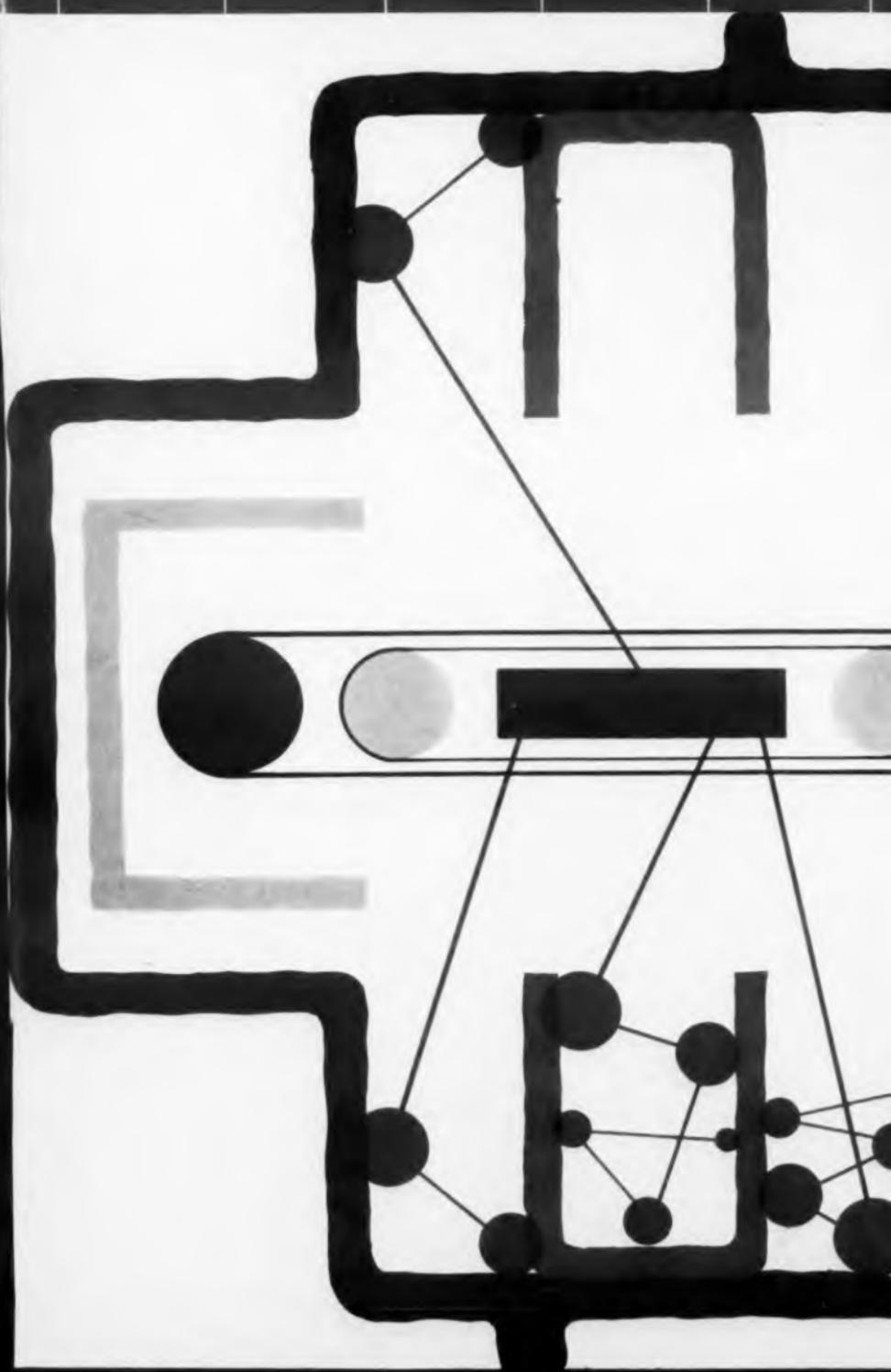


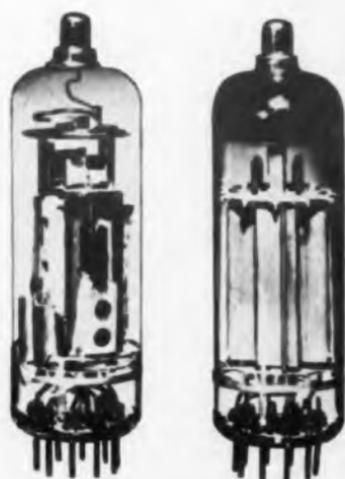
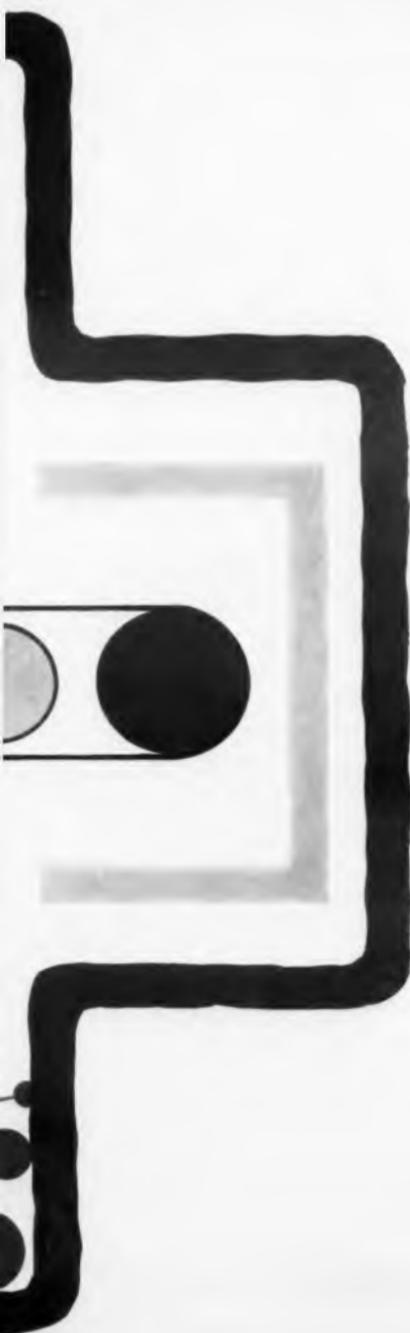
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# RONIC E S I G N

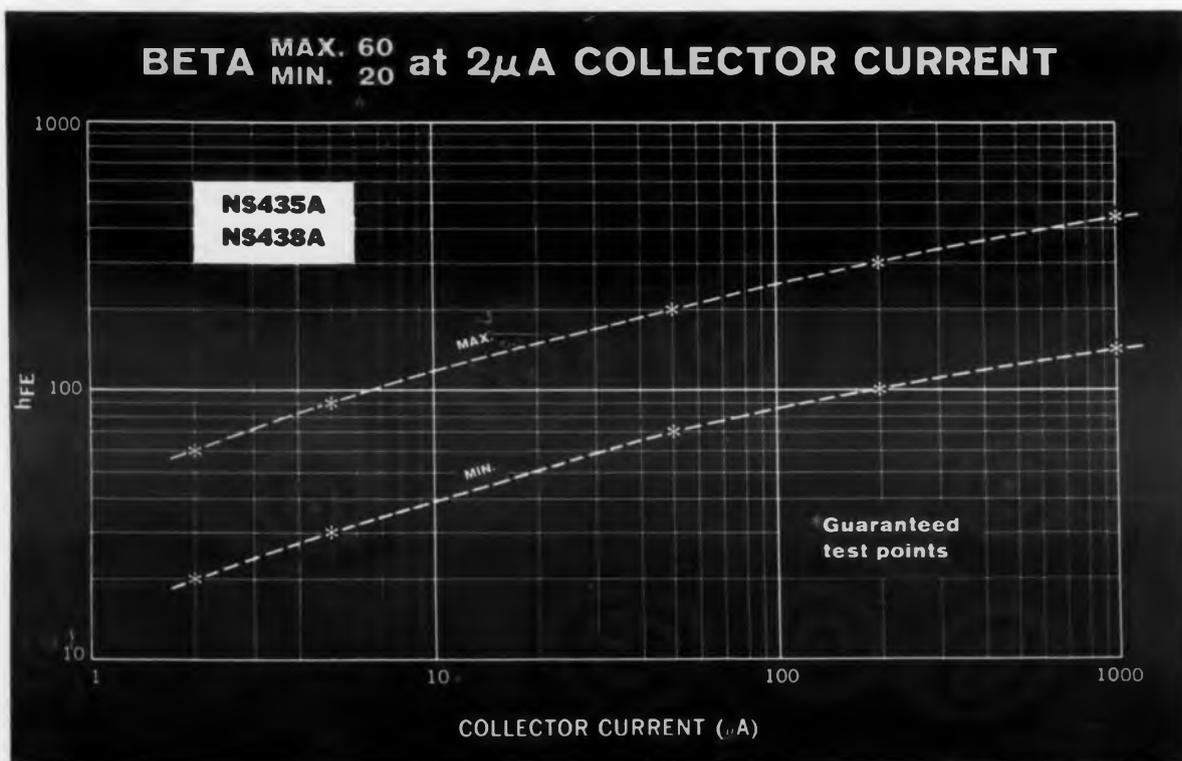
DECEMBER 6, 1961



Secondary emission is reduced by novel plate construction, resulting in a 40 per cent increase in peak plate current... p 54

# LOW LEVEL/LOW NOISE

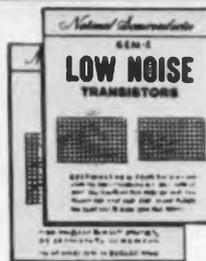
NS433A—438A SILICON NPN TRANSISTORS



Equiv. Input Noise Voltage	.....	1 $\mu$ V max.
Equiv. Input Noise Current	.....	200 $\mu$ A max.
LVCEO	to .....	45V
Cob	.....	8 pfd max.
VCE (sat) (at 1mA)	.....	0.2V max.
ft (at 1mA)	.....	60 mc min.
Physical Package	.....	TO-18

## TWO NEW APPLICATION REPORTS AVAILABLE!

Two new papers on low noise transistor design, "Low Noise Transistors: A General Discussion," and "Calculating Noise Figure When Equivalent Input Noise Voltage and Noise Current are Known," are available from NSC.



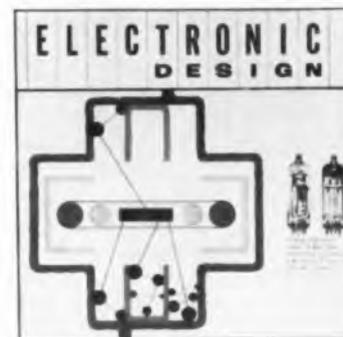
For complete technical information on NS433A series transistors and new engineering papers, check key number below, or write:



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CIRCLE 1 ON READER-SERVICE CARD



COVER: The novel simplicity of the horizontal-output pentode (p 54) is captured in the artist's bird's-eye view of the tube. Shown are the anode and control grid, which accelerates a stream of electrons into the cavitrap plate. Inside the cavitrap, as the drawing suggests, those electrons that do not adhere to the plate are bounced back to the plate, thus reducing secondary emission. The pictures show the tube with envelope and unsheathed.

## Sidelights of This Issue

A platoon of ELECTRONIC DESIGN editors returned from the Northeast Electronic Research and Engineering Meeting (p 4) with a host of favorable impressions—both theirs and those of attendees. NEREM would seem to have moved firmly into third rank in size among professional conferences. Some 17,000 persons were tallied at the Boston meeting, and the returns still were not complete.

Our editors noted that NEREM continues to stress basic research. This year's session also came up with several superb survey papers, on varactor diodes, generation of coherent light, new materials, FM stereo, among others. And a word about the NEREM Record: it was handsome, complete and arrived on time.

NEREM, like all conventions, produced a goodly number of chuckles in lobbies and bars. For example:

Question: What is an elephant?

Answer: A mouse produced under a cost-plus-fixed-fee contract.

And

Question: What is a kangaroo?

Answer: A horse developed by a committee.

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#### New Microwave Catalog

A new 32-page Hewlett-Packard Microwave Instrumentation catalog is yours for the asking. Contact your rep or write direct for this catalog which discusses theoretical and how-to-do-it techniques and includes a complete listing of  microwave instruments and their specifications.



## NOISE FIGURE MEASURING EQUIPMENT



#### 344A Noise Figure Meter

Quickly, accurately measures noise figure of operating radar sets. Automatic operation; simple front panel calibration. Militarized, transistorized, reliable in extreme environments, minimum size and weight. Continuous noise figure presentation on most radar receivers. Extremely high sensitivity permits decoupling noise source up to 20 db from main transmitter line to minimize system degradation. Provision for automatic alarm, remote noise figure monitoring, modulating. Meter scale/excess noise options: 25 or 30 MC input frequency, 1 MC bandwidth, 75 ohms input impedance. Approx. \$1,600.00 (depending on options, modifications).



#### 340B/342A Noise Figure Meters

General-purpose instruments making possible, in minutes, receiver and component alignment jobs that once took hours. Simplifies accurate alignment; encourages better maintenance, performance.

 340B automatically measures, continuously displays IF or receiver noise figure at 30 or 60 MC; other frequency on order. \$715.00 (cabinet), \$700.00 (rack).

 342A, similar, operates on 30, 60, 70, 105, 200 MC. 30 MC and 4 other frequencies between 38 and 200 MC on order.

CIRCLE 2 ON READER-SERVICE CARD

\$815.00 (cabinet), \$800.00 (rack). (Note: Models 340B and 342A available only in the U.S.A. and Canada.)

 343A VHF Noise Source, temperature limited diode broadband source, 10 to 600 MC, 5.2 db excess noise, \$100.00.

 345B IF Noise Source, 30 or 60 MC (others to order); 4 impedances, 5.2 db excess noise, \$100.00.

 347A Waveguide Noise Source, Argon gas discharge tubes in waveguide section; frequencies 2.6 to 18.0 GC, 15.2 db excess noise. \$200.00 to \$300.00.

 349A UHF Noise Source, 400 to 4,000 MC, wider with correction. 15.2 excess noise. \$325.00.

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**BASIC TEST EQUIPMENT**

◆ 382A/B/C Broadband Precision Waveguide Attenuators



Dielectric loading in new S832, X382 produces long electrical length for high accuracy with short physical dimension, provides hitherto unknown convenience. Calibrated range, 0 to 60 db. Degree-of-rotation scale allows accurate small changes at high attenuation and accurate resetting to high values of attenuation. ◆ 382B models calibrated to 0.1 degrees; 382C models to 0.01 degrees. ◆ 382A series rotary-vane attenuators, 3.95 to 40 GC, attenuation 0 to 50 db, \$275.00 to \$800.00; ◆ 382B/C models, \$295.00 to \$650.00.



◆ 422A, Crystal  
High series flat frequency and accurate characteristic —40 dbm new ◆ 4 (pictured) to 40 GC. ◆ 422A, \$200 matched pairs for reflectometer a pair. ◆ also offers high frequency covering a wide frequency GC, \$75.00 to \$130.00; 4 lines, 10 MC to 12.5 GC, reflectometer systems, m

◆ 532/536A Frequency Meters



Comparable wide band, direct reading convenience are offered by ◆ 532 series, 3.95 to 40 GC, and ◆ 536A, 1 to 4 GC coaxial, Frequency Meters. Comprise high Q resonant cavity tuned by choke plunger; no sliding contacts. Transmit virtually full power at resonance. 532 series, \$175.00 to \$325.00; ◆ 536A, \$500.



◆ 914A/B, 906A Moving Loads

Full frequency coverage, 1 to 40 GC is available from ◆ waveguide or coaxial moving loads. Model 914 series, 2.6 to 40.0 GC, are waveguide sections containing sliding, tapered, low-reflection loads. Plunger controls load position, travels 1/2 wavelength at lowest frequency to n load reflection GC, coaxial, Type N male, 914A/B series 906A, \$250.00.

**POWER MEASURING EQUIPMENT**

◆ 431A Microwave Power Meters. ◆ 478A/486A



◆ 434A Calorimetric Power Meter

Connect and read powers 10 mw to 10 watts, dc to 12.4 GC. No barretter, thermistor needed, no external terminations or plumbing. Measures CW or pulsed power. Two simple controls. DC input impedance 50 ohms approx.; input SWR less than 1.7 full range, less than 1.3 to 5 GC. Accuracy within 5% full scale. \$1,600.00 (cabinet); \$1,585.00 (rack mount).



Now end tedious zero setting. Power Meter (pictured). Full scale in 7 ranges, also accuracy all ranges, drift zero setting for all ranges, good for hours. Provides 10 db over previously available instruments. Operates Thermistor Mounts. ◆ 431A, \$345.00. New ◆ 478A (1 MC to 10 GC without tuning, is truly temperature compensated thermistor pairs for use with dual bridge of 431A. 5 accuracy, drift-free operation. \$145.00. New ◆ X486A temperature compensated, gives high accuracy, new GC without tuning, SWR less than 1.5. \$145.00.

**IMPEDANCE MEASURING EQUIPMENT**

◆ 809B/814B Universal Probe Carriages



◆ 809B, 810B



Easy waveguide interchanges

◆ 814B, 815B, 446B

Models 809B and 814B are precision built mechanical assemblies operating, respectively, with ◆ 810B and 815B series slotted sections.

Combination of the 809B carriage and 810 slotted sections covers 2.6 to 18.0 GC. Combination of 814B carriage and 815B series sections covers 18.0 to 40.0 GC.

On either carriage, waveguides can be interchanged in seconds. Only one probe (for each carriage) covers full frequency range. Manufacture is of highest quality, assures positive mechanical positioning of interchangeable waveguides and precise installation of mating ◆ probes. ◆ 809B has vernier scale reading to 0.1 mm, is equipped for dial gauge mounting. ◆ 814B has dial read directly to 0.01 mm. ◆ 809B, \$175.00, ◆ 814B, \$225.



ing; sense rate single Range 3 bore, ◆ Carriage to 40.0 ◆ 446B, \$1 el 440A, Type N



# L-RANGE TESTED waveguide and coaxial equipment

## 422A, 421A, 420A/B Crystal Detectors

High sensitivity (0.05 v/mw), frequency response ( $\pm 2$  db) accurate square-law characteristics ( $\pm 1$  db from  $-3$  to  $0$  dbm) are available with  $\odot$  422A Crystal Detectors (cutured), K and R bands, 18 \$200.00 each, available in reflectometer systems, \$420.00. High sensitivity detectors frequency range: 421A, 7 to 18 GC; 420A for Type N coax 5 GC, \$50.00 each; 420B for matched pair, \$150.00.

to reverse phase of residual section. Model 806A, 1 to 12.4 GHz, includes adapters for male, female connectors.  $\odot$  series, \$50.00 to \$250.00;  $\odot$  \$0.00.

## 36A Thermistor Mounts

Setting with new  $\odot$  431A. Measures  $10 \mu\text{w}$  to  $10 \text{mw}$  also reads in dbm.  $\pm 3\%$  drift less than  $2 \mu\text{w}/^\circ\text{C}$ ! One side additional sensitivity of operates with  $\odot$  478A, 486A.  $\odot$  48A (center, above) covers 10 GHz compensated, contains two A. SWR less than 1.5, high 486A Waveguide Mount, also new convenience. 8.2 to 12.4

## MENT

$\odot$  444A/446B Untuned Probes  
 $\odot$  444A (shown) is modified crystal (1N76 or 1N26) plus small antenna in convenient housing. Probe penetration easily variable; locks in position. No tuning sensitivity superior to elaborate, double tuned probe. Range 3.0 to 18.0 GC; fits  $\frac{3}{8}$ " carriage, similar but covers 18.0 to 40.0 GC.  $\odot$  444A, \$40.00.  $\odot$  446B, \$145.00.  $\odot$  also offers model 440A, for barretter or crystal.  $\odot$  N coaxial, \$85.00.



## $\odot$ 752 Multi-Hole Coupler

Precision directional couplers provide coupling factors of 3, 10 or 20 db. Coupling accuracy  $\pm 0.4$  db or 0.7 db. Directivity better than 40 db full range, SWR less than 1:1 (752A), 1:05 (752C/D). Cover frequencies 2.6 to 40 GC. \$100.00 to \$375.00.



## $\odot$ 372 Precision Attenuators

Rugged, broadband fixed attenuators retaining precise calibration regardless of humidity, temperature or time. Invariant attenuation assured by permanent, "multi-hole coupler" joining of two waveguides. 10 and 20 db models, 2.6 to 18.0 GC. \$110.00 to \$400.00.



## $\odot$ 780D/761D Dual Directional Couplers

Ideal for reflectometer systems, these coaxial couplers are flat to  $\pm 0.5$  db over 4-to-1 frequency range. Directivity is 35 db (760D) and 30 db (761D). Feature high power capacity, low insertion loss and SWR.  $\odot$  760D, 250 MC to 1 GC, \$200.00;  $\odot$  761D, 1 to 4 GC, \$185.00.



## $\odot$ 375A Variable Flap Attenuators

Simple, convenient for adjusting waveguide power or isolating source and load. Max. SWR less than 1.15 full range; attenuation variable 0 to 20 db, dissipates average powers up to 0.5 or 1 watt. S through R bands, 2.6 to 40.0 GC. \$90.00 to \$190.00.



## $\odot$ 870A/872A Slide Screw Tuners

For waveguide, coaxial (872A shown) applications. Probe position, penetration sets up reflection cancelling existing reflection. Lead screw or micrometer varies probe insertion for 870A Tuners, 2.6 to 40 GC, \$125.00 to \$300.00. Micrometer drive varies insertion on 872A, 500 MC to 4 GC, \$525.00.



## $\odot$ 362A Low Pass Filter

Compact models increase SWR measurement accuracy by suppressing harmonics; feature low insertion loss, broad stop band. 8.2 to 40.0 GC (includes N-band model). \$325.00 to \$385.00.



## $\odot$ 430C Microwave Power Meter $\odot$ 476A/477B/485 Mounts

$\odot$  430C reads rf power direct in dbm or mw, requires no calculations. Covers 2.6 to 40.0 GC, operates with  $\odot$  476A, 477B, 485 bolometer, thermistor or detector mounts; also with  $\odot$  487 Broadband Waveguide Thermistor Mounts (see alongside).  $\odot$  430C, (cabinet), \$250.00;  $\odot$  430CR, (rack mount), \$255.00.  $\odot$  476A Universal Bolometer Mount, 10 to 1,000 MC without tuning, \$85.00.  $\odot$  477B Coaxial Thermistor Mount, 10 MC to 10 GC without tuning, \$75.00.  $\odot$  485 Detector Mounts available in three basic series: S485A 2.60 to 3.95 GC, no tuning; 485B, 3.95 to 12.4 GC; 485D, 2.6 to 8.2 GC. 485 models, \$75.00 to \$185.00.



## $\odot$ 487 Waveguide Thermistor Mounts

Models covering 2.6 to 40.0 GC. Each covers full range of guide; no tuning, SWR 1.35 to 2.0. 10 mw max power. Uses permanently installed 100 ohm negative coefficient thermistor; 18.0 to 40 GC models use 200 ohm thermistor. \$75.00 to \$225.00.

## $\odot$ 810/815B Slotted Sections

$\odot$  810B Slotted Sections.  $\odot$  810B, for 809B carriage, flanged, waveguide section with accurately machined slot. Slot tapered at ends to minimize reflection. 3.95 to 18.0 GC. \$90.00 to \$125.00.

$\odot$  8810A. Complete slotted section assembly including probe carriage. In 2.6 to 3.95 GC (S-band) size only. \$450.00.

$\odot$  815B Slotted Sections. For mounting in 814B carriage. Available in two bands, 18.0 to 40.0 GC. Accurately machined; easy interchange, precise positioning. \$265.00.

$\odot$  806B Coaxial Slotted Section. 3-12 GC, fits 809B, Type N connectors. \$200.00.

## $\odot$ 805C/D Slotted Lines

Utmost mechanical rigidity, less leakage, greater accuracy, SWR 1.02 or 1.04. Range 500 MC to 4 GC, reads in cm and mm to 0.1 mm.  $\odot$  805C, for 50 ohm Type N,  $\odot$  805B, for 46.3 ohm RG 44/U.  $\odot$  805C, \$525.00; 805D, \$600.00.

## $\odot$ 415B/C Standing Wave Indicators



$\odot$  415B operates with all  $\odot$  waveguide and coaxial slotted sections, gives readings in SWR or db. Low noise level.  $0.1 \mu\text{v}$  full scale sensitivity, 60 db calib. attenuator. \$200.00 (cabinet), \$205.00 (rack). New  $\odot$  415C (pictured) offers similar characteristics but is transistorized, incorporates revolutionary four-times expansion of readings at any point on any scale. Price on request.



## $\odot$ 416A Ratio Meter

Displays ratio between two signals, irrespective of common amplitude variations. Especially useful for swept frequency measurement of VSWR, reflection coefficient, gain, insertion loss and other microwave parameters. Calibrated in VSWR, % reflection, db. See offer for  $\odot$  Application Note 42 elsewhere in this advertisement. \$550.00 (cabinet), \$535.00 (rack).

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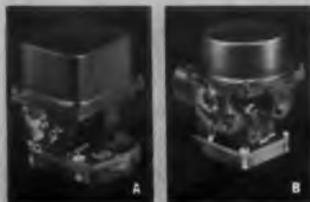
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CIRCLE 3 ON READER-SERVICE CARD

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## Coming in Future Issues

Seldom has an industry moved so rapidly from infancy to apparent maturity as automatic test equipment. We say "apparent maturity" because basic conflicts within the industry indicate that ATE has grown phenomenally, but has not yet stabilized. Even as ever-more elaborate ATE systems roll into the hands of the military, the fundamental design philosophies are still being debated. And as ATE equipment proliferates, the Pentagon is about to mount a determined battle for standardization. All this signals considerable turmoil for ATE in 1962.

ELECTRONIC DESIGN will analyze the conflicts and aspirations among ATE users and designers in a Special Report, in the next issue of ED.

In this report, the military users sound off about inadequate ATE equipment in emphatic terms. Designers take their stand in the debate: special-purpose or general-purpose systems? And the Air Force details its pioneer standardization project—hailed by some and denounced by others in the industry.

Watch for the ATE special report in the Dec. 22 issue of ED.



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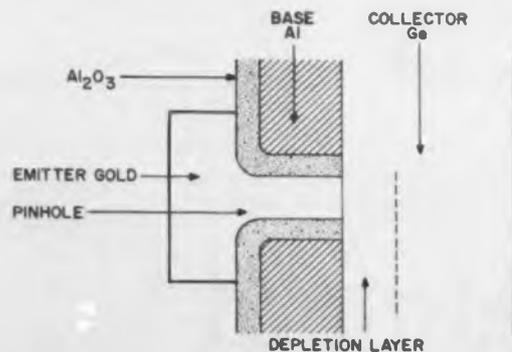
# Electronic Progress Keyed to New Materials

## *NEREM Focuses on Metal-Interface Amplifiers, Thin-Film Titanium Components and Phototube Light Demodulators*

**M**ETAL-INTERFACE amplifiers, thin-film titanium components and phototube light demodulators came in for extended discussion at the Northeast Electronics Research and Engineering Meeting (NEREM), held Nov. 14-16 in Boston. These and other advances pointed up the increasing dependence of electronic devices on materials and materials processing.

Although the individual NEREM talks were primarily descriptions of developments in the glamorous areas of electro-opticals, satellite communications and microwaves, it was obvious that the common base supporting advances in all these fields is improved materials. In some areas of transistor technology, thermoelectric conversion and high-field-strength magnetics, lack of adequate materials was said to be hindering developments.

A theory on tunneling in metal interface amplifiers (MIA) was presented by Dr. J. M. Lavine of Raytheon. It contradicts the the-



**Metal-interface amplifiers**, a new class of solid-state devices, operate because pinholes in the aluminum thin film bring the gold emitter in contact with the germanium base, according to a theory advanced at NEREM.

ory advanced by Philco Corp. and others. The alternate theory was originally proposed by Dr. R. N. Hall, General Electric Research Laboratory.

When a paper on Philco's MIA was cancelled, because the speaker was ill, Dr. Lavine, NEREM session chairman, pinch-hit with a discussion of the Raytheon work in this field. He said Raytheon's experimental configuration was very similar to the Philco model; collector material is 1.0-ohm-cm N-type germanium. Philco is said to use an evaporated gold emitter, while Raytheon turned to Dupont 5780 gold-conductive cement.

Philco says its MIA structure works because hot electrons can be transported across a metallic film of suitable dimensions and still remain distinguishable from the less energetic carriers in the film. Consequently, a high-impedance collector attracts only these energetic electrons. Experiments by Raytheon have led it to support Dr. Hall's theory that pinhole effects within the aluminum thin film is the dominant mechanism in such an amplifier. Electrons are injected directly into the space-charge region of the collector via the pinholes, which permit the gold emitter to be in contact with the germanium base, and are collected as in typical depletion-layer transistors. "Hot" electrons also may be present, Dr. Lavine said, but their role is not significant.

Philco's hypothesis was rejected on several accounts. One was the mean free path (1,000 Å) required to permit 90 per cent of the electrons to pass through an aluminum film 100 Å thick.

Both Raytheon and Philco agree on the feasibility of this new kind of solid-state amplifying device. Current gains ( $\alpha$ ) up

to 0.97 have been reported. With alphas of this order, low input resistances, and high output resistances, useful power gains are anticipated; MIAs would be the first active thin-film device. Dr. Lavine predicted the eventual elimination of the semiconductor substrate in MIAs.

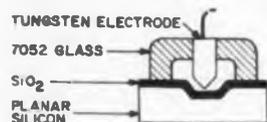
### **Titanium Compounds to be Versatile High-Temperature Thin-Film Material**

The wide applicability of titanium for thin-film circuits was described by W. D. Fuller of Lockheed Missiles and Space Co., Sunnyvale, Calif. Titanium-chemical technology already is practical, he said, and permits more space reduction than conventional methods. Individual thin-film circuits of the digital type generally are not as small as monolithic structures, it was reported, but in multiple assemblies titanium would be very size-competitive.

Titanium's advantages include its high-temperature capabilities and its electronic versatility in compound form. The double oxides exhibit dielectric properties; those in the maximum oxidation state are very-high-resistivity materials. Those in the minimum oxidation state are near-metallic in properties. The intermediate oxides frequently display semiconductive properties.

To fabricate a thin-film titanium microcircuit, a thick film of very pure titanium is coated on an inorganic substrate, an interconnection pattern is electroplated into the metallized substrate, and the circuit pattern is photoetched from the metallized substrate.

Selected areas of the titanium film then are converted into resistive or dielectric material. An anodic technique in which the electrolyte and the electrical process param-



**Glass-sealed diodes** made at CBS Laboratories have only the tantalum electrode portion of the diode sealed in glass rather than the entire side.

eters determine the resulting characteristics is used to produce these materials. Component values are continuously monitored during processing.

The dielectric material thus formed has a value of 0.01 mfd/cm<sup>2</sup>, with dissipation factor less than 1 per cent. Capacitors are formed by the addition of a counter electrode. Mr. Fuller predicted that active elements eventually would be produced from titanium compounds. Polycrystalline diodes already have been made.

#### Surface-Passivated Planar Transistor For Low-Power Systems Draws 1 $\mu$ a

Another development in microminiaturization was described by W. W. Gaertner, CBS Laboratories, Stamford, Conn. CBS has developed a double-diffused surface-passivated planar silicon transistor that provides current gain when supplied with as little as 1  $\mu$ w of power (*ED*, Oct. 25, 1961, p 26).

The design goal was said to be the lowest possible junction capacitance. This required an extremely narrow junction and development of materials processing techniques able to produce it. Capacitance at 0 v was said to be 2.6 pf for present models and, it is hoped, as little as 0.6 pf in future transistors. Current gain of 2.2 at 1  $\mu$ a collector current and 1 v has been measured.

The transistors have been designed into experimental counters, adders, and small-signal amplifiers, Mr. Gaertner reported. He said a three-bit serial multiplier containing 150 low-power transistors is nearing completion. It will require only 100  $\mu$ a less than 1  $\mu$ w per transistor, and will operate at 10 kc.

The limitations on speed imposed by the low capacitance involved was said to be unimportant for most space applications, especially in view of the weight saved through elimination of cooling equipment.

The transistor work is part of a CBS program that includes research on micropower backward diodes and thin-film tunnel diodes operated in the linear region of their characteristic curve as resistors. The tunnel diodes consist of a 10-mil-thick Si-Si<sub>3</sub>O<sub>4</sub>-Si sandwich mounted on transistor headers.

Another part of the program is a study of direct-glass-to-silicon hermetic seals for diodes and transistors. The company reported

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5B3*	H.W. RECT. (to 36 000 Ft.) CLIPPER DIODE	2.5	4.9	17,000	0.250	0.065
	(to 36 000 Ft.)	2.5	4.9	15,000	4.0	0.240
3B24W 3B24WA*	H.W. RECT. (HALF FIL.) (FULL FIL.)	2.5	3.0	20,000 20,000	0.150 0.300	0.030 0.060
	CLIPPER DIODE	2.5	4.75	15,000	8.0	0.020
3B20	H.V. RECT. (OP. 1)	2.5	4.9	16,000	0.250	0.065
	(OP. 2)			7,700	0.300	0.080
	(OP. 3)			5,000	0.300	0.095
4B31*	CLIPPER DIODE	2.5	4.9	10,000	8.0	0.018
	H.W. RECT. CLIPPER DIODE	5.0	5.0	16,000 16,000	0.470 12.0	0.150 0.060

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## NEWS

### NEREM . . .

(continued from p 5)

it has selectively sealed silicon planar diodes so that only the tungsten electrode on one side of the wafer is covered by the hard glass. A recently announced process developed at International Business Machines Corp. coats one entire side of a diode (*ED*, Oct. 25, 1961, p 22).

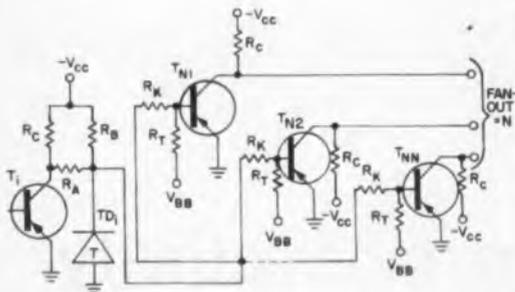
#### Ordinary TWT Superheterodynes Beams From Lasers for Microwave Demodulation

Prof. A. E. Siegman told an interested NEREM audience that he and other scientists at Stanford University have been demodulating coherent beams from optical ruby masers with an ordinary traveling-wave tube. They did this by focussing beams from a local optical oscillator and from another optical source on the photocathode of the twt. Photocurrent produced by the cathode has a frequency equal to the difference of those of the two impinging beams.

In the Stanford experiments, the laser signal contained multiple modes and was modulated by taking out some of the beats. The phototube demodulation technique was said to be applicable to any of the other types of optical modulating systems, such as the electro-optic-effect schemes using crystals.

The main advantage cited for the phototube method was its wideband characteristic—it demodulates at microwave frequencies and produces coherent and nearly monochromatic signals. The experiments were performed with a tube operating in the 2-to-4-Gc region. Other advantages were described as a very-high-frequency potential, built-in amplification, good sensitivity and suitability for fm signals. A microwave discriminator phototube for demodulating fm-coherent light was built at Stanford. It uses a crystal to disperse the incoming signal on the photocathode.

Though an ordinary barium-strontium-oxide cathode was used, Prof. Siegman said materials with better photon emission yields would be highly desirable. Sylvania Electric Products, Inc., Mountain View, Calif., is preparing commercial versions of a photo twt suitable for experimental use. These tubes, which are being evaluated now, operate in the 1-4-Gc region and have a cathode that is easily seen through the tube's glass envelope. They probably will be permanent-



**Hybrid circuit** using transistors and a tunnel diode to implement fan out in an inverter designed to drive  $n$  loads was described at NEREM by Philco engineers. Advantage of the hybrid logic is its operation at milliwatt power levels. In this circuit the GaAs tunnel diode provides two discrete voltage states for triggering the high-speed Gc transistors. Backward diodes insure unilateral operation of the tunnel diodes.

magnet focussed, straight-field devices.

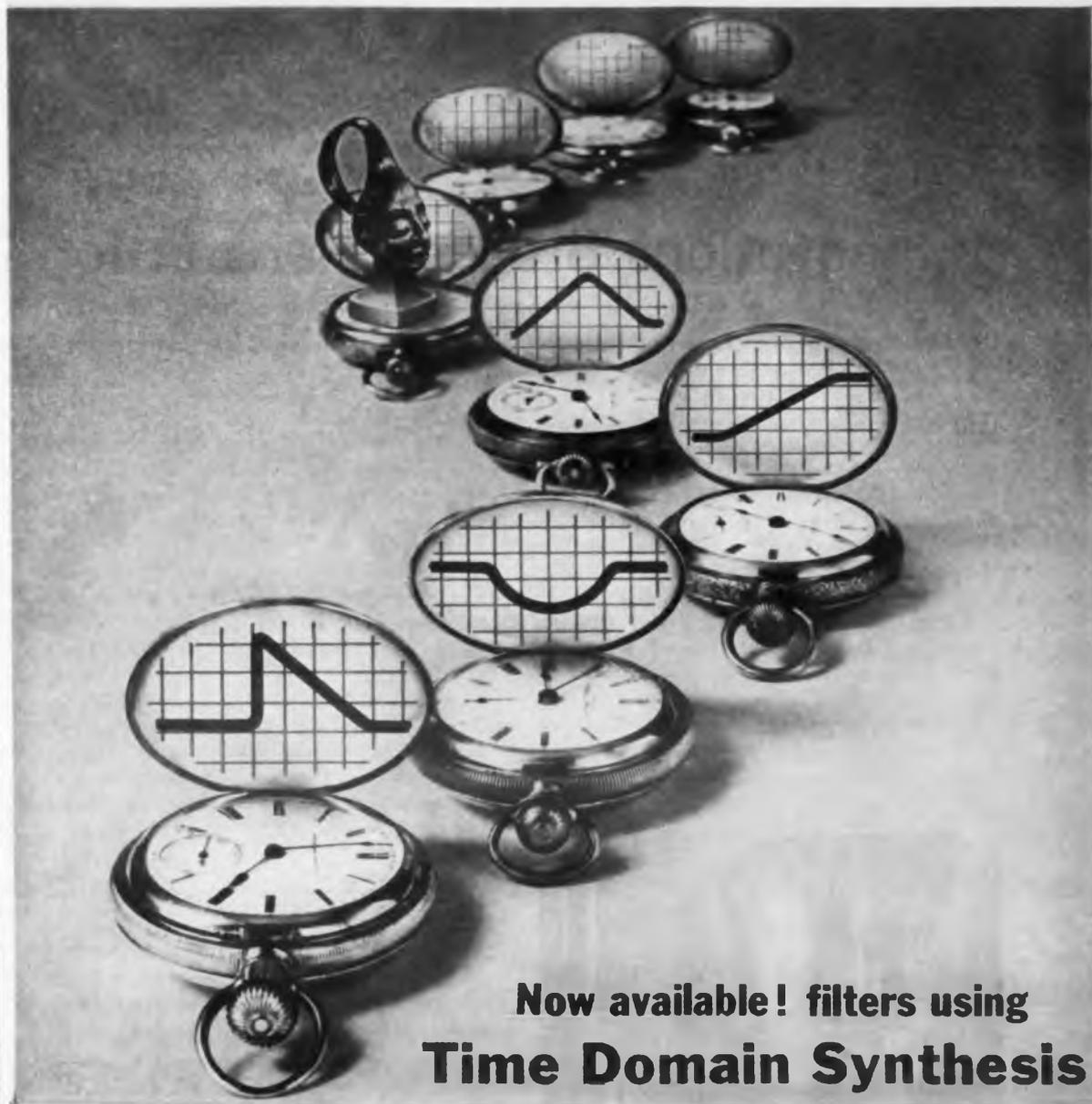
A debate between adherents of linear-beam and cross-field superpower microwave tubes demonstrated that both schools still have a few developmental tricks up their sleeves.

For the cross-field forces, W. C. Brown of Raytheon proposed a tube concept called the electromagnetic amplifying lens. This tube would be an inside-out rotating field Amplitron of fairly long coaxial structure with the cathode outside and the anode inside.

The anode would be formed of numerous skewed slots extending down the length of the tube. Rf input would be through a metallic lens admitting energy to each anode slot in correct phase. In traveling down the length of the tube, the rf would be amplified in a fast-wave interaction and collected at the output by a second metallic lens. The tube would be a direct radiator with a radome at the output in lieu of the conventional, power-limited output window.

Dr. Brown, associate director of Raytheon's Microwave Tube Div., predicted that the efficiency of the lens concept will permit tubes several orders of magnitude more powerful than the Amplitron and at a cost well below \$10 per kw cw.

Linear-beam advocates were represented by T. D. Sege, chief engineer of Sperry's Electronic Tube Div. He noted that the inherently higher gain and bandwidth of linear-beam tubes might outweigh the efficiency of cross-field devices. Multiple-cavity, extended-interaction-region klystrons were proposed as an approach to increasing the efficiency and output of linear-beam tubes. Conduction-cooled twts, Mr. Sege declared, are attaining power levels comparable to klystrons and bandwidths of more than 30 per cent. ■ ■



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## 2 Innovations Broaden Horizon for Thermoelectricity

*RCA's Silicon-Germanium Alloys Suited for High-Temperature Operation;  
New Brazing Material to Improve Joining of Thermocouples, Conductors*

**W**IDESPREAD use of thermoelectric devices has been brought closer by the discovery of materials for high-temperature operation, and an improved brazing material for joining thermocouples to conductors.

The high-temperature materials—heavily doped alloys of silicon and germanium—were discovered by RCA's David Sarnoff Research Center, Princeton, N. J. The new brazing material, called Generallock, and a process for making joints with it, were developed by General Instruments Corp., Newark, N.J.

The RCA alloys have figures of merit, or  $Z$ , of  $1 \times 10^{-3}$  for n-type and  $0.6 \times 10^{-3}$  for p-type, according to Dr. Fred D. Rosi, associate director of the materials-research lab-

oratory at the center. The p-type figure is smaller because of the densities of states—the effective mass of holes being less than that of electrons. The  $Z$  curve remains fairly flat over the 400- to 850-C region, Dr. Rosi said.

The material has a density about a third less than that of other common thermoelectric materials. It also is said to have high mechanical strength and good stability at high temperatures. Power density of the new alloys, Dr. Rosi estimated, is about 1.5 w/gm. Variation of doping levels permits tailoring of characteristics of the resulting alloys.

