thin shields may lead to an increase in damaging radiation.

*Proceedings of the IRE, 5/60, Page 952*

Researchers who recently uncovered a new radiation hazard are now searching for ways to counteract it. When transient radiation (gamma rays and neutrons) strikes electronic instruments, they act up, components don't function properly, and false data are sent out or received. Dose rates don't have to be high, and even "safe" radiation levels are unsafe for electronics, says the Defense Dept. Implications are serious because computers, missiles, and defense electronics systems are all susceptible.

*MACHINE DESIGN, 8/18/60, Page 23*



## NUCLEAR RADIATION PROBLEMS

### 3. TIMM CIRCUITS (Thermionic Integrated Micro Modules)



TIMM circuits, inherently resistant to radiation, are made of ceramic and titanium components which tolerate nearly 10,000 times the steady-state radiation of circuits employing solid-state devices, and more than 1,000 times greater high-intensity pulse radiation. No transients were produced in the output of a test TIMM during a  $5 \times 10^7$  R/sec. dose rate pulse.

TIMM circuits operate at 580° C., utilizing normal heat losses to increase efficiency; B+ power usage is no more than solid-state circuitry. High, constant temperature provides improved circuit stability. Rugged, micro-miniature construction is highly resistant to shock and vibration and allows component densities as high as one million parts per cubic foot.

Write for your free radiation file folder containing all the latest information on components and applications data. To: General Electric Co. Receiving Tube Dept. Room 7139 B Owensboro, Kentucky



*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

### Time Generator

573



For oscilloscope calibration and time measurements. Model 166B time generator gives intensity-modulated time markers synchronized to the trace of the firm's 160B and 170A oscilloscopes. It provides marker intervals of 10, 1 or 0.1  $\mu$ sec with an accuracy of  $\pm 0.5\%$ .

Hewlett Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.

*P&A: \$130; 10 weeks.*

### Transistor Testers

353



An electronic servo automatically sets transistor biases in the series TAB transistor testers. Basic parameters of npn and pnp, small and medium power transistors can be measured. Collector voltage range is 0 to 30 v dc; current range is 0.1 to 100 ma; base current, -1 to 100 ma.

Deltron, Inc., Dept. ED, 4th and Cambria Sts., Philadelphia 33, Pa. *Price: \$240 to \$305.*

### Ripple Meter

447



For aircraft and missile dc power supplies, model T256 ripple meter measures peak-to-peak, plus peaks, minus peaks and rms. It can be battery or line powered.

Avtron Mfg., Inc., Dept. ED, 10409 Meech Ave., Cleveland 5, Ohio.

*Price: \$350.*

CIRCLE 76 ON READER-SERVICE CARD



**NEWS! API NOW HAS A CONTINUOUS READING METER-RELAY.** No signal-sampling interrupters necessary. The CRMR indicates continuously, controls continuously, resets automatically. Built around an unrestrained D'Arsonval movement, it will monitor and control any variable translatable to analogous voltage or current values. Sensitive enough to operate on inputs as small as 5 millivolts or 10 microamps full scale, it will accept low-level signals without amplification. Compact as a panel meter, it needs only a power supply and load relay (both of which API can furnish) to make a complete little control system. Or, you can build it into an equipment control network. Bulletin S-2-1 will give you details on operation, along with specifications and price information. A copy is yours for the asking.



**ASSEMBLY PRODUCTS, INC.**

CHESTERLAND 17, OHIO



CIRCLE 77 ON READER-SERVICE CARD

SA 2576

## NEW PRODUCTS

### High-Voltage Capacitors

682



Paper-dielectric capacitors type RA are available in 10 different voltage ranges from 10 to 60 kv dc. Operating from  $-55$  to  $+115$  C, they are rated for 10,000 hr at 85 C. Capacitors are impregnated with polybutene oil.

Corson Electric Manufacturing Corp., Dept. ED, 540 39th St., Union City, N. J.

### Indicator Light

678



Miniature indicator light, called Mini-Cator, consists of a replaceable lamp cartridge and mating lamp holder. Holder mounts in a 3/8-in. diameter hole. Cartridge has nylon shell and stainless steel pins.

Industrial Devices, Inc., Dept. ED, Edgewater, N. J.

### DC Relay

690



Sensitive dc relay of SP series operates as low as 15 mw, spdt, and 70 mw, dpdt. Contacts are rated for 5 amp resistive, 115 v ac or 26.5 v dc. Size is 2 x 2-1/8 x 1-3/4 in., temperature range  $-45$  to  $+85$  C. Standard coil resistances are 2.5, 5, and 10 K.

Elgin Advance Relays, Electronics Div., Elgin National Watch Co., Dept. ED, 2435 N. Naomi St., Burbank, Calif.

*P&A: About \$3 ea; stock to 8 weeks.*

*Why Die Stamped Circuits by Dytronics?*

## ELECTRICAL PROPERTIES UNIMPAIRED

Die stamped circuits are produced by a dry technique which employs a heated metal-cutting die to delineate the conductor pattern and bond it to the base material by activating the adhesive between the metal foil and the insulating material.

The electrical properties of the base material are unimpaired, because no chemicals are used, and there is no adhesive residue or residual metal on the insulating surfaces. This gives the designer the advantage of selecting base materials for physical and electrical properties without considering chemical resistance.

A new booklet, "Designing with Dytronics Die Stamped Circuits," will help you evaluate and design with die stamped circuits. Write for your free copy today.



**Dytronics**  
INCORPORATED

ROCHESTER 48, MICH.

A subsidiary of Taylor Fibre Co.  
Morristown, Pa.

CIRCLE 78 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • July 19, 1961

## Telemetry Filters

363



All standard bands, transmit and receive, are covered by the series N filters. Output is within 1.5 db of input over  $\pm 7.5\%$  of center frequency for channels 1 through 18, and  $\pm 15\%$  for channels A through E. Insertion loss is less than 3 db. Distortion over entire band is less than 1%. Units, epoxy-encapsulated, have a temperature range of  $-55$  to  $+85$  C.

Key Resistor Corp., Dept. ED, Gardena, Calif.

Availability: 30 days.

## Cable Strap

365



Self-locking cable strap can be inserted into a blind mounting hole and locked by thumb pressure without tools, forming a hermetic seal. Construction is of grey plastic. Insulating straps resist chemicals, corrosion, wear, and vibration. Various sizes are available.

Budwig Manufacturing Co., Dept. ED, P. O. Box 4212, Glendale 2, Calif.

## Radio Beacon Transmitter

352



Re-entering space vehicles can be identified and located with this transistorized beacon transmitter. Transmitter is crystal controlled and amplitude modulated with two or more audio frequencies, one for identification and others for telemetering. Telemetering modulation frequencies are variable.

Cook Electric Co., Dept. ED, 2700 Southport Ave., Chicago 14, Ill.



## Now, you can save time and insure reliability... by specifying DK Coaxial switches in your design

It's easy. DK Coaxial switches are available in scores of shapes, sizes, and functions *from factory stock*. RF Products' new DK Coaxial switch catalog lists over 130 variations of 16 basic coax switch designs, covering a proven 90% of all known applications. All the facts and figures on the industry's most complete line of coaxial switches are at your finger tips.

You'll also find that these switches successfully combine ruggedness with the highest standards of precision: spring-leaf switching blades, gold-plated silver contacts and impedance matched connectors keep insertion loss and VSWR (1.3 @ 4,000 MCs) low, Crosstalk high (in

decibels down); electro-mechanically actuated models operate and release in 8 to 20 milliseconds, depending on type and function, with a proven mechanical life of 1,000,000 cycles minimum when operated under 10 cps.

And, don't forget that RF Products, pioneers in the development of the coaxial switch, will continue to offer you design and engineering services whenever you need them. Whether you order a switch from the catalog or a switch designed to meet your exact specifications, you can be assured of the same high quality and service.

For details on our new line of standard switches, write for catalog DK 61.

**RF PRODUCTS**

DIVISION OF AMPHENOL-BORG ELECTRONICS CORPORATION



33 EAST FRANKLIN ST., DANBURY, CONN.

# The Untouchables (Part 4)

## Specify Crucible Charges of Deposited Hyper-Pure Silicon



Free brochure—"Hyper-Pure Silicon for Semiconductor Devices." Write Dept. 4019.

*Pre-packaged* single piece crucible charges . . . in sizes and weights to meet the exact requirements of your Czochralski crystal growing equipment . . . are now available from Dow Corning.

*Accurately Pre-weighed*, these single piece crucible charges assure easy handling . . . smallest surface area . . . highest purity . . . an exceptionally clean melt and a savings in crucible costs.

*High Quality* is inherent in Dow Corning crucible charges. The *deposited* polycrystalline silicon in these charges has never touched a mold. Result — highest purity.

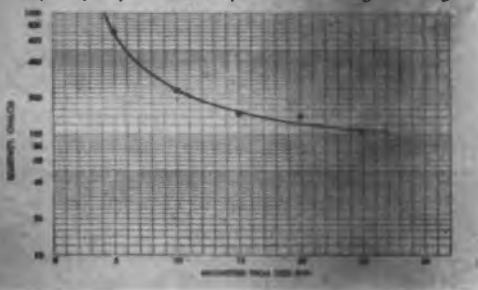
*This High Purity* means consistently higher quality crystals — simplifies doping procedures — increases device yield. Typical resistivity of N-type crystals grown from Dow Corning pre-packaged crucible charges is greater than 100-ohms centimeter for 80% of the crystal; maximum boron content, 0.3 parts per billion atoms; maximum donor impurity, 2.0 parts per billion.

*Now You Specify the Weight and Diameter*, up to 38 mm (about 1½"), best suited for each crucible of your Czochralski crystal growing machines. Your crucible charges will be supplied in the appropriate length to provide the exact weight you require in just one piece.

*Protective Packaging* guards initial *deposited* purity right through crucible charging. Charges are individually wrapped in special cellophane, and sealed in airtight polyethylene envelopes to assure untouchable purity.

Whatever your need — deposited silicon crucible charges; polycrystalline rod or chunk; high resistivity P-type single crystal rod; single crystal rod doped to your specifications — Dow Corning should lead your list of sources.

Profile of Crystal Grown from Pre-Packaged Charge



**HYPER-PURE SILICON DIVISION**  
Address: **HEMLOCK, MICHIGAN**

**Dow Corning CORPORATION**  
MIDLAND, MICHIGAN

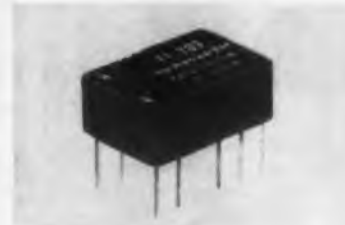
ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

CIRCLE 80 ON READER-SERVICE CARD

## NEW PRODUCTS

### Digital Modules

681



Encapsulated digital logic modules of series 200 operate from dc to 250 kc, in temperatures from -54 to +71 C. Included are active-NAND and OR elements, diode gating, and logically gated flip-flops. Terminals match 0.200-in. grid.

Data Systems Div., Harman-Kardon, Inc., Dept. ED, Ames Court, Plainview, N. Y.  
**Price:** \$5 to \$20 ea in quantity.

### Log Frequency Converter

680



With 2% accuracy. Model HLFC-120 log frequency converter provides a dc voltage output which varies in proportion to the log of the frequency of an input signal. Used with X-Y plotters, the unit has full-scale output of 100 mv at 400 ohms. Interchangeable discriminators cover 1, 2 or 3 decades from 5 cps to 20 kc. Accuracy is 2% from 20 cps to 20 kc.

Houston Instrument Corp., Dept. ED, P. O. Box 22234, Houston 27, Tex.

**P&A:** \$565; 45 days.

### Sequencer

691



Miniature, modular sequencer type SSL-101 is designed to produce signals on separate output lines at a rate equal to that of the input clock. The 10-count unit allows only one output to be energized at a time. Size is 0.7 x 0.7 x 3.0 in. max; weight is under 1 oz.

Alpha-Tronics Corp., Dept. ED, 1033 Engracia, Torrance, Calif.

**Availability:** 30 days.

## Linear Potentiometer

679



Low-noise linear pot series 431 is made with strokes from 0.5 to 12 in., power rating 1.2 w per in. Stability is under 30 ppm per deg C to 150 C; resistance range is 50 ohms to 1 meg. Accuracy is  $\pm 2\%$  to  $\pm 0.5\%$ . Unit withstands heavy shock and vibration.

Hyres Electrical Div., Hydraulic Research and Manufacturing Co., Dept. ED, 11675 Sheldon St., Sun Valley, Calif.

**P&A:** \$200; 30 days.

## Insulation Tester

684



With megohmmeter. Model 2955 Vibrotest is designed for dielectric absorption tests and plotting of insulation resistance vs time. The dc test potential is continuously adjustable from 0 to 2,500 v. Meters with 4-1/2 in. scale indicate test voltage and insulation resistance from 100 K to 50,000 meg.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

## Digital Printer

683



Front-feed printer model 400DT can be coupled to any electronic counting equipment or control system that provides 1-2-4-8 binary-coded decimal output with a swing of  $-6$  v. The six-digit unit has a cycling rate of four lines per sec max. Printer mounts in cabinet or rack.

Computer Measurements Co., Dept. ED, Sylmar, Calif.

**P&A:** \$1,700; 60 days.

**DORSETT'S  
3 NEW  
SILICON  
SOLID STATE  
SUBCARRIER  
OSCILLATORS  
FOR FM TELEMTRY**

SPECIFICATIONS	
<b>Input:</b>	0 to 5 volts, or $-2.5$ volts to $+2.5$ volts.
<b>Output:</b>	Adjustable from 0 to .5 volts RMS into 8K load impedance. Fixed output at least 3 volts RMS into 100K or higher load impedance. 28 volts DC at 10 milliamperes.
<b>Power Requirements:</b>	500K for Channels 1 through 18.
<b>Linearity:</b>	Deviation from the best straight line less than .25%.
<b>Distortion:</b>	Less than .75% harmonic distortion.
<b>Amplitude Modulation:</b>	Less than 1db across the band.
<b>Input Impedance:</b>	250K for Channels A through E.
<b>Electrical Stability:</b>	No more than $\pm .5\%$ FBW change in center frequency or deviation sensitivity for a supply voltage change of $\pm 10\%$ .
<b>Temperature Stability:</b>	Less than 2% FBW change in center frequency or band-width for a $50^\circ\text{C}$ change within the range of $-55^\circ\text{C}$ to $+100^\circ\text{C}$ .
<b>Acceleration:</b>	100G Linear
<b>Vibration:</b>	20G, 55 to 100 cps
<b>Shock:</b>	100G for 11 milliseconds
<b>Altitude:</b>	Unlimited
<b>Size:</b>	<b>O-18</b> 1.75 in. x 1.36 in. x .76 in. <b>O-20</b> 2.25 in. x 1.88 in. x .88 in. <b>O-28</b> 1.27 in. x 1.25 in. x 1.25 in.
<b>Connector:</b>	Cannon DE-9P.
<b>Controls:</b>	Output, Centering, Deviation Sensitivity

To meet increased demand for a wide range of subcarrier oscillator configurations Dorsett Electronics now offers its extremely reliable solid state subcarrier oscillator in three new package forms.

Dorsett's three new configurations provide the systems engineers with unmatched mechanical flexibility in telemetry system design, without sacrificing component reliability and stability.

These new subcarrier oscillators are only a few of the many state of the art telemetry components currently in production at Dorsett Electronics. Put Dorsett's experience to work for you on your next telemetry requirement. Your inquiries and specifications will receive a prompt reply.



# DORSETT ELECTRONICS, INC.

P. O. BOX 862 • NORMAN, OKLAHOMA • JEFFERSON 4-3750

CIRCLE 81 ON READER-SERVICE CARD





**Cary Electrometers measure insulation resistance of  $10^{15}$  ohms at potentials of one volt or less with  $\pm 1\%$  accuracy**

*Provide fast accurate leakage measurements; eliminate instrument loading of the test circuit*

In addition to measuring large resistance values Cary Electrometers are used for measuring charging phenomena, hysteresis and photo effects of semi-conductors and insulating materials. Applications include air ionization studies, measurement of ion currents in mass spectrometry, radioactivity measurements of solids, liquids and gases and Hall effect studies.

Cary Electrometers detect currents as small as  $10^{-17}$  amperes; charges to  $6 \times 10^{-16}$  coulombs; and voltages as low as 20 microvolts.

High stability (less than  $5 \times 10^{-17}$  amperes steady drift), high accuracy ( $\pm 0.25\%$  using a precision potentiometer), and operation independent of changes in vacuum tube and component characteristics are just a few of the features contributing to the superior performance of Cary Electrometers.

Choose from several models: MODEL 31 for measuring currents from grounded sources and voltages from ungrounded sources; MODEL 31V for voltage measurements from grounded sources; MODEL 31-31V for measuring voltage or current from grounded sources.



INSTRUMENTS

**Additional information**  
on Cary Electrometers and Accessories  
is yours for the asking.  
Write for data file M14-71

*Electrometers • UV-Visible - Near IR and Raman Spectrophotometers*

**APPLIED PHYSICS CORPORATION • 2724 So. Peck Rd., Monrovia, Calif.**

## NEW PRODUCTS

### Delay Line

685



Lumped-constant delay line provides a delay of 0.21  $\mu$ sec, with a rise time of 0.08  $\mu$ sec max. The line withstands 800 v min; maximum continuous operating temperature is 125 C. Attenuation is 20% max. Diameter is 0.3 in., length 1.5 in.

Andersen Laboratories, Inc., Dept. ED, 501 New Park Ave., West Hartford 10, Conn.

### Silicon Diodes

660

Diffused-junction silicon diodes MA-4413 and MA-4414 have a junction capacitance of 1.8 pf max at -6 v bias, and combine low leakage with 2-nsec switching speed. They are rated at 10 ma at 1.0 v forward with breakdown voltages at 0.1  $\mu$ a of 40 and 30 v. Made for computer applications, the diodes are sealed in a subminiature glass case.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

### Reflecting Tape

661

Pressure-sensitive tape Y-9050 is capable of performing continuously at temperatures of 500 to 600 F, and can withstand more than 3,000 F radiant heat for short periods. Thickness is 0.006 in., weight 0.0038 lb per ft/in. width, tensile strength 75 lb per in. width. Roll lengths of 36 yards are 1/4 to 36 in. wide.

Minnesota Mining and Manufacturing Co., Dept. J1-1, Dept. ED, St. Paul 6, Minn.

### Limit Stop

689



Screw adjustment from 0 to 40 turns is provided by mechanical limit stop model 40. The size 10 device has 0.04 oz-in. starting torque with 0.50 oz-in. load limit. Weight is 1-1/2 oz, length 2 in.

Elm Instrument Corp., Dept. ED, 30 Chasner St., Hempstead, L. I., N. Y.

P&A: \$62.80 to \$78.50; stock.

## The quickest most practical way to put strong threads in soft materials the **TAP-LOK**<sup>®</sup> INSERT



SLOTTED

**IN SOFTER METALS AND PLASTICS**... Has full V-form external threads to provide maximum locking torque and permit wide choice of mating hole sizes. Recommended for soft aluminum, zinc die castings, sand castings and plastics. Meets requirements of MIL-MS-35914.



H-SERIES

**FOR HIGHER STRENGTH MATERIALS**... Has heavy wall and truncated root external thread and three-flute cutting edges for hard-to-tap higher-strength materials and to meet MIL and other specs calling for Class 3B thread fit for gaging after installation.



F-SERIES

**ELIMINATES CHIPS**... The F-Series Form-Lok self-tapping insert is thread forming and firmly locks itself in the base material. Available from stock in sizes  $\phi$ 4 through  $\frac{1}{2}$ ".



W-SERIES

**FOR WOOD**... Has coarse pitch external threads offering maximum strength in combination with ability to be driven into thin sections without splitting them. For furniture, cabinets and other wooden parts where strong, permanent threads are needed, or that are frequently assembled and disassembled.



Another fastener development from —

**TAP-LOK**  **GROOV-PIN CORPORATION**

1146 Hendricks Causeway, Ridgfield, N.J.  
CIRCLE 83 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961

## Digital Cards

441



For computer applications, these digital cards include a BCD-to-decimal decoder, an accumulator and a decade counter. The BCD-to-decimal decoder has repetition rates of 100 kc; flip-flops are used as basic storage device. The accumulator has five adder sections and the decade counter contains two full decimal digits of serial counters.

Computer Techniques Inc., Dept. ED, 3300 Northern Blvd., Long Island City 1, N. Y.

## Zener Diodes

390

Highly stable Zener reference diodes PS1511 through PS1517 are available with temperature coefficients ranging from 0.01% to 0.0005%. Made for 10-v decimal readout in differential and digital voltmeter applications, the units have low dynamic impedance characteristics and are not position-sensitive.

Pacific Semiconductors, Inc., Dept. ED, 12955 Chadron Ave., Hawthorne, Calif.

Price: \$7.65 to \$34.00 ea, 100 to 999.

## Long-Delay Relays

444



Accuracy is  $\pm 5\%$  for relays with time delays ranging from seconds to over 1-1/2 hr. Models can be furnished for on-time delay, off-time delay and interval timing. Contacts are 5 amp, 3pdt. Adjustable units have calibrated, etched dial. They can be surface mounted or flush-panel mounted.

Clearview Electronics Corp., Dept. ED, 140 E. Main St., P. O. Box 294, Elkton, Md.

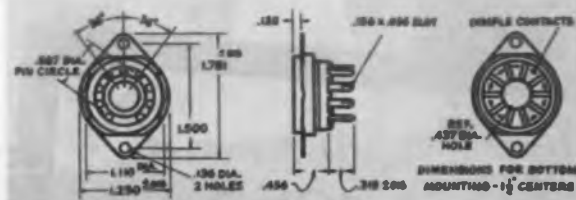
CIRCLE 84 ON READER-SERVICE CARD >

ONLY  
FROM  
CINCH.



# NOVAR TUBE SOCKETS

DEVELOPED IN CONJUNCTION WITH THE NOVAR TUBE



### ELECTRICAL RATINGS

1 1/2" Mtg. Ctr. Socket Ratings

- a. Adj. terminals (see level)  
b. Terminal to ground (see level)

Volts	
AC RMS	DC
3000	4800
4300	7050

current rating— 9 amperes  
contact resistance— 0.05 OHMS MAX.

### NOVAR SOCKET ASSEMBLIES

BOTTOM MOUNTING	CINCH PART NUMBER	TOP MOUNTING	CINCH PART NUMBER
1 1/2" mounting centers GP Black (CFG)	149 19 00 033	1 1/2" mounting centers— GP Black (CFG)	149 19 00 045
Mica (MFE)	149 19 10 034	Mica (MFE)	149 19 10 046

Complete engineering data and detailed specifications are yours for the asking. Contact the Cinch Sales Office in your area.

- Cinch is the *only* source for Novar Sockets.
- Fits Present Chassis Cutouts. You don't have to redesign chassis to accommodate the Cinch Novar Socket; physical dimensions are the same as octal sockets.
- Electrical and mechanical tests performed according to EIA Standards.
- Contact Design. Contacts are designed for long-lasting resiliency and to withstand fatigue. This means dependable operation and reliability.
- Contact Finishes: insure constant voltage performance. Different finishes are available for extraordinary environmental conditions.

Write for full information today!



## CINCH MANUFACTURING COMPANY

1026 South Homan Avenue • Chicago 24, Ill.

Division of United-Carr Fastener Corporation, Boston, Massachusetts

DOT

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; and St. Louis, Missouri

## NEW PRODUCTS

### Servo Amplifier

657



For motors to size 15. Model A429 germanium servo amplifier, rated at 400 cps  $\pm 10\%$ , operates servomotors at 6-w output over the temperature range of  $-55$  to  $+71$  C. It is supplied with two parallel summing signal inputs each having independent gain.

Westamp, Inc., Dept. ED, 112 Massachusetts Ave., Los Angeles 25, Calif.

Availability: 1 week.

### Crystal Ovens

653

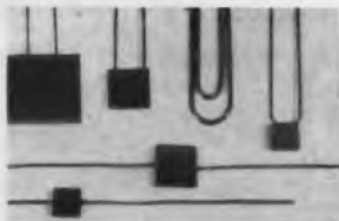


Temperature stability is  $\pm 0.1$  C for cycling; operating temperature is  $75$  to  $85 \pm 2$  C. The JK09S1 crystal oven holds two HC-6/U crystals; the JK09S115 holds two HC-13U crystals. Units with other ranges can also be furnished.

James Knights Co., Dept. ED, Sandwich, Ill.

### Microminiature Capacitor

656



Capacity is  $0.075 \mu\text{f}$ . Measuring  $0.5 \times 0.5 \times 0.125$  in., this capacitor has a voltage rating of 200 wvdc with a capacity variation of less than 10% from  $-55$  to  $+150$  C. Units with ranges from 47 pf to  $0.01 \mu\text{f}$  are also available. Dielectric is barium titanate.

American Components Corp., Dept. ED, 15222 Grevillea St., Lawndale, Calif.

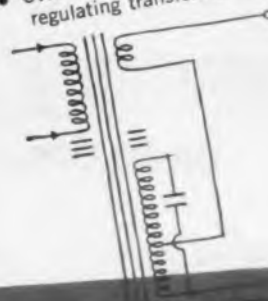
P&A: \$0.30 to \$2; stock.

# SO LA ... for progress

WEDNESDAY, JULY 13

1938

- CVN — the first practical regulating transformer



FRIDAY, SEPTEMBER 3

1948

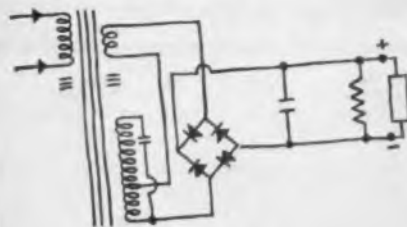
- CVS — the first integrally packaged sine wave regulating transformer



THURSDAY, AUGUST 19

1954

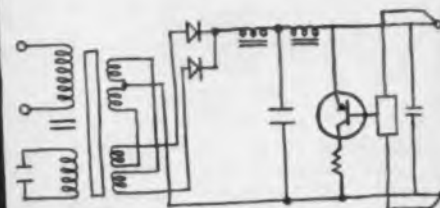
- CVDC — the first static-magnetic dc power supply



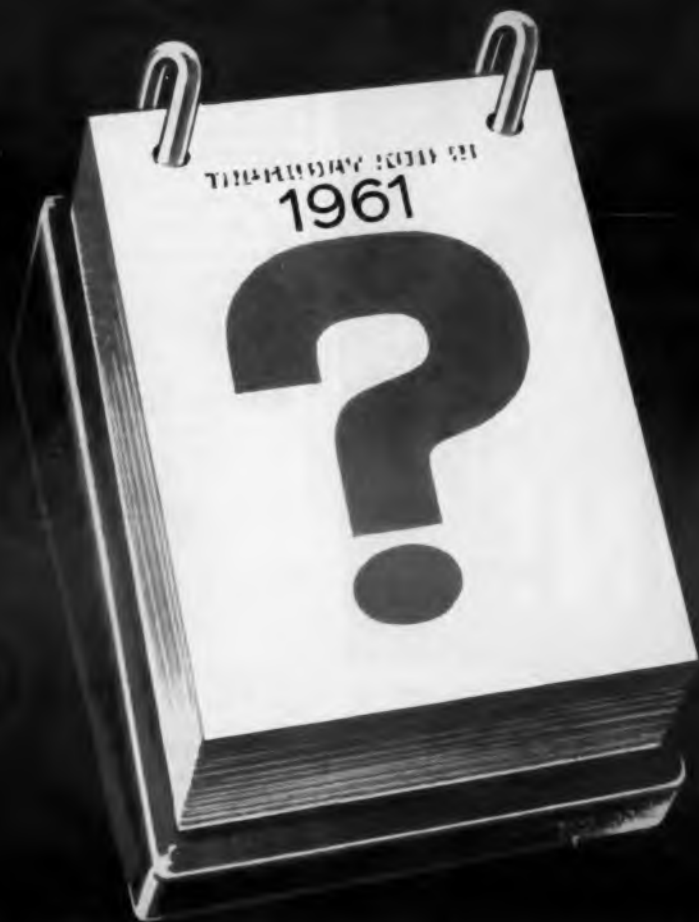
TUESDAY, FEBRUARY 7

1961

- CVQ — the first ultra-reliable transistorized dc power supply



# in "engineered" voltage regulation



The most significant thing about past performance is the promise it holds for the future. Each day, our engineering moves forward toward new milestones. We will welcome your problems in ac or dc power regulation. For immediate attention, write or phone Mr. A. Steichen, Product Manager, Electronics, Sola Electric Company, Elk Grove Village, Illinois.

**SOLA**

Division of  
Basic Products Corporation



SOLA ELECTRIC CO.  
1717 Busse Road  
Elk Grove Village, Ill.  
HEmpstead 9-2800  
IN CANADA, Sola-Basic  
Products Ltd., 377 Evans  
Ave., Toronto 18, Ont.

## Laboratory Electromagnet

658



Rotating 6-in. laboratory electromagnet type V-4007-2 features pole pieces of which the air-gap width may be adjusted from 1/32 to 5-1/2 in. by means of an integral gap-adjusting mechanism. The gap-adjusting device can be furnished separately.

Varian Associates, Instrument Div., Dept. ED, 611 Hansen Way, Palo Alto, Calif.

P&A: \$6,450; 45 days.

## Tube-Replacement Rectifiers

652



Provide long life inherent in silicon rectifiers. Types are 1N5070, 1N1262, 1N2630, 1N2631, 1N2632, 1N2633, 1N2634, 1N2636. They feature all-welded construction, are rugged and can be mounted in any position. They are suitable for new designs as well as replacement.

Ling-Temco Electronics, Inc., Dept. ED, P. O. Box S-1, Anaheim, Calif.

## Dual-Speed Drive

659



Accuracy is 12 min of arc. Designed for positioning a variety of rotary components, model DSD-40 dual-speed drive meets MIL-E-4970. An outer dial, for fine positioning, has a velocity ratio of 10:1; an inner dial, for course positioning, is directly coupled to the output shaft.

Technology Instrument Corp., Dept. ED, 533 Main St., Acton, Mass.

CIRCLE 85 ON READER-SERVICE CARD

*Never before could you*

# DIAL THE RIPPLE AND REGULATION!

Try this new twist: a built-in Adjustable Parameter control that actually lets you dial precisely the regulation and ripple characteristics you need in a power supply—quickly, economically! NJE's entirely new concept in power supply design—the Vari-Reg\*—enables the engineer to eliminate overspecification of costly regulation and ripple. You arrive at the combination of characteristics that best suits your application, without wasting time or money—then you

order production models accordingly.

Regulation may be smoothly adjusted between  $\pm 0.005\%$  and  $\pm 10\%$ . Ripple is accurately and smoothly adjustable between 3 and 200 millivolts peak to peak.

All NJE CR and QR Transistor-Regulated Power Supplies now feature the Adjustable Parameter Vari-Reg as an optional extra (\$75). All are available for immediate delivery. Write today for complete technical specifications and prices!

\*Patent Applied For



**NJE CORPORATION**  
20 Boright Avenue • Kenilworth, New Jersey  
BR. 2-6000 • TWX Cranford, NJ 51 • FAX-FFP

## NEW PRODUCTS

### Portable Oscilloscope

651



Measures 5-1/8 x 6 x 7 in. and weighs 5-1/2 lb. The Nuscope oscilloscope is for modulation control, production-line testing and equipment servicing. The vertical amplifier has a flat response from 40 cps to 225 kc and can be used from 10 cps to 500 kc and over. Sweep frequencies are 20 to 30 cps.

National Union Electric Corp., Electronics Div., Dept. ED, Bloomington, Ill.

P&A: \$89.50; from stock.

### Antenna Pedestal

655

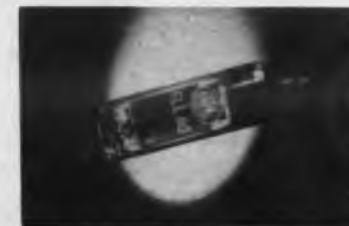


Weights 300 lb. Model 3606 azimuth antenna pedestal can be used at the top of a tower as well as at lower levels. It develops a torque of 1,000 ft-lb at 1.5 rpm. A mast of up to 5-1/2 in. may be installed through the vertical axis. Either ac or dc motors may be used.

ANTLAB, Inc., Dept. ED, 6330 Proprietors Road, Worthington, Ohio.

### Double Pentode

686



Miniature 9-pin double pentode ELL80/6HU8 is made for audio output stages. Tube has common cathodes, delivers 9 w with low distortion and can be used in push-pull or two single-ended circuits.

ITT Components Div., Dept. ED, Clifton, N. J.

## Power Attenuator

649



Dummy load bank is combined with power attenuator in model 511A. The attenuator has a rating of 50 w and is for use where a power amplifier is used to drive a low-power amplifier. An rf input can be connected from any 50-ohm coaxial line to the input connector.

Seco Electronics Inc., Dept. ED, 5015 Penn Ave. S., Minneapolis 19, Minn.

## Sound Meter

646



Range is 5 cps to 30 kc. Model 412 sound meter is designed to meet ASA S1.4-1961 standard. Sound-level range is 24 to 150 db. A ceramic microphone permits use over a wide temperature range. It has a built-in electroacoustic calibrator and operates on two batteries plus a single bias cell.

H. H. Scott, Inc., Dept. ED, 111 Powdermill Road, Maynard, Mass.

## Static Inverter

654

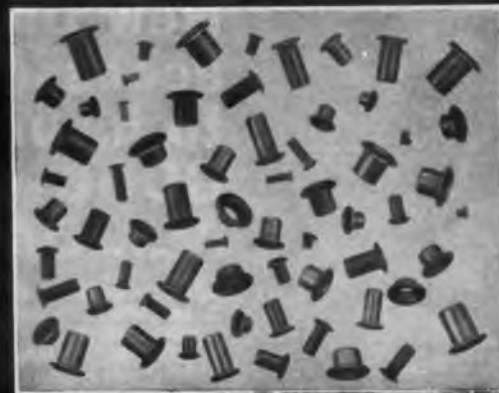


Rated at 1,200 va, model SI-4 static inverter delivers 115 v ac at 60 cps from 48 v dc. Other features are: maximum harmonic distortion, 7%; power factor, 0.8; temperature ranges, -20 to +60 C. Uses include standby sources for microwave broadcast equipment.

Kidde Electronic Laboratories, Dept. ED, Brighton Road, Clifton, N. J.

The only  
true measure of  
**eyelet  
price**

**Installed Cost**



\*IC Installed Cost... not the initial cost of eyelets, but the total cost when the eyelets have been installed in your product.

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**TOOLING COSTS  
REDUCED UP TO 90%!**



With United's system of standardized eyelet sizes, only 7 sets of tools are required for all 65 eyelets. One tool can set up to 12 different lengths of the same diameter! Initial tooling costs are greatly reduced... and the high quality and long life of United's setting tools keep replacement costs to a minimum as well. Where special eyeleting jobs call for special tooling, the ready availability of United's complete tool engineering service will help you save time and money. Savings in all these areas can help you cut your total tooling costs up to 90%!

for all the dollar-saving facts... that show how United can help you cut Installed Costs through lower tooling costs (and through lower engineering, down-time and tool acquisition costs), ask for your free copy of "Eyelets and Price Buying." Simply phone the United office in your area or write direct to Fastener Division, United Shoe Machinery Corporation, 1752 River Road, Shelton, Connecticut.



**United Eyelets**



Fastener Division

UNITED SHOE MACHINERY CORPORATION

Shelton, Connecticut

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CIRCLE 87 ON READER-SERVICE CARD

# New Unitek accessories to insure **GOOD WELDS ALL DAY**

1. Electrode Kit (EK-1000)
  2. Insulated Electrodes  
(CO-0400) Moly  
(CO-0402) RWMA-2
  3. Electrode Holders—3½ in. (HE-1200)
  4. Magnifier (MA-2117)
  5. Bracket Assembly (MA-2115)
  6. Illuminator (MA-2118)
  7. Horizontal Adapter (MA-2042)
  8. Riser Assembly (MA-2041)
  9. Force Gage (MA-2031)
  10. Electrode Aligner (MA-2102)
  11. Precision Wire Cutters (MA-2052)
- Not Shown: Visor (MA-2116)  
Swing Pedal—15 lb. (MA-2022)



New from Unitek — a coordinated line of accessories to keep space clear, to make operations fast and easy, to reduce eye strain, and to increase reliability in every step of the process. Write for detailed information and prices. 950 Royal Oaks Drive, Monrovia, California

**UNITEK**  
WELDMATIC  
DIVISION

CIRCLE 88 ON READER-SERVICE CARD



## NEW PRODUCTS

### Control Switch

430

Made for lamp or relay drive at currents up to 200 ma and voltages up to 32 v, model 600100 operates with nominal input voltage levels of 0 v and +3 v or more, with maximum loading of 100  $\mu$ a at -5 v. Sensitivity is under 30  $\mu$ a. Size is 0.88 x 0.88 x 2.00 in.

Weber Aircraft Corp., Weber Electronics Div., Dept. ED, 2820 Ontario St., Burbank, Calif.



### DC Signal Amplifier

373

Gain is 50 to 500, continuously variable. Model SA9-0 dc signal amplifier accepts inputs from thermocouples, thermal sensing to bridges and dc transducers. Output is 0 to 5 v; input is 0 to 10 mv; power required is 30 ma at 28 v  $\pm 10\%$ . It operates under environmental extremes and is suitable for airborne use.

Satham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.



### Transistor Tester

378

Displays beta as a function of collector current. Model T3A-2 transistor tester shows a complete plot of beta vs  $I_c$  from 0 to 500 ma peak at 1 to 10 kc. Provision is made for plots to 1 mc. Accuracy is 5%. The unit may be used with any dc scope.

Orbitec Corp., Dept. ED, 512-30th St., Newport Beach, Calif.

Price: \$1,125.



### Rack-and-Panel Connector

369

Multi-service, rack and panel, 14-contact connector has two RGU coaxial fittings. They are designed for either RGU 50 or RGU 70 ohm-matched impedance cable. Contacts are for AWG 20 wire; pin diameter is 0.040 in. Positive polarizing guide hardware is of nonmagnetic passivated stainless steel.

Precision Connectors, Inc., Dept. ED, P. O. Box 96, Mineola, L. I., N. Y.



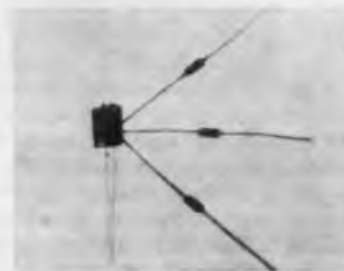
### Voltage References

372

Rated at 1.15 to 3 v with tolerances of 2% and 5%. Types SS3140 through SS3145 voltage references consist of series strings of silicon and germanium diodes. Dynamic resistance ranges from 20 to 40 ohms at 10 ma; average current at 25 C is 50 to 200 ma max; temperature coefficient is 2.4 to 5.6 mv per deg C.

Semiconductor Specialists, Inc., Dept. ED, 5706 W. North Ave., Chicago 39, Ill.

Price: \$2.50 to \$4.00.



## Connectors

648

For wire-wrap terminations. Type FT-WJ-100 Press-Fit Teflon connector is rectangular with truncated circular ends. When properly seated, it provides extremely high torque. Over-all height is 1.2 in., above-the-chassis height is 0.46 in. and below-the-chassis is 0.459 in.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N. Y.



## Logic Element

375

For 10 to 16 mc. Type LE-40 logic element can be used as a static flip-flop or dynamic logic element. It consists of four input AND gates which buffer into a steering circuit. It is compatible with the firm's 3C-PAC series H units.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

P&A: \$249; stock.



## Milliwatt Relay

376

Requires 40 mw. Series AV pillbox relay withstands 15-g vibration and 50-g shock. Header terminals are placed on the flat side of the relay. It can be supplied as spdt or 2pdt with contacts suitable for 2-amp or dry-circuit loads.

Filtors, Inc., Dept. ED, Port Washington, N. Y.



## Telemetry Transmitter

432

Used in rotors of high-speed machinery, telemetry transmitter WTT-102 transmits data on the subcarrier oscillator frequency directly, with no rf carrier, through noncontacting slip rings. Subcarrier frequency deviations of  $\pm 40\%$  are readily obtained. Cylindrical model WTT-103 is also available.

Wiley Electronic Products Co., Dept. ED, 2045 W. Cheryl Drive, Phoenix, Ariz.



## Isolator

421

Circuits at 25,000 v can be controlled from ground-level circuits through a high-voltage isolator. A light source operates a photosensitive cell in the separate high-voltage unit. Type CK-1105 isolator requires a control potential of 120 v; and CK-1108, 5 v. Signal resistance off is over  $10^7$  ohms, on is less than  $10^3$  ohms for the CK-1105 and less than 500 ohms for the CK-1108.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass.  
P&A: \$24.50; immediately in sample quantities.





precise  
**5 VOLT  
POWER  
SUPPLY**  
for instrumentation  
and telemetry

This compact, reliable DC to DC converter provides conversion of  $28 \pm 4$  volts DC to a precision 5 volts DC @ 100 ma. or 1 amp. Measuring only  $4\frac{3}{4}$  " x  $3\frac{1}{2}$  " x  $1\frac{1}{4}$  ", weighing only 20 ounces, it gives a completely accurate power supply and maintains it, with no change, within the temperature range. Designed, developed and produced by Temco Electronics, the converter is a solid state, off-the-shelf package that meets or exceeds mil specs. It will meet your airborne or ground telemetry and instrumentation power supply specifications with no necessity for change in configuration. We invite your inquiries on this unit. It is also available in other voltages to meet specific applications.