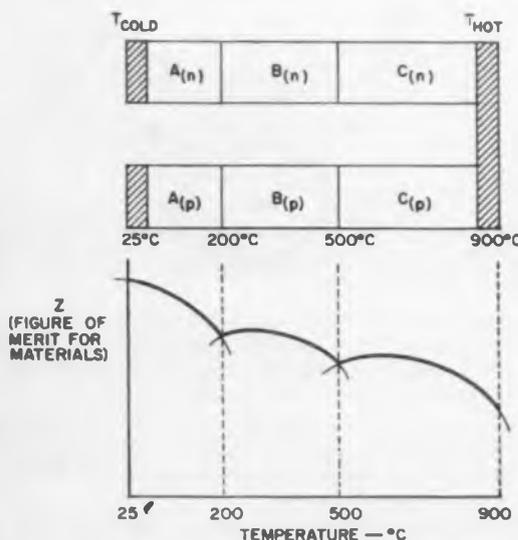
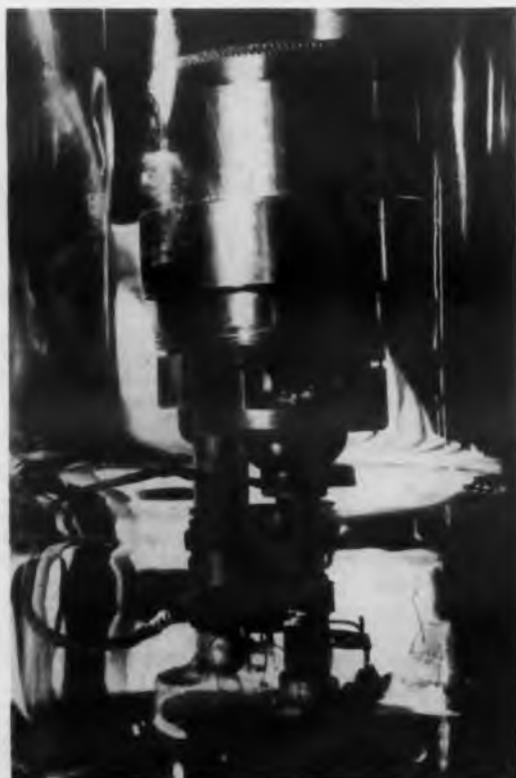
Discovery of the new GeSi alloys came as a by-product of RCA research on thermal

transport in semiconductor materials at high temperatures. Measurements made by a special thermal diffusivity technique are said to be accurate within about 2 per cent up to the melting point of silicon—about 1,400 C. These measurements showed heat conductivity at high temperatures to be much lower than had been expected.

RCA plans to use the new alloys in thermoelectric sandwich modules, as shown in the diagram. This allows materials that have peak efficiencies in different temperature ranges to be used at the range where the peak occurs. Bonding within the sandwich will be done with special low-resistance bonding materials developed by RCA's Tube Div., according to Dr. Rosi. The bonds should be as stable as the new materials.

Thermoelectric power developed by the alloys in the 400-500-C range is said to be about 250 to 325  $\mu\text{V}/\text{C}$ , and in the 600-800-C range about 300 to 325  $\mu\text{V}/\text{C}$ .

The brazing material developed by General Instrument is intended to overcome one of the main difficulties in present thermoelectric design: high loss in efficiency at the junctions between n- or p-type elements and the metal conducting strip joining the two.



**High-temperature** tests are performed on new RCA thermoelectric materials, made from heavily doped silicon-germanium alloys, in glass-enclosed vacuum chamber at left. Sandwich construction using materials with peak efficiencies at different temperature ranges is shown above. Type C, at the high-temperature end of the thermocouple, would be the new silicon germanium alloy.

### Thermoelectric Figure of Merit-Z

Since efficiency of thermoelectric materials depends on measurement temperature, a factor proportional to efficiency, but independent of temperature, has been developed. This factor,  $Z$ , is defined as:  $Z = S^2/\rho k$ ; where  $S$  is the Seebeck coefficient in  $\text{mV}/\text{C}$ ,  $\rho$  is electrical resistivity in  $\text{ohm-cm}$ , and  $k$  is thermal conductivity in  $\text{w/cm}^2/\text{C}$ . Thus high values of  $Z$  are obtained for materials with high Seebeck coefficients (or thermoelectric power), low thermal conductivity and low resistivity.



**Powdered brazing material** developed for joining thermoelectric elements to conductors is shown being applied to an element surface. Low-junction resistance without degradation of junctions through changing of doping levels are said to be achieved with the new General Instrument material.

Brazing materials used for making these bonds have caused gradual deterioration of the junction by changing the doping level of the thermo-electric material. In some cases this has been avoided by the use of spring-loaded junctions between carefully prepared surfaces. But in this case gradual oxidation caused junction resistance to rise.

Generallock, the new brazing material, is said to provide a very low-resistance bond that does not affect doping levels in thermoelectric elements. Composition of the new material was not disclosed by General Instrument, but several characteristics of the new material were given. It is said to have a Z factor of about  $1 \times 10^3$  in "the temperature range of interest." It can be prepared commercially in the form of powder, strip or disc.

Joints are made by applying Generallock to junction points and raising temperatures under a controlled atmosphere. The brazing material is said to melt and flow freely at temperatures below those of the thermoelectric materials themselves.

The resulting joints, General Instruments said, maintain low resistivity up to 1,100 F. They are also said to be stronger.

General Instrument expects to license the process and the use of Generallock to manufacturers of thermoelectric devices. Generallock is described as applicable to both generator and Peltier cooling applications. ■ ■

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## NEWS

### SIGNIFICANT BITS

*Important news items for electronic designers written for fast scanning.*

**An alarm-radio** that sounds a warning and automatically tunes in to a station for instructions in case of enemy attack has been developed by General Electric Co., Schenectady, N.Y. The table radio uses two GE Compactron multi-function devices instead of the five tubes a similar receiver would require. The radio, demonstrated to the Office of Emergency Planning, is designed to operate in conjunction with the proposed National Emergency Alarm Repeater system (NEAR).

0001

**Satellites might land and take off** from space stations with the help of magnets, in the view of Dr. Elliott T. Benedikt of Northrop Corp.'s Norair Div. space physics laboratory. With a power source in the satellite and electric coils around the hull, Dr. Benedikt reasons, the vehicle can be attracted to or repelled from a space platform by changing the polarity of the resulting electromagnetic field.

0010

**Four 50,000-w transmitters**—three of them short-wave and one medium-wave, will be included in a mobile radio-relay station ordered by the U. S. Information Agency. The units will be equal in power to four large commercial stations. A contract for \$1,340,970 went to Alpha Corp., Richardson, Tex., a division of Collins Radio Co., Dallas. The air-transportable facility, has long-range receivers, studios, workshops, microwave-communications systems, sectionalized antennas, transmitters and generators.

0011

**Nickel-cadmium batteries** aboard Courier 1-B are still operating despite months of continued over-charging, according to the Army Signal Corps. Communication with the satellite, launched Oct. 4, 1960, ceased soon after launching—probably due to failure of

some device in the interrogation system. A tracking beacon, however, continues to transmit from the vehicle, even during the dark-side portion of its orbit. The solar cells aboard the vehicle supply some 80 w of power to the batteries, while the beacon draws only 12 w.

0100

Analog-computer tests have saved a British manufacturer substantial time in designing packaging for the Seacat ship-to-air guided missile. Short Brothers & Harland, Ltd., Belfast, simulated the physical properties of shock absorbers designed to support the missile inside a packing case. Electric current representing the velocity of impact of the case hitting the ground was fed into the circuits. Output currents then were used to assess the movement of the missile under stress.

### More Punch for Polaris



A tiny accelerometer, expected to be a key to increasing Polaris range from 1,200 to 2,500 miles, is assembled in a sterile laboratory at Sperry Gyroscope Co., Great Neck, L. I., N. Y. The company is producing sub-miniature prototype models of the new MIT-designed devices for a smaller, lighter and more accurate missile-guidance system. The accelerometers can sense and measure changes in the velocity of the missiles in flight.

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- Low  $I_{CBO}$
- Matched Pairs Available

TYPE	Min. $V_{CBO}$ (Volts)	Max. $I_{CBO}$ ( $\mu a$ )	Max. $V_{EC}$ (mv)	Min. $h_{FE}$	Max. $C_{OB}$ (pf)	Min. $f_r$ (mc)
2N2162	30	.01	2	20 at 1 kc	10	14
2N2163	15	.01	2	20 at 1 kc	10	14
2N2164	12	.02	1.5	25 at 1 kc	10	24
2N2165	30	.02	3	2.5 at 4 mc	10	10
2N2166	15	.02	3	2.5 at 4 mc	10	10
2N2167	12	.02	2.5	4 at 4 mc	10	16

For application engineering assistance without obligation, write Transistor Division, Product Marketing Section, Sprague Electric Co., Concord, N. H.

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

### SPRAGUE COMPONENTS

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CAPACITORS  
MAGNETIC COMPONENTS  
RESISTORS

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PULSE TRANSFORMERS  
PIEZOELECTRIC CERAMICS  
PULSE-FORMING NETWORKS

HIGH TEMPERATURE MAGNET WIRE  
CERAMIC-BASE PRINTED NETWORKS  
PACKAGED COMPONENT ASSEMBLIES  
FUNCTIONAL DIGITAL CIRCUITS





METOHM precision resistors in handy protective "pop-out" package of ten.

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Now Ward Leonard offers you the same uncompromising quality, the same superlative reliability in a metal-film precision resistor that you've come to know and expect in Ward Leonard power resistors.

Ward Leonard METOHM molded metal-film precision resistors exceed the requirements of MIL-R-10509D, characteristics B, C, and E. Standard METOHM resistance tolerances are  $\pm 1\%$ ; tolerances to  $\pm 0.05\%$  on special order.

METOHMS exceed wire-wound precision resistors in high-frequency performance yet are smaller and lighter weight. And, they far excel other types of precision film resistors in low, and controllable, temperature coefficient of resistivity. Moreover, these low TC's apply over the entire range of resistance values. 20

METOHM TYPE	MIL EQUIVALENT	RATED WATTS	OHMIC VALUES		MAX. VOLTAGE RATING
			MIN.	MAX.	
WL 60	RN 60	1/2	30	500K	250 V.
WL 65	RN 65	1/4	50	1 meg.	300 V.
WL 70	RN 70	1/2	50	1.5 meg.	350 V.

You'll find full data on METOHM resistors in Ward Leonard Catalog No. 50. Write for your copy and a list of distributors today. Ward Leonard Electric Co., 77 South Street, Mount Vernon, New York.



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CIRCLE 11 ON READER-SERVICE CARD

## NEWS

### Infrared Camera Spots Malfunctions

*Photographic Method Used to Measure Radiation Power Emitted By Overheated Components, Circuits*

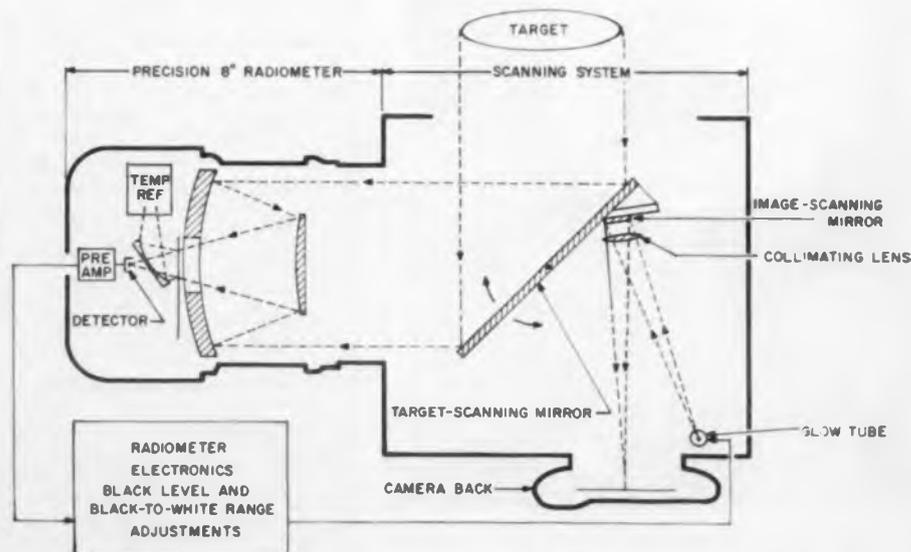
**B**Y PHOTOGRAPHING a circuit board with an infrared scanning camera, engineers can, within 10 to 60 sec, detect overheated components. This infrared technique is presently being used by engineers at International Business Machines Corp. to measure temperature levels on computer printed-circuit cards.

Designed and manufactured by Barnes Engineering Co., Stamford, Conn., the camera has many applications. For example, IBM engineers say the equipment is extremely effective in testing crowded printed-circuit boards or components that normally are inaccessible when in op-

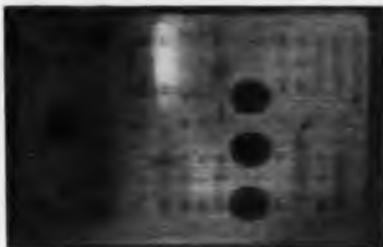
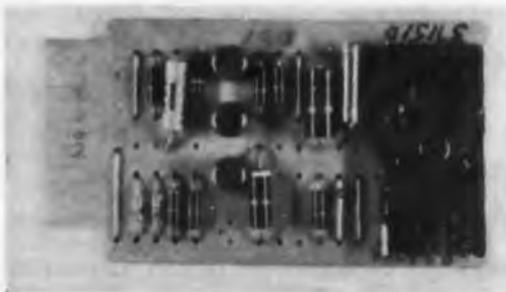
eration. Immediate effects of such a testing operation would be increased circuit life and reliability, and lower manufacturing costs.

The infrared-camera can check the heat distribution over an entire assembly and indicate if and where modifications should be made to the unit's cooling system. The device readily can indicate that certain heatsinks will be inadequate for keeping over-all temperatures within limits.

The camera's optics system uses a target-scanning mirror, which views the target in small increments, since the field of view of the detector is 1 by 1 milliradian. These increments



Radiation power emitted from the target is projected by the optics system into the radiometer. There the radiation is converted to an ac signal, which is amplified several thousand times. A glow-modulator tube in the image-scanning system converts this signal to visible light, which is proportional to the radiation of the target. Depending on the film, a target can be photographed within 10 to 60 sec after scanning. Total scanning time ranges from 6.5 to 13 min, depending on the size of the target.



By comparing a conventional photograph (top) with the infrared photo, the overheated unit easily can be detected. In the infrared photo, the four black circles represent relatively cold transistors while the white area, top center, shows a hot resistor.

measure 0.12 in. by 0.12 in. at a distance of 10 ft from the camera. The mirror moves horizontally from left to right, while slowly tilting in the vertical direction. As the mirror returns quickly to its initial position, the electronic picture is blanked out; thus, the camera produces a horizontal raster similar to that seen on a television receiver. With this technique, the camera will make up to 60,000 individual temperature measurements in the scanning period.

Light and other extraneous signals are eliminated by a filter in the radiometer, which screens out wavelengths shorter than 1.8 microns. A "mirror-chopper" alternately shows the target radiation and the known radiation standard. This produces an ac signal proportional to the difference between the unknown radiation and the known. After amplification, the target signal, now expressed as volts/radiation watt, is processed through a constant-current driver amplifier whose output is a current signal that drives the glow-modulator tube. ■ ■

## LOW COST / SILICON 2N957

Fairchild Industrial Transistor for

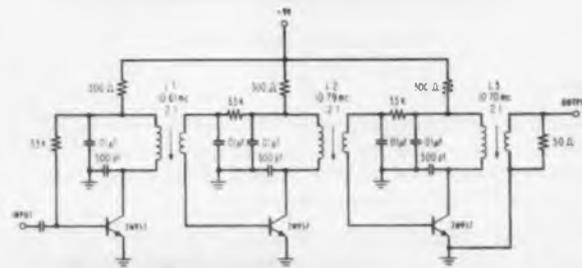
- VHF AND IF AMPLIFIERS
- OSCILLATORS
- MIXERS AND CONVERTERS
- HIGH SPEED SWITCHING CIRCUITS

### FAST SWITCHING—HIGH FREQUENCY—200 mc GAIN BANDWIDTH

First low cost, high frequency NPN silicon transistor on the industrial market, the Fairchild 2N957 is rated at 0.8 watts (25° C case temperature) and 0.3 watts (100° C case temperature). Guaranteed parameters include:  $BV_{CBO}$  of 40 volts;  $BV_{CEO}$  of 30 volts;  $BV_{EBO}$  of 3.0 volts; minimum D.C. Beta of 45; minimum A.C. Beta at 1 mc of 40; maximum  $C_{ob}$  of 6.0  $\mu\text{f}$ .

The Fairchild 2N957 offers silicon performance—higher reliability, broad temperature range, parameter stability—at low cost. This enables you to build amplifiers, oscillators, mixers, converters, and switching circuits with silicon advantages at no price premium. Contact your Fairchild Distributor or sales office for off-the-shelf delivery.

A 2N957 APPLICATION:  
10.7 MC, STAGGERED, TRIPLE TUNED IF AMPLIFIER FOR F.M.



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# Which AC/DC digital voltmeter should you buy?

...seven questions to help you decide

## 1. Is it reliable, dependable?

A rather general question, and one you often get rather general answers to. But with such an important consideration, you should get answers like these:

The stepping switches in the KIN TEL 502B AC/DC digital voltmeter are guaranteed for two years. KIN TEL can make this guarantee because it operates stepping switches conservatively, driving them with DC (as in telephone service) at a rate somewhat below their peak speed. This gentler drive gives the 502B a longer life, makes it capable of more sensitive measurements, eliminates the need for stepping switch adjustments or other maintenance, and greatly reduces down time.

When servicing is ultimately needed, KIN TEL-trained personnel in 22 different maintenance shops throughout the country are prepared to put your 502B in factory condition with minimum delay.

Each 502B is manufactured on a true production-line basis. KIN TEL has used this method in building over 10,000 "standard-cell-accuracy" instruments, instruments known for their consistent, trouble-free performance.

## 2. Does it have automatic range selection for AC and DC?

Auto-ranging is a convenience. It makes your job a little easier, a little surer. It permits unattended operation with a printer to record voltages on the range giving the best resolution.

The KIN TEL 502B has it.

## 3. Does it have a single-plane readout?

A single-plane readout reduces reading errors. Each number is displayed individually. There are no superimposed outlines of "off" digits. You can read the numbers as easily from the side as from the front.

The KIN TEL 502B has a single plane readout.

## 4. Can you program it?

A programmable instrument is a more useful instrument. It can be used with a printer for unattended checkout of missile components, quality control of specific items, and other automated measurements.

You can program the 502B. It's one of the two standard, off-the-shelf digital voltmeters controllable by remote contact closures. With the AC converter control set to REMOTE, closures command any desired sequence of measurements at 10-volt AC, 100-volt AC, 1000-volt AC, auto-range AC, or auto-range DC.

## 5. Will it over-range on both AC and DC?

A loaded question, perhaps, since the KIN TEL 502B is the *only* digital voltmeter on the market with 100% over-ranging on AC and DC. But this is an important feature, not just an extra one.

The 502B displays 4 complete digits plus a 5th over-ranging digit (0 or 1). This 5th digit gives ten times more resolution at the often-measured decade points (1, 10, 100 volts) than 4-digit voltmeters that lose a digit changing from .9999 to 1.000. This means you get the useful accuracy of a 5-digit voltmeter over a large part of the measurement range while retaining the stability, reliability, and price advantage of a 4-digit instrument.

## 6. Does it offer the highest accuracy?

Of course, none of the features listed so far are worth a dime if you can't depend on what the instrument tells you. So let's be specific:

With the 502B, DC measurements are accurate to within .01% of reading  $\pm$  one digit. AC accuracy is the highest in the industry — within 0.1% of reading or  $\pm$  3 digits (0.03% of full scale) for signals between 30 cps and 10 kc up to 10,000, 100.00, or 1000.0 volts on the respective range scales. With manual or programmed ranging, this same accuracy is maintained up to 15,000 or 150.00 volts for signals between 50 cps and 7 kc.

This accuracy is maintained by a constant and automatic calibration of the metering circuit against an unsaturated mercury-cadmium standard cell.

## 7. Is it worth what it costs?

The KIN TEL 502B costs \$4245, and is delivered from stock. Compare it — what it does and what it costs — with any other AC/DC digital voltmeter. We think that when you do, the 502B will rate the same answer on this question that it has on the other 6: yes.



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on this exceptional voltmeter.  
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## NEWS

# Voice Recognizer Knows 16 Words

*Small Experimental Model Uses Only 31 Logic Units*

A SMALL experimental instrument has been developed to perform arithmetical operations by responding to vocal commands. Called "Shoebbox," the speech-recognition device recently was demonstrated at the headquarters of International Business Machines Corp. in New York City.

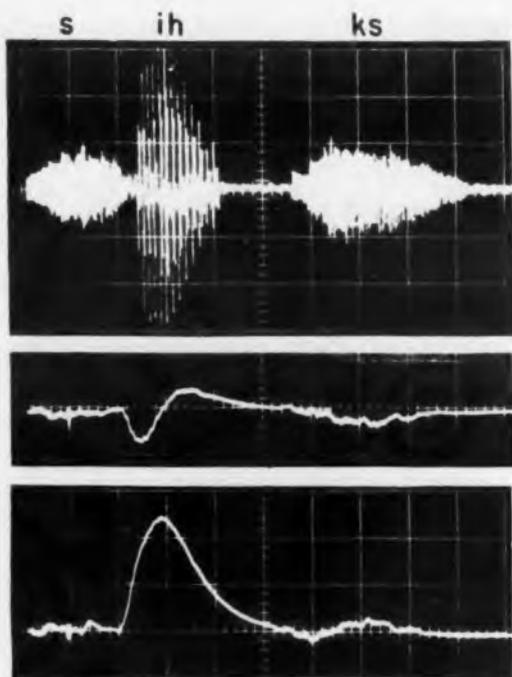
The unit, actually smaller than a shoebbox, recognizes up to 16 complete words, which include 10 digits (zero to nine) and six word commands: plus, minus, subtotal, total, false, and off. As demonstrated by Dr. W. C. Dersch, inventor of Shoebbox and an IBM development engineer, the machine will recognize the digit, follow the given command and instruct an adding machine to calculate and print out solutions to basic arithmetic problems.

## Device Employs Asymmetrical Character of Voice Waveforms

Shoebbox uses a novel recognition principle, which is not based, as is the human ear, on frequency measurement, but on phase information. Shoebbox distinguishes voices from other sounds by observing the asymmetrical properties of portions of the speech waveform. It was emphasized by Dr. Dersch that these properties apply almost exclusively to voiced waveforms and, as a result, Shoebbox can recognize machine-vocabulary words in ambient-noise conditions. In Shoebbox, this asymmetry characteristic is magnified by passing the voice waveform through an all-frequency-pass phase-shift filter. These effects are shown graphically on the accompanying oscillographs.

A 90-degree relative phase shift of the critical parameters is typical for frequencies under 1,000 cycles, Dr. Dersch said. Further information on the phase-shifting operation was not disclosed.

Operation of Shoebbox is relatively simple. A microphone converts the speaker's voice into electrical impulses. These impulses will energize specific logic elements in Shoebbox's recognition circuit which, in turn, energizes the appropriate key on the adding machine.

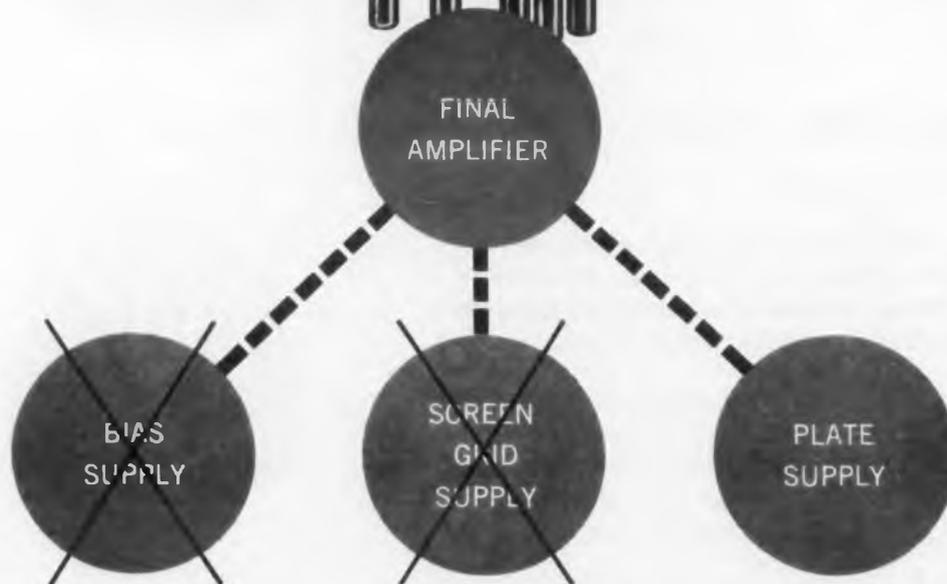


In the time-energy distribution of the spoken word "six" (top waveform), it is not apparent that asymmetry exists, i.e., that the positive peaks of the waveform are greater in magnitude than the corresponding negative peaks. After summing the envelopes of the positive and negative peaks, however, asymmetry can be determined (center waveform). To enhance the asymmetry characteristic and, accordingly, improve voice identification, the speech wave is passed through a phase-shift filter (bottom waveform). Since only voiced sounds produce a consistent unipolar asymmetrical envelope, this phase-shifting process allows Shoebox to identify vocabulary words even in ambient noise conditions.

In recognizing vocabulary words, Shoebox uses two identification techniques, each based on fundamental characteristics of the spoken word. The first process takes advantage of the two distinctive elements in the spoken word: sounds formed in the speaker's larynx (voiced sounds), and sounds formed by air escaping through the speaker's lips, tongue, or teeth (friction sounds). Since Shoebox's logic circuit can detect these distinctions, it can divide the word into three sounds, or units. The middle unit always is a voiced sound, and the first and last units are friction sounds.

Using this segmentation process, and making further distinctions as to the strength of the friction sounds, Shoebox can recog-

(continued on p 16)



### Cross off two power supplies with one of Eimac's new zero-bias triodes!

Another major advance from Eimac: the first high power zero-bias triodes anywhere. Just one of these new tubes will eliminate *both* screen grid and bias power supplies to simplify your circuit designs. Take your pick of the 3-400Z, shown above actual size, (plate dissipation: 400 watts) ... the 3-1000Z (1000 watt plate dissipation) ... the ceramic-metal 3CX10,000A7 (10,000 watt plate dissipation). Each offers a power gain of over *twenty times* in grounded grid service. And their small size accommodates today's lower, more compact equipment. You'll find these zero-bias triodes ideal for class B RF and audio amplifiers. And you'll find them *only* at Eimac... world leader in transmitting tubes. For ratings, specifications, other details, write: Power Tube Marketing, Eitel-McCullough, Inc., San Carlos, California.



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CIRCLE 15 ON READER-SERVICE CARD



## NEWS

### Shoebox . . .

(continued from p 15)

nize several of its vocabulary words.

Because many of the vocabulary words are similar in sound construction, and because of the usual presence of ambient noise, Shoebox uses a second recognition technique—the previously discussed measurement of the asymmetry characteristic of voiced sound. According to Dr. Dersch, registration, as the latter technique is called, actually could identify all words in the vocabulary, but it would seriously complicate the logic circuitry. As a result, the techniques supplement each other.

#### Shoebox Breaks Down Friction, Voiced Sounds

In recognizing the word "six," for example, an indicator identifies the first sound, "s," as strong friction, and transfers this data to a storage relay. The second sound analyzed as "ih," is voiced and energizes the voicing indicator. Since voicing is now determined, the signal in the "hold" relay is transferred to a relay labeled "strong-frictional early." The last syllable "ks" energizes the "strong-frictional late" relay. The combination of the three relays electronically defines "six."

Dr. Dersch asserted out that Shoebox is the smallest speech-recognition device to date. The circuitry employs only 31 logic units or 2 units per vocabulary word. Ac-

### Missile Programmer Tolls Church Bells

Church bells in three California edifices are being electronically activated by a device that normally programs missile blast-offs.

The eight-pound programmer can take nearly five hours of pre-punched taped information and performs 13 independent switching functions. The device is made by Beattie-Coleman, a division of Coleman Engineering Co., Los Angeles. In military applications, it relays information to ground-support equipment used with the Air Force's Titan and Navy's Terrier and Polaris missiles.

tually, Shoebox's design is a refinement of "Suitcase," a voice-recognition device developed by Dr. Dersch in 1960. Suitcase was limited to recognition of 10 digits and required 10 logical units per recognized word.

IBM announced that there are no immediate plans for manufacture of Shoebox, but the device is considered to be the forerunner of larger voice-responsive systems. Dr. Dersch's ultimate goal in these experiments is the design of a voice-responsive machine with a 10,000-word vocabulary. These devices would be extremely effective in such applications as stock inventory, customer-order-number data, personnel number data, teaching machines or composing typewriters. ■ ■

### Another Segment Completed In AF Communication System

The Air Force recently announced completion of a new link in the Defense Communications System, connecting Anchorage, Alaska, with Shemya at the western tip of the Aleutians.

The new segment, designed to provide instantaneous rearward communications from the Air Force installation at Shemya, consists of a three-station tropospheric-scatter radio-relay network between Nikol'ski and Shemya. The segment engineered, installed and tested by Western Electric Co., New York, ties into existing Alaskan communication networks from Anchorage to Nikol'ski.



Klystron carrier, which is part of the Aleutian communications project, is unpacked and assembled by Western Electric engineer.

**this failure-proof  
3 amp glass diode**

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**STACKS\*** to 20,000 Volts at 125°C

**BRIDGES\*** to 2 amps and to 5,000 Volts  
SINGLE AND 3 PHASE

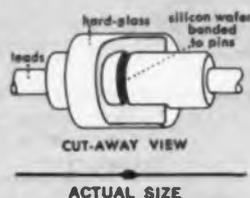
Unitrode starts with its famous diffused silicon glass diode, having a body length of only .135" and diameter of .080". This tiny diode conducts 3 amps, takes voltage spikes to 5,000 volts, operates up to 250°C, and withstands 10 watts continuous overloads — without heat sinks. Unitrode matches, assembles and pots these diodes into space-saving stacks and bridges offering maximum performance and reliability.

\*Shown actual size — 5,000 Volt stack, 800 Volt bridge.

**UNITRODE STACKS** — high voltage rectifiers. Unique resistance to voltage spikes and ability to sustain overloads mean no need to string on capacitors and resistors to balance out the network.

**UNITRODE BRIDGES** — single phase and three phase full wave bridge rectifiers, bridge modulators, phase sensitive detectors, and suppressed carrier modulators.

Both faces of the silicon wafer are bonded throughout their entire surfaces to the terminal pins. A hard glass sleeve is fused to all exposed silicon and terminal pin surfaces to positively exclude any space, air, or contaminants.



The Unitrode glass diode takes high forward current, because the heat generated in the junction is quickly dissipated through the terminal pins, and the glass fused to the silicon permanently stabilizes its super-clean surface. There is no whisker to burn out. All materials are stable to over 600°C.

Available in standard configurations shown, or TO-5 and other miniature packages and mounting styles. A selection of lead materials for soldering and welding, lugs, or plug-in pins.

The Unitrode glass diode withstands up to 5,000 volt inverse transients, because it conducts zener current with no degradation until the transient voltage drops to the rated level. Elimination of voids prevents internal arcing.

Unitrode assemblies, available for prompt delivery, include these ranges: Stacks—from 1000 volts to 20,000 volts, 25 ma to 2 amps. Bridges — from 50 volts to 5,000 volts, 25 ma to 2 amps. Write for full information. Special electrical and mechanical requirements quoted promptly.

Unitrode stacks and bridges conduct up to 2 amps at 125°C, because of the high temperature materials used and the high thermal conductivity of the package. No heat sinks are required. The one-piece diode construction insures a rugged mechanical package, unaffected by shock or vibration.

**Unitrode**

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able. All Inland products are backed by extensive experience . . . thorough quality control, reliability, and field testing . . . successful performance in practically every major missile and space vehicle program. For details, complete specifications, and illustrated brochure, write Department 312

Standard Model Specification Range from smallest to largest torque motors*		
FRAME SIZE	1.3 INCHES	36.0 INCHES
Peak torque, lb.-ft.	0.1	3000
Volts at peak torque, stalled at 25°C	48	246
Amps at peak torque	1.21	30
Sensitivity, lb.-ft./amp	.09	100
Temperature rise per watt, ultimate, °C	13.4	0.04
Total friction, lb.-ft.	0.003	18
Ripple torque, pound-feet		
At low torque levels	0	0
At peak torque	0.1	trace
Weight, lbs.	0.313	1200

\*Numerous sizes available in between. Non-Standard sizes designed to meet specific requirements in these ranges and larger.

# INLANDMOTOR

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## NEWS

### PCM Telemetry Set For AT&T Satellite

*3 Decommutation Sites to Handle  
Data from Telstar's 118 Channels*

**T**ELSTAR, American Telephone & Telegraph Co.'s experimental communications satellite, will employ pulse-code-modulation (pcm) techniques in its telemetry system.

Bell Telephone Laboratories has received the first of three pcm decommutation stations from Electro-Mechanical Research, Inc., Sarasota, Fla., and has awarded a contract to Radiation, Inc., Melbourne, Fla., for the design and development of an airborne pcm/fm telemetry system for Telstar. Launching of Telstar is expected next spring.

The equipment from Electro-Mechanical Research will process data transmitted by the satellite on 118 channels. These channels will handle such data measurements as temperature, voltages, vibration, radiation effects and other factors vital to the satellite's performance. Each decommutation system will receive, record, display and print this data.

Any of 16 data channels can be selected for analog display; 30 can be displayed via binary lights; and one channel can be presented in decimal form. To indicate possible malfunctions, each channel is compared with



**Pulse-code-modulation** equipment is checked out at Bell Laboratories' Hillside, N. J., test site. The unit is one of three to be used in American Telephone & Telegraph Co. satellite.

preset high and low limits. When these limits are exceeded, an out-of-limits mark is printed alongside the data.

The completed station now is at Hillside, N. J., while the two other systems will be installed at Rumford, Me., and Cape Canaveral. The latter station will be used for prelaunch checkout and launch telemetry. Data collected at the Rumford station will be placed on punched tape and relayed by teletype link to Murray Hill, N. J., for computer analysis.

#### Delivery of Airborne Unit Expected by Early 1962

The airborne pcm/fm telemetry system for Telstar will be designed for Bell Laboratories by Radiation, Inc. As specified by Bell, the telemetry system will have an RZ code output with an fm shift of 450 cps at 3 kc and will weigh 8 lb.

The telemetry unit is expected to multiplex and encode 77 high-level (0-5 v) channels and 14 medium-level (0-500 mv) channels. Satellite-aspect data and the effects of radiation on solar cells will be transmitted on 10 low-level (0-100 mv) channels. Three channels will check the calibration of the telemetry system.

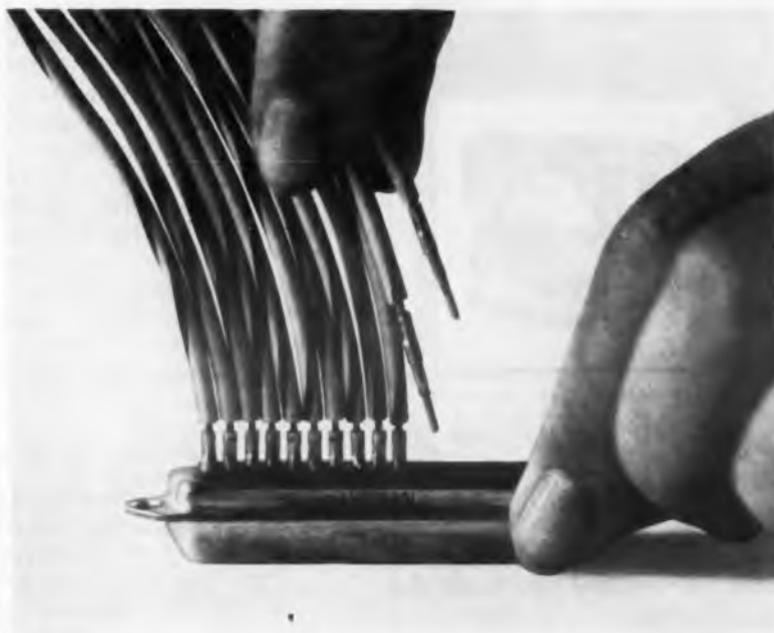
Different portions of four radiation-particle experiments will be represented by 14 multi-plexed digital channels. The telemetry system will decommutate and perform a radiation-particle check on each of the 14 channels.

Feedback current for the system will be less than 5  $\mu$ a. The basic bit rate for the telemetry system will be generated internally by a phase-shift oscillator to within 1 per cent of 16 cps. Word rate will be set at 2 cps with a corresponding frame rate of once a minute. The system will generate word and frame synchronization formats, each word consisting of 8 bits of information, 7 data plus 1 synchronization. Each frame consists of 120 words, two of these being a 7-bit Barker Code synchronization pattern and its complement, respectively.

The entire telemetry system can be activated by ground command into ON-OFF modes and either of its redundant coders can be selected for operation. Other specifications for the system include an accuracy rate within  $\pm 1$  per cent, with a low and medium accuracy within  $\pm 2$  per cent. Power dissipation will be less than 700 mw. Size of the unit is expected to be about 8 x 4-1/2 x 6-1/2 in. ■ ■

## Broad and deep

To benefit you, an electronic parts distributor must offer both variety and volume capacity. Amphenol Industrial Distributors in seventy key locations offer variety because Amphenol lines are amazingly complete. They achieve volume capacity by knowing from long experience which lines and styles must be stocked in depth. Here are just three examples:



#### Min-Rac 17<sup>®</sup> line

Have you heard about the new movement to stamp out close-quarter soldering? It's being spearheaded by Amphenol Min-Rac 17 connectors, the only miniature rack and panel connectors with Poke-Home<sup>®</sup> contacts. This money-saving feature permits you to do your soldering (or crimping) before the connector is finally assembled. It means you no longer have to hire midgets to wire 50 contacts in a connector not much larger than an air-mail stamp. Your

AID (Amphenol Industrial Distributor) carries shelf stock of these ingenious components.

#### RF Connectors, too

With the combining of the Amphenol and ipc lines, your local AID



is now able to offer a line of RF connectors that is unequalled for

## TAKING STOCK

depth and completeness. Your AID stocks just about every type of RF connector and can make them instantly available to you.

Same-day delivery is not at all unusual. Amphenol Industrial Distributors can provide this service by maintaining broad stocks *locally*, and by knowing which particular styles must be stocked in depth because of their popularity.

#### Borg Pots and Dials

Micropot<sup>®</sup> and Microdial<sup>®</sup> are two names you'll be hearing about more frequently. They designate two high



quality product lines now being stocked by many Amphenol Industrial Distributors. Micropots—or Borg precision potentiometers to be more formal—are known for their accuracy and reliability. Borg Microdials, in direct-reading digital or concentric scale types, are sister-components to Borg Micropots, and are also used for control of many other shaft-operated devices.

#### For More Information . . .

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- Min-Rac 17 Brochure
- RF Connector (Catalog IEC-4)
- Borg Short Form Catalog
- List of AIDs (Amphenol Industrial Distributors)



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THE NP5 SERIES CYCL-FLEX FOR  
TIME CONTROL

Yes, our New Cycl-Flex Timer is as easy to adapt and change as a simple electric plug.

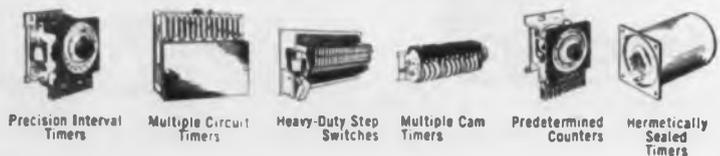
Don't let automation troubles get you down! . . . use our New Cycl-Flex for TIME CONTROL functions. Should your automatic controls fail for any reason, you can trace your trouble by plugging-in a spare timer. Movement of the TIME pointer indicates whether trouble is in the input or the output circuits.

Eagle's New Cycl-Flex Timer has been enthusiastically adapted by leading manufacturers of molding presses, dielectric heaters, machine tools and feed controls.

Write for Bulletin 125 or call your local Eagle Representative. He's listed in Sweet's Product Design File, Section 7d, or in Thomas Register.

**SPECIFICATIONS** • 10 sec. to 60 hr. dial • 2 instantaneous switches • 2 delayed switches • 12 terminals • Resets in 1/2 sec. • Mounts in 3/4" dia. hole

MANUFACTURERS OF THE MOST COMPLETE LINE OF INDUSTRIAL TIME-COUNT CONTROLS AVAILABLE



Precision Interval Timers

Multiple Circuit Timers

Heavy-Duty Step Switches

Multiple Cam Timers

Predetermined Counters

Hermetically Sealed Timers



**EAGLE SIGNAL COMPANY** • Moline, Illinois  
INDUSTRIAL DIVISION

A DIVISION OF THE GAMEWELL COMPANY, AN E.W. BLISS COMPANY SUBSIDIARY  
CIRCLE 19 ON READER-SERVICE CARD

## WASHINGTON REPORT



**Wilbur H. Baldinger**  
Washington Editor

### SATIC AND MIPC OPPOSED AS DATA AGENCIES

A new Washington alphabet agency—SATIC, for Scientific and Technological Information Center—is advocated by Lieut. Gen. Arthur G. Trudeau, the Army's R&D chief. It would supersede ASTIA—Armed Services Technical Information Agency—as "a national scientific switchboard" and clearinghouse.

SATIC would be set up to cope with a growing deluge of scientific papers that has been pouring out from researchers and designers at a rate of 500,000 a year. As it is now, Trudeau says, these papers scarcely are cataloged, let alone read and digested. His objective is "the most complete and comprehensive acquisition, translation and exchange of information that we can get from all segments of our nation and from the rest of the free world."

An auxiliary government service for data-seekers—MIPC, for Materials Information Processing Capability—is proposed by the Air Force. Using computers in a programming plan outlined in a Belfour Engineering Co. report, MIPC would sift descriptive and empirical data to give scientists primary information applicable to immediate problems and help solve this paradox: R&D staffs need more data faster, but they do not have time to look over what they already have.

### PENTAGON SHIFTS SIDES IN PATENT FIGHT

Government R&D contractors who have been counting on the Defense Dept. for help in the coming free-enterprise-vs.-federal-ownership showdown on patent policy in Congress (See *ED*, Nov. 8, p 20) had better start looking elsewhere for allies.

Behind-the-scenes maneuvering for advantage in the policy fight—with industry on one side and such Democrats as Louisiana's Sen. Russell B. Long on the other—has produced a little-reported but significant change in the Pentagon's position.

Until recently the Defense Dept. held fast to a general policy permitting companies to hang on to rights to inventions developed under government contract. Now it has shifted toward patent practices of the Atomic Energy Commission and National Aeronautics and Space Administration. They turn patents over to companies that develop them, but retain rights for the government and reserve the right to license other companies to use the inventions.

The tipoff on the Pentagon's new policy alignment came in testimony on satellite communications by Edward C. Welsh, director of Vice President Johnson's Space Council. Appearing before the Senate Small Business Monopoly Subcommittee, headed by Long, Welsh disclosed that the Defense Dept. is adopting NASA's patent formula for space contracts—which account for a big chunk of the annual \$9-billion R&D bill.

Supporters of Long's position in the policy debate—that the public is entitled to keep patents it pays for, and that is is a scandalous

giveaway to let companies exploit them for private profit—also got some powerful backing from Adm. Hyman G. Rickover, who is no stranger to controversy. John L. McClellan (D, Ark.), chairman of the Senate Judiciary Patents Subcommittee issued closed-door testimony in which Rickover came out swinging against company retention of government-contract inventions—and against patent lawyers generally.

Rickover pointed out acidly that privately employed researchers must agree to assign patents to their firm, but that when it comes to government-paid work, "the company claims everything is different." Rickover also said most of the free-enterprise arguments in the policy debate have come from patent lawyers who "are defending their own special interest rather than the public interest."

#### ULCER OR HERNIA? PERCEPTRON MAY KNOW

The Perceptron electronic eye, whose trained retina reacts to specific stimuli to pinpoint military targets on aerial photographs, may have medical applications, too. In tests conducted by Defense Dept. researchers, it has demonstrated its ability to glance at physicians' case records and make diagnoses, which the doctors themselves have been unable to make without recourse to surgery.

Two sets of medical charts depicting similar but different symptoms of hernias and ulcers were submitted to the Perceptron, which had been fortified with photo-recognition data. Surgery had already established that gastric ulcers existed in 22 of the cases and hiatus hernias in 23. Without benefit of this information, the Perceptron's diagnoses were 91.1 per cent correct.