**LING-TEMCO ELECTRONICS, INC.**

TEMCO ELECTRONICS DIVISION • DEPT. 221N  
P. O. BOX 6191 • DALLAS 22, TEXAS

CIRCLE 89 ON READER-SERVICE CARD



## ENGINEERING REPORT ON BENDIX COMPONENTS

**SELECTED FOR**



**PROJECT ADVENT!**



# BENDIX REACTION WHEEL FOR SATELLITE CONTROL AND STABILIZATION

Precision reaction wheels developed at Bendix meet requirements for attitude control of space vehicles and satellites. For example, these wheels will be used for Project ADVENT—advanced Army research program which will use satellites as relay stations for global communications.

Since reaction torque is directly proportional to applied voltage, the reaction wheel provides a means for proportional control of vehicle attitude. An integral tachometer senses wheel speed and direction of rotation.

Several wheel configurations are now available, and the basic design concept offers flexibility to meet still broader requirements. Individual wheels can be tailored to specific voltage, torque, inertia, and momentum storage requirements.

#### ADVANTAGES AND FEATURES

- Minimum weight and power • Brushless motor and tachometer
- Low friction • Flexible design
- Consistent performance over environmental range

**Eclipse-Pioneer Division**

Teterboro, N. J.



District Offices: Burbank, and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D.C.  
Expert Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N.Y.

CIRCLE 90 ON READER-SERVICE CARD

## NEW PRODUCTS

### DC Power Supplies

650



Regulation is  $\pm 0.1\%$ . Six of the power supplies in the MRST series have an output of 24 to 32 v at 100 to 600 amp and one has an output of 24 to 40 v in two ranges at 250 amp. Applications are in plant-central supplies and laboratory testing. Response time is 20 to 200 msec.

Perkin Electronics Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

### Electric Heater Blankets

381

For defrosting, curing plastics or adhesives and standby temperature control for solid propellant missiles. In sizes to 30 x 10 ft, the Heat Sheet electric heater blankets use resistance-alloy foil which is etched to shape and laminated in Neoprene, epoxy or silicon rubber to meet MIL and U1 specification.

Thermal Circuits, Inc., Dept. ED, 59 Park St., Beverly, Mass.

Availability: 10 days.

### Volt-Millivoltmeter

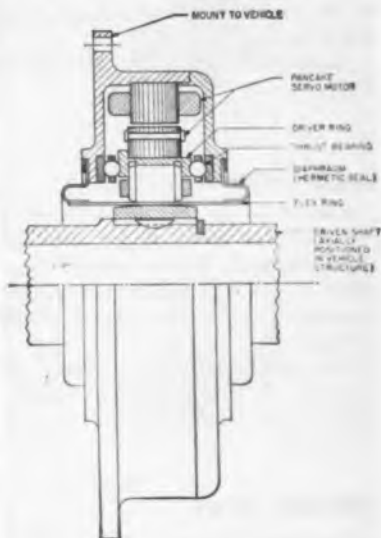
647



Vacuum-tube millivoltmeter model 100 has 12 ranges from 1 mv full scale to 300 v and 12 db ranges from -72 to +52 full scale. Accuracy is 1%; readout is on a 5-in. scale. It operates from 115 or 230 v at 50 to 1,000 cps and is portable.

Sun Electric Corp., Dept. ED, Harlem and Avondale, Chicago 31, Ill.

P&A: \$284; from stock.



## CYCLO-SINE

Hermetically-sealed drive  
for space applications

The Bendix® Cyclo-Sine Drive provides an absolute, hermetically-sealed actuator for varied space applications. Operating through a flexible ring, the drive offers infinite resolution and irreversibility for general-purpose and precision servo devices.

### OUTSTANDING CHARACTERISTICS:

5:1 weight advantage over conventional drives • Up to 20,000:1 speed differential • No backlash • Infinite resolution

Manufacturers of

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RADAR DEVICES • INSTRUMENTATION  
PACKAGED COMPONENTS

Eclipse-Pioneer Division



Teterboro, N. J.

CIRCLE 91 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • July 19, 1961

## Relay Receptacle

370



For subminiature relays with plug-in design. Series 3030 relay receptacles use a wide-bevel receptacle which allows for misalignment of relay pin contacts. Thickwall socket contacts provide for high-spring tension. Various terminations can be furnished.

Precision Connectors Inc., Dept. ED, P. O. Box 96, Mineola, L. I., N. Y.

## Linear Potentiometer

383

Operates at 500 F. Model 147 long-travel linear potentiometer provides a linearity of  $\pm 0.25\%$ , resistance of  $5\text{ K} \pm 5\%$ , resolution of  $0.045\%$  and a power rating of  $1\text{ w}$  at  $500\text{ F}$ . The potentiometer element is platinum alloy wire. Dimensions are  $1.4\text{ in.}$  in diameter and  $12\text{ in.}$  in length.

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

## Connector Housing

377



With split-backshell design. The firm's DPJ connector can be completely wired before this housing is applied. Maximum cable size is  $0.937\text{ in.}$  Solder-pot area is fully protected.

Glenair, Inc., Dept. ED, 1211 Airway, Glendale, Calif.

## AC-DC Converter

645



Accuracy is  $\pm 0.15\%$  absolute from  $0.5$  to  $1,000\text{ v ac}$ . Model C-100AR converter features a frequency range of  $30\text{ cps}$  to  $10\text{ kc}$ , solid-state circuitry and standard rack mounting design. Suitable for use with differential and digital voltmeters, it operates from  $115\text{ v ac}$ .

Calibration Standards Corp., Dept. ED, 1025 Westminster Ave., Alhambra, Calif.

Price: \$455.

ELECTRONIC DESIGN • July 19, 1961

This  
Solid-State 1 MC  
Counter/Timer  
Frequency Meter\*  
has



# Proven Reliability

Eighteen months ago, TSI introduced the Model 361 as the industry's first completely transistorized 1 MC digital Counter/Timer. It won immediate acceptance. The integrity of the original design has been preserved through eleven successive production runs.

Field reports on the 361 are consistently impressive. We have rarely received a valid report of malfunction due to a manufacturing or design defect.

There are good reasons for this record of proven reliability. The NOR-logic design of the 361, for example, drastically reduces its semiconductor count over that of conventional instruments. Our inflexible attitude toward derating, and our refusal to use "selected" components or transistors add significantly to the performance margins this instrument will maintain over wide ranges of power line voltage and ambient temperature. Like all TSI instruments, the 361 is 100% solid-state. It runs cool, despite its compact design.

Engineers who use it tell us that the 361 has the best amplifier of any 1 MC Counter/Timer . . . sensitive, wideband, and unaffected by noise and jitter. They also compliment the straightforward readout, the flexibility provided by its dual-channel logic, and its crystal-clock stability.

It will pay you to consult TSI when you need digital instrumentation in the real-time domain.

\* Model 361 Solid State 1 MC Counter/Timer/Freq. Meter. 10 MV sensitivity. 3 ports in  $10^4$ /week stability. Six-digit in-line Nixie readout.  $0.1\text{ cps}$  -  $1\text{ MC}$  freq. standard outputs in decade steps. Modes: Count, frequency, frequency ratio, period A, period

A - B, freq. st'd, self-check. Dual amplifiers with unique "level-sampling" design. Available in  $3\frac{1}{2}$ " rack (Model 361-R). Bench version shown. Available from stock.

One of 17 Solid State Instruments by TSI.

TRANSISTOR SPECIALTIES  
INCORPORATED

Sophisticated Digital Instrumentation



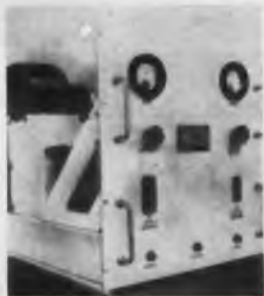
TERMINAL DRIVE, PLAINVIEW, NEW YORK • WELLS 5-8700

CIRCLE 92 ON READER-SERVICE CARD

## NEW PRODUCTS

### Power Supply

431

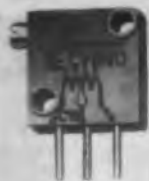


Solid-state power supply has separate electronic and magnetic overload-sensing systems; either can independently sense voltage and current, and adjust or shut off as required. Input-output efficiency is about 80%. Special features simplify maintenance.

Weber Aircraft Corp., Weber Electronics Div., Dept. ED, 2820 Ontario St., Burbank, Calif.

### Trimming Potentiometer

428



Square trimming potentiometer weighs 3/4 g and is rated at 1 w at 50 C. Resistance range is 10 ohms to 50 K. Maximum operating temperature is 175 C; temperature coefficient is 20 ppm per deg C. Equivalent noise resistance is 0.1%. Trimmer measures 3/8 in. square and meets applicable military requirements.

Techno-Components Corp., Dept. ED, 18232 Parthenia St., Northridge, Calif.

### Ceramic Capacitor

374



Rating is 100,000 pf. The Cerol capacitor meets MIL-C-11015B. Specs include: 50 wvdc from -55 to +85 C, derated to 25 wvdc at 125 C; series resistance of 0.2 ohm max from 8 to 10 mc; power factor 2% max; temperature coefficients of +10% or -30% from -55 to +125 C at 0 v and +10% or -40% at rated voltage.

Aerovox Corp., Hi-Q Div., Dept. ED, Olean, N. Y.

## Design MICRO SWITCH Reliability Into Your Equipment!



**Direct Logic Input Switch** generates single square wave output pulse in synchronism with an external clock pulse with each operation. Saves engineering time needed to develop flip-flop and gating networks for synchronizing one-shot circuits. Variations available to fit a wide variety of clock pulse rise times, voltages and frequencies and d-c supply voltages. Write for Data Sheet 172.



**Modular Lighted Push-Button Switches** offer customized combinations of eight different basic switches and dozens of colored display screens. Smart styling and enough flexibility to fit your control panel's design exactly. They simply snap together and then snap into your panel—all without tools. Display screens can be engraved. Write for colorful Catalog 67.



**Decimal-to-Binary Switch** Space-saving answer for computer control panels. Wiring requires fewer connections than wafer-type rotary. Snap-action gold contact, switching elements are enclosed and tamper-proof. Requires only 1.3 square inches of mounting surface on control panel. All operating positions are detented to give the operator positive feel of the switching action. For MICRO SWITCH reliability write for Data Sheet 170.



**Door Interlock Switches** Used on hazardous equipment cabinets to cut off power when service door is opened. Complete line is available including high-temperature, environment-free and subminiature models. A two-switch model controls two circuits simultaneously. Special design of brackets eliminates dangers of "tying down" that could occur with conventional type interlocks. Write for Data Sheet 186.



MICRO SWITCH Precision Switches

*In electronic equipment...*

## SWITCH RELIABILITY SAFEGUARDS YOUR PRODUCT'S REPUTATION

If you manufacture electronic equipment, remember that the success of your product often depends on a switch. The design of switches for complex electronic applications is a specialty. By specifying MICRO SWITCH Precision Switches you can open new possibilities for automatic control. You can also be sure of precision and reliability that is thoroughly tested in the industry's most complete test laboratory for small and subminiature switches. Find out about the important new switch ideas being added to the MICRO SWITCH line, every one with MICRO SWITCH reliability.

MICRO SWITCH . . . FREEPORT, ILLINOIS  
A division of Honeywell

*In Canada: Honeywell Controls, Limited, Toronto 17, Ontario*



**Honeywell**  
MICRO SWITCH Precision Switches

**HONEYWELL INTERNATIONAL**  
Sales and service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

CIRCLE 93 ON READER-SERVICE CARD

### Printed-Wiring Board

607



Shatter-proof printed-wiring board type CU-SIL uses NEMA grade G-17 glass silicon, meeting MIL-P-997. It withstands continuous exposure to temperatures of 150 to 250 C. Conductive pattern is pure copper. Uses include environmental testing of semiconductors and other devices, power supplies, computer modules and airborne apparatus.

Conductorlab, Inc., Dept. ED, Groton, Mass.

### Speech Compression System

664

Bandwidth is 150 cps. Speech compression system based on format tracking communicates speech in a total bandwidth of 150 cps. Speech signal can be digitized and transmitted at 1,000 bits per sec. System weighs less than 50 lb and occupies 1.3 cu ft.

Melpar, Inc., Dept. ED, Falls Church, Va.

### Power Supply

384

For plasma research. Output of this power supply is 0 to 8,000 v at 0 to 3 amp from an input of 240 v, 60 cps, three phase. Either current or voltage can be regulated. Ripple is below 2% rms. Regulation is 0.25% for up to 100% load charge or 10% line charge.

Duncan Electric Co., Inc., Davenport Manufacturing Div., Dept. ED, 2530-32 N. Elston Ave., Chicago 47, Ill.

### Induction Motor

606



Pancake-type, 12-pole induction type 113 motor is rated to deliver 0.025 hp at 3,750 rpm. Stator windings are encapsulated in a Fiberglas reinforced epoxy. Temperature limit is 350 F. Input is 115 or 200 v, 400 cps, three phase. Dimensions are 3-13/16 in. in diameter and 1-1/2 in. long.

Curvin Development Co., Dept. ED, 13735 Saticoy St., Van Nuys, Calif.



# Small Size and Long Life Make G-E Glow Lamps Ideal as Indicators

There are over 60 General Electric glow lamps made especially for use as indicators in appliances, business machines, military equipment—wherever indicating devices are needed. They're small, rugged, usually low-cost, operate on standard AC voltage at low wattage and give off very little heat. All of which makes them ideal for use as indicators. Here are details on a few of them:



**NE-2H** lasts 25,000 hours on standard AC voltage,\* only  $\frac{1}{4}$  inch long, operates on just  $\frac{1}{5}$  watt, is a high brightness lamp and costs much less than a dime including an attached resistor (5 different resistors are available).



**NE-2J** another high brightness lamp with a 25,000 hour life\* on standard AC voltage, operates on  $\frac{1}{5}$  watt, is less than one inch long, has a single contact midget flange base and will fit most standard indicator fixtures. This lamp is not available with attached resistor.



**NE-45** has a 7,500 hour average useful life on standard AC voltage; operates on  $\frac{1}{4}$  watt, is  $1\frac{1}{2}$  inches long, has 30K resistor built into screw base and big electrode that presents a large glowing area when lit.

*\*With a 30K resistor.*

For detailed information on the 18 most popular General Electric glow lamps, write for bulletin #3-0193. General Electric Co., Miniature Lamp Dept. M-134, Nela Park, Cleveland 12, Ohio.

*Progress Is Our Most Important Product*

**GENERAL**  **ELECTRIC**

CIRCLE 94 ON READER-SERVICE CARD

## NEW PRODUCTS

### Use Timers

611



**Ranges to 1,000 hr.** Called Time Totalizers, these time clocks are for preventive maintenance of electronic gear in ground and airborne applications. They are essentially mercury coulombmeters, operated by an integral electrical network which compensates for temperature differences and supply-voltage variation.

American Machine & Foundry Co., Leland Airborne Products Div., Dept. ED, 261 Madison Ave., New York 16, N. Y.

**Price:** \$12 to \$15.

### Telemetry Transmitters

382

For use on rotors of high-speed rotating machinery. These transmitters permit transmission of data on the subcarrier oscillator frequency, with no rf carrier, through capacitively coupled noncontacting slip rings. Model WWT-102 measures 1.75 x 1.75 x 2.25 in. and model WWT-103 measures 1.25 in. in diameter and 3.1 in. long.

Wiley Electronic Products Co., Dept. ED, 2045 W. Cheryl Drive, Phoenix, Ariz.

### Single-Turn Potentiometers

595



**Wirewound types.** Series 2490 potentiometers are in 3 in. in diameter for ranges from 100 to 200,000 ohms; series 2480, 2 in. for 20 to 125,000 ohms; series 2460, 1-7/16 in. for 20 to 100,000 ohms; series 2440, 7/8 in. for 10 to 50,000 ohms. All are gangable in up to eight units except for the 2440 which is gangable in up to six units.

Borg Equipment Div., Amphenol-Borg Electronics Corp., Dep. ED, Janesville, Wis.

**Availability:** sample quantities only until Aug. 15.



## glass for your diode packages... precision drawn to specifications

— GARNER provides tighter tolerances . . . improved roundness and concentricity . . . squarer and smoother end cuts.

Parts ultrasonically scrubbed, chemically cleaned, and rinsed in deionized water. Shipped ready for your production line.

Meeting your specifications is insured by continuous inspection, starting with raw material.

Fast dependable deliveries based on large stocks of redraw tubing . . . advanced production equipment, and the ability to move quickly.

*Send for complete data.*

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ELECTRONIC DESIGN • July 19, 1961

## Power Supply

598



Rated at up to 60 v, 7.5 amp, type 810B power supply can be voltage or current regulated. Load regulation for constant voltage operation is less than 0.02% or 10 mv from no load to full load, and for constant current operation, less than 0.05% or 3.5 ma. Ripple and noise are less than 1 mv rms for constant voltage and less than 3 ma rms for constant current.

Harrison Laboratories, Inc., Dept. ED, 45 Industrial Road, Berkeley Heights, N. J.  
P&A: \$795; 20 to 30 days.

## Glass Mount

662

Electron gun mount glass M-10 is made in rods of standard round, square, or D shape, and in custom configurations. Annealing point is 507 C, softening point 780 C. Thermal expansion coefficient is 2.8 ppm, density 2.17. Ten colors are produced.

Mansol Ceramics Co., Dept. ED, Belleville, N. J.

## Distribution Amplifier

642

For closed-circuit television. Unit is of modular construction. Bandwidth with six outputs is over 8 mc. Gain variation is to 190% of unity. Unit fits into 3-1/2 in. of 19 in. rack space and is 12 in. deep.

Nassau Laboratories, Dept. ED, 42 Valley Road, Plandome, N. Y.

Price: Under \$400 for six outputs.

## Wire Cutter

605

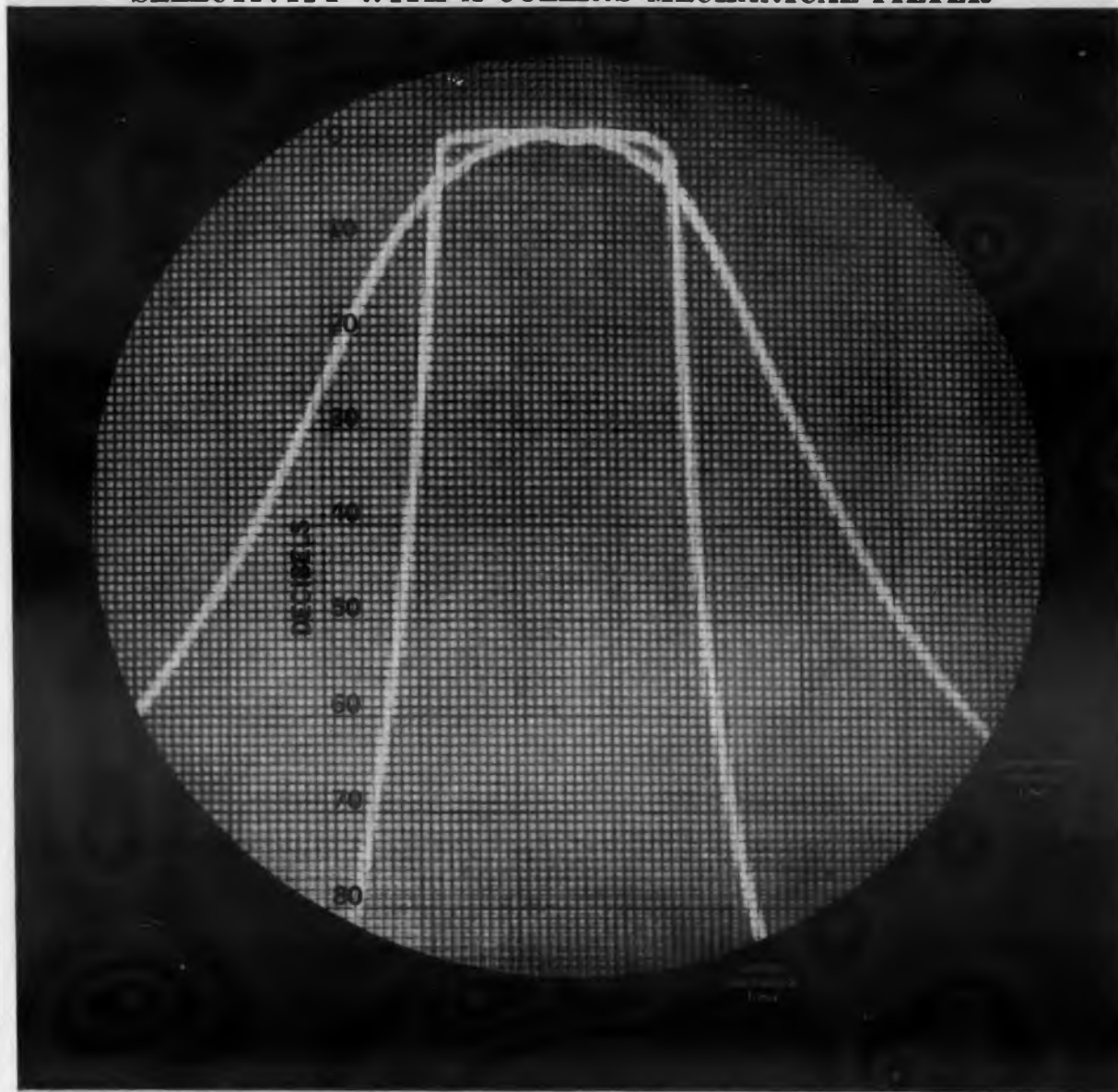


Accuracy is  $\pm 0.005$  in. Model MMP-203 wire cutter is for cutting and handling wire, ribbon and rods for welded or micromodular circuit work. It handles AWG 40 or larger wires, bare or insulated, and ribbon as small as 0.003 x 0.015 in. Speed is 1,200 pieces per hr.

Dickinson & Assoc., Dept. ED, 334 N. Central Ave., Glendale 3, Calif.

Price: \$845.

## YOU GET THIS MUCH MORE SELECTIVITY WITH A COLLINS MECHANICAL FILTER



Choose Collins filters, and you don't have to choose between small size and selectivity. The steep, flat-topped curve above is the work of a few dime-size discs sealed in a case often smaller than a penlight battery. These resonant discs have Q's of 8,000-12,000, up to 150 times that of bulky electrical LC filter elements.

Collins mechanical filters also offer you unprecedented stability. Frequency shift can be held between 1.5 and 2 parts per million per degree centigrade over the range  $-25^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ , and there is no observable drift with age.

For carrier systems, single sideband equipment, bandpass filtering in high-

performance receivers—in fact, for any filtering job between 50 and 600kc, a Collins mechanical filter does a better job in less space.

Made to take it, Collins mechanical filters meet MIL-Spec requirements for humidity, corrosive environments, shock, vibration—the works. Literally hundreds of thousands now demonstrate their reliability throughout the world in communications equipment made by major electronic companies. A Collins filter may be your best answer, too.

Write for literature describing our line of more than 100 mechanical filters. Ask for Data File C-101A.



Collins also offers a full selection of compact crystal filters, which cover the range of frequencies from below 10kc to as high as 30mc.



**COLLINS RADIO COMPANY**  
19700 San Joaquin Road  
Newport Beach, California  
World's Largest Producer of  
Mechanical Filters

COLLINS RADIO COMPANY • NEWPORT BEACH, CALIFORNIA • DALLAS, TEXAS • CEDAR RAPIDS, IOWA

Check Collins at WESCON, Booths 1301-1302.

CIRCLE 96 ON READER-SERVICE CARD



## How to shrink a filter!

Magnetics Inc. "120" solves the problem of core size vs. inductance in miniaturized circuits

Trying to squeeze high core inductance into a small space for use in miniaturized resonance, filter, audio, or carrier frequency circuits usually ends in a compromise. You either force more out of a smaller core, or you use a larger one. Not so, however, if you're familiar with the Magnetics Inc. "120."

This molybdenum permalloy core has a .655 inch outer diameter—is just between the .500 and the .800 inch core you may be using. What makes this little fellow unique is its inductance per 1,000 turns . . . higher than either of its neighbors, whether 60, 125 or 160 permeabilities.

Note, too, that like all Magnetics Inc. powder cores, the "120" is performance-proved and rated within realistic

inductance limits. All permeabilities are available from stock now. What's more, the 125 permeability core is inductance stabilized within  $\pm 0.1\%$  from  $0^\circ$  to  $55^\circ\text{C}$ .

More information on this and other cores in the Magnetics Inc. line is contained in design bulletin PC-203 R. It's yours by writing Magnetics Inc., Department ED-91, Butler, Pennsylvania.

**MAGNETICS Inc.**

CIRCLE 97 ON READER-SERVICE CARD

## NEW PRODUCTS

### Radiator-Retainers

610



Reduce heat by 25%. Types 3AL-725 and 3AL-728 transistor heat radiator and retainers accept case diameters from 0.31 to 0.325 in. and from 0.475 to 0.49 in. for all standard transistor package sizes. Parts are available with hard anodize finish for breakdown voltage to 200 v dc.

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

Availability: 2 to 3 weeks.

### RF Transformers

636

For balanced modulating systems of airborne single-sideband communications transceivers. Type 1039 rf transformers can be used throughout the frequency range of intelligence transfer. They meet the environment requirements of MIL-C-15305A, Grade 1, Class B.

Applied Components Inc., Dept. ED, 401 E. Beach Ave., Inglewood, Calif.

### RF Coils

640

Ranges from 2 to 32 mc. Type 1067 rf coils are for use in the front section of a fixed-tuned single-sideband military communications systems. Each unit contains two coils operating on different bands. They can be made to meet MIL-C-15305A, Grade 2, Class B requirements.

Applied Components Inc., Dept. ED, 401 E. Beach Ave., Inglewood, Calif.

### Decade Counter

608



Reversible type CM-105 modulator decade counter integrates plus or minus pulses at rates up to 150 kc. It consists of a printed-circuit card with a four-stage binary decimal counter and control circuits. It counts 4 to 6-v pulses with 4-v per  $\mu\text{sec}$  risetime and 2- $\mu\text{sec}$  pulse width.

Circuit Structures Lab., Dept. ED, 3014 Halladay, Santa Ana, Calif.

### High-Impedance Amplifier 639

Response is 1 db from 5 cps to 100 kc, or 3 db from 3 cps to 300 kc. This solid-state amplifier has an input impedance of 15,000 meg shunted by 1 to 1.5 pf and an output impedance of 1 meg shunted by 3 to 10 pf. Power gain is to 35 db; voltage gain is to 0.5 db; noise level is 50 to 100 mv at output with input open; output voltage is 0.6 v max.

Denro Lab, Dept. ED, 2801 15th St., N. W., Washington 9, D. C.

Price: \$87.

### Traveling-Wave-Tube Base 609



Ceramic-to-metal tube base for traveling-wave tubes withstands repeated welding operations and bakeout in air at 700 C for 72 hr without leaking. Assembly consists of a nickel cap supporting 4 to 8 ceramic-to-metal tubular feedthroughs, together with an integral ceramic-to-metal input adaptor and copper evacuation tube.

Ceramics International Corp., Dept. ED, 39 Siding Place, Mahwah, N. J.

### Magnetic Tape Translators 641

Honeywell and IBM computers are made compatible with these tape translators. Honeywell 800 and 400 EDP systems work from tapes written by IBM machines and write tapes acceptable by IBM equipment with the translators. Model 36 is for the 800 series and model 436 is for the 400 series.

Minneapolis-Honeywell Regulator Co., Electronic Data Processing Div., Dept. ED, 60 Walnut St., Wellesley Hills, Mass.

P&A: 836; \$93,600, rents for \$1,950 mo; 436: \$43,875, rents for \$975 mo. 12 to 15 mos.

### RF Transformer 634

Range is 50 kc to 30 mc. Type 1008 rf transformer is an output transformer for a crystal filter used in airborne single-sideband communications transceivers. It meets environmental requirements of MIL-C-15305A, Grade 2, Class B.

Applied Components Inc., Dept. ED, 401 E. Beach Ave., Inglewood, Calif.

Availability: made to meet customer specs.

NEW TR GLASS



WITH A



## GRIP LIKE A VISE

now

available

on many

FUSITE

TERMINALS

Never before has a glass been developed that is so compatible for use with 52% nickel alloy leads.

The result is a compression between the glass and pins so tight that twisting and bending of the pins to the breaking point will not cause rupture or leakage. (Determined by Veeco Leak Detector with sensitivity at  $10^{-10}$  std. cc/sec.) Thermal shock is excellent with this new TR-Glass. Salt spray resistance exceeds 100 hours.

Every performance feature is well in excess of Mil Specs. The use of TR-Glass may be considered for all types of Fusite solid glass headers as well as many other style terminals.

Samples on request. Write Fusite, Department C-4



Fusite Corporation, Cincinnati, O.  
Woodford Mfg. Co., Versailles, Ky.  
Fusite N. V., Konigweg 16, Almelo, Holland  
Fusite GmbH, Dieselstrasse 5 Karlsruhe, W. Germany

THE FUSITE CORPORATION

6000 FERNVIEW AVENUE,  
CINCINNATI 12, OHIO

CIRCLE 98 ON READER-SERVICE CARD

*all the cards...*



*You bet, it's hard to beat 4 aces! It's just as hard to beat 4 years of R. F. Choke production experience. Originally designed, developed and introduced by ACDC the 'RFC Series' of preferred inductors has become the standard for OEM manufacturers everywhere.*

## 125° C. HIGH RELIABILITY, SMALL ENCAPSULATED ACDC R. F. CHOKES

As always, ACDC RF Chokes are 1st choice of the industry... and, as always, they are available for immediate delivery from stock. ● 123 Standard Values to choose from ● Inductance ranges from 0.1  $\mu$ H to 10 MH ● Temperature range -55°C to +125°C ● Designed to meet MIL-C-15305-A ● Epoxy encapsulated for maximum resistance to moisture and immersion.

In circuits where RF inductors are required and the equipment design objective includes maximum reliability under the most stringent environmental conditions, these ACDC RF Chokes will help you attain optimum circuitry performance.

Put this combined experience and know-how to work for you. In the long run you will find it will save you both time and money; like holding 4 aces, you can't do better!

Full specifications included in Bulletin 125-A, write for yours today.



### ACDC ELECTRONICS, INC.

2979 North Ontario Street, Burbank, California  
Manufacturers of regulated power supplies, inductive devices from power to radio frequencies, pulse circuitry components and magnetic amplifiers



## NEW PRODUCTS

### Welding Power Supply

425



Rated at 30 kva. The Weldpower ac welding power supply features a half-cycle timing switch for use with single or dual-synchronous timers. Transformers are made for use at 550 and 440 v ac, for outputs of 30 kva at 50% duty cycle, and 220 v for 22 kva. Unit has a 0.5 to 10-cycle timing range and a 6 to 30-cycle timing range with the heat program timer.

Raytheon Co., Commercial Apparatus & Systems Div., Dept. ED, 225 Crescent St., Waltham 54, Mass.

### Logic Test Panel

638

For maintenance testing of logic areas and functions, a selective test panel has been incorporated in the firm's DynaPath-20 numerical control systems. Each logic area is isolated through a series of switches. Measurements are taken in each area to determine marginal operating level. Flow of information can be controlled stage-by-stage.

The Bendix Corp., Industrial Controls Section, Dept. ED, 21820 Wyoming, Detroit 37, Mich.

### Magnetic-Tape Cleaner

601



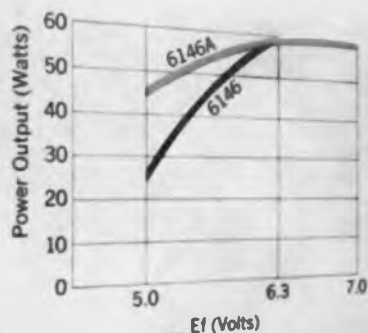
Sonic and ultrasonic cavitation at the tape surface removes loose oxide, base chips and dirt from magnetic tape. Model CT-2 magnetic-tape cleaner handles 1/4, 1/2 or 3/4 in. tape in thicknesses of 1/2 to 5 mils. Speed is 300 ft per min. Water is used as the cleaning fluid.

General Kinetics Inc., Dept. ED, 2611 Shirlington Road, Arlington 6, Va.

P&A: \$4,434; 30 to 60 days.

# ELECTRON TUBE NEWS...from SYLVANIA

## NEW SYLVANIA



# 6146A



delivers 45W output\* with  
heater-supply as low as 5 Volts

New Sylvania-6883A (12.6V type), 6159A (26.5V type) maintain  
45W power at reduced Ef of 10V and 21V, respectively

RF amplifier output.  
Class C service—  
70W (ICAS) up to 60MC,  
35W (ICAS) up to 175MC.

From Sylvania comes the first major performance improvement to the popular 6146 and associated family since their introduction 7 years ago. The new, Sylvania-originated 6146A, 6883A, 6159A eliminate communications fade-out caused by decreased heater voltage supplies. Designed for use as an AF power amplifier and modulator, RF amplifier and oscillator, they offer the same excellent output capabilities (at normal heater ratings) and reliability that characterize their prototypes.

At Sylvania even established types undergo intensive and continuous field examination to incorporate up-to-the-minute design requirements. In fact, it was in just this way that the well-known line of Sylvania

Gold Brand premium tube types was originated. All are specifically designed to fill critical application requirements—effectively, efficiently, reliably.

If your industrial or military design demands specialized tube types, call on the creative engineering and production capabilities of Sylvania. Your Sylvania Sales Engineer will be pleased to work with you. For tech data on specific types, such as the new Sylvania-6146A, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

\*Minimum output limit for an individual tube (CCS) measured in a single-tube self-excited oscillator circuit. Conditions: plate voltage—600Vdc; grid #2 voltage—180Vdc; grid #1 resistor—30,000 ohms; plate current—100 to 112mA; grid #1 current—2 to 2.5 mAdc; frequency—15MC.

# MICROWAVE DEVICE NEWS from SYLVANIA

120KW



20 KW  
to  
120 KW  
peak power output



with Sylvania Ka Band Magnetrons

20KW

Sylvania Ka Band Magnetrons offer a remarkable range of powers, fill virtually all your Ka band requirements. They include extremely compact types with exceptional power-to-weight ratios. All are fixed-frequency types for pulsed operation, utilize stabilized magnets, and exhibit outstanding reliability and longevity.

**SYLVANIA-5789**, first commercially available U. S. type for Ka band, uses 22-vane "rising sun" anode, and improved dispenser-type cathode. With hermetically sealed input and pressurized output, it is highly adaptable to high altitude operation.

**SYLVANIA-6799** features 120KW peak power output and is a proven high-power millimeter wave source. It is available for use with longer pulses and higher duty cycles at slightly reduced power.

**SYLVANIA M-4155A**, ruggedized version of the 5789, features compact size and weight of only 9 lbs., improved heat dissipation and excellent stability. It utilizes a special cone-shaped cathode support and "building block" mounting arrangement for added mechanical strength. M-4155A possesses both long- and short-pulse capabilities.

**SYLVANIA XM-4064**, ruggedized magnetron, offers exceptional stability under severe environmental conditions. Only 9 lbs. in weight, it provides peak power output of 70KW for a remarkably good power-to-weight ratio.

**SYLVANIA XM-4158**, ruggedized magnetron, provides 120KW peak power output. Weight is only 27 lbs. It uses E type magnets for a uniform, flat surface configuration that can be used as a structural part of the chassis. XM-4158 is compatible with either long- or short-pulse operation.

**SYLVANIA XM-4218**, ruggedized tube, provides a power-to-weight ratio of 8:1 making it especially suited for portable, field-type radar. It uses metal-to-ceramic seals, ceramic cathode capsule, cantilever cathode support. The tube withstands 50g shock, 10g vibration tests. XM-4218 provides a lower pushing factor than tubes of comparable performance. Weight is only 4 lb.

**SYLVANIA XM-4206** is a ruggedized, compact tube with encapsulated cathode. Only 10.5 lbs., it provides 40KW peak power output.

SYLVANIA Ka BAND MAGNETRONS

	Frequency (KMc)	Peak Power Output (KW)	Max. Duty Cycle	Max. Pulse Width (μsec)
5789	{ 34.512	40	.0006	1.0
	{ 35.208			
6799	{ 34.512	120	.0005	1.0
	{ 35.208			
M-4155A	{ 34.512	40	.0006	1.0
	{ 35.208			
XM-4064	{ 34.512	70	.0008	1.0
	{ 35.208			
XM-4158	{ 34.512	120	.0008	1.0
	{ 35.208			
XM-4218	{ 34.512	32	.0006	0.4
	{ 35.207			
XM-4206	{ 34.7	40	.0006	1.1
	{ 35.0			

Investigate the design advantages of Sylvania Ka band magnetrons and associated Ka band TR tubes. Contact your Sylvania Sales Engineer for complete information. For technical data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. MDO-D, 1100 Main St., Buffalo 9, N. Y.

# SYLVANIA

SUBSIDIARY OF

**GENERAL TELEPHONE & ELECTRONICS**



P-537-3



## The all-new, all solid-state Philbrick P2 amplifier



**NO TUBES, NO CHOPPERS, NOTHING BUT PERFORMANCE.** An ingenious arrangement of all solid-state components endows this operational amplifier with the most remarkable and versatile characteristics. But let's let them speak for themselves. *Full differential input: truly floating with respect to ground. No common mode error. Low input current: typically 10<sup>-11</sup> amps. Low noise: typically under 10 microvolts in the dc to 1 kc range. Sub millivolt long term stability: less than 100 microvolts drift per day. Cool running: typically 330 milliwatt dissipation. Wide band pass: typically 75 kc as a unity gain follower. High open loop gain: typically 30,000. **\$210.** Truly low cost:*

Use the P2 for instrumentation, analog computation, and other applications requiring high reliability and accuracy. Discover its marvelous versatility and convenience. Add, integrate, scale, invert with it. Take advantage of its differential inputs to perform very high impedance voltage following (or amplification), precise current driving, and many other useful applications. The P2's output delivers 1 ma at  $\pm 10$  volts. The cast aluminum housing fits right in your hand.

Please write for further information to:

GEORGE A.  
**PHILBRICK**  
RESEARCHES, INC.

127 CLARENDON ST. BOSTON 18, MASS.  
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REPRESENTATIVES IN PRINCIPAL CITIES  
EXPORT OFFICE: 240 W. 17TH ST., N. Y. 11, N. Y.  
TEL. CHALSEA 3-3200, CABLE: TRILRUBH

CIRCLE 100 ON READER-SERVICE CARD

### Pulse Counter

597

**Dual-channel, 10-mc pulse counter** type HW consists of two separate seven-decade units in module form. Each channel consists of a 10-mc decade scaler followed by six 1-mc scalars. Readout is in neon-lighted decimal digits. The 8-4-2-1 binary-coded decimal count in each scaler is available for performing logic operations.

Harvey-Wells Electronics, Inc., Dept. ED, 14 Huron Drive, Natick, Mass.

**P&A:** \$2,500; 2 weeks.

### Frequency Divider-Clock

596

**Accuracy is  $\pm 10$   $\mu$ sec** for time comparison Model 113BR frequency divider-clock provides comparisons between local time or frequency standards and hf or vlf broadcasts. Drive rates can be recorded over long periods and time or frequency differences can be determined between oscillators in widely separated systems. Requirements of MIL-E-16400 are met.

Hewlett-Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.

**P&A:** \$2,750; 3 weeks.

### Pressure Transducer

602

**Silicon-semiconductor, strain-gage pressure transducer** provides 250 mv output without an amplifier from 10 to 30 v dc. It is sensitive to static and hf dynamic pressures. Range is 0 to 100 through 0 to 10,000 psia or psig. Standard linearity is 0.25% max. Uses are in steel, missile, underwater and nuclear fields.

Fairchild Controls Corp., Dept. ED, 219 Park Ave., Hicksville, L. I., N. Y.

### Miniature Amplifier

600

**Rated at 5 w, type C70 3146 001 1-cu in. amplifier** is designed for use at ambient temperatures of 125 C. Component leads are interconnected by means of electrical-resistance spot welding. Completely potted in epoxy, the unit is suitable for missile and aircraft applications where extremes in shock and vibration are encountered.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

### Universal Motor

599

**Rated up to 1/10 hp** at 10,000 rpm, type GR ac-dc motor is 2-1/4 in. in diameter and 3-1/4 to 4 in. long. Output torque at 10,000 rpm is 10 oz-in. with a current of 1.3 amp at 115 v ac, 60 cps. Field and armature windings can be varied to provide different speed-torque characteristics. Units meet Mil specs.