The researchers' report on the experiment had a cautionary footnote, however: "Such results are not necessarily conclusive, since the Perceptron's answers depend on whether sample cases are truly representative, in terms of variables, of the population from which future samples could be drawn."

#### OVERLAPPING TRADE GROUPS DISTURB PENTAGON

Pentagon officials are beginning to complain openly that defense industries are over-organized into technical and lobbying trade groups. Deputy Defense Secretary Roswell L. Gilpatric put it this way in one recent speech:

"In my opinion, there are too many industry associations dealing with military departments with the resulting multiplication of effort both on the part of industry and the Defense Dept. We recognize the importance of keeping industry informed of our needs and our problems, but we cannot afford to do this job several times over. There are simply not the people or the time to do it."

A characteristic case cited at the Pentagon is that of a contractor who acknowledged he was a card-carrier in no fewer than 15 organizations, to which his company paid \$43,000 in annual dues. In addition to the U.S. Chamber of Commerce and Electronic Industries Association, they ranged all the way from the Air Force Association to the Woods Hole Oceanographic Institute.

#### CAPITAL CAPSULES

An active earthquake zone near Fallon, Nev., is the likely site for 1963 five-kiloton underground nuclear-detection Shoal tests in Project Vela Uniform ■■■ A "Data Processing and Programming" bibliography (SB-474) has been published by the Commerce Dept.'s Office of Technical Services. Price: one dime ■■■ Computers are nearly human when it comes to making mistakes. A General Accounting Office report on Army supply mistakes blames \$8.1 million in errors on humans, \$7.4 on crossed computer wires.



## rectifier components news

### Get 'Em While They're Hot



... and they're burning up the presses at this very moment. The second edition of the now famous G-E Controlled Rectifier Manual has been expanded to 19 passionate chapters, has almost 100 additional pages crammed with exciting information you can't afford *not* to know. A daring introduction tells you what an SCR is, what it *isn't*, where it can be applied, and possible future applications, among other things. There's a new chapter on static switching circuits, and applications for the new 2N1929 and C5 series low current SCR's. Other compelling new chapters include information on DC regulated power supplies, the care and feeding of grey whiskered ocelots, AC phase control circuits, suppressing RFI and other interference in SCR circuits, and the complete solution of the Sunday Times crossword puzzle, Sept. 3, 1913.

If that isn't enough to impress you, the chapter on inverter and chopper circuits includes basic design techniques for Morgan and MacMurray-Bedford circuit transformers. AND the chapter entitled "Selecting the Right SCR" has a checklist referring to the pertinent section of the manual, PLUS a chart showing SCR current and voltage as a function of load and line parameters for major AC and DC circuits, including inverters.

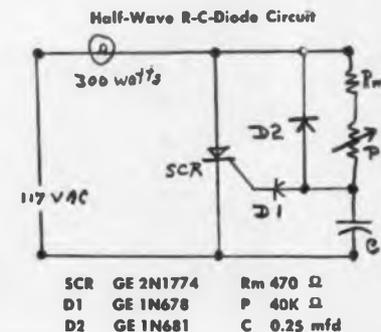
Try to put that in your pipe! And only \$1.50! Call your G-E District Sales Manager today. Or write us at Section 20135. Order several G-E Controlled Rectifier Manuals, 2nd Edition: they make dandy Christmas gifts.

*Special Bulletin: G-E announces addition of 800 and 1,000 PRV units to 1N3289 high current 100 amp rectifier line. Rumor says this is first commercial release of 1,000 PRV rated rectifiers in high current range. Further rumor says G-E started rumor, based on best information available.*

### ■ The Whites of Their Eyes?

You remember at Bunker Hill the fellow said "Don't fire until you see..." Pretty hard on myopic Minutemen. Firing SCR's doesn't present nearly as much of a problem. We tell you the gate current required. In many cases the SCR will provide you with an unusually simple, low cost firing circuit, like the one shown. It features a wide range of stepless phase control, and

the total cost of all the components used to fire the G-E 2N1774 SCR is amazingly low.



Gate current to fire the 2N1774 is 15 ma at room temperature. Of course, the R-C-diode combination shown can't fire just any old SCR. Some require exotic firing devices to get the gate current up high enough to turn them on. But then too, G-E also makes SCR's which turn on with only 200 microamps of gate current. So, just to keep the historical references consistent, you may fire when ready, Gridley, with G-E SCR's.

*Special Late Bulletin: 50% more power in same package or 50% smaller package, with no decrease in power now possible with new G-E miniature Vac-u-Seal® Selenium Rectifiers. And the secret is out... reason for tremendous improvement is new "thin cell" construction (0.010" in thickness). Write to Section 11L35 for complete details.*

### ■ Like David said to Goliath...

as he nonchalantly stepped over the body, "Try more power in a smaller package. Daddio." Take the new G-E subminiature rectifiers, for example, and consider this: PRV's up to 600 volts; transient PRV's up to 720 volts; average forward current up to 400 ma; maximum thermal conductance; extremely low level leakage currents; low cost.

Any questions? Write to Section 11L35. Rectifier Components Department, General Electric Company, Auburn, New York. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: International General Electric, 150 E. 42nd St., New York 17, N. Y.



# GENERAL ELECTRIC

CIRCLE 20 ON READER-SERVICE CARD



**Automatic control** of four flame-cutting heads is provided by GE's Mark Century Numerical Contouring control for an automated flame cutter built by Air Reduction Co. The solid-state electronic-control system generates slope and circular arc motions from a simplified programming input of desired end point and angular velocity.

## Numerically Controlled Systems: Big Leap Forward

*Half of all machine tools sold will be numerically controlled by 1965, according to recent surveys in this fast growing branch of industrial electronics. About 10 per cent of this year's machine tool sales will be in electronically controlled devices, industry sources indicated. Some of the important design work in this field is illustrated here.*



**Positioning tables**, with Numeripoint control, can move 5-ton loads at 360 in. per min. Each axis has dual motors: high-speed motor for rapid traverse and a servomotor for final locating. Sizes are from 38 x 50 in. to 38 x 102 in.; height, 26-1/2 in. Features include adjustable reference offset, plus and minus programming and axis-reverse switches. The system was developed by Giddings and Lewis Machine Tool Co., Fond du Lac, Wis.

**Rocket engine injector**, (right) formerly requiring a week to complete, is now finished in 3-1/2 hours. Ninety-six milling operations are numerically controlled with the Traveling Column Numerically Controlled Milling Machine integrated with Cincinnati Milling Machine Co.'s Acramatic Numerical Control System.



Advertisement

## Miniaturized Packaging Facilitated by Space-Saving Crimp-Type Modular Connector



A miniature modular terminal block, employing crimp type contacts with a variety of bussing arrangements, has been announced by Burndy Corporation as a new product development.

Occupying only 1/8 of the space required previously, the MINILOK<sup>®</sup>, provides density of 100 connections in only 2 1/2 inches. Top and side feed nylon modules may be easily interlocked on a PVC rigid plastic track which may be cut to any desired length.

A variety of bussing configurations permit the electronic design engineer unusual flexibility as well as the advantage of truly miniaturized electronic packaging. Snap-in HYTIP<sup>™</sup> contacts simplify wiring assembly and circuit changes. Sockets embody tip plated, heat treated, beryllium copper springs for contact retention.

Reliability is heightened by the use of basic parts that have already been proven by extensive field use. For economical production runs, with maximum reliability, contacts are installed by high-speed tooling of a type already in successful operation.

For further information contact Burndy Corp., Norwalk, Connecticut.

CIRCLE 21 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • December 6, 1961

# HYFEN

## RACK and PANEL CONNECTORS

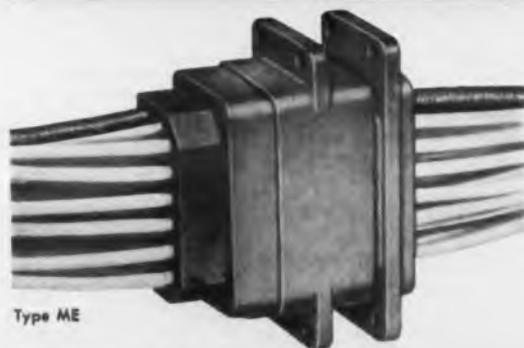


One piece high dielectric strength insert contains molded in ferrules for positive contact retention. Eliminates one cause of moisture entrapment.

Configurations accommodate three types of contacts: 1 Standard, 2 Standard Coax, 3 Miniature Coax (below), in any combination. All are plated in accordance with your requirements and are crimp type, snap locked HYFEN contacts.

One piece die cast shell design permits inserts to be interchanged in shells, allowing dead front in either plug or receptacle.

*crimped-contact reliability—snap-lock versatility*



Burndy's line of rack and panel HYFEN connectors offers the high reliability of crimp-type, snap-locked contacts. The versatility of the HYFEN technique is increased by the accommodating of a wide range of wire types and sizes... coax, miniature coax and standard cable.

FOR FURTHER INFORMATION CONTACT OMATON DIVISION

# BURNDY

NORWALK, CONNECT.

BICC-BURNDY Ltd. Prescot, Lancs., England

In Continental Europe: Antwerp, Belgium

TORONTO, CANADA

CIRCLE 22 ON READER-SERVICE CARD

## NEWS

### New Seismic Post To Detect World-wide Nuclear Blasts

A seismic observatory, designed to detect and measure underground nuclear explosions anywhere in the world, will be built soon in Arizona.

The observatory, estimated to cost several million dollars, will be an important addition to the grid of seismic posts being established across the nation. It will aid the advancement of seismology in general as well as assuming its primary role in national defense.

The center, to be known as the Tonto Forest Seismological Observatory, is a part of Project Vela, under the direction of the Advanced Research Projects Agency of the Dept. of Defense.

United Electro Dynamics, Inc., Pasadena, Calif., will construct the facility in Tonto National Forest near Payson, Ariz. The central control building at Payson will house monitoring and recording equipment and working facilities for an initial staff of 30 scientists and technicians. Fanned out through an area of 23,000 acres will be 31 seismometers buried in vaults.

### TV System Aids Contractor Reps



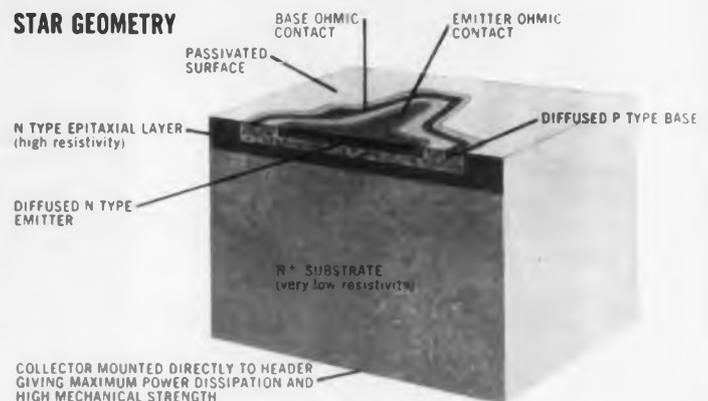
With the aid of closed-circuit television, contractor representatives review drawings of FPS-7 equipment to determine maintenance requirements. The technique, developed by General Electric Co.'s Heavy Military Electronics Dept., Syracuse, N. Y., provides simultaneous viewing. Microfilmed drawings are enlarged to an 18-in. image by rear-screen projection unit, left, then televised by lightweight, multi-lens camera and relayed to monitors. A remote-control device, regulates both pan and tilt of camera, as well as positioning turret lenses for desired close-ups.

# THE MOTOROLA SILICON

## HOW TO PRODUCE A "UNIVERSAL" TRANSISTOR WITH OPTIMUM PERFORMANCE AND MAXIMUM RANGE OF USAGE



### STAR GEOMETRY



**FIRST** - Create a new geometry to provide increased edge periphery of the emitter-base for desirable current rating with decreased junction area for good high frequency characteristics.

**SECOND** - Combine the new geometry with Motorola's superior epitaxial process to provide higher frequency response, lower total control charge, high breakdown voltages, and at the same time, lower saturation voltage and collector capacitance.

**THIRD** - Protect the new epitaxial device against junction contamination during manufacture, and against change with time, and ensure more uniform gain at low and high currents by passivating the surface through the planar process.

### WHAT THE STAR PLANAR CAN MEAN TO DESIGNERS

To one company it meant being able to reduce the number of different devices required in their equipment from 7 types to 1 type. To another it meant effective high-current switching 4 times faster than the type previously used.

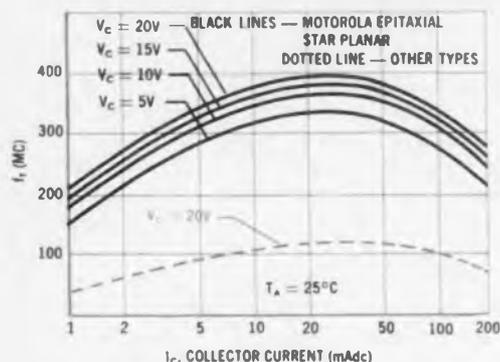
### HERE ARE THE NEW MOTOROLA SILICON EPITAXIAL STAR PLANAR TYPES

The introduction of Motorola's new Epitaxial "Star" Planar family marks a dramatic advance in the design and manufacture of silicon transistors. The new devices are available now in TO-5 and TO-18 packages. Only Motorola offers these star planar types.

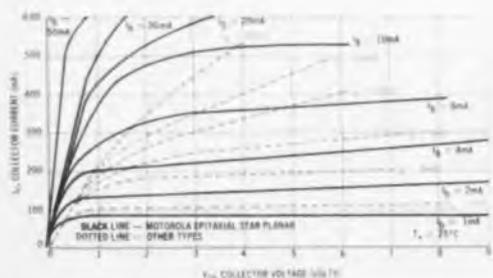
	TO-5 Package			TO-18 Package		
	MM486	MM487	MM488	MM511	MM512	MM513
$I_{cmax}$ @ $I_c = 150$ mA	20-60	40-120	100-300	20-60	40-120	100-300
$V_{CE(sat)}$ (volts) (max) $I_c = 500$ mA $I_b = 50$ mA	—	1.6	1.6	—	1.6	1.6
$C_{ob}$ $I_c = 0, V_{ce} = 10$ V	8 picofarads (maximum) — All Types					
$f_T$ $I_c = 20$ mA, $V_{ce} = 20$ V	250 mc (minimum) — All Types					
Switching Time (total) non-saturated	14 nsec (typical) — All Types					
Switching Time (saturated)	60 nsec (typical) — All Types 45 nsec (typical) — All Types					

# EPITAXIAL STAR PLANAR

## COMPARE THESE PERFORMANCE FEATURES



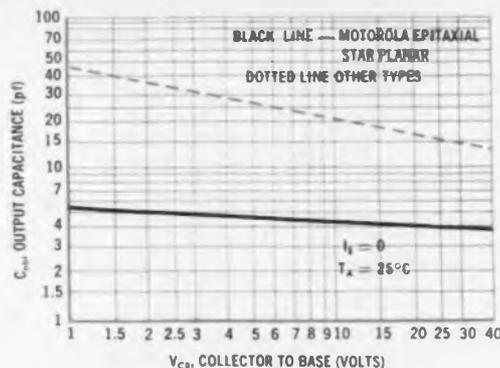
**400% HIGHER GAIN-BANDWIDTH PRODUCT** The small emitter area (star) and Motorola's advanced diffusion techniques combine to improve frequency performance.



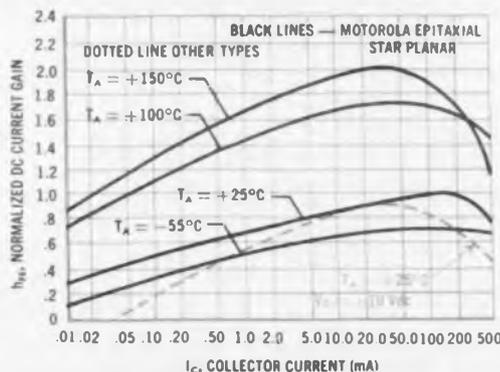
**ONE SEVENTH THE SATURATION VOLTAGE** With the low substrate resistance of the epitaxial process, collector saturation voltage is greatly reduced.

The Motorola Silicon Epitaxial Star Planar types are immediately available from your Motorola Semiconductor Distributor. So, if yours is an application requiring high-speed, high-current switching for line driving applications... or if you need low  $I_{CEO}$ , low-noise front end silicon amplifiers... or you want the low output capacitance at low voltage which makes it possible to choose either a low or high capacitance tank circuit in a tuned RF Power Amplifier, the "Universal" Epitaxial Star Planar is your answer.

Compare the Motorola Epitaxial Star Planar with the type you are presently using in your application. Prove to yourself that this "universal" transistor gives you the improved performance you want.



**ONE FIFTH THE OUTPUT CAPACITANCE** The reduced emitter area of Star geometry, plus the high-resistivity epitaxial layer combine to substantially lower collector capacitance.



**EXTENDED BETA RANGE — FROM 10  $\mu A$  TO .5 AMPS** Passivated to stabilize surface characteristics and eliminate recombination effects, this new transistor provides more uniform gain at low and high current.

For more information on this remarkable new Motorola Epitaxial "Star" Planar family, contact your local Motorola Distributor or District Office, or call or write: Motorola Semiconductor Products, Inc., Technical Information Department, 5005 East McDowell Road, Phoenix 8, Arizona.



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 CANADA Canadian Motorola Electronics Co.,  
 165 Barkley Drive, Toronto 14, Ontario (Plymouth) 9-2272  
 OUTSIDE U.S.A. Motorola Overseas Corp.,  
 4543 West Augusta Blvd., Chicago 51, Ill. (Spaulding) 2-4500

## Inductive Coils Radiate Signals to Receivers

Two British systems that pick up signals inductively from coils surrounding a room are being introduced to the American public.

One, the Induct-O-Phone uses a loop of aluminum or copper wire, which encircles a room. The loop is connected to the output of a standard radio, television or audio amplifier. Pole pieces in the headphones collect flux from this magnetic field. This flux then passes across short air gaps and through a circular armature disc attached to a conical diaphragm, thus producing the desired audio signals.

Individual volume control is effected by rotating a small permanent magnet, used to polarize the pole pieces. This reduces or increases the flux in the air gaps.

The system can provide good reception for a 1,000-sq ft area with a 10-w amplifier, according to Fen-tone Corp., sole distributors of the system in the United States.

The device has been installed in the House of Commons of the British Parliament. Prices for Induct-O-Phone range from \$19.95 to \$125, plus wire and installation.

### Multitone Device Aimed At Museums, Galleries

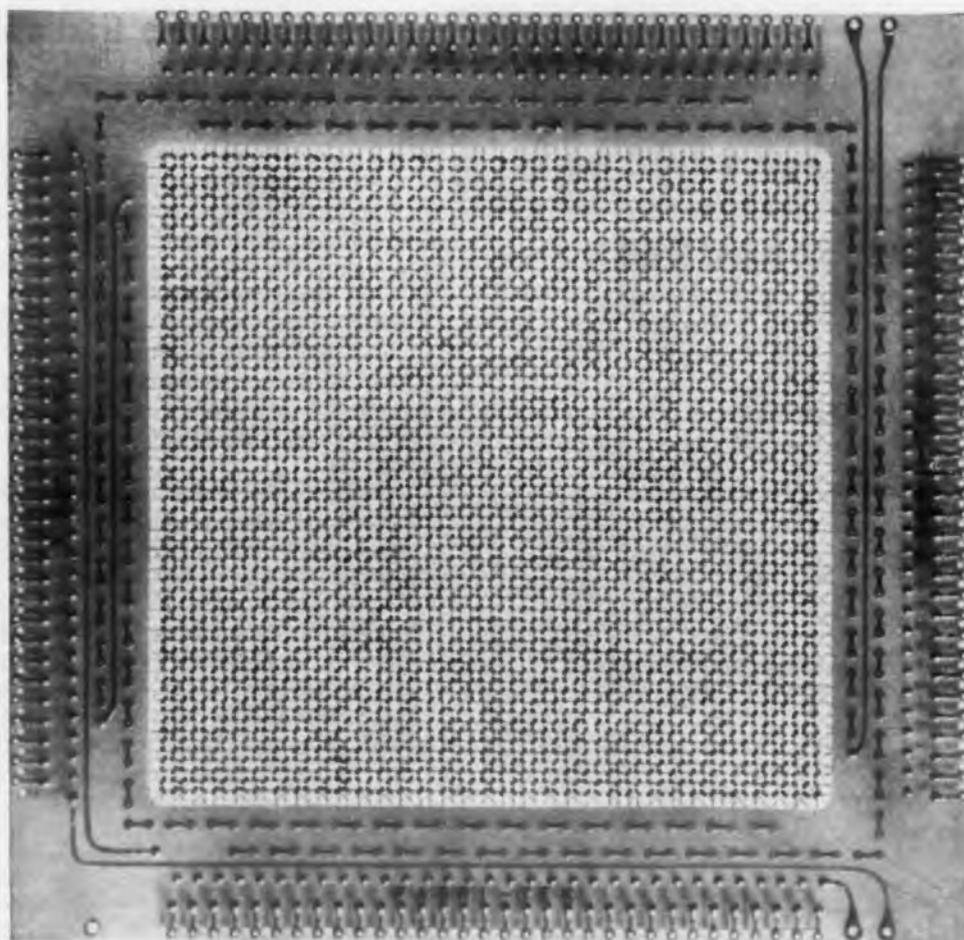
The other device, the Multitone Radio Guide, also operates on the induction-loop principle, but is geared toward museums and art galleries. Basic equipment for Radio Guide consists of a transistorized transmitter, an automatic tape playback unit, and a receiver.

Commentary recorded on tape is loaded onto the playback unit, which feeds it into a preamplifier in the transmitter. The signal from the tape modulates the output of an oscillator. This output then is fed to a loop of wire encircling the room. The radiated signal is picked up inductively by a transistorized receiver. This receiver is in the form of a lorgnette, weighs about 7 oz, and is 14 in. long.

The Radio Guide can operate on a multichannel basis, if required. A low-power transmitter is available with a four-channel output and the receiver is equipped with a four-channel switch.

Multitone Electronics Ltd. of London, manufacturers of the system, says that Radio Guide can be leased or purchased. A typical system including 50 receivers, one 4-channel transmitter, two 1-channel transmitters, and three 2-channel playback units costs \$9,700.

CIRCLE 23 ON READER-SERVICE CARD



Memory unit fabricated by Fabri-Tek, Incorporated, Minneapolis, Minnesota;  
Unit frame base material laminated by Mica Corporation, Culver City, California.

## DOW EPOXY CAPABILITY SOLVES COMPUTER MAKER'S PROBLEM

This precision memory unit is the heart of a new computer. Long-term, dependable operation calls for the utmost in dimensional stability in the memory unit's laminated frame, to maintain the highly critical spacing of the wire-and-core grid assembly.

The problem: which material will provide the best possible combination of needed properties . . . dimensional stability, physical strength, resistance to heat, good electrical characteristics plus a self-extinguishing factor? The solution: a brominated Dow epoxy resin.

Because of Dow's unique basic position in epoxy resins, Dow offers manufacturers an unusual capability in supplying materials to fill the most demanding requirements. An

example is the self-extinguishing Dow epoxy resin chosen for this application.

Dow offers a wide range of "controlled property" epoxy resins—to meet the exacting needs of today's complex electronic circuitry. Among these materials are Dow brominated epoxies, unusual resins with excellent self-extinguishing properties . . . flexible epoxy resins . . . epoxy novolac resins for high temperature use . . . and specially refined epoxies for the most critical applications.

For information on Dow epoxy resins for many varied applications, including the unusual, write us in Midland, C/O Coatings Sales Department 1955BC 12-6.

THE DOW CHEMICAL COMPANY

**DOW**

Midland, Michigan

CIRCLE 24 ON READER-SERVICE CARD

## NEWS

### Space A-Reactor Would Have Built-In Thermionic System

An atomic reactor using thermionic units right in its fuel elements to convert heat directly into electricity has been predicted by 1966. Such a unit, having no movable parts, would find use in space stations and electrical-propulsion engines.

Advanced design work has been completed by the Martin Co., Baltimore, Md., on direct-conversion systems in the 60- and 300-kw range. Dr. Clare P. Stanford, Martin's director of nuclear engineering, described the thermionic units at the recent International Symposium on Aerospace Nuclear Propulsion, in Las Vegas.

Dr. Stanford said the 300-kw direct-conversion reactor would call for some 250 thermionic fuel rods, all contained in a core 22 in. high and 11.75 in. in diam.

The 300-kw unit would integrate its thermionic converters and nuclear fuel into modules, interconnected to form elements 22 in. long. Liquid lithium would be circulated through the core as a coolant by an electromagnetic pump. The initial system would operate at about 1,400 F. A major obstacle, Dr. Stanford said, is the lack of an effective seal between ceramic and metal components that could withstand extreme temperatures and corrosion.

### Airborne Thin-Film Memory Has 1.5 Microsec Access

A complete thin-film memory for airborne use is in production for a military application, according to Univac Div. of Sperry Rand Corp., St. Paul, Minn.

The unit is said to have a capacity of 166,000 bits divided into 6,912 24-bit words. Access time is 1.5  $\mu$ sec and cycle time is 3  $\mu$ sec, permitting a maximum operation rate of over 80,000 operations per sec, the company said.

The memory and its associated circuitry occupy one-third of a cubic foot. The entire computer is said to require only a little over 1 cu ft of space.

Encapsulated welded-circuit modules are used in conjunction with the thin-film components, Univac says.

CIRCLE 245 ON READER-SERVICE CARD ►

New from Alloys Unlimited...leading manufacturer of  
critical space-age materials

# ALLOYS UNLIMITED SOLDER



**ATTENTION  
SOLDER USERS:**

if someone has  
removed your  
copy of  
Alloys Unlimited  
informative  
new brochure  
on solder  
just circle 245  
on reader  
service card,  
or write:



**Suddenly makes all other standards for solder obsolete**

ALLOYS UNLIMITED SOLDER



ALLOYS  
UNLIMITED  
SOLDER

100 West Avenue,  
Long Island City 1,  
New York  
Phone 7-4000



Suddenly makes all other standards for solder obsolete

# ALLOYS UNLIMITED ELECTRONIC SOLDER

All the facilities and know-how that have made Alloys Unlimited a leading materials manufacturer for the semiconductor industry are now being applied to the manufacture of solder. To meet the needs of the semiconductor industry, where consistency of quality, purity of materials and close tolerances are critical, Alloys Unlimited has the experience, facilities and techniques which are uniquely applicable to the manufacture of solder.

When you specify Alloys Unlimited Electronic Solder, you have the knowledge that you get solder of uncompromising quality. More goes into the manufacture of Alloys Unlimited Electronic Solder than you could ever possibly require. But these extras cost you nothing more; you get a better product at no extra cost. So specify Alloys Unlimited Electronic Solder and enjoy the product that makes all other standards for solders obsolete.

# ALLOYS UNLIMITED SOLDER FOR INDUSTRY

Incorporating the same high quality standards maintained in the production of Alloys Unlimited Electronic Solder.



## ALLOYS UNLIMITED B-CORE SOLDER

Developed after special research to meet the specific requirements of lamp, fuse, Christmas lighting, jewelry and other non-electronic industries. A mild organic type of flux core solder as active as the regular acid type although considerably less corrosive and conductive. Because there is precisely the correct quantity of flux core, heat causes almost complete decomposition. Flux contains no zinc-ammonium chloride or free hydrochloric acid.

Manufactured in all commercial sizes and alloys

Furnished in 1-5-25 lb. spools



## ALLOYS UNLIMITED ACID CORE SOLDER

The all-purpose answer to sheet metal and general soldering requirements. For safe, effective, and economical soldering of all common metals. Contains fast acting, zinc-ammonium chloride flux and non-sputtering flux agent.

Manufactured to all commercial sizes and compositions.

Furnished in 1-5-25-50 lb. spools



## ALLOYS UNLIMITED SOLID W

Extruded drawn solder for performance external soldering. Is required in limited's manufacturing produces various alloy die dra smooth, that is id hand sold use with soldering

Manufactured in all commercial sizes and alloys

Furnished in 1-5-25-50 lb. spools



AE 16 ROSIN CORE ELECTRONIC SOLDER

Specially developed to meet high speed production requirements in the electronics industry. AE 16 Rosin Core Solder is non-corrosive, non-hygroscopic, non-conductive, meets or exceeds the requirements of Federal Specifications QQ-S-571c and MIL-S-6872. The solder is a homogeneous alloy of Virgin Metals scientifically blended and quality controlled to eliminate voids and insure peak performance. The flux core of the AE 16 Rosin Core Solder is

a combination of superior grade water-white, natural rosin and a minute amount of unique oxide removing agent which conditions surfaces to be soldered in the minimum time. Manufactured to conform to rigid industrial standards, AE 16 Rosin Core Solder is available in any combination of Tin, Lead, and related elements. It is supplied in any diameter with controlled flux percentages.

Reports of laboratory tests furnished upon request.

Furnished in 1-5-20-25-50 lb. spools

## ALLOYS UNLIMITED "WW" ROSIN CORE SOLDER

Setting the standard on all electronic solder. A natural water-white gum rosin and clear volatile solvent flux core solder. Guaranteed to be non-corrosive and non-conductive. Meets Federal Specifications QQ-S-571c for rosin core solder and MIL-S-6872.

Manufactured in all commercial sizes and alloys

Furnished in 1-5-20-25-50 lb. spools



## ALLOYS UNLIMITED WIRE SOLDER

Extruded and die cast solder for peak performance wherever manual soldering flux required. Alloys Unlimited's modern manufacturing facilities produce a homogeneous alloy extruded and drawn into a smooth, uniform wire. This is ideal for either manual soldering or for automatic soldering equipment.

Manufactured in all commercial sizes and alloys.

Furnished in 1-5-25-50 lb. spools

**TRI-PURE BAR SOLDER** is manufactured under an atmospheric containment exclusion principle that prevents air from contacting metals. Results: a solder free of drosses and oxides. Method produces better, smoother grained alloy. Superior extrusion process maintains a uniform crystal arrangement. Spectrographically controlled to insure lower impurities than called for in Federal specifications. With Alloys Unlimited Tri-Pure Bar Solder, connections are brighter, oxide accumulation in melting pot considerably reduced.

**ALUMINUM SOLDER #400.** A high tin alloy specifically compounded for greater ease in soldering aluminum to aluminum and other metals without flux. It has a high tensile strength and melts at 400°F. Furnished in sticks and/or wire of various diameters.

**RIBBON SOLDER.** Used for soldering seams with a torch. Supplied in thicknesses of 1/32" to 1/8", widths of 1/4" to 2" in coils or cut lengths.

**FLUXES.** Rosin fluxes specifically created for printed circuitry and hot dip tinning applications. Without parallel for speed and spreading power. Long shelf life. Easily and safely bites through oxides and any residues remaining, yet gives resistance in excess of 50,000 megohms after soldering or when baked dry. Fluxes, thinners and flux removers for printed circuitry are all available to you from Alloys Unlimited.

**ELECTRO SOLDER PASTE.** A New non-corrosive Solder in Paste form. Especially designed for electrical and electronics soldering. Excellent for intricate and blind soldering operations. Ideal for induction and oven soldering where continuous and automatic production is required. May be thinned as required. Needs heat

**REGULAR BAR—1 lb. Extruded Bar**

**MEDIUM BAR—1/2 lb. Extruded Bar**

**CAPPING BAR—1/4" x 1/4" x 12" Extruded Bar**

**TRIANGULAR—1/4" - 3/8" - or 1/2" x 14" Extruded Bar**

**95/5 SOLDER.** Alloy of 95% Tin, 5% Antimony. Melting Range 460°-470°F. Used on sweat fittings for copper when high pressures are encountered, also recommended for electrical motors when temperatures are higher than the safe range of tin-lead solders. Furnished on spools.

**LOW MELTING POINT SOLDER.** Low melting point solders listed on back page and others desired in the same range can be supplied in sticks or wire coils.

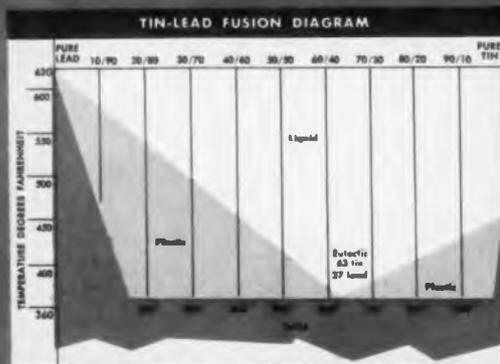
- 183 Flux for printed circuitry.
- XX Rosin flux for other fine electrical work.
- 390 Zinc-Chloride flux used for most sheet metal, mechanical industry and other general use.
- 388 B-core flux for general industrial use including the electrical, jewelry and novelty fields where a faster acting but less corrosive flux than zinc-chloride is required. Remains inert below 400°F.

only. A high Tin-Lead Solder combined in a 60/40 alloy with fast-acting, non-corrosive flux in stable proportions especially designed for all electrical and electronic soldering. Obtainable in other alloys. Available in 1, 3, and 5 lb. cans.

**LEAD.** Wire, Bar, Ribbon, rings, washers, etc.

## SOLDER REFERENCE CHARTS.

The charts on this page are useful guides in choosing the solder alloy for each application; they provide information on the characteristics of the individual alloy. This enables you to use the alloy correctly and minimize your production problems. When ordering, please refer to Alloy Reference Number.



PHYSICAL PROPERTIES OF COMMERCIAL SILVER SOLDERS

Alloy No.	Composition				Other	Melting Range		Recommended Soldering Temp.	Shear Strength		Tensile Strength As Cast
	%Ag	%Cu	%Zn	%Cd		Solder Pt	Liquidus Pt		As Cast	As Cast	
36	83				Min 15	1760	1778	1880	20,000	70,000	20,000
37	80	16	4			1360	1490	1380	23,800	42,000	40,000
38	75	22	3			1365	1450	1430	23,000	41,000	40,000
39	75	20	5			1330	1425	1430	23,000	42,000	40,000
40	75		23			1310	1325	1325	27,000	30,000	30,000
41	72	28				1435	1435	1430	23,000	40,000	40,000
42	70	20	10			1325	1390	1400	30,000	44,000	40,000
43	65	20	15			1380	1325	1330	33,000	50,000	30,000
44	65	28			Min 5, Min 7	1380	1430	1380	32,000	41,000	40,000
45	60	25	15			1360	1325	1330	30,000	50,000	43,000
46	60	20			Sn 10	1130	1370	1330	30,000	50,000	43,000
48	56	22	17		Sn 5	1145	1205	1210	28,000	43,000	30,000
49	54	40	6		Ni 1	1375*	1575	1600	30,000	50,000	30,000
50	50	13.3	16.3	18.0		1180	1175	1175	30,000	43,000	60,000
52	50	24	16			1275	1425	1425	30,000	46,000	43,000
53	50	15.5	15.5	16	Ni 2	1175	1450	1370	30,000	46,000	43,000
54	50	28	22			1230	1340	1330	33,000	51,000	43,000
55	45	13	16	24		1193	1145	1130	33,000	43,000	60,000
56	45	30	23			1330	1370	1375	33,000	47,000	53,000
58	40	18	13	27		1135	1205	1200	23,000	36,000	53,000
59	40	20	28		Ni 2	1340	1435	1400	37,000	46,000	50,000
61	40	26	24			1230	1400	1400	33,000	49,000	33,000
63	40	20	23		Ni 3	1230	1400	1380	40,000	48,000	30,000
62	35	24	21	18		1125	1295	1300	33,000	38,000	30,000
65	30	38	32			1370	1410	1400	43,000	38,000	60,000
66	30	43	27	3		1140	1360	1400	33,000	43,000	42,000
67	30	43	23			1430	1580	1430	33,000	49,000	53,000
68	15	80			P 3	1185	1260	1260	33,000	49,000	33,000
69	10	53	38			1330	1380	1380	33,000	45,000	43,000
70	7	93			Sn 8	1225	1885	1530			
71	4	86.5			P 7.5	1165	1380	1380			
72	3	58	37			1375	1680	1600	33,000		
73	5				95	640	740				
74	5					450	680				
75	3	91			P 7	1185	1430	1300			

LEGEND: Ag—Silver, Cu—Copper, Zn—Zinc, Cd—Cadmium, Ni—Nickel, Mn—Manganese, Sn—Tin, In—Indium, Bi—Bismuth, P—Phosphorus.

COMMON TIN-LEAD BASE SOLDER ALLOYS

Alloy No.	Composition					Temp. at which solder becomes plastic		Temp. at which solder becomes liquid	
	%Sn	%Pb	%Ag	%Bi	%Cd	C°	F°	C°	F°
1	0	100				327	620		
2	5	95				270	522	315	598
3	10	90				225	440	260	505
4	15	85				185	360	215	415
5	20	80				163	340	200	390
6	25	75				163	340	205	395
7	30	70				163	340	210	405
8	35	65				163	340	215	410
9	40	60				163	340	220	415
10	45	55				163	340	225	425
11	50	50				163	340	230	435
12	55	45				163	340	235	445
13	60	40				163	340	240	455
14	65	35				163	340	245	465
15	70	30				163	340	250	475
16	75	25				163	340	255	485
17	80	20				163	340	260	495
18	85	15				163	340	265	505
19	90	10				163	340	270	515
20	95	5				163	340	275	525
21	95.5	4.5				222	420	240	464
22	95	5				180	355	235	450
23	95	5				180	355	235	450
24	95	5				180	355	235	450
25	95.5	4.5				180	355	235	450
26	95.5	4.5				180	355	235	450
27	95.5	4.5				180	355	235	450
28	95.5	4.5				180	355	235	450
29	95.5	4.5				180	355	235	450
30	95.5	4.5				180	355	235	450
31	95.5	4.5				180	355	235	450
32	95.5	4.5				180	355	235	450
33	95.5	4.5				180	355	235	450
34	95.5	4.5				180	355	235	450
35	95.5	4.5				180	355	235	450
36	95.5	4.5				180	355	235	450
37	95.5	4.5				180	355	235	450
38	95.5	4.5				180	355	235	450
39	95.5	4.5				180	355	235	450
40	95.5	4.5				180	355	235	450
41	95.5	4.5				180	355	235	450
42	95.5	4.5				180	355	235	450
43	95.5	4.5				180	355	235	450
44	95.5	4.5				180	355	235	450
45	95.5	4.5				180	355	235	450
46	95.5	4.5				180	355	235	450
47	95.5	4.5				180	355	235	450
48	95.5	4.5				180	355	235	450
49	95.5	4.5				180	355	235	450
50	95.5	4.5				180	355	235	450
51	95.5	4.5				180	355	235	450
52	95.5	4.5				180	355	235	450
53	95.5	4.5				180	355	235	450
54	95.5	4.5				180	355	235	450
55	95.5	4.5				180	355	235	450
56	95.5	4.5				180	355	235	450
57	95.5	4.5				180	355	235	450
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63	95.5	4.5				180	355	235	450
64	95.5	4.5				180	355	235	450
65	95.5	4.5				180	355	235	450
66	95.5	4.5				180	355	235	450
67	95.5	4.5				180	355	235	450
68	95.5	4.5				180	355	235	450
69	95.5	4.5				180	355	235	450
70	95.5	4.5				180	355	235	450
71	95.5	4.5				180	355	235	450
72	95.5	4.5				180	355	235	450
73	95.5	4.5				180	355	235	450
74	95.5	4.5				180	355	235	450
75	95.5	4.5				180	355	235	450
76	95.5	4.5				180	355	235	450
77	95.5	4.5				180	355	235	450
78	95.5	4.5				180	355	235	450
79	95.5	4.5				180	355	235	450
80	95.5	4.5				180	355	235	450
81	95.5	4.5				180	355	235	450
82	95.5	4.5				180	355	235	450
83	95.5	4.5				180	355	235	450
84	95.5	4.5				180	355	235	450
85	95.5	4.5				180	355	235	450
86	95.5	4.5				180	355	235	450
87	95.5	4.5				180	355	235	450
88	95.5	4.5				180	355	235	450
89	95.5	4.5				180	355	235	450
90	95.5	4.5				180	355	235	450
91	95.5	4.5				180	355	235	450
92	95.5	4.5				180	355	235	450
93	95.5	4.5				180	355	235	450
94	95.5	4.5				180	355	235	450
95	95.5	4.5				180	355	235	450
96	95.5	4.5				180	355	235	450
97	95.5	4.5				180	355	235	450
98	95.5	4.5				180	355	235	450
99	95.5	4.5				180	355	235	450
100	95.5	4.5				180	355	235	450

Eutectic — heat mixture of two or more metals that goes immediately from a solid to a liquid (no plastic range) upon reaching its melting point.  
15-16—best tensile strength, 23—best shear strength, 25—best creep strength.  
LEGEND: Sn—Tin, Pb—Lead, Ag—Silver, Bi—Antimony, Cd—Cadmium.

## ALLOYS UNLIMITED SOLDER

Suddenly makes all other standards for solder obsolete

Why do other standards for solder become obsolete? Because never before have such advanced techniques and facilities gone into the manufacture of solder. As a leading manufacturer of materials, sub-assemblies and sub-components for the semiconductor industry, Alloys Unlimited has developed the capacity to meet and solve some of today's most difficult technical problems, work in areas that are outposts of science. New and higher standards constantly replace standards that everyday become obsolete. These are the advanced standards applied to the manufacture of Alloys Unlimited solder.

### ALLOYS UNLIMITED SOLDER

21-01 43rd Avenue, Long Island City 1, New York  
Empire 1-8540



Call or write with your specifications for immediate quotation

INDIUM BASE SOLDERS

Alloy No.	Composition					Melting Point C	Tensile Strength
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## Inorganic Fuel Cells Provide 0.95 V at 100 C

A fuel cell the size of a quarter and composed of an inorganic ion-exchanging membrane has produced 0.95 v in an open circuit. Developed at the Armour Research Foundation of the Illinois Institute of Technology, Chicago, the new cell is said to remain stable at 100 C, 30 deg higher than comparable organic membrane cells.

The cell also is said to be more resistant to radiation of nuclear or cosmic origin than organic cells. Energy-to-weight ratios expected from the devices may reach 100 amp per sq ft, the institute reports.

The cells use hydrogen and oxygen as fuel and do not require water to maintain stability. The cells are said to work as follows:

Hydrogen causes a reaction on one side of the membrane, which gives off electrons. Oxygen on the other side creates a void of electrons. When hydrogen ions traveling through the membrane complete the circuit, electrons flow from the anode side to the cathode side of the membrane. This completes the electrochemical reaction.

The organic membrane was developed specifically for fuel-cell use in space, where it would be lighter in weight than organic materials, which, Armour scientists say, can attain only about 35 amp per sq ft of membrane.



Fuel cell apparatus based on new organic ion-exchanging membrane uses basic cells about the size of a quarter that develop 0.95 v in an open circuit. Shown are co-inventors Andrew Dvarnieks, left, and Jack Bregman, of Armour Research Institute.



## Contact Redundancy in New UNION Crystal Case Relays

The UNION 2-pole double throw General Purpose Crystal Case Relay is designed to consistently meet the requirements of Mil-R-5757D and Mil-R-5757/10. Its essential features . . . from minimum size to optimum reliability . . . permit it to be used in aircraft, guided missiles, shipboard and ground control electronic equipment.

A unique torsion-wire armature suspension system and a rugged all-welded frame construction provide a high level of vibration and shock immunity. Contact redundancy, which assures reliability in dry circuit and higher level contact loads, is provided through the use of bifurcated contacts.