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

# New Philbrick 6033 solid-state power supply



**BALANCED OUTPUTS, COMPUTING GRADE.** The 6033 is the latest addition in the distinguished line of Philbrick power supplies. It will energize at least 10 Philbrick P2 amplifiers and other transistorized electronic equipment. Like the P2, its remarkable characteristics speak for themselves. *Low internal impedance:* less than 2 milliohms. *Low noise and hum:* guaranteed less than 150 microvolts rms (0.001%). *Highly regulated outputs:* against load, less than 300 microvolts; against line, less than 200 microvolts. *Low long term drift:* typically 0.1%. *Short transient recovery time:* no load to full load, less than 1 millisecond. *Unique short circuit overload protection:* inherent in the 6033's design with no extra circuitry to deteriorate performance. *Truly low cost:* about half that of supplies with comparable performance: **\$285.**

Operates from 115 volt, 50-400 cycles, providing up to 150 ma at plus AND minus 15 volts, slaved to a common reference. Conveniently packaged, cool running, and highly reliable. Available as bench model or modular plug-in. Bench model dimensions:  $3\frac{1}{2}$ " h x  $5\frac{1}{2}$ " w x  $7\frac{1}{2}$ " d. Also available with 300 ma output.

*Complete facts are waiting for you. Please write:*

GEORGE A.  
**PHILBRICK**  
RESEARCHES, INC.

127 CLARENDON ST. BOSTON 18, MASS.  
COMMONWEALTH 6-3373. TWX: 88 1032. FAX: 88N  
REPRESENTATIVES IN PRINCIPAL CITIES  
EXPORT OFFICE: 240 W. 17TH ST., N. Y. 11, N. Y.  
TEL. CLEVELAND 3-5200, CABLE: TRILRUSH

CIRCLE 101 ON READER-SERVICE CARD

## NEW PRODUCTS

### Copper-Clad Laminate

404



Glass-fiber reinforced plastic circuit board offers superior electrical performance and resistance to breakage. The material processes easily and punches at room temperature. It is self-extinguishing.

Cimastra Div., The Cincinnati Milling Machine Co., Dept. ED, Cincinnati 9, Ohio.

### Laser Materials

644

Barium fluoride doped with various rare earths and transition elements is available in single crystals 3/4 in. in diameter and 1 in. long. The crystal can be used as a laser material. Chips of the material, suitable for investigating properties of the various dopings, are also available.

Semi-Elements, Inc., Dept. ED, Saxonburg, Blvd., Saxonburg, Pa.

P&A: Chips, \$15; Crystals, \$400 each. From stock.

### RF Voltmeter

666

For avionics and laboratory use. Model 400 rf voltmeter measures input and output voltages in rf, video, audio and servo systems. Alpha transistors permit calibration as an rf indicator or null detector up to 30 mc. Transistorized, the unit is portable.

R-K Labs, Dept. ED, Box 700, Wantagh, N. Y.

P&A: \$245; 45 days.

### Diode Module

396

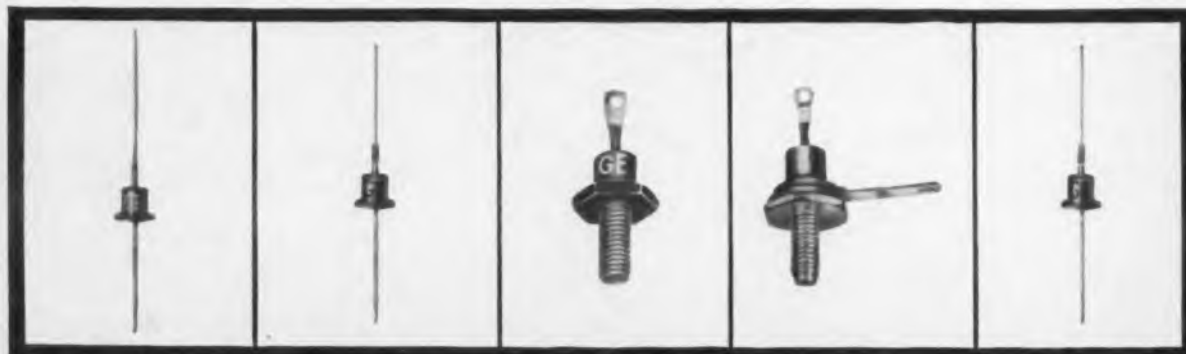
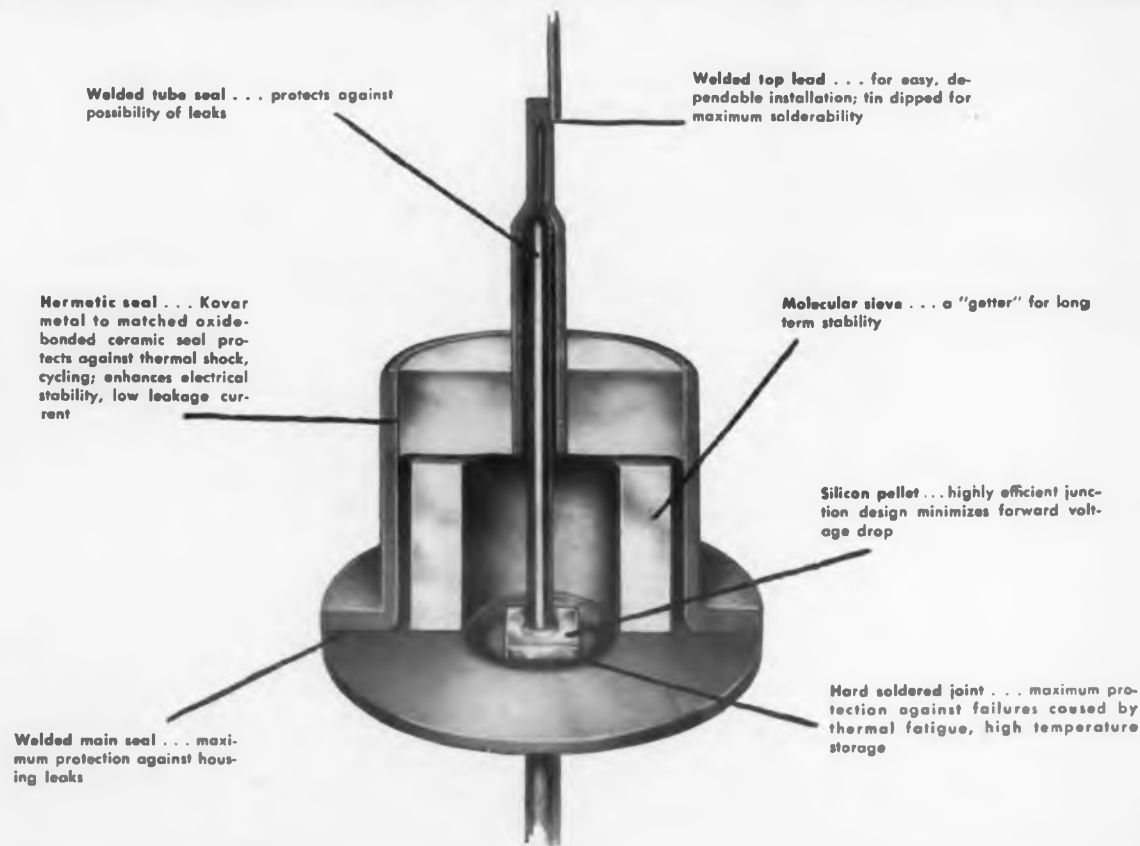


High-density packaging for 12 diodes is provided by this module. Individual pin terminations connect module to the master board. Contacts are silver-plated with gold flash.

Precision Connectors Inc., Dept. ED, P. O. Box 96, Mineola, L. I., N. Y.

## HERE'S THE INSIDE STORY OF

# General Electric low current



**GERMANIUM RECTIFIERS**  
UP TO 1200 MA • UP TO 400 PRV

11 types, including MIL approved units, recognized as the industry standard for high reliability. Features include extremely low forward resistance, high back resistance, and transient PRV ratings for safer applications.

**LEAD MOUNTED SILICON RECTIFIERS**  
UP TO 750 MA • UP TO 1000 PRV

54 types, including MIL approved units, featuring transient PRV ratings, maximum forward conductance at high operating temperatures, very low leakage and unusual freedom from thermal fatigue.

**STUD MOUNTED SILICON RECTIFIERS**  
UP TO 1.5 AMPS • UP TO 1000 PRV

50 types, including MIL approved units. Most types identical to the popular lead mounted units, except for the stud mounting. Transient PRV ratings, high reliability.

**INSULATED STUD SILICON RECTIFIERS**  
UP TO 1.5 AMPS • UP TO 600 PRV

6 types, identical to the popular stud mounted 1N115-1N1120 series, except that the stud is electrically insulated from the junction. Transient PRV ratings.

**SILICON ZENER DIODES ONE WATT AXIAL LEAD**

28 types, including A and B versions, featuring low junction temperatures under operating conditions, cool operation for improved characteristics and long life. All-welded package for reliability under extreme environmental conditions.

# rectifiers and Zener diodes

An average of 16 separate life, electrical, mechanical and environmental tests prove out the quality that has been built into General Electric low current rectifiers and zener diodes. The use of "getters", the finest hermetic seal available, hard soldered joints, and welded main and tube seals are only a few of the reasons they test out so well. Silicon rectifier type 1N538, for example, was put through torturous life test studies over a period of 10,000 hours at maximum temperature, current and PRV . . . and came through with a 99% survival percentage.

For complete technical information, just call your Semiconductor Products District Sales Manager. Or write Rectifier Components Department, Section 23G26, General Electric Company, Auburn, New York. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: International General Electric, 150 E. 42nd Street, N.Y. 17, N.Y.

**For fast delivery of selenium, germanium,  
and silicon rectifiers at factory-low prices,  
see your authorized G-E distributor**

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

CIRCLE 102 ON READER-SERVICE CARD

## Photovoltaic Detector

403



Gallium arsenide photovoltaic detector GAU-401, designed for the 0.4 to 0.9 micron region, has peak sensitivity at 0.85 microns. It is housed in a TO-18 case with a glass window. Square or circular cell areas from 0.2 to 4.0 sq mm can be provided. The device operates at temperatures up to 120 C.

Philco Corp., Lansdale Div., Dept ED, Lansdale, Pa.

*P&A: \$100 ea; 1 to 14 days.*

## Core Tester

663

Constant current flux reset tester model D is made for production testing of tape-wound cores for magnetic amplifiers. Test conforms to AIEE procedures, in frequencies of 60, 400, and 1,600 cps. Tester handles cores with a cross-sectional area of 0.04 to 3.0 cm<sup>2</sup> and with mean lengths from 3.5 to 20 cm at 2 overstruts drive.

Magnetics, Inc., Dept. ED, Butler, Pa.

*Availability: 10 to 14 days.*

## Cords and Cables

637

High-temperature types. Called Hot Spot Securityflex, these cords and cables are designed for use where intense heat would ordinarily curtail the life of a cable. Cords use butyl insulation with a butyl jacket; control and power cables use butyl insulation with asbestos braid jacket.

Anaconda Wire and Cable Co., Hot Spot Securityflex, EFL-P5, Dept. ED, 25 Broadway, New York, N. Y.

## Signal Monitor

400



Compact signal monitor type SM-9310 is a display unit using solid-state devices. Designed for use with vhf receivers, it provides a sweep width of 3 mc max. Panel height is 3-1/2 in.

Communication Electronics, Inc., Dept. ED, 4900 Hampden Lane, Bethesda 14, Md.

# FROM MOLTEN SOLDER TO COLD WATER

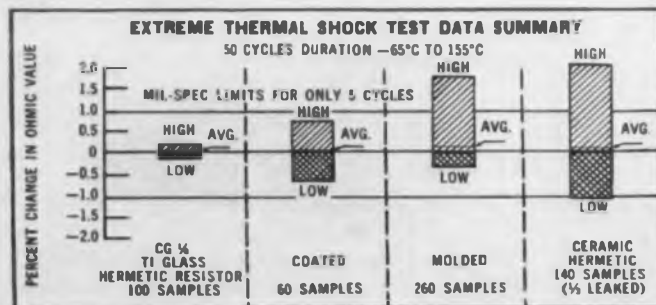


## Positive Proof: TI HARD GLASS ENCAPSULATED RESISTORS Give You Unexcelled Resistance to Thermal Shock

Make this dramatic test yourself and discover why Texas Instruments *hard glass* encapsulated carbon film resistors outperform those of any other construction. First torture the resistor by immersing it in molten solder at 350°C — then quickly dip it in water. Now, test the device for electrical stability and mechanical intactness and you'll find as we have that these precision hermetic resistors are completely unaffected by violent thermal shock. Such performance is possible ONLY because TI type CG 1/4 and CG 1/2 resistors are protected by a *hard glass* encapsulant and entirely *solderless* construction. These same features virtually eliminate possible damage to the resistors during installation in your assemblies.

The extreme thermal shock test is only one of many tests that have proven over the past two years that TI type CG 1/4 and CG 1/2 resistors are virtually indestructible. Over eleven million unit hours of test data have been compiled on moisture resistance, thermal shock, extended overload, and load life to *prove* that TI hard glass encapsulated resistors give you reliable performance under *all* environments and operating conditions. When you specify TI CG 1/4 and CG 1/2 hermetic resistors, you can be assured of getting the most rugged, reliable, precision resistors available... at prices you would pay for *ordinary* resistors!

Take advantage of the *proven* reliability of TI hard glass resistors... order them *today* through your nearby TI Sales Office or authorized TI Distributor.



SPECIFICATIONS				
CG 1/4				
ACTUAL SIZE				
TI type number	wattage rating	MIL designation	standard resistance ranges	maximum recommended voltage
—	watts	—	—	volts
CG 1/4	1/4	RW60B	24.9Ω to 1 megΩ	350
CG 1/2	1/2	None	10Ω to 100k	250

Call or write today for complete specifications on TI's CG 1/4 and CG 1/2 resistors, or any of TI's complete line of semiconductors and components: silicon and germanium transistors, diodes and rectifiers, precision resistors, *resistor* silicon resistors, *TI-2000* tantalum capacitors.

## NEW PRODUCTS

### Rotary Switch Kit

356



Engineers can design and build miniature rotary switches with kit No. PK-20-S. Up to 25 four-section switches similar to the firm's types PA1000 and PA2000 switches can be constructed with factory precision.

Centralab Div., Globe-Union Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

Availability: From distributors.

### Receiving Tubes

388

Novar tubes in four types have integral 9-pin all-glass bases. A low-temperature heater is used. Types RCA-6AY3, RCA-12AY3 and RCA-17AY3 are half-wave rectifier tubes rated at 5 kv plate piv. Peak plate current is 1.1 amp max, with dc plate current of 175 ma max. Type RCA-7868 is a high-perveance power pentode for audio output. A push-pull pair can deliver a signal-power output of 44 w max, with 5% total harmonic distortion.

Radio Corp. of America, Electron Tube Div., Dept. ED, 30 Rockefeller Plaza, New York 20, N. Y.

### Motor-Generator

361



This 5-kw motor-generator is a power source in laboratory testing. Equipment includes a static regulator, output meters, a selector switch and rheostat adjustment. Voltage regulation is within 1%, no-load to full-load. Input is 60 cps, 1,200 rpm, 220 or 440 v with a 10-hp motor.

Kato Engineering Co., Dept. ED, Mankato, Minn.



18160

SEMICONDUCTOR COMPONENTS  
DIVISION  
PLANTS IN DALLAS, TEXAS  
BEDFORD, ENGLAND  
AND NICE, FRANCE



**TEXAS INSTRUMENTS**  
INCORPORATED  
13500 N. CENTRAL EXPRESSWAY  
P. O. BOX 5012 DALLAS 22, TEXAS

## Reverse Dynamic Curve Tracers

359



High-voltage diodes can be tested with these curve tracers which provide 0 to 5 kv at 60 cps. Reverse current is 20  $\mu$ a to 1 ma. Model 1031-2A, providing true peak meter readings and oscilloscope plotting, is made for precision on-line inspection. Model 1031-2B, giving a calibrated oscilloscope plot, is made for economical on-line inspection with moderate accuracy.

Instrument Techniques, Inc., Dept. ED, Henderson and Shoemaker Roads, King of Prussia, Pa. Price: 1031-2A, \$2,375; 1031-2B, \$1,900.

## Wire Markers

524

Up to 50 circuits can be coded on both ends with Trace-Tab wire markers. Divided strips, numbered from 1 to 10, are printed on a color coded, adhesive-backed cloth tape. Five colors are used.

Pyramid Instrument Corp., Dept. ED, 630 Merrick Road, Lynbrook, N. Y.

## Image Orthicon TV Camera

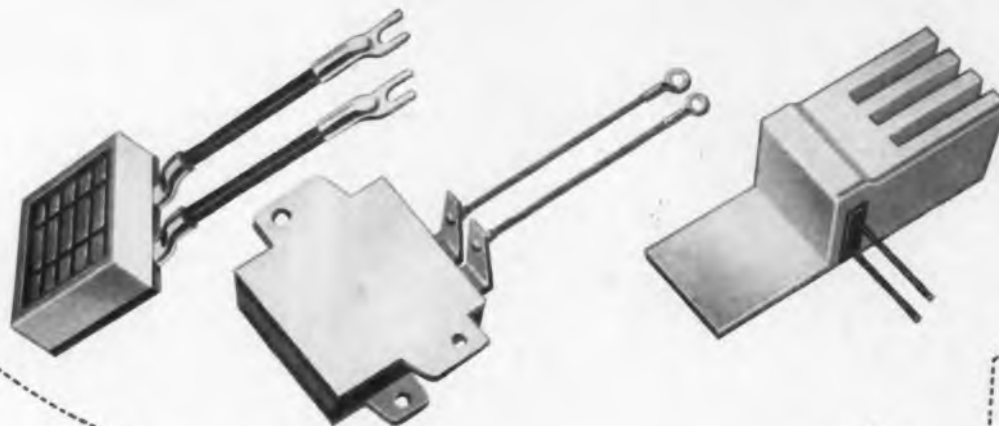
577



For live-image or closed-circuit monochrome use at 600-lines minimum resolution. Type V-600 camera can be used in military and industrial plants without intense illumination. It reduces radiation hazard in survey, medical and radiological uses. It occupies 2 cu ft and weighs 25 lb.

Foto-Video Electronics, Inc., Dept. ED, 36 Commerce Road, Cedar Grove, N. J.

## If you're now designing for THERMOELECTRIC HEATING-COOLING



## Now is the time to contact STEVENS FOR THERMOSTATIC CONTROLS



Stevens Type MX thermostats, either hermetically sealed (left) or semi-enclosed (right), help you avoid complicated control circuits in thermoelectric devices.

One method is to apply a Type MX thermostat to the cold plate with a spot of epoxy and have the thermostat control the input, either through a relay or by controlling AC input to a rectifier which feeds the thermoelectric cooling unit. Simple and reliable? You bet. Inexpensive, too! Check us for full details while your product is in the design stage.

A-4210 A



STEVENS manufacturing company, inc.

P. O. Box 1007 • Mansfield, Ohio

**THERMOSTATS**

...variations  
on a  
theme

POWER



BR-12P (case removed)

In one versatile new BR-12 micro-miniature series, Babcock offers relay types suitable to a wide range of novel uses in extreme environments.

The BR-12P is an especial boon to those designing for both sides of the component card due to low profile and side header mounting arrangement. A second type, the BR-12K, provides sensitivity down to 20 mw. Both types have contacts rated at dry circuit through 3 amps resistive.

Performance characteristics are generally shared with other types in the BR-12 Series. All are available with activated getter material, providing lifetime prevention of contamination effects at dry circuit to rated current on contacts.

You are invited to request complete technical data.



BR-12



BR-12K

SENSITIVE

PERFORMANCE  
CHARACTERISTICS - BR-12 SERIES

Contact Rating: 3 amps resistive @ 32 VDC Standard

Vibration: Minimum 30g to 3000 cps,  
to 50g on special units.

Shock: Standard, 75g or special, 125g.

Temperature: -65°C to +125°C

Note: All Babcock Relays are checked out for  
leakage rate of 10<sup>-6</sup> cc per second  
on mass spectrometer

BABCOCK RELAYS, INC.

1645 Babcock Avenue  
Costa Mesa, California

CIRCLE 105 ON READER-SERVICE CARD

## NEW PRODUCTS

### Flush Circuit Devices 618

Selector switches and pulse generators are typical applications of these flush circuit devices called Permadiscs. Precious metals deposited on insulating board create pie-section terminals in concentric circles. Height difference between conductor and board is 0.0001 in. There is no electrical noise at 50 rpm. Temperature range is  $-65$  to  $+125$  C.

Precision Circuits, Inc., Dept. ED, 87 Weyman Ave., New Rochelle, N. Y.



### Pressure Switches 616

Water columns of 0.25 to 16 in. will actuate these signal and differential pressure switches. Known as the Deltadyne series, the devices have a spring-biased diaphragm, and activate a switch at a preselected pressure. Units measure about 2 x 3 in., and are vibration-resistant.

Pall Corp., Dept. ED, Glen Cove, N. Y.



### Vacuum Transfer Relay 693

Interrupts 18 kw dc. Vacuum transfer relay RB1R handles 18 kv peak and 15 amp rms. It will interrupt 18 kw dc for over 100,000 operations at 3 amp or 6 kv. Size is 2-3/4 in. overall. Operate time is 3 msec max, release time 5 msec max.

Jennings Radio Manufacturing Corp., Dept. ED, P. O. Box 1278, San Jose 8, Calif.



### Contactors and Starters 443

Size 3 and 4 contactors and starters have been added to the firm's 100-line. Size 3 devices are rated for control of up to 50 hp, 600 v; size 4 for up to 100 hp, 600 v. They use a horizontal straight-line magnetic action. Contacts are slanted.

General Electric Co., Dept. ED, Schenectady 5, N. Y.



### Direct-Recording Oscillograph 613

Built-in timing circuit of the Visicorder 906C can be triggered externally. Timing intervals of 0.01, 0.1, 1 sec, and 0.01, 0.1, and 1 min are available. Device records as many as 14 channels simultaneously at frequencies to 5 kc. Optical system uses mercury ultraviolet light on photosensitive paper.

Minneapolis-Honeywell, Heiland Div., Dept. ED, 5200 E. Evans Ave., Denver 22, Colo.

P&A: \$2,145 to \$2,700; immediate delivery.





## Decade Counter

555

Compact decade counter tube CK7978 is a bi-directional, ring stepping type with maximum dimensions of 2.3-in. heights, 1.16-in. width. The cold-cathode, gas-filled tube provides visual and electrical readout up to 5 kc. Total anode current ranges from 0.30 to 0.60 ma.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass.  
**P&A:** \$11; immediate.



## Magnetic Probe

553

Ac magnetic field evaluation probe operates with an ac vtvm for determining ac magnetic field intensity. Calibrated probe consists of an air core inductor, cast in epoxy, within a shielded enclosure. Shielded cables and connector are included.

Perfection Mica Co., Magnetic Shield Div., Dept. ED, 1322 N. Elston Ave., Chicago 22, Ill.  
**P&A:** \$15; stock.



## Copper-Clad Laminate

615

Developed for printed circuits, this copper-clad epoxy paper base laminated plastic is designated grade EP-492-1. Specimens 1/16 in. thick have flexural strength of 25,000 psi lengthwise, 23,000 psi crosswise. Dissipation factor is 0.031 to 1 mc; dielectric constant is 4.17. Insulation resistance is 190,000 meg. Material is flame-resistant.

National Vulcanized Fibre Co., Dept. ED, 1061 Beech St., Wilmington 99, Del.  
**P&A:** \$1.55 sq ft in maximum quantity; 3 weeks.



## Clutch/Brake

692

Integrally matched with a customer-specified precision servo pot, this clutch/brake is said to eliminate shaft misalignment, backlash and end play. Power is 2 w, 24 v dc. Clutch torque is 10 oz-in. min brake torque 6 oz-in. min. Response time is 8 msec, weight 1.3 oz.

Dynamic Instrument Corp., Dept. ED, 59 New York Ave., Westbury, N. Y.



## Ratio Drives

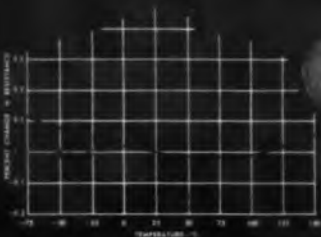
360

Concentric ratio drives use ballbearings rather than gears to transfer power. Designated type RDLCC, drives have ratios of 2.66 to 1 and 7.08 to 1. Units, permanently lubricated, are made for servo-mechanism and instrumentation applications. Drives can be panel-mounted.

Jan Hardware Manufacturing Co., Dept. ED, 38-01 Queens Blvd., Long Island City 1, N. Y.



*Up to 19.6% less  
cost per megohm!*



*Up to 14.1% more  
ohms per pound!*

## HOSKINS ALLOY **815-R** Precision Resistor Wire



The trouble with using only one type of alloy wire in all of your precision resistors is that very often you and your customers end up paying for something that really isn't required so far as the end use is concerned. Now take Hoskins Alloy 815-R, for example. It's a relatively new custom-quality iron-chromium-aluminum composition. But a number of alert and cost-conscious manufacturers have already found that it possesses all of the physical and electrical properties necessary for many precision resistor applications. High strength, good ductility. Excellent resistance to corrosion. Controlled low temperature coefficient. What's more—and more to the point these days—they've also found that Alloy 815-R's lower density and higher electrical resistivity combine to give them very worthwhile savings. Up to 14.1% more ohms per pound—up to 19.6% less cost per megohm!

**Yours for the Asking**—If you're a man who fancies such figures, we'd like to send you an eyeful—namely: A handy little "Cost-per-Megohm" Comparator, plus a 12 page catalog that's loaded with technical data. If you also happen to make precision resistors, sample spools of 815-R wire are available for testing and evaluation.



*Sizes from .001" down to .0001"—Bare and enameled—Temperature Coefficients:  $0 \pm 10\text{ppm}$  and  $0 \pm 80\text{ppm}/^\circ\text{C}$ .*

## HOSKINS MANUFACTURING COMPANY

4445 Lawton Avenue • Detroit 8, Michigan • TYler 5-2860

In Canada: Hoskins Alloys of Canada, Ltd., 45 Racine Rd., Rexdale P.O., Toronto, Ontario

*Producers of Custom Quality Resistance, Resistor and Thermo-Electric Alloys since 1908*

**CIRCLE 106 ON READER-SERVICE CARD**

Good base for a decade of dependability

**All Sangamo Type TR High Reliability Electrolytic Capacitors** have this highly effective end seal. It gives them an unusually long operating life... gives you dry electrolytics that you can depend on for at least ten years when operated within their ratings.

Available in ratings from 3 to 450 D. C., and designed to operate in a temperature range from  $-20^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ , Sangamo Type TR capacitors are perfect for low-frequency filter, by-pass and coupling applications in communication systems, electronic industrial controls, laboratory test instruments, computers, and similar equipment. For more complete information write for Engineering Bulletin 2227.



## NEW PRODUCTS

### DC Power Supply

494



Delivers 120 w. Power supply MC-40V3SS, measuring 4-11/16 x 6 x 7-1/2 in., delivers 0 to 40 v dc at 3 amp. Load regulation is 0.01%, line regulation 0.005%; ripple is 1 mv rms. Transient recovery time is 50  $\mu\text{sec}$ , efficiency 80%. Input is 105 to 125 v ac.

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

Price: \$380.

### Extra-Strong Plastic 436

For printed-circuit boards, insulators, switch gear and electromagnetic devices. Lexan plastic offers excellent heat stability, impact strength, creep resistance and dielectric properties. Sheets are 1/4 to 1-1/2 in. thick in widths to 12 in. and lengths of 3 or 4 ft. Rods are 1/4 to 8 in. in diameter and 6 ft long.

Cadillac Plastic & Chemical Co., Dept. ED, 1511 Second Ave., Detroit 3, Mich.

### Potentiometers

366



Weatherproof potentiometers, called Cap-Pot, have their electrical element within the operating knob which serves as a moisture- and dust-proof housing. Terminations are brought through the rear of the unit and are sealed. Resistances are from 10 ohms to 10 K,  $\pm 10\%$ . Units are made for weatherproof, explosion-proof, and pressurized equipment.

Clarostat Manufacturing Co., Dept. ED, Dover, N. H.

◀ CIRCLE 107 ON READER-SERVICE CARD



ELECTRONIC COMPONENTS

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

## Diallyl Phthalate Cases 358



Made to encapsulate components thin-wall tubular and rectangular diallyl phthalate cases are molded as small as 0.065-in. OD, 0.055-in. ID, and 0.125-in. long. Glass-fiber-filled and Orlon-filled styles are available. Material is said to have good dimensional stability and moisture permeability.

Industrial Electronic Rubber Co., 31945 Aurora Road, Solon 39, Ohio.

**Availability:** Samples supplied on request.

## Data Printer 389

Cards or continuous paper forms are handled by the 1404 printer, operating directly from the output of the 1401 data processing system. Card output is 800 per minute max; card size is 51 to 160 columns. Continuous paper forms are printed at 600 lines per minute max. A read-compare feature is optional.

International Business Machines Corp., Data Processing Div., Dept. ED, 112 E. Post Road, White Plains, N. Y.

**P&A:** \$85,500; two years.

## Telemetry Transmitter 354



Solid-state, crystal-controlled telemetry transmitter, model N15A-125, measures 5 x 5 x 1-7/8 in. and weighs less than 20 oz. Supplies fm or cw signals on the 135-mc band. Requires a 20- to 24-v power supply and provides 0.5 to 1 w output. The transmitter withstands extreme conditions of shock, vibration and temperature.

DuKane Corp., Government Div., Dept. ED, St. Charles, Ill.

CIRCLE 108 ON READER-SERVICE CARD ►

# The smallest rotary switch ever made!

*Daven's New Series G Sub-Miniature Switch...1/2" Diameter!*

A new sub-miniature rotary selector switch, developed by DAVEN, is specifically suited for application in missiles, aircraft, handy talkies, field pack sets, frog-man communication equipment, and all types of mobile apparatus. This explosion-proof, waterproof switch has the same reliability as its bigger brothers... but in a fraction of the space. It meets applicable military specifications on temperature, humidity, corrosion, vibration, acceleration, shock and immersion.

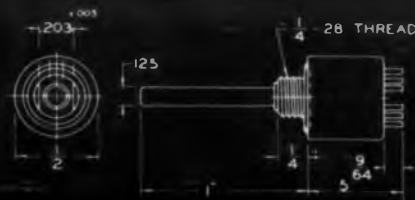
This unit is available as a single pole, 10 position switch and can be obtained with up to four poles on a single deck.

**Contact Resistance:** Less than .008 ohm.

**Contact Rating:** 1 ampere, 250V D. C. into resistive load  
350 MA, 100V D. C. into inductive load.

**Insulation Resistance:** 200,000 megohms between any two terminals or between any terminal and shell.  
Measured at 25° C., 50% RH, at sea level.

**Life Expectancy:** 50,000 cycles minimum  
Shaft and case: Stainless steel  
Panel and hub: Glass filled epoxy  
Contacts and terminals: Silver alloy  
Rotors: Rhodium plated beryllium copper



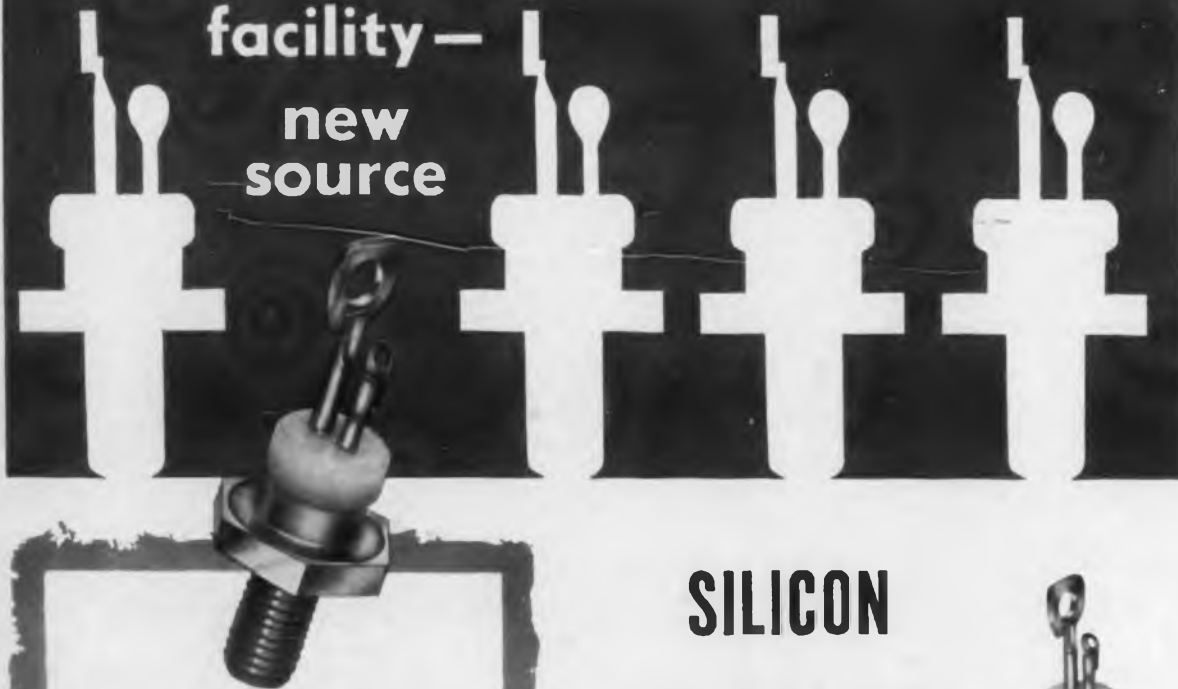
THE **DAVEN** CO.

LIVINGSTON, NEW JERSEY

Write today for comprehensive technical report  
on the new Series G Sub-Miniature Rotary Switch.

TODAY, MORE THAN EVER, THE DAVEN © STANDS FOR DEPENDABILITY!

new  
facility —  
new  
source



Tyco Semiconductor brings you a complete line of silicon controlled rectifiers designed and precision produced to meet and exceed MIL-S-19500 requirements.

You can now design with the assurance that a reliable source can deliver silicon controlled rectifiers in the 10 and 16 ampere range with each current rating available in voltage increments up to 500 volts.

Tyco silicon controlled rectifiers feature all welded hermetically sealed construction — uniform gating characteristics and low forward voltage drop. You will find the 2N1842 through 1850 and the 2N681 through 689 ideally suited for your industrial and military applications that require a reliable efficient method for the switching and control of power.

## SILICON CONTROLLED RECTIFIERS



Actual Size

2N681 — 2N689      2N1842 — 2N1850

Type Number	PRV and V <sub>90</sub>	Max. I <sub>oc</sub> @ Temp. °C	Max. Temp. °C Oper.	Max. Temp. °C Stor.	Max. Req'd Gate Signal
2N681	25	25 A @ 57°C stud	125°	150°	3V, 25 ma @ 125°C T <sub>J</sub>
2N682	50	25 A @ 57°C stud	125°	150°	3V, 25 ma @ 125°C T <sub>J</sub>
2N683	100	25 A @ 57°C stud	125°	150°	3V, 25 ma @ 125°C T <sub>J</sub>
2N684	150	25 A @ 57°C stud	125°	150°	3V, 25 ma @ 125°C T <sub>J</sub>
2N685	200	25 A @ 57°C stud	125°	150°	3V, 25 ma @ 125°C T <sub>J</sub>
2N686	250	25 A @ 57°C stud	125°	150°	3V, 25 ma @ 125°C T <sub>J</sub>
2N687	300	25 A @ 57°C stud	125°	150°	3V, 25 ma @ 125°C T <sub>J</sub>
2N688	400	25 A @ 57°C stud	125°	150°	3V, 25 ma @ 125°C T <sub>J</sub>
2N689	500	25 A @ 57°C stud	125°	150°	3V, 25 ma @ 125°C T <sub>J</sub>
2N1842	25	16 A @ 25°C stud	100°	125°	3.5V, 50 ma @ 100°C T <sub>J</sub>
2N1843	50	16 A @ 25°C stud	100°	125°	3.5V, 50 ma @ 100°C T <sub>J</sub>
2N1844	100	16 A @ 25°C stud	100°	125°	3.5V, 50 ma @ 100°C T <sub>J</sub>
2N1845	150	16 A @ 25°C stud	100°	125°	3.5V, 50 ma @ 100°C T <sub>J</sub>
2N1846	200	16 A @ 25°C stud	100°	125°	3.5V, 50 ma @ 100°C T <sub>J</sub>
2N1847	250	16 A @ 25°C stud	100°	125°	3.5V, 50 ma @ 100°C T <sub>J</sub>
2N1848	300	16 A @ 25°C stud	100°	125°	3.5V, 50 ma @ 100°C T <sub>J</sub>
2N1849	400	16 A @ 25°C stud	100°	125°	3.5V, 50 ma @ 100°C T <sub>J</sub>
2N1850	500	16 A @ 25°C stud	100°	125°	3.5V, 50 ma @ 100°C T <sub>J</sub>

For additional information — or immediate shipment, Call or Write:



# TYCO SEMICONDUCTOR

C O R P O R A T I O N

BEAR HILL · WALTHAM 54 · MASSACHUSETTS

TWInbrook 9-2400

## NEW PRODUCTS

### Silicon Rectifiers

603



Rating is 1 amp, continuous duty. Silicon rectifiers with ratings of 200 to 1,000 piv do not require heat sink. Double-diffused silicon junction is hermetically sealed in cylindrical case with all parts silver-plated for minimum contact resistance, good solderability of leads and thermal conductivity.

Electronic Devices, Inc., Dept. ED, 50 Webster Ave., New Rochelle, N. Y.

### Accelerometer-Amplifier

387

Solid state accelerometer-amplifier combination model 50X2 has continuously variable gain from 0 to 50, with a maximum sensitivity of 2 v per g. Frequency response is 5 to 4,000 cps for acceleration levels from 2 to 100 g. Size is 2-3/4 x 1 x 1-1/8 in., weight 4 oz. Power is 3.8 ma at 28 v dc.

Columbia Research Laboratories, Dept. ED, MacDade Blvd. & Bullens Lane, Woodlyn, Pa.

### Junction Capacitance Tester

399



Semiconductor junction capacitance test set model 705 C<sub>0</sub> measures 0 to 43 pf in four ranges. Accuracy is ±0.2 pf on all ranges. The low-cost set provides adjustable junction rf voltage, limited to 0.2 v rms.

Summers and Mills, Inc., Dept. ED, 1511 Levee St., Dallas 7, Tex.

### Power Supply

546

RF type, high voltage power supply provides continuously variable dc output voltages in a range from 10 kv to 40 kv. High voltage limit

ELECTRONIC DESIGN • July 19, 1961

control sets the upper voltage limit from 35 to 45 kv. Line regulation is better than 0.05%; load regulation is 0.5%; ripples is less than 0.5%.

Electro Scientific Industries, Mikros, Inc., Subsidiary, Dept. ED, 7620 S.W. Macadam Ave., Portland 19, Ore.

**P&A:** \$550 to \$600; 15 days.

### Power Supply

604



Rated at 150 v, 70 ma. Model 22-130 modular dc power supply has an output adjustable from 130 to 170 v and from 0 to 70 ma. Input is 105 to 125 v, 2.5 amp, 50 or 400 cps. Line regulation is 300 mv or 0.2%; load regulation is 150 mv or 0.1%. Ripple is 3 mv rms.

Dressen-Barnes Electronics Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena, Calif.

**P&A:** \$198.50; 30 days.

### Magnetic Memories

398



With a cycle time of 6  $\mu$ sec, coincident current magnetic memories type 3300 provide storage capacities from 128 to 4,096 words and from 4 to 64 bits per word. Digital data are accepted either synchronously or asynchronously, and stored in randomly specified or sequential addresses.

Rese Engineering, Inc., Dept. ED, A and Courtland Sts., Philadelphia 20, Pa.

### Differential Amplifier

380

For airborne use, model A differential amplifier occupies less than 3/4 cu in. Response is flat within  $\pm 1\%$  to 150 kc, 3 db down at 400 kc; linearity is better than  $\pm 0.05\%$  at 5 v; gain is up to 40; standard input is 20 v dc; temperature range is  $-100$  to  $+350$  F.

Stanaway Associates, Dept. ED, 3820 E. Colorado Blvd., Pasadena, Calif.

**FIRST  
PORTABLE  
LOW COST**

# DUAL GUN OSCILLOSCOPE

Featuring \* DC to 5 Mc Bandwidth \* 1 mv/cm sensitivity \*

**AT HALF THE EXPECTED PRICE** **\$495**

Available now for the first time — the only light weight, 5 Mc dual gun oscilloscope with all these features:

**VERTICAL AMPLIFIERS:** DC to 5 Mc bandwidth (3 db); 70 nanoseconds rise time; 100 v/cm to 100 mv/cm on both amplifiers, 1 mv/cm preamplifier on lower amplifier.  
**INPUT IMPEDANCE:** (each channel) 30 picofarads across 1 Megohm.

**HORIZONTAL SWEEP:** 1 microsecond/cm to 1 second/cm in 5 steps.

**TRIGGER:** Internal; free running, or with 0.5 cm excursion by either beam; External;  $\pm 0.5$  v to 2.5 v; TV frame and TV line.

**WEIGHT:** 22 pounds **SIZE:** 9 1/2" x 8 1/2" x 13"

**Price:** Model 5Mc-2 Oscilloscope with 2 Probes \$495.00  
Immediate delivery. All prices are quoted f.o.b. Los Angeles, and are subject to change without notice.