Available with 0.2" grid-spaced header or "S" type header, with various mountings, terminals, and operating voltages. Write for Bulletin 1064.



## Why UNION Relays Are So Dependable

There's a good reason why our relays are the standard for reliability. For years, we've been building tough, reliable relays for use in airborne and guided missile electronic equipment and similar vital applications where perfect operation under severe environmental conditions is mandatory.

Our engineers created a compact 6-PDT miniature relay with just three major assemblies . . . instead of a fistful of small parts. This was accomplished by using a balanced rotary-type armature that provided a maximum resistance to the severe shock and vibration environment of aircraft and guided missiles. The rotary principle of operation is utilized in all our relays.

We have a reputation for building reliable electronic components and we intend to maintain our tradition for building reliable relays. And we supply these quality relays in quantity. Stocks are now available for prototype requirements in New York, Pittsburgh, Dallas and Los Angeles.



For additional information, write for Bulletin 1017 or call Churchill 2-5000 in Pittsburgh.

MEMBER OF THE NATIONAL ASSOCIATION OF RELAY MANUFACTURERS



**UNION SWITCH & SIGNAL**

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY —  
PITTSBURGH 18, PENNSYLVANIA

CIRCLE 26 ON READER-SERVICE CARD

## New 4-PDT-10-amp Relay Most Compact Rotary Type Available

This new durable relay is designed to meet the requirements of Mil-R-6106. It's a rugged relay featuring exceptionally sturdy terminals and husky contacts for high current applications. Glass-coated cylindrical contact actuators attached to the rotary armature provide square mating of contact surfaces, thereby assuring longer relay life. The balanced rotary armature provides maximum resistance to severe shock and vibration.

This small 4-PDT-10-Ampere relay is currently available with 115VAC and various DC operating voltages. Various mounting styles are provided. Write for bulletin 1069.

# Bomb Tests Trigger Boom in Radiation Detectors

*Recent Soviet nuclear explosions in the atmosphere, and the threat of more tests by both East and West, have resulted in growing consumer and industrial apprehension about the danger of fallout. Consequently, sales of radiation-detection devices have risen sharply, and new instruments are reaching the market constantly. Pictured here are some typical consumer-type measuring devices.*



1



2



3



1. **Radiation-monitoring system**, covering large areas, employs small halogen tubes as sensing devices. Manufactured and installed by Tracerlab Inc., Boston, the equipment indicates ambient radiation dose-rates for as many as 10 remote stations. Alarm trip points are provided for each channel. The system is being installed in John Hancock Life Insurance Building in Boston.

2. **Family radiation-measurement kit** stresses simplicity in both design and operation. Developed by Bendix, Cincinnati, the equipment includes a ratemeter with two radiation ranges, 0-120 Roentgens per minute and 0-12 roentgens per 10 minutes; a dosimeter indicating accumulated radiation in the 0-600 Roentgen range; and a battery-powered charging unit which resets both instruments after use. Suggested retail price is \$24.95.

3. **Portable fallout-detection meter** measures gamma-radiation dose rates as high as 500 Roentgens per hour. The sensing device used is a hermetically sealed ionization chamber in lower front portion of equipment. Designed by the Victoreen Instrument Co. of Cleveland, all electrical components, including a high-impedance circuit and semiconductor elements, are fastened to a printed-circuit board. Two "D" size batteries will operate the instrument for more than 150 hours. Retail price is \$49.95.

4. **Home owner's radiation meter** can be used either as a portable nuclear-detection device or as a remote-survey meter. A Geiger-Mueller, halogen-quenched tube acts as the sensing device, both in the instrument and the probes. Varying lengths of the lead wires will not affect the calibration of the meter. Designed by Lionel Electronics Laboratories, Brooklyn, N. Y., the instrument will measure radiation rates up to 100 Roentgens per hour. A standard flashlight battery provides operating power. The meter is expected to be on the market in early December.

TODAY'S  
MOST RELIABLE  
SOLID TANTALUM  
CAPACITORS



## HYREL<sup>®</sup> ST Capacitors, developed and qualified for use in the Minuteman Missile, are NOW available to you in ALL RATINGS!

- Quality *100 times greater* than that of former high-reliability components! That's the ultra-high-reliability now demanded of electronic parts in the Minuteman missile's intricate guidance and control system.

- An unmatched test history of over 111 million unit-hours backs up the design of HYREL ST Capacitors to withstand the rigorous performance requirements specified for Minuteman components.

- The pioneer in solid tantalum capacitors, Sprague is one of 12 nationally-known manufacturers chosen to participate in the

Air Force's Minuteman Component Development Program of Autonetics, a division of North American Aviation, Inc.

- All of the special processes and quality control procedures that make HYREL ST Capacitors the most reliable in the world can now help you in your military electronic circuitry. A tantalum capacitor engineer will be glad to discuss the application of these capacitors to your missile and space projects. Write to Mr. C. G. Killen, Vice-president, Industrial and Military Sales, Sprague Electric Company, 347 Marshall St., North Adams, Mass.

### SPRAGUE COMPONENTS

CAPACITORS  
RESISTORS  
MAGNETIC COMPONENTS  
TRANSISTORS

INTERFERENCE FILTERS  
PULSE TRANSFORMERS  
PIEZOELECTRIC CERAMICS  
PULSE-FORMING NETWORKS

HIGH TEMPERATURE MAGNET WIRE  
CERAMIC-BASE PRINTED NETWORKS  
PACKAGED COMPONENT ASSEMBLIES  
FUNCTIONAL DIGITAL CIRCUITS

**SPRAGUE**  
THE MARK OF RELIABILITY

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

CIRCLE 27 ON READER-SERVICE CARD

**NEW**

**DOOR INTERLOCK SWITCH eliminates momentary circuit break during re-set**



A few of the many different door interlock switches available. Write for Data Sheet 186 or see the Yellow Pages for the nearby MICRO SWITCH Branch Office.

A new model in MICRO's line of protective door interlock switches, the "13AC" is designed to eliminate that momentary power interruption when the interlock is re-set upon closing the door. This feature is particularly desirable on electronic equipment such as data processing consoles, transmitters or computers.

Door interlock switch assemblies automatically break the power circuit when a door or drawer is opened, make it easy to intentionally energize the circuit for check or test, and eliminate the use of dangerous jumpers or tie-downs. When the door is closed, these devices automatically re-set so that next time the door is opened, power is safely cut off.

MICRO SWITCH door interlocks are the ultimate in reliability as protective devices on cabinets and enclosures containing electronic equipment that may be hazardous to personnel. More than 150 models include environment-proof and high temperature designs, subminiature and multi-circuit assemblies and some with self-lubricating thermoplastic actuating rods.

MICRO SWITCH . . . FREEPORT, ILLINOIS

A division of Honeywell

In Canada: Honeywell Controls, Limited, Toronto 17, Ontario



**Honeywell**

MICRO SWITCH Precision Switches

CIRCLE 28 ON READER-SERVICE CARD

## NEWS

### Data-Recording System Used In Semiconductor Studies

An automatic data-recording system has been developed for research on the properties of semiconductors and electronic components.

The device, designed and built by scientists at Battelle Memorial Institute, Columbus, Ohio, automatically measures electrical properties of the specimens and records data by typing them on paper and simultaneously coding them on paper tape. The coded data can be transferred directly to punch cards and fed into a digital computer to calculate the characteristics of the specimens.

The automatic data taker can measure current, resistivity, temperature, magnetic field strength, or any other property that can be translated into a dc voltage between 1  $\mu$ v and 100 v. It can measure up to 17 different signals from a single specimen, 4 different signals from each of 4 specimens simultaneously, or various combinations.

Properties such as resistivity, Hall coefficient, magnetoresistance, and thermomagnetic effect can be measured in any sequence and combinations of sequences up to a total of 100 measurements. This set of up to 100 measurements can be repeated automatically at each of up to 100 variations in time or environmental conditions such as temperature, pressure or magnetic field.

Thus, in a single programming, the machine can take and record up to 10,000 individual measurements.

### Portable Theodolite Retains Its Accuracy

The first completely portable aiming theodolite, which is said to still maintain accuracy in its basic function, has been shipped to the U.S. Army for its Pershing missile project.

Built around a north-seeking gyroscope, by Electro-Optical Div. of Perkin-Elmer Corp., Norwalk, Conn., the system quickly establishes and corrects azimuth headings. When the gyro is set up it begins to hunt north exactly. At this time the theodolite tripod, which has a finder sight and a small lamp mounted on it, is set up close to the nose fed to the missile-launching ring, incorpo-



**Portable azimuth-alignment** theodolite is being checked for accuracy of its auto-collimator and encoder prior to shipment. Employing 6,400 part mil-circle-type scale in place of conventional azimuth scale, the instrument is going into the Pershing-missile system.

rating a third encoder for proper missile lamp reflected in a mirror prism inside the window of the missile.

After the first step is completed, the telescope theodolite is mounted on the tripod and lined up to look at the missile prism and at another prism on the north-seeking gyro. The gyro prism is remotely controlled to allow correct positioning for sighting. Once auto-collimation is finished, shaft position encoders are used for automatic, electronic readout of two angles, of which the sum is the angle between north and the missile platform. Information thus obtained is fed to a computer, along with the desired firing direction. The result of this calibration is fed to the missile-launching ring, incorporating a third encoder for proper missile erection and firing.

**Mil-Circle-Type Scale  
Simplifies Use By Soldiers**

Further simplification for use by artillery men is achieved by using the mil-circle-type scale, rather than a conventional azimuth scale. This 6,400 part scale can be read easily to within 1/100th of a mil. One mil on the scale subtends an arc of 1 yard at a distance of 1,000 yards.

All structural components, including the tripod, are aluminum and were designed to allow thermal expansion without loss of accuracy. Heat absorption is kept to a minimum through the use of 95 per cent-reflective-titanium white paint on the housings. The weight is decreased by using honeycomb structures of aluminum bonded with epoxy resins.



**New! Higher permeability,  
no extra cost...**

**in small transformer core laminations.**

Pack extra performance into your miniature transformers *at no extra cost* with Magnetic Metals' new mite-size transformer core laminations. Use these carefully engineered laminations where you need high specific resistivity and low hysteresis loss, particularly where you require low core loss at high frequencies. They let you miniaturize your designs even further without sacrificing performance.

Supplied only by Magnetic Metals, these new small laminations are made of "Supermu 40"\* which provides the highest permeability commercially available. Advanced manufacturing techniques now bring this premium line of laminations to you at no extra cost.

\*79% nickel-iron molybdenum alloy

Write today for more information on our entire line of small transformer core laminations. Our engineers are ready to help you select, from the most comprehensive line of laminations in the industry, the best grade of material for the exact results you want.

**MAGNETIC METALS** 

Hayes Avenue at 21st Street, Camden 1, New Jersey  
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## NEWS

### DESIGNERS' DATEBOOK

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#### DECEMBER

- 12-14**  
Washington Eastern Joint Computer Conference; Sheraton Park Hotel; IRE, AIEE, ACM.
- 26-31**  
Denver Annual Meeting and Exposition of Science and Industry; Hilton Hotel; AAAS.
- 27-29**  
Los Angeles American Physical Society Meeting; University of California; APS.

#### JANUARY

- 9-11**  
Washington 8th National Symposium on Reliability and Quality Control; Statler-Hilton Hotel, PGRQC, AIEE, ASQC, EIA.
- 29-Feb. 2**  
New York AIEE Winter General Meeting and Exposition; New York Coliseum; AIEE.

### Microwave Airborne Antenna Made for Space Programs

A maneuverable microwave airborne antenna with a 6,000-mile range has been developed for space and satellite research.

Designed by the Boeing Co., the antenna is capable of covering 360 deg in azimuth, -25 to +120 deg in elevation, and a 180-deg change in polarization. The upward-looking, three-axis antenna has a beam width of 5 deg.

When mounted in high-flying aircraft, Boeing says, the antenna can be used to investigate such areas as earth albedo (reflecting power of the earth) and cloud and atmospheric physics. Additional applications of the antenna include high-altitude noise-profile testing, planetary radio astronomy, and reception of re-entry telemetry data. Because of its range, the antenna also can be used to receive radio signals reflected from orbiting dipole antennas, such as those in Project West Ford, Boeing points out.

## NBS Center Supplies Radio-Refractive Data

The National Bureau of Standards has announced the opening of a Radio Refractive Index Data Center, which will study the effects of the earth's atmosphere on radio propagation.

The new center, in Boulder, Colo., has collected refractive-index data from more than 300 stations in 14 countries. Using weather radiosonde observations and special airborne measuring devices, each station has determined in its zone the relative effects of atmospheric pressure, temperature and humidity on the refraction of radio waves. This information then was relayed to the center where it was correlated and referenced on punch cards. The center already has more than 7 million cards.

NBS says this information will benefit such programs as the evaluation of missile-tracking and guidance systems, the establishment of error correction for height-finding radars, prediction of transmission losses for tropospheric communications links and the estimation of radio-wave field strengths for many types of radio propagation.

The center already has published an analysis of radio-refractive-index data, titled "Climatic Charts and Data of the Radio Refractive Index for the United States and the World (1960)." Copies can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D. C., at \$2 each.

## Data-Processing Center Opens



International Electric Corp., a subsidiary of the ITT Corp., has announced its entry into the commercial data-processing field. With the opening of a \$3.5 million center in Paramus, N. J., IEC offers services ranging from blocks of computer time (\$55 per 6 minutes) to a complete data-processing operation. Facilities include an IBM 7090 and a 1401 processing system. To expedite operations, IEC is prepared to establish a direct communication link (telephone, teletype, or microwave) between the customer's base of activities and the center.

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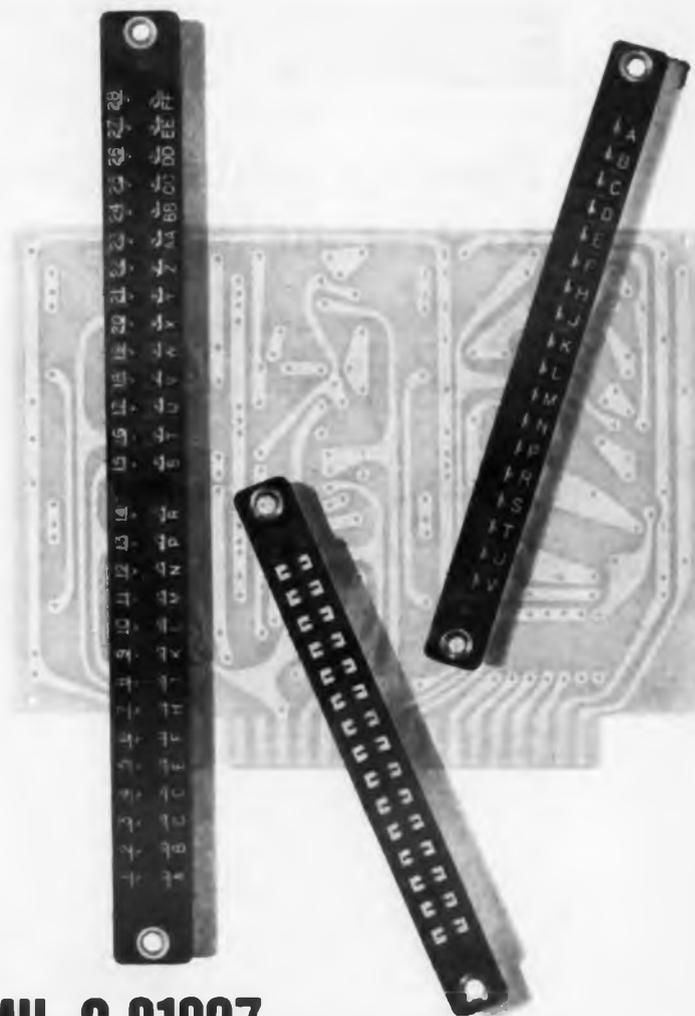
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**SPERRY**ELECTRONIC  
TUBE  
DIVISION

microwave memo

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

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

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

### EASY RADAR APPLICATION

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

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

### VERIFIED RELIABILITY

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

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

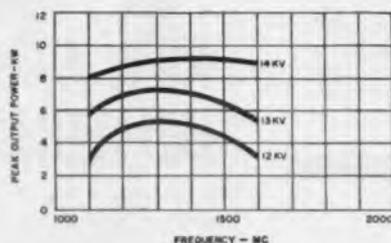
**FREE TECHNICAL INFORMATION** on the Sperry line of high-power pulsed traveling wave tubes may be obtained by writing to Sec. 104, Sperry Electronic Tube Division, Gainesville, Florida.

### V BAND CAPABILITY

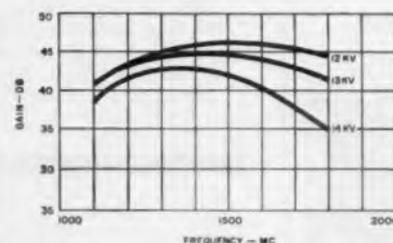
Among Sperry's other interesting activities in pulsed TWT's is the extension of capability into the V Band—26.5 to 40.0 kMc. Although these efforts are largely classified, inquiries are invited from those who have the necessary clearance and need to know.



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



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



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



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ELECTRONIC DESIGN • December 6, 1961

# EDITORIAL

## Are You Ready for Peace?

"To secure peace, prepare for war." Yet each new advance in the destructive power of our weapons increases the pressure for a reasonable form of disarmament.

It is generally agreed that the electronics industry, with sympathetic government aid, somehow will survive an "outbreak of peace", but what happens to those who have devoted their careers to the acquisition of skills for which the demand would be reduced drastically?

In time, the electronics industry will recover. Here and there, individual engineers have already taken the long-term view and established themselves in relatively stable commercial and industrial electronic fields. In the main, however, the opportunities for such mobility are limited, and we continue in our jobs, worrying or not worrying, as the case may be.

An intelligent man, however, worries to some purpose. When properly applied, worry is an effective catalyst for individual action.

The applied worrier might, therefore, ask two basic questions:

How well qualified am I for employment in nonmilitary areas of electronics? And, what is my company doing to diversify?



The two questions are related, for a company is not just machinery and finances, but the expression of the professional skills and interests of its employees.

If a company is to move successfully into nonmilitary activities, the impetus must come from within, not from above. The specialists who cannot adapt will find themselves in trouble.

What do you know about the potentials and problems of medical electronics, industrial control, consumer electronics, instrumentation, data processing?

What professional books and magazines do you read? What graduate courses do you take? What conferences do you attend? To what professional groups do you belong? What do you talk about at coffee breaks and around the lunchtime chess game?

Each of these areas presents an opportunity to diversify professionally. Why not grow with an eye to the future?

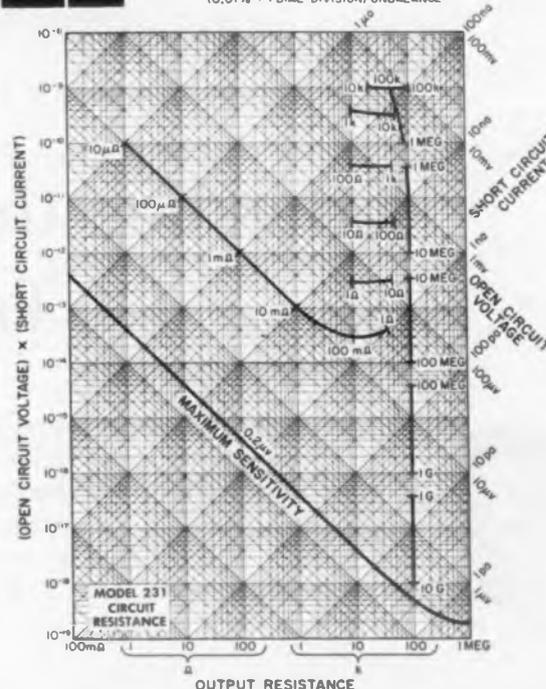
*Manfred W. Weisels*



**esi**

## new graphic method\* for analyzing BRIDGE PERFORMANCE

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### An example of ESI leadership in precision measurement techniques and instrumentation

Electrons have known and understood bridge performance ever since Christie invented the Wheatstone bridge in 1833.

The equations for calculating bridge performance have been known and used almost as long.

The ESI graphic method, illustrated above by a bridge performance graph of the Model 231 Guarded Wheatstone Resistance Measuring System provides a simplified means of determining whether any particular combination of bridge and detector will have sufficient sensitivity to make a measurement to the precision required.



MODEL 231

Specifically, this new graphic approach provides a convenient and useful technique for:

1. Separating the bridge and detector performance.
2. Determining optimum detector control settings.
3. Quickly predicting measurement sensitivity of a new detector over the entire bridge range.
4. Comparing the performance of different bridges for a specific measurement.
5. Determining measurement sensitivity.
6. Determining necessary supply voltages.

*Design Ideas*, ESI's quarterly technical bulletin, presents bridge performance graphs for the ESI Model 250-DA Universal Impedance Bridge; the Model 291-A Universal Impedance Measuring System; the Model 231 Guarded Wheatstone Resistance Measuring System; and the Model 242 Kelvin Resistance Measuring System. This issue also discusses in detail the techniques for constructing generator and detector curves.

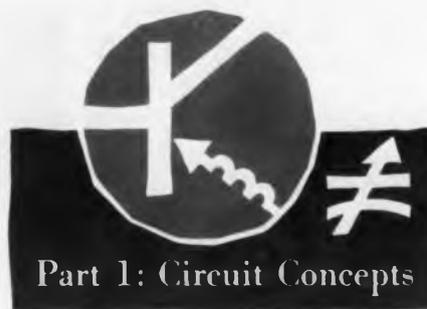
For additional information, send for "Design Ideas," Volume II, No. 1 and current ESI engineering bulletins on this subject.

\*Jack C. Biley, Director of Technical Services, Electro Scientific Industries—"A New Approach to Bridge Sensitivity", ISA Winter Instrument-Automation Conference and Exhibit, January 17-19, 1961 (Preprint No. 23-51-61).

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Part 1: Circuit Concepts

# Extending the High-Frequency Response Of Transistor Amplifiers



*The high-frequency performance of transistor circuits is limited by small inductances in the emitter circuit. W. A. Rheinfelder, in the first of a two-part article, describes his step-by-step development of a technique to neutralize the detrimental inductance effects. In the second part, he will describe practical circuits illustrating the technique. Performance data on high-frequency improvement will be included.*

**W. A. Rheinfelder**  
Staff Scientist  
Motorola, Inc.  
Semiconductor Products Div.  
Phoenix, Ariz.

**H**IGH-FREQUENCY transistor limits can be extended and circuit gain increased through a new technique that neutralizes the detrimental effect of emitter inductance. This parameter has a serious effect on the high-frequency performance of transistor circuits. Equivalent circuits presently used to explain the operation of transis-

tors can be very misleading and should be treated with utmost care. Many times one is led to believe that a circuit, such as a hybrid- $\pi$ , permits the accurate calculation of high-frequency performance. It is not generally recognized that all transistor parameters are not only functions of current but also of frequency, and that these circuits are at best a guide useful over a small frequency range.

### Internal Feedback Not Considered In Present Equivalent Circuits

Among several effects virtually neglected in presently accepted equivalent circuits are the internal feedback paths in transistors. For example, the base-emitter capacitance  $C_{b'e}$  contains a component that is due to internal Miller effect and exists even with the output shorted, because of intrinsic collector resistance and high transconductance,  $g_m$ . Also, as will be shown, an emitter inductance as small as 10 nh in conjunction with a  $C_{b'e}$  of 10 pf produces a resistive input component that reduces  $R_{i_{in}}$ , for example, from 1,000 to 330 ohms at 100 mc. This effect follows at least a 6-db/octave curve and by itself could explain the loss of high-frequency power gain

in transistors in a manner that is quite different from equivalent circuit concepts presently in vogue.

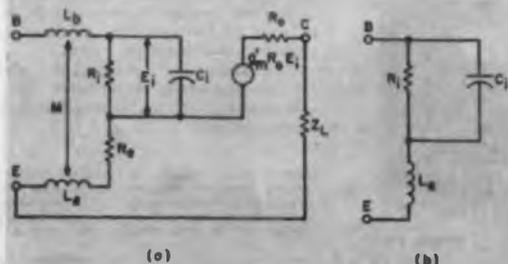
Similar effects are observed in tubes, but their magnitudes are much smaller because of the lower  $g_m$ . In transistors, the intrinsic  $g_m$  of the junction can be as high as 500,000  $\mu$ mhos, or more, although the effective  $g_m$  is much lower due to internal and external emitter impedances. An impedance of only 2 ohms, for example, reduces ( $g'_m$ ), by roughly 50 per cent. Also, it easily can be calculated that with a load resistance of only 10 ohms, a voltage gain of 5 would be obtained through the use of  $g'_m$  in the standard formula. Since the intrinsic collector resistance of a transistor is usually much higher than 10 ohms, the internal voltage gain and Miller effect—with output shorted—could be very high.

Considerations of this kind lead to very different equivalent circuits.  $R_{b'e}$  and  $C_{b'e}$  are no longer constants, but depend rather on the effectiveness of bypassing the emitter and can change drastically. The same is true for the parallel output resistance and capacitance of the transistor.

### Three Factors Influencing Total Emitter Inductance

The total emitter inductance includes primarily (1) the inductance of the bonding wire from the emitter to the header pin, (2) the inductance of the transistor's emitter lead and (3) the inductance of external leads and parts associated with the emitter circuit.

While certain improvements can be made to decrease the internal emitter inductance by careful design of the transistor case and header, the advantage gained is small due to



**Fig. 1.** Equivalent circuit (a) simplifies to (b) for computing power-gain loss caused by reduction in  $R_{i_{in}}$ .

the larger inductance normally inherent in external circuitry.

Total lead lengths, however, including the emitter lead as well as those of associated circuit parts between the header of the transistor and input ground, do become important considerations.

These problems are not resolved through the use of heavy interconnecting wires since the inductance is determined primarily by the lead lengths rather than the diameter. It is necessary, therefore, to develop methods for the removal of the detrimental effects caused by these inductances.

#### Calculation of Losses Due to Emitter Inductance

For convenience, power gain is evaluated using the formula:

$$G_e = \frac{g_m^2 R_{in} R_L}{4} \quad (1)$$

The total emitter inductance of a typical transistor with short lead length<sup>1</sup> is about 13.5 nh. The reactance at 100 mc is then 8.5 ohms. In series with this reactance is an ohmic resistance of 0.35. It has been shown that skin effect in transistors of small physical size, such as the 2N700 mesa, is small and can be ignored. Let us then see how the seemingly small inductance of 13.5 nh affects high-frequency performance.

The loss in  $g_m$  is determined by<sup>2</sup>

$$g_m = \frac{g'_m}{1 + g'_m Z_e} \quad (2)$$

where

$g_m$  = effective transconductance,  
 $g'_m$  = intrinsic transconductance, and  
 $Z_e$  = emitter impedance.

With

$g'_m = 0.2$  mhos and  
 $Z_e = R + jX_L = 0.35 + j8.5$

solution of Eq. 2 yields:

$$g_m = 0.49 g'_m$$

The loss in power gain due to loss in  $g_m$  is therefore 6.1 db (from Eq. 1).

The equivalent circuit of the transistor, shown in Fig. 1a, is used to compute the reduction in  $R_{in}$ . Neglecting  $L_b$ ,  $R_e$  and  $M$ , the circuit is shown in Fig. 1b. Using the loop equations and certain manipulations,<sup>3</sup> the load impedance in the output drops out, and the input admittance is expressed as follows:

$$Y = (G_i + jB_i) \left[ 1 - \frac{g'_m + G_i + jB_i}{g'_m + G_i + j(B_e + B_i)} \right] \quad (3)$$

Separating real and imaginary parts, the input resistance is:

$$R_b = \frac{(g'_m + G_i)^2 + (B_e + B_i)^2}{B_e G_i (B_e + B_i) - B_e B_i (g'_m + G_i)} \quad (4)$$

With only a small error, this simplifies to:

$$R_b = \frac{g'_m{}^2 + B_e^2}{B_e (B_e G_i - B_i g'_m)} \quad (5)$$

Typically the values for a 2N700 mesa are:

$g'_m = 0.2$  mhos  
 $G_i = 10^{-3}$  mhos  
 $B_e = -0.118$  mhos  
 $B_i = (6.2)10^{-3}$  mhos.

This assumes a capacitance from  $b'$  to  $e$  of 10 pf. Calculating  $R_b$  from expression 4:

$$R_b = 330 \text{ ohms}$$

The input resistance was therefore decreased from 1,000 ohms to 330 ohms due to the action of the inductance of 13.5 nh. The loss in power gain, from Eq. 1, is 4.8 db.

#### Summary of Losses Calculated at 100 mc.

The loss in power gain due to inductance of 13.5 nh in the emitter of the 2N700 mesa is thus found to be 10.9 db at 100 mc. (6.1 db due to reduction in  $g_m$  and 4.8 db due to reduction in  $R_{in}$ ).

The loss, of course, is considerably higher at frequencies above 100 mc. The input resistance decreases approximately with the square of the frequency; therefore the power loss increases at a 6-db/octave rate. Loss of  $g_m$  also increases with frequency.

The intrinsic  $g_m$  ( $g'_m$ ) used in the above calculations was conservatively chosen at 0.2 mhos. In actual practice, measurements have shown  $g'_m$  values of up to 1.0 mho. The actual losses in practical circuits, therefore, can be expected to run much higher than the calculated losses, as shown later in this article.

#### Methods of Bypassing In Tuned Amplifiers

While in wide-band amplifiers the problem must be solved by short total lead length, there are various methods of effective bypassing in tuned amplifiers, some of which have been known in a less effective form for some time. A discussion of the various steps taken in designing effective bypassing follows. Fig. 2a shows conventional emitter circuitry. The emitter bias resistor, typically 220 ohms, is bypassed with a 0.001  $\mu$ f capacitor. Internal emitter inductance from junction to end of emitter lead is designated  $L_1$ . This conventional circuit will be regarded

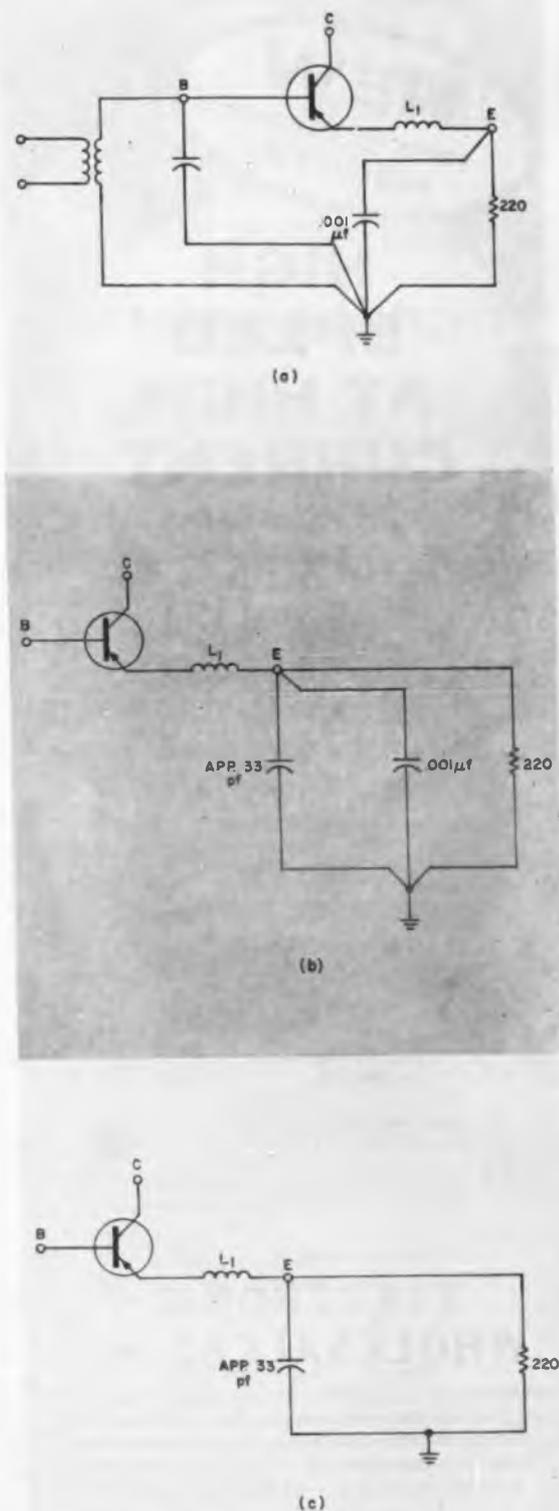


Fig. 2. Various steps taken in designing effective bypassing to neutralize detrimental effect of emitter inductance.

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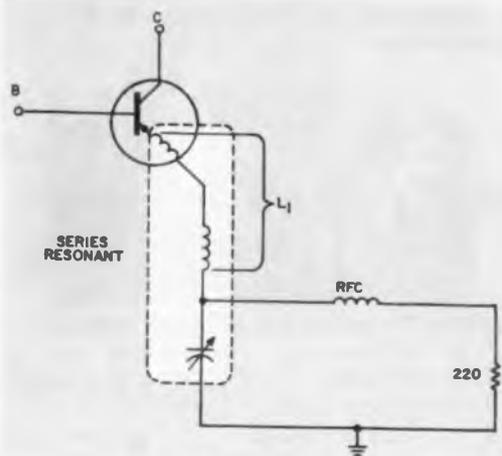


Fig. 3. Final bypass circuit uses rf choke to isolate effect of emitter bias resistor on series-tuned circuit.

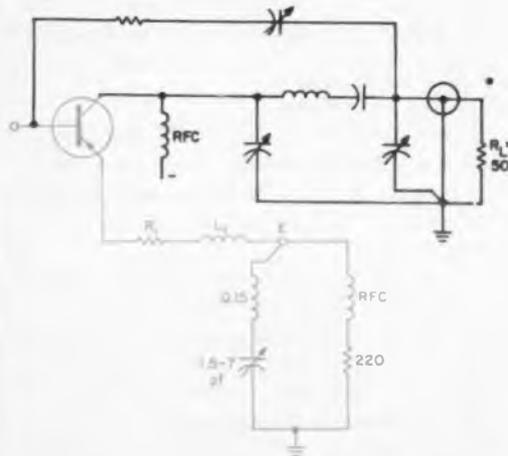


Fig. 4. This circuit effectively utilizes the intrinsic  $g'_m$  of the transistor to provide very high power gains.

as the reference case and all other circuits will be compared with it.

Considering that the bypass capacitor shown contains series inductance and is, therefore, a poor bypass capacitor, a series resonant capacitor might be connected in parallel (Fig. 2b). Such a series resonant capacitor may be selected using a grid-dip meter, whereby the leads of the capacitor are connected and the resonant frequency is determined. The lead length may be trimmed and the capacitor value selected for a particular frequency. For 100 mc, a value of from 30 to 43 pf will be found. Using the grid-dip meter to determine resonance, however, is not very accurate. In joining the leads, the

inductance of the capacitor is increased. Also a resonance including  $L_1$  is desired. Therefore the final adjustment should be made in the circuit.

It is also found that the inductance of the parallel 0.001  $\mu$ f capacitor can form a parallel resonant circuit with the newly installed capacitor. This tends to obscure the effect, and in some cases the gain actually is decreased. The 0.001  $\mu$ f capacitor is therefore removed, as shown in Fig. 2c.

This circuit gives a definite increase in gain with the proper capacitor; however the increase is disappointingly small—less than 6 db, while theoretically much larger figures should be possible.

From Fig. 2c it becomes evident that the parallel resistance reflects a series resistance into the series-tuned circuit. Therefore the Q is very low and the series resistance at resonance very high, resulting in a very "lossy" capacitor.

In order to remedy this situation, an rf choke is used, as shown in Fig. 3, to isolate the effect of the emitter resistance. Also a variable trimmer has been installed because the Q now becomes quite high and a continuous adjustment becomes necessary.

This circuit leads to quite acceptable results. An external series coil may be used to reduce the size of the tuning capacitor at low frequencies. Because of the reduction in Q, however, use the smallest series coil, which leads to the desired results.

### Stability, Input and Output Are Impedance Factors

The Q of the series-resonant circuit in Fig. 4 is determined mainly by  $R_e$ , the equivalent emitter series resistance. This is very close to the intrinsic emitter resistance,  $r_e$ , and is a function of emitter current. By changing the emitter current, the Q of the series-resonant circuit can be changed but the resonance frequency is unaffected and remains constant.

The circuit in Fig. 4 provides effectively the intrinsic  $g'_m$  of the device. Therefore, it may be approximated

$$g'_m \sim \frac{1}{r_e} \sim \frac{J_e}{25} \quad (\text{for germanium, } J_e \text{ in ma}) \quad (6)$$

An emitter current of 5 ma results in a  $g'_m$  of 200,000  $\mu$ mhos. The circuit in Fig. 4 is designed to utilize this high  $g'_m$  and provide very high power gains even with small load resistances.

The approximate voltage gain is:

$$A \sim \frac{g'_m R_L}{2} \quad (7)$$

and the power gain:

$$G \sim \frac{g_m R_{in} R_L}{4} \quad (8)$$

The values to be used in the equations are those measured in the practical circuit including effects due to feedback in the emitter. As the feedback is decreased,  $g_m$  approaches  $g'_m$ ,  $R_{in}$  increases because of phase shift action, and  $R_{out}$  decreases as the current feedback is decreased. In a cascade of stages, this means that the matching ratio is reduced considerably.

The high gain results in a tendency towards oscillation in small signal amplifiers, due to feedback capacitance from collector to base. Stability is solely a function of voltage gain, not power gain. It is well known that by mismatching at the output, voltage gain may be decreased at little or no expense in power gain. Typically, a load of one-fourth the output resistance decreases voltage gain by 8 db at the expense of 2 db in power gain. This 2-db loss normally can be offset by a better interstage network whose losses decrease with the matching ratio. Therefore the over-all power gain in a cascaded amplifier configuration may remain unchanged, although the stability has been greatly increased.

This means of mismatching is generally used in rf-amplifier design. However, with the circuits under investigation here, the gain may become so high that neutralization is necessary even in the mismatched condition. For example, the neutralization may be taken from the output of a pi-network to the base; this is the so-called capacitive output bridge.

All neutralizations using an output bridge are load-sensitive, and insensitive to changes in source resistance. This is desirable where the load is fixed and parameters in the input circuit may vary. Neutralization is adjusted by maximizing the backward loss. The series resistor is adjusted in steps for a deeper null. Neutralization also may be set with a sweep generator by adjusting for symmetrical bandpass characteristic. Both methods lead to the same setting but the sweep method is more desirable in that the bandpass action of all tuned circuits may be observed simultaneously. ■ ■

#### References

1. Motorola Application Report No. 64, "Effects of Lead Inductance on High Frequency Transistors."
2. Martin, Electronic Circuits, Prentice Hall, 1955, Section 3.10.
3. Sturley, Radio Receiver Design, Vol. I, 2nd Edition, Wiley, 1953, Part I, Similar Calculations on p 86.

# NEW! MICRO LOGIC TWINS!

Offering specifications never before available in micro components

## Ultra fast triple diffused planar

### LOGIC SWITCHING MICRO TRANSISTOR

# 2N2214

- $h_{FE} > 20$  @ 100 $\mu$ A and 3.0 Volts
- $T_s < 20$ ns @ 10mA ●  $I_{CBO} < 5$ nA @ 15 Volts ●  $V_{CE}(\text{Sat}) < .15$  Volts @ 100 $\mu$ A

#### MICRO-TRANSISTOR SPECIFICATIONS

##### ABSOLUTE MAX. RATINGS:

$V_{CE0}$	15 Volts
$V_{CER}$ (R=10 $\Omega$ )	20 Volts
$V_{CBO}$	25 Volts
$V_{EBO}$	5 Volts
Power Dissipation @ 25°C	250 Watts

##### ELECTRICAL SPECIFICATIONS:

	MIN.	MAX.
$h_{FE}$		
$I_C = 10$ mA; $V_{CE} = 1.0$ V.	25	
$I_C = .1$ mA; $V_{CE} = 3.0$ V.	20	
$C_{ob}$		7 pf
$V_{CE}(\text{SAT})$	$I_C = 10$ mA; $I_B = 1.0$ mA	0.2 V
	$I_C = .1$ mA; $I_B = .01$ mA	0.15 V
$V_{BE}(\text{SAT})$	$I_C = 10$ mA; $I_B = 1.0$ mA	.75V .85V.
	$I_C = .1$ mA; $I_B = .01$ mA	.60V .70V.
$T_s$	$I_C = 10$ mA; $I_{B1} = I_{B2} = 10$ mA	20 ns
$I_{CBO}$	$V_{CB} = 15$ V. @ 25°C	5 nA
	$V_{CB} = 15$ V. @ 150°C	5 $\mu$ A
$I_{EBO}$	$V_{EB} = 5$ V.	5 nA

These brand new micro devices are ideal companions for use in advanced designs of high performance microminiaturized logic circuits. In the various configurations available they lend themselves admirably to all assembly techniques... "swiss cheese", "cordwood", "wafer" and the ultimate in microminia-

### HIGH CONDUCTANCE LOGIC MICRO-DIODE

# 1N3567

- $t_{rr} < 2$ ns - (10mA to -6 Volts)
- $C_0 < 2$ pf @ 0 V. ●  $I_f > 100$ mA @ 1V.
- Rectification Efficiency > 60% @ 100mc

#### MICRO-DIODE SPECIFICATIONS

##### ABSOLUTE MAX. RATINGS:

PIV	50 volts
$I_0$	60 mA
Power Dissipation @ 25°C	.150 watts
Surge Current	1 second .500A 1 $\mu$ second 2.0 A

##### ELECTRICAL SPECIFICATIONS:

	MIN.	MAX.
$I_f$	1 V.	
$I_b$	50 V. @ 25°C	100 mA
	@ 150°C	.05 $\mu$ A 25 $\mu$ A
BV	100 $\mu$ A	75 V.
C	0 V.	2.0 pf
$t_{rr}$	10 mA to -6 V. Recovery to 1 mA Lumatron Circuit	2.0 ns
Rectification Efficiency		60%
	100 mc; 2.0 $V_{rms}$ $R_L = 5K\Omega$ ; $C_L = 20$ pf	

turization—the PSI "pico" approach. Another reason it will pay you to "look first to PSI" for micro-components, transistors and all your requirements for silicon diodes, rectifiers, zeners and welded assemblies. For full details ask for your copy of the new 16-page PSI Micro-Electronics Brochure.

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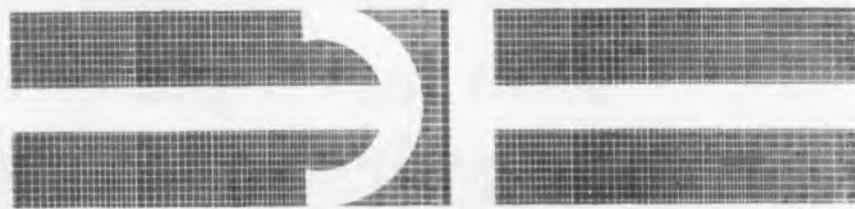


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CIRCLE 37 ON READER-SERVICE CARD

# Capacitor Survey Pinpoints



## User Needs And Opinions

*More than 1,000 domestic user-manufacturers of capacitors spoke their minds in the first comprehensive survey of the market. The study, made by the Film Dept. of E. I. du Pont de Nemours & Co., revealed, for example, that engineers are only vaguely aware of the cost competition in capacitors.*

**T**HE FIRST national survey of the needs and opinions of the users of 1.2 billion capacitors has been completed by the Film Dept. Marketing-Research Section of E. I. du Pont de Nemours & Co.

The investigation covered:

- Principal types and end-uses of electronic capacitors in 1960.
- Distribution among consumer, industrial and military markets.
- Uses, by types of capacitor insulation materials.
- Engineers' opinions on performance characteristics and cost of insulation materials.
- Improvements needed in capacitors.