For complete information and demonstration contact nearest representative.

Anderson-Stone Engineering, Newton, Mass.  
Brogan Associates, Mineola, Long Island; Syracuse, New York  
J. E. Cuesta Company, Paoli, Pennsylvania  
Datronics, Houston, Dallas, Fort Worth, Texas  
Kittleson Company, Los Angeles, Palo Alto, California  
S. S. Lee Associates, Washington, D.C.; Baltimore, Maryland;  
Winston-Salem, North Carolina; Orlando, Florida  
Pivan Engineering, Chicago, Illinois; Indianapolis, Indiana



**Packard Bell Electronics**

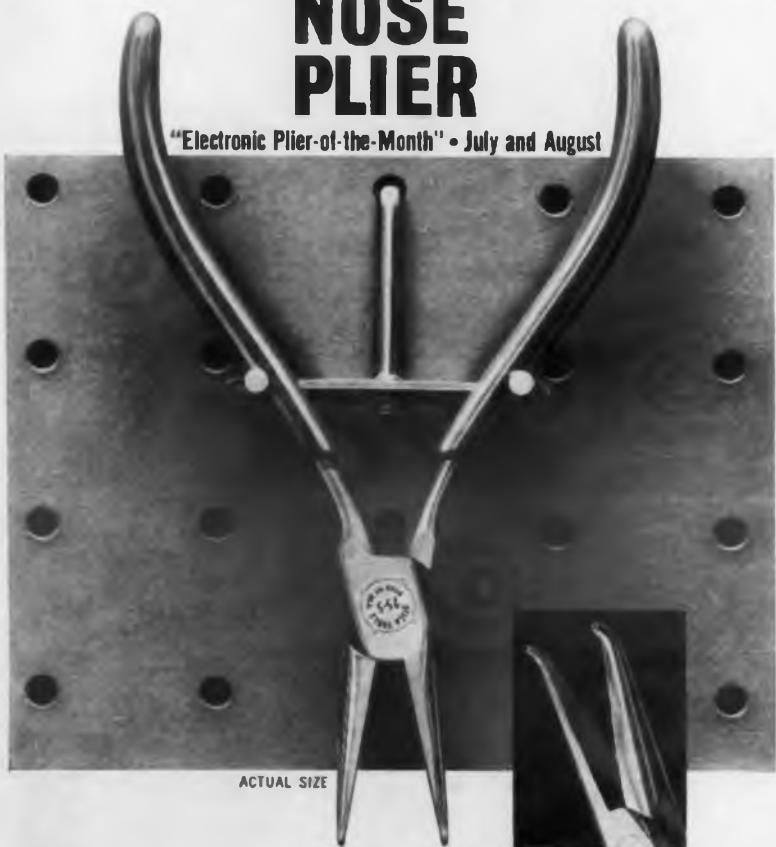
ENGINEERING BEYOND THE EXPECTED

12333 West Olympic Boulevard, Los Angeles 64, California

CIRCLE 110 ON READER-SERVICE CARD

# UTICA UNWRAPS A NEW BENT CHAIN NOSE PLIER

"Electronic Plier-of-the-Month" • July and August



Never before available on an industry-wide basis! This month's Utica special is the #25-5 . . . a new bent chain nose plier designed to grip, twist and loop very fine wire in closely confined areas. It's ideal for work on chassis as well as other subminiature electronic assemblies. Special features include 60° angle bent chain nose • Beveled edges full length of jaw • Fine serrations in jaws to prevent nicking or marking • Primer coated *dipped* cushion grip handles and Bauer spring to reduce operator fatigue • Induction hardened edges • Gleaming finish • Backed by Utica's famous full guarantee. Write for complete information on the #25-5 or the Utica Electronic Plier of the Month program. Or ask to have your Utica distributor call!

UTICA DROP FORGE & TOOL DIVISION • KELSEY-HAYES COMPANY, UTICA 4, NEW YORK

# UTICA

CIRCLE 111 ON READER-SERVICE CARD

## NEW PRODUCTS

### Novar-Socket Tubes

623



These receiving tubes have ninepin novar sockets. Types 6AY3, 12AY3, and 17AY3 are half-wave rectifiers designed to serve as damper diodes in horizontal deflection circuits. Plate voltage is 5,000 max; plate current is 1,100 ma peak-to-peak or 175 ma dc. Type 7868 is an audio power output pentode.

Radio Corp. of America, Dept ED, 30 Rockefeller Plaza, New York 20, N. Y.

### VLF Timing Receiver

625



Used at 16, 18, or 20 kc for reception of the major standard frequency stations, model 400 receiver provides an accurate means of checking local standards. Sensitivity is better than  $1\mu\text{v}$ . A built-in 100-kc oscillator is optional.

Interstate Electronics Corp., Dept. ED, 707 E. Vermont Ave., Anaheim, Calif.

### Rotary Solenoid

620



No linkages are required to convert linear motion to rotary with this solenoid, whose action is pure rotation of a balanced rotor. Unit, originally designed for missile applications, resists shock and vibration.

Singer-Bridgeport, Dept. ED, 915 Pembroke St., Bridgeport 8, Conn.

# TRIPLE PURPOSE TRIPLE SERVICE



## L&N's Stabilized 9835-B Microvolt Amplifier

Designed for low-level d-c measurements of thermocouples, strain gages, etc., in research and production testing, this amplifier combines the functions of three instruments in one:

1. A Direct Reading Indicator that has a sensitivity of  $0.25\mu\text{v}$ ;
2. A Recorder Preamplifier that extends the range of any Speedomax<sup>®</sup> (type G or H) 0-to-10 MV Recorder;
3. A Null Detector that provides a short period of only two to three seconds.

**Ranges**— $-25$  to  $+25$ ,  $-50$  to  $+50$ ,  $-100$  to  $+100$ ,  $-250$  to  $+250$ ,  $-500$  to  $+500$  and  $-1000$  to  $+1000$  microvolts.

**Accuracy**—As recorder preamplifier,  $\pm(0.4\%$  of range  $+0.5\mu\text{v}$ ). As direct reading indicator,  $\pm(1.4\%$  of range  $+0.5\mu\text{v}$ ).

**Source Resistance**—10,000 ohm, max.

**Response Time**—Within 1% of balance: (1) 2 sec. for 2,000  $\Omega$  max. source resistance; (2) 3 sec. for source resistance from 2000 to 10,000  $\Omega$ .

**Switches**—(1) Six-position range switch; (2) Three-position selector switch: non-linear meter response, linear meter response, recorder-output to recorder connector; (3) On-off line power switch.

**Amplifier Output at Recorder Connection**—with extremes of meter scale: (1)  $\pm 5$  mv across 500  $\Omega$  for null recorder; (2)  $\pm 0.5$  volt for external indicator having resistances of 20,000  $\Omega$  or higher.

**Case**— $10\frac{3}{4}$ " (h) x  $19\frac{3}{8}$ " (w) x  $8\frac{3}{8}$ " (d). Weight is approximately 34 lbs.

**Power Input**—115 volts, 60 or 50 cycles.

**Price**—\$640.00 F.O.B. Phila. or North Wales, Pa. (subject to change without notice). Specify List No. 9835-B when ordering from L&N, 4908 Stenton Ave., Phila. 44, Pa. or nearest L&N Office.



CIRCLE 112 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • July 19, 1961



## TELEMETRY BY TELE-DYNAMICS

# 1 and 2-watt

## Transistorized FM Transmitters



If you've a need for light—17 ounces—extremely compact—20 cu. in.—215 to 260 telemetry transmitters, specify Tele-Dynamic's Type 1053A and Type 1055A.

Providing one- or two-watt true FM output respectively, they employ dependable silicon transistors for high efficiency and offer better than 0.01% frequency stability. Type 1055A uses germanium transistors in the output stage. Each will operate reliably at any altitude and under any environment. Pressurized aluminum cases seal out the effects of altitude, humidity, salt spray, sand and dust.

These units, representative of Tele-Dynamic's latest creative effort in the complete telemetry field, are capable of being combined into various custom systems and are low in cost.

For detailed technical bulletins, call the American Bosch Arma marketing offices in Washington, Dayton or Los Angeles. Or write or call Tele-Dynamics Division, American Bosch Arma Corporation, 5000 Parkside Avenue, Philadelphia 31, Pa. Telephone TRinity 8-3000.

0512

## TELE-DYNAMICS DIVISION

**AMERICAN BOSCH ARMA  
CORPORATION**

5000 Parkside Ave., Philadelphia 31, Pa.

CIRCLE 113 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961

## Welding Head

622



Subminiature electrical and mechanical parts can be welded with the model JA head. The instrument has a fast forging force and adjustable steel ball bushings. Operation is by foot-treadle. Forging force range is 1 to 10 lb. Device measures 8 x 3 x 9 in. with welding heads extended. Weight is 9 lb.

Raytheon Co., Commercial Apparatus and System Div., Production Equipment Dept., Dept. ED, 25 Crescent St., Waltham 54, Mass. P&A: \$134; immediate.

## Electro-Optical Devices

554



Relay and potentiometer, made for noise-free signal control, incorporate a light source and a photocell in a light-proof casing. The CK-1111 relay can be used with 300 v dc or peak ac, with typical "on" resistance of 13 K. The CK-1112 provides continuous control in potentiometer function, operating to 10 v at 20 ma input.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass. P&A: \$11 ea, 1 to 9, immediate.

## Commutators

576



For wide variety of uses, including telemetry, multi-point checkout and commercial instrumentation. These commutators use Drireed contacts which are rated for 1 billion operations. The unit shown is single-pole with 12 channels and is 1-9/16 in. in diameter and 1-1/4 in. long.

Hathaway Instruments, Inc., Hathaway Denver Div., Dept. ED, 5800 E. Jewell Ave., Denver 22, Colo.



## not recommended for hi-fi enthusiasts



(Although we don't have too many reasons why it isn't.)

Just because the frequency response of our new 6 watt transistorized servo amplifier is extra good, someone had to suggest its use as a HI-FI component. He proved his case, too, by playing MANTOVANI through it without losing a string! Actually, the exceptional bandwidth which permits its operation on either 60 or 400 cycle carriers is only one of many features that make this amplifier outstanding.

Low dynamic output impedance insures good linearity and minimizes distortion between "motor-line performance" and "motor-amplifier performance"

High (30K) input impedance permits operation from most of the common input sources.

And high reliability has been achieved without the finality of potting; aluminum oxide articles provide good thermal conductivity at the same time affording protection against adverse environments.

For additional information on this servo amplifier No. TA006-0A-100 write: Diehl Manufacturing Company, Somerville, New Jersey.

### SPECIFICATIONS

Cat. No.	TA006-0A-100
Output	Continuous: 10 watts max. (unmounted, in free air at 25 ° ambient, no heat fins); 4 watts max. (mounted on 12 x 12 x 1/4" aluminum plate, at 71 ° ambient, with 1/2" heat fins)
Gain	1000 volts/volt, nominal
Input Imp.	30K minimum
Phase Shift	a) No measurable phase shift in 20 cps passband for 60 cps carrier b) Less than 10° phase shift in 100 cps passband for 400 cps carrier
Noise	013 volts, input shorted
Power Req.	-28 ± 2 volts DC at 600 amp; +9 ± 1 volts DC at .015 amp

Diehl

†A Trademark of THE DIEHL MANUFACTURING COMPANY

**DIEHL MANUFACTURING COMPANY**

A SUBSIDIARY OF THE SINGER MANUFACTURING COMPANY

Somerville, New Jersey

CIRCLE 114 ON READER-SERVICE CARD

## A new concept in contact design



## New Wire-Form Contact Cuts Miniaturization Costs

As you can see, it's quite different from conventional solid pin and socket contacts—and for good reason.

Spring action of the beryllium-copper beam sections exerts an equalized force at 4 separate points on the wall of the socket contact. This eliminates the need for a costly and space-consuming spring member in the socket contact. Result: economical micro-miniaturization . . . with densities of 100 to 175 contacts per square inch. Tests show that Wire-Form Contacts retain consistently low resistance after 1,000 cycles of repeated insertions and withdrawals. And unlike solid pin contacts, Wire-Form Contacts can be easily realigned, even after severe bending.

The Wire-Form design makes possible a completely new series of AMPHENOL Micro-Miniature Connectors. Included are 52- and 104-contact Micro-Rac rack and panel connectors with integral body-dielectric construction. They provide up to 20% more contacts in an equivalent space—

at nearly half the "standard" cost. And with Wire-Form Poke-Home Contacts, assembly time is shortened, since all wire terminations are made independent of the connector.

Multi-Purpose Strip Connectors are also available. Applicable to a wide range of uses, they are especially suited for use as printed circuit, tape cable and modular connectors. Bulk Wire-Form Contacts are also supplied for use where it is desirable to plug in modules and components to printed circuit boards and other miniaturization devices.

A complete description of this new micro-miniaturization technique is available by writing: Vice-President, Marketing, Amphenol Connector Division, 1830 S. 54th Avenue, Chicago 50, Illinois.

**AMPHENOL** CONNECTOR DIVISION  
*Amphenol-Borg Electronics Corporation*

Pat. applied for



## NEW PRODUCTS

### High-Voltage Power Supply

355



Bright-trace storage tubes can be powered by this dual-output, high-voltage power supply. Input is 25 to 29 v dc at less than 1 amp. Output is regulated  $-1.5$  kv, 1 to 3 ma dc for the writing gun and  $+10$  kv,  $100\mu$ a dc for the accelerating anode. Device measures 6 x 4 x 1-1/2 in., weighs 3 lb, and operates to 25,000 ft at temperatures from  $-55$  to  $+71$  C.

Espey Manufacturing and Electronics Corp., Saratoga Industries Div., Dept. ED, Saratoga Springs, N. Y.

### Power Sensors

440

For in-line measurement over a wide frequency range extending from dc to the vhf region. These power sensors measure true power of complex waveforms and can be furnished for ranges of a few milliwatts to hundreds of watts.

Consolidated Aviation Equipment, Inc., Dept. ED, 104 Atlantic Ave., Lynbrook, L. I., N. Y.

### Input Scanner

357



Programmable input scanner, model DY-2901, accepts up to 25 inputs, or 100 inputs with slave units, and selects system functions, ranges, and measurement delay for each input channel. Channel selection is by pushbutton; connectors can be quickly removed, and programing is by pinboard. Channel identification recording outputs are provided.

Hewlett-Packard Co., Dymec Div., Dept. ED, 395 Page Mill Road, Palo Alto, Calif.

P&A: \$1,950; 14 weeks.

◀ CIRCLE 115 ON READER-SERVICE CARD

### Telephone-Type Relay 574



For aircraft, ship-to-shore communications and mobile radio installations. Series 995 telephone-type relay carries up to 4pdt contacts, rated at 150 w, 3 amp max for palladium types and platinum-ruthenium and rated at 150 w, 1-1/2 amp for silver types. Coils are available from 3 to 110 v dc.

Guardian Electric Manufacturing Co., Dept. ED, 1550 W. Carroll Ave., Chicago 7, Ill.

### Carbon-Metal Resistors 438

Offered in three types: military, commercial and epoxy sealed, designated MP, CP and EP. Power ratings are 1/8, 1/4, 1/2, 1 and 2 w; resistance range covered is from 10 ohms to 50 meg. These resistors have additives of metal as well as the usual pyrolysis of carbon.

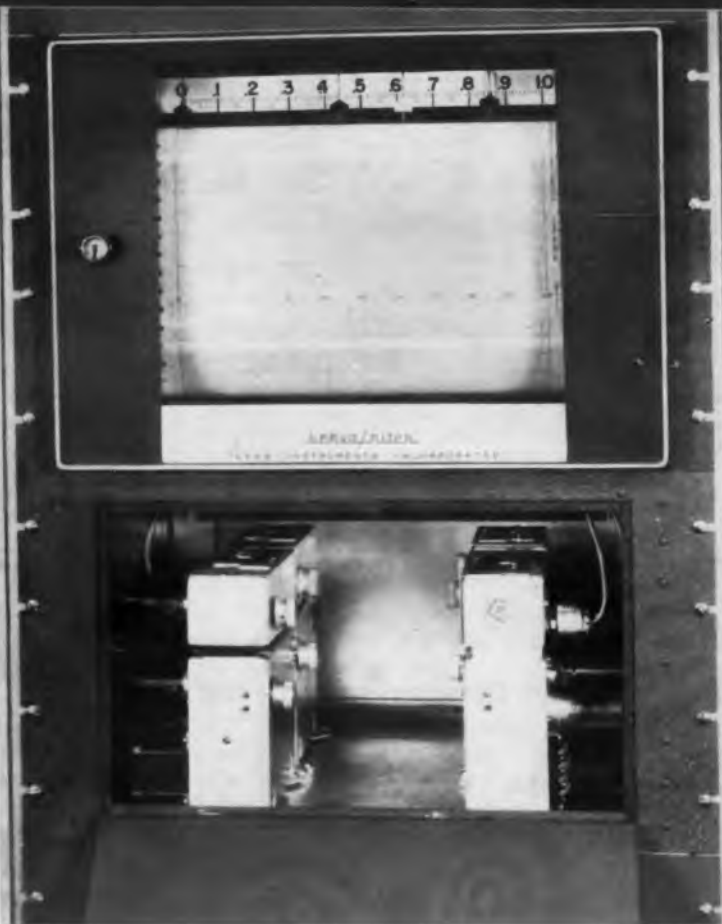
American Components, Inc., Dept. ED, 8th Ave. at Harry St., Conshohocken, Pa.

### Vacuum Furnace 442



Cold-jacket type, this vacuum-furnace operates continuously at 2,500 C. It is heated by six pairs of tungsten strips suspended by water-cooled, low-thermal-loss feed-throughs. The hot zone is 3-1/2 in. in diameter, 5 in. high. A 40-kw saturable-core reactor control is used.

F. J. Cooke, Inc., Dept. ED, 145 Water St., S. Norwalk, Conn.



## NEW from TI

# 4-CHANNEL *servo/riter* RECORDER



## RECORDS 4 CONTINUOUS CHANNELS

## ON A WIDE SINGLE CHART

You can now record four continuous channels of data on a wide single chart . . . four overlapping pens continuously recording on the full width of the 9 3/4" chart. For the first time in a potentiometric recorder four variables can be traced with high resolution on a single sheet of chart paper! The recorder is the proved *servo/riter* in the flush-mounting configuration for use in standard 19" relay racks.

Amplifiers are separate from the recorder and may be mounted as far as 15 feet from the recorder chassis. An optional factory-assembled package places the four amplifiers in a standard rack-mounting case for location adjacent to the recorder case.

In addition, five- and six-channel *servo/riter* recorders are available, utilizing overlapping pens on dual side-by-side 4 1/2" charts. Two- and three-channel recorders are offered in both the narrow and wide configurations, with all pens writing on only *one* sheet of chart paper.

The same industry-proved performance characteristics and wide ranges of the single and dual-channel *servo/riter* recorders are designed into the new multi-channel instruments. These include:

- HIGH SENSITIVITY—  
1.0 mv to 100 mv full-scale
- HIGH INPUT IMPEDANCE—  
4 megohms off-balance
- FAST RESPONSE—  
.5 second full-scale rise time
- HIGH REJECTION RATIOS—  
"Transverse" ..... 1,000/1  
"Longitudinal" ..... 330/1  
d-c Common Mode ..... 30,000/1  
d-c & a-c Guard ..... 30,000,000/1
- HIGH RELIABILITY—Non-lash gearing and conservatively rated electronics.

Write for complete information.

APPARATUS DIVISION  
PLANTS IN HOUSTON  
AND DALLAS, TEXAS



## TEXAS INSTRUMENTS

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# New

## Sonic Energy Cleaning Systems

### REDUCED INITIAL COST

25% less cost

### LESS FLOOR SPACE

up to 40% less

### MAXIMUM RELIABILITY

proven design—field tested

### IMPROVED EFFICIENCY

compact power generation

### LIFETIME WARRANTY

on new Omnimite® transducer

### SYSTEM INTEGRATION

improved filter, rinse & dryer

### RESTYLED CABINETS

for maximum adaptability

From Bendix . . . pioneer and largest  
producer of Sonic Energy Cleaning  
equipment



Pioneer-Central Division  
The Bendix Corporation  
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**SONIC ENERGY CLEANING**

Please send complete information on your new Sonic Energy  
Cleaning line, including compact Uni-Son® models.

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Zone \_\_\_\_\_

State \_\_\_\_\_

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## NEW PRODUCTS

### Power Converter

694



Rated from 10 to 100 w for 6 or 12 v dc operation, commercial and industrial power converters measure 1-1/2 x 1-1/2 x 3 in. The transistorized units are complete with rectifier and filter system.

James Electronics Inc., Dept ED, 4050 N. Rockwell St., Chicago 18, Ill.

P&A: \$11.95 to \$39.95; stock.

### Energy-Storage Capacitors

668

Complete line offered. Using single-unit and multi-unit block construction, these energy-storage capacitors are for applications such as high-energy pulses for radar, electrohydraulic metal forming and arc-air heating for wind tunnels.

Westinghouse Electric Corp., Dept. ED, P.O. Box 2099, Pittsburgh 30, Pa.

Availability: Stock or made to order.

### Shaft Position Encoder

707

Analog-to-digital shaft position encoder CG-733 uses a U-scan technique for simplicity of design and performance. Binary outputs of 128, 8192 and 524,288 counts are provided with an accuracy of  $\pm 1$  count. Conforming to environmental requirements, the units operate from  $-65$  to  $+85$  C.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

### DC Converter

560



Voltage-to-frequency converter changes 0 to 5 v dc into pulse or square-wave output. Frequency varies linearly within 1% with the dc input. Full-scale output frequencies range from 500 to 2,000 cps. Models with 0.1% linearity and 50 ppm per deg C temperature sensitivity are also available.

Pioneer Magnetics Inc., Dept. ED, 850 Pico Blvd., Santa Monica, Calif.



PERMACEL Electrical Tapes for Class B and Class H insulation. Glass backing, silicone-varnished or plain. Highly adhesive, strong, conformable, time and temperature resistant.

**PERMACEL**® NEW BRUNSWICK  
NEW JERSEY

Tapes • Electrical Insulating Materials • Adhesives

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## TRANSISTOR TRANSFORMER SELECTOR KIT

save valuable time  
in optimizing circuitry



**\$2950**  
user net

Available off-the-shelf  
from franchised  
distributors.

Model No. 400K

APPLICATIONS FOR SERVO AUDIO  
INSTRUMENTATION AND CONTROL CIRCUITRY

Set of 9 transformers covers impedance range of 150 through 200,000 OHMS

Matches most new transistor impedance ratings

### FULL DESIGN DATA ENCLOSED

1. Nomographs and circuitry for determining correct impedances
2. Power versus DBM chart
3. Guide to MIL-T-27A
4. Cross Reference index
5. Outline drawings

**MICROTRAN** company, inc.  
145 E. Mineola Ave., Valley Stream, N.Y.

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ELECTRONIC DESIGN • July 19, 1961



## ISOGLAS<sup>®</sup> and ISOLASTANE<sup>®</sup>

SHEETS  
ROLLS  
TAPES

FOR CONTINUOUS  
OPERATION AT TEMPERATURES  
UP TO 155° C.

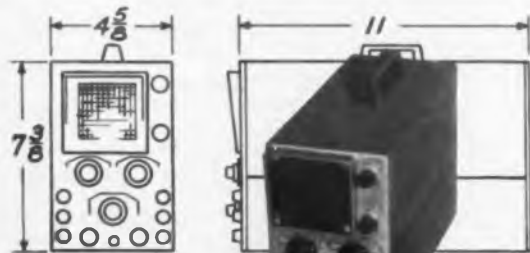
Natvar Isoglas and Isolastane afford heavy duty equipment extra protection against frequent overloads beyond Class B rating. Isoglas consists of a glass fabric coated with an isocyanate reacted resin. Isolastane is similar except that an elastomeric resin is used. These products are outstanding in their

- thermal stability
- resistance to crazing and cracking
- resistance to solvents, Askarel, and other non-flammable synthetic insulating liquids
- toughness and scuff resistance
- wet dielectric strength
- flexibility at low temperatures
- fungistatic qualities

Also available laminated with other insulating materials for slot lining, coil supports, and phase insulation. Ask for Data Sheet and Samples.

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### NEW 3" "SPACE SAVER" DC OSCILLOSCOPE

Model IO-10  
**\$7995**

The little IO-10 has big applications. Use it in industrial, medical and general service fields for computer "read out" and for voltage, frequency and phase shift measurement. It features identical vertical and horizontal AC or DC coupled amplifiers, external sync terminal, external capacity binding posts for sweep rates lower than 5 cps, transformer-operated power supply, voltage-regulated B+ and bias and excellent specifications. 3RP-1 CR tube included. Send for free Heathkit catalog or see your nearest Heathkit dealer.

HEATHKIT DAYSTROM

HEATH COMPANY Benton Harbor 60, Michigan  
Please send the Free Heathkit catalog.

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ELECTRONIC DESIGN • July 19, 1961

### 3-Mode Controller 561



Transistorized 3-mode controller SCD-1001-P accepts input signals of 60 or 400 cps, 50 mv. Proportional settings from 5 to 1,000%, reset time of 0.1 to 300 repeats per min and rate times of 0.005 to 2 min are standard. Current or voltage outputs can be obtained.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Road, Nashville 10, Tenn.

### Laboratory Standards 699

Voltmeter, milliammeter. Model 1700 dc voltmeter and model 1702 milliammeter both have 10 ranges and provide an accuracy of 0.5% of full scale. They are temperature compensated from 15 to 35 C. Self-shielded core magnet-meter movements protect the instruments from external fields.

Simpson Electric Co., Dept. ED, 5200 W. Kinzie St., Chicago 44, Ill.

P&A: 1700, \$160; 1702, \$135: From stock.

### Pyrolytic Graphite 391

Plates, cylinders, and special shapes of pyrolytic graphite are available in sizes up to 1/2 in. thick and 4-1/2 ft long. The crystal structure of the material permits it to conduct heat and electricity in one plane, but to insulate perpendicular to that plane. High-temperature tensile strength is 60,000 psi at 2,750 C. The material polarizes infrared light.

General Electric Co., Metallurgical Products Dept., Dept. ED, Detroit 32, Mich.

### Pulse Transformer Kit 552



With 25 units. Pulse transformer Test-Chest contains 25 different units, in 20 case styles, providing over 500 variations. Turns ratios are 1:1:1, 2:1:1, 4:1:2, and 4:1:4. Inductive values range from 50µh to 140 mh.

Pulse Engineering, Inc., Dept ED, 560 Robert Ave., Santa Clara, Calif.

P&A: \$125; immediate.

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Yes, you can really relax when you place your aluminum fabricating problems in the competent hands of American Aluminum. Backed by 50 years of progressive engineering know-how, AA can serve you from design to finished product... all under one roof. Immediate attention, with emphasis on quality and dependability, is given to your specific needs when using American Aluminum's "Peace of Mind" service. All you have to do is sit back and relax... let us do the worrying!

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Complete die making facilities  
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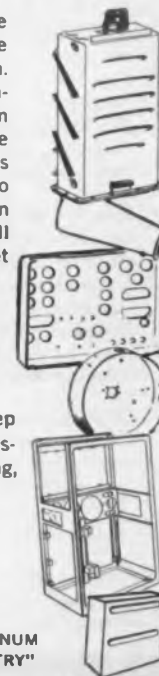


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Manufacturers of Aluminum Products  
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Model ST-300

## COMBINE VIBRATION AND SHOCK TESTING

### IN ONE COMPACT 250 FORCE-POUND INSTRUMENT

**FOR LARGE COMPONENTS AND SMALL SUBSYSTEMS . . .** the new ITT ST-300 offers a 250 force-pound exciter for vibration and shock testing. This latest in a series of dynamic new vibration equipment utilizes the unique concepts of lateral motion excitation and air-bearing support—both developed by ITT engineering and proved on ITT's other vibration exciters of the 100 and 200 Series.

The exceptionally flat frequency response of the ST-300 permits precise testing without the need for elaborate compensating devices. Natural resonances are unaffected by table loadings. In addition, by checking shock and vibration on the same instrument, testing time and cost are substantially reduced. Other significant features of the ST-300 include:

- *no significant distortion throughout normal test range*
- *first major resonance above 5 Kc*
- *useful frequency from 5 cycles to 50 Kc*
- *shock testing to over 5,000 g's*
- *table size: 5" x 8"*

For complete information and applications data, call an ITT Instruments representative or write for Data File ED-1426-1

Other ITT vibration exciters include:



ST-150 for testing one ounce loads to over 100 g's



ST-100 for small component production testing and accelerometer calibration

# ITT

**Industrial Products Division**

International Telephone and Telegraph Corporation  
15191 Bledsoe Street • San Fernando, Calif. • EMpire 7-6161

power conversion • instruments • closed circuit TV • avionics • mobile radio/telephone

CIRCLE 123 ON READER-SERVICE CARD

## NEW PRODUCTS

### Accelerometer

401



Ranges from 0.03 to 40,000 g, with frequency response flat within  $\pm 5\%$  from 0.2 cps to 12 kc, are provided by model 504 miniature accelerometer. Sensitivity is 20 mv per g, amplitude linearity  $\pm 1\%$ . Temperature range is  $-65$  to  $+350$  or  $+500$  F. Height is 0.53 in., weight 15 g.

Columbia Research Laboratories, Dept. ED, MacDade Blvd. & Bullens Lane, Woodlyn, Pa.

P&A: \$139.50 ea, 6 to 10; two weeks.

### Switching Transistors

643

High-speed npn epitaxial switching transistors have high breakdown voltages, low saturation voltages, and low output capacities. Designated types NS-381 through NS-384, the devices come in TO-18 packages.

National Semiconductor Corp., Dept. ED, Danbury, Conn.

P&A: \$20.90 to \$22.90 for 1-99; from stock.

### RF Transformer

635

For low-power radar receivers in airborne and ground equipment, type 1044 rf transformer is used at frequencies under 100 mc. Ratings are: primary windings, 1 to 1.3  $\mu$ h with a Q-factor of 26 min; secondary windings, 0.1 to 0.14  $\mu$ h with a Q-factor of 66 min.

Applied Components Inc., Dept. ED, 401 E. Beach Ave., Inglewood, Calif.

Availability: made to meet customer specs.

### Linear Actuator

402



With stroke to 6 in. Polynoid linear actuators provide reliable, easily controlled motion at low cost. They can be used to hold underload at any position or provide reciprocating motion. Stroke is up to 6 in. standard. Foot mounting is provided.

Skinner Precision Industries, Inc., Dept. ED, New Britain, Conn.

## Select the transistorized DYN-EMPIRE GAUSSMETER best suited to your needs

Completely transistorized Dyna-Empire gaussmeters accurately measure flux density and determine "flow" direction. Ideal for measuring and locating stray fields, plotting variations in strength and performing rapid comparisons of production lots against a standard. Easy-to-operate,—no jerk, pull, ballistic readings or circuit breaking required.



### NEW TRANSISTORIZED GAUSSMETER MODEL D-874

#### Special Features:

FIVE RANGES: 300 gauss full scale, 1,000 gauss full scale, 3,000 gauss full scale, 10,000 gauss full scale, 30,000 gauss full scale.

LINEAR OVER ENTIRE OPERATING RANGE

PORTABLE, OPERATES FROM OWN SELF-

CONTAINED BATTERIES

BATTERY LIFE—1,000 HOURS

REQUIRES NO EXTERNAL POWER SOURCE

INTERNAL CALIBRATION STANDARD

WEIGHT—4 LBS.

UNIVERSAL PROBE SUPPLIED IS 0.025" THICK BY 0.200" WIDE. ACTIVE AREA IS ONLY 0.0079 SQUARE INCHES LOCATED NEAR THE TIP OF THE PROBE.

Complete with Universal probe \$195.

### TRANSISTORIZED GAUSSMETER MODEL D-855

This quality precision built Gaussmeter reads flux densities to 30,000 Gauss full scale  $\pm 2.5\%$ . It is a highly sensitive instrument and provides tremendous flexibility. Complete with two linear probes—one high sensitivity probe for measurement of low density fields and one probe for measurement of high density fields. Special probe available for reading 3 gauss full scale.

Write to

Dyna-Empire, Inc.

1075 Stewart Avenue, Garden City, N. Y.



CIRCLE 124 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961



## Connectors

364



Microminiature connectors have contact densities of 100 to 175 per sq in. Series 220 Micro-Rac is a rack and panel connector, and series 221 Strip is for in-line, stacked, and special configurations. Current rating is 3 amp max, and temperature range is -65 to +250 F. Contacts, beryllium-copper, are spring-tempered and resist deformation.

Amphenol - Borg Electronics Corp., Amphenol Connector Div., Dept. ED, Broadview, Ill.

## Rotary Solenoid

367



Requires 0.0033 amp input at room temperature or 0.005 amp at -55 C. Voltage range is 25 to 29 v. Type 9931-04 rotary solenoid meets MIL-1-22075 and is for devices requiring 35-deg rotation.

John Oster Manufacturing Co., Avionic Div., Dept. ED, Racine, Wis.

Availability: 60 days.

## Switchlight Adaptors

368



Snap-in adaptors simplify mounting of the firm's switchlights and indicators. They can be supplied with legend engraved or stamped. Round and square types are available. They are made of nylon with cadmium-plated spring-steel retaining clips.

Pendar, Inc., Dept. ED, 14744 Arminta St., Van Nuys, Calif.  
P&A: under \$1; stock.

CIRCLE 125 ON READER-SERVICE CARD

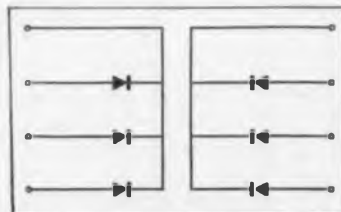
# General Instrument Silicon Planar Microdiodes



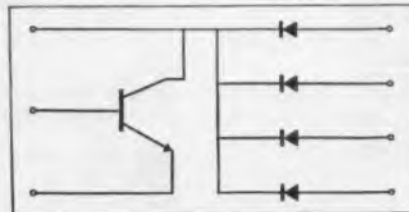
## New from General Instrument: the only planar microdiode

This planar microdiode could help a designer make a new reputation. Here are the parameters of a "big" planar diode...but this is the first and only planar diode available in micro-size. ■ You get the high-reliability advantages of planar structure in a package 0.080" by 0.045"...microdiodes which have passed 10-day JAN humidity test cycles and ionic salt immersions with no degradation of electrical parameters...true surface passivation only available from General Instrument's unique Molecular Shield™ process. ■ Here is instant availability of a full line of planar microdiodes for computer and general purpose design, in any quantity, either as individual devices or pre-assembled as complete nanocircuits in standard TO-5 cans (up to six diodes per can). ■ For full information on General Instrument microdiode types MD 4, 6, 8 and 10 call the sales office or franchised distributor nearest you. In addition, the same reliability benefits of true passivation planars are available in General Instrument's microtransistors. Write today to General Instrument Semiconductor Division, 65 Gouverneur Street, Newark 4, New Jersey.

Typical Nanocircuit Assemblies Available in TO-5 Packages...



NC-1. Six Diode Assembly



NC-3. Diode-Transistor Logic Assembly

### TYPICAL SPECIFICATIONS ● 25°C.

- Max. power dissipation: 250 mw.
- Reverse Recovery: JAN 256 ckt. 100 Kohms in 0.3 μsec switching from 5 ma forward current to 40v reverse voltage.
- BDV: 100v; continuous working voltage: 80v.
- Average rectified current: 75 ma DC.
- Minimum forward current: 20 ma DC ● 1v DC.
- Reverse current: ● 80v DC; 0.005 μa, 5 μa ● 150 C.
- Storage and operating temperature range: -65°C to +150 C.

**GENERAL INSTRUMENT SEMICONDUCTOR DIVISION**  
**GENERAL INSTRUMENT CORPORATION**

ACTUAL SIZE

# SEE YOU AT



## WESCON

Why should a publication have a booth at WESCON? So that our editors can meet you in person to discuss what you like—or would like to see—in **ELECTRONIC DESIGN**. So that we can find out about the projects you are working on that would interest many of your 38,500 fellow subscribers.

If you are thinking of writing an article yourself, so much the better. Come in and talk it over. And while you are in the booth, you can pick up a copy of the *new tabloid size Electronic Daily* . . . it's published each day to bring you all the latest news, announcements, and the significance of behind-the-scene developments at the show.

**ELECTRONIC DESIGN— Electronic Daily**

**BOOTH P1—AT WESCON**



## NEW PRODUCTS

### Shock Recorder

417



Statistical recorder has four channels, each of which can be set from 1 to 25 g. Accuracy is  $\pm 5\%$ . Frequency response is 0 to 40 cps min. Temperature range is  $-65$  to  $+250$  F; unit meets MIL-E-5272 specifications. Electrical output is optional. Devices are made to monitor shocks received in shipping.

Inertia Switch, Inc., Dept. ED, 311 W. 43rd St., New York 36, N. Y.

P&A: \$75.00 per channel; one week.

### Surge Suppressors

669

Ranges are 2 to 85 amp, maximum discharge current, and 30 to 480 rms v ac. Available in polarized or nonpolarized units, the Voltrap surge suppressors protect silicon and germanium cells, controlled rectifier cells and similar devices. Multiple units are available in a single assembly.

Westinghouse Electric Corp., Dept. ED, P. O. Box 2099, Pittsburgh 30, Pa.

### Thermo-Converters

667

For frequencies to 400 mc. the UF7 series coaxial thermo-converters are for rugged remote monitoring or recording of rf and af voltages and currents. Full-scale voltage ranges are from 0.1 to 101 v.

Altron Electronics Co., Dept. ED, P. O. Box 141, Ridley Park, Pa.

P&A: \$155; 15 days.

### Right-Angle Connector

395



For circuit boards. Right-angle plug and receptacle series 6040 is designed for printed circuit applications where a soldered joint is required between board and connector. Contacts match 0.100-in. grid. Closed-entry socket receptacles and die-cast aluminum protective shells are optional.

Precision Connectors Inc., Dept. ED, P. O. Box 96, Mineola, L. I., N. Y.

## ASSURED RELIABILITY



### G-M provides continuous quality control

Your need for a full margin of reliability in servo systems is matched by the continuous quality of G-M Servo Motors and Generators. The extra design experience that goes into every G-M unit is guided through production by test, after test, after qualification test. Sizes range from 5 to 18, with prompt availability that promises quick adaptation to your servo development and production programs.

Qualify G-M Servos for all of your projects, now, in advance of actual need. Send procurement specs and prints, today.

Phone: PEnsacola 6-1800 (TWX CG-3266)



4284 N. Knox Avenue • Chicago 41

Other offices in principal cities

CIRCLE 127 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • July 19, 1961

## Epoxy Applicator

362



Hand dispenser for epoxy adhesives and potting compounds, called the Epoxer, provides fingertip control of epoxy flow, with positive cut-off. Unit, pressure-charged, dispenses filled or unfilled materials over a range of viscosities. It can dispense dots, drops, and beads.

Kenics, Corp., Dept. ED, P. O. Box 27, Greenwood Station, Wakefield, Mass.

**P&A:** \$48.00; from stock.

## Cryogenic Sensors

385

Measure to 4 K or  $-269$  C. These miniature cryogenic sensors are germanium semiconductors for use in test and operation of space vehicles using liquid helium and nitrogen, and for use in calibration and standards laboratories. One type measures surface temperatures; the other is for internal applications.

Minneapolis-Honeywell Regulator Co., Dept. ED, Wayne & Windrim Aves., Philadelphia 44, Pa.

## Modular Delay Lines

351



Delays of 10 to 100 nsec are provided by modular sections, each an encapsulated LC circuit. Lines comprising 6 to 60 modules are available, and may be stacked to provide over 200 sections. Called Wee Lines, the units have 500-ohm impedance and include phase correction for proper pulse response. Taps may be pulled at any increment of delay without distorting pulse shape.

Nytronics, Inc., Dept. W-1, Dept. ED, 500 Springfield Ave., Berkeley Heights, N. J.

**Availability:** From stock to 8 weeks.

YOU'RE

# SPERRY

SPERRY SEMICONDUCTOR  
DIVISION

OF

SPERRY RAND CORPORATION  
NORWALK, CONNECTICUT



## THE CIRCUIT JUDGE . . .

**... and it's up to us to present the facts.**

Here's evidence on Sperry's PNP alloy junction silicon transistors:

1. All units are baked at 200°C for 200 hours and each device is doubly tested for a perfect hermetic seal — through a 150°C hot oil check and a separate hydrostatic test at 100 psi.
2. Sixty-three QC checks are performed before and during mechanized manufacture.
3. Our newly-built 65,000 square foot facility in Norwalk, Connecticut incorporates the latest techniques to produce the quality and quantity you require.
4. We offer you a wide variety of PNP types from which to choose.

May we have your verdict?