In addition, interviews revealed how users select capacitor types, and from what channels of distribution they are purchased. Through questionnaires, interviews and telephone rechecks of non-respondents, Du Pont analysts obtained data from about 85 per cent of the 1,007 domestic user-manufacturing plants queried.

One of the most interesting aspects of study was the rating of seven insulating materials in eight performance areas. These areas were cited as the most important limit-

ing factors in capacitor selection. The ratings appear in box form elsewhere in this article.

Since the respondents were component engineers most knowledgeable about capacitor insulation materials, their ratings for the eight technical areas reflect accurately the actual performance of each type.

In a ninth "performance" category, that of the relatively low cost of capacitors made of the various dielectrics, the study showed that engineers are not fully aware of the close cost competition among them. Although paper and ceramic capacitors were correctly listed by many of the respondents as the cheapest units, capacitors of Mylar polyester film, which also belong in this category, were rated at the bottom of the list on cost. Even metallized and electrolytic capacitors, recognized as among the highest priced, received better ratings as low-cost items than did those of Mylar.

### Overlapping Availability Charted in 3 Categories

The availability overlap among insulating materials, charted by capacitance, voltage and price, was developed in another section of the survey. Each major insulation system was charted for that portion of the capacitor market for which it competes. These plots were made within coordinates of capacitance ranging from 10 pf to 100  $\mu$ f, and voltages from 3 to 1,000 v dc. It is estimated that within these coordinates are represented 95 per cent of the capacitors made in the United States.

The range in capacitance and voltage for each insulating material is as follows:

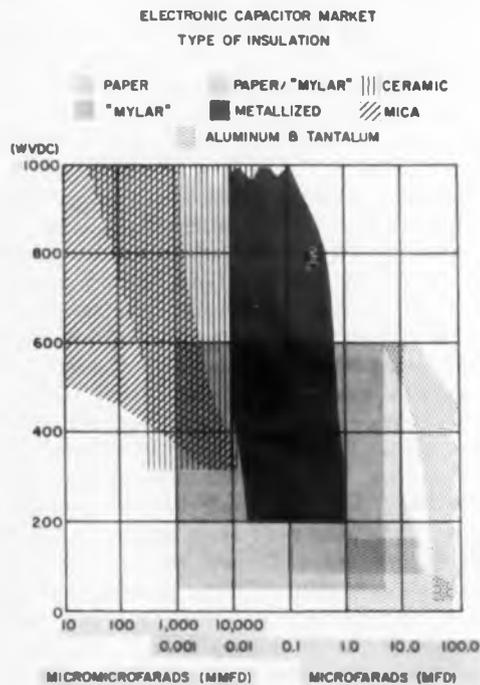
Mylar	0.0001 to 5.0 $\mu$ f; 50 to 600 v
Paper	0.001 to 1.0 $\mu$ f; 200 to 1 kv +
Mylar-paper	0.009 to 0.9 $\mu$ f; 200 to 1 kv +
Metallized paper & film	0.09 to 20 $\mu$ f; 100 to 600 v
Ceramics	500 pf to 0.1 $\mu$ f; 300 to 1 kv +
Mica	10 to 10,000 pf; 300 to 1 kv +
Tantalum	
Electrolytics	1.0 to 100 $\mu$ f; 3 to 150 v
Aluminum	
Electrolytics	8.0 to 100 $\mu$ f; 10 to 600 v

A master plot of the availability of capacitors made of the eight insulation types shows the major overlaps in ratings lie between 0.001 and 1.0  $\mu$ f and between 200 and 600 v (see Fig 1).

Within the overlap area established for capacitance and voltage, costs of most types of insulation were found to be very similar. For example, ceramics are the least expensive units at the lower levels of capacitance and voltage, but gravitate toward the more expensive at upper-performance levels. Units of Mylar are the next cheapest at lower capacitance and voltage levels, become the lowest in cost in the 0.01 to 0.5  $\mu$ f and mid-voltage range and switch this position with paper at the 0.5 to 1.0  $\mu$ f level.

### Price of Paper Units Tops That of Films, Ceramics

In the lower capacitance and voltage levels, paper is plotted somewhat higher in cost than the film and ceramic types. The combinations of Mylar and paper are rated slightly above the individual films. Mica is shown as the highest cost material in the 10 to 10,000 pf range. In the area between 0.01



A master plot of the availability of capacitors made of the insulation types shows the major overlap in ratings to lie between 0.001 and 1.0  $\mu\text{f}$  and between 200 and 600 v.

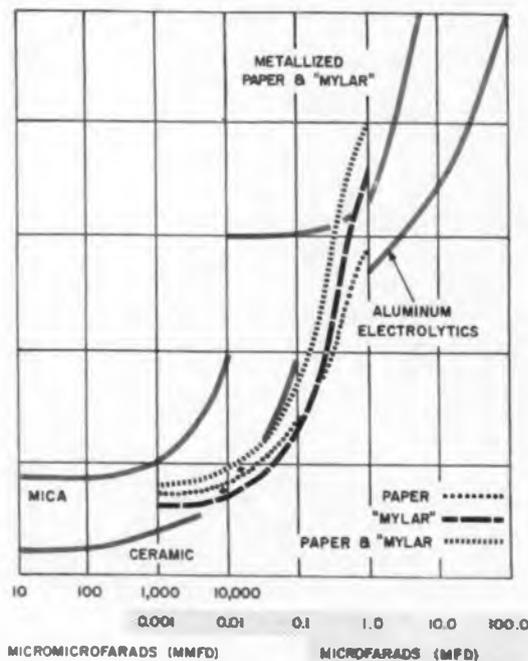
and 5.0  $\mu\text{f}$ , capacitors of metallized materials start as the highest cost items but become competitive with other systems at the upper levels of capacitance and voltage.

Tantalum electrolytics are well above the plotted range and are not shown on the chart.

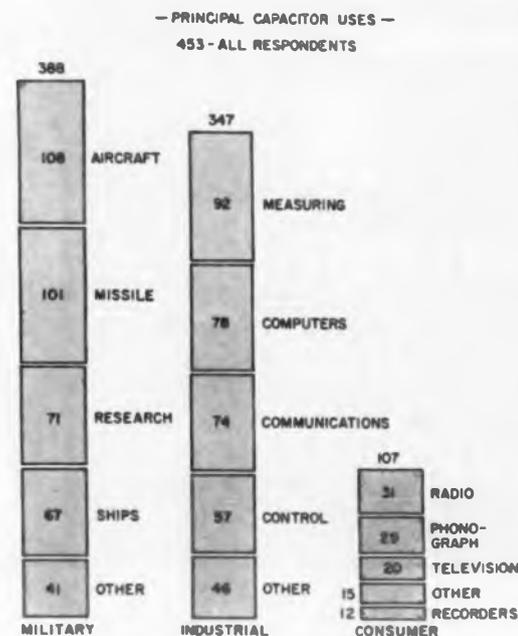
Another aim of the Du Pont survey was the plotting of end-uses of capacitors within each of the three basic markets—military, industrial and consumer. Among the 453 respondents to the question on principal uses for capacitors, 388 identified military applications, 347 industrial and 107 indicated consumer uses. Capacitor uses within each category break down as follows:

Military—aircraft, 108; missiles, 101; research, 71; ships, 67; other, 41. Industrial—measuring, 92; computers, 78; communications, 74; control, 57; other 46. Consumer—radio, 31; phonograph, 29; television, 20; recorders, 12; other 15.

However, the survey also showed that, while there are more capacitor-using plants in military business than in either of the



Cost comparison for typical large-use capacitors was difficult to generalize because of case construction, environmental and reliability specifications. The study did provide an "order of magnitude" for cost comparison for the various insulation systems.



While there are more capacitor-using plants engaged in military business than in either of the other two categories, there are more capacitors (51 per cent) going into consumer applications than in the other two categories combined.

### Survey of Insulating-Material Performance

Performance Area	Insulating Material By Rating						
	1	2	3	4	5	6	7
Highest Capacitance For Smallest Size	Electrolytic	Metallized Films	Ceramic	Mylar	Paper	Mica	Teflon
Reliability	Mica	Mylar	Ceramic	Paper	Teflon	Electrolytic	Metallized Films
Capacitance Stability	Mica	Mylar	Ceramic	Teflon	Paper	Metallized Films	Electrolytic
Temperature Range	Teflon	Mica	Ceramic	Mylar	Paper	Metallized Films	Electrolytic
Voltage Life	Mica	Mylar	Ceramic	Teflon	Paper	Metallized Films	Electrolytic
Moisture Resistance	Mylar	Teflon	Mica	Ceramic	Paper	Metallized Films	Electrolytic
High Insulation Resistance	Mylar	Teflon	Mica	Ceramic	Paper	Metallized Films	Electrolytic
Low Loss	Mica	Teflon	Mylar	Ceramic	Paper	Metallized Films	Electrolytic

## MICROWAVE ASSOCIATES PROGRESS REPORT



# Microwave Power from Varactor Diodes

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

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

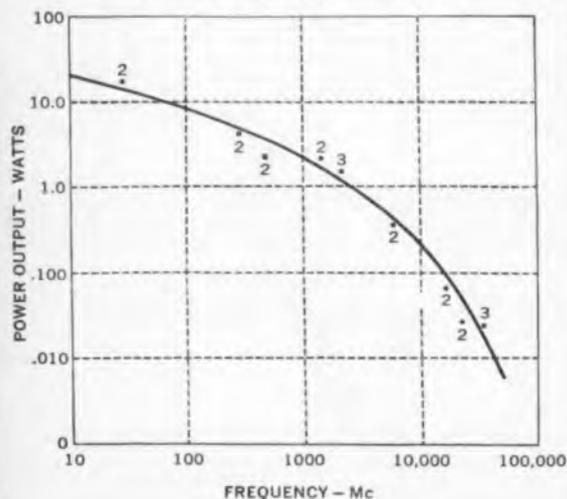
Efficiencies of these units range from 80 — 90% in the UHF region and from 20 — 30% at X-band. At present, the highest efficiencies are achieved at relatively narrow bandwidths (1%—2%). However, our capabilities are rapidly improving efficiencies for broader band operation. An example of a fixed-tuned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

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

Our progress in producing efficient microwave

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ALL SOLID-STATE  
FREQUENCY MULTIPLIERS  
Power Output (vs) Frequency



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

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

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



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other categories, 51 per cent of the capacitors go into consumer products.

One question, answered by 375 capacitor users who consume 417 million units a year (about 35 per cent of the total users and units), breaks down the percentage use of capacitors by insulating material and identifies the number of each type devoted to consumer and non-consumer uses. The data developed here differ in part from those reported by the joint survey of the Electronic Production Resources Agency of the Dept. of Defense and the Business and Defense Services Agency of the Dept. of Commerce. The Du Pont analysts, however, believe their finding represents a more detailed analysis of the distribution pattern than does the government study.

These new volume figures are: ceramics represent 28.3 per cent of all electronic capacitors used, 70 per cent of them for consumer use; paper, 20.8 per cent of market, 50 per cent consumer; electrolytic, 18.3 per cent of market, 50 per cent consumer, Mylar polyester film, 13.4 per cent of market, 45 per cent consumer; mica, 11.1 per cent of total, 40 per cent consumer; metallized, 7.4 per cent of market, 25 per cent consumer; other (Mylar-paper, etc.), 0.6 per cent of market, 15 per cent consumer; Teflon TFE, 0.1 per cent of total produced, 40 per cent consumer uses.

The "how" of capacitor selection by engineers was studied through interviews. The factors users must consider once a circuit has been designed, were tabulated.

The first factor in selection is capacitance and, for critical work, tolerance limits for this capacitance. Next is the rated voltage that the capacitor must take. Then come the special electrical and environmental characteristics that apply to the eventual use of the circuit.

Once these three basic parameters are resolved, the analysts learned, a balance must be reached between price vs size vs over-all performance requirements. The final decision involves acceptance of brand names.

### Most Capacitor Sales Made Directly to Users

The study also determined that between 80 and 90 per cent of all capacitor-manufacturer sales are direct to the users—the original-equipment manufacturer. The remainder go to electronic distributors who, in turn, resell a little more than half of their capacitors to the original-equipment producers. Thus the replacement side of the

market is estimated at 7 or 8 per cent of total production.

Historically, sales of electronic capacitors have fluctuated with general business activity, but there have been changes in the pattern of sales among the three basic types—paper and film, electrolytics, and all others.

Statistics maintained jointly over the past five years by the Electronic Production Resources Agency and the Business and Defense Services Agency show that, in 1955, sales of electrolytic types amounted to about \$55 million and those for paper and film to about \$90 million. By 1958, a low sales year, the two types were in balance at about \$68 million. By 1960, however, the electrolytics had taken the lead over the paper and film types—\$84 million to \$66 million. Total sales for all other types maintained a relatively stable position over the period, ranging from about \$60 million in 1955, to a low of \$37 million in 1958, back to the 1960 level of \$74 million.

The final section of the survey, dealing with improvements suggested by users, brought responses from 82 per cent of those queried. The top five areas for suggested improvements are: high capacitance/small size, over-all reliability, capacitance stability, temperature range and low cost.

#### Areas of Improvement Suggested By Users

Typical of the hundreds of comments on possible improvements were:

- "The proper selection of a type will cover all the electrical requirements—what is needed is more on the reliability end—we are shooting for 0.001 per cent per 1,000 hours."

- "We use wet tantalum capacitors in timing circuits—improvements in retrace, lower leakage, and temperature stability would help."

- "Would like to see high voltage capacitors improved in stability over temperature range—and a tantalum capacitor with high voltage characteristics."

- "Need construction of units compatible with automated assembly methods."

- "Want electrolytics with high capacity 20-20-20  $\mu$ f, 500-600 v dc working in short 1-3/8-in. cans—computer quality for printed-circuit boards."

The Du Pont findings have been compiled in a report for those who participated. A copy may be obtained from the Industrial Sales Div., Film Dept., E. I. du Pont de Nemours & Co., Wilmington 98, Del. ■ ■



#### Proved in performance

## THE TUNG-SOL LINE OF HIGH-POWER GERMANIUM TRANSISTORS

#### ■ WIDELY INTERCHANGEABLE ■ MORE FLEXIBLE IN APPLICATION ■ UNIFORMLY RELIABLE

For several years Tung-Sol has been manufacturing high-power germanium transistors to the industry's most exacting standards of electrical and mechanical reliability.

They have proved themselves efficient and fully reliable in countless installations, providing rugged, long-life performance for equipment in commercial and military use.

As further proof of peak performance, the fact may be cited that Tung-Sol's complete line of high-power transistors includes the JAN 2N174 and USA 2N1358, fully inspected and guaranteed to their respective MIL specifications.

The Tung-Sol line offers widest applicability in high-power amplifiers, DC-to-AC converters, DC-to-AC inverters, regulated power supplies, motor controls, servo amplifiers, relay drivers and high-power switches.

Designed for wide interchangeability, they may be specified for new, improved equipment. Their features of vacuum-tight, copper-to-copper "Cold-Welded" sealing increase design flexibility and make them more reliable. Stud-mounted, single-end construction, with solid-lug terminals, simplifies

installation in all chassis and allows sufficient heat-sink design.

Ask your Tung-Sol representative for full technical details, or write: Tung-Sol Electric Inc., Newark 4, N.J. TWX: NK 193.

#### TUNG-SOL HIGH-POWER GERMANIUM TRANSISTORS

TYPE	MAXIMUM RATINGS (25°C)				TYPICAL VALUES (25°C)			
	V <sub>ce</sub> Volts	V <sub>ce</sub> Volts	I <sub>c</sub> A	T <sub>J</sub> °C	MAX. I <sub>CM</sub> Ma	h <sub>FE</sub>	f <sub>osc</sub> Mc	MAX. T <sub>h</sub> °C/W
2N173	-80	-80	18	100	8	82	10	.8
2N174*	-70	-80	18	100	8	37	10	.8
2N174A	-70	-80	18	100	8	37	10	.8
2N277	-40	-40	18	100	8	82	10	.8
2N278	-48	-80	18	100	8	82	10	.8
2N441	-40	-40	18	100	8	30	10	.8
2N442	-48	-60	18	100	8	30	10	.8
2N443	-60	-60	18	100	8	30	10	.8
2N1099	-70	-80	18	100	8	82	10	.8
2N1100	-80	-100	18	100	8	37	10	.8
2N1358*	-70	-80	18	100	8	37	10	.8
2N1419	-80	-100	18	100	8	37	10	.8
2N1970	-80 (1)	-100	18	100	4	29	10	.8

(1) BV<sub>CEO</sub>

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\*Also available in military versions.

 TUNG-SOL

CIRCLE 39 ON READER-SERVICE CARD



# Printed-Circuit Boards: An Evaluation of Fabricating Techniques

Part 2 of a 2-part series.

**Walter J. Prise**  
Design Specialist  
Missile & Space Div.  
Lockheed Aircraft Corp.  
Sunnyvale, Calif.

**F**ROM a careful study of the four printed-circuit-board production processes presented in the first article, it was hoped to select the best fabrication procedure. However, it was recognized that each process has its problem areas; each requires step-by-step quality control measures to assure a trouble-free end product. Thus, in selecting a production method, the process should be compared with the following factors in mind:

(a) the number of steps involved in the process, and their complexity

(b) the effect of the manufacturing process on characteristics of the finished printed-circuit board

(c) expected behavior and reliability of the printed-circuit board in certain environmental applications

(d) actual characteristics of the printed-circuit board as compared with its desirable characteristics

(e) difficulty in application of the product-control techniques

Based on these factors, the important production features of each of the processes are summarized below.

## ***Process A*** ***Solder-Coated Eyeletted Board***

### **Advantages**

Simplicity of process and small number of steps aid quality control.

Small number of chemical steps reduces chance of contamination.

Solder is simple to apply and is a quite reliable conductor.

Eyelet offers strong mechanical joint.

*Presented are the findings and recommendations of Lockheed's survey of printed-circuit-board manufacturing techniques. Part 1, appearing in ED, Nov. 22, p 42, was a guide to common production procedures.*

### **Disadvantages**

Pressure control is necessary for installation of an eyelet.

Thermal cycling may lead to opening between eyelet and baseboard foil.

Protective coating on eyelets is needed to prevent oxidation.

Damage to eyelet by application of poor tool is possible.

Residue of etching solution may contaminate installed eyelet.

Reheating may cause electrical discontinuity between foil and eyelet.

Variation in thickness of baseboard affects quality of juncture.

These have been the general features of process A. Additional factors must be considered when either the flat or funnel eyelet is used, as in processes 1A and 1B. These eyelet types are compared next.

The principal difference between part 1 and part 2 of processes A and C is in the use of eyelets. In part 1 of each process, flat eyelets are used. Part 2 uses funnel eyelets. As is to be expected, both flat and funnel eyelets have definite advantages and problem areas. Some of these are common to both types. Thus:

With the flat eyelet there is a lack of solder penetration between the eyelet and the conductive pattern. Inspec-

tion of solder penetration is difficult.

Flat eyelets require less vertical room and are easier to install.

Funnel eyelets assure better penetration of solder, take smaller land area, but require greater vertical clearance.

It is easier to insert wire through funnel eyelets.

Area of contact between body of the funnel eyelet and walls of the hole is relatively small. It is difficult to install this eyelet snugly without applying excessive pressure on the sides of the hole.

Excessive pressure may delaminate contact area of the board.

Flat eyelets require larger lands.

Rough edges on flat eyelets may cut and damage conductive trace.

Funnel eyelets are subjected to smaller internal stress in setting process.

Under thermal cycling, the flanges of flat eyelets may separate from the foil.

With both eyelets there are certain problem areas that cannot be eliminated:

Stress and vibration may cause the joint between eyelet and trace to open.

Uneven length of eyelets can lead to cracking due to localized stress.

If the cut-off on the eyelet is not straight, uneven stressing will result.

Pressure of eyelet causes the solder and conductive foil to separate.

Eyelets must be closely matched to size of hole.

## ***Process B*** ***Gold-Plated Through-Hole,*** ***Gold-Plated Conductive Pattern***

### **Advantages**

Plated through-hole eliminates need

for mechanical connection, provides an homogeneous uniform bond.

Metal in plated through-hole is less affected by vibration than an eyelet.

There is uniformity between plating of hole and land.

Installation can be inspected.

Size of hole is not critical.

#### Disadvantages

Strength of plated through-hole is less than that of an eyeletted hole.

Chemical contamination can readily occur due to the many chemical processes needed during plating.

Air bubbles encapsulated in plating can create voids.

Voids may trap contaminants.

Corrosion and contamination may have time-delayed action.

Plating process is difficult to control.

Defects in plating process may cause gold-plating to peel.

Provision for unplated holes requires additional production steps.

Because of porosity of copper plating, gold appears uneven.

Corner area of plated through-hole may shear.

Repair of plated through-hole is difficult; usually hole is replaced by eyelet.

Gold thickness should be greater than 0.000050 in. Surveillance and continuous control must be maintained.

Pinholes and voids may exist at the middle of a hole.

Corners inside of holes easily can be damaged.

Break in gold-plating will cause corrosion and underetching.

Contact between dissimilar metals may lead to electrolytic corrosion.

In vibration and shock, sections of plated metal may separate.

Resoldering of connector leads on board may destroy conductive pattern and plated metal in the hole.

Resoldering and reheating is difficult and may affect continuity of joint.

#### *Process IC Plated Through-Hole and Flat Eyelet*

#### Advantages

Redundancy of electrical path.

*the only one of its kind!*



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**CAPACITANCE BRIDGE:** 1 $\mu$ f to 2,000  $\mu$ f in five overlapping ranges, with laboratory accuracy.

**INSULATION RESISTANCE:** 50 megohms to 20,000 megohms. Only 25v d-c is applied, permitting measurements on low-voltage ceramic, paper, mica, and film capacitors. For ceramics rated below 25 volts, IR may be calculated from leakage current measurements at exact rated voltage.

**POWER FACTOR:** Measured by Wien Bridge from 0 to 50%.

**LEAKAGE CURRENT:** 0.6 $\mu$ a to 600 $\mu$ a in 7 ranges. Measured directly on meter at exact rated d-c voltage of capacitor. No guessing on eye-width or counting lamp blinks!

**A-C BRIDGE VOLTAGE:** Only 0.5v is applied to the bridge. The voltage across the capacitor is less than this applied voltage, the amplitude depending upon capacitance being measured. No danger of overheating and ruining even a 1-volt electrolytic or a 3-volt ceramic.

**POLARIZING VOLTAGE:** Continuously adjustable, 0 to 150v.

**STABILITY:** Dual regulation of the power supply assures short-time reliability, while specially processed etched circuits and complete encapsulation of the critical meter amplifier insure long-time stability.

**MAGIC-EYE TUBE:** Simplifies bridge balancing for capacitance and power factor measurements.

**HIGH GAIN AMPLIFIER:** Sensitivity control for magic-eye null detector permits accurate measurements of small capacitances.

**CAPACITANCE DIAL:** Latest design jet black dial with brilliant white calibrations for quick, accurate readings from any position.

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Double security of a joint.

Failure of one item (eyelet or plated hole) may leave another in operation.

#### Disadvantages

Cost is higher due to double nature of process.

Inspection of joint is difficult.

Reheating, resoldering are difficult.

Too many steps in the process may lead to operational error.

Dissimilar metals used in process may lead to galvanic action.

Chemical contamination is possible due to presence of many chemicals.

Effects of poor plating are the same as in process B.

Solder between eyelet and foil may have poor penetration.

Sharp edges on eyelet flanges may damage plated metal.

Variation in thickness of plated metal may affect quality of juncture.

Plated hole must be closely matched with an eyelet.

In vibration and shock, sections of plated metal may separate from main body of plated metal.

#### **Process 2C** **Plated Through-Hole and** **Funnel Eyelet**

#### Advantages

Redundancy of electrical path.

Double security of a joint.

Failure of one item (eyelet or plated hole) leaves another in operation.

#### Disadvantages

Inspection of completed joint is difficult.

Reheating and resoldering operations are difficult.

Cost is high because of the double nature of process.

Chemical contamination due to pres-

ence of many chemical processes.

Dissimilar metals may lead to galvanic action.

Multi-step process leads to possibility of operational errors.

Effects of poor plating are the same as in process B.

Pressure exerted by eyelet on the plated metal may cause damage.

Variation in thickness of plated metal may affect quality of juncture.

Plated hole must be closely matched with an eyelet.

In vibration and shock, sections of plated metal may separate from the main body of plated metal.

#### **Process D** **Resistance Fusing of Eyelets**

This process is a refinement of process A. All steps are identical except for the method of installing the eyelets. These are installed by bringing the foil and eyelet, Fig. 4, together under pressure and fusing them with an electric current. The heat required to induce the fusion is generated by the electrical resistance of the parts at the joint. Control of magnitude of current and timing of application of heat are an important factor in this process.

#### Advantages

Mechanical insertion and soldering of an eyelet are combined in one step.

Fusion provides homogeneous joint.

Absence of many dissimilar metals reduces electrolytic corrosion and galvanic action.

Difficulties associated with separate soldering process are eliminated.

Probability of "open" circuits in the joint due to springing of an eyelet in vibration and thermal cycling is reduced.

Absence of chemical processes (reaction) eliminates chance of contamination.

#### Disadvantages

Periodic examination and cleaning of the electrode surfaces is necessary.

Failure of current will result in cold joint.

Application time of current must be controlled.

Value of current must be controlled.

Electronics must be controlled.

Eyelets must be pre-tinned.

#### **Comparison of Processes Favors** **Resistance Fusing of Eyelets**

An analysis of each of the processes and comparison of their characteristics lead to the following conclusions:

Of the four methods evaluated, process D is most promising. It contains very few steps and is relatively simple to control and handle.

Control of eyeletting operations in process D, a one-step operation, is easily achieved. Fusion will produce a uniform and strong juncture. Speed of operation in this process is comparable with other methods.

Equipment used in this process consists of eyeletting press and welding transformer with auxiliary controls. These are rugged and reliable.

Inspection and quality control features easily could be incorporated.

Fusion process may resolve the controversy between flat and funnel eyelets.

Precoating of eyelets with compatible alloys may provide complete penetration between eyelet and foil.

#### **Recommendations For Improving** **Printed-Circuit Board Facilities**

The following steps are recommended for improving printed-circuit-board manufacturing facilities:

- Design of the printed-circuit boards should be coordinated with essential characteristics of the manufacturing process.
- Information on current-carrying capacities of conductive foils, on minimum width of traces, on working tolerances, spacing of adjacent conductor, hole sizes, land sizes, eyelets base material, etc., should be available to designers of the printed-circuit boards.
- Designers should be informed of the limitations of etched circuitry, such as effects of overetching on sizes of conductors, to avoid incorporating potential defects into printed-circuit drawings.
- Art masters should be prepared, taking into consideration characteristics of photographic, etching and drilling processes.
- Specification drawings should provide all necessary material classifications, dimensions, tolerances, etc., to assure uniformity of purchased product.
- Detailed manufacturing specifications

should cover entire process of manufacture.

- Reliability of the final product can be achieved only if every step is controlled for quality. There should be quick tests throughout the process.
- All material should be rigidly inspected.
- Standard dimensional drawings covering eyelets should be used as a guide in establishing inspection and quality control procedures.
- Eyelets and other materials should be procured only from qualified vendors.
- Eyelets should be kept in original containers until used, or protected against deterioration of coating or physical damage.
- Only limited number of eyelets should be kept in hoppers to avoid contamination.
- Boards should be inspected after eyelets are installed for loose eyelets and damaged foil.
- Trimming and cutting of epoxy board should avoid delamination of base material.
- Copper-clad board should be stored in dry places, should be protected against excessive moisture, warpage, corrosion, mechanical damage and temperature fluctuations.
- Drilling of epoxy boards should be covered by instruction. Drills must be inspected periodically and replaced when worn.
- Holes should be cleaned and vacuum-cleaned after drilling, followed by visual inspection for delamination of base-board and damage to the coated foil.
- Etching process should be controlled throughout the entire cycle to assure uniformity and consistency of etch.
- After completion of etching and washing, boards should be examined for traces of remaining etchant.
- The sludge from the etching tank should be removed occasionally.
- Specification for soldering operation should include temperature and time of immersion.
- Pre-assembly time storage should be limited to a minimum to avoid possible damage. Long storage of parts should be eliminated altogether.
- Prolonged interruption in the production cycle should be avoided.
- Content of dip soldering pot and standing wave types of soldering equipment should be examined periodically. ■ ■



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- readout
- store
- compute
- sort
- control
- time
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# Motor Current Drives Switching Transistors In High-Efficiency Power Converter

**Here's an innovation in converter circuitry. The load, in this case a single-phase, low-power-factor motor, serves as an integral part of the ac-to-dc converter circuit.**

**T. M. Corry**  
Westinghouse Electric Corp.  
Cheswick, Pa.

**A** NOVEL converter circuit can be used to drive low-power-factor, single-phase motors at high efficiency. Usually, when such ac motors must be driven from dc supplies, standard square-wave power converters are used. But the high reactance of the motor makes for a bad impedance mismatch between converter and motor which reduces the efficiency of both.

The converter circuit is particularly useful wherever the primary power source is a dc voltage and it is undesirable to use dc motors to operate pumps, control systems, and other devices. In addition, the converter allows high-speed, and variable-speed ac motors to be run from dc as well as 60-cps sources.

In the new circuit, the motor is part of the converter circuit and motor current is used to drive the switching transistors. An application of the circuit is shown in Fig. 1 in which a fan with a 115-v, 60-cps motor is operated from a low-dc-voltage, thermoelectric power supply.

The tea kettle has a thermoelectric generator built into the bottom; the generator is heated by the camp-stove flame and cooled by boiling water. The ac-to-dc power converter, which weighs 12 oz, is attached to the rear of the fan.

## Circuit Cuts Motor Heating Boosts Conversion Efficiency

The converter circuit reduces motor heating and raises power-conversion efficiency because the transistors switch a sine-wave current into an essentially tuned load. Since the motor functions as part of the converter, the system is always tuned.

No saturating cores are required and voltage spikes across the transistors are eliminated. An additional advantage of the circuit is that converter frequency and consequently motor speed can be varied simply by varying the value of a capacitor.

This innovation makes possible a new type universal motor that does not have the inherent disadvantage of requiring carbon brushes. It is a motor-converter combination that can operate from thermoelectric, battery, or dc-generator power sources. In air-conditioner and pump applications, this scheme can be used to energize high-speed compressor systems which are more efficient and occupy less volume.

Fig. 2 shows the converter circuit. It consists of a transformer  $T$ , transistors  $Q_1$  and  $Q_2$  operating in push pull, capacitor  $C$ , motor  $M$ , and feedback resistors  $R$ . The resistances of resistors  $R$  are greater than the forward resistances of the base-emitter diodes of the transistors. In circuits requiring high-Q operation and in which the base-emitter-diode

forward resistances of the transistors approach the resistance values of  $R$ , diodes  $D$  can be substituted for the resistors.

## Extra Transformer Winding Provides Square-Wave Source

Winding  $FG$  on the transformer allows for additional square-wave power to be taken from the basic circuit and used to energize counters, synchronizing circuits, or other low-power apparatus. The motor can be either the shaded pole or capacitor type.

In Fig. 3 the motor is shown in equivalent form. The circuit functions as follows: Assume that transistor  $Q_1$  is switched on. Current then flows in the primary and secondary winding of the transformer. The polarity of the voltage drops across resistors  $R_1$  and  $R_2$  due to motor-current flow is such that  $Q_1$  conducts and  $Q_2$  is cut off.

When  $Q_1$  is completely switched on, the battery voltage  $E$  is applied to terminals  $C$  and  $D$  of the transformer. The induced voltage in the transformer is then  $(N_2/N_1) E$ . Though the induced voltage is constant, the combination of motor inductance and capacitance  $C$ , connected in series, permits a sine wave of current to flow.

## Transformer Turns Ratio Must Not Exceed Transistor B

By neglecting transformer magnetizing current we can write the relationship between primary and secondary currents as

$$N_1 i_1 = N_2 i_2$$

If the transformer turns ratio  $N_2/N_1$  does not exceed the large-signal current gain of the transistors and if the current feedback is positive, then the circuit can oscillate.

Current  $i_2$  cannot flow through the base-emitter diode of  $Q_2$ . Therefore, it flows through  $R_2$  and from the emitter to base of  $Q_1$ , in parallel with  $R_1$ . The fraction of current  $i_2$  that flows from the emitter to base of  $Q_1$  is sufficient to maintain the transistor in the conducting state.



**Fig. 1.** Whistling while it works, this tea kettle supplies dc voltage to the novel converter described in the article. The converter, not shown, powers the ac fan. The kettle has a thermoelectric generator built into its bottom and the boiling water removes heat from the generator's "cold" junction.

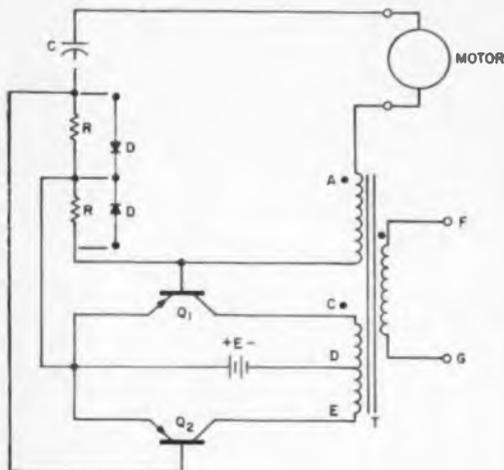


Fig. 2. Schematic of the motor-converter circuit.

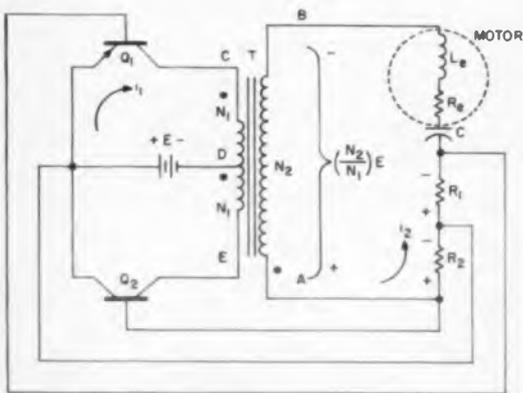


Fig. 3. Converter circuit with the motor in equivalent-circuit form.

Transistor  $Q_1$  conducts until capacitor  $C$  charges. As the motor current decreases, transistor drive decreases. This action continues until the drive is insufficient to keep  $Q_1$  saturated and the transistor begins to switch off.

At this instant the induced voltage in the secondary winding of the transformer begins to drop and  $C$  starts to discharge. The instant capacitor current reverses,  $Q_2$  begins to switch on and  $Q_1$  is switched off. The switching action is cumulative and it takes place in microseconds.  $Q_2$  continues to conduct until the capacitor is completely charged and then the transistors switch again.

#### Transformer Secondary Current Must Keep Transistors Saturated

Since for proper circuit operation the transistors must function as switches, secondary current must be large enough to keep the

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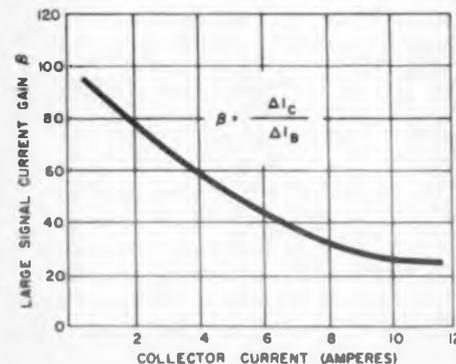
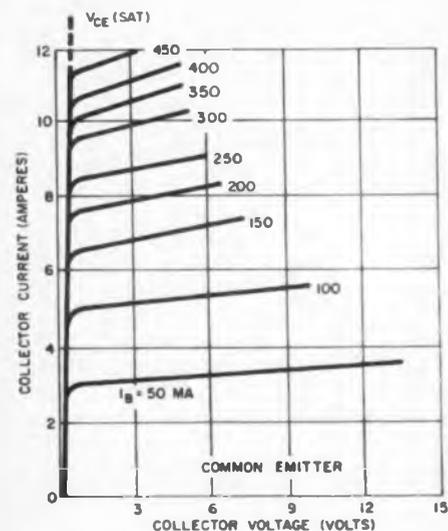


Fig. 4. Transistor characteristics important in the converter design.

transistors saturated for all values of  $i_1$ . For example, if  $N_2/N_1 = 10$ , then  $i_2 = i_1/10$ . Assume that the total current  $i_2$  flows through the bases of the transistors.

Referring to the transistor characteristics in Fig. 4, one can see that if collector current  $i_1 = 2$  amp and base current  $i_2 = 200$  ma, the collector voltage will be determined by the  $V_{CE}$  (SAT) voltage line. With a base drive of 200 ma, the collector current could be as high as 7.5 amp and the transistor would still be saturated.

It should be noted that the collector-current lines compress as base-drive current and collector current increase. The plot of large-signal current gain vs collector current indicates the drop in gain as collector current increases. The plot of large-signal current gain vs collector current indicates the drop in gain as collector current increases. Therefore, to insure that the transistors will al-

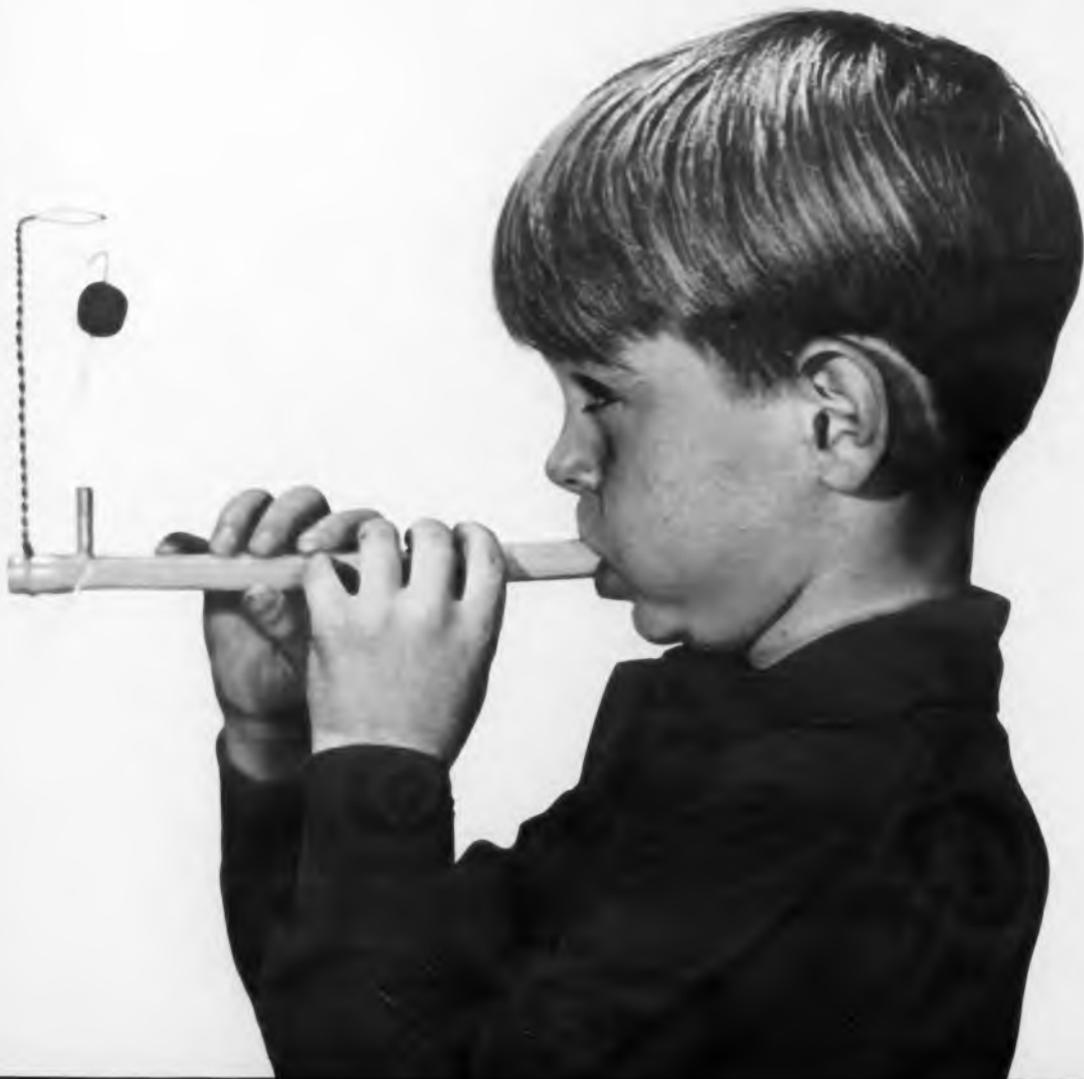
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*says Robert Troxell, Relay Engineer, Cook Electric Company, Chicago, Illinois*

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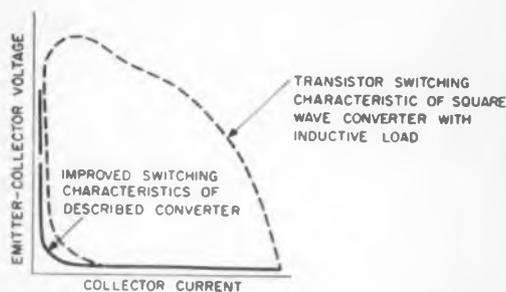


Fig. 5. Comparison of switching characteristics of new converter with those of conventional square-wave converters driving inductive loads.

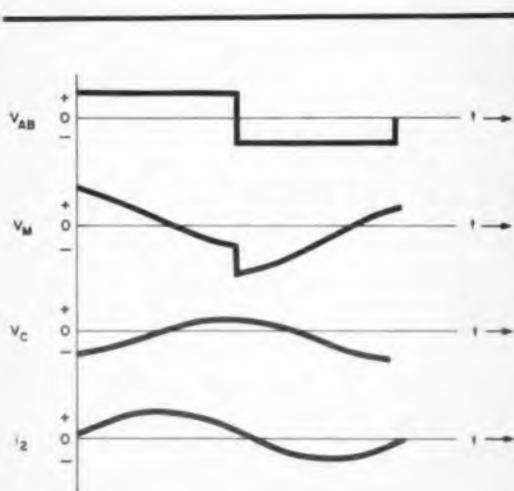


Fig. 6. Waveshapes in the converter circuit.

ways be saturated when switched on, the ratio  $N_2/N_1$  must be less than the large-signal current gain for the maximum value of collector current.

In a properly designed circuit the transistors switch only during those portions of a cycle when the motor current is low. This switching technique reduces transistor power dissipation and permits switching close to the voltage and current axes as shown in Fig. 5.

One feature of this circuit is that the peak voltage across the motor is higher than the secondary voltage of the transformer because the peak capacitor voltage adds to the transformer voltage each half cycle. The capacitor then discharges through the transformer and delivers stored energy to the motor. Varying the value of the capacitor varies motor speed. Fig. 6 indicates the various voltage and current wave shapes in the circuit. ■ ■

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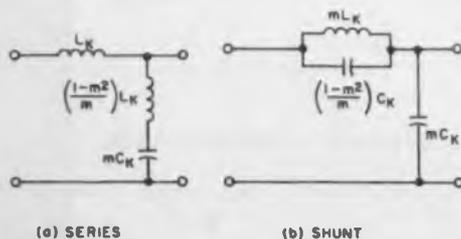
# Curves Help Determine Envelope Delay of m-Derived Filters

*While doing advanced development work on communications systems, author Frank worked out relations and drew some curves that helped him design m-derived filters. Herewith, his idea.*

**Joseph Frank**  
Sr. Member Technical Staff  
Defense Electronics Products  
Radio Corp. of America  
New York, N. Y.

**D**ELAY distortion of m-derived filters can be quickly obtained from standard curves of envelope delay plotted as a function of normalized frequency. These curves can be used for both m-derived high- and low-pass filters.