**SEMICONDUCTOR IS OUR MIDDLE NAME . . . SEMICONDUCTOR INTEGRATED NETWORKS (SEMI-NETS®), TUNNEL DIODES, MESA AND ALLOY SILICON TRANSISTORS AND DIODES. SALES OFFICES: CHICAGO, ILLINOIS; EL SEGUNDO, CALIFORNIA; WESTWOOD, NEW JERSEY; TEWKSBURY, MASSACHUSETTS; STAMFORD, CONNECTICUT; TOWSON, MARYLAND; MASSAPEQUA PARK, NEW YORK.**

**SEMICONDUCTOR OPPORTUNITIES AVAILABLE TO QUALIFIED ENGINEERS**

**\*Trade Mark, Sperry Rand Corporation**

# THE CALL OF THE TALOS COMES IN LOUD AND CLEAR

through CECO's compact,  
low noise, telemetering  
preamplifier

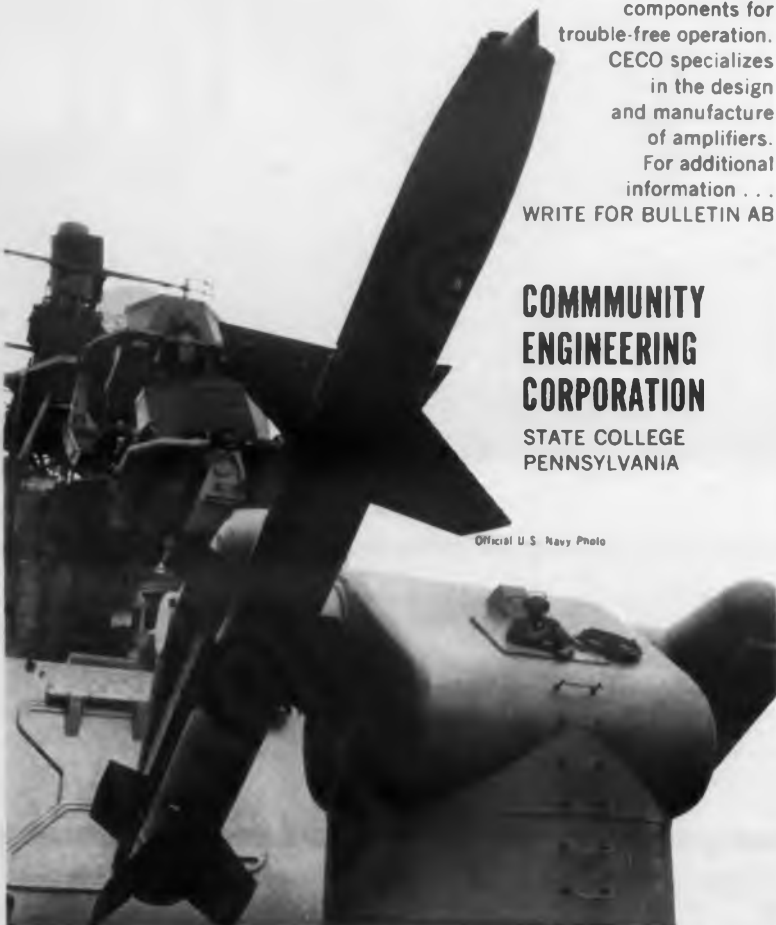
CECO's Model 3010, wide band, telemetering preamplifiers, used aboard the Navy's new CLG-series cruisers, boost air-to-surface signals, minimize noise, reduce output and size requirements of missile transmitters. Used in the AN/UKR-10 telemetering and AN/USQ-11 missile systems manufactured by Aircraft Armaments, Inc., for the Talos, Terrier, and Tartar missiles, the Model 3010 is simple, highly compact and flexible in physical configuration. It is characterized by extremely low noise and stable gain and features new tube types and conservatively rated components for trouble-free operation. CECO specializes in the design and manufacture of amplifiers. For additional information . . .

WRITE FOR BULLETIN AB

## COMMUNITY ENGINEERING CORPORATION

STATE COLLEGE  
PENNSYLVANIA

Official U.S. Navy Photo



CIRCLE 129 ON READER-SERVICE CARD

## NEW PRODUCTS

MICROWAVES

### Square-Wave Generator

474



Adjustable 850 to 1,150 cps. Designed for modulating microwave amplifiers, signal generators, and traveling-wave tube amplifiers, model 305 provides a square wave up to 60 v peak-to-peak. Rise time is 0.4  $\mu$ sec, with 5  $\mu$ sec fall. Frequency stability is  $\pm 0.2\%$ . Size is 3-3/8 x 6 x 5-3/8 in. Weight is 2-1/2 lb.

Alfred Electronics, Dept. ED, 897 Commercial St., Palo Alto, Calif.

### C-Band Transponder

476



Recovery time is 30  $\mu$ sec. Beacon transponder model SC-702 operates in the 5.4 to 5.9 Gc range. It can decode 38 different codes. Solid-state modulator gives recovery time of 30  $\mu$ sec. Output stage uses pulsed triode for reliability; input power is less than 30 w. Transmitter output is 1 kw peak. Weight is 10 lb.

General Dynamics/Electronics, Public Relations Dept., Dept. ED, 100 Carlson Road, Rochester 3, N. Y.

### VHF-UHF Power Oscillators

571



50 mw to 50 w of power are provided by the firm's model 408 and 410 power oscillators. Frequency ranges are from 200 to 550 mc and 500 to 1,050 mc for the two instruments respectively. Dial resettability is within 0.002%.

# 0 TO 1500 V COMPLIANCE

## with ELECTRONIC MEASUREMENTS



MODEL C638A

## CONSTANT CURRENT POWER SUPPLIES

You'll find a whole new world of application in Electronic Measurements Constant Current Power Supplies. Take the husky Model C638A shown here. It'll deliver up to 1500 V dc at any output current from a few microamperes up to 100 ma. There are other features too . . . a modulation input, programmability, less than 0.01% + 1  $\mu$  ripple . . . and the all-important voltage control that lets you set the maximum voltage compliance.

For complete information ask for Specification Sheet 3072B.

#### BRIEF SPECIFICATIONS

MODEL	RANGE		VOLTAGE COMPLIANCE (MINIMUM)
	MIN.	MAX.	
C612A	1 $\mu$ a	100 ma.	100 V
C631A	1 $\mu$ a	100 ma.	300 V
C638A	1 $\mu$ a	100 ma.	1500 V
C624A	2.2 $\mu$ a	220 ma.	100 V
C632A	2.2 $\mu$ a	220 ma.	300 V
C629A	2.2 $\mu$ a	300 ma.	50 V
C633A	2.2 $\mu$ a	300 ma.	300 V
C620A	5 $\mu$ a	500 ma.	50 V
C621A	5 $\mu$ a	500 ma.	100 V
C613A	10 $\mu$ a	1 AMP	50 V
C614A	10 $\mu$ a	1 AMP	100 V



**ELECTRONIC  
MEASUREMENTS  
COMPANY, INCORPORATED**

CIRCLE 130 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961

A meter indicates proper loading. Modulation can be cw, external, pulse, internal square wave (1 kc 100%) or, on special order, am. Stability is  $\pm 0.1$  db per hour.

Microdot Inc., Dept. ED, 220 Pasadena Ave., South Pasadena, Calif.

### Sweep Generator

702



Model SP-1200 sweep generator has a center frequency range of 5 to 1,200 mc and a sweep width of 5 to 1,200 mc. An automatic gain control circuit continuously samples the swept output to insure a uniform signal level over the entire range. Flatness is within  $\pm 0.2$  db over a 100 mc width and within  $\pm 0.75$  db over-all. Rf output is over 0.25 v rms into 50 ohms and can be adjusted in steps of 0, 10, 20, 30, 40 or 50 db.

Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.

### Coaxial Isolator

703



L-band coaxial isolator is 6.45 in. long weighs less than 2 lb. Standard units covering 1.0 to 2.0 Gc have a 10:1 isolation/insertion loss ratio, vswr of 1.15 max. Narrow-band models with higher isolation/insertion ratios are also made.

E & M Laboratories, Dept. ED, 15145 Califa St., Van Nuys, Calif.

P&A: \$325; 3 weeks.

### Tunable Magnetron

712

Voltage-tunable magnetron ZM-6014 covers the 500 to 1,200 mc range with a power output of 1/2 w. It can sweep the band in 0.01 usec or less; tuning rate is 0.65 mc per v. Tube operates at 2.5 kv max, anode current of 20 ma max, filament current of 3.2 amp max. Weight is 3-1/2 lb.

General Electric Co., Power Tube Dept., Dept. ED, Schenectady 5, N. Y.

P&A: \$950; 180 days.



Encapsulation with putty-type Alkyd satisfies need for reliability by resistor maker and customers.

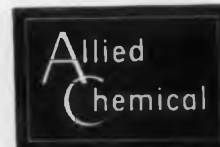
Today's creative engineers design with PLASKON Alkyd in mind for the manufacture of delicate electronic components. Here are reasons why electronic engineers prefer PLASKON putty-type Alkyds as the encapsulation medium:

- Simple to fabricate . . . molds quickly at extremely low pressures . . . permits rapid production cycles.
- Clean to handle . . . nothing to mix.
- Dimensional stability prevents distortion or damage to delicate inserts.
- Coefficient of linear thermal expansion is similar to that of popular wire alloys . . . reduces strain in service . . . aids the functioning of encapsulated units.
- Thermal conductivity helps to dissipate heat faster, resulting in less change in resistance value before and after encapsulation.
- Available in colors, for coding.
- More economical than most encapsulating processes.

Ultronix, Inc., San Mateo, Calif. manufacturer of quality electronic components, effectively utilizes PLASKON putty-type Alkyd in resistor production. The resistor pictured above in several stages of assembly includes an ingenious combination of three Alkyd parts—each one molded within the other—a most severe test of dimensional stability, moisture resistance, and consistency in performance. This resistor is built to meet or exceed all requirements of MIL-R-93B and MIL-R-9444.

PLASKON Alkyd Molding Compounds are outstanding for the qualities most necessary in molded parts for electronic and electrical applications. Competent Plaskon representatives will be glad to discuss material recommendations and fabricating techniques to fit your performance requirements. Telephone your local Plaskon representative or write to:

**PLASTICS DIVISION**  
40 RECTOR STREET, NEW YORK 6, N. Y.





## NEW PRODUCTS

MICROWAVES

### Coaxial Switches and Attenuators 714

Solid-state devices are made for microwave receiver applications. Series MA-3460 switches operate from 210 to 2,850 mc with a typical switching speed of 4 nsec. Insertion loss is 0.2 db max closed and 20 db min open. Driving power is 10 to 100 mw. Series MA-3441 variable attenuators have the same frequency range and insertion loss characteristics. Bias is  $-30$  v at  $10 \mu$ a to  $+1$  v at 10 ma.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

### Coaxial Attenuators 704



Operate to 5 Gc. Carbon film resistive elements are used in this series of coaxial attenuators. Attenuation accuracy is  $\pm 0.1$  to  $\pm 0.5$  db up to 3 Gc; vswr is 1.02 to 1.3:1, dc to 5 Gc. Power handled is 1 w for cw, 1 kw peak. Input and output impedance is 50 ohms. Type C connectors are standard, with other types available.

Ad-Yu Electronics Lab., Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N. J.

P&A: \$36; 2 weeks.

### Traveling-Wave Tube 715

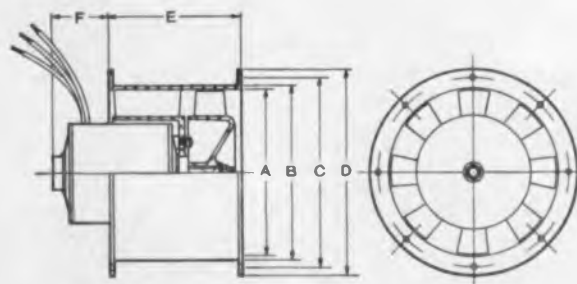
An 8-db over-all noise figure is achieved by a radar using the N1042M traveling-wave tube. Under typical operating conditions, the tube requires a magnetic focusing field of 525 gauss, has a gain of 25 db, noise factor of 6.5 db, and saturated output of 1 mw.

English Electric Valve Co. Ltd., Dept. ED, Chelmsford, England.

### Helical Antennas 394

Made for 2-Gc band, helical antennas of the TY-52 and TY-53 series are designed for easy maintenance accessibility. Two-bay models have a 9.4 gain, three-bay 14.1. The antennas withstand wind up to 112 mph, and can be deiced by passing low-voltage, high-current power through the helix.

General Electric Communications Products Dept., Dept. ED, P. O. Box 4197, Lynchburg, Va.



Model X702-402

## A Complete New Line of Electronic Cooling Fans JOY Axivane Series 60

Developed by Joy specifically for 60 cycle commercial duty, the Series 60 vaneaxial fans operate at 3400 rpm, 115 volts, single phase, 50/60 cycles and produce from 50 to 500 cfm at static pressures of  $\frac{1}{4}$ " through 1" wg. They are extremely compact and ruggedly built

of anodized aluminum. There are only four major parts; rotor, housing, motor, and separately mounted capacitor. Production quantities are available on order and small quantities are available off-the-shelf. For more information write for bulletin 3313-57.

Model No.	Design CFM $\pm 3\%$	Max. CFM at Free Flow	Design PS $\pm 7\%$	Max. Pressure	Motor Data		Mechanical Dimensions (Inches)						$\frac{1}{2}$ " Holes Per Flange	Total Weight Pounds
					BHP	CAP* MFD	A	B	C	D	E	F		
X702-401	50	70	0.30	0.45	.005	NONE	4.37	4.62	5.25	5.87	4.50	0.9	4	5.4
X702-402	100	145	0.35	0.60	.010	NONE	5.12	5.37	6.00	6.62	4.50	0.9	4	5.8
X702-403	150	180	0.35	0.80	.015	NONE	5.62	5.87	6.50	7.12	4.50	0.9	4	6.1
X702-404	200	265	0.40	0.79	.035	5	5.62	5.87	6.50	7.12	5.00	1.3	8	7.2
X702-405	250	330	0.40	0.82	.043	5	5.87	6.12	6.75	7.37	5.00	1.3	8	7.4
X702-406	300	340	0.40	0.93	.052	5	6.12	6.37	7.00	7.62	5.00	1.3	8	7.6
X702-407	350	430	0.50	1.10	.060	5	6.37	6.62	7.25	7.87	5.00	1.5	8	8.5
X702-408	400	520	0.75	1.20	.068	5	6.62	6.87	7.50	8.12	5.00	1.5	8	8.7
X702-409	450	560	0.75	1.30	.075	5	6.87	7.12	7.75	8.37	5.00	1.5	8	8.9
X702-410	500	625	0.75	1.40	.083	5	7.12	7.37	8.00	8.62	5.00	1.5	8	9.1

\*Rated 236 WVAC—

Note: Span aluminum inlet bells and aluminum wire inlet bell screens are available to fit all sizes of fans.

### AIR MOVING EQUIPMENT FOR ALL INDUSTRY

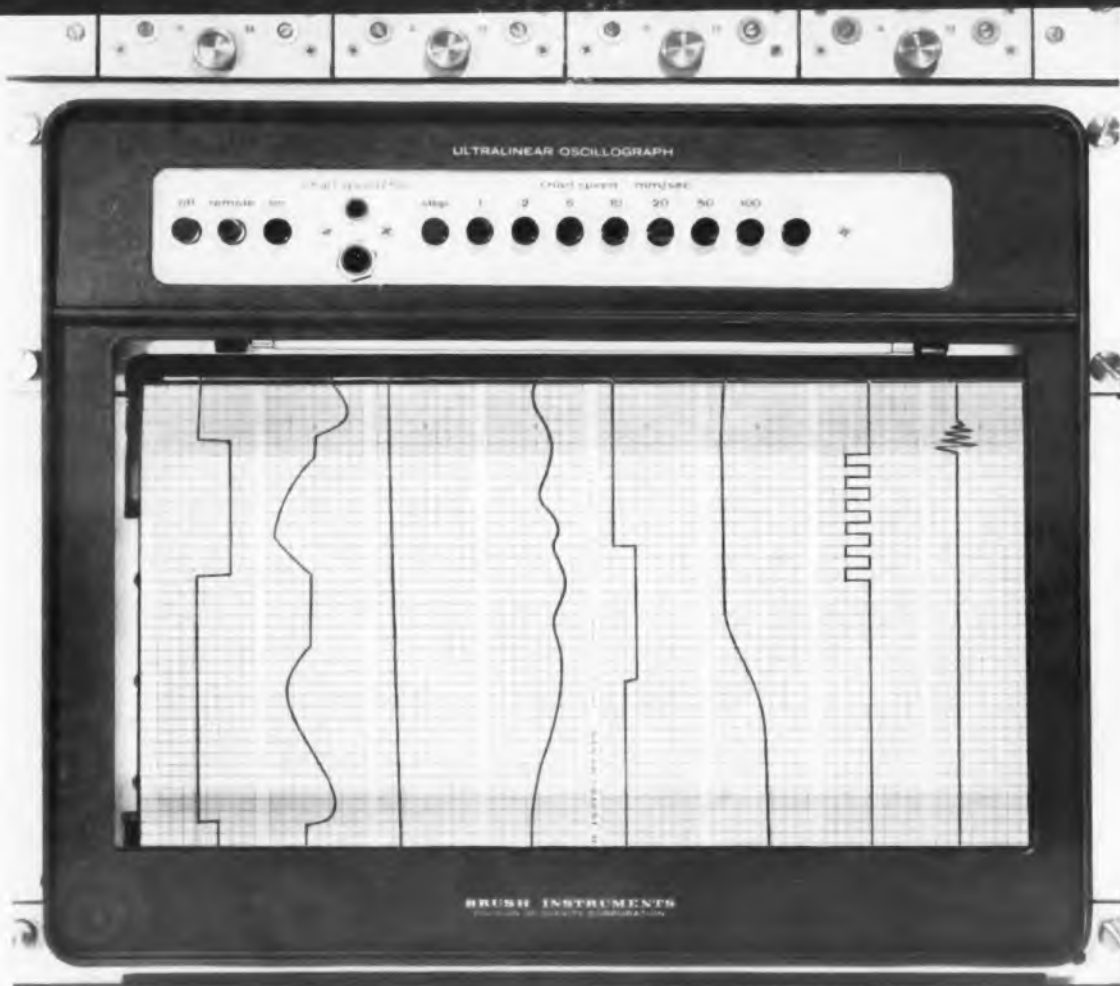


CIRCLE 132 ON READER-SERVICE CARD

# JOY

Joy Manufacturing Company  
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company  
(Canada) Limited, Galt, Ontario



in multi-channel  
 recording  
 systems  
 there is  
 nothing newer

... There are many reasons why Brush's newest oscillograph is the ideal choice for today's most advanced telemetry and computer systems. Its precision and reliability are proven. You get analog data instantly recorded on eight 40mm channels . . . and the sharpest traces on rectilinear coordinates you've ever seen. Thirteen electrically controlled chart speeds take the guesswork out of interpretation. *All* functions are operated by pushbutton . . . including an ingenious auto-load chart changing arrangement. But . . . the most important reason of all is that this vertical panel oscillograph carries the name "Brush". No one is as qualified. See for yourself. Call, write or wire.

**brush** INSTRUMENTS

37TH AND PERKINS

DIVISION OF  
**CLEVITE**  
 CORPORATION

CLEVELAND 14, OHIO



**SCOTCH® BRAND MAGNETIC INSTRUMENTATION TAPES  
OFFER A RIGHT TAPE FOR EVERY APPLICATION**

Knowledgeable tape users realize that magnetic tapes are not all alike—that it takes specific constructions to meet the needs of specific applications. And they've learned to rely on "SCOTCH" BRAND to supply the one right tape for each application. Not only does "SCOTCH" BRAND offer a complete line, it offers that something extra that makes all the difference in performance—the uniformity and reliability that result from 3M's experience, technical skill, and continuing research. Make the "SCOTCH" BRAND label your guide in buying instrumentation tapes. Your 3M Representative is close at hand in all major cities—a convenient source of supply and information. For details, consult him or write Magnetic Products Division, 3M Co., St. Paul 6, Minnesota.

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The wide "SCOTCH" BRAND line provides many tapes, including these broad classifications:

**SANDWICH TAPES 488 and 489**—exclusive with "SCOTCH" BRAND, offering 30 times the wear of standard tapes, drastic reductions in head wear, elimination of oxide rub-off. In standard or extra-play lengths.

**HIGH RESOLUTION TAPES 458 and 459**—offering superior resolution in high frequencies, greater pulse density in digital recording. In standard and extra-play lengths.

**HEAVY DUTY TAPES 498 and 499**—offering exceptional life, good resolution, high resistance to temperature and humidity, reduction in the build-up of static charge. In standard and extra-play lengths.

**HIGH OUTPUT TAPE 428**—offering top output in low frequencies. Performs well even in temperature extremes.

**STANDARD TAPES 403 and 408**—offering the good all-round performance at low relative cost which has made them the standards of the instrumentation field.

MINNESOTA MINING AND MANUFACTURING COMPANY  
... WHERE RESEARCH IS THE KEY TO TOMORROW



"SCOTCH" BRAND MAGNETIC TAPES FOR INSTRUMENTATION

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CIRCLE 134 ON READER-SERVICE CARD

### Fixed Magnetron

715

Operating at 3.04 to 3.06 Gc, the M561 fixed-frequency magnetron handles 80 kw peak, 80 w avg. Pulse length is 1.0  $\mu$ sec, prf 1,000 pps. Size is 6.28 x 6.11 x 3.28 in., weight 3-1/4 lb. Peak anode current is 15 amp, peak potential 13 kv.

English Electric Valve Co. Ltd., Dept. ED, Chelmsford, England.

### Hybrid Mixer

705



The V-8302B hybrid mixer is designed for waveguide coupling in both local oscillator and signal arms. It performs without adjustment over 8.5 to 9.6 Gc frequency range. Maximum vswr in both signal and local oscillator arms is 2.0; isolation is 20 db min. Typical noise figure is 8.5 db; it weighs three oz.

Varian Associates, Dept. ED, 611 Hansen Way, Palo Alto, Calif.

Price: \$395 fob Palo Alto.

### Traveling-Wave Tube

572

Low noise traveling-wave tube, model 2110A, is periodic permanent magnet focused and of metal-ceramic construction. The tube operates from 2.3 to 4.45 Gc and provides 10 mw output. Gain is 30 db with a 10-db max noise level. Power consumption is less than 3 w; auxiliary cooling is unnecessary. The unit weighs 6 lb and measures 17-1/8 in. long x 2-1/4 in. in diameter.

Microwave Electronics Corp., Dept. ED, 4061 Transport St., Palo Alto, Calif.  
P&A: \$3,500; 30 days.

### Ferrite Material

706

Microwave ferrite type 1-101 is for use in devices requiring a high phase shift and low insertion loss in the medium power range. In some applications this material may be used down to S-band frequencies. Characteristics are: saturation magnetization, 2,000 gauss; line width, 400; dielectric loss tangent, 0.0005; dielectric constant, 13; curie temperature, 300 C.

Irvan Engineering Co., Inc., Irvan Ferrite Co., Inc., Div., Dept. ED, 13856 Saticoy, Van Nuys, Calif.

## HERE YOU SEE IT



## HERE YOU DON'T!



Value is what we're talking about. There isn't a soul alive who would knowingly throw away a gold or silver or platinum watch case or pin or eyeglass frame. Because they're *worth money*. This sense of value is responsible for a considerable part of Handy & Harman's Refining activity. Constantly, we are sent precious metal scrap from retail jewelers all over the country. (Yes, often in shoe boxes.)

And just as constantly we wish that industry had the same sense of value when it comes to their precious metal "waste." Just because it doesn't *look* like anything doesn't mean that it isn't *worth* something.

To show you where profits lurk, we've included a list showing the various forms of precious metal waste.

It is by no means complete (it is possible that you have other forms). May we suggest that—should you be in doubt—you contact the Handy & Harman Refining Center nearest you. Further, if you are not in doubt about your waste bearing precious metals, but you are (or have been) in doubt as to its full value, it will profit you to send it to us. Our Bulletin 24 describes our Refining Division in detail. A copy awaits you at

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CIRCLE 135 ON READER-SERVICE CARD



## Circuit Board Retainer 632

Eliminates grooving operations in module construction by becoming a finished slot. Two lanced tabs hold board under a 3-g shock load. Material is beryllium copper. It is 4-1/4 in. long and is made for 3/32 or 1/16 in. boards.

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

## Data System 612



Alarm scanning, telemetering, and recording is performed by the series 7000 data system, which measures, converts, transmits, and records analog values in digital form. System is of modular design. Operation can be manual or automatic, controlled by a digital timing clock. System automatically checks itself. Any number of remote stations can be accommodated.

Monitor Systems, Inc., Dept. 14, Dept. ED, Fort Washington Industrial Park, Fort Washington, Pa.

## Multi-Turn Limit 525

Positive mechanical limit stop can be set for any number of shaft revolutions from 1 to 1,500 turns. Operating speed is 1,800 rpm max. Anodized aluminum case measures 1-1/16 x 2-1/4 x 3-1/4 in. Military specifications are met.

Computer Sciences, Inc., Dept. ED, 603 Main St., Westbury, N. Y.

## Low-Temperature Cabinet 393

For storing epoxy compounds. Model E-40-2 has a 2-cu-ft capacity and provides temperatures to -50 F. Cabinet measures 32 x 24 x 43 in. and is mounted on casters.

Cincinnati Sub Zero Products, Dept. ED, 3932 Reading Road,

## Only Ampex AR-300/FR-700 systems make all these wideband recording techniques practical and routine

It takes 4 mc response to fully encompass all the above applications. Increasing tape speed past static heads would demand 1,300 ips and record only 3 minutes, using massive 19" reels ... but Ampex puts a full hour on standard 10 1/2" reels, by rotating the recording heads at 12,000 rpm transversely across slow-moving tape (12 1/2 and 25 ips) to get the needed relative head-to-tape speed for 4 mc. In so doing, the AR-300 and FR-700 recorders borrow from Ampex's VIDEOTAPE® Recorders, which use an identical technology to capture TV frequencies.

More bits per hour, another bonus from rotating heads. Rotating heads reconcile two ideals: relative freedom from information dropout, and maximum information recorded per reel of tape. With head-to-tape speed to spare, each bit of information can be permitted to occupy a greater wave length along the track to minimize dropout. At the same time, rotating heads are ideal for recording very narrow, closely-spaced tracks across the tape. This narrow spacing puts 64 tracks into each inch. Up to 5,000,000 bits of PCM data can be recorded per second, or  $1.8 \times 10^{10}$  bits on a one-hour reel.

750 similar recorders have written the reliability record. Better than 99% reliability from over 750 VIDEOTAPE Recorders in worldwide use is a matter of record. Sole routine replacements necessary are heads and tapes. On a megacycle-hour basis, life compares favorably with lower performance recording methods.

Some significant specifications. One or two tracks available. Tape speeds: 12 1/2 ips for single track and 1 hour—25 ips for two tracks and 1/2 hour. Models: AR-300 Mobile or Airborne for record only—FR-700 single rack laboratory record/playback. Response: by FM 10 cps to 4 mc ( $\pm 3$  db). Tape: 1.0 mil Mylar (DuPont T. M.), 2" wide on 10 1/2" reels. Electronics: all solid state. Environmental (AR-300): 50,000 feet altitude, temperatures -54°C to +55°C. Tape interchangeability between all AR-300 and FR-700 recorders.



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138

## NEW PRODUCTS

### Delay Line 568

Magnetostrictive delay line model 20Mol provides a time delay of 60  $\mu$ sec. Adjustment range is  $\pm 3 \mu$ sec; input impedance is 550 ohms; output impedance is 2,000 ohms, attenuation is 50 db; signal ratio is 12:1. Uses are in computers, data processing and airborne instruments.

ESC Electronics Corp., Dept. ED 534 Bergen Blvd., Palisades Park, N. J.  
*Availability: 6 weeks.*

### Operational Amplifier 709



Loop gain of  $10^7$  is provided by model TR-1 amplifier. The device, all-transistorized, is stable within 10  $\mu$ v in 24 hr. Output from 0 to 1 kc at 20 ma is  $\pm 50$  v. For  $\pm 25$  v output, current is 100 ma. Input impedance is about 1 meg. Output loop impedance is 250 ohms. For a loop gain of 10, output impedance is 0.1 ohm. Unit weighs less than 2 lb.

Boonshaft and Fuchs, Inc., Dept. ED, Hatboro Industrial Park, Hatboro, Pa.

### Telephone-Line Filter 562

With 100-db attenuation from 14 kc to 10 Gc. Type WFV-3111-1 telephone-line filter permits the use of a telephone inside a shield room. Other applications include use on teletype machines or other data-transmitting lines which enter into interference-free areas.

Cornell-Dubilier Electronics Div., Federal Pacific Electric Co., Dept. ED, 4144 Glencoe Ave., Venice, Calif.

### Slip Ring Assemblies 564

For  $-200$  to  $+200$  C use, these Teflon-clad slip ring assemblies handle high voltages without arcing damage, even under conditions of extreme humidity. They maintain high resistance between circuits.

Electro-Tec Corp., Dept. ED, 10 Romanelli Ave., S. Hackensack, N. J.

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

CIRCLE 139 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961



# NOW TIN OXIDE RESISTOR RELIABILITY FOR JUST 6¢

Now you have a happy combination you can play two ways. Use our C resistors in place of composition types to boost product performance at virtually the same cost *or* to maintain the high performance of precision type resistors while cutting costs markedly, saving space.

These C resistors are available in 1/2 and 1 watt sizes. Both are available in  $\pm 5\%$  tolerance. They have the inherent stability of a tin oxide conductor fired onto a glass substrate. We add a special solventproof insulation. Current noise level is less than 0.1 microvolt per volt of applied signal.

The C is the ideal resistor for any of your applications which involve radio or television components, instruments, computers, or other communications equipment.

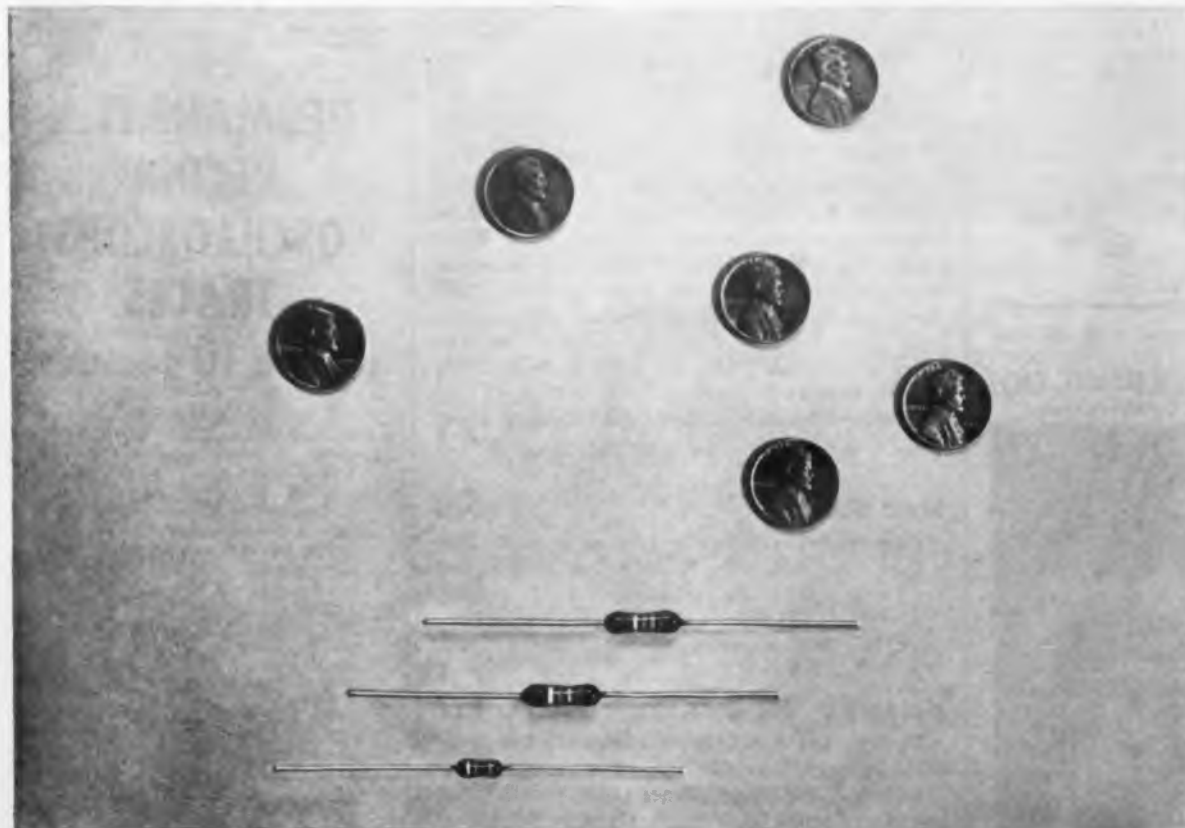
If you're interested in higher wattages, you can get the same basic construction in our low-cost LPI series, which ranges from 3 to 10 watts.

Typical values of Corning C resistors:

Type	Resistance	Wattage	Load Life	Moisture Resistance	Temperature Coefficient	Nominal Dimensions
C-20	51 to 150K	1/2	.5%	0.3%	150 ppm/°C. (-55°C. to +150°C.)	.375"x.138"
C-32	51 to 470K	1	.5%	0.3%	150 ppm/°C. (-55°C. to +150°C.)	.562"x.200"

You can get off-the-shelf delivery from your local Corning distributor.

For complete specs on both C and LPI types, write to Corning Glass Works, 540 High St., Bradford, Pa.



## Vertical Sensing Element

565

**Snap-action**, subminiature type 228571-1 vertical sensing element has a tilt angle of 0.75 deg. Differential output is 18 v; maximum current through either contact is 18 ma; range is 75 to 135 min of arc. Design is single-axis.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

## Vacuum Furnaces

710



**Cold-wall vacuum furnaces** produce temperatures up to 2,500 C at  $10^{-5}$  mm Hg. Made for materials research, development, and production programs, the ovens have internally heated hot zones which may be either vertical or horizontal, providing from 60 to 2,700 cu in. Heating-element life is practically unlimited. Automatic control is optional.

Vacuum Specialties, Inc., Dept. ED, Somerville, 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.

## Pressure Transducer

711

**High-line, low-differential pressure transducers**, series 4-351, are rated at 5,000 psi with less than 1% range shift, and withstand 8,000 psi. Differential pressure range is  $\pm 15$  to  $\pm 100$  psid. Compensated temperature range is -65 to +250 F. Units measure 2-3/4 in. in diameter and 2-3/8 in. long.

Consolidated Electrodynamics Corp., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.



**CORNING ELECTRONIC COMPONENTS**

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# AMCO 1000 G's CERTIFIED SHOCK TESTS

**Amco Aluminum and Semi-Custom Modular Frames qualify for Airborne, Shipboard and Ground Support Applications**

Certified Independent Tests prove Amco Aluminum and Semi-Custom Frames withstand shock & vibration under Mil E-5272C; Procedure XI (5-500cps), Procedure III (approx. 1000g's shock Mil-S901), Procedure II (15g's and drop Mil-S4456). Write for Test Report Supplement E.

**ALUMINUM . . . Unique! Meets any size. . .** Flush or recessed mounting of panels. Almost any shape from 13 basic parts . . . 3 castings & 10 extrusions. Units from 6" to 20 ft.; slopes from 0° to 90° standard. MilSpecs 6062-T6 extrusions and 356-T6 castings.

**SEMI-CUSTOM . . . Heavy-duty, more internal clearance . . .** 14 ga. box-channel steel frames, 12 ga. gusseting provides exceptional rigidity both front-to-back and side-to-side. Frames based on 22 $\frac{1}{16}$ " increments provides clearance for recessing 19" wide panels. Meets EIA Standards.

**CUSTOM . . . When space and appearance are critical . . .** 16 ga. double-channel steel frames, based on increments of 19 $\frac{1}{16}$ " widths, supports in excess of 3000 lbs. Multi-width panels and cowlings give single-unit appearance with series mounted racks. Meets EIA Standards.

Amco manufactures all necessary blowers, chassis slides, doors and drawers, writing surfaces, cowlings lights and other accessories. **Check the extra savings you get thru Amco's combined-discount system of racks and accessories. PLUS FREE ASSEMBLY.**

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## NEW PRODUCTS

### Tape Recorder

407

**Continuous-loop recorder/reproducer GL-2510** uses tape lengths up to 75 ft at speeds from 1-7/8 through 60 in. per sec. The self-contained system has 14 analog, fm, or pdm amplifiers, power supply, and ventilating blower unit housed in a single cabinet.

Consolidated Electrodynamics Corp., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

### Panel Meter

557



The 1-1/2 in. model 15LP panel meter, in clear or black acrylic case, conforms to industrial and military mounting standards. Core-magnet movement is used. Other meters to 7 in. are available.

Pace Electrical Instruments Co., Dept. ED, 70-31 84th St., Glendale 27, N. Y.

### Phenolic Rods

411

**Paper base phenolic rod, Insurok T-308R**, has high density, low moisture absorption, good electrical properties and is suitable for high-speed machining. Uses include cam-actuated pins, machine screws and inside-threaded caps. Rod is available in 42-in. lengths with diameters from 0.093 to 0.509 in. Natural tan and black colors are supplied with standard and special finishes.

The Richardson Co., Dept. ED, Melrose Park, Ill.

### Solar Cells

570

**Conversion accuracy is 10% or greater.** N-P silicon solar cells type N120CG-10 are designed for use in solar power supplies in space vehicles.

Hoffman Electronics Corp., Semiconductor Div., Dept. ED, 1001 N. Arden Drive, El Monte, Calif.

### Metal-Film Resistors

437

**Ratings are 1/8 to 2 w, 250 to 750 v, from 25 to 10 meg.** Type EE Noble-Met resistors surpass MIL-R-10509C, Characteristic C. All types can be furnished with temperature coefficients of 25, 50 or 100 ppm per deg C. Standard tolerance is  $\pm 1\%$ .

American Components, Inc., Dept. ED, 8th Ave. at Harry St., Conshohocken, Pa.

Model F-296 makes full-size photo record of single transients or identical repetitive phenomena.



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For literature and prices, write to Industrial Products Division, Fairchild Camera and Instrument Corp., 580 Midland Ave., Yonkers, N.Y. Dept. ED-5.



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INDUSTRIAL PRODUCTS DIVISION

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## Encapsulated Transformers

439

For printed-circuit applications, these encapsulated transformers are offered in five sizes of 0.08 to 1.2 cu in. A total of 64 units, all meeting MIL-T-27A Grade 5 Class S requirements, offer a wide choice of power levels.

ADC Inc., Dept. ED, 2833-13th Ave. S., Minneapolis 7, Minn.

Price: \$5.40 up.

## Strain Gage Amplifier 614



Variable gain device provides excitation voltage to a Wheatstone bridge. Subcarrier oscillator provides 75 mw excitation. Unit has a negative feedback amplifier and a phase-sensitive demodulator. Gain is continuously variable over a range of 20 to 1. Amplifier is a plug-in module measuring 1.725 x 1.875 x 2.75 in.

Natel Engineering Co., Dept. ED, 15922 Strathern St., Van Nuys, Calif.

P&A: \$375 to \$495; 3 weeks.

## Heat Sinks 392

Natural-convection aluminum coolers, models 10106 and 20107, can be adapted for forced-convection requirements. Made for transistors, diodes, rectifiers, and similar components.

Anderson Machine Inc., Dept. ED, 50 Brook Road, Needham Heights, Mass.

## Vertical Sensing Element 567

Two-axis vertical sensing element type C70 1807 000, for such uses as initial alignment of a gyro platform, has a sensitivity of 20  $\pm$  2 mv per min for up to  $\pm$  10 min. Linearity is within 5% of 3 min of arc sensitivity; output symmetry is within 5% for up to 20 min. Damping ratio is up to 100.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N. J.



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## NOW COMMERCIALY AVAILABLE FOR TV AND HIGH-FIDELITY CIRCUITS

Novar, RCA's line of 9-pin all-glass integral-base tubes, provides superior performance at lower cost than those high-dissipation type receiving tubes, regardless of base configuration, which were previously manufactured with octal bases and T9 or T12 envelopes.

*Among all-glass integral-base receiving tube designs only novar offers:*

**Larger internal lead diameter**—for strong cage support, and high thermal conductivity for very effective heat dissipation.

**Wider spacing between pins (0.172")**—to assure freedom from voltage breakdown and, therefore, to provide greater assurance of reliability.

**Pin length of 0.335"**—to insure firm retention of tube in socket.

**Pin-circle diameter of 0.687"**—large enough to accommodate both T9 and T12 envelopes.

**Revolutionary "Dark Heater"**—found only in RCA receiving tubes, is additional assurance of high reliability.

*First Commercially Available Novar Types Are:*

RCA-6AY3, 12AY3, 17AY3 HALF-WAVE VACUUM RECTIFIERS—These novar types are specifically designed for use as damper diodes in horizontal-deflection circuits of TV receivers. Rated to withstand a maximum peak-inverse plate voltage of 5000 volts, they can supply a maximum peak plate current of 1100 ma and a maximum dc plate current of 175 ma. The heater-cathode insulation withstands negative peak pulses up to 5000 volts with a 900 volts dc component. Low-impedance cathode coating withstands high-voltage pulses encountered in TV damper circuits. New RCA "Dark Heater" assures unusually long tube life and reliability.

RCA-7868 POWER PENTODE—For high-fidelity audio amplifier applications, two of these novar high-perveance power pentodes can deliver up to 44 watts of power output in Class AB<sub>1</sub> push-pull service. Extra base-pin connections for grids #1 and #2 and special radiator on siderods of grid #2 assure cooler operation...and, of course, the RCA-7868 has the revolutionary "Dark Heater."

Sockets are readily available for novar tube types. For additional information on novar types, call your RCA Field Representative or write RCA Electron Tube Division, Commercial Engineering, Section G-18-DE-2, Harrison, N. J.



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 pthalate housing to withstand shock

and protect against fungus or attack  
 by acids or alkali. Servo or bushing  
 mountings and operating tempera-  
 tures to 150° C are available.

**DUNCAN ELECTRONICS, INC.**  
 2865 FAIRVIEW ROAD • COSTA MESA, CALIFORNIA  
 CIRCLE 144 ON READER-SERVICE CARD

## NEW PRODUCTS

### Thermoelectric Material 410

**Gadolinium selenide**, a thermoelectric material with a high Z factor, is available in a powdered form for further processing by the customer into rods. Undoped material, as well as n-type and p-type material are available.

Semi-Elements Inc., Dept. ED, Saxonburg Blvd., Saxonburg, Pa.

### Pressure Transducer 409



Provides high continuous output, type 78-C pressure transducer provides an output of 500 mv with 10 v, 60 cps input; over 1 v at 400 cps. It is available in ranges 0-5 to 0-350 psi, gage, absolute or differential. Excitation is 6 to 10 v from 50 to 20,000 cps. Temperature range is from -115 to 500 F. OD is 1-1/4-in.

United Aero Products Corp., Dept. ED, Burlington, N. J.

### Thermocouple Kit 408

For many applications. Thrift/Therm test kit has a spring-loaded thermocouple for internal surface measurements, a ceramic-beaded unit for multiple surface temperatures, a probe-type unit for liquids and gases, capable of handling 3,500 psi, and an exposed-junction type for fluids, suitable for 3,000 psi.

Harco Laboratories, Inc., Dept. ED, New Haven, Conn.

### Ultrasonic Cleaner 405

For small parts, model 100 ultrasonic cleaner can be operated with detergents, mild acids, solvents and alkaline cleaners. It has a capacity of 1-1/4 qt. It is suitable for hard-to-clean intricate assemblies. Other standard models hold up to 14 gallons.

Hermes Sonic Corp., Dept. ED, 13-19 University Place, New York 3, N. Y.

### Parametric Amplifier 406

Reliable, low-noise parametric amplifiers are made for use in tropospheric scatter, radio relay, radar and telemetry systems. Unit includes diode mount and klystron pump, power supply and automatic level and frequency control may be included as optional extras.

Control Electronics Co., Inc., Dept. ED, 10 Stepar Place, Huntington Station, N. Y.

## How to buy a down payment on a new home for \$1.25 a day



**Will he ever save the down payment?** He'll be in his new home sooner than he thinks, if he saves something every payday. The effortless, automatic way is the Payroll Savings Plan for U.S. Savings Bonds.

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You save more than money with U. S. Savings Bonds



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## BASIC PRECISION SWITCHES

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CONTROL SWITCH DIVISION

### Material-Level Control 626

Heavy-duty relay rated at 10 amp is an optional feature of the L-400 rotary-paddle material-level control. The unit is mounted on bin, hopper or tank walls by 1-1/4-in. pipe coupling. Control signal is from a circular magnet mounted on the motor shaft. Enclosures can be weather-and-dust tight or explosion-proof.

Flo-Tronics, Inc., Electronics Control Div., Dept. ED, 712 W. Ontario Ave., Minneapolis 3, Minn.

### Power Supplies 556



Photomultiplier power supplies in the PM series have line regulation of  $\pm 0.005\%$  and load regulation of 0.002%. Ripple is less than 1 mv rms; stability is 0.01% per hr. Three models have ratings of 300 to 1,800 and 2,500 v dc at 0 to 10 ma, and 1 to 3.5 kv at 0 to 5 ma.

PRL Electronics, Inc., Dept. ED, 232 Westcott Drive, Rahway, N. J. P&A: \$290 to \$360; stock to 4 weeks.

### High-Voltage Transformers 569

For high-power uses, a line of 39 models of high-voltage transformers is offered. Single-phase and three-phase rectifier-plate transformers range from 1 to more than 250 kva. Applications include areas such as microwave, broadcast, laboratories and electronic heating.

Electro Engineering Works, Dept. ED, San Leandro, Calif.

### Tape Editing System 624

Automatic magnetic-tape editing system model MT-1 provides an edited composite record of any two telemetry tapes received from the same missile. Final tape can be processed through PAM and PDM commutators without data dropout. Both switched and continuous editing are possible.

Gulton Industries, Ortholog Div., Dept. ED, Princeton Junction, N. J.

## Meet Thousands of Application Needs with these Five Basic Switch Types

**STANDARD MODELS** in a wide range of dimensional and characteristic designs—from the tiny, powerful sub-subminiature type to the large, general purpose type where size is not important. See each switch series for application suggestions and brief specifications.

**VARIATIONS**—hundreds available—designed and engineered to meet such specific requirements as:

U.L. listings  
high temperatures  
dry circuitry  
extra long life  
high electrical ratings

reset for 2-way limit  
high in-rush  
AN and MS  
specifications  
special terminals

**ACTUATORS**—toggle, push-button, leaf, roller leaf, lever, roller lever, etc., available.

Choose the Switch Series that meets your basic application needs. Then tell us the specific characteristics you want. Chances are, we have a standard ready for your use. We are fully equipped to make the switch you need in any quantity.

perfect for  
super-sensitive  
uses...

T SERIES



SUB-SUBMINIATURE, SPDT,  
 $\frac{1}{4}'' \times \frac{1}{4}'' \times \frac{3}{32}''$   
high current capacity in any case.  
excellent shock and vibration resistance.  
solder terminals, others on request.  
25,000 ops. min per MIL-S-6743.  
7.5 amps @ 125/250 VAC, 60 cycles  
Ind. & Res.

ideal  
for compact,  
precision control uses...

E4 SERIES



SUBMINIATURE, SPDT,  $\frac{3}{32}'' \times \frac{1}{4}'' \times \frac{3}{16}''$   
low movement differential and  
operating force permit precision control  
in critical applications.  
solder; single, double and long double  
turret terminals.  
150,000 ops. @ 125/250 VAC, 2.5 amps.

for rugged,  
low-cost,  
easy wiring uses...

F SERIES



MINIATURE, SPDT,  $1\frac{1}{32}'' \times 1\frac{1}{32}'' \times \frac{5}{16}''$   
rugged, low-cost design.  
convenient terminals simplify wiring.  
solder, screw and spade terminals.  
150,000 ops. 10 amps @ 125/250 VAC,  
28 VDC Res.

good for  
power  
circuits,  
precision control  
uses...

S SERIES



2-CIRCUIT, SPDT double break,  $1\frac{1}{4}'' \times \frac{1}{2}'' \times \frac{1}{4}''$   
combines high capacity, moderate size,  
long life and precision control.  
tested to 10,000,000 operations.  
end and side solder, screw and spade terminals.  
750,000 ops. @ 125 VAC, 10 amps., U.L. rated.

For more details on  
these basic precision  
switch types write  
for catalog No. 110.

for general purpose,  
high in-rush  
and  
repeatability uses...

S2B SERIES



SPDT,  $1\frac{1}{16}'' \times 1\frac{1}{16}'' \times \frac{3}{16}''$   
tough, durable, compact.  
handles high in-rush loads easily.  
repeats to 10,000,000 cycles min.  
screw terminals.  
20 amps, 125/250/480 VAC, U.L. rated.  
 $\frac{1}{2}$  amp, 125 VDC;  $\frac{1}{4}$  amp, 250 VDC.

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CONTROL SWITCH DIVISION

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World's first all-electronic, digital voltmeter with full-five-digit accuracy!

Consider what you get with the new Eltronic 880. Twenty readings per second. True, absolute 0.01% accuracy. Solid state reliability and coolness. Silent operation. Only the Eltronic 880 can give you these advantages.

Switching is accomplished electronically. There are no moving parts. No contacts to clatter and wear. Hence, no noise. Exclusive "conductance adder" logic tracks varying voltages, permitting exact values to be read instantly.

For operator convenience, measurements are digitally displayed on a unique readout which tilts to three different positions. Measurements can be easily and accurately read

whether the 880 is used on a bench, at eye level or high in a rack. Clear, bright, digital indicators have 10,000-hour life, eliminating troublesome bulb changing.

Reliability too, is exceptional. Each component, circuit board and sub-assembly is rigorously "pyramid" tested. Each completed 880 is subjected to a program of accelerated aging, simulating 100 hours of actual use. Questionable components are discovered *before* delivery, sharply increasing field reliability.

The Eltronic 880 is available now. Its cost is surprisingly low, so why settle for less? Get in touch with your nearest EI field office today.

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**Electro Instruments, Inc.**

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Engineers: Challenging opportunities now available. Contact Mr. Harvey Fleming.



## NEW PRODUCTS

### Semiconductor Strain Gage 696

For general-purpose use. Series DB semiconductor strain gages include matched gages for a variety of materials, gages for dynamic measurements, small gages for limited space and gage factors of  $-140$  to  $+170$ . Resistance ranges are 120 to 5,000 ohms.

Kulite-Bytrex Corp., Dept. ED, 50 Hunt St., Newton 58, Mass. P&A: \$90 per pkg; stock.

### VHF Triode 559



A 100-w triode for af and vhf rf applications, the PL-254W operates at 4,000 v max plate potential. Filament requires 5.0 v at 7.5 amp. The tube is suitable for class C cw or fm uses.

Penta Laboratories, Inc., Dept. ED, 312 N. Nopal St., Santa Barbara, Calif.

### Lightweight Reflectors 563

Accuracy is 1 min of arc for surface deviation. These all-metal, lightweight reflectors are furnished with diameters of less than 1 in. to over 5 ft and weigh from 0.4 to 1.5 lb per sq ft. Aperture ratio is from f/8 to f/0.4.

Electro-Optical Systems, Inc., Dept. ED, 125 N. Vinedo Ave., Pasadena, Calif.

### Navigational Counters 566

Slewing speeds to 1,800 rpm can be furnished. These navigational counters include digital counters, bevel-gear driven units, geared high-speed latitude and longitude counters and miniature counters. Units can be designed to meet customer requirements.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N. J.



## Data Commutator 631

Four-channel data commutator type DC-11 has an input-output speed of 480,000 characters per sec. The unit is designed for use with the firm's G-20 computer. Sorting operations are sufficiently fast for 100,000 records of 80 alpha-numeric characters to be sorted in less than 18 min.

The Bendix Corp., Computer Div., Dept. ED.

## Disk Brakes 619



Floor-mounted, through-shaft disk brake has its own ball-bearing mounted shaft. Designated series 55,200, these devices are applicable where it is necessary to drive through the brake. Brakes are operated and have torques of 1-1/2, 3, 6, 9, and 15 lb-ft.

Stearns Electric Corp., Dept. ED, 120 N. Broadway, Milwaukee 2, Wis.

## Universal Recorder 633

Has 23 ranges, extending from 30 ma to 15 amp ac and dc and from 30 to 600 v ac and dc. Other features of model 802 universal recorder include permanent magnet moving-coil movement, three-speed transmission, synchronous 60-cps chart drive and inkless or ink recording. It measures 13-3/4 x 11-3/4 x 11 in. and is portable.

Curtiss Wright Corp., Princeton Div., Dept. ED, Princeton, N. J.

## Radio Receiver 697

For am, cw or ssb. Model NC-190 radio receiver has an hf ferrite filter for sensitivity of adjacent channels. Three positions are provided: 600-cps for single-signal cw reception, 3-kc for single sideband and am reception and 5-kc for clear channel speech and music reception.

National Radio Co., Inc., Dept. ED, 37 Washington St., Melrose 76, Mass.

P&A: \$199.50; immediate.

CIRCLE 147 ON READER-SERVICE CARD ➤

## Crimp-type Connectors



These solderless, coaxial connectors are available in a variety of mounting configurations, including snap-locking versions. Male and female connectors may be mounted interchangeably. Mated length is 1 1/4". Working voltages: 1,000 V. maximum, at sea level; 500 V. maximum, at 60,000 feet. VSWR; less than 1.2 up to 2,000 mc. Life; 5,000 matings, minimum, without electrical deterioration. Tensile strengths of the crimps exceed the breaking strength of the cable. Hard gold plated Beryllium copper and TFE plastic are extensively used to assure optimum reliability.

Microdot, Inc., 220 Pasadena Avenue, South Pasadena, California

CIRCLE 247 ON READER-SERVICE CARD

## Coaxial Switch



SPDT miniaturized switch features a case volume of 1/2 cu. in. and weight of 1 1/4 oz. Design allows direct insertion into miniaturized circuit without cumbersome adapters. Toggle action is positive, rf characteristics are highly efficient. VSWR is less than 1.25 to 2.0 kmc. Insertion loss is 0.8 db at 2.0 kmc. Contact rating is 1/2 amp at 150 V. resistive. Operating is 50,000 operations, minimum. Special stripline manufacturing technique provides low loss, wide frequency band properties.

Microdot, Inc., 220 Pasadena Avenue, South Pasadena, California

# MICROMINIATURE COAXIAL CABLE



Microdot's Cable Facilities specialize in precise metallic braiding of micro-miniature coaxial cables. In a new, ultra-modern plant, special advanced techniques of cylindrical weaving are combined with the utilization of highest quality materials and rigid quality control methods, to produce a wide range of miniaturized RF frequency cables... cables designed and produced to yield the same matched impedance as required for larger cables.



"Mini-Noise" cable, a result of Microdot research, is specially processed to minimize self-generated noise—prevents noise interference with low strength signals. These cables also offer high performance in extreme temperature ranges.



Twinax cable produced by Microdot is a shielded, twisted pair of conductors utilizing prime dielectrics for low loss, featuring controlled capacitance and impedance. Shield is added after insulation and conductors are arranged in a balanced to ground configuration.



Triax cable by Microdot offers rf leakage below the level experienced with Double Shielded Coax. Three active conductors permit feedback to cancel a known noise source. Capacitance-cancelling hook-ups are possible for cathode followers.



Use reader service card in this publication, or write today for 4-page folder of performance charts, design characteristics, and specifications on the following cables: Coax 50, 70, 75, 93, 95 ohm. Twinax 125 and 160 ohm. Triax 50 and 93 ohm.

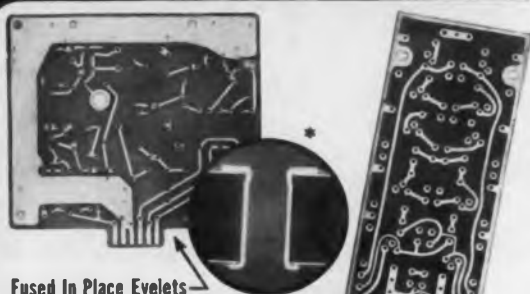
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220 Pasadena Avenue, South Pasadena, Calif.  
MUrray 2-3351 SYcamore 9-9171



# Methode Thru-Connected Printed Wiring Boards

**HIGH** Reliability!  
Re-usability!



### Fused In Place Eyelets

Solder flowed under flanges by high current electrode set dies using latest equipment improvements — fast, flexible, economical.

### Plated Thru Holes

Using copper reduction techniques for sensitizing in conjunction with preclad laminates — compact, reliable, excellent component soldering and high component density.



### Funnel Tubelets

Funnel shaped tubelets — permit easy component insertion, repeated removal and re-mounting without damage to board or adhesion — maximum re-usability.

### New Three-Dee Sealed Harness

Methode's new fully encapsulated multi-layer circuitry — permits unlimited cross-overs and taps, flexible, conformal, light and tough for interconnecting individual circuit cards or black boxes.

\*37 to one micro photographic cross-section view

Use the Best Prefabricated Wiring Technique for Your Requirement . . .

ALL ARE AVAILABLE FROM:



**Methode manufacturing corp.**

7447 W. Wilson Ave.

Chicago 31, Ill.

CIRCLE 148 ON READER-SERVICE CARD

## PRODUCTION PRODUCTS

### Welding Machine 261

Pincer and vertical heads are interchangeable. The pincer head has a pressure range of 0.5 to 5 lb; the vertical head, 0.5 to 8 lb. Throat depths are 9 and 7 in. This welding machine requires no adjustment of electrodes, heads or power settings. Power supply is regulated to  $\pm 0.05$  w-sec or  $\pm 2\%$ .

Sippican Corp., Dept. ED, Marion, Mass.  
Price: \$950.

### Eyeletting Machine 262



Is fully automatic. Eyeletting machine automatically feeds, sets and resistance fuses eyelets as small as 0.020 in. inside diameter to boards as thin as 1/64 in. Through connections conform to Military Standard 275A. Mechanical dwell time and heat cycle are variable up to 1 sec.

Edward Segal, Dept. ED, 132 Lafayette St., New York 13, N. Y.

### Transistor Marker 263

Speed is 3,000 units per hr max. Model U1038 marker prints trademarks, date codes, part numbers and other data on tops and sides of JETEC transistors. Offset printing heads compensate for dimensional differences. Components are automatically fed to the printing positions and ejected into a gravity chute.

Markem Machine Co., Dept. ED, 172 Congress St., Kenne, N. H.

### Microcircuit Machine 264

Prototype or production microcircuits up to 1.25 in. sq can be made with model 410 microcircuit machine. Tools and parts are mounted in positioners accurate to a few millionths of an inch. Microscope is mounted on a joystick X-Y positioner with 1.25-in. travel. Indexing tool mounts hold 8 tools; a complete assortment of tools is available. The machine is suitable for research and high-speed production.

Kulicke and Soffa Manufacturing Co., Inc., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.



## PRECISION PLASTIC BALLS

ACE is one of America's leading mass producers of seamless plastic balls for almost every commercial and industrial use. Most plastics including nylon and teflon. Complete range of sizes, colors and tolerances. Small runs or large runs. Huge stocks for immediate delivery. Quick, low-cost service on specials. Write, wire or call for samples, price lists and handy new selection chart.

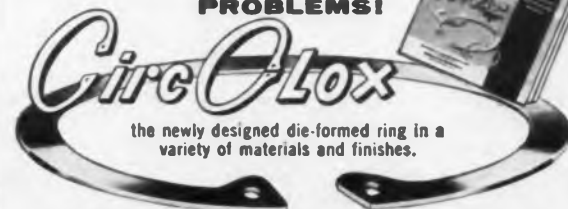
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ACE PLASTIC COMPANY 91-58 VAN WYCK EXPWY - JAMAICA 35, N. Y.

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the newly designed die-formed ring in a variety of materials and finishes.

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MULTI-TURN RINGS

Spirolox

the unique 360° spiral wound ring offers many design variations

RAMSEY CORPORATION a subsidiary of Thompson Ramo Wooldridge Inc. Box 513, Dept. P. St. Louis 64, Missouri 100

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ELECTRONIC DESIGN • July 19, 1961

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INCREDUCTOR®  
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Transformer**

**FREQUENCY RESPONSE** within  $\pm 1/2$  db over 20 mc—500 mc frequency range and  $\pm 1/2$  db from 10 mc—1,000 mc.

**AVERAGE INSERTION LOSS** 1 db between 20 mc—500 mc and 2 db between 10 mc—1,000 mc.

**SIZE**  $1\frac{1}{16}$ " x  $2\frac{1}{4}$ " x  $1\frac{3}{16}$ ". Hermetically sealed.

**AVAILABLE IMPEDANCE RATIOS** presently 200 ohms balanced to 50 ohms unbalanced. Other ratios to be announced.

**TYPICAL APPLICATIONS** Antenna matching, Input and Output matching of broad band push-pull for single ended amplifiers.

**MILITARY SPECIFICATIONS** On special order.

We invite you to write for INCREDUCTOR® Wideband RF Transformer Technical Bulletin No. 460.



MAGNETIC  
COMPONENTS  
DEPARTMENT

**TRAK  
ELECTRONICS CO.  
INC.**

61 DANBURY ROAD, WILTON, CONNECTICUT

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ELECTRONIC DESIGN • July 19, 1961

### Dust-Free Cabinet

265

Distortionless plexiglass provides unobstructed view over 34 x 28 x 16 in. work area inside this molded dust-free cabinet. Filter system removes 99.97% of all particles of 0.3 micron size, and all larger particles. Optional under-the-hood equipment is available.

Gerwen Electronics, Inc., Accessory Dept., Dept. ED, 7-22 149th St., Whitestone 57, N. Y.  
**P&A:** \$300; 30 days.

### Wafer Sorter

266



Automatically gaging germanium or silicon pellets, the TSK Auto-Sorter has consistent repetitive accuracy to within 0.00040 in. The machine will gage and sort 2,400 pellets per hour into any one of 10 categories. A variety of automatic controls is included as standard equipment.

D. M. Gaskill & Associates, Inc., Dept. ED, 342 Budlong Road, Cranston 10, R. I.

### Solderless Terminal Tool

267

Cuts, strips and crimps. Type 9900 solderless-terminal tool cuts solid or stranded wire and accommodates AWG sizes 22 through 10. It is made of spring steel and has a ground cutting edge. A sliding set screw is provided on one handle.

R. N. Hunter Sales Co., Dept. ED, 9851 Alburton Ave., Santa Fe Springs, Calif.

**Price:** \$2.50.

### Cutting Machine

268

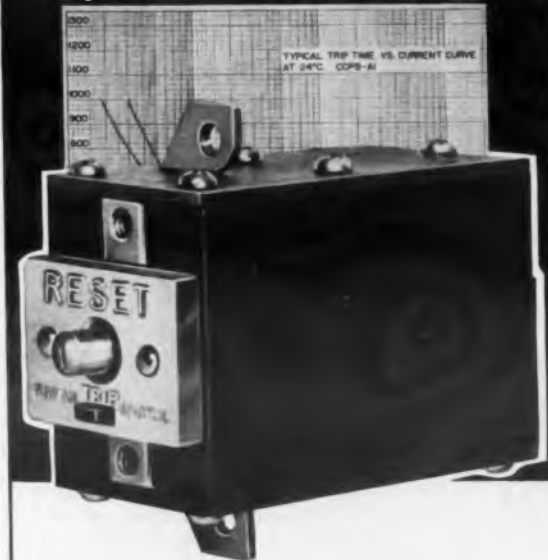
For shielded cable. Having semi-automatic operation, this cutting machine provides rates of 600 to 1,200 per hr for most cables. Stripping length can be adjusted from 1/2 to 1-1/2 in. As the machine cuts, it fuses together the ends of the shielding.

Ewald Instruments, Dept. ED, Box 124, Kent, Conn.

**P&A:** \$1,000 to \$1,500; 4 to 6 weeks.

# Rowan Control

**ROWAN CIRCUIT PROTECTORS  
FOR ALL REQUIREMENTS  
COMPLETELY FIELD TESTED**



Rowan Circuit Protectors, Type CCPB-A are completely field tested. New Literature just available describes the versatility of the complete line which is proven by the numbers of circuit protectors in use — protecting electronic circuits in important computing, laboratory and industrial applications.

The chief reason for the lines immediate success lies in the wide selection of trip-time-versus-current curves the Type CCPB-A Circuit Protectors offers. There are two thermal versions: Type CCPB-A1 for medium lag and Type CCPB-A2 for slow lag; also a magnetic Type CCPB-AM, which is instantaneous. You select curves exactly tailored for your particular application.

Other advantages in the Rowan Circuit Protectors include ease of resetting, small-space mounting and precise calibration, etc.

See all models at the WESCON Show, Booth 221, or ask for new technical literature, Form #6-61-10000.

Sales Representatives in Principal Cities.

CIRCUIT PROTECTOR DIVISION

**THE ROWAN CONTROLLER COMPANY**

30 BRIDGE AVENUE, RED BANK, NEW JERSEY

CIRCLE 152 ON READER-SERVICE CARD

New advanced coil forms  
and internal PERMA-TORQ®



## RELIABILITY... locked In and guaranteed

Working on the problems plaguing electronic systems design, CAMBION® engineers developed a new device to keep coils and coil forms in proper adjustment.

This exclusive development is the CAMBION internal PERMA-TORQ, a miniaturized, constant tensioning unit located completely within the CAMBION ceramic coil form. Allowing tuning cores to be locked while still tunable, it considerably reduces harmonics, provides increased stability and decreases oscillation in high gain IF strips. Reliability under all conditions keynotes the performance.

New Internal PERMA-TORQ is available in coil forms with the normal yellow, red, green and white slugs — (range: 0.2-300 MC) and with purple slugs (range: 2-40 MC) and blue slugs (range: 40-300 MC). Mechanically, PERMA-TORQ is very easy to adjust. Only a special tuning tool is needed.

CAMBION makes more than 1500 coil forms with varying collar-and-terminal arrangements — including ceramic, phenolic and shielded forms for conventional and printed circuits. All are guaranteed to meet your specifications.

The broad CAMBION line includes plugs and jacks, solder terminals, insulated terminals, terminal boards, capacitors, shielded coils, coil forms, panel hardware, digital computer components. For a catalog, for design assistance or for both, write to Cambridge Thermionic Corporation, 457 Concord Ave., Cambridge 38, Massachusetts. In Europe contact Maitland Engineering, Ltd., 50 Heaton Moor Rd., Stockport, England, or Uni-Office, N.V., P.O. Box 1122 Rotterdam, The Netherlands.

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**CAMBION®**

The guaranteed electronic components

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## PRODUCTION PRODUCTS

### Hard Water Still 269

Electric and steam heated, the Hy-Thermco stills produce high ionic-pure water that is free of organic and bacteria impurities. Capacities are from 1/2 to 10 gallons per hr; heating elements are side mounted.

The Electric Hotpack Co., Inc., Dept. ED, Cottman Ave. at Melrose St., Philadelphia 35, Pa.

### Inspection System 270

Length and diameter of parts are gaged by automatic inspection machine. Up to 1,200 parts per hr are checked and sorted into acceptable and reject categories. Machine can be quickly adjusted for various part sizes.

Radio Corp. of America, Dept. ED, 12605 Arnold Ave., Detroit 39, Mich.

### Drawer Oven 271



A five-drawer oven with mechanical convection and horizontal airflow is said to increase production and reduce cost per part. Temperature ranges are 100 F to 356 F and 600 F. Drawer size is 18-1/2 x 20 x 5 in.

Blue M Electric Co., Dept. ED, 138th & Chatham St., Blue Island, Ill.

### Clean-Room Uniforms 272

For special environments. Uniforms can be furnished for protection against contamination in white rooms or for use in Class II, III and IV clean rooms. Gloves for liquid oxygen applications are also available.

Angelica Uniform Co., Dept. ED, 1429 Olive St., St. Louis 3, Mo.

### Sleeve Cutting Machine 273

Operation is automatic. Up to 200,000 lengths of 1/4 and up to 50,000 lengths of 1 in. are produced per hour. The Richmond sleeve cutting machine cuts paper, plastics, nylon, rub-

**IDEAL FOR  
CRITICAL  
LABORATORY  
VACUUM BAKE  
NEEDS**

**TEMPCOR  
COMPACT TABLE MODEL  
VAC-U-THERM OVENS**



Electronics, food, drug, chemical and steel laboratories find this table model VAC-U-THERM OVEN ideal when accelerated drying operations are required for rapidly drawing off moisture in test-samples. Prevents decomposition through oxidation and throws off inflammable gases and explosive vapors. Table top design and portability features allow for use of storage space beneath unit and controls and working chamber at convenient height.

Bakes materials in temperatures up to 250° C at 1x10<sup>-2</sup> MM hg.

Hydraulic type thermostat.

Compound Vacuum gauge.

Aluminum sheathed nickel-chromium alloy heaters operate with consistency at black heat.

Stainless steel shelves with pre-positioned tracks.

Stainless steel meshed glass viewing window.

MODEL 1425 (shown) . . . 8" x 8" x 9" . . . \$190.00 F.O.B. River-  
ton, N.J.

Other models . . . table or flange  
types . . . aluminum or stainless  
steel . . . sizes to 13" x 14" x  
18" . . . prices to \$1970.00.



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Manufacturers of  
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Electronic, Electrical,  
Mechanical Components  
and Contacts with  
NO Film or Residue

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HIGH-VELOCITY  
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### APPLICATIONS

Electronic Components & Assemblies: Diodes, Transistors, Slip-Ring Commutators, Crystals, Vacuum Tube Components, Sub-Miniature Assemblies.

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### FEATURES

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ELECTRONIC DESIGN • July 19, 1961

ber, fiber glass, tinned copper wire and other materials.

Martin Engineering Co., Dept. ED, 40 Woodbine Lane, Holyoke, Mass.

### Wire Bonder

274

**Thermocompression** wire bonder model 401C, for microcircuit construction, provides a vacuum pickup needle for handling components. A supply tray for components is mounted on a swinging arm. Extra-force bonding hammer and flat-top heat column are standard. The machine handles circuits up to 1 in. square.

Kulicke and Soffa Manufacturing Co., Dept. ED, 1234 Callowhill St., Philadelphia 23, Pa.

### Orienting Table

275



An **orienting table** for semiconductor crystal slicing is accurate to 1 min of arc. It can be installed on machines now in operation or supplied as optional equipment on new machines. The fully automatic slicing machines produce wafers with thickness from 0.025 to 0.007 ± 0.0005 in. An automatic back-off mechanism minimizes surface imperfections.

Fitchburg Engineering Corp., Electronic Div., Dept. ED, Fitchburg, Mass.

### Fluxing Machine

276

**Solders printed circuit boards.** The FWL automatic fluxing machine pumps flux through an elongated nozzle so that the liquid forms a continuous, double-sided, standing, laminar wave. The wave is 1/4 to 3/4 in. high, controlled to ±1/32 for resin-based or water-soluble flux.

Electrovert, Inc., Dept. ED, 124 E. 40th St., New York 16, N. Y.

### Wire Stripper

277

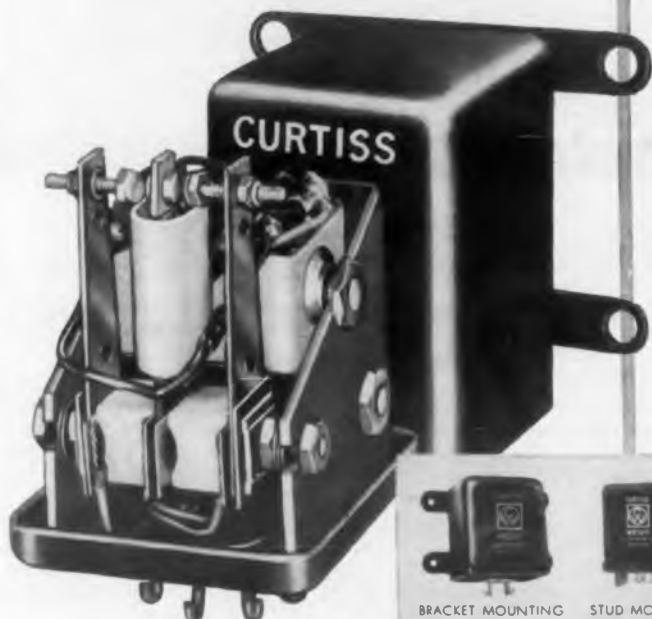
**Capacity is 32 through 50 AWG.** Model WR-6 has two abrasive wheels to remove the wire coating without damage to the conductor. Wheels of various densities are available. Motor requirements are 1,725 rpm, 115 v, single-phase, 60 cps.

High Speed Hammer Co., Dept. ED, 313 Norton St., Rochester 21, N. Y.



*NEW Time Delay Relays*

**INSTANTANEOUS RESET...  
VOLTAGE-TEMPERATURE  
COMPENSATED**



RUGGED CONSTRUCTION THROUGHOUT



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**



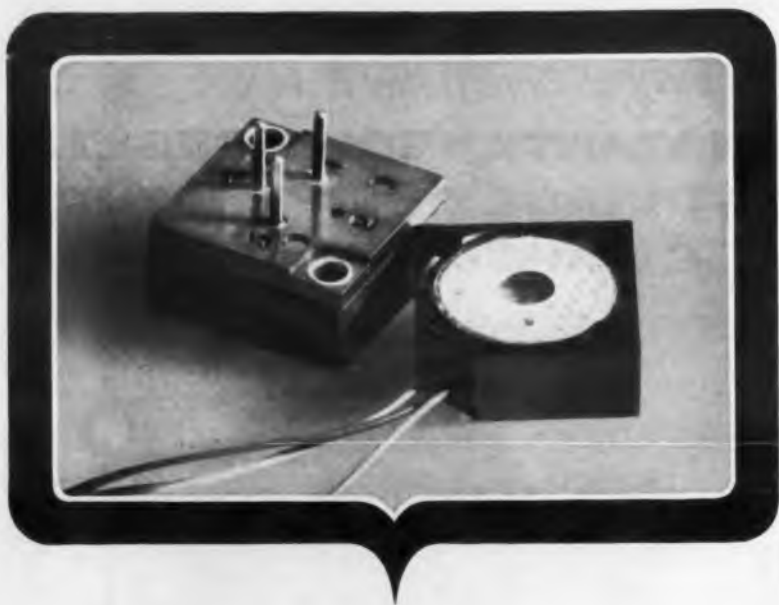
Curtiss-Wright Stepping Motors convert digital pulses into mechanical work or motion. Units are bi-directional with high starting torque.

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

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*Helitrim® 1/2" square trimming pots give you...*

**•UNIQUE SLIP CLUTCH STOP •SEALED ALL-METAL HOUSING**  
*as standard features!*

Where small size and high operating temperature are important considerations, choose between two 1/2" square Helitrim trimming potentiometers. The Model 70 has Teflon leads. The Model 71 has gold-plated pins. Both are precision-built by Helipot to give you *special features as standard!*

These Helitrim extras include a slip clutch stop that prevents open circuits - positively keeps the wiper from going off the end of the coil and into dead space. And sealed all-metal housings that provide humidity-resistant operation under the most severe environmental conditions.

Just as important is ease and accuracy of adjustment. There's no guesswork with Helitrim potentiometers - the adjustment screw makes 42 complete turns. This gives extra meaning to the pot's outstanding resolution - as fine as 0.083% in the upper resistance values.

Performance? Take a look at these specs. You'll see why top performance, too, is standard with Helipot.

**STANDARD SPECIFICATIONS**

Resistance range, ohms .....	10 to 50,000
Resistance tolerance .....	±5%
Resolution in percent .....	1.01 to 0.083
	(depending upon total resistance)
Adjustment screw rotation .....	42 turns, ±1 turn
Power rating, watts .....	1 at 50°C
Torque, max. oz. in. ....	10
Life expectancy, adjusting screw revolutions .....	10,000
Temperature range .....	-55°C to +150°C

Price? Helitrim pots are competitively priced at \$5.35 for the Model 70 and \$5.95 for the Model 71. Considerably less in quantity!

Availability? Your nearest Helipot representative has both models in stock - ready for immediate delivery. Call him today.



INSTRUMENTS, INC.  
**HELIPOT DIVISION**  
 Fullerton, California  
 POTS : MOTORS : METERS

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CIRCLE 158 ON READER-SERVICE CARD

# NEW LITERATURE

## General Equipment

278

Catalog No. 161, 240 pages, describes electric ovens, furnaces, baths, environmental cabinets, related temperature control equipment and accessories for laboratory, pilot plant and production applications. Supplementary scientific data in charts and tables is included. Blue M Electric Co., 138th and Chatham St., Blue Island, Ill.

## Power Supplies

279

Transistorized power supplies are described in this 12-page catalog, No. 61A. Wide-range, high-current supplies, ac-dc modular supplies, general purpose supplies, and high-current, switching type power supplies are included. Consolidated Avionics Corp., 800 Shames Drive, Westbury, N. Y.

## Reliability Nomograph

280

Designed for application to semiconductors, this nomograph allows computation of the acceptance number for any given sampling plan. Success rate can be predicted from life test data either at a 90 per cent confidence level or for individual risks. Instructions are included. Raytheon Co., Semiconductor Div., 215 First Ave., Needham, Mass.

## Silicon Rectifiers

281

Six-page short form data folder gives electrical and physical characteristics of the firm's JEDEC-type silicon rectifiers. Over 600 types are included. Bradley Semiconductor Corp., 275 Welton St., New Haven, Conn.

## Miniature Bearings

282

A line of miniature bearings is described in Catalog 3E. Radial, roller, pivot, and special bearings are covered. Dimensional data, photographs, and full-sized drawings are included. Installation information is given. Landis and Gyr, Inc., 45 W. 45th St., New York 36, N. Y.

## Fans and Blowers

283

A line of fans and blowers for ventilating electronic equipment is described and illustrated in this 48-page catalog. Mechanical and electrical characteristics, performance curves and engineering drawings are included. Solid state and vacuum tube cooling are considered in a special section. McLean Engineering Laboratories, P. O. Box 228, Princeton, N. J.

## Numerical Control

284

Entitled "Numerical Control, as applied to the complete integration of product testing with a manufacturing business", this nine-page brochure discusses numerical control in testing procedures. The paper finds that the benefits of numerical control extend beyond the actual testing procedures. Designers for Industry, Inc., 4241 Fulton Parkway, Cleveland 9, Ohio.

## Universal Timing Set

285

Applications of digital time signals to coordinate remote equipment in complex instrumentation and data-processing systems are described in this 18-page, spiral-bound brochure. The Hallicrafters Co., 4401 W. Fifth Ave., Chicago 24, Ill.

## Electronics Catalog

286

Electronic equipment, components, radio and TV supplies of over 115 manufacturers are listed in a 268-page catalog. It is cross indexed and includes an industrial tube cross reference. Wedemeyer Electronic Supply Co., Dept. ED, Ann Arbor, Mich.

## Electron Tubes

287

Condensed 16-page catalog provides quick reference specifications and photos describing the firm's line of microwave tubes, display devices, and operational accessories. Litton Industries, 960 Industrial Road, San Carlos, Calif.

**Magnetic Shields 288**

Curves and tables to aid in the selection of magnetic shields are given in this 16-page booklet. Nicoloi and Mu-Metal shields for electron tube applications are discussed. The firm's shields and shaft hardware are cataloged. James Millen Manufacturing Co., Inc., 150 Exchange St., Malden 48, Mass.

**Transistor Circuitry**

Entitled "Transistor Guide for Communications Circuit Designers", this guide surveys the basic rules pertaining to transistorized communications circuits. Practical information, circuit diagrams, curves and equations which aid in design of circuitry for audio, video, and rf equipment are presented. *Write on company letterhead to: Philco Corp., Dept. ED, Church Road, Lansdale, Pa.*

**Transformer Catalog 289**

Electrical and physical specifications are given for almost 900 industrial transformers in a 36-page catalog. It is cross-indexed and includes units for military and commercial applications. Chicago Standard Transformer Corp., 3501 W. Addison St., Chicago 18, Ill.

**Precision Switches 290**

Catalog 104 describes precision switches for various applications. It has photographs and condensed descriptions of over 200 items including miniature switches, limit switches, proximity switches and electronic switch-circuit assemblies. Micro Switch, Div. of Minneapolis-Honeywell, Freeport, Ill.

**Glass History 291**

"This Is Glass," 68 pages, gives the history of glass and details the basic types of glass. It includes glass-ceramic materials and a two-page chart giving properties of selected glasses and glass-ceramics. Corning Glass Works, Public Relations Dept., Corning, N.Y.

**Electronics Catalog 292**

Product data for electronic parts, equipment and accessories are given in a 236-page catalog. Radio, TV, audio, amateur radio and industrial components of 115 manufacturers are listed. Tydings Co., Electronics supplies, 933 Liberty Ave., Pittsburgh 22, Pa.

**Electronic Components 293**

Catalog No. 105, 204 pages, lists the products of approximately 100 component manufacturers. Test equipment, high fidelity and recording equipment, intercom systems, hand tools and hardware are also included. Star Electronic Distributors, 7736 S. Halsted St., Chicago 20, Ill.

**Piezoelectric Devices 294**

Applications of piezoelectric devices are discussed in this 16-page illustrated booklet. Performance characteristics of major piezoelectric substances are outlined and compared. Clevite Electronic Components, Bedford, Ohio.

**Aircraft System 295**

Bulletin GER-1704, 16 pages, describes GE's integrated ac electrical system aboard the F4H Mach II all-weather aircraft. It includes a discussion of the system components, schematic diagrams, technical drawings and photographs of the equipment. General Electric Co., Schenectady 5, N.Y.

**Welding Techniques**

"Fabrication of Welded Motor Rocket Cases" is described in this 72-page booklet. Illustrations, tables and diagrams are given. Areas covered are materials, design, welding and quality assurance. Chemical compositions of the ultra high strength steels are given along with their mechanical properties, heat treatment and fracture toughness data. *Send \$2.50 to American Welding Society, Dept. ED, 33 W. 39th St., New York 18, N. Y.*

ANGLE COUNTER



# KEARFOTT NAVIGATIONAL COUNTERS

Direct visual counter display provides the advantage of enabling lower valued increments of various angles to be easily read in terms of minutes and seconds of arc by means of relatively large size numerals. This advantage is achieved without the necessity of having vernier dials or similar devices. These counters are precision designed and their rugged construction assures a long life of trouble free service. B422 units are provided with either odometer or Geneva drives, while MK II units use Geneva drives. Gears, wheels, housings, and mounting flanges are constructed of durable materials, and Kearfott design techniques provide maximum readability in a relatively small amount of space. Kearfott counters operate reliably throughout a temperature range of  $-65^{\circ}\text{C}$  to  $+90^{\circ}\text{C}$  and meet the military requirements for shock, vibration, and case size.