The m-derived filter, Fig. 1, is quite popular because of the ease with which it can be designed. When  $m = 1$  the filter reduces to constant-k type. The attenuation of these



**Fig. 1.** For pulse applications, the envelope delay of m-derived filter half-sections is of interest.

filters can be easily calculated using the standard formula,<sup>1</sup> or it can be obtained even more easily with the aid of the tables.<sup>2</sup>

For many applications involving the transmission of pulses, both the amplitude and phase characteristics of the filter must be considered. But, the quantity that is usually of concern is not the phase itself but the envelope delay—the derivative of the phase shift with respect to the radian frequency.

### Expression For Envelope Delay Of Low-Pass Filter

If the network is terminated in its image impedance

$$\frac{E_{in}}{E_{out}} = e^{\theta} = e^{\alpha} \cdot e^{j\beta} \quad (1)$$

the pass band  $\beta$  for a full filter section is given by the expression

$$\beta = \cos^{-1} \left[ 1 - 2 \frac{m^2}{\frac{\omega_c^2}{\omega^2} - (1 - m^2)} \right] \quad (2)$$

where  $\omega_c$  is the cut-off frequency of the filter and  $0 \leq \beta \leq \pi$ .

The envelope delay  $\tau_d$  is given by

$$\tau_d = - \frac{d\beta}{d\omega}$$

If we let  $\frac{\omega}{\omega_c} = X$ ,  $X$  is the frequency normalized with respect to the cut-off frequency. The expression for  $\beta$  then becomes

$$\beta = \cos^{-1} \left[ 1 - 2 \frac{m^2}{\frac{1}{X^2} - (1 - m^2)} \right] \quad (3)$$

By the chain rule

$$\frac{d\beta}{d\omega} = \frac{d\beta}{dX} \frac{dX}{d\omega} = \frac{1}{\omega_c} \cdot \frac{d\beta}{dX} \quad (4)$$

Differentiating Eq. 3 and simplifying

$$\frac{d\beta}{dX} = \frac{-2m}{[1 - (1 - m^2) X^2][1 - X^2]^{1/2}} \quad (5)$$

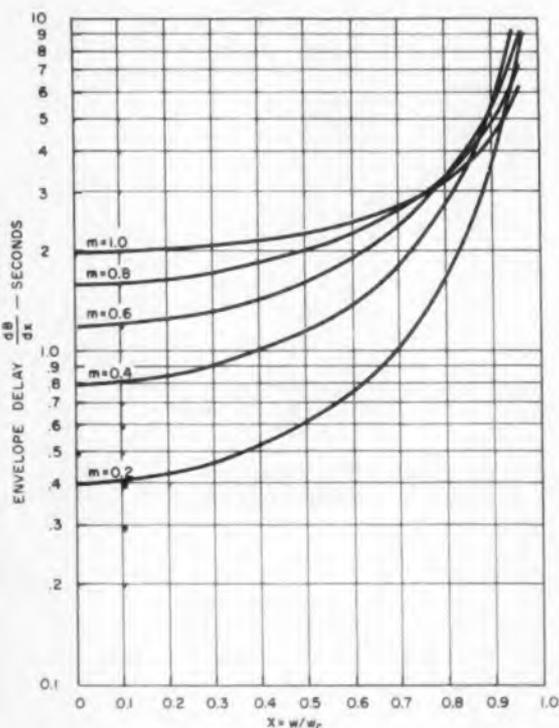


Fig. 2. Envelope delay of full-section,  $m$ -derived filter can be found with aid of these normalized curves.

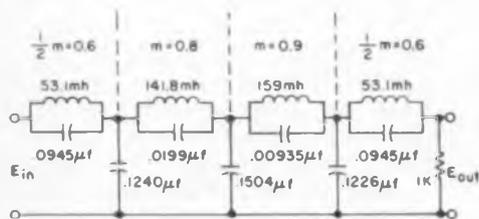


Fig. 3. Parameters of  $m$ -derived filter used in illustrative example.

and

$$\tau_d = \frac{1}{\omega_c} \cdot \frac{2m}{[1 - (1 - m^2)X^2][1 - X^2]^{1/2}} \quad (6)$$

Curves are plotted of  $d\beta/dX$  as a function of  $X$  for various values of  $m$  in Fig. 2. To obtain the delay for a multi-section filter the delay of the individual sections is simply added. The delay of a half section is one half the delay of a full section.

#### Expression for Envelope Delay Of High-Pass Filters

For a high-pass filter, the pass band  $\beta$  for a full filter section is given by

$$\beta = -\cos^{-1} \left[ 1 + \frac{2m^2}{(1 - m^2) - \frac{\omega^2}{\omega_c^2}} \right] \quad (7)$$

Value of  $d\beta/dX$  at different frequencies, found from the curves of Fig. 2, are tabulated. Final envelope delay is computed for each frequency.

Section	Frequency=cps					
	$f=0$	$f=540$	$f=900$	$f=1,260$	$f=1,440$	$f=1,620$
$m$	$X=0$	$X=0.3$	$X=0.5$	$X=0.7$	$X=0.8$	$X=0.9$
0.6	1.20	1.34	1.65	2.45	3.38	5.70
0.8	1.60	1.74	2.03	2.73	3.50	5.18
0.9	1.80	1.91	2.18	2.78	3.44	4.86
Total	4.60	4.99	5.86	7.96	10.32	15.74
Delay = Total						
$2\pi(1,800)$	407	441	519	704	914	1,392 $\mu$ -sec

where  $-\pi \leq \beta \leq 0$ .

If we let  $X = \frac{\omega_c}{\omega}$

$$\frac{d\beta}{dX} = \frac{+2m}{[1 - (1 - m^2)X^2][1 - X^2]^{1/2}} \quad (8)$$

which is the negative of the expression for  $d\beta/dX$  we obtained for the low-pass filter.

For the high-pass case

$$\frac{dX}{d\omega} = -\frac{\omega_c}{\omega^2} \quad (9)$$

and

$$\tau_d = \frac{\omega_c}{\omega^2} \frac{2m}{[1 - (1 - m^2)X^2][1 - X^2]^{1/2}}$$

Thus, the same curves of  $d\beta/dX$  can be used to find the envelope delay of both high- and low-pass filters.

#### Improper Termination Can Introduce Errors

The expression for time delay, Eq. 6, assumes that the filter is terminated in its image impedance. However,  $m$ -derived filters are usually terminated in a resistance equal to the zero frequency value of the image impedance. The error in the delay due to the nonimage termination increases with frequency.

For the filter used in the illustrative example below, the exact delay with the resistive termination was calculated using a digital computer. The error made in using the delay formulas is less than 1 per cent for values of  $X$  less than 0.7 and less than 2.5 per cent for values of  $X$  less than 0.9.

#### Example Uses Curves to Find Envelope Delay Time

Let us consider a low-pass,  $m$ -derived filter having full sections for which  $m = 0.8$  and  $m = 0.9$ , and two half sections at the input and output for which  $m = 0.6$ , Fig. 3. The filter has a cut-off frequency of 1,800 cps.

To obtain the delay at various frequencies, we find the value of  $X$  corresponding to the frequency in question, and look up the value of  $d\beta/dX$  for the various values of  $m$ . The sum of these values is divided by  $\omega_c$  to give the envelope delay in seconds.

The values found from the curves are given in the table. Note that the two half sections,  $m = 0.6$ , are handled as one full section. ■ ■

#### References

1. "Reference Data for Radio Engineers" 4th Ed. pp 166-7.
2. Storer, "Passive Network Synthesis" pp 92-7.

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Things



Itek Crystal Filter Model 4150A combines notch rejection and bandpass characteristics in a single rugged filter, tunes out ground return while passing a doppler-shifted radar signal. The double function reduces componentry, improves reliability, and demonstrates the unique and wonderful possibilities of Itek Crystal Filters.

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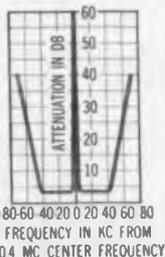


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CIRCLE 47 ON READER-SERVICE CARD



Itek

## PRODUCT FEATURE

# New Pentode Design Gives 40% More Plate Current

**N**OVEL construction increases by 40 per cent the available plate current in these horizontal-plate output pentodes. A very high ratio of plate current to screen-grid current is realized by the suppression of secondary emission with the use of the "Cavitrap" plate.

The new design is used in the tube types 6GB5 and 27GB5, manufactured by the Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y. It has made possible the reduction of screen-grid current to the extent that the available peak-plate current of these horizontal output pentodes is increased by 40 per cent over the more familiar 25E5 pentode tube.

### Need For Higher Currents Made Improvements Necessary

Improvements to pentode construction during the past decade have included the shadowing of grids and coating the plate of the tube with materials having a small electron reflection and low secondary emission. Though the combination of these improvements resulted in a series of power pentodes with excellent properties, the need for higher peak-plate currents made further improvement of these tubes necessary. The most acceptable solution thus far has been to reduce the screen-grid current.

In the "Cavitrap" construction, the plate has a number of

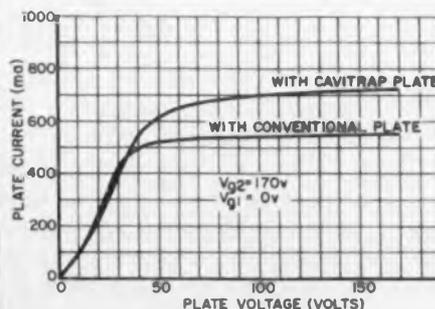


Fig. 1. Plate current vs plate voltage plot shows the improvement made possible with the "Cavitrap" plate.

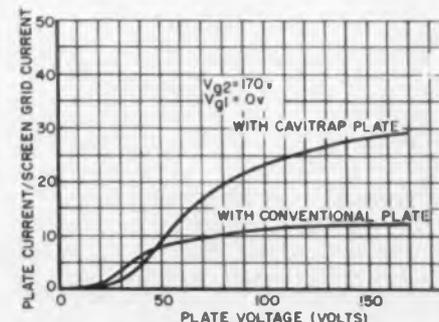
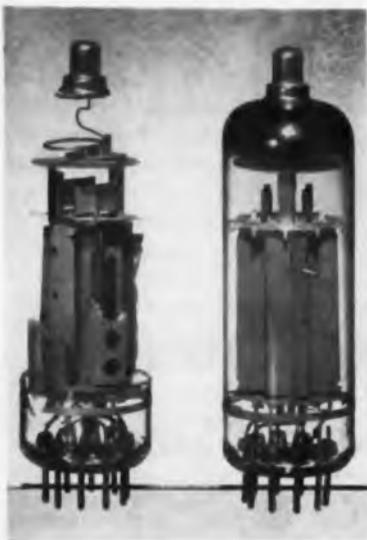


Fig. 2. Improved ratio of plate current to screen-grid current, made possible by the use of "Cavitrap" construction, is shown.



**ELECTROLYTIC CAPACITORS**—Reliability is our first ingredient



vertical partitions, which are at right angles to the plate. The effect of this is to form a number of cavities facing the cathode. The secondary electrons, ejected by the impact of the primary electrons on the plate, are for the greater part absorbed by these partitions. Secondary electrons that escape from the cavities will be forced back by the space charge formed by the beam-plate construction of the pentode.

The 6GB5 and the 27GB5 have enlarged noval bases called the magnavol base. This tube base contains nine 0.050-in. sealed-in pins arranged in a circle with a radius of 0.689 in. Over-all length of the tube is 4.104 in. max and the diameter is 1.189 in. max. Typical characteristics of the 6GB5 are: plate current, 440 ma; screen-grid current, 37 ma; heater voltage, 6.3 v; heater current, 1.45 amp; plate voltage, 75 v; screen-grid voltage, 200 v; control-grid voltage, -10 v.

These horizontal output pentodes, having "Cavitrapp" construction, are available immediately at \$1.02 each. For further information on these high plate-current pentode tubes, turn to the Reader-Service Card and circle 250.

CIRCLE 48 ON READER-SERVICE CARD ▶



NEW G-E FOIL TANTALYTIC CAPACITOR  
"A CASE" (POLAR)

SOLID TANTALUM CAPACITOR

NEW G-E FOIL TANTALYTIC CAPACITOR  
"A CASE" (NON-POLAR)

## NEW smaller size foil Tantalytic\* capacitors pack foil advantages in near solid dimensions

No longer can limited space prevent your specifying a foil capacitor with its superior characteristics. General Electric now offers an 85C Tantalytic "A Case" capacitor .131" diam., .47" long—almost as small as the smallest solid!

The General Electric foil "A Case" is available at higher voltages, and is inherently more reliable than solids

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when operated at rated voltages. It is available in non-polar as well as polar ratings. Further, it matches solids for volumetric efficiency.

But there's no compromise on electrical characteristics. The lower leakage currents of the "A Case" actually decrease during operation, while leakage currents in solids normally increase.

The "A Case" comes in single-end, .47"-long, .131"-diam., polar type; or double-end, .54"-long, .131"-diam., polar or non-polar types—rated 6v (12uf) to 50v (1.4 uf) and to higher voltages.

For data, call your G-E Sales Engineer. Or write for Bulletin GEA-7226, General Electric Co., Schenectady, N. Y., Capacitor Department, Irmo, S. C.

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in this audio amplifier  
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Here's a fifty-watt power amplifier with harmonic and intermodulation distortion of less than .005%. Distortion so low — you'd need special equipment to measure it!

That's why the UF-101A is a natural as a reference source, with a suitable oscillator, for low distortion measurement of power components, as well as a highly linear amplifier within the audio band.

The other characteristics of the UF-101A are equally outstanding. Phase distortion is negligible —  $\pm 2^\circ$  maximum deviation from linear phase shift. Total hum and noise level less than 10 microvolts input equivalent. Frequency range is from 20 cps to 20 kc. For convenience, the UF-101A has taps for matched load impedances from 1 to 225 ohms.

Some of the applications of this ultra-low distortion amplifier are: checking the residual distortion of distortion-measuring equipment, reproducing non-sinusoidal wave forms faithfully, and as an ultra-low distortion, high power source to supply test benches. Write for full information on the UF-101A.

Other Krohn-Hite amplifiers include the direct-coupled, wide band DCA-10 (10 watts), and DCA-50 (50 watts). Also, Krohn-Hite Oscillators, Filters and Power Supplies.



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## PRODUCT FEATURE



## Bi-Level Series Regulation Reduces Power-Supply Size

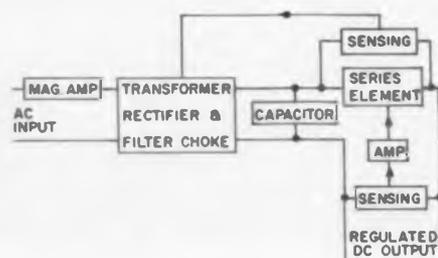
**S**PACE requirements are cut in half by this 12-v, 2-amp power supply. Its circuitry reduces heat dissipation, thus permitting significant space savings. Regulation for the unit is  $\pm 0.1$  per cent and ripple is less than 5 mv.

The compact unit, manufactured by Atlas Controls, Inc., 9 Erie Drive, Natick, Mass., is packaged in a standard 4 x 4 x 3 in. can. It operates from an input of 115 v  $\pm 10$  per cent, 2,000 cps with input transients of up to 300 v. For load transients from no-load to full-load, the unit will operate within 0.5 per cent. It withstands continuous short and meets the requirements of MIL-E-5272C.

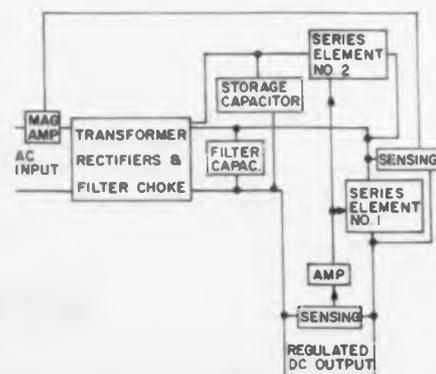
The bi-level series regulation method used in this power supply has the following advantages:

1. Efficiency is 20 to 30 per cent higher than in conventional series regulators.
2. Fewer series elements and capacitors are used for high-current applications, increasing reliability and reducing size.
3. In low-temperature, high-current applications, the use of tantalum capacitors is made economically feasible.

In a conventional series-regulated power supply, the series element must have sufficient drop to handle line-voltage variations, transformer rectifier-load regulation and the adjustment range of the output voltage. In high-current units the dissipation is, therefore, very high, requiring parallel transistors, large heat dissipating surfaces and large transformers because of lower efficiency.



**Fig. 1.** This circuit will overcome the problem of high dissipation, but if a sudden input voltage undershoot or increase occurs, the regulator response will be only as fast as the preregulator.



**Fig. 2.** This circuit will overcome high dissipation, give tight regulation and reduce space requirements up to 50 per cent for given ambient temperature conditions and ratings.

The circuit shown in Fig. 1 will overcome the dissipation problem because the preregulation can maintain a long-term low voltage across the series element. If, however, a sudden input voltage undershoot occurs, or step increase in load is applied, the regulator will only be as fast as the preregulator unless the storage capacitor is large enough to handle the load current during the response interval. This would require a large capacity value.

The technique that reduces this capacitor value is shown in Fig. 2. The transformer rectifier has two dc outputs. The low level is regulated at approximately 2 v above the output by the magnetic amplifier. The upper level is not necessarily regulated and its level is selected along with the storage capacitor to provide the required energy during the response interval of the magnetic amplifier. The high level is connected to the low level through the series element No. 2. This element is biased in the off state as long as series element No. 1 is not saturated.

Saturation will occur only when the sudden load or line voltage drop occurs, causing the lower level to drop momentarily to the output voltage level. During this period the higher level will take over and prevent an undershoot of the output voltage. During the steady state conditions the dissipation in series element No. 2 will be virtually zero.

Under these conditions the storage capacitor required to handle the load during the magnetic amplifier response is much less than that needed for the circuit in Fig. 1.

The price of these 12-v power supplies ranges from \$380 up and they are available in four to six weeks. For more information on these compact power supplies, turn to the Reader-Service Card and circle 251.

CIRCLE 50 ON READER-SERVICE CARD ➤

## When should you use Mercury-Wetted Contact Relays?



IF YOUR RELAYS  
**MUST**

SWITCH UP TO  
**100 TIMES**  
PER SECOND

HAVE A LIFE  
IN EXCESS OF  
**A BILLION**  
CYCLES

BE COMPLETELY  
**RELIABLE**  
AND FREE FROM  
CONTACT BOUNCE

THEN SPECIFY  
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**MERCURY**  
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CONTACT RELAYS

An unusual combination of advantages found only in mercury-wetted relays has led many design engineers to specify them for tough switching jobs. Here are but 3 typical characteristics of our JM series:

**RELIABILITY.** Sealed-in-glass mercury contacts are renewed with every operation. Won't pit or weld. Make or break is positive . . . every time. No bounce, no chatter. Signals ranging from a few micro amps to 5 amps are switched with singular consistency.

**LONG LIFE.** Think in terms of *billions* of operations when considering JM series relays. Proper application, of course, is a requisite.

**SPEED.** Operate time is just less than 3 milliseconds using 2 watts of power. Release time is about 3.2 milliseconds. Thus, relays can be driven 100 times per second.

If your project calls for exceptional relay performance, perhaps the answer lies in our JM Mercury-Wetted contact relay.



### JM SERIES ENGINEERING DATA

**Contact Rating:**

5 amperes maximum  
500 volt maximum  
250 volt-amp max. with required contact protection.

**Contact Configuration:**

Each capsule SPDT. Combination of capsules in one enclosure can form DPDT, 3PDT, 4PDT. (All Form D.)

**Terminals:**

Plug-in or hook solder; 8, 11, 14, or 20-pin headers.

**Coil Resistance:**

2 to 58,000 ohms.

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# 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.



## Ten-Inch Storage Tube Features Two-Color Display

255

Capable of displaying and retaining information in either of two colors or in a combination of the two, this tube features a useful screen diam of 7-1/2 in. min and an over-all diam of 10-1/2 in. nominal. Range of stored colors includes: red, orange, yellow, and yellow green. Typical viewing screen voltage is 10 kv; writing gun cathode voltage, -3 kv. Stored brightness is 75 ft-L, and stored resolution is 60 lines per in. The new tube, which features a 40,000-in. per sec writing speed, has a storage time of 10 min and an erasure time of 500 msec.

Hughes Aircraft Co., Vacuum Tube Products Div., Dept. ED, 2020 Short St., Oceanside, Calif.

*P&A: on request, depending on quantity and performance required; approximately 6 months.*



## Electrolytic Potentiometer Uses Spirit-Level Principle

256

This gravity-sensing potentiometer consists of a curved glass tube containing a predetermined amount of electrolytic solution to create an air bubble. The bubble's motion creates variable impedance by more or less immersion of the top electrodes. The EP series is designed for use in gyroscope correcting mechanisms, and other devices which require a gravity reference or tilt indication. Output range from 1.8 to 8.8 v is available at a 30 min tilt and 12.5 v power supply.

Hamlin, Inc., Dept. ED, Lake and Grove Sts., Lake Mills, Wis.

*P&A: \$15.00; stock.*



## Transformer Simulator Is Variable To 6,000 v Output

257

Designed for laboratory, industrial or test purposes, model TS460 offers ratings to 250 va. Operating from 115 v, 50 to 1,000 cps, the four primaries are independently variable from 0 to 150 v. The four independent, removable center-tap secondaries, supplied from a choice of 11 ratings, allow various combinations to 6,000 v ac. A 36-lb unit, it measures 20 x 10 x 8 in. Primaries can be varied by using direct inputs and jumpers on the back of the unit.

Electronic Research Associates, Inc., Dept. ED, 67 Factory Place, Cedar Grove, N. J.

*P&A: \$425.00; 30 days.*

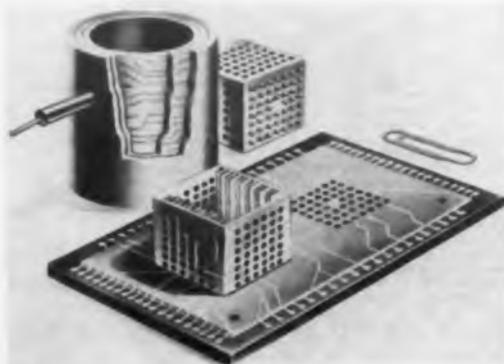


### Current Source Accurate To 0.0025%

258

Programmable constant current source is designed for gyros, semiconductors and magnetic components. An input of 115 v  $\pm 10\%$ , 60 cps, 10 amp provides an output current of from 0.1  $\mu$ a to 1,000 ma. Ripple is 0.02% full scale +0.1  $\mu$ a rms, with long term stability of 0.01% full scale, per day. The unit measures 19 x 18 x 14 and weighs 105 lbs.

North Hills Electronics, Inc., Dept. ED, Alexander Place, Glen Cove, N. Y.  
P&A: \$4,350; stock to 60 days.



### Multi-Layer Printed Circuits Take Any Geometric Shape

259

Geometric shapes, such as cubes, spheres, and cylinders, are now available with circuits printed on outside and/or inside, including thru-hole connections. Manufactured to the customer's specifications, circuits can be printed in copper, silver, nickel, gold and rhodium. Stacking and inter-connection of circuits separated by layers as thin as 2 mils is possible with the firm's "Mono-Clad" insulation. Circuit packaging is said to be resistant to vibration, solvents, humidity and temperatures to 500 F.

J. Frank Motson Co., Dept. ED, Flourtown, Pa.

P&A: \$5.00 to \$25.00 each, in production quantities; within 30 days after receipt of final order.



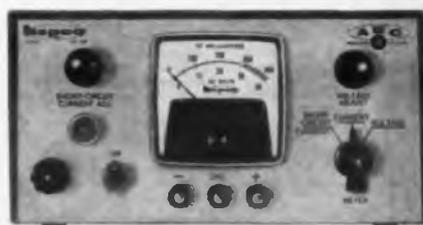
## test-bench instrument



## or systems component



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MODEL	DC OUTPUT RANGE		DIMENSIONS			PRICE
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ABC 7.5-2	0-7.5	0-2 amp	4 1/4"	8 3/4"	9 3/8"	\$139.00
ABC 15-1	0-15	0-1 amp	4 1/4"	8 3/4"	9 3/8"	\$139.00

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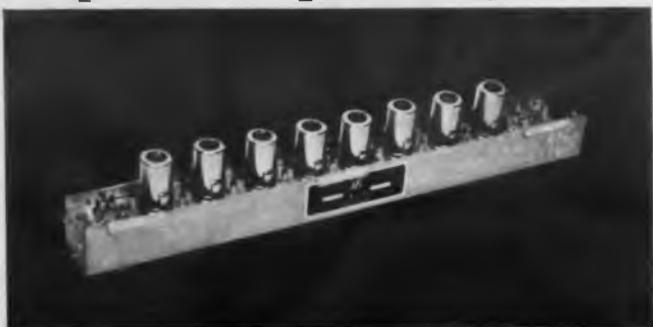
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CIRCLE 52 ON READER-SERVICE CARD

# New Products Directory

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<b>Terminals and Connectors</b>		
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The New Product Locator section of EDC 1961-62 contains all new products which appeared in ELECTRONIC DESIGN from January, 1960 through June 22, 1961, arranged by product category. Issue and page number of original appearance in ELECTRONIC DESIGN are included.

CIRCLE 53 ON READER-SERVICE CARD ➤



This semiconductor network data processor was developed by Texas Instruments Incorporated under the direction of Manufacturing and Electronic Technologies Laboratories, Aeronautical Systems Division, Dayton, Ohio.

# Now Reduce Your Microelectronic Design Time with Series 51 **SOLID CIRCUIT**\* semiconductor networks

## HERE'S HOW:

-  designed to fulfill logic functions of complete equipment assemblies—compatible with most of today's logic circuitry.
-  low power drain minimizes thermal problems and reduces power supply requirements.
-  advanced manufacturing techniques including diffused planar structures, deposited leads, oxide protection, and hermetically sealed package—offer you the potential for improved circuit reliability.
-  today's ultimate in microelectronics—with the highest function/size ratio for your digital circuits or equipments.
-  provide reduced microelectronic cost through TI's standard silicon wafer design.
-  meet military requirements:

Power Drain \_\_\_\_\_ 2-4 mw @ 3 volts  
 Fan-Out (TI SN 510, 512, 514, 515) \_\_\_\_\_ 4  
 Fan-Out (TI SN 511, 513) \_\_\_\_\_ 20  
 Propagation Delay \_\_\_\_\_ 75 to 450 nsec  
 Power Supply \_\_\_\_\_ 3 to 6 volts  
 Temperature Range \_\_\_\_\_ -55° to +125°C

UNIT	TI SN 510	TI SN 511	TI SN 512	TI SN 513	TI SN 514	TI SN 515
FUNCTION	Flip Flop, Counter	Flip Flop with emitter follower output	NOR NAND Gate (6 input)	NOR/NAND Gate (6 input) with emitter follower output	Two NOR/NAND Gates (3 inputs each)	Exclusive OR
	Clock pulse is internally capacitive-coupled					

CONTACT YOUR NEARBY TI SALES ENGINEER TODAY FOR COMPLETE  SPECIFICATIONS AND CUSTOM DESIGN ASSISTANCE.

\*Trademark of Texas Instruments Incorporated

COMPONENTS DIVISION  
 CAPACITORS, DIODES,  
 RECTIFIERS, RESISTORS,  
 SEMICONDUCTOR NETWORKS,  
 SILICON CONTROLLED RECTIFIERS

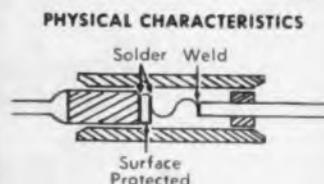


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 INCORPORATED  
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# NOW AVAILABLE

From the pioneer in silicon diffused junction zener diodes...

A Complete  
400 mw Glass  
Package Series  
Manufactured  
To Military  
Standards



1N958 — 1N992  
1N755 — 1N759

- *Ultra-low Leakage*
- *No Pressure Contact (leads soldered internally directly to die)*
- *Standard 5% Tolerance*
- *Leakage Current Specified and Guaranteed. Devices tested 100% in production.*

*Pioneering Solid State Products*



SOLID STATE DIVISION  
NUCLEAR CORPORATION OF AMERICA

3540 West Osborn Road • Phoenix 19, Arizona • BRwning 2-1341

DIVISIONS: ELECTRON TUBE DIVISION • NUCLEONICS SERVICE CORP. • INSTRUMENT AND CONTROLS DIVISION  
RESEARCH CHEMICALS, ADVANCED MATERIALS DEVELOPMENT DIVISION • U. S. SEMCOR, SOLID STATE DIVISION

CIRCLE 54 ON READER-SERVICE CARD

## NEW PRODUCTS

### Switch Contact Assembler

513



Assembles stop lamp switch contacts at the rate of 1,200 pieces per hr. Controls are completely electrical and interlocked with an air motor driven index table. The silver contact points are automatically fed and driven. These special machines are designed and built to the specifications of the individual purchaser.

Gardner-Denver Co., Dept. ED, Gardner Expressway, Quincy, Ill.

### Photoelectric Controls

512



Type 23DF3 is a fully transistorized unit designed to operate on any small change in the light reaching the photoconductive cell. A scanner has been designed for use with the unit as a registration control. Type 42RA1 scanner is lightly larger in size than a cigarette lighter.

Electronics Corp. of America, Photoswitch Div., 1 Memorial Drive, Cambridge, Mass.

### Program Boards

486



Single-contact boards provide individual, isolated terminations for every coordinate point on the matrix. The upper deck has a common bussed line for combining parallel input signals, while the lower deck has individual contacts to permit distribution of the combined output to isolated or associate circuitry.

Sealectro Corp., Dept. ED, 139 Hoyt St., Mamaroneck, N. Y.

Availability: 2-4 weeks.

## Dual Signal Generator

536



Designed for two-tone testing of single-side-band communications equipment, model 210A dual-signal generator has separate calibrated frequency controls for each oscillator. Frequency range of either oscillator is 10 cps to 1 mc in 5 bands; harmonic distortion is less than 0.1% and total intermodulation products are 60 db below output level. Balanced and unbalanced outputs are provided.

RON Electronics Corp., Dept. ED, 150 Pine St., Montclair, N. J.

P&A: \$480, fob Montclair; from stock.

## Polyester Film

357

This 14-mil Mylar film is for electrical insulation. Characteristics are: 25-kv ac dielectric strength; 3.3 dielectric constant at 1,000 cps; 2 to 3.5% shrinkage at 150 C; melting point 245 to 260 C. The films primary use is for wedge insulation in hermetic motors.

E. I. du Pont de Nemours & Co., Dept. ED, Wilmington, Del.

## Magnetic Data Recorder

537



Completely transistorized. 7-channel, 4-speed model 2000 magnetic data recording system conforms to accepted instrumentation standards. It uses interchangeable fm or direct-record/reproduce electronics. Maximum error due to non-linearity is 0.2% and maximum drift is  $\pm 0.5\%$  of full scale for 10 v power line change. Direct recording bandwidth is up to 50,000 cps and fm bandwidth is up to 5,000 cps.

Sanborn Co., Industrial Div., Dept. ED, 175 Wyman St., Waltham 54, Mass.

Price: \$6,800.



The  
Handy & Harman

# Silver Supermarket

Has every form of silver for your electronics applications

Silver, in many forms and alloys, is a necessity in the electronics and electrical industries. To meet this need on a high quality level, Handy & Harman manufactures powder, flake, paint, paste, sheet, strip, wire, etc., for printed circuits, wiring, resistors, condensers, thermistors, contacts, printed terminal strips on glass, ceramics, plastic laminates, etc.

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### VISIT OUR BOOK DEPARTMENT

We have five Technical Bulletins giving engineering data on the properties and forms of Handy & Harman Silver Alloys. We would like you to have any or all of those that

particularly interest you. Your request, by number, will receive prompt attention.

Fine Silver .....	Bulletin A-1
Silver-Copper Alloys .....	Bulletin A-2
Silver-Magnesium-Nickel .....	Bulletin A-3
Silver Conductive Coatings .....	Bulletin A-4
Silver Powder and Flake .....	Bulletin A-5

Your No. 1 Source of Supply and Authority  
on Precious Metal Alloys

**HH**  
**HANDY & HARMAN**

General Offices: 850 Third Avenue, New York 22, N.Y.

CIRCLE 55 ON READER-SERVICE CARD

## NEW PRODUCTS

### Phase Shifter

531



Model CO3 721 018 is useful in any application requiring either a known phase angle or the measurement of an unknown phase angle. The unit provides a constant output voltage continuously variable in phase from 0 to 360 deg. Accuracy is  $\pm 1\%$  and readability is 0.5 deg. Other specifications are: gear ratio is 10:1, output voltage variation is 2%, and input voltage is 115 v ac, single phase.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

### Portable Micromanometer

590

Measures differential gas pressures down to 0.004 in. water gage, full scale deflection, with 3% accuracy. Four standard pressure heads are available. All heads are designed for static working pressures up to 1,000 psi, and have a frequency response of 200 cps. Damping switch increases time constant to 0.3 sec.

Gelman Instrument Co., Dept. ED, Chelsea, Mich.

### Servo Motor

511



Digital motor rotates bi-directionally in increments of 15 deg when 28 v dc is switched sequentially between the three motor windings. Operating rate is 590 increments per sec and the slewing rate is 1,200 increments per sec. Acceleration exceeds 90,000 rad per sec<sup>2</sup>. The units weighs 3.5 oz in a standard size 11 case, and meets MIL specs in an ambient temperature range of  $-55$  to  $+125$  C.

Digital Servo Corp., Dept. ED, 13425 Wyandotte Ave., North Hollywood, Calif.

Select from *four*, big, basic families . . .

VT2	VT4	TV8	VT20
1.5-1.8 amp	3.5-4.75 amp	7.5-10 amp	20 amp

- Get *immediate delivery* from your distributor or the factory on 39 stock sizes and types: single transformers, tandems, with and without over-voltage, low voltage, single-phase, three-phase, cased, fixed mounting, portable, 120V and 240V.

- Choose from *many* special features: tandems, multi-taps, motor drives, concentric controls, special windings, shafts of all types, and job-matched enclosures among others.

- Specify from innumerable possibilities in "custom-engineered" combinations with unusual reciprocating motor drives, complex double-track arrangements, rheostats, toggle switches, and precision switches.

- Pick 36V transformers in 5-, 12-, or 22-amp ratings for your transistorized circuits.

# the big

From every aspect, you'll find that Ohmite is a good place to purchase variable transformers. If you need a "special" . . . okay, just tell Ohmite. Need some engineering assistance? All right! What about quantity? Ohmite can handle big orders, medium, and small. The Ohmite VT line of variable transformers is broad and deep. So is the service. Find out by specifying "Ohmite" on your next requirement for variable transformers.



# choice in fine variable transformers

**OHMITE**  
**OHMITE**  
MANUFACTURING COMPANY  
3643 Howard Street, Skokie, Illinois

Resistors Power Resistors Precision Resistors Relays  
R. F. Chokes Germanium Diodes Micromodules  
Variable Transformers Tantalum Capacitors Tap Switches

CIRCLE 56 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 6, 1961

## Pressure Switch

576



Designated SM/I Type TR 2129, this pressure switch supplies a switch closure or opening on either an increasing or decreasing pressure. The unit has a complete solid-state switching function, eliminating all moving parts and contact closure points normally found in mechanical switches. Hysteresis is 0.1% of the pressure cycle experienced by the Bourdon tube. Repeatability is 0.2% of full scale, with max overpressure 150% of full scale.

Servomechanisms, Inc., Dept. ED, 200 N. Aviation Blvd., El Segundo, Calif.

## Coil Bobbins

534



One-piece, laminated glass cloth coil bobbin has an overall length of 0.698 in. and an ID of 0.218 in. with a wall thickness of 0.020 in. The bobbins are full class H insulation and are available in round and rectangular shapes.

Silicone Insulation, Inc., Dept. ED, 1383 Seabury Ave., Bronx 61, N. Y.

## Radiation Resistant Cable

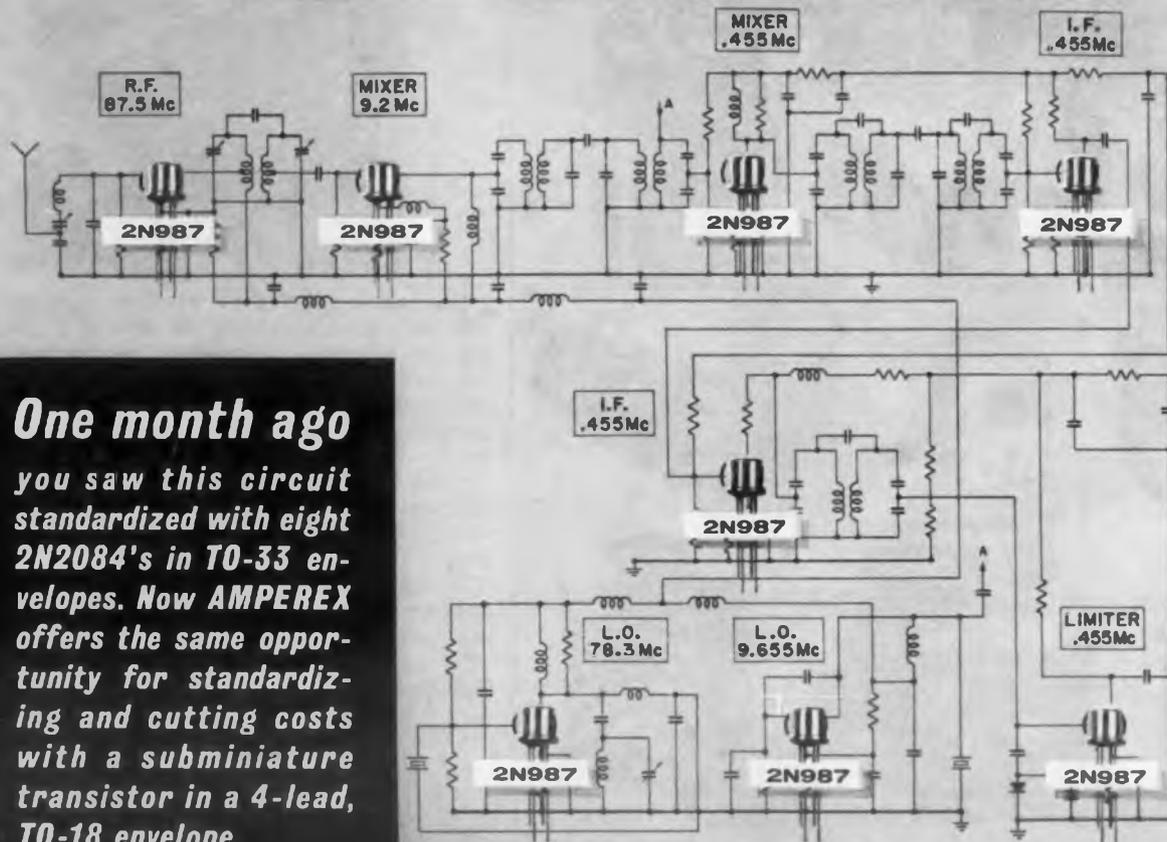
508



Resists radiation intensity of as much as 10<sup>7</sup> Roentgens. The cable is made of stranded wire imbedded in a specially compounded silicone rubber base. Termination may be custom made or with military grade connectors. Voltage handling capability is in excess of 3,000 v. Cable lengths are available up to 9 ft.

Cicoil Corp., Dept. ED, 13833 Saticoy St., Van Nuys, Calif.

# NOW for Subminiature Applications, too...



**One month ago** you saw this circuit standardized with eight 2N2084's in TO-33 envelopes. Now AMPEREX offers the same opportunity for standardizing and cutting costs with a subminiature transistor in a 4-lead, TO-18 envelope.

## Amperex<sup>®</sup> announces the new 2N987 a Subminiature Universal Communications Transistor in a TO-18 envelope, available in production quantities and priced for universal acceptance

The new 2N987 employs the identical approach used in the development of the AMPEREX 2N2084. This revolutionary approach combining the best features—high voltage, high beta and high frequency—of many specialized front end and IF types, results in a new PADT germanium-alloy-mesa subminiature transistor that provides a distinct competitive edge to the designer of HF and VHF pocket paging systems, airborne, mobile communications and other miniaturized equipment.

### Cuts costs 3 ways:

AMPEREX advanced design — plus the high yields characteristic of the PADT process — now provides to the manufacturer of miniaturized industrial equipment a single communications transistor with an unrivaled combination of application flexibility, high quality and low price. The long-sought degree of universality offered by the new AMPEREX 2N987 results in —

1. Lower procurement costs: only one type to order — with a better price break through volume purchasing.
2. Lower designing costs: only one type to specify — because of the wide range of desirable characteristics.
3. Lower inventory costs: only one type to stock — simplifies inventory control and disbursement.

**It's as simple as that!**

CIRCLE 191 ON READER-SERVICE CARD

# Amperex<sup>®</sup> 2N987

- CALIFORNIA**  
R. V. WEATHERFORD COMPANY  
Glendale 1, Calif.  
BRILL SEMICONDUCTOR CORP.  
Oakland 6, Calif.  
ELMAR ELECTRONICS INC.  
Oakland 7, Calif.
- COLORADO**  
INTERSTATE RADIO & SUPPLY  
Denver 4, Colorado
- CONNECTICUT**  
RADIO SHACK CORP.  
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W. Hartford, Conn.  
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- DISTRICT OF COLUMBIA**  
ELECTRONIC WHOLESALERS, INC.  
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- ILLINOIS**  
NEWARK ELECTRONICS CORP.  
Chicago, Ill.
- INDIANA**  
RADIO DISTRIBUTING COMPANY  
Indianapolis 6, Indiana
- MASSACHUSETTS**  
RADIO SHACK CORP.  
Boston, Mass.
- MICHIGAN**  
RADIO SPECIALTIES COMPANY  
Detroit, Michigan
- MISSOURI**  
INTERSTATE INDUSTRIAL ELECTRONIC  
St. Louis 32, Missouri  
BURSTEIN-APPLEBEE COMPANY  
Kansas City, Missouri
- NEW YORK**  
MILO ELECTRONICS  
New York, N. Y.  
ROME ELECTRONICS  
Rome, N. Y.
- OHIO**  
UNITED RADIO, INC.  
Cincinnati, Ohio
- OREGON**  
UNITED RADIO SUPPLY, INC.  
Portland 9, Oregon
- PENNSYLVANIA**  
RADIO ELECTRIC SERVICE CO.  
Philadelphia, Pa.
- TEXAS**  
ADIETA COMPANY  
Dallas 1, Texas  
Fort Worth, Texas  
BUSACKER ELECTRONIC  
EQUIPMENT CO., INC.  
Houston 19, Texas

CIRCLE 192 ON READER-SERVICE CARD

#### TYPE 2N987 SPECIFICATIONS AND FEATURES

Gain Bandwidth Product .....  $f_{\beta} = 100\text{mc}$   
Typical Beta .....  $\beta_{dc} = 140$   
Breakdown Voltage .....  $BV_{BO} = 40\text{V}$   
Typical Power Gain ..... 14db (at 100mc)  
27db (at 30mc)  
Output Capacitance .....  $C_{ob} = 2\mu\text{f}$   
Case ..... TO-18, 4 lead



for complete data and applications information on universal communications transistors in both TO-18 and TO-33 envelopes.