- FEATURES:**
- Long Operational Life
  - High Speed
- Compact Design
  - Lightweight

## CHARACTERISTICS:

All Counters Below Incorporate Geneva Drive

TYPE	PART NUMBER	NO. OF DIGITS	MAXIMUM COUNT	COUNTS PER REV.	MAXIMUM SPEED RPM	MAXIMUM BREAK AWAY TORQUE @ $20^{\circ}\text{C}$
<b>B422 SERIES:</b> <sup>1</sup>						
<b>ANGLE</b>	B422-□ <sup>2</sup>	5	179° 59'	20'	1200	.75
(center scale)	C160432-□	5	179° 59'	20'	1200	.75
	C160431-□	6	179° 59.9'	2'	1200	1.0
	C160435-□	4	179.9°	2°	1200	.75
<b>DECIMAL</b>	C160433-□	3	99.9	2.0	1200	.75
(center scale)	C160434-□	4	999.9	2.0	1200	.75
<b>MK II</b>	MK 2 MOD 1	4	359.9	2.0°	1800	.35
<b>Mod I</b>	MK 3 MOD 1	3	359.	2.0°	1800	.35
<b>SERIES:</b>	C160407004 <sup>3</sup>	4	359.9	2.0°	1800	.35
	A403-20B	4	359.9	2.0°	1800	.35

<sup>1</sup> Available in left or right Shaft, End or Side Mount, Mask readout of N-S, E-W, (+), (-)

<sup>2</sup> Same as C160432-□ except .040 shorter length (C160432 preferred for new designs)

<sup>3</sup> Available in various shaft extensions and white or bare aluminum numerals

Write for complete data



**KEARFOTT DIVISION  
GENERAL PRECISION, INC.**

Little Falls, New Jersey



# WIDER

## RANGE WITH GREATER ACCURACY!

This Vought Electronics Servo Analyzer is an *all-electronic* instrument covering the dynamic range of most servo systems *without* the troublesome maintenance requirements of mechanical multipliers.

Modulation rates of .005 to 1000 cps in five ranges are provided in sinusoidal, step, and ramp functions either directly or in suppressed carrier form. Modulation frequency accuracy readings of 2% are possible.

*Other important unit specifications are:*

- carrier frequency range of 50 to 10,000 cps
- carrier phase shift of less than 2° to 5 kc
- signal attenuation of 0 to 99 db in 0.1 db steps
- phase measurement accuracy of 2°

Use of Vought Electronics Servo Analyzer has been demonstrated successfully with *Titan* and *Minuteman* missiles as well as in industrial laboratory applications. It is available in both bench and rack mounted models.

For more complete information about this versatile instrument, contact:

*Chief of Product Sales*  
*Chance Vought Electronics Division*  
*P. O. Box 1500, Arlington, Texas*

CHANCE VOUGHT



ELECTRONICS

ANTENNAS • AUTOMATIC CONTROLS • NAVIGATIONAL ELECTRONICS • GROUND SUPPORT ELECTRONICS  
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## NEW LITERATURE

### Insulation Products 296

Catalog A-61 covers laminated plastics, printed circuit boards, flexible insulation, molded plastics, vulcanized fibre and mica products. Capabilities for advanced military and industrial applications are listed. A product materials directory for critical electrical insulation and mechanical applications is also included. Continental-Diamond Fibre Corp., Subsidiary of the Budd Co., Newark, Del.

### Spring Design 297

A 16-page manual summarizes basic information concerning helical springs, flat springs, wire forms, special fasteners, precision metal stampings and assembled spring-like devices. Mechanical properties and recommended uses of commonly used spring materials are presented in tabular form. Associated Spring Corp., Bristol, Conn.

### Business Automation 298

Operations of the engineering documents section of the United States Army Rocket and Guided Missile Agency are described in an eight-page pamphlet. The instant mechanical retrieval of engineering drawings from a file of over two million drawings, 850,000 of which are active, is outlined. Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul 6, Minn.

### Test Instruments 299

Information on spectrum analyzers, frequency response plotters, communications systems analyzers and telemetry test instruments is included in Catalog Digest E. Frequency range of the instruments is 1/2 cps through 44 mc. Block diagrams illustrate applications. Panoramic Radio Products, Inc., 520 S. Fulton Ave., Mt. Vernon, N. Y.



## BOX FILES

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\*Regular price \$2.50, save 50% if cash enclosed with order.

## Systems and Instruments 300

Programable systems for data handling, component testing, automatic measurement and control applications are described in a 16-page catalog. Special purpose test and measurement equipments are also described in the catalog. Specifications and prices are given for each item. Dymec Div. of Hewlett-Packard, 395 Page Mill Road, Palo Alto, Calif.

## Digital Modules 301

Series 300 transistorized digital system modules are covered in a 16-page catalog. It describes the system functions which are packaged on each gold plated module. Block diagrams, logical design considerations and input-output specifications are included. All data necessary for the design of a digital system are provided. Navigation Computer Corp., Valley Forge Industrial Park, Norristown, Pa.

## Safety Starters 302

Bulletin GEA-7321, four pages, describes combination safety magnetic motor starters that offer protection against unauthorized entry and personnel injuries. Photographs illustrate safety devices and how to perform inspection or maintenance with or without power interruption. Pricing information is also included. General Electric Co., Schenectady 5, N. Y.

## Resin System Pumps 303

A 10-page booklet illustrates and gives complete specifications for 20 basic models of the Triplematic pump and the available variations of each model. These pumps are designed for multi-component resin systems. Also included is an outline of the technical services available from the company and a series of questions and answers about resin system technology. H. V. Hardman Co., Inc., 571 Cortlandt St., Belleville, N. J.

when  
seconds  
count

IN ASSEMBLY WORK...



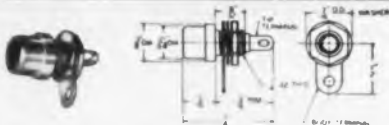
USE

**SWITCHCRAFT**  
"PHONO-JAX"

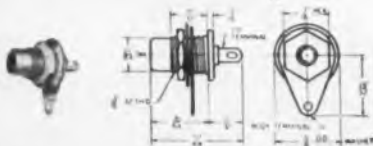
- Low Cost
- Easy to Assemble
- Occupy Small Space

Also available with Nylon insulation for Radio-Frequency Applications.

Write for Catalog C-501.



**3501FP—FOR FRONT OF PANEL MOUNTING.**  
Hex nut attached on back side of panel eliminates unauthorized tampering. Requires only  $\frac{3}{16}$ " dia. mounting hole—can be mounted on  $\frac{1}{2}$ " centers.



**3501PR—FOR BACK OF PANEL MOUNTING.**  
Mounts with a standard  $\frac{3}{16}$ "-32 threaded locknut in front. Requires only  $\frac{3}{16}$ " dia. mounting hole—can be mounted on  $\frac{3}{8}$ " centers.

**SWITCHCRAFT, INC.,** 5529 N. Elston Ave.  
Chicago 30, Ill.

Canadian Rep.: Arlos Radio Corp., Ltd., 50 Wingold Ave., Toronto

CIRCLE 162 ON READER-SERVICE CARD

SHOWN 1/2 SIZE



## HIGH- ACCURACY, WINDING COMPENSATED RESOLVERS

Kearfott precision resolvers are high accuracy units particularly applicable to analog computers and automatic control systems. The resolvers are capable of holding the angular arc error to accuracies within 20 seconds from electrical zero. A compensator winding provides feedback voltage for a resolver isolation amplifier. Unity gain from the amplifier input to resolver rotor output is made possible by adjustment of a resistor. Since compensator and rotor winding voltages vary with temperature and frequency in a parallel manner, the feedback loop is automatically adjusted to compensate for these variations.

### TYPICAL PERFORMANCE DATA

Unit No.	R980-41D	T980-003	CZ05180202
Size	11	15	25
Accuracy (Max Error from E.Z.)	5 minutes	5 minutes	20 seconds
Function Error	.1% max	.05% max	.01% max
Excitation (400 cps)	60 volts	60 volts	115 volts
Transformation Ratio (Rotor to Stator)	980±.020	980±.010	980±2%
Phase Shift	7.5 lead	8.5 lead	2.5°±1 min

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KEARFOTT DIVISION  
GENERAL PRECISION, INC.

Little Falls, New Jersey

CIRCLE 163 ON READER-SERVICE CARD



**John  
Gregorio  
can  
show  
you...**



**how to measure ac ratios to  
one part per million...  
at a sensible price**

In fact, any of North Atlantic's field engineering representatives can quickly demonstrate how the Models RB-503 and -504 Ratio Boxes will meet all your requirements for high accuracy at lowest cost.

Designed for either bench or rack mounting, both models provide rated accuracy over their full ratio range, with six-digit, in-line window readout for best readability. Both incorporate heavy duty switches with transient suppression, fold-away legs, easily removeable end plates and voltage dividing transformers to MIL-T-27A. Abridged specifications are given below:

	<b>RB-503</b>	<b>RB-504</b>
<b>Ratio Range</b>	0.000000 to 1.111110	-0.111110 to +1.111110
<b>Accuracy Of Ratio For All Ratios (at 400 cps)</b>	$\pm \left[ 0.001 + \frac{0.0001}{(\text{Ratio})} \right] \%$	$\pm \left[ 0.0001 + \frac{0.000025}{(\text{Ratio})} \right] \%$
<b>Frequency Range (Useful)</b>	50 to 10,000 cps	50 to 10,000 cps
<b>Nominal Input Impedance (at 400 cps)</b>	50K-60K	> 250K
<b>Max. Input Voltage</b>	0.5f, Volts, (f in cps) (not to exceed 350 V.)	1.0f, Volts, (f in cps) (not to exceed 350 V.)
<b>Max. Effective Series Resistance</b>	3.5 ohms	8 ohms
<b>Resolution</b>	5 decades plus 1 turn potentiometer	5 decades plus 1 turn potentiometer
<b>Size</b>	13½" h. x 19" w. x 8" d.	3½" h. x 19" w. x 8" d.
<b>Price</b>	<b>\$295.00</b>	<b>\$450.00</b>

Also from North Atlantic: Model RB-510 for high precision at 10 kc and RB-520 for MIL Spec applications.

If you're up against critical jobs of ac ratio measurement — in the laboratory, on the production line, or in the field — it will pay you to talk to the North Atlantic man in your area. For his name, call or write today. Or request Bulletin RB 503-504 for complete data.



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## NEW LITERATURE

### Diodes 304

Most standard EIA cool-junction diodes are listed in this catalog. Included are computer switching diodes, high-conductance all-purpose diodes and high-voltage silicon subminiature rectifiers for commercial or military applications. Delta Semiconductors, Inc., 835 Production Place, Newport Beach, Calif.

### Transducer Data 305

A Fourth Edition of the 2200 Series Accelerometers Technical Book contains recent information on vibration and shock instruments. Discussions of piezoelectric materials, nonvibration environments, mounting techniques, applications and calibration techniques are included. Maintenance data and useful formulas are given. Endevco Corp., Literature Dept., 161 E. California Blvd., Pasadena, Calif.

### Microwave Equipment 306

The firm's line of microwave equipment is described and illustrated in this 25-page catalog. Physical and electrical specifications are given for attenuators, rf sources, tuners, terminations, and related devices. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

### Cathode Ray Tubes 307

Physical dimensions, electrical characteristics, and line width specifications of over 200 cathode-ray tubes are given in this 12-page brochure. Included are oscilloscopes, radar monitors, video records, flying-spot scanners, industrial monitors, receiver check tubes and spiral accelerator tubes for precision scope applications. Sylvania Electric Products, Inc., 1100 Main St., Buffalo, N. Y.

### Electric Ovens 308

A line of electric ovens, furnaces, magnetically agitated baths, environmental cabinets and related temperature-controlled equipment is described in this 64-page pocket-size catalog. Photographs and brief descriptions are included with technical specifications. Blue M Electric Co., 138th and Chatham St., Blue Island, Ill.

## How to make more money on payday without getting a raise



You save more than money. You make sure of enjoying the things you're saving for. Every U.S. Savings Bond helps your Government keep the Peace.

Why wait for a raise when you can do something now about increasing your income? More than 8 million Americans are doing it every payday by buying U.S. Savings Bonds on the Payroll Savings Plan. It works like this: each payday your payroll clerk sets aside whatever amount you wish, buys your Bonds, and delivers them. You receive \$4 for every \$3 you put in, guaranteed. Why not start planning a bigger payday this easy way today?

*Why U.S. Savings Bonds are good to buy and hold*

You can save automatically on the Payroll Savings Plan • You now earn 3 $\frac{3}{4}$ % to maturity • You invest without risk • Your Bonds are replaced free if lost or stolen • You can get your money with interest anytime you want it • You buy shares in a stronger America.

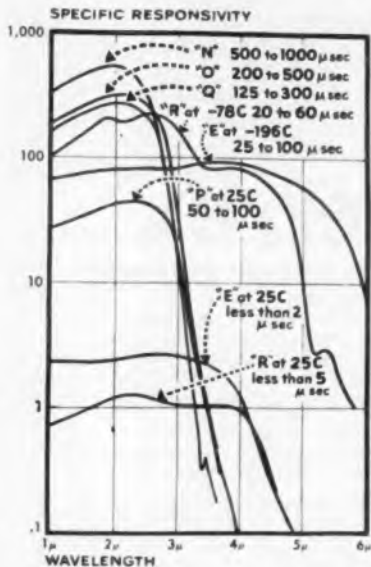
You save more than money with U. S. Savings Bonds



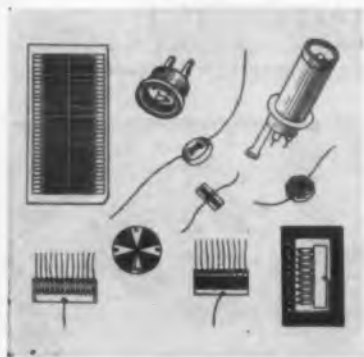
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-for the  $1\mu$  to  $6\mu$  infrared



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—

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Apparatus and Optical Division

Rochester 4,  
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Kodak  
TRADE MARK

CIRCLE 166 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • July 19, 1961

### Antenna Calculator

Frequencies from 30 to 30,000 mc are covered by this parabolic antenna calculator. The scales include: frequency, wavelength, beamwidth, vswr, windloading and focal length, as well as spectrum scale for band designation, conversion scales for inches, and vswr-return loss. Send \$2.00 to Gabriel Electronics, Dept. ED, Main and Pleasant Sts., Millis, Mass.

### Transformers

309

Electrical and physical specifications on 870 transformers for a wide range of radio and television, industrial and communication applications are listed in this 32-page catalog, No. S-106. Output transformer chart indicates the recommended output transformer to be used with various standard and high-fidelity output tubes. Stancor Electronics, Inc., 3501 Addison St., Chicago 18, Ill.

### Digital Data Applications

310

A quarterly company magazine, *Datex Digest*, has begun publication. It intends to report significant achievements in digital data recording and control. The first issue contains a survey article on radiotelescope antenna position recording and control systems. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

### Knobs

311

Over 200 different knobs in a variety of sizes, shapes and colors for radio, television, automotive and electronic instrument applications are illustrated in this 24-page full color brochure. Shaft mountings and miscellaneous parts are also described. Rohden Manufacturing Co., 4739 Montrose Ave., Chicago 41, Ill.

### Microwave Instruments

312

Noise and field intensity meters, impulse generators, power density meters, modulation meters, coaxial attenuators and other microwave components are described in this 56-page catalog, No. 614. Each item is described with its applications and specifications. Photographs, charts, tabular data, formulas, and line drawing are included. Empire Devices, Inc., Amsterdam, N. Y.



2



1



3



4



5

# 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. K<sub>a</sub> 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.

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**KEARFOTT DIVISION  
GENERAL PRECISION, INC.**

*Little Falls, New Jersey*

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Photo: Stelma, Inc., Stamford, Conn.  
Electronic Communications Systems

## Becco Ammonium Persulfate etches cleanly!

For etching printed circuits, Becco's ammonium persulfate process offers important advantages. As one large producer of printed circuits puts it: "Ammonium persulfate is better all around. We have experienced little trouble and far fewer rejects. It is more easily dissolved than ferric chloride, and can be safely handled in large volumes, with resultant cost savings.

"Moreover, the persulfate solution etches cleanly with a minimum of undercut and can be used with all conventional resists, and on all laminates. A 'natural' for solder-plated resist."

Switch to Becco ammonium persulfate and get these advantages:

1. Various types of circuits can be etched in one system.
2. Etchant is relatively non-corrosive.
3. Etchant remains clear and transparent in use.
4. After-treatment is simplified.
5. Sludge formation is avoided during etching.
6. Waste solution can be easily disposed of.
7. Copper can be recovered from spent etching solution.
8. Venting of the etching area is unnecessary.
9. Equipment corrosion is minimized.
10. Cost of etching solution is low.
11. Conversion from other etching processes is simple and inexpensive.

Want more information? We'll be glad to send full details. Just write us at Department ED-61-21.

### BECCO Ammonium Persulfate



**BECCO  
CHEMICAL DIVISION**

General Sales Offices: 161 East 42nd Street, New York 17, N.Y.  
CIRCLE 168 ON READER-SERVICE CARD

## NEW LITERATURE

### Crossbars 313

Technical bulletin No. 60-115 reviews six types of crossbars, the various means of actuation and control and suitable applications, as well as presenting the results of experimental tests on various models. Photographs, tables, drawings, and curves are included. James Cunningham, Son & Co., 33 Litchfield St., Rochester, N. Y.

### Microwave Components 314

Specifications for a standard line of precision wavemeters, preselector-balanced mixers, bandpass and low pass filters are contained in six-page brochure. Information on a custom line of bandpass filters, discriminator cavities, diplexers, wave traps and reference cavities is also given. Frequency Standards, P. O. Box 504, Asbury Park, N. J.

### Transistors and Diodes 315

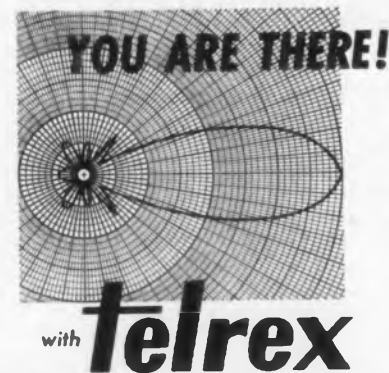
A line of semiconductor products is listed with technical specifications and dimensional diagrams in this 10-page catalog. Included are transistors, diodes, rectifiers, controlled rectifiers, switches, microcomponents, regulators and references, capacitors and encapsulations. Transitron Electronic Sales Corp., 168-182 Albion St., Wakefield, Mass.

### Nickel-Chromium Wire 316

Nonmagnetic nickel-chromium wire is described in this eight-page brochure. Temperature resistance, specific resistance, coefficient tolerances, yield strength vs diameter and elongation vs diameter at different temperatures are given. Molecu Wire Corp., Eatontown-Freehold Pike, Scobeyville, N. J.

### Frequency and Time Standard Systems

A general discussion of problems related to frequency and time standards and detailed consideration of system operations are given in this 56-page manual, Application Note No. 52. Illustrations, tables, sample problems and solutions are included. Data sheets on some of the firm's equipment appear in the appendix. Write to Mr. Harry J. Lewenstein, Dept. ED, Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif.



### "BEAMED-POWER" ANTENNAS

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## High-Voltage Rectifier Assemblies 317

A new line of double-diffused high-voltage potted rectifier assemblies, designated Series SDI, is covered in this 10-page catalog. Technical data and drawings on single- and three-phase rectifier assemblies rated up to 50,000 piv and 1 amp dc are included. Other semiconductor products are also described. Solitron Devices, Inc., 500 Livingston St., Norwood, N. J.

## AGC Characteristics of Transistors 318

Forward and reverse agc characteristics of vhf germanium mesa transistors are described in this eight-page booklet. Characteristics at 45, 100 and 200 mc are detailed. Operating curves are given. A simplified design procedure is outlined. Texas Instruments Inc., Semiconductor-Components Div., P. O. Box 5012, Dallas 22, Tex.

## Transistor Substitutions

Called the "International Transistor Substitution Guidebook," this 64-page publication recommends interchangeabilities among transistors manufactured in the U. S. and six foreign countries. Physical dimensions of the transistors are included. Send \$1.50 to John F. Rider Publisher, Inc., Dept. ED, 116 W. 14th St., New York, N. Y.

## Bearings 319

Sealed bearings, rod ends, spherical and corrosion-resistant bearings are described in this 16-page illustrated catalog, No. 560. Physical specifications and dimensional drawings are included. Stephans-Adamson Mfg. Co., Sealmaster Bearing Div., Aurora, Ill.

## Thyratrons 320

Two bulletins, No. PA-223 and PA-503, are entitled "Thyratrons Are Different" and "The Care and Control of Thyratrons" They discuss how thyratrons differ from high vacuum tubes, ionization and deionization, temperature effects, installation precautions, dc control, ac control, and how to interpret thyratron ratings. A separate section describes applications. CBS Electronics, Information Services, 100 Endicott St., Danvers, Mass.

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# IDEAS FOR DESIGN

## Fifth \$50 "Most Valuable of Issue" Award for Cable Shielding Method

H. W. McCord, engineer in the Electron Tube Div. of the Radio Corporation of America. Harrison, N. J., has won ELECTRONIC DESIGN's fifth \$50 Most Valuable of Issue Award.

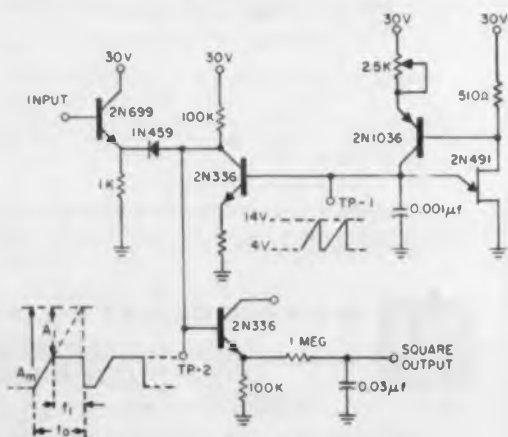
Mr. McCord receives the award for his Idea for Design "Ungrounded Shield Reduces Effective Cable Capacitance," which appeared in the April 26 issue. The idea pointed out that the input capacitance of a cable feeding a cathode follower can be reduced by connecting its shield to the stage input instead of to ground.

## Circuit Squares DC Input Voltage

741

Here's a circuit we designed whose output is proportional to the dc input, squared. Its operation is based on the fact that the area of a right triangle is proportional to the product of its sides.

With a direct voltage applied at the input, the wave-shapes at the emitter, point 1,



Output voltage of circuit is directly proportional to the dc input voltage squared.

of the 2N491 unijunction and at the base, point 2, of the 2N336 are as shown in the figure. The clipping level at point 2 set by the dc input, with the average value of the waveform given by:

$$E_{DC} = \frac{A_p}{2} - \frac{A_1 t_1}{2t_0} \quad (1)$$

where

$$A_p = kt_0$$

$$A_1 = kt_1$$

$$E_{DC} = \frac{A_p}{2} \left[ 1 - \frac{t_1^2}{t_0^2} \right]$$

$$= \frac{A_p}{2} - \frac{A_p t_1^2}{2t_0^2} \quad (2)$$

But  $A_p/2$  is a dc offset level, and hence:

$$\Delta E_{DC} = \frac{A_p t_1^2}{2t_0^2} = Kt_1^2$$

Since  $t_1 = A_1/k$  and  $A_1$  is the input level, the output is proportional to the input squared, within the range of  $0 < t < t_0$ .

Robert L. Colcord, Radar Engineer, Magnavox, Fort Wayne, Ind.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 741.

## 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.

The Ideas chosen as the most valuable in each issue will be eligible for the \$1,000 Idea of the Year award.

So vote for the Ideas you find most valuable. And, after you've voted, why not send in an Idea of your own?

## Inverted Exclusive-OR Circuit Compares Binary Bits

739

Binary bits taken from a film store had to be compared with binary numbers set on switches. The comparison was made with a circuit, Fig. 1, which uses a single transistor to perform the inverted exclusive-OR function:

$$\overline{AB + BA} = AB + \overline{AB}$$

With the preset switch open, the output signal will be high (+12 v) only if the film-

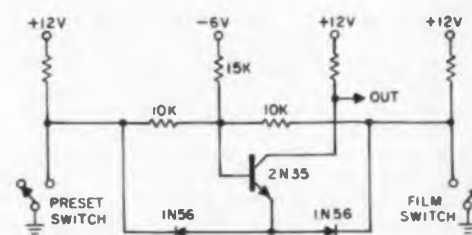


Fig. 1. Transistor and diodes are used to provide inverted exclusive-OR function for comparing binary bits.

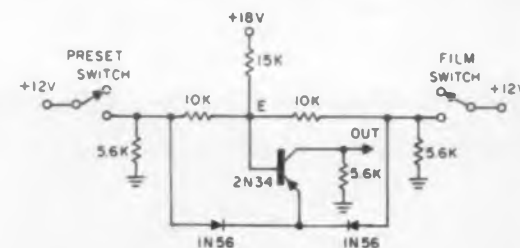


Fig. 2. Basic circuit of Fig. 1 can be modified to perform exclusive-OR function.

operated switch is open. If the preset switch is closed, the output will be high only if the film switch is closed.

The circuit can be modified to perform the exclusive-OR function:

$$\overline{AB} + \overline{BA}$$

If the preset switch, Fig. 2, is open, the output signal is high only if the film switch is closed. With the preset switch closed, the output is high only if the film switch is open.

Both sets of conditions allow point E to drop below +12 v, so that the transistor is turned on.

Frank Neu, Electronic Engineer, Lawrence Radiation Laboratory, Berkeley, Calif.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 739.

## 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**  
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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.  
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## IDEAS FOR DESIGN

### Voltage Changes Transmitted 736 As Shifts in Frequency

The difference of two signals, normalized to their sum, had to be accurately transmitted over very long cables. At first, voltage drops along the cables presented a great problem. However, this problem was soon solved by converting the information to frequency variations and transmitting frequencies rather than amplitudes.

Shown in the block diagram are the basic sections used in the circuit. As a unit they:

1. Convert a voltage to a frequency that is directly proportional to the voltage (digitizing).
2. Divide two voltages dynamically and with a fast response, digitizing the output.

The transfer ratio depends solely on the time constants chosen. The voltage may be either constant or varying, as long as the time constant is short compared to the period of the variation.

If  $V_2$  is fixed and  $V_1$  is integrated until a level of  $V_2$  is reached, (at which the integrator is reset to zero), then

$$V = \frac{V_1 t}{RC}$$

$$\text{When: } V = V_2, \quad \tau = \frac{V_2}{V_1} RC$$

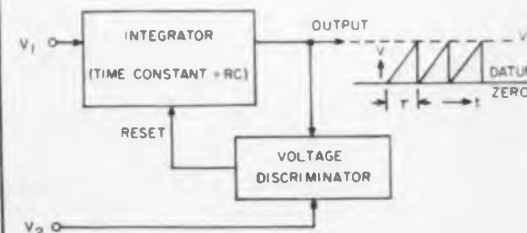
$$\text{then: } f = \frac{1}{\tau} = \frac{V_1}{V_2 RC}$$

$$\text{or: } f = KV_1, \quad \text{where } K = \frac{1}{V_2 RC} \quad (1)$$

If  $V_2$  is also varied:

$$f = k \frac{V_1}{V_2}, \quad \text{where } k = \frac{1}{RC} \quad (2)$$

It may be necessary to restrict the frequency range, that is, to keep the frequency from



Voltage drops in cables did not have to be considered when voltage differences were converted to proportional frequencies.

going to zero when  $V_1 = 0$ . This can be done by adding  $V_1$  to  $V_2$  and, instead of integrating  $V_1$ , we integrate  $V_1 + V_2$ . Reset still occurs at a voltage level of  $V_2$ .

For the first case, with  $V_2$  fixed:

$$f = \frac{V_1 + V_2}{V_2 RC} = KV_1 + f_0$$

where  $K = \frac{1}{V_2 RC}$

and  $f_0 = \frac{1}{RC}$

For the second case, with  $V_2$  varying:

$$f = k \frac{V_1}{V_2} + f_0$$

$$= f_0 + f_0 \frac{V_1}{V_2}$$

$$\pm f_0 \left(1 + \frac{V_1}{V_2}\right)$$

where  $k = \frac{1}{RC}$

$$f_0 = \frac{1}{RC}$$

There are many variations possible with this basic block diagram. In our application the circuit was used to indicate the proton beam location in the Brookhaven alternating gradient synchrotron.

*Martin Plotkin, Electrical Engineer, Brookhaven National Lab., Upton, L. I., N. Y.*

If this idea is valuable to you, give it a vote by circling Reader-Service number 736.

## One-Shot Multi Fixes 734 Turn-On State of "Bistable" Unit

Added circuitry is usually required when a bistable multi is to come "on" in its correct stable state after power is applied. This turn-on problem is, however, avoided if a one-shot multi can be used instead.

It is possible to use a one-shot when its timing cycle is longer than the time between the set and reset pulses. If this is the case, the output will have the desired pulse-width. And, because it has only one stable state, the one-shot will always be turned on correctly. It must be remembered, though, that the reset pulses must be large enough to overcome the bias caused by the timing components.

*Irving Bayer, Principal Engineer, Budd Electronics, Long Island City 1, N. Y.*

If this idea is valuable to you, give it a vote by circling Reader-Service number 734.

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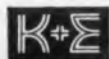
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## IDEAS FOR DESIGN

### Modified Circuit for Constant-Width Pulses

749

Alfred W. Zinn's circuit, Fig. 1, for making the pulse width of a monostable multivibrator independent of its circuit components (Ideas for Design, "Delay Line Added for Constant-Width Pulse," *ED*, Dec. 7, 1960, p 194) can be improved by using the delay-line to transmit a double pulse to a bistable multi, Fig. 2. The advantages of this circuit over Mr. Zinn's are that:

- Load does not affect output waveform.
- Pulse base line is clamped.
- Opposite polarity pulses may be obtained, since both sides of multi can be used.
- No critical time constants are required, as in the case of the "one-shot."
- There is no ringing on the output, since the delay line is on the input.
- Pulse width may approach the pulse repetition rates.

Monroe Landau, EDO Corp., College Point, N. Y.

Readers Zinn and Landau have suggested two delay line circuits for obtaining con-

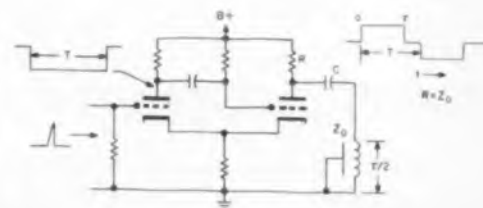


Fig. 1. Alfred W. Zinn's circuit places a shorted delay line on the output side of a monostable multi to help form a constant-width output pulse.

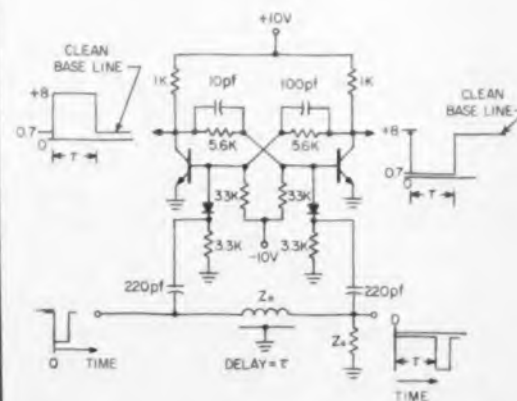


Fig. 2. Reader Landau's circuit uses the delay line to transmit a double-pulse to a bistable multi.



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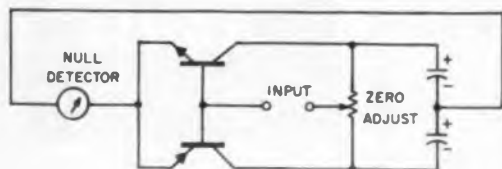
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**ELECTRONIC DESIGNERS' CATALOG.**)

stant-width output pulses. If anyone knows of any other circuits, either modifying these or offering new approaches, we'd certainly like to hear about them. Just send the circuits, with a brief description, to Ideas for Design Editor, ELECTRONIC DESIGN, 850 Third Ave., New York 22, N. Y. Those that are published will be eligible for the Most Valuable of Issue Award.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 749.

## Two-Transistor Circuit 729 Increases Null-Detector Sensitivity

The sensitivity of null detectors can be considerably increased by using the amplifying circuit shown in the figure. This circuit



**Five-component circuit** increases null detector sensitivity, allowing high-accuracy bridge measurement to be made in the field with rugged, relatively insensitive equipment.

was found to be particularly useful for in-the-field work. It permitted high-accuracy bridge measurements to be made with a rugged, but relatively insensitive, null-detecting device.

Only five components are used in the circuit, including two complementary transistors operated push-pull. A current gain equal to the average beta of the transistors is provided. Voltage gain is unity. The circuit was found to be extremely stable, with drift over a few hours use between 0.02 and 0.10  $\mu$ A. For more gain, circuits can be cascaded.

The resistance of the potentiometer is not critical. It is used as a zeroing control to center the needle of the null indicator.

Matching of the transistors is not necessary although the circuit is more stable if they are matched. The resistance of the null detector is not critical either. Input impedance of the current multiplier is beta times that of the null device.

*Yale Jay Lubkin, Senior Staff Engineer, Loral Electronics Corp., New York, N. Y.*

If this Idea is valuable to you, give it a vote by circling Reader-Service number 729.

## Westinghouse announces new VOLTRAP surge suppressor



The Westinghouse VOLTRAP is a unique voltage limiting device which has been designed and constructed for the sole purpose of providing a shunt path for transient overvoltages. It provides positive protection, year after year for all static devices such as silicon and germanium cells and silicon controlled rectifier cells.

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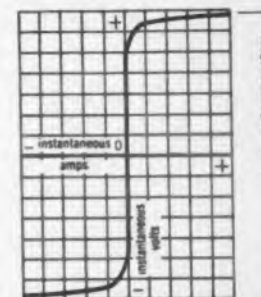
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Ranges: 0-10 psi to 0-100 psi.

Non-linearity and hysteresis: Less than  $\pm 1.0\%$  of full scale.

Transduction: Resistive, complete strain gage bridge.

Available for absolute, gage or differential pressure measurements.



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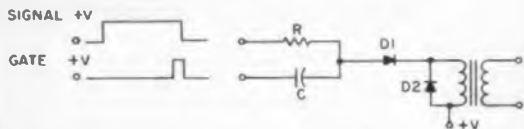
CIRCLE 178 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

### High-Power AND Gate 738 Uses Discharging Capacitor

Whenever a high current or high voltage AND function is required, the circuit shown in the figure can be used. A typical application would be the writing of information from a shift register into a core memory.

Initially, the signal source supplies sufficient current to charge capacitor  $C$  through



**Presence of signal** and gate pulses discharges capacitor to supply high-voltage or high-current output pulse.

resistor  $R$ . The capacitor's final charge depends upon the  $RC$  time constant and must not exceed the back bias on diode  $D_1$ .

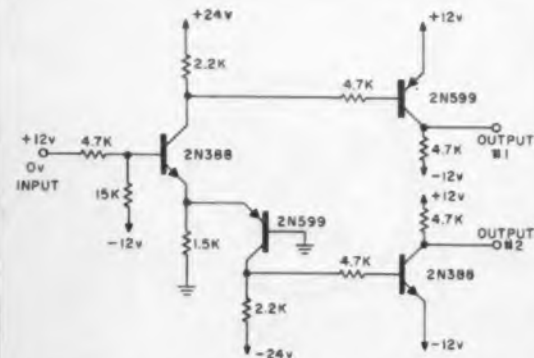
When the gate pulse occurs, it forward biases  $D_1$ . The capacitor then discharges through the transformer. Diode  $D_2$  is used to clamp the backswing. The transformer can be either step-up or step-down, depending on whether the application requires high current or voltage.

*Charles Becklein, Engineer, Sanders Associates, Plainview, N. Y.*

If this idea is valuable to you, give it a vote by circling Reader-Service number 738.

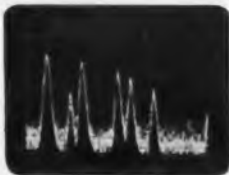
### Simplified Gate Driver 745 Reduces Delay Between Outputs

Six-diode gates are used extensively in electronic systems. Waveforms for driving these are opposite going square-waves. For proper operation it is desirable that there be a minimum delay between waveforms.



Gate driver uses one stage of common base amplification per channel.

Discrete signals in noise background are easily detected and measured on SB-7bZ display. Automatic high sampling rate (6.7/sec.) speeds measurements.



# versatility + economy

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200 cps to 300kc



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- FM Telemetry subcarrier channel analysis
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The SB-7bZ features:

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- Amplitude scales: 40db log, 20db linear and 2.5db expanded
- Resolution: variable from 100 cps to 2kc
- Sensitivity:  $25\mu\text{v}$  for full scale deflection, calibrated to measure signals as low as  $25\mu\text{v}$
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- 5" high-persistence CRT Tube

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ELECTRONIC DESIGN • July 19, 1961



## new, millivolt discriminators

The new Keithley Models 710 and 711 are extremely stable, light-modulator dc amplifiers operating a thyratron tube and relay. They are identical except for method of trip level adjustment. Uses include a broad range of Go, No-Go automatic control applications such as testing of diode and capacitor leakage currents, controlling temperatures, sorting resistors in automatic bridges. They can also be used in nuclear safety installations and numerous process control functions. The discriminators are fail-safe in that failure of any component creates the alarm condition. They are immune to vibration, chatter-free, can be made locking or non-locking, and can be floated up to 500 volts above ground.

**Sensitivity:** 0.2 to 10 mv; can be extended with internal resistive divider.

**Max. Source Impedance:** 100 K

**Repeatability of Trip Point:** Better than 200 microvolts.

**Speed of Response:** 40 to 60 milliseconds with signal 50% larger than trip level.

**Price:** Model 710, .....\$450.00  
Model 711, .....\$470.00



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Because one waveform is the inverse of the other, the usual method of generation is to use separate channels for each output, one containing an odd and the other an even number of inversions. This means that high speed design techniques must be used to reduce the delay between outputs.

A very satisfactory approach is to use one stage of common base amplification in one channel. Because of the high speed of the common base mode, very little delay results between outputs.

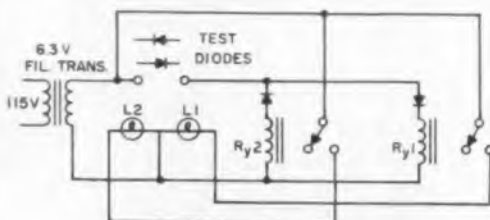
The switch driver shown in the figure has a delay between outputs of less than 0.1  $\mu$ sec. This can be reduced to a lower figure by the use of diodes to prevent saturation of the transistors and by adding speed up capacitors.

*Jim Curry, Engineer, Tasker Instruments Corp., Van Nuys, Calif.*

If this idea is valuable to you, give it a vote by circling Reader-Service number 745.

## Diodes Checked Out On Single 60-Cycle Tester 737

Here's a simple testing circuit we devised for the rapid processing of semiconductor diodes. With the diodes placed across the test clips, the set-up determines its polarity, or whether it is shorted or open. An alternating, rather than dc, voltage is used.



Diodes placed on test clips can be rapidly checked on this 60-cycle, rather than dc, tester.

The circuit works as follows:

- |                         |                                       |
|-------------------------|---------------------------------------|
| Cathode placed to right | — Relay No. 1 operates and lights L1. |
| Cathode placed to left  | — Relay No. 2 operates and lights L2. |
| Short circuit           | — Both relays and both lamps operate  |
| Open circuit            | — Neither relay or lamp operates      |

*Raymond J. Shaughnessy, Text Engineer, Raytheon Co., Brighton, Mass.*

If this idea is valuable to you, give it a vote by circling Reader-Service number 737.



## **Rockbestos Firezone Aerospace Wire Resists Jet Engine Heat in B-52**

Rockbestos Firezone Type 101 Aerospace Wire is used for power and control circuits in the B-52 jet bomber, renowned for its high performance and dependability.

Dependability is designed into Rockbestos Aerospace wire too. In jet aircraft Rockbestos Wire resists the high temperatures around engine and afterburner sections. It is also used for high impedance circuits in guided missiles.

Standard Rockbestos Aerospace wires cover a temperature range from 257 F to 750 F. Many special wires have been produced to operate at even higher temperatures. In addition to high temperature aerospace wire, Rockbestos supplies hook-up wire, coaxial cable, and ground support cable.