**AMPEREX ELECTRONIC CORPORATION**  
230 Duffy Ave., Hicksville, Long Island, N.Y.  
In Canada:  
Philips Electronics Industries, Ltd., Tube, Semiconductor & Component Depts., 116 Vanderhoof Ave., Toronto 17, Ontario

## Illuminated Push Button

509



Switch ratings are 3 amp, 250 v ac and 6 amp, 125 v ac. Units are available in normally open or closed contact arrangements and feature one-hole mounting, shallow panel depth and 90 deg "snap-on-cap" orientation. Rating for removable incandescent lamps are 14 v, 0.08 amp; for integral incandescent lamps, 28 v, 0.04 amp.

Cutler-Hammer, Dept. ED, 538 N. 12th St., Milwaukee, Wis.

## Resonance Spectrograph

582

Electrospec 200A employs an rf approach toward the observation of electron spin resonance phenomena. Magnetic field coils are of the air core type. The unit records the first derivative of the electron spin resonance absorption vs magnetic field characteristic of the sample under observation.

Elion Instruments, Inc., Dept. ED, U. S. Route 130 N., Burlington N. J.

## UHF TV Translator

496



Known as the UST-20, this automatic heterodyne repeater picks up vhf TV signals off-the-air and converts them to a uhf channel for rebroadcast. This 20-w translator requires no operator and is turned on and off by the originating stations signals. It rebroadcasts both color and monochrome.

Adler Electronics, Inc., Dept. ED, 1 Le Fevre Lane, New Rochelle, N. Y.



# FORGET IT! AMP has a crimp for coaxial connections

AMP rolled out all 20 years of its initiative in solderless termination techniques to meet the double challenge of coaxial wire termination. The goal: get rid of the solder; get rid of the double danger of burned insulation; get rid of the overtime in labor and costs; and measurably increase reliability.

AMP's new COAXICON\* contact line gets rid of the solder. In its place, the COAXICON contact technique gives you the fastest, lowest-installed-cost crimped coaxial wire termination available anywhere in the industry.

One crimp does it—one stroke of an AMP tool attaches a COAXICON contact simultaneously to coaxial outer braid and inner conductor.

The COAXICON contact line has remarkable depth, for both single and multiple-connector applications. COAXICON contacts will accommodate the popular sizes of coaxial cables from RG 196/U to RG 62/U having stranded and solid conductors and have a very low VSWR in the KMC ranges when used with cables having a nominal impedance of 50 ohms.

Invite AMP COAXICON contacts to save you time and money on your specific coaxial application.

\*Trademark of AMP INCORPORATED

# AMP

INCORPORATED  
HARRISBURG, PA.

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



One crimp does it . . .

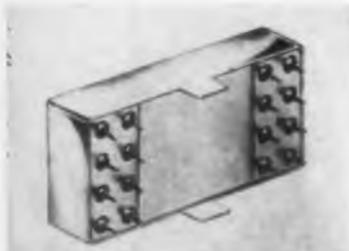
for multiple connectors . . .

or through-panel.

CIRCLE 58 ON READER-SERVICE CARD

## NEW PRODUCTS

### Crosspoint Relays 451



Miniature reed switches are used in MRRC-5A relays. Operating time is 2.0 msec max and contacts are rated at 4 w, 250 v max, 125 ma. Standard unit measures 1-5/8 x 13/16 x 1/2 in. and contains 5 reed switches, surrounded by 3 coils.

Struthers-Dunn, Inc., Dept. ED,  
Pitman, N. J.

### Linear Accelerometer 449



Piezoelectric accelerometer weighs 4.5 g. Model AK106 features a natural frequency of 60 kc and operates over a range of  $\pm 10,000$  g. Encased in a stainless steel case, the unit operates at temperatures between  $-65$  and  $+250$  F.

Statham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

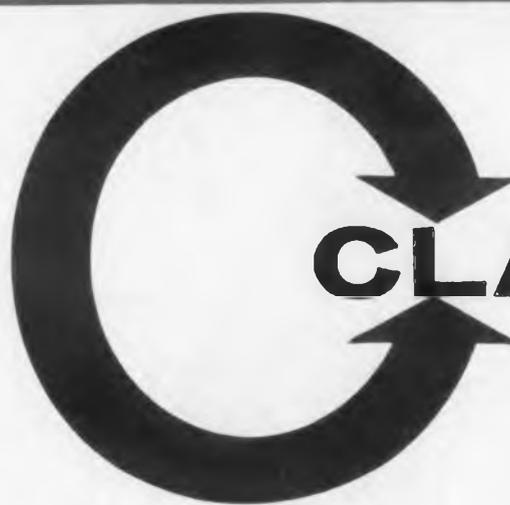
### Decimal Indicator 446



Conversion and display of binary to decimal format is provided by series 1000 decimal indicators. Inputs can be static or pulse, for from 3 to 6 decimal digits. Display is 1-in. numerals, said to be readable to 25 ft. Input impedance is compatible with transistor logic circuits.

Howard Instrument Co., Dept. ED, Red Bank, N. J.

# HIGH-SPEED SWITCHING



Check these

# CLARE

Mercury-Wetted  
Relays  
against your  
design needs

## Choice of two basic switches

### SPEED TO 200 CPS



This CLARE TYPE HGS is the fastest operating, most sensitive mercury-wetted contact relay obtainable. It will operate at speeds to 200 cps with sensitivity as low as 2.5 milliwatts with a contact rating of 2 amperes, 500 volts (100va max.). Two permanent magnets provide single-side stable and bi-stable adjustments. Available with Form D (bridging) contacts.

### LOADS TO 250 VA



This CLARE HG capsule will handle contact loads as high as 5 amperes, 500 volts (250va max.). Operating time may be as low as 3 milliseconds. It is also available equipped with two permanent magnets (HGP TYPE) for single-side stable, bi-stable or chopper operation.

## The Clare Mercury-Wetted Relay Principle

The remarkably long life of CLARE mercury-wetted relays is the result of a design principle whereby a film of mercury on the contacts is constantly renewed, by capillary action, from a mercury pool. Both CLARE HGS and HG switch capsules employ this principle. Both switches are sealed in high-pressure hydrogen atmosphere. Certain construction differences, however, give greater speed and sensitivity to the HGS switch.

# FOR BILLIONS OF OPERATIONS

## Choice of three convenient packages

### ENCLOSED MODULES



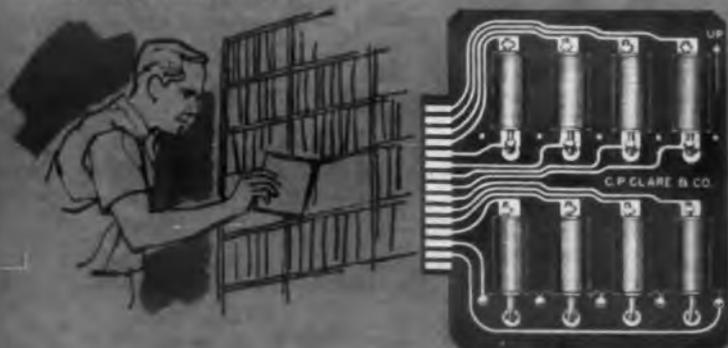
Both CLARE HGS and HG switch capsules are available in steel-enclosed modules for convenient mounting on printed circuit boards in the same manner as resistors, capacitors and similar components. The enclosure is ruggedly designed and provides both excellent mechanical protection and magnetic shielding. These modules are ideal for design and prototype work.

### CONVENTIONAL PLUG-IN RELAYS



CLARE HGS switch capsules are available in single switch units, surrounded by a coil, mounted in high-melting point wax and encased in cylindrical steel containers provided with plug-in base. A smaller type (HGSS) is designed for use where space is limited. HG relays are available with one, two, three, or four capsules, surrounded by a single coil. Also with permanent magnets (HGP) for single-side stable, bi-stable or chopper operation.

### PCB ASSEMBLIES



Printed circuit board assemblies are available with either HGS or HG switch capsules to meet design specifications. These may be designed to customer specifications by CLARE or mounted on boards supplied by the customer. Number of relays is limited only by the dimensions of the printed circuit board.

See your nearest CLARE representative or address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ontario. Cable Address: CLARELAY.



**C. P. CLARE & CO.**

*Relays and related control components*

### NEW! Design Manual 201A

Complete data on characteristics, circuitry, mountings, coil tables and information for ordering CLARE mercury-wetted contact relays.



### DC Voltage Comparator 457



Accepts inputs of any parameter which can be reduced to a dc voltage and compares this unknown voltage to two, externally provided high and low limit references. Input impedance is 10 meg; input grid current is less than  $10^{-11}$  amp; and operating differential is 1 mv max. Sensitivity in the nulling mode is  $250 \mu\text{v}$  per meter-scale division.

Binary Electronics, Inc., Dept. ED, 30-48 Linden Place, Flushing 54, N. Y.

P&A: \$1,135; 60 to 90 days.

### Probe Thermostat 453



Bi-metal unit is a positive switching probe type thermal switch. Switching is accomplished by the expansion of the outer jacket of the probe. The hermetically sealed unit, designated model 4100-1, measures 1 x 1/4 in.

Thermel, Inc., Dept. ED, 677 Elmwood Ave., Providence 7, R. I.

### Plating Console 440



Self-contained printed-circuit console also can be used for small cleaning operations. The entire installation needs only one water, electrical and drain connection. With tanks at normal cabinet height, a typical unit occupies 6 x 4 ft of floor space.

Davies Supply & Manufacturing Co., Dept. ED, 4160 Meramec St., St. Louis 16, Mo.

Price: \$3,000 up.

◀ CIRCLE 60 ON READER-SERVICE CARD

*made to  
"minuteman"  
specifications*



HILL  
announces new 5 mc  
ultra-high precision  
crystal for primary  
frequency standards  
now available in  
commercial quantities

**Frequency Tolerance at Zero Temperature Coefficient:**  
± .0001%

**Zero Temperature Coefficient:** Any particular temperature from +40° C to +85° C, ±5° C tolerance. Actual temperature marked on each unit.

**Vibration:** Less than  $2 \times 10^8$  frequency change for vibration per MIL-C-3098.

**Aging:** Less than 1 part per  $10^8$  per week at delivery.

**Q:**  $3 \times 10^6$  minimum.

**Shock:** Less than  $2 \times 10^8$  frequency change for 50 G shock.

This crystal also is available for use in more rigorous environment.

**TYPICAL VALUES:**

Turning Point..	+44° C
$f_0$ .....	5.000025
$R_p$ .....	105 ohms
$L_1$ .....	16.2 henries
$C_1$ .....	.0000626 uuf
$C_2$ .....	5.30 uuf
Q.....	4,844,500

Write for complete specifications.

**HILL ELECTRONICS, INC.**

MECHANICSBURG, PENNSYLVANIA

CIRCLE 61 ON READER-SERVICE CARD

**NEW PRODUCTS**

**Induction Heating Stations**

494



Output stations are for use at frequencies from 1 to 10 kc. Power levels to 100 kw can be handled in the smaller unit (type MFO-2) and to 500 kw in the larger station (type MFO-1). Both stations can be provided with electrically operated capacitor tap changing switches and an auto-transformer tap switch.

Westinghouse Electric Corp., Induction Heating Dept., Dept. ED, 2519 Wilkens Ave., Baltimore 3, Md.

**Insulated Terminals**

589

Externally threaded units are designated Nos. 2640, 2641, 2642, and 2643. Terminal No. 2640 has double-turrets at each end and has No. 10-32 thread. Terminal No. 2641 has No. 8-32 threads and shank diam of 0.052 in. No. 2642, with 6-32 thread, has turret diam of 0.040 in. Terminal No. 2643 has a pin-type terminal at each end and is available with No. 4-40 thread.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

**Switches and Relays**

522



Solid-state units operate from 28 v dc or ac to 1,000 cps source which is completely isolated from contacts. The devices are available as 1-amp and 5-amp spst units. Custom designs are available with ratings to 200 amp multi-pole ac or dc output. Units meet applicable MIL specs.

El-Tek Components Div., Dept. ED, 13040 S. Cerise Ave., Hawthorne, Calif.

New, improved EDC contains 8,700 New Product items arranged by product category.

**NEW  
METER  
CALIBRATOR**

AC and DC  
60 and 400 CPS  
Voltage and Current



Twincos says you won't match the features of the new MC5400 without paying thrice the price. Not twice. Thrice. Will you let us prove it to you?

✓ Check these features; make a note of this price; compare to your heart's content. We'll be happy to arrange a demonstration on request.

For all conventional laboratory, panel and standard meters. 54 ranges — 3 ranges per decade: 1-2-5-10

2 volts to 1000 volts DC  
2 millivolts to 1000 volts AC  
20 microamps to 10 amps DC  
20 milliamps to 10 amps AC

0.5% accuracy meters

0.1% precision resistors

Certified calibration curves to

0.25% accuracy

• Traceable to U.S. Bureau of Standards  
High Power Output, Negligible Loading Errors

• No correction required for any conventional meter voltage drop or current drain

All DC supplies filtered to 0.5% or better  
No warm-up needed. 2 controls select function and range

Fully interlocked for safety

Reliable — meters in calibrator cannot be overloaded

Portable — just 55 lbs. including walnut cabinet and cover

PRICE: \$975

For details call or write:

**twincos inc.**

10 Cheney Street, Boston 21, Mass.  
Phone HI 5-0180

CIRCLE 62 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 6, 1961

## Variable Attenuator

447



Frequency range of 0 to 3,000 mc is offered by model RT-1, variable attenuator. The accuracy of the device is  $\pm 2$  db over the entire range. Max standing-wave ratios are 1.2, input and 1.4, output. Models come in 50-, 60-, and 75-ohm impedances, with a power handling capacity of 0.5 w.

International Telephone and Telegraph Corp., Dept. ED, 320 Park Ave., New York 22, N. Y.

## Pressure Transducer

452



Airborne pressure transducer is designated Teleflight model 185. Pressure ranges are from 0 to 2,000 psig. Weighing less than 9 oz, this unit produces an output accurate to  $\pm 0.25\%$  and proportional to the pressure applied.

Taber Instrument Corp., Dept. ED, 107 Goundry St., North Tonawanda, N. Y.

## Pyrotechnic Gyro

445



Attitude data for short range missiles is said to be highly accurate, from Pyrogyro model 34110. Max drift rate is  $\pm 1$  deg per min and the Gimbals freedom is unlimited. Runup time is 100 msec and usable rundown time is around 4 to 10 min.

Giannini Controls Corp., Dept. ED, 1600 S. Mountain Ave., Duarte, Calif.

Availability: 120 days.

CIRCLE 63 ON READER-SERVICE CARD >

# DALMESA

## APPLICATION REPORT NUMBER 2



## Apply Low-Noise, High-Gain DALMESA Transistors to Your Amplifier Designs

■ Solve your industrial communications design problems today with TI's new DALMESA 2N2188 series. This new germanium alloy diffused mesa transistor family is specifically designed to meet your requirements for high-performance, low-noise, economically-priced transistors for application over the entire communications band from dc to 150 mc. ■ The extremely low, low-frequency noise corner and high alpha cutoff frequency offered by new DALMESA transistors result in low-noise performance over a very wide bandwidth—the 2N2188 series gives you a typical mid-frequency noise



figure of 1.5 db. ■ These new devices also give you guaranteed gain/bandwidth products of 60 and 102 mc to assure excellent performance in your IF, RF and video amplifiers. Increased high-frequency stability results from the guaranteed maximum output capacitance of 2.5 pf at 9 volts. ■ Apply new DALMESA transistors to your communications designs today and take advantage of the increased performance capabilities of this new Texas Instruments series. These new 125-mw transistors are immediately available through your nearest TI Sales Office or Authorized TI Distributor.

PARAMETER	TEST CONDITIONS	2N2188	2N2189	2N2190	2N2191
$BV_{CE0}$ † AND $BV_{CES}$	$I_C = -50 \mu a$	40 v min	40 v min	60 v min	60 v min
$BV_{E0}$	$I_C = 0$ , $I_E = -100 \mu a$	2 v min	2 v min	2 v min	2 v min
$h_{FE}$	$V_{CE} = -6 v$ , $I_C = -2 ma$	40 min	60 min	40 min	60 min
$h_{FE}$ (at 1 kc)	$V_{CE} = -6 v$ , $I_E = -2 ma$	40 min	60 min	40 min	60 min
$f_T$	$V_{CE} = -9 v$ , $I_E = -1.5 ma$	60 mc min	102 mc min	60 mc min	102 mc min
$I_{CBO}$	$V_{CB} = -12 v$ , $I_E = 0$	3 $\mu a$ max			
$C_{OB}$ (at 1 mc)	$V_{CB} = -9 v$ , $I_E = 1.5 ma$	2.5 pf max	2.5 pf max	2.5 pf max	2.5 pf max
Noise Figures‡ (at 1 mc)	$V_{CE} = -5 v$ , $I_E = 0.5 ma$	1.5 db typ	1.5 db typ	1.5 db typ	1.5 db typ
Maximum Power Dissipation	25°C Ambient	125 mw	125 mw	125 mw	125 mw
† $I_E = 0$ ‡ $R_G = 1K\Omega$					

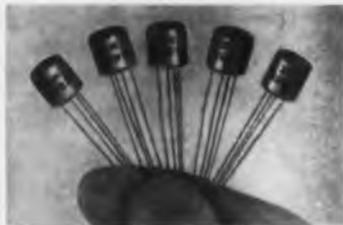
TRANSISTOR  
PRODUCTS  
DIVISION



TEXAS INSTRUMENTS  
INCORPORATED  
13500 N. CENTRAL EXPRESSWAY  
P. O. BOX 5012 • DALLAS 22, TEXAS

## NEW PRODUCTS

### Germanium-Alloy Mesa Transistors 497



Five rf transistors for fm and am home and portable radios are available with low collector leakage current ( $1.2 \mu\text{a}$ ), high current gain  $h_{fe}$  of 150 and high breakdown voltage  $V_{cb}$  of 20 v min. 2N2089, 2N2090 and 2N2091 are respectively rf amplifier, oscillator-mixer and an if amplifier. 2N2093 is an universal type for use up to 6 mc, and 2N2093 is for use in auto radios.

Amperex Electronic Corp., Semiconductor and Special Purpose Tube Div., Dept. ED, 230 Duffy Ave., Hicksville, L. I., N. Y.

### Wideband DC Amplifier 581

Model 112A has stability of  $\pm 2 \mu\text{v}$  for over 400 hr. The unit provides amplification of low level signals from dc to 40 kc. Plug-in attenuator unit provides 10 gain steps from -20 to -1,000. Noise is less than  $5 \mu\text{v}$ . Output is  $\pm 45 \text{ v}$  at  $\pm 40 \text{ ma}$ . Gain accuracy is  $\pm 0.5\%$  dc to 2 kc. Adjustment of model 112A-A plug-in permits setting individual gain steps to better than  $\pm 0.01\%$  accuracy.

Kintel Div., Cohu Electronics, Inc., Dept. ED, Box 623, San Diego 12, Calif.

Price: model 112A with 112A-A plug-in, \$625 fob San Diego.

### Potentiometric Accelerometer 499



Subminiature model 1028-360000 has range of  $\pm 3 \text{ g}$  min, and is available in ranges up to  $\pm 100 \text{ g}$ . Linearity is  $\pm 2\%$  full scale, resistance is 5,000 ohms with  $\pm 5\%$  tolerance. The unit, which operates from -65 to 165 F, has a potentiometer power rating of 0.5 w at 165 F.

Beech Aircraft Corp., Dept. ED, Wichita 1, Kan.

## Design with MALLORY MERCURY BATTERIES for new sales appeal in your products



**PERSONAL RADIATION MONITOR**, developed at Oak Ridge National Laboratory, warns of radiation levels by flashing a neon lamp and sounding a tone in a hearing aid earphone. The transistorized circuit operates 24 hours a day for 30 days at a time, from power by a single Mallory TR-133R mercury battery.

Photo courtesy Oak Ridge National Laboratory  
Operated by Union Carbide Corporation  
For the U. S. Atomic Energy Commission



**PORTABLE TRANSISTOR TEST SET** is made by Metronix, Inc., a subsidiary of Assembly Products, Inc. Used as the DC power source, Mallory Mercury Batteries assure stable voltage over long periods of time, are undamaged by momentary short circuits, and provide long shelf life.



**MICROMINIATURE TRANSMITTER**, used for monitoring tooth wear and pressures and for other biomedical applications, is made by Varo, Inc. Small enough to be fitted into a dental bridge, it transmits information over short distances to a pickup/preamp, utilizing an RM-312 Mallory Mercury Battery smaller than an aspirin tablet.



**A DUAL INSTRUMENT FOR REACTOR MONITORING**, the log n Period Amplifier made by Keithley Instruments, Inc. gives extremely accurate low-level DC measurements. The constant voltage source used for calibrating this sensitive instrument is a Mallory Mercury Battery . . . chosen for its steady voltage and an accuracy within  $\pm 1/2\%$ . Stable, long-lived Mallory Mercury Batteries are used as the power supply for several other Keithley instruments.

Miniaturize your new product . . . make it more portable . . . give it extra long service between battery changes . . . with Mallory Mercury Batteries. Pioneered by Mallory, these unusual batteries last 3 to 7 times longer than conventional batteries, depending on drain. They provide the highest watt-hours per pound of any commercially available primary battery. Sizes smaller than an aspirin tablet deliver ample energy for many miniature circuits.

Mallory Mercury Batteries have the unique characteristic of staying at constant voltage throughout their long life. This property is ideal for transistor circuitry . . . also proves useful in applying these cells as a highly stable source of voltage for reference or calibration. Voltage of cells coming from production varies no more than a few millivolts.

As for shelf life, we've tested mercury batteries held in storage for over six years: capacity loss was minimum. Steel case construction with molded grommet seal makes them free from leakage.

Choose from a broad line of standard single or multiple voltage cells . . . or let us develop a custom power pack for you. Write us for consultation and engineering data.

Mallory Battery Co., North Tarrytown, N. Y.  
a division of P. R. Mallory & Co. Inc.



In Canada: Mallory Battery Company of Canada Limited,  
Toronto 4, Ontario  
In Europe: Mallory Batteries, Ltd., Crawley, Sussex, England

## Metallized Ceramic Tubes

501



Ceramic utilized is 90-97% pure alumina. Bonding strength of the metallizing techniques used is 15-20,000 psi. Ceramic tubes can be metallized in sizes varying down to 0.080 in. ID. Ends of the tubes, which have a maximum length of approximately 8 in., can also be metallized where required.

Ceramics International Corp., Dept. ED, 39 Siding Place, Mahwah, N. J.

P&A: \$0.07 ea in quantities of 500,000; stock to 3 weeks.

## Solid-State Inverters

588

Featuring zero to zero power factor load capability. Efficiency is said to be better than 80% at full load, nominal input. Regulation is 1/2% for input regulation within  $\pm 25\%$  of nominal and 0 to 100% loads. Distortion is less than 2% at unity power factor. Frequency is stabilized to within  $\pm 0.0005\%$  independent of the load.

Electrosolids Corp., Dept. ED, 12740 San Fernando Road, N., Sylmar, Calif.

## High-Filter Power Supply

519



Rated at 300 ma, model DT-30 features variable power from 3 to 25 v. The unit has ripple of less than 0.1% and is designed for transistor and solid-state circuits. A pair of transistors and Zener diodes act as a regulator for the unit. A voltmeter that registers 0 to 50 v is standard equipment.

Dynatech Corp., Dept. ED, 471 N. E. 79th St., Miami, Fla.

Price: \$45.00 fob Miami.

8,700 New Product items arranged by category  
—EDC 1961-62.

CIRCLE 64 ON READER-SERVICE CARD



- RMS, AVERAGE AND PEAK DETECTION
- COMPLETE OVERLOAD PROTECTION
- $\pm 0.2$  db, 2 TO 200,000 c/s



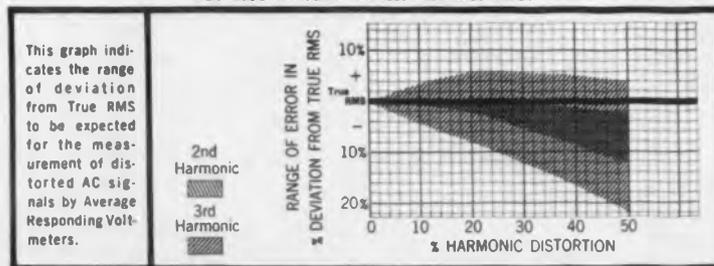
**NEW**  
**MODEL 2409**

## TRUE RMS ACCURACY NOW UNIVERSALLY PRACTICAL

The most important single quantity to express the magnitude of any AC signal is its RMS value. To assure positive accuracy for the measurement of all wave forms, you must really measure the RMS value.

On an average responding voltmeter, the RMS values indicated for rather complex signals may be as much as 20% to 100% low.

You need not settle for less than true RMS!



This graph indicates the range of deviation from True RMS to be expected for the measurement of distorted AC signals by Average Responding Voltmeters.

The ruggedness, reliability and price advantages of the Model 2409 break through all 'roadblocks' to realizing the full advantages of DIRECT MEASUREMENT READINGS OF TRUE RMS values as your company-standard practice.

**\$315**

Available Now!

Write today for the new '2409 Brochure' and explore the major benefits to your company of universal RMS voltage measurements.

**B & K INSTRUMENTS, INC.**

Please send me . . .  
 NEW, 2409 Brochure  
 New, Short Form Catalog



**B & K INSTRUMENTS, INC.**  
BUCK & KIKER PRECISION INSTRUMENTS

3030 West 106th Street • Cleveland 11, Ohio • Clearwater 1-8430

CIRCLE 65 ON READER-SERVICE CARD

## NEW PRODUCTS

### Transducer Exciter-Demodulator 510



Model 201AH adapts differential transformer transducers to dc actuated read-out devices. Frequency response is flat from 0 to 100 cps. Typical sensitivity is 50 mv per 0.001-in. core deflection with accuracy to 0.2% of scale. Operation from either ac line or dc power sources is selectable.

Daytronic Corp., Dept. ED, 225 S. Jefferson St., Dayton 2, Ohio.

Price: \$245.00.

### Logic Modules 597



Two megacycle dual emitter follower, PS-1910, is one of five modules in the PS series. Other modules include an and gate, an or gate, a flip-flop and a dual inverter. The two gate modules measure 7/16 in. on all surfaces and the other units are 1/2 in. epoxy cubes.

Pacific Semiconductor, Inc., Dept. ED, 12955 Chadron Ave., Hawthorne, Calif.

Price: \$24 to \$77.

### Silicon Alloy Transistors 493



PNP 400-mw transistors for switching and chopping meet MIL-S-19500B specifications. Collector saturation resistance is less than 10 ohms. Units are manufactured in the 2N327A series and 2N1228 series. Leakage currents into the na range and high voltages in the reverse configuration enables them to be suitable for chopper service.

Western Transistor Corp., Dept. ED, 13021 S. Budlong, Gardena, Calif.

# ELECTRON TUBE NEWS from SYLVANIA

Eliminate optical systems  
in coding data ...

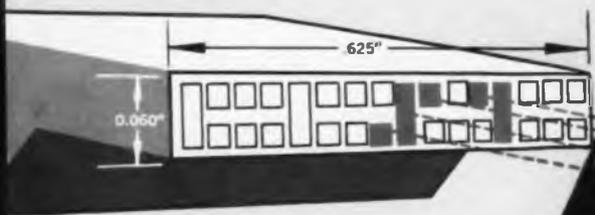


FIG. 1

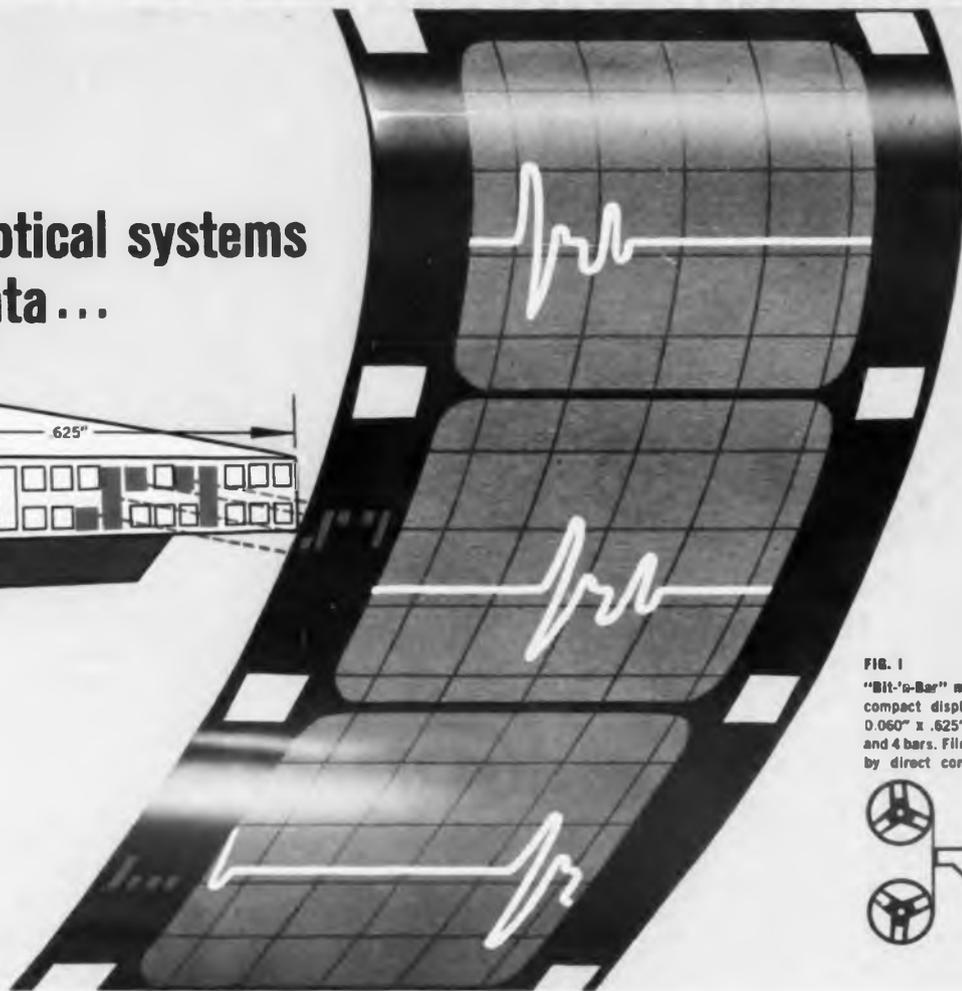
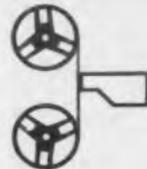


FIG. 1  
"Bit-'n-Bar" matrix features  
compact display area, only  
0.060" x .625", with 24 bits  
and 4 bars. Film is calibrated  
by direct contact printing.



## New! Panelescent® EI Devices for photo-recording

Sylvania electroluminescent devices can be successfully used in movie cameras to calibrate time on each frame of film. Significantly, this is accomplished by direct contact printing, eliminating costly, space-consuming optical systems. Pinpoint-positioning of light output for high definition is obtained by means of a transparent conductor that confines light to desired paths. Power requirements are negligible; life attainment is outstanding.

This is but one of many unique applications that illustrate the practical capabilities of electroluminescence. Present devices—10-digit multinumerics, binary dot or

"Bit-'n-Bar" matrices—are flat, ultracompact. Convex, concave or cylindrical devices also are feasible. Since graphic arts techniques are used to produce electroluminescent displays, the variations in patterns are limitless.

If you are working on similar applications, such as instrumentation equipment, Panelescent devices can aid your design. Look into its many advantages and see for yourself. If you need assistance, call on your Sylvania Sales Engineer. For technical data, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, N. Y.

®Registered trade mark



FIG. 2  
SD114, ten-digit 1/4" multinumeric. With all segments lighted each numeric draws only 5mW. Sylvania can also produce alpha-numeric and symbols.

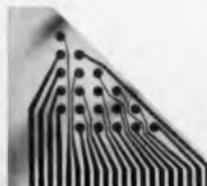


Fig. 3  
SD104, triangular binary dot matrix. Dots are only .030" in diameter. Total power consumption for the matrix is approximately 3mW.

# NEEDED NOW:

## Radiation-Resistant Components!



Few reliability studies hold such great import for national security as those investigating radiation effects on electronic components. Will, for example, electronic components withstand continuous radiation from the reactor of a nuclear-powered craft?

Intense radiation is known to have catastrophic effects on solid-state performance. How, then, do you design for reliable, compact circuitry without imposing prohibitive weight penalties of massive shielding?

One good way: design around radiation-resistant Sylvania Gold Brand Subminiature Tubes! All Gold Brand Subminiature types are rated for steady state radiation resistance. Extensive testing proves them capable of withstanding  $10^{12}$  neutrons/sq. cm./sec. dose rate

for a total dosage of  $10^{16}$  neutrons/sq. cm. Further, Gold Brand Subminiature Tubes tolerate pulses of pure gamma radiation of approximately  $10^6$  R./sec. Compare this with the gamma dose rate of 0.1 R./sec. absorbed  $\frac{1}{4}$  mile from a 20KT bomb—it's well within the operating capability of Gold Brand Subminiature Tubes.

Vacuum tubes are compatible not only with nuclear environments but extreme shock and excessive temperatures. Extended periods of storage, too, have little or no effect on vacuum tubes. Ask your Sylvania Sales Engineer for complete information on the many remarkable capabilities of electronic tubes. He can supply you with detailed documentation of Sylvania Gold Brand Subminiature Tube reliability.

# SYLVANIA

SUBSIDIARY OF

**GENERAL TELEPHONE & ELECTRONICS**



P-1775-3

## Delay Line Network

442



Type CTC-168 Q-Line has an 8-mc bandwidth for an overall delay of 6.3  $\mu$ sec, at an impedance level of 200 ohms. Rise time is 0.08  $\mu$ sec with a resulting delay-to-rise time ratio of 80:1. The unit has 63 taps at 0.1  $\mu$ sec intervals. Housed in a 5 x 5 x 4-in. steel case, the unit is designed to meet environmental requirements of MIL-STD-202B.

Columbia Technical Corp., Dept. ED, Woodside 77, N. Y.

P&A: \$500.00 to \$600.00; 5 to 6 weeks.

## Temperature Controller

381



Maintains temperatures to within  $\pm 0.05$  C for variations in ambient temperature, in heat load, and in line voltages. Range controlled is approximately 50 to 300 C. Model 104 is capable of continuously controlling up to 1.5 kw. Units, which are for ac operation only, are available with or without precision temperature indicating meters.

Electro-Age Corp., Dept. ED, 611 Broadway, New York 12, N. Y.

Availability: 4 to 6 weeks.

## Pressure Transducer

380



Accuracy is  $\pm 0.25\%$  of full range, from 15 to 5,000 psi and  $\pm 1.0\%$  to 10,000 psi, based on calibrated performance. Model 6001-B is equipped with a differential transformer and bourdon tube assembly. Bourdon tubes are constructed of phosphor-bronze for pressure ranges up to 1,000 psi, and beryllium-copper for ranges above 1,000 psi.

Automatic Timing & Controls, Inc., Dept. ED, King of Prussia, Pa.

# Checking Computer Storage Units

with a

## Tektronix Dual-Beam Oscilloscope



Photographed at Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

Engineers at the Los Alamos Scientific Laboratory in New Mexico presently use a Tektronix Type 555 Dual-Beam Oscilloscope for checking out the magnetic-core storage units in Stretch, the new high-speed computer. Upper trace is a storage pulse from one of the units. Lower trace is free-running, awaiting the next storage pulse switched in by the computer.

Six of these magnetic-core storage units constitute the basic memory of Stretch, reputed to be the world's most powerful computer. The computer memory can store 98,304 words of information, equivalent to more than 1,500,000 decimal units—with data retrievable electronically from any unit in approximately 2 microseconds.

## Tektronix, Inc. P. O. BOX 500 • BEAVERTON, OREGON / Mitchell 4-0161 • TWX-BEAV 311 • Cable: TEKTRONIX

**TEKTRONIX FIELD OFFICES:** Albuquerque, N. Mex. • Atlanta, Ga. • Baltimore (Towson) Md. • Boston (Lexington) Mass. • Buffalo, N. Y. • Chicago (Park Ridge) Ill. • Cleveland, Ohio • Dallas, Texas • Dayton, Ohio • Denver, Colo. • Detroit (Lathrup Village) Mich. • Endicott (Endwell) N. Y. • Greensboro, N. C. • Houston, Texas • Indianapolis, Ind. • Kansas City (Mission) Kan. • Los Angeles, Calif. Area (East Los Angeles Encino • West Los Angeles) • Minneapolis, Minn. • Montreal, Quebec, Canada • New York City Area (Albany, N. Y. • Stamford, Conn. • Union, N. J.) • Orlando, Fla. • Philadelphia, Pa. • Phoenix (Scottsdale) Ariz. • Portland, Oreg. • Poughkeepsie, N. Y. • San Diego, Calif. • San Francisco, Calif. Area (Hayward, Palo Alto) • Seattle, Wash. • Syracuse, N. Y. • Toronto (Willowdale) Ont., Canada • Washington, D.C. (Arlington, Va.).

**ENGINEERING REPRESENTATIVES:** Keronon Hawaii, Ltd., Honolulu, Hawaii. Tektronix is represented in twenty-five overseas countries by qualified engineering organizations. European and African countries, the countries of Lebanon and Turkey, please contact TEKTRONIX INTERNATIONAL A. G., Terrassonweg 1A, Zug, Switzerland, for the name of your local engineering representative. Other Overseas areas, please write or cable directly to Tektronix, Inc., International Marketing Department, P. O. Box 500, Beaverton, Oregon, U.S.A. Cable: TEKTRONIX

## CHARACTERISTICS

Independent X and Y Deflection • DC-to-30 MC, 12-nsec Risettime with Fast-Rise Plug-In Units • 21 Calibrated Sweep Rates from 0.1  $\mu$ sec/cm to 5 sec/cm • 5X Magnifier • Single-Sweep Provision • Calibrated Sweep Delay • Amplitude-Level (Manual) Selection or Fully Automatic Triggering Facilities • 10-KV Accelerating Potential • 4-cm by 10-cm Display for Each Beam, with 2-cm Overlap • Amplitude Calibrator.

## CAPABILITIES

With a Tektronix Type 555 Dual-Beam Oscilloscope, you can control either or both beams with either time-base generator. You can operate one time-base unit as a delay generator—hold off the start of any sweep generated by the other for a precise interval from one-half microsecond to 50 seconds—and observe both the original display and the delayed display at the same time.

By interchanging any combination of 17 letter-series plug-in units, you have signal-handling versatility in such applications as dual-beam pulse-sampling . . . transistor-risettime testing . . . semiconductor-diode-recovery-time studies . . . strain gage and other transducer measurements . . . differential-comparator displays . . . as well as multiple-trace work in general laboratory experiments.

The Type 555 can mean better engineering for you—in less time.

Type 555 . . . \$2600  
(without preamplifiers)

Includes Indicator Unit, Power Unit, 2 Time-Base Units, 4 Probes, Time-Base Extension, 7 other accessories. U.S. Sales Price f.o.b. Beaverton, Ore.

Designed and built for the Laboratory by IBM, in cooperation with the Laboratory's Theoretical Division staff members, Stretch permits scientists to work with far more realistic weapons simulations than in the past, and to analyze the vast amount of data gathered during the tests of nuclear rocket propulsion reactors.

For your own scientific tests and measurements—in analyzing waveforms in the dc-to-30 mc range—you will find a Tektronix Type 555 Dual-Beam Oscilloscope extremely adaptable and reliable. You can use it to display almost any signal in almost any laboratory application.

To observe the signal-handling ease and capabilities of this dual-beam oscilloscope in your own laboratory application, please call your Tektronix Field Engineer. He will gladly arrange a demonstration for you at your convenience.

CIRCLE 67 ON READER-SERVICE CARD

## NEW PRODUCTS

### Aluminum Cases

350



MIL-C-4150E aluminum military cases are available in 11 sizes from 18 x 21 in. to 28-1/4 x 28-1/4 in. The female closure has an environmental gasket seal. Standard equipment includes handles, latches, pressure and humidity valves and shock support cushioning. Cases meet applicable standards for temperature, humidity, fungus, salt-spray, etc.

Zero Manufacturing Co., Dept. ED, 1121 Chesnut St., Burbank, Calif.  
Availability: 5 to 6 weeks.

### Transducer

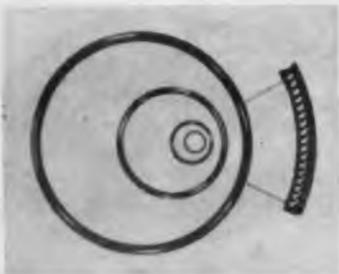
571

Weighing less than 1/2 lb, the unit provides high-pressure measurements in a 50-g environment, in a variety of ranges over 0 to 100 psi to 0 to 8,000 psi. Resolution is 0.25%, hysteresis and repeatability 0.5%. The unit is a high-temperature, spiral bourdon type measuring 1-3/8 in. in diam x 1-1/2 in. long.

Giannini Controls Corp., Dept. ED, 1600 S. Mountain Ave., Duarte, Calif.

### Seal Rings

351



Astra-Seal withstands pressures up to 10,000 lb per sq in. and environmental temperatures from -450 to +400 F. The Teflon and stainless steel seals are designed for installation in valves and lines carrying oil, water, liquid oxygen, nitrogen and helium.

Carmac Aviation, Dept. ED, 8414 San Fernando Road, Sun Valley, Calif.  
Availability: 2 weeks.

EDC 1961-62 contains 8,700 New Product write-ups arranged by product category.

# FROM MOTOROLA . . . . POWER

NEW PNP GERMANIUM SERIES RATED AT

# 170 W. $P_d$

OPERATES UP TO

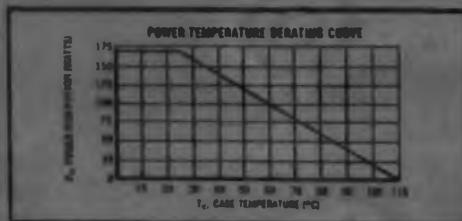
# 110° C. $T_j$

AVAILABLE WITH CERTIFIED RELIABILITY

# “MEG-A-LIFE”

## NEW 2N2075-82 SERIES OFFERS:

- 170 WATTS—93% greater power dissipation capability than conventional TO-36 power transistors.
- 110° C.  $T_j$  — Maximum junction temperature rating (15° higher than conventional TO-36 units) provides added operating temperature safeguard and also increases allowable power dissipation at any given case temperature. In over 3,000,000 device hours of storage life testing at temperatures up to 150°C. the failure rate was only 0.030%/1000 hrs.
- “MEG-A-LIFE”—a program offering industrial users certified reliability based upon complete electrical, mechanical, and environmental tests to military type specs. Lot acceptance data and test results available to purchasers of “MEG-A-LIFE” versions of these devices.



2N2075 SERIES, 15 AMP				
$h_{FE} @ 5A$	$BV_{CES}$			
	40V	50V	70V	80V
20-40	2N2078	2N2077	2N2076	2N2075
35-70	2N2082	2N2081	2N2080	2N2079





# RELIABILITY

## IS AN OUTSTANDING CHARACTERISTIC OF ALSiMAG® CERAMICS

ALSiMag Ceramics offer exceptional resistance to heat and erosion. They have marked electrical and physical stability at elevated temperatures and in varying environments. Chemically inert. Good strength. Can be accurately fabricated in micro-miniatures.

ALSiMag Ceramics include many special purpose ceramics, some especially adapted to hermetic sealing. Widest choice of materials, more than half a century of specialized experience. Send blue print and operating conditions.