*For complete information on Rockbestos Aerospace Wire & Cable write for Bulletin.*

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DIVISION OF **CERRO CORPORATION**

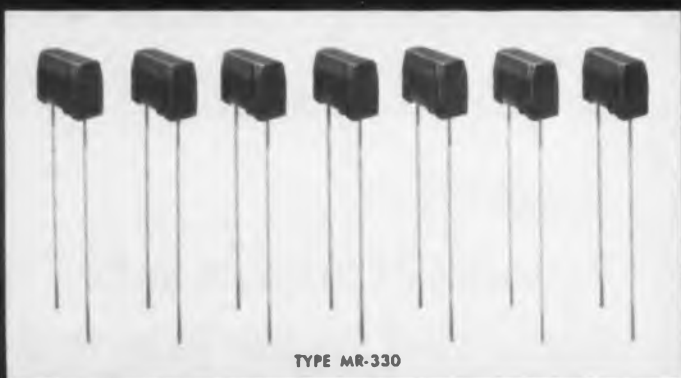
MAIN OFFICE AND FACTORY: Nicoll and Canner Streets, New Haven, Conn.

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# BOOKS

## Electric Circuits and Machines

Eugene C. Lister, McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y., 397 pp, \$5.50.

This third edition presents the fundamentals of both direct and alternating current circuits and machinery. It is designed for use in technical high schools, technical institutes, community colleges, and in survey courses for nonelectrical engineering students. Information on all major types of electrical machinery is included, and basic principles of electricity are presented with a minimum of detailed mathematical analyses. Material is also included on

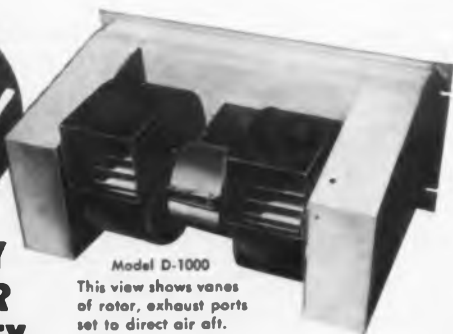
circuit protectional equipment and the effective use of industrial symbols. Questions and problems are also provided with many numerical examples worked out in detail.

## Microwave Transmission

J. C. Slater, Dover Publications, Inc., 10 Varick St., New York 14, N. Y., 309 pp, \$1.50.

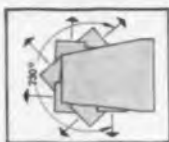
Described here is the general theory underlying the methods used for transmitting microwaves from point to point, from the generator in which they are produced to the receiver in which they are detected. Emphasis

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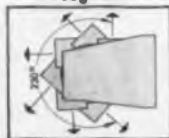


Model D-1000  
This view shows vanes of rotor, exhaust ports set to direct air aft.

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is on the fundamental theory of electromagnetic waves rather than on practical applications. Chapter headings include: Transmission Lines, Maxwell's Equations, Plane Waveguides, and Reflection, Rectangular Waveguides, Radiation From Antennas, and Coupling of Coaxial Lines and Waveguides.

#### Field Theory of Guided Waves

Robert E. Collin, McGraw-Hill Book Co., Inc. 330 W. 42 St., New York 36, N. Y. 606 pp, \$10.00.

An account of guided wave theory at the graduate level, this text sets forth the mathematical techniques and solutions of the more elaborate wave-guiding structures, waveguide discontinuities, waveguide antennas and coupling apertures. Both the basic theory and mathematical techniques involved in this field are discussed. In addition, the book has been planned as a reference for the engineer or physicist. The treatment pre-

supposes a prior knowledge at the introductory level of field theory and propagation in waveguides. Emphasis is on the field solutions in contrast to a description of microwave structures in terms of equivalent-circuit parameters. However, an amount of microwave circuit theory is included for a logical interpretation of field solutions in terms of possible equivalent circuits. Chapter headings include: Green's Functions; Transverse Electromagnetic Waves; Transmission Lines; Propagation in Cylindrical Waveguides; Inhomogeneously Filled Waveguides; Periodic Structures; and Surface Waveguides.

#### Transcendental and Algebraic Numbers

A. O. Gelfond, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 210 pp, \$1.75 (paperbound).

Translated from the Russian, this volume discusses the modern theory of transcendental numbers and the fundamental methods of this theory.

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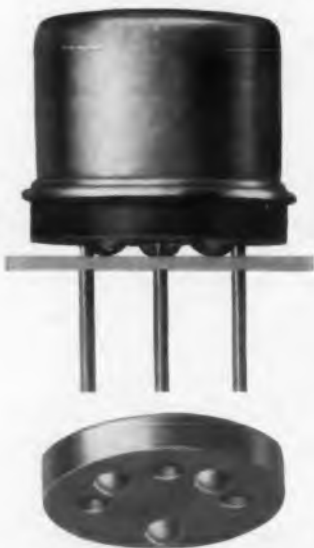
**SIGMUND COHN** MFG. CO., INC.  
121 SOUTH COLUMBUS AVENUE, MOUNT VERNON, N. Y.

SINCE 1901

The advertisement features a large white circle containing text about electroplating. To the right of the circle is a close-up of a metal ring with a wire looped through it. The ring has the text 'SIGMUND COHN' and 'MOUNT VERNON, N. Y.' engraved on it. At the bottom left is a logo with the text 'SINCE 1901' and a stylized 'S' inside a triangle. At the bottom right is a dark banner with white text providing contact information for Sigmund Cohn Mfg. Co., Inc.

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**FOR TRANSISTORS**

Transipads put a little extra security into printed-circuit assemblies. For a cost you count in pennies. A Transipad mounting is rock solid. It eliminates strain on delicate leads, provides vibration-proof separation between them. It isolates the transistor case from contact with printed conductors. And, perhaps most important, it provides a built-in air space to dissipate the heat of soldering (how many transistors have you lost lately through heat shock?). Transipads come in sizes and styles to fit most transistor types; some will convert lead arrangements from in-line to pin-circle, or vice-versa; others will widen lead spacing. Samples and drawings are yours for the asking. A note or a phone call will bring them.



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## DESIGN DECISIONS

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### Steel Ribbon Converts Linear to Angular Motion

A steel ribbon helps convert linear to angular motion in a single-axis, flight-simulation table. At its lower end, the ribbon is secured to a flat tangent plate. At its upper end, it is secured to a rocker that drives the table.

A similar mechanism appears at the lower end of the voice-coil-driven rod that moves the tangent plate. The lower mechanism has a reverse arrangement, however. Here, the upper end of the ribbon is secured to the tangent plate while the lower end is secured



**Steel ribbon**, secured to flat tangent plate and curved rocker, converts linear-to-angular motion with virtually no backlash. Ribbon has been emphasized in photograph for clarity.



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*Unique Transmission characteristics*

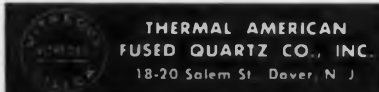
**PURITY** — purest form of fused silica

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**AVAILABILITY** — block material for lenses, prisms, etc; rod, fiber, wool; hollow ware as tubing, crucibles, and special apparatus.

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to the rocker. This opposing arrangement maintains constant tension on both the upper and lower ribbons.

The unusually simple linear-to-angular-motion converter, designed by David S. York, vice president and chief mechanical engineer of MicroGee Products, Inc., 6319 Slauson Ave., Culver City, Calif., provides several advantages. It offers very little noise, virtually no backlash, and a very high order of stability and linearity.

These factors are extremely important in testing systems for small perturbation stability. The usual mechanisms for converting linear-to-angular motion, like rack-and-pinion and other backlash-type devices, give a "staircase effect" in the input-output characteristics. This effect can be disastrous in measurements involving small displacements.

### Liquid Lock Makes Loose Fit Press Fit

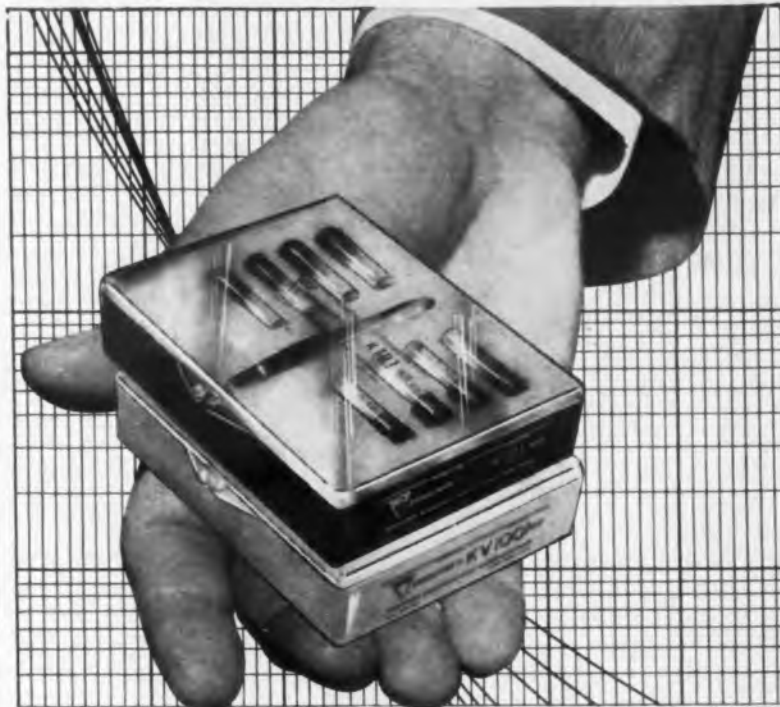
A drop of liquid holds an aluminum collar securely in place in a subminiature trimmer potentiometer. The collar helps provide a hermetic seal for the resistance element in the WeeTrim potentiometer, model 500, manufactured by Handley, Inc. of 12960 Panama St. in Los Angeles.

Handley could not use a press fit because the pressure required might distort the high-resolution, high-stability resistance winding. Instead, Handley used Loctite sealant, a liquid manufactured by American Sealants Co. of Hartford, Conn. This liquid hardens into a tough plastic bond when it is confined between close-fitting metal parts.

The Loctite is available in different grades offering shear strengths ranging from as low as 75 psi to as high as 1,500 psi.



Subminiature trimming pot uses liquid sealant to lock aluminum collar in place without requiring a force fit.



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HYDE PARK, NEW YORK...AND AT NORCO, CALIF.  
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## DESIGN DECISIONS

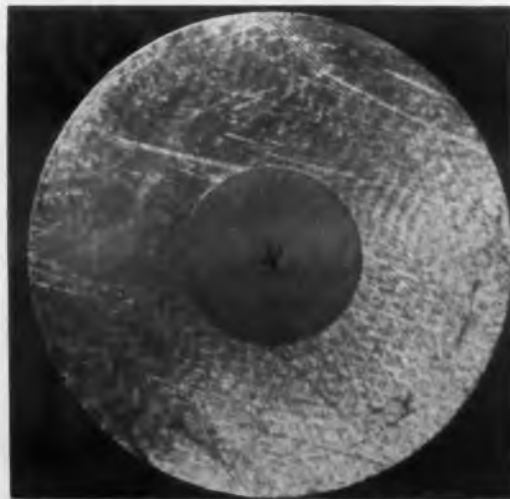
### Hi-Fi Die Obviates Milling In St-Erie-o Cartridge Element

A tiny ceramic element for a high-fidelity phonograph cartridge posed some unusual problems for Erie Technical Ceramics of State College, Pa. The engineers at Erie needed a special extrusion die to make a tight tolerance, X-shaped element for their "St-Erie-o" reproducer cartridge. Unfortunately, the "obvious" methods for making the die were difficult and costly.

The arms of the asymmetrical, X-shaped ceramic element were to be only 31 mils long and 15.5 mils wide and the tolerances were to be held to within 1/2 mil. The lengths were to be equal within 1/2 mil while the 7.5-mil radii between the arms of the X were to be held to within 1/2 mil.

A first glance at the problem suggested the use of an electro-erosion milling process for fabricating the die. But a second look indicated that this would require lapping to the final tolerances and lapping would have been impractical in such a tiny orifice. Furthermore, because of the large depth of the hole compared with its width, vibrations in the electrode would have made it extremely difficult to hold the proper dimensions.

Erie's engineers found the solution when they turned to William C. Bobbitt, manager of the Punch & Die Div. of F. J. Stokes Corp. in Philadelphia. He designed a four-segment die, with the segments clamped to-



Exit-face of four-piece, hi-fi extrusion die. Four segments in center are so perfectly mated that mating lines are undetectable.



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Check these advantages in resistance temperature measurement applications:

- Suppresses large lead resistance changes (up to 5 ohms)
- Suppresses variable lead resistances at null and when unbalanced
- Suppresses unequal lead resistances
- Trims out calibration differences
- Multiple temperature ranges
- Standardized 10 mv. DC output
- Full line of auxiliary equipment

This precision-made, plug-in unit permits convenient change of full-scale temperature and corrects known calibration errors of sensor. Basic 10-channel unit provides 10 temperature ranges for each of 10 sensors.

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CIRCLE 194 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • July 19, 1961

gether in a circular holder. Matching pairs of the segments were ground simultaneously while the profiles were monitored on a ground-glass screen under a 40X magnification.

Matching the segments to within 1/2 mil, one of the tightest tolerances encountered in die work, according to Bobbitt, was the really difficult part of the job. But the resulting hi-fi die made fabrication of the ceramic cartridge element a simple matter for Erie.

## Noisy Multivibrator Helps Locate Distress Light

Components and circuits which generate radio-frequency-interference should normally be designed out of electronic equipment. But in one case, an RFI-producing circuit was deliberately made even noisier.

A high-intensity distress light, manufactured by ACR Electronics Corp. of 551 W. 22nd St., New York, uses a modified multivibrator in a transistorized dc-to-dc converter. When the unit was first designed and found to be noisy, the first thought was, of course, to eliminate the noise. But Chief Engineer Morton Sunshine suggested, "Let's make it noisier and let's use the noise."

In the production model of the distress light, the noise is passed through filters which pass the distress frequency, 243 mc. This distress signal can be picked up as far as 25 to 30 miles away. Rescue craft can follow this signal with radio direction finders to locate a person lost at sea.

The circuitry in the distress light is arranged so the discharge of a capacitor into a Zenon light acts as a pinger in the water. The pinging "noise" can be received as far as 15 miles away by standard sonar equipment.

Of course the basic function of the device is generating high-intensity light. This function is implemented with a "lens" made of a molded, clear epoxy resin which completely encapsulates the Zenon lamp. The "reflector" behind the lamp is a small strip of aluminized Mylar tape with a checkboard pattern. This low-cost material is similar to that used as automobile bumper strips.

The 1-lb distress light can be seen 50 miles away on a clear night. Its prime function is admirably supplemented by the use of both electrical and acoustical noise.

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## LETTERS

### Objects to Superfluous Styling

Dear Sir:

Your editorial, "Good Styling a Critical Factor", brings to attention a serious problem confronting design engineers today. Most electronic equipment is designed to fulfill some definite objective, toward which all design effort should be directed. In addition to the technical features inside the unit, various other factors such as layout, external appearance, color, etc., apparently may have subtle psychological as well as practical advantages in meeting this objective, and must be considered as an important part of the over-all design.

On the other hand, there are certain aspects to styling which can only be regarded as unrelated and superfluous. Their most obvious purpose is to increase sales appeal by purporting to demonstrate a pride in workmanship and design by the manufacturer over and above the "standard" (i.e. his competitors). Such "frills" have become increasingly evident in recent years, particularly in consumer products (automobiles for example). Not only are they sometimes crude, but worse still, they are often actually detrimental to the primary objective of the equipment. They also increase the cost.

Determining the dividing line between essential styling and superfluity is a job which calls for the highest degree of practical engineering judgment. It is not a job for artists, as your editorial would imply. Nor can it be judged very intelligently by walking past two miles of exhibits noting such trivialities as silk screen, "ordinary" engravings, etc. Before passing judgment on the styling of any instrument, I would suggest that a person first use the instrument.

The problem confronting design engineers is that currently popular styling frills are often expected (or even demanded) by the customer which are actually in conflict with the primary objective of the equipment, as

## Genisco APD\* system



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The new Genisco APD requires low power and is ideal for portable, laboratory, or field use. Call or write today for prices and complete details.

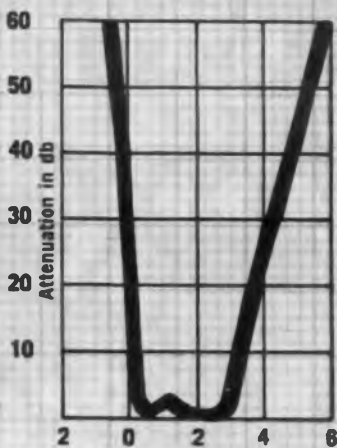
\*Analog-to-Pulse Duration  
Patent Applied For

Genisco  
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2223 Federal Ave., Los Angeles 64, California

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# crystal filters



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- High attenuation
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Ortho Crystal now offers a complete line of quality crystal filters with particular applications in doppler radar, receiver IF, comb filter sets or where ever filters of high stability factors and narrow bandwidths are required. Compact, ruggedized packaging will meet all MIL specs. Ortho will custom design to your exacting requirements. Write for complete catalog.

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Carrier Frequency: 3.0 mc  
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60 db Attenuation: - 300 cps, 6 kc  
Min. Attenuation: 60 db  
Insertion Loss: 5 db max.  
Passband Ripple:  $\pm 1/4$  db  
Input & Output Impedance: 3000 ohms  
Operating Temp. Range:  
- 40°C to +70°C

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crystal Inc.

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well as adding to the cost. This is particularly evident where specifications as well as expenditures are controlled by nontechnical personnel.

Stewart Coffin  
Dynamic Controls Co.  
Cambridge, Mass.

## Need for "Impedance-Matching" Electronic Device Stressed

Having just read your editorial "Good Styling a Critical Factor" I should like to extend my thanks for your most complimentary remarks concerning our new packaging system. Much of the credit for its development belongs to our designers, Tom Lauhon, Allen Inhelder, Don Pahl, Andi Are, Dale Gruye, Herb Beaven, and Ken Dinwiddie; and to Dick Payne and Ron Perkocha for the sometimes thankless job of drafting.

Since we regard ELECTRONIC DESIGN as one of our most important sources of information, it is especially encouraging to note the theme expressed in your editorial. We are in whole-hearted agreement. We have found that the value of an electronic device—just as of any other product—is determined on the basis of many attributes. Of course, most importantly, does it work at all? But of growing significance, as the complexity and sophistication of our industry increases, is the effectiveness of the coupling between the device and its human user. This coupling depends, to a great extent, upon a visual clarity of function and a professional appearance, which serve not only to simplify the operation of the device, but to inspire the confidence of the operator. In this area lie the real challenges for the electronic industrial designer—and the real opportunities for making worthwhile contributions.

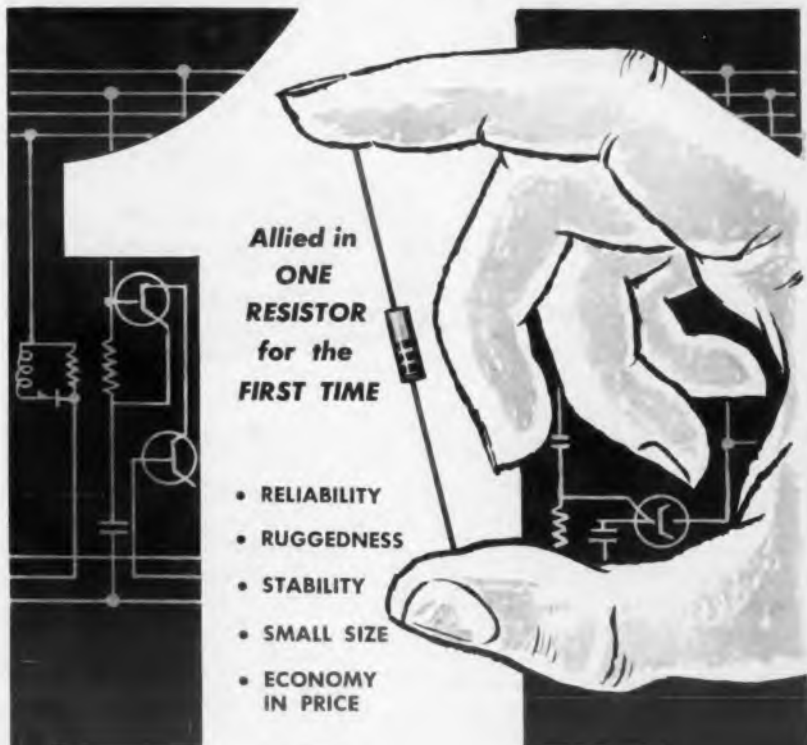
Carl J. Clement, Jr.  
Manager, Industrial Design  
Hewlett-Packard Co.  
Palo Alto, Calif.

## Accuracy Is Our Policy...

In the "Letter to the Editor" by Sam Ringel May 10, bond strength is printed as 320 psi when actually it is ten times as great—3,200 psi.

# METOX TYPE F-20

## MINIATURE MOLDED OXIDE RESISTORS



**Allied in  
ONE  
RESISTOR  
for the  
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- RUGGEDNESS
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- SMALL SIZE
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IN PRICE



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**RELIABILITY** — Failure rate is better than one per ten million hours.

**STABILITY** — Under full load, the stability is better than 2% after 10,000 hours. Subsequent rate of change will not exceed 0.1% per thousand hours.

**TEMP. COEF.** — Will not exceed  $\pm 0.05\%$  per  $^{\circ}\text{C}$ .

**NOISE** — Less than 0.5  $\mu\text{V/V}$  applied.

**TOLERANCE** — All MIL-R-11C values at  $\pm 5\%$ .

**SIZE** — Same as the Mil Type RC20.

**SPECIFICATION** — Exceeds materially Mil-R-11C.

**PRICE** as compelling as the performance and related to 5% carbon composition resistors.

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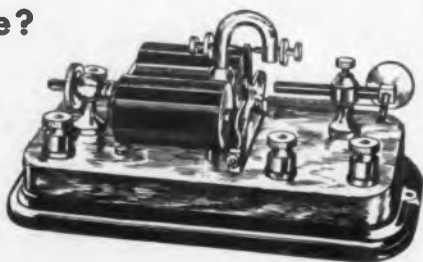
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where  
have the  
simple relays  
gone?



Many, of course, have disappeared along with the relatively simple jobs they were asked to perform. (A good telegraph relay\* or pulse repeater today, for example, should not only be small but able to transfer its contacts on a milliwatt or so about 500 times a second for half a billion operations — and then be repairable, adjustable and lovable besides.) But there are still plenty of naive, uncomplicated loads around that ask only to be switched on and off, at reasonable intervals, by a device that doesn't have so many parts and fancy thingamajigs that it may become temperamental and refuse to work without being coaxed.

For such applications we are happy to say we have a paragon of ingeniously simple, fool-proof relay design. It won't make the same confidence-inspiring noise as the classic above and it's not for telegraphy, but you can see through its enclosure and watch its contacts surely open and close. The designer started with the familiar enclosure and octal plug-in base and then developed the relay accordingly (with UL requirements in mind); he didn't

\* Plug Octal, 1bat is) for Sigma Series 72 relay



just take an existing relay and tack on a new base and enclosure. As a result, the parts make the best use of the volume (1 5/16" square x 2 1/16" high) and are big, simple, rugged and few in number. The base is specifically designed to carry the 10 amp. loads the relay will switch.

The relay is designated "Series 46" and intended for general purpose, heavy-duty DPDT switching on AC or DC inputs. Rated DC loads are 5 amps at 28 volts, 1 amp. at 120 volts; AC, 1200 volt-amperes per pole with 240-volt and 10-amp. maximums. Life ranges from 10 million operations with 1-amp. loads to half a million with 10-amp. loads. The relay can be as sensitive as 200 milliwatts DC, or 0.2 v-a AC.

We've looked at what else is available for the same modest price and the "46" specs give us considerable hope. If your problem has been the right specs but the wrong price, or vice-versa, perhaps you'd like the 46 AC and DC bulletins. In the meantime, always remember: You can be sure if it's Sigma, it's simple.



SIGMA

SIGMA INSTRUMENTS, INC.

91 PEARL ST., SO. BRAINTREE 85, MASS.

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## LETTERS

### MRC-66 Not Wideband

Dear Sir:

Your article on wideband communications, April 26, 1961, p 4, may be somewhat misleading to your readers in referring to the AN/MRC-66 system as having been part of the groundwork for the current wideband investigations. To clarify the point, the MRC-66 "Communication Central" is a narrow-band ssb system employing 4,750 privately assigned channels in a 33-mc spectrum beginning at 132 mc.

Arthur T. Klingberg  
Motorola, Inc.  
Chicago, Ill.

### Let's Talk the Same Language

Dear Sir:

A recent advertisement in one of the electronics magazines demanded that vendors adhere to specs, delivery, and other essentials. Illustrated with a photo of two men—one an engineer, the other a purchasing agent—the ad was headed, "Don't Play Games With *These* Boys."

The time has come to expand on this theme. We in the electronics industry must stop "playing games." One of the most costly of the games many of us have been playing is that of over-specifying—or of specifying without understanding.

We at Mid-Eastern Electronics had two dramatic examples of such specifying recently. Two of our representatives reported that some important customers wanted us to convert our entire line of transistorized power supplies to fully programmable units. This would have required new design, more inventory, and substantially higher costs.

Rather than jump into a large conversion program blind-folded, Mid-Eastern's president, William W. Hartz, visited the engineers who had insisted on "programmable" supplies.

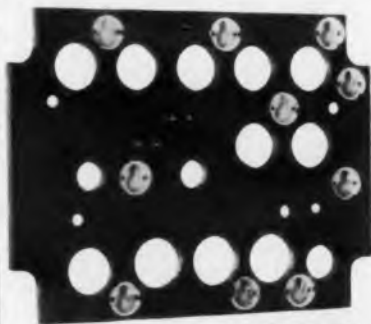
In the first case, the engineer required *tamper-proof* power supplies. It was essential that the voltage be adjustable *only* at the rear of the power-supply units. A simple screwdriver adjustment with a locking nut and a modified panel solved this problem.

In the second case, the engineer needed only a means of remotely controlling the output voltage—a far cry from true remote programming. An inexpensive pushbutton-controlled, gear-motor drive, built into the power supplies, solved this problem.



# NEW!

## BODNAR CONTROL PANELS



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## TRANSISTORIZED DIGITAL SYSTEMS

Digital Systems—The NAVCOR systems approach is one encompassing modular units of standard NAVCOR plug-in modules. This permits future change or expansion of your requirements—minimizes the possibility of obsolescence. Every NAVCOR system includes indicators on all memory elements for easy checkout and maintenance.

NAVCOR development and production facilities can expedite your digital system program—offering a unique combination of technical experience and production economy.



Creative engineering by NAVCOR has successfully developed the 100 Series transistorized modules for digital test equipment and prototype development, and the newer 300 Series card modules for constructing complete data handling systems. Delivered complete and attractively packaged, these economical systems modules are ready to operate with a minimum of inter-unit wiring.

NAVCOR can engineer and manufacture complete systems to your requirements. Years of experience, devoted exclusively to semiconductor digital systems design, have produced hundreds of thousands of operating logic stages.

### FREE

Send for complete data and specifications on the 300 Series systems blocks.



NAVIGATION COMPUTER CORP.  
VALLEY FORGE INDUSTRIAL PARK  
NORRISTOWN, PA.  
Glendale 2-6531

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In both these cases there was but a small additional cost per unit. The cost of the "fully programable units," originally specified, would have been at least double the standard prices, since 100-v, 10-amp, and 18-v, 35-amp units were needed. Space required would also have been doubled. Delivery would have been two months for programable units instead of two weeks for the slightly-modified units.

It would be to everybody's advantage if we thought twice before talking, and if we talked twice before acting. We're not playing games! Language is a tool for exchanging ideas and facts and for clarifying thought. When it serves only to confuse, to impress, or to please the speaker with the sound of his own voice, valuable time and effort are going up in hot air.

Whether we're buying or selling—let us know what we're talking about. The growing number of new terms is increasing the possibility of misunderstanding. This makes it imperative that both user and supplier take time to work together and understand each other.

Gunther A. Bielefeld  
Mid-Eastern Electronics, Inc.  
Springfield, N. J.

## The Puff's Have It

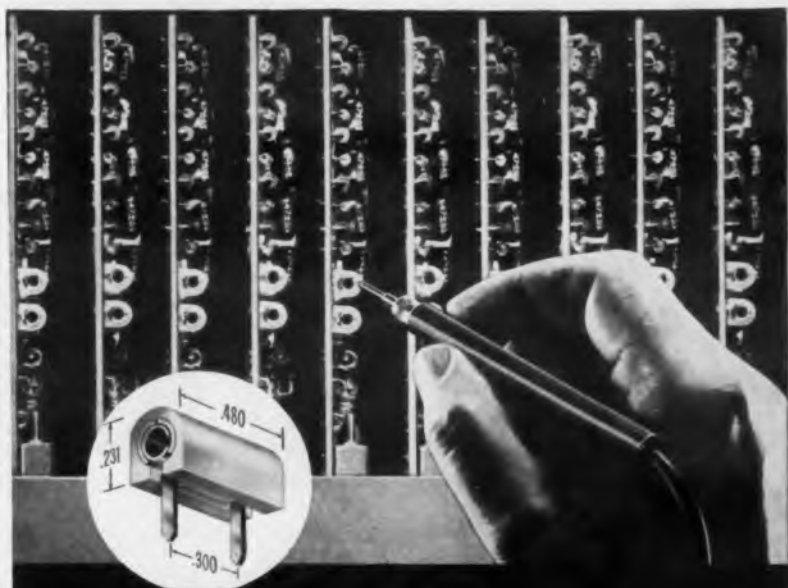
Referring to his letter in your 7 June issue, I am confident that it will please Mr. D. C. Friedmann to know that his idea is so good that, in fact, one of his suggested abbreviations, "puff," for picofarad was adopted by British engineers about a generation ago. Let us hope that the more elderly of these engineers will not now, at this late stage, be deprived of their puff by Americans who, as Madison Avenue now has it, are "on their way up."

F. D. Harris  
British Radio Electronics Ltd.  
Washington, D. C.

Referring to the correspondence from Mr. Friedman on a nickname for picofarads, I'd like to argue for "puff" as being it, because the picofarad has been in use in the United Kingdom for quite a while and this is their slang for it. We so often find ourselves separated from our English cousins in the field of electronic terminology, so let's not start still another separation.

R. D. Cortright  
Union Thermoelectric  
Chicago, Ill.





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## The Art of Tacking

*"Tacking" a breadboard together with a soldering iron has much in common with tacking a sailing craft against the wind. Uncommon skill is needed to do both well. Here a seasoned "tacker" sets forth his Six Johnson Laws of Tacking.*

**R. W. Johnson**  
Consulting Engineer  
R. W. Johnson Co.  
Anaheim, Calif.

**A**LL PROFESSIONS have artistic elements. The skilled trial attorney masters the sly innuendo and the subtle suggestion to the jury, the surgeon deftly knots the stitch, the dentist undercuts the filling, and the most adroit electronics engineer knows the *art of tacking*.

Although many seek to proceed from notebook to production, this species is all but extinct, lost in the company failure statistics. We are thus inflicted with the *breadboard*, the artistic masterpiece of electronics. The breadboard stands as the electronic engineers' sole remaining bastion against regimented conformity in these days of plug-in modules; his sole opportunity for exercise of the creative, artistic urge; his single link to a happier and more relaxed era.

As a timely and highly significant contribution to the art, this article presents Johnson's Six Laws of Tacking.

### LAW ONE

**Never twist.** Although an engineer might naively (or even smugly) believe that some components at least have been calculated correctly and will not change, such belief is foolhardy. This can be amply demonstrated in any breadboard by simply twisting the wires of any two or more components tightly together and soldering. It is a fundamental law that whenever this is done, at least one of these components will change during the inventing process. To avoid this in tacking, never twist.

### LAW TWO

**Never cut.** The economy minded prefer to use components over and over again. Using

parts from the Private Collection also avoids renewing old battles with the purchasing department, stock room clerks, inspectors, value analysts and others. The extent to which re-use is possible depends on two factors: the length of the lead and how much overheating has occurred. The two factors are not independent; for the shorter the lead, the more heat from soldering.

Again, simple demonstration can prove another fundamental truth: cut the lead off any component (diode, resistor, capacitor, transistor, or what have you) and leave just enough to solder it into the circuit. One will see that inevitably this component is precisely the one that must be changed, thereby leaving a useless component with leads too short to use the next time. So, never cut.

### LAW THREE

**Avoid parallelism.** What stereo does for good music, what solid state does for reliability, added dimensions can do for a breadboard. Three-D circuits are the ultimate in electronic artistry; one can always follow the leads, make contact with probes, test leads and iron, and there is less mutual magnetic and capacitive coupling when wires are skew rather than parallel. The best breadboard circuits expand outward in geometrically spherical fashion akin to a galactic nova. Thus, no two components or wires should ever be parallel.

### LAW FOUR

**Always use old solder.** Bright, shiny, new 60/40 solder is attractively packaged these days in handy dispensers, and the temptation is strong to use it. Unfortunately the dispenser can never be located among the pile of used components, tools and test leads on the bench. Anyhow, old used solder is far superior for tacking. In fact, the more crys-

talline and pithy, the better. Like vintage wines, solder improves with age for tacking purposes.

One therefore develops the habit of picking up bits of old solder from the bench with the tip of one's iron and using this for tacking. This helps keep the bench clean (at the expense of an occasional burn), saves money on solder, and avoids the splatter of resin. But most important, the joint barely stays together. So for good tacking, always use old solder.

### LAW FIVE

**Never tack more than two wires.** In the art of tacking one soon learns the difficulty of tacking more than two wires together. One genuine artist has even mastered the finesse of holding "N" wires in contact by skilled use of an alligator clip while he places a tiny drop of solder (old solder; remember Law Four) at precisely the right spot.

But not all engineers can achieve such creative heights; so when more than two wires are to be tacked, there is a problem. When the engineer goes to tack the third wire, the others ungratefully fall apart. Without violating Law One (never twist), the recourse is to tack each succeeding component further up the lead of its neighbor. This is of assistance in satisfying Law Three as well, as there will be a more rapid geometric expansion of the circuit. So for all but the purist: Never tack more than two wires at a time.

### LAW SIX

**Stop at 14 changes!** No discussion of this subject is complete without a reference to etched circuits. It could be argued that by the time one has reached this stage, he should be over the breadboard phase. Statistics show, however, that 78.2 per cent of all electronic

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ELECTRONIC DESIGN's Confidential Career Inquiry Service helps engineers "sell" themselves to employers—as confidentially and discreetly as they would do in person. The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

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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.

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

- All forms are delivered unopened to one reliable specialist at ELECTRONIC DESIGN.
- Your form is kept confidential and is processed only by this specialist.
- The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
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Date of Birth \_\_\_\_\_ Place of Birth \_\_\_\_\_ Citizenship \_\_\_\_\_

Position Desired \_\_\_\_\_

Educational History				
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Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

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# If you were a *surgeon* instead of an *engineer*...



... you'd want to work at one of the *leading* hospitals in the nation—where your associates would represent the finest medical talents available. In such a situation you could grow more in a year than in a lifetime spent in an ordinary clinic.

The same thing is true of every profession. Your own stature as an engineer is determined to a great extent by the calibre of your associates.

At Motorola you will be working for and with some of the most respected engineers and scientists in the electronics field—Motorola is an "engineer's company." And, here at Motorola the horizon is wide and the ceiling unlimited—you can go as far—as fast—as your capabilities permit. You'll be working for a *secure*, diversified company—not wholly dependent on one single market.

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engineering is done on the production line and after delivery. In these cases the engineer must cope with a temporary regression to what might be called the *etched-circuit breadboard*. Here one has the annoying problem of how to tack on various components as fixes for the defect without heating the board so much as to loosen the glue.

Painstaking research by the author has disclosed that with the soldering iron operating at precisely 93 v, it is possible to tack a component on an etched board and remove it a total of 14 times, provided that Law Three (use old solder) has been obeyed. Beyond this cut-off point, one of two things is most apt to happen: the component already on the board becomes overheated and changes its value, correcting the defect; or the copper separates from the board, so one can blame the defect on the etched-circuit board manufacturer. It's a good idea to remember: Make fewer than 14 changes in each component after release for production.

So much for the laws of tacking.

Now a corollary to the art of tacking is the *art of untacking*. If what goes up must come down, what is tacked must be untacked. One untacks to change one of the added components. And, of course, one untacks when he is finally satisfied with the design—to save the components for his Private Collection, so the same design mistakes can be corrected the next time.

Fortunately, if Johnson's Six Laws have been observed, untacking becomes a relatively simple matter. One simply touches the iron to the joints, and the breadboard flies apart like a mainspring. In fact, this is the test of a really good breadboard—every tack should fly apart by itself when touched by an iron. About the only precaution in untacking is to leave enough old solder on the leads so they can be tacked again the next time without violating Law Four.

A number of the more artistic breadboards constructed according to the Johnson Laws have been used to illustrate this instruction. Note that like so many items that obey strict engineering laws, the results have an artistic "essence" of their own. ■ ■

Note: Readers who have found this article helpful will look forward to a future article on the semiconductor properties of cold-soldered joints.

Credits: Photo by courtesy of DLE-GT Productions.

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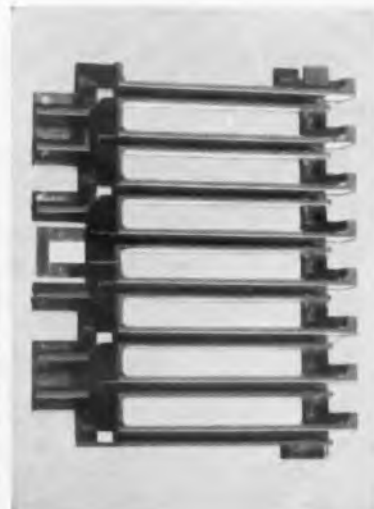
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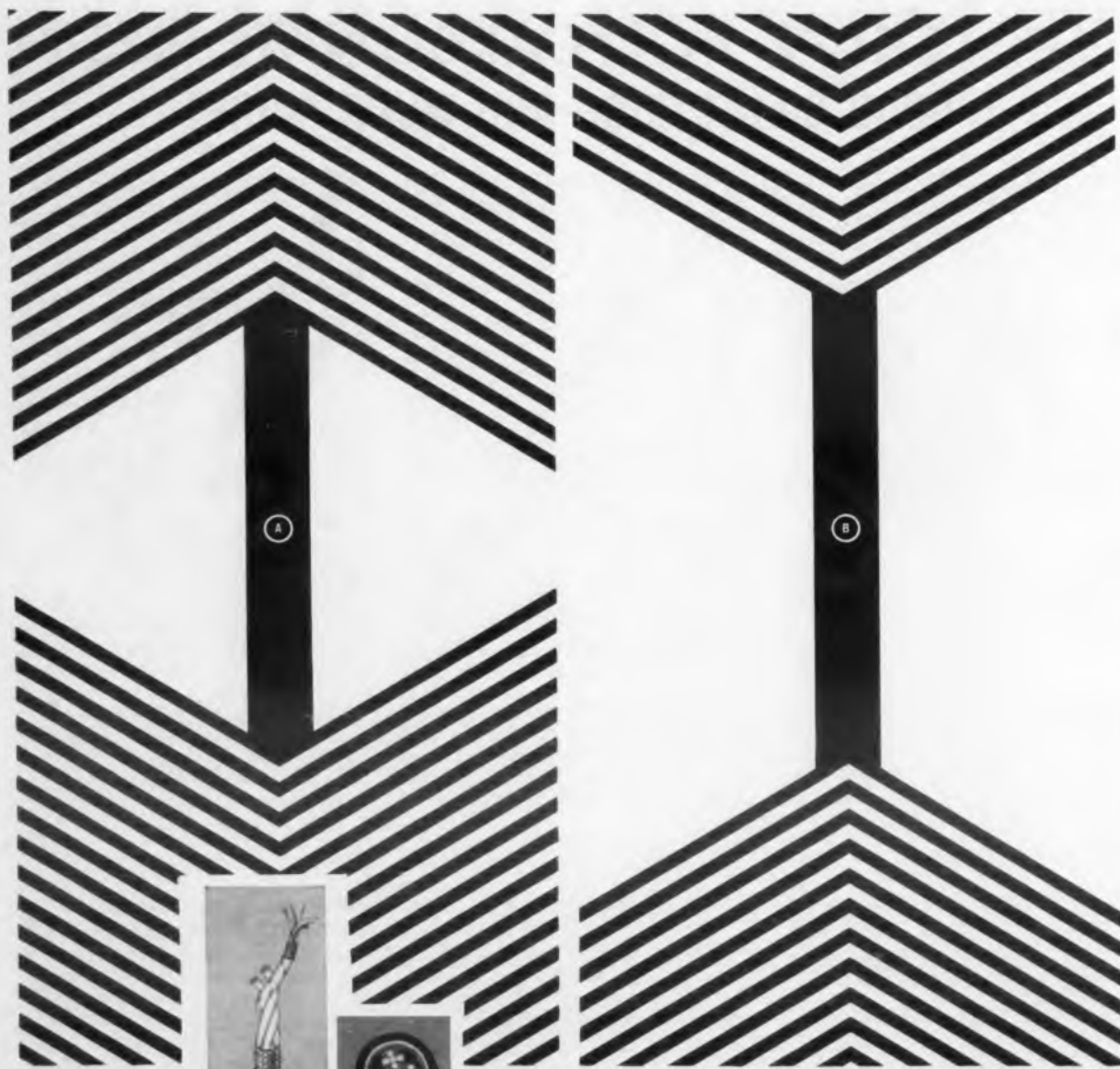
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