ALSiMag pioneered micro-miniature ceramics . . . some as thin as 0.005". Relatively high strength, superior performance at high temperatures, high frequencies. Excellent record for withstanding fatigue, heat, shock, vibration.



The ALSiMag Ceramics in these multiple pin headers may be safely used up to 2800°F. The metal components are the limiting factors.

These tantalum pins with nickel braze alloy operate around 1000° F. All materials are rugged. Strong hermetic seal. Low vapor pressure. High temperature bake-out is practical.

A Subsidiary of  
Minnesota Mining and  
Manufacturing Company



**AMERICAN LAVA**  
CORPORATION

CHATTANOOGA 5, TENN.  
60TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Boston: Newton Center, Mass. • Chicago: Bedford Park, Ill. • Cleveland, O. • Dallas, Texas • Los Angeles, Cal. • New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash. All other exports: Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

## NEW PRODUCTS

### Variable Autotransformer

399



Rated at 10.0 amp and 1.4 kva (max), the input voltage is 120 v and the output voltage on line voltage connection is 0-120 v and on over voltage connection is 0-140 v. Model T101U features a snap-on rotor for easy accessibility for inspection of the unit.

Standard Electrical Products Co., Dept. ED, 2240 E. Third St., Dayton, Ohio.

P&A: \$31.00; stock.

### 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.

Cornel-Dubilier Electronics Div., Federal Pacific Electric Co., Dept. ED, 4144 Glencoe Ave., Venice, Calif.

### Oscillator Mount 435



From 4 to 16 units can be mounted on type 1470. Unit will accommodate manufacturers type 1270 and 1274 voltage-controlled oscillators and the 1170 wideband amplifier.

American Bosch Arma Corp., Tele-Dynamics Div., Dept. ED, 5000 Parkside Ave., Philadelphia, Pa.

◀ CIRCLE 69 ON READER-SERVICE CARD

## Vacuum Furnace

374



Operates up to 2,500 C. Model 435-585 is equipped with a tantalum hot zone 7 in. in diam and 14 in. high, and uses no refractory insulation. All controls are housed in a panel at the top of a metal cabinet which houses the power supply. The latter consists of a heavy-duty transformer and three saturable core reactors, capable of 75 kva output.

F. J. Stokes Corp., Dept. ED, 5500 Tabor Road, Philadelphia 20, Pa.

P&A: \$20,000 to \$25,000; stock.

## Circuit-Card Enclosure 450

Holds up to 24 printed-circuit cards. The computer mounting TDC "Uni-cage" is of 16 gage steel and has molded nylon card guides. Cards are spaced 0.680 in. apart. The unit, which weighs approximately 5 lb, may be mounted in a standard 19-in. relay rack or cabinet.

Epsco-Components, Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.

## Solid-State Annunciators 436



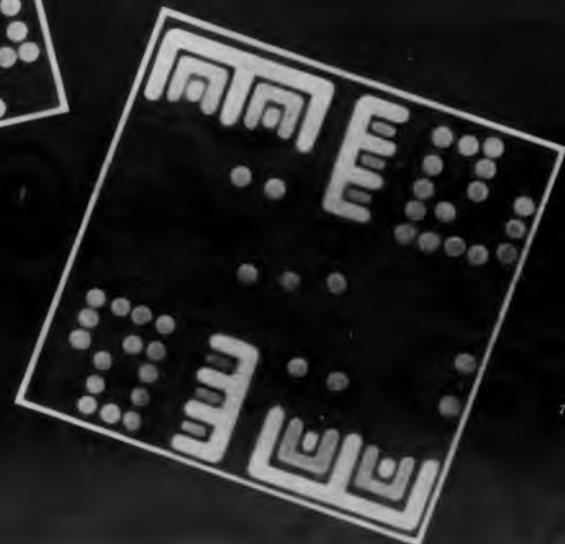
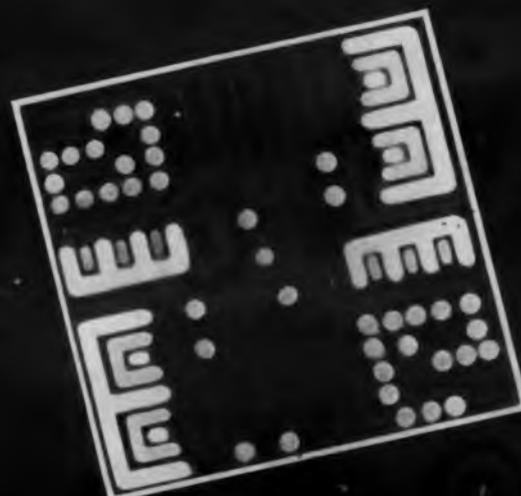
Indication areas are 5/8 x 7/8 in. on 1200 series. Up to 90 units can be installed in an area of 1 sq ft. Installation is a simple plug-in provided by a punched panel. Windows also serve as press-to-acknowledge switches.

Radiation Technology, Inc., Dept. ED, 657 Antone St., N.W., Atlanta 18, Ga.

Price: \$53.10 to \$57.25.

Interested in New Products? EDC 1961-62 contains over 8,700 New Products.

CIRCLE 70 ON READER-SERVICE CARD ▶



# LOADED DICE

## SEMI-NETS\*

### SEMICONDUCTOR INTEGRATED NETWORKS



\*TRADE MARK  
SPERRY RAND  
CORPORATION

# SPERRY

## SEMICONDUCTOR

DIVISION OF  
SPERRY RAND CORPORATION  
NORWALK, CONNECTICUT

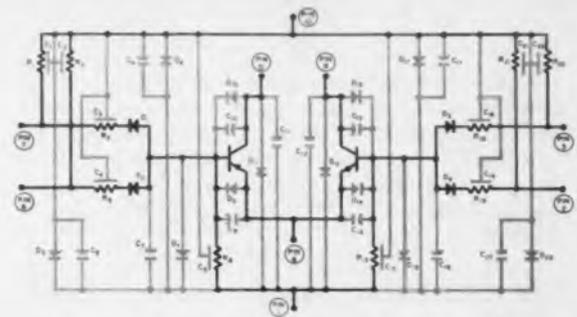


BOTTOM VIEW  
OF HEADER

#### LEGEND

— DESIGNED CIRCUIT  
— DISTRIBUTED CONSTANTS

NOTE: DIODES  $D_1, D_2, D_3, D_4$   
AND CAPACITORS  $C_1, C_2, C_3, C_4$   
ARE PORTIONS OF TRANSISTORS



## COMPLETE CIRCUIT ON A SILICON SLICE REDUCES ASSEMBLY COSTS... INCREASES CIRCUIT RELIABILITY.

Through the use of photoresists, planar diffusion, and surface passivation, the complete circuit, shown above, has been fabricated in one silicon slice — packaged in a multilead TO-5 case.

Because this high density device eliminates 75% of conventional connections, your circuit assembly costs are reduced. And because fewer interconnections mean less opportunity for circuit failure, your overall circuit reliability is increased.

In addition, SEMI-NETS offer design and systems engineers weight and volume reduction over conventional miniature components, between 100:1 and 1000:1. Low power requirements further the overall advantages of the SPERRY SEMI-NET.

If you are interested in the development of a SEMI-NET circuit for your equipment, we would like the opportunity to show you how we may help you.

Write today for comprehensive brochure describing the state of the art of SEMI-NETS.

SEMICONDUCTOR INTEGRATED NETWORKS (SEMI-NETS\*),  
TUNNEL DIODES, MESA AND ALLOY SILICON TRANSISTORS AND DIODES  
SALES OFFICES: CHICAGO, ILLINOIS; LOS ANGELES, CALIFORNIA; OAKLAND, NEW JERSEY;  
MEDFORD, MASSACHUSETTS; SYKESVILLE, MARYLAND; FOREST HILLS, NEW YORK  
SEMICONDUCTOR OPPORTUNITIES  
AVAILABLE TO QUALIFIED ENGINEERS

\*Trade Mark, Sperry Rand Corporation

## NEW PRODUCTS

### Pressure Transducer

384



Has multiple taps or "sawtooth" outputs suitable for aircraft control systems. Model 45176 is available in a variety of ranges, including absolute, differential or gage. The unit is said to feature low friction and repeatability error, and has low to high impedance outputs.

Giannini Controls Corp., Dept. ED, 1600 S. Mountain Ave., Duarte, Calif.

### High-Mu Triode

387



Miniature high vacuum type 581 delivers 13 kw pulse power output in pulse modulator service. Maximum anode voltage is 20 kv; peak plate current, 1.2 amp; and grid bias is 300 v. The tube is 2.75 in. long and 1.13 in. in diam.

United Electronics Co., Dept. ED, 42 Spring St., Newark, N. J.

### Transistorized Inverters

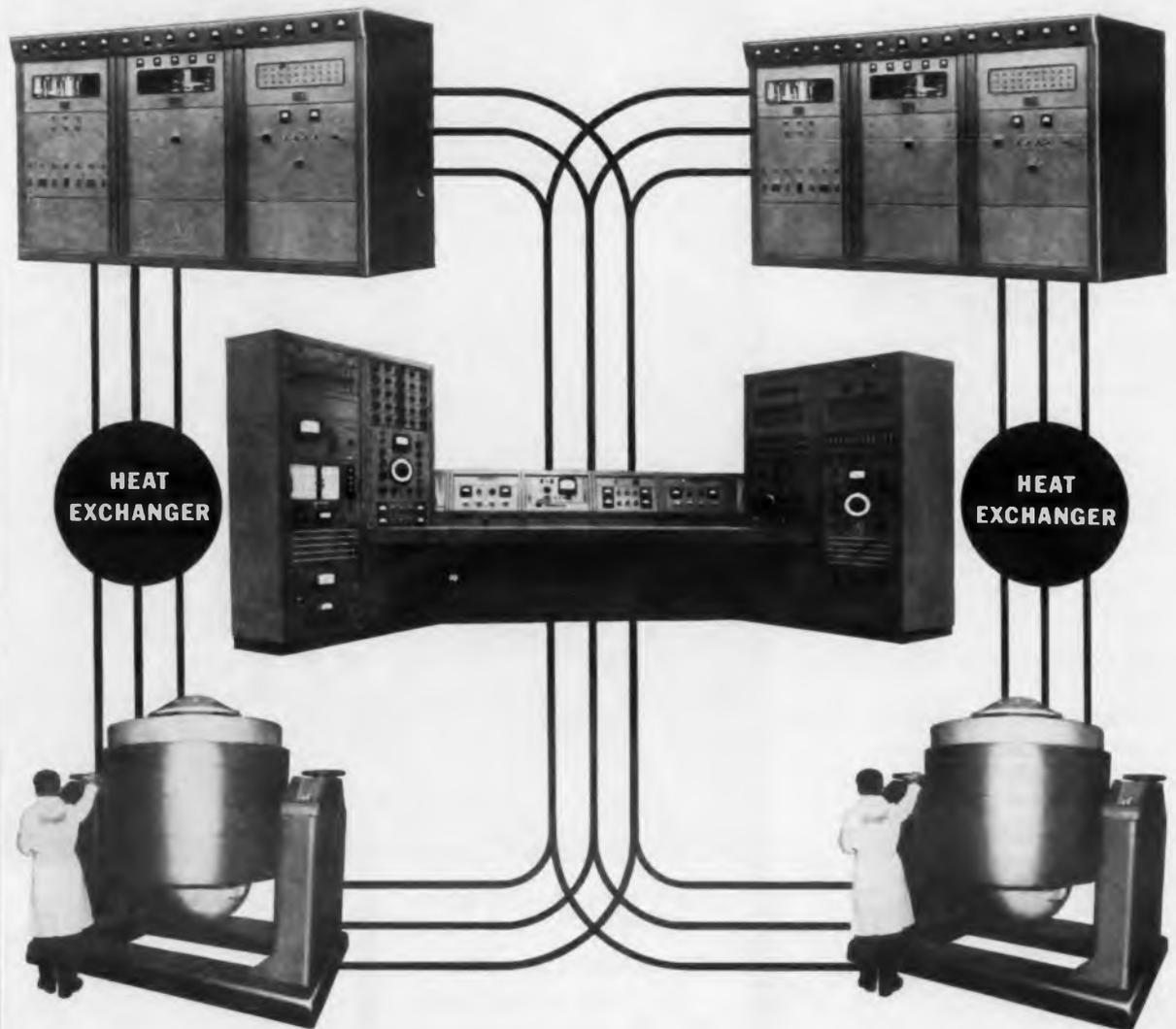
356



Twelve models from 20- to 500-w output are claimed to have efficiency ratings in excess of 80%. Units have no mechanical moving parts and are not affected by humidity. All models are available with normal or constant frequency controls.

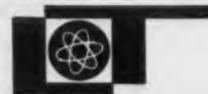
Dynamic Instrument Corp., Dept. ED, 190 Michel Drive, Syosset, N. Y.

Availability: 6 to 8 weeks.



## A BETTER SHAKE FOR POLARIS... Aerojet-General installs Ling vibration system with world's highest force rating - 60,000 pounds

When faced with unsolved vibration testing problems on its vital part of the Polaris program, Aerojet-General Corporation, a subsidiary of The General Tire and Rubber Company, turned to Ling Electronics. To give its solid propellant rocket engines the severest shake-up, Aerojet-General improved its test facilities with two Ling vibration systems—controlled simultaneously or independently by one console. The system, now operating, includes two Model 249 shakers delivering 30,000 pounds force each and two Model PP 120/150, 120 KVA water-cooled amplifiers—for a total force delivery of 60,000 pounds. The special random/sine wave console not only provides simultaneous or independent control of both exciter systems, but features Ling's famous ESD-ASD 20 spectral density equalizer/analyzer, the industry standard. Like Aerojet-General, you too may find the superior quality and rugged reliability of Ling systems answer your testing problems. For more information, write Department ED-1261 at the address below.



**LING-TEMCO ELECTRONICS, INC.**

LING ELECTRONICS DIVISION

1515 SOUTH MANCHESTER, ANAHEIM, CALIFORNIA • PROspect 4-2900

## LING ELECTRONICS

The powerful Ling vibration system shown at the left is just one more example of the way Ling's continuing program of research serves industry and defense programs.

As package weights rise, so does the need for vibration testing systems of higher performance and reliability. And Ling engineers have consistently anticipated these demands with designs that keep pressing toward higher ratings.

The powerful Model 249 shaker shown below delivers 30,000 pounds of force when combined with its mating amplifier. Only the high force rating of the 249 shaker made it possible to meet the big systems needs of Aerojet-General as described at the left.

Ling amplifiers offer equally impressive ratings. Ling pioneered in the manufacture of electronic amplifiers for driving electro-dynamic shakers and has produced liquid-cooled amplifiers that deliver from 10,000 to 5,000,000 watts.



Listed below are performance ratings of high power Ling vibration systems employing the Model 249 shaker:

LIQUID-COOLED SHAKER	LIQUID-COOLED AMPLIFIER	FORCE LBS. SINE	FORCE LBS. RANDOM
249	PP 175/240	30,000	32,000
249	PP 120/150	30,000	28,000
249	PP 75/90	23,000	21,000

Whatever your needs in high power electronics—vibration testing, acoustics or sonar, you'll find Ling systems offer high performance, high reliability, and quality that sets the standard.



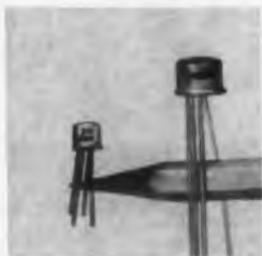
**LING-TEMCO ELECTRONICS, INC.**  
LING ELECTRONICS DIVISION

HIGH POWER ELECTRONICS FOR  
VIBRATION TESTING · ACOUSTICS · SONAR  
CIRCLE 72 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 6, 1961

## Communications Transistors

352



Post alloy diffused transistors are designated 2N987 and 2N2084. The 2N987 is housed in a 4-pin, TO-18 case and the case of the 2N2084 is a TO-33. These transistors are suited for rf and if amplifiers in hf and vhf bands. Typical characteristics: power gain, 14 db at 100 mc;  $h_{fe}$ , 140;  $BV_{cbo}$ , 40 v;  $C_{ob}$ , 2 pf.

Semiconductor Div., Amperex Electronic Corp., Dept. ED, 230 Duffy Ave., Hicksville, L. I., N. Y.

Price: \$1.55 ea, 2N987; \$1.25 ea 2N2084, (per 1,000).

## Alumina Ceramic Substrates

359

Precision substrates are 96% aluminum oxide. These flat substrates are drilled, slotted, or notched to less than  $\pm 0.001$ -in. tolerance. Substances are capable of very high to very low temperature operation. The smooth surface enables their use for IR mirrors.

Electro-Ceramics Inc., Dept. ED, 2645 S. Second West, Salt Lake City 15, Utah.

## Vertical Sensing Element

478



Electromagnetic vertical sensing element model 218995-1 is a gravity-sensitive liquid-damped pendulum device. It can be applied to any vertical sensing situation requiring an electrical output. A jewel-suspended permeable mass acts as the variable reluctance portion of two orthogonally mounted differential transformers to provide a phase-sensitive output signal proportional to tilt angle. Containing only one moving part, this hermetically sealed unit has the following specifications: excitation, 3 v, 400 cps; output, 78 mv  $\pm 10\%$  at 30 arc min; null voltage, 7 mv; linearity,  $\pm 3$  mv up to 18 arc min.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

# FILMISTOR

## METAL FILM RESISTORS OFFER 5 DISTINCT TEMPERATURE COEFFICIENTS TO MEET ALL CIRCUIT REQUIREMENTS

RUGGED END-CAP CONSTRUCTION  
FOR LONG TERM STABILITY

...

EXCEPTIONAL RESISTANCE TO  
MOISTURE AND MECHANICAL DAMAGE

...

SURPASS MIL-R-10509  
PERFORMANCE REQUIREMENTS

...

Providing close accuracy, reliability and stability with low controlled temperature coefficients, these molded case metal-film resistors outperform precision wirewound and carbon film resistors. Prime characteristics include minimum inherent noise level, negligible voltage coefficient of resistance and excellent long-time stability under rated load as well as under severe conditions of humidity.

Close tracking of resistance values of 2 or more resistors over a wide temperature range is another key performance characteristic of molded-case Filmistor Metal Film Resistors. This is especially important where they are used to make highly accurate ratio dividers.

Filmistor Metal Film Resistors, in  $\frac{1}{8}$ ,  $\frac{1}{4}$ ,  $\frac{1}{2}$  and 1 watt ratings, surpass stringest performance requirements of MIL-R-10509D, Characteristics C and E. Write for Engineering Bulletin No. 7025 to: Technical Literature Section, Sprague Electric Co., 347 Marshall Street, North Adams, Mass.

For application engineering assistance write:  
Resistor Division, Sprague Electric Co.  
Nashua, New Hampshire

## SPRAGUE COMPONENTS

RESISTORS	PIEZOELECTRIC CERAMICS
CAPACITORS	PULSE-FORMING NETWORKS
MAGNETIC COMPONENTS	HIGH TEMPERATURE MAGNET WIRE
TRANSISTORS	CERAMIC-BASE PRINTED NETWORKS
INTERFERENCE FILTERS	PACKAGED COMPONENT ASSEMBLIES
PULSE TRANSFORMERS	FUNCTIONAL DIGITAL CIRCUITS

# SPRAGUE

THE MARK OF RELIABILITY

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

CIRCLE 73 ON READER-SERVICE CARD



## KEARFOTT SYNCHROS AND RESOLVERS FOR GIMBAL APPLICATIONS

Precision wound components for direct mounting to gimbal structures are now available for application in gyros, platforms and other devices. These components can be supplied with or without appropriate precision bearings.

A wide range of mounting configurations are available and special adaptations can be provided. High accuracy components, featuring maximum error of 20 seconds of arc are in quantity production. Improved accuracy can be provided as required. Materials used as housing can be either aluminum or beryllium weight reduction. Stainless steel housings for rigidity and corrosion resistance are available in many standard units.

Typical gimbal mounted components are tabulated below. Special units are available with beryllium housings and include two multipole (equivalent to 25 speed) units with accuracy of 12 secs/speed. The CZ 06311 001 is a synchro transmitter, the CZ 09623 001 is a combination transmitter-DC torquer concentrically mounted. A "piggy-back," two unit transmitter, one 3 wire the other 4 wire with stack height of 1" is also available.

### SPECIFICATIONS

Typical Part Numbers	Size	Function	Excitation	Accuracy
325720 325721	8	Resolver	2V 400 cps	15 min.
<i>(Diameter .750" Length 1.250" See 326390-001 below)</i>				
326390-001	25	Resolver Transmitter	20V 900 cps	3 min.
<i>( "Ring" housing—special hub designed to operate concentrically around a smaller unit.)</i>				
C206380-002	As req'd.	Resolver Transmitter	115V 800 cps	20 sec.
<i>(Pancake configuration beryllium housing 5.375" dia. X 1.437" high.)</i>				
826380-000	As req'd.	Resolver	115V 800 cps	3 min. or 5 min.
<i>(Flat aluminum housing conforms to BuOrd 1980052-MIL-R-21530.)</i>				
209981 209984	23	Resolver	As required	10 min.
<i>(High accuracy machined stack allows direct mounting without housing.)</i>				
326210-008	25	Synchro	As required	2 min.
<i>(Various hub and housing configurations available.)</i>				
1/326380-008	As req'd.	Resolver	115V 800 cps	20 sec.
<i>(High accuracy transformation ratio 1.0160 conforms to BuOrd 1980055.)</i>				

Write for complete data



KEARFOTT DIVISION  
GENERAL PRECISION, INC.

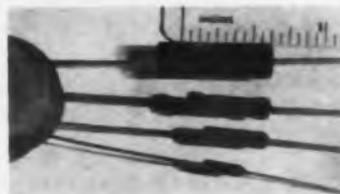
Little Falls, New Jersey

CIRCLE 74 ON READER-SERVICE CARD

## NEW PRODUCTS

### Metal Film Resistors

388



Vac-Ohm resistors exceed MIL-R-10509D, characteristic C. Available in temperature coefficients of 25, 50, and 100 ppm per C, units are coated with high temperature epoxy. Sizes available include 1/8 w, 1/4 w, and 1/2 w. Resistance range is 30 ohms through 1.0 meg, rated at full load at 125 C, derating to zero at 175 C. Resistance tolerance is  $\pm 1\%$ .

Vac-Ohm Electronics Co., Dept. ED, P. O. Box 444, Haddonfield, N. J.

Availability: stock.

### Shift Register Bit

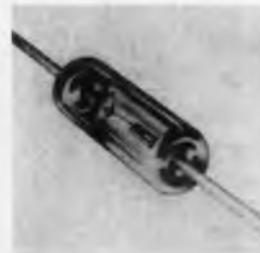
377

Microminiature magnetic bit operates from  $-55$  to  $90$  C and can stand vibrations of 20 g, 3 perpendicular axes, 0.44 to 2,000 cps. Developed for missile applications, type MRC 846 weighs 2.5 g and occupies approximately 1/16 cu in. Frequency is dc to 150 kc, and shift current at 150 kc is 150 ma. Output voltages are: 5 v min, "1"; and 0.6 v max, "0".

Magnetics Research Co., Dept. ED, 179 Westmoreland Ave., White Plains, N. Y.

### Germanium Diode

474



Ultra-fast germanium gold-bonded diodes, types CGD-1092 and CGD-1093 are operable over an ambient temperature range of  $-65$  to  $+90$  C. At 25 C, type CGD-1092 with a mercury relay square wave generator and a scope with a rise time less than 1 nsec, switching from 10 ma with 100 ohms loop impedance, attains a reverse recovery speed to 1 ma of 8 nsec max. Under parallel conditions, type CGD-1093 attains a reverse recovery speed to 1 ma of 3 nsec max. Average power dissipation of both types is 80 mw.

Clevite Corp., Clevite Transistor Div., Dept. ED, Waltham 54, Mass.

## NEW Stromberg- Carlson lightweight telephone handsets



... for a wide range of applications such as dictating systems, mobile radio, carrier and microwave.

These new lightweight Stromberg-Carlson handsets, No. 33 and No. 35, incorporate push-to-talk switches, broadening the range of their applications. Both feature high gain, high efficiency transmitter and receiver.

The No. 33 model is furnished with a bar-type switch, located on the underside of the handle.

The No. 35 handset is furnished with a button switch on the side of the handle near the receiver end. Also available with both button and bar switches.

For technical details and ordering information, contact any of these sales offices: Atlanta—750 Ponce de Leon Place, N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Ave.; San Francisco—1805 Rollins Rd.

**GENERAL DYNAMICS**  
**TELECOMMUNICATION**  
CIRCLE 75 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 6, 1961

## AC Voltage Standard 464



Accuracy is  $\pm 0.05\%$ . Model DFVS-101 has outputs of 1, 10, and 100 v ac rms to load impedances of 10 K, 100 K and 1 megohm respectively. Frequency is 400 cps (with others available on special order) and harmonic distortion is less than 0.1% total. The 12-1/2-lb unit requires 117 v ac, 60 cps.

Delta-f, Inc., Dept. ED, 113 E. State St., Geneva, Ill.

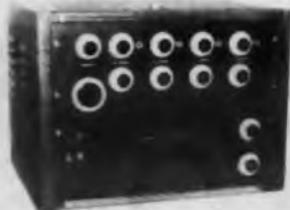
P&A: \$825.00 fob Geneva; 6 weeks.

## PTC Thermistors 454

Positive temperature coefficient disks are available in 0.2 to 0.4-in. diameters and have a PTC of resistance at room temperature of 1.1% per C. The devices, which increase in resistance as the temperature increases, are applicable for temperature stabilization of transistor circuits and for temperature sensing in a variety of applications.

Magnetic Materials Section, General Electric Co., Dept. ED, Edmore, Mich.

## Wave Generator 437



In the range of 50 to 3,000 cps, any waveform represented by a Fourier series can be generated. Unit provides a fundamental and 2nd, 3rd, 4th, and 5th harmonic, in any percentage of relative phase. Mathematical motions of up to 5 variables may be studied with this unit.

Instant Circuits Corp., Dept. ED, Terminal Drive, Plainview, N. Y.  
Price: \$995.00.

CIRCLE 76 ON READER-SERVICE CARD

NEW HIGH IN  
RELIABILITY  
*Transitron's*  
EXCLUSIVE

## HEATLESS SEAL RECTIFIERS

This new line of heatless seal silicon rectifiers by Transitron, the originator of the silicon rectifier, brings to the electronic industry a notable new advance in the state of the art.

The reliability of internal rectifier junctions is now further enhanced because no heat is used to seal the packages. Cap and base are joined by the "cold flow" of copper into steel as the parts are forced together under high pressure. Rectifier junctions are no longer exposed to contamination by the sputtering or splashing of molten metals or by flux fumes and gases, weld flashes, or hot sparks. Therefore the new process creates the most reliable hermetic seal yet attained in silicon rectifiers. Consequently heatless seal rectifiers meet or exceed all required military and industrial tests for moisture resistance and hermeticity. Four series now in quantity production are available for immediate delivery.

For further information, write for bulletins indicated in the chart at right.



SERIES TYPE	PEAK INVERSE VOLTAGE (VOLTS)										BULLETIN NUMBER	
	50	100	150	200	250	300	400	500	600			
3 AMP TYPES	1R1501 (TR27)	1R1502 (TR17)		1R1503 (TR27)		1R1504 (TR37)		1R1505 (TR47)	1R1506 (TR57)	1R1507 (TR67)		VE-2301
20 AMP TYPES	1R240A	1R240A	TR152	1R250A	TR252	TR302	TR352	TR402	TR502	TR602		VE-2304
50 AMP TYPES	TR153	TR200	TR153	TR200	TR253	TR300	TR353	TR400	TR500	TR600		VE-1304-1
MILITARY TYPES		1R253		1R254				1R255		1R256		VE-1305

Base and cap supplied by Standard Pressed Steel Co., Juchitown, Pa.

Circle 76 on Reader-Service Card

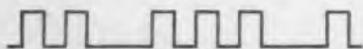
# Transitron

electronic corporation  
wakefield, melrose, boston, mass.

SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U.S.A. AND EUROPE • CABLE ADDRESS: TRELCO  
For quantities 1-999 call your nearest Transitron Industrial Distributor.

**GETTING INFORMATION FROM ONE PLACE TO ANOTHER**—for communication or control between people and (or) machines—has been a job pulses have been doing very well for quite a few years. Lately, more sources have had more and more to say in the same or less time, so it's only natural that pulse trains have been getting increasingly crowded and travelling at higher and higher speeds. If your problem is in this area—trying to perform a control or communications function with several hundred pulses per second—we can probably help you. We have been making a well-proven, pulse-repeating relay which operates dependably at speeds up to 500 pulses per second, that can do more to reshape weak and distorted signals into useful waveforms than any other relay we know of. (Modest, huh?) We're even beginning to suspect that this veteran may have been a little ahead of its time when it was introduced in 1953.

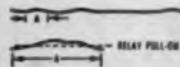
If your pulses start out as beautiful square waves



but suffer the consequences of distributed constants, line losses, random noise and wholesale dissipation, they probably arrive for work at the receiving end looking something like this

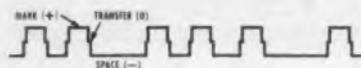


It takes an extremely sensitive relay to look at these little bumps as if they were nice square pulses. The Sigma Series 72 is this sensitive, operating positively on as little as a fraction of a milliwatt. While your drive circuit probably provides several times this amount of coil signal to the relay, such high sensitivity nevertheless gives reliable operation and plenty of overdrive even if input power becomes marginal:



With the shrunken pulse amplitude problem now taken care of, the next question is one of distortion at high operating speeds. With a "72", total operate time (break plus transfer) is typically 0.9 ms; contact bounce is virtually non-existent because of special compliant, shock-absorbing contact mounts; and the relay is symmetrical in operation—in both directions there are equalities in trip points, speed of operation and travel.

But since you're buying results and not slick design features, here is what a "72" will do: (1) rarely, if ever, misinterpret even the most distorted pulse; (2) give high contact efficiency (max. dwell time) through rapid transfer and max. bounce of 50 microseconds



(3) won't introduce unsymmetrical response and output (although you can turn a screw and deliberately introduce bias, to compensate for an unsymmetrical input).

Saying that you can have all this and long life in a compact, polarized relay may seem like stretching it a little, but a "72" will dependably switch a 60 ma, 120 VDC inductive load 500 million times, with correct drive circuit design and arc suppression. When wearing parts do need maintenance, you can replace the contacts and armature yourself—a good instruction manual is available. You can also buy a comprehensive test set if you use many relays of this type and follow a regular adjustment and maintenance program. For such work, the Sigma Test Set can be a very useful addition to your lab.

A new bulletin on the "72" is now available on request; the relays have been tooled up and built in quantity since 1953. Send us your weak and weary pulses today, attention Pulse Reclamation and Wildlife Bureau. SIGMA INSTRUMENTS, INC., 91 Pearl St., So. Braintree 85, Mass.

## NEW PRODUCTS

### Precision Angle Indicator

475



Angular displacement is reproduced and displayed in digital readout by this precision angle indicator when signalled by a remotely located synchro transmitter. The unit has a removable face and may be modified to meet panel requirements. A variety of synchros up to and including two size 15s may be used. Standard accuracy is  $\pm 6$  min max; repeatability is  $\pm 1$  min; readability is 0.5 min. Slewing speed is 25 deg per sec nominal.

Clifton Precision Products Co., Inc., Dept. ED, 5050 State Road, Drexel Hill, Penn.  
Availability: 30 days.

### Solderless Terminal Blocks

470



Made of flexible polyester material, model 905 may be bent in any direction to fit contours and sharp angles. The shortest distances between live parts is 3/8 in. Max wire size accommodated is No. 10. Rating of the material from which the blocks are fabricated is 25 amp.

National Tel-Tronics Corp., Dept. ED, 52 St. Casimir Ave., Yonkers, N. Y.

### Recycling Timer

468



Electronically controlled timer maintains accurate time intervals on either the "on" or "off" cycle, from 0.05 sec to 5 sec. Model A Regent is a dpdt 10-amp, 115 v ac switching relay equipped with a synchronized switch. Power consumption at peak is said to be less than 3 w. Hufco Industries, Dept. ED, 2815 W. Olive Ave., Burbank, Calif.  
P&A: \$49.50; 1-2 weeks.

— the ultra  
new **YOKE!**



**Deflectron\***  
By **Celco**

**MAJOR ADVANCE IN  
THE SCIENCE OF  
ELECTRON BEAM DEFLECTION!**

**SPOT RECOVERY**

**Fastest! to 1  $\mu$ s**

**SPOT SIZE**

**Smallest—by 25%**

**SPOT SWEEP**

**Straightest.....**

**\* DEFLECTRONS for DISPLAYS**  
Where ordinary precision  
yokes **FAIL** to meet your  
requirements.

Write for NEW "DEFLECTRON"  
Data and Standard Yoke  
Catalog. 

**Celco**

Constantine Engineering  
Laboratories Co.

Main Plant: MAHWAH, N. J. DAVIS 7-1123  
PACIFIC DIV.—UPLAND, CALIF. YUKON 2-0215  
CENTRAL DIV.—LANESBORO, PA. ULYSSES 3-3500

CIRCLE 77 ON READER-SERVICE CARD

## Trimmer Delay Line 366



Variable delay network has wide applications where size is a factor. Delay time is 0.05  $\mu$ sec min at max position. Unit measures 2.25 x 0.35 x 0.75 in. and has a terminating resistance of 1-K  $\pm$ 10%. Dielectric strength is 500 v dc.

ESC Electronics Corp., Dept. ED, 534 Bergen Blvd., Palisades Park, N. J.

Availability: 6 weeks.

## Synthetic Rubbers 362

Four grades of synthetics are for electrical applications. These synthetics are part of the Plioflex styrene-butadiene rubber (SBR) line. Gaskets, cable insulation and applications where contact with water is made are suggested uses for these synthetics.

Goodyear Tire and Rubber Co., Inc., Chemical Div., Dept. ED, Akron 16, Ohio.

## FM Telemetry System 372



The standard MIDAS fm-fm radio telemetry system consists of a data transmitter, receiver and recorder. This solid-state unit has a dynamic signal input range of 0.02 to 20 mv. Input transducer impedance is 50 to 500 ohms and system linearity is  $\pm$ 1% of indicator reading. Operation is 9 v dc for transmitter and 110 v ac for receiver/indicator.

Unilectron Inc., Dept. ED, 129 Binney St., Cambridge 42, Mass.

CIRCLE 79 ON READER-SERVICE CARD

DC to 5000 cycles  
over an amplitude  
of 4" peak to peak



## NEW SANBORN "650" SYSTEM

OFFERS DIRECT READOUT, 8 TO 24 CHANNELS, ALL SOLID STATE CIRCUITS, FOR RACK MOUNTING OR INDIVIDUAL CASES.

**SENSITIVITY** 20 mv input gives 8" deflection; 12 attenuator steps to X5000, smooth gain control.

**INPUT RESISTANCE** 100,000 ohms all ranges. Floating and guarded; DC source resistance must be kept below 1000 ohms on mv ranges only.

**COMMON MODE PERFORMANCE** Rejection at least 140 db at DC, tolerance to  $\pm$ 500 volts, max.

**GAIN STABILITY** Better than 1% to 50°C. and for line voltage variation from 103 to 127 volts.

**LINEARITY** 1 1/2% of full scale (8 in.)

**NOISE** 0.02" peak-to-peak, max.

**MONITOR OUTPUT** On front panel; provides  $\pm$ 1v full scale across 100,000 ohm load

**POWER REQUIREMENTS** 103-127 volts, 60 cycle AC, 625 watts



Here's the *one* system that lets you record inputs from DC to 5 KC within 3 db at 4" peak-to-peak amplitudes, without changing galvanometers. The "650" system consists of an 8-channel medium gain, general purpose amplifier unit driving a high speed, high resolution optical oscillographic recorder. It can be easily built into your system, packaged in a mobile cabinet or housed in individual cases. The single-chassis, 7" high amplifier module has 8 separate channels, complete from floating and guarded inputs to galvanometer outputs; each channel comprises a front end modulator and input transformer, carrier amplifier, demodulator, filter and driver amplifier. Power Supply and Master Oscillator Power Amplifier are built-in. All amplifier elements are plug-in transistorized units for easy servicing.

Immediately readable recordings are made on 8" wide daylight-loading ultra-violet-sensitive charts which require no chemical development. Features of the 12 1/4" high recorder unit include 9 electrically controlled chart speeds from 1/4" to 100"/sec; calibrated monitoring screen; automatic trace identification and timing lines at 0.01 or 0.1 sec. intervals; amplitude lines spaced 0.1" apart which can be blanked from 1/4, 1/2, 3/4 or all of chart. Recorder is available with an 8-, 16- or 24-channel galvanometer block which is then equipped with the number of galvanometer elements desired by the customer. Either the Recorder or Amplifier are also available as individual units for use with other equipment.

Contact your Sanborn Sales-Engineering Representative for complete specifications and applications engineering assistance. Offices throughout the U. S., Canada and foreign countries.

**SANBORN COMPANY**  
INDUSTRIAL DIVISION  
175 Wyman St., Waltham 54, Massachusetts



Whether in the advanced laboratory, or on a production line the Datapulse 102 PULSE GENERATOR continues to operate with maximum accuracy and high reliability.

The 102 is a quality test instrument designed for use on tomorrow's equipment today. Problem areas where the 102 will serve as a standard include logic and memory circuit development, magnetic material study, telemetry and navigation system test, and semiconductor evaluation.

With such outstanding features as high repetition rate and fast rise time, high output power, excellent resolution and accuracy, low jitter, and long term stability the critical scientist or engineer will be able to make significant use of this quality instrument.

Review the abbreviated specifications of the 102 Pulse Generator and more detailed information will be forwarded on request.

#### ABBREVIATED SPECIFICATIONS

**REPETITION RATE:** Variable 2cps to 3mc, single shot, or externally triggered.

**AMPLITUDE:** Variable to  $\pm 50$ v peak into 50 ohms.

**RISE TIME:** Variable 10 to 500 nanosec.

**PULSE DELAY:** Variable 150 nanosec. to 10 millisecc.

**PULSE DURATION:** Variable 50 nanosec. to 10 millisecc.

**DUTY CYCLE:** Provides up to 225ma average output current, with fully automatic overload protection.

**SIZE AND WEIGHT:** 8 $\frac{3}{4}$ "h x 17" w x 15 $\frac{1}{4}$ "d, 45 lbs.

Visit our exhibit at the Eastern Joint Computer Conference. Booth B17

**SALES REPRESENTATIVES**

**EASTERN SEABOARD STATES**

George Goetschhofer and Associates, Inc.  
Waltham, Mass. TW 4-9500 • Cheshire, Conn. BR 2-3091

B. Curtis Engel and Associates, Inc.  
Ridgefield, N.J. GI 4-1400 • New York, N.Y. RE 2-0001

Philadelphian, Penn. WA 2-2770

Brimberg Associates, Inc.  
Washington, D.C. DI 7-4234 • Baltimore, Md. VA 3-0886

J. D. Ryan Associates, Inc.  
Springfield, N.Y. GI 4-1771

**CENTRAL SOUTH CENTRAL STATES**

Leslie Associates, Inc.  
St. Louis, Mo. MI 5-1470 • Kansas City, Mo. HI 2-5313

Wallace Associates  
Dallas, Texas PL 7-7080

Widway Associates  
Chicago, Ill. TU 5-5718 • Indianapolis, Ind. ME 5-2201

Cleveland, Ohio LA 4-1421 • Detroit, Michigan LI 6-3312

Dayton, Ohio CL 2-5604

**WESTERN STATES**

Hytronic Measurements, Inc.  
Denver, Colo. PE 3-3701 • Salt Lake City, Utah UR 6-4924

Albuquerque, N.M. AL 5-0569

John Francis O'Hanlon and Associates  
Los Angeles, Calif. TR 7-0173 • San Diego, Calif. BR 3-5500

San Francisco, Calif. DA 6-1493 • Phoenix & Tucson, Ariz. SN 1200



**DATAPULSE INCORPORATED**  
509 Hindry Avenue, Inglewood 1, California  
Data Systems • Pulse Instrumentation  
ORegion 1-7713 — ORchard 8-3983

CIRCLE 80 ON READER-SERVICE CARD

## NEW PRODUCTS

### Industrial Dehumidifier

386



Removes moisture up to 36 gal daily. Model D20 uses 2 hp hermetic refrigerating cycle. Operating range is 50 to 110 F, with relative humidities down to 40%. Equipment includes electric humidistat, magnetic starter, freeze-stat, 12-ft, 3-wire lead, and pail compartment with 5-gal pail. Unit requires 208 or 230 v, 60 cps, or 200 or 230 v, 50 cps single-phase.

Remington Air Conditioning Div., Remington Corp., Dept. ED, Auburn, N. Y.

### Power Control Units

410

SCR packages have ratings from 1 to 15 kva and extend to over 30 kva in the forced air cooled types. Input signals are dc ma control currents into isolated control windings. Units are designed for proportioning or switching control of power, ac or dc, to a variety of loads. Ratio of max to min output voltage at rated conditions and at 110% supply voltage is greater than 10,000 to 1.

Control Div., Magnetics Inc., Dept. ED, Butler, Pa.

### Data Acquisition System

479



The 10-channel analog-to-pulse duration instrumentation system is for precision applications in process control through direct digital conversion of analog input from dc sensing devices. It provides accuracy of 1 part in 1,000 full scale, regardless of range. The unit operates at a 20 sample per sec rate, ideal for acquisition of static or quasi-static data. Data reduction is automatic. Power requirements is approximately 10 w.

Genisco, Inc., Dept. ED, 2233 Federal Ave., Los Angeles, Calif.

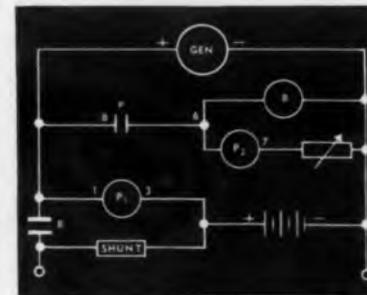
Interested in the number of New Products generated by a manufacturer from January, 1960 to June, 1961? See EDC!



## Ultra-sensitive relays

### HELPFUL DATA FOR YOUR CIRCUITRY IDEA FILE

The circuit drawing below indicates just one of the hundreds of ways many manufacturers utilize Micropositioner® polarized relays to solve complex control problems.



#### BATTERY REVERSE CURRENT DETECTOR

Among the many applications for the Barber-Colman Micropositioner in the railroad and industrial fields is that of reverse current protection between the generator and battery on diesel locomotives and industrial trucks. In the circuit illustrated, the Micropositioner, P<sub>1</sub>, is energized when the generator voltage exceeds the battery voltage by approximately one-half volt. A secondary relay, R, connects the generator to the battery and simultaneously energizes an auxiliary coil, P<sub>2</sub>, on the Micropositioner which aids the main coil in holding the contact closed until a predetermined amount of reverse current is flowing from the battery. The point of drop-out is controlled by the variable resistor in series with the auxiliary coil. This system offers accurate control of the points at which the generator is connected and disconnected from the battery, thereby eliminating unnecessary discharging of the battery or hunting between generator and battery control.

#### BARBER-COLMAN MICROPOSITIONER® POLARIZED D-C RELAYS

Operate on input power as low as 40 microwatts. Available in three types of adjustment: null seeking... magnetic latching "memory"... and form C break-make transfer. Also transistorized types with built-in preamplifier. Write for new quick reference file.



#### BARBER-COLMAN COMPANY

DEPT. X, 1883 ROCK STREET, ROCKFORD, ILLINOIS  
CIRCLE 81 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 6, 1961

## Amplifier Tester

416



On-the-spot testing of plug-in dc amplifiers analog computers is achieved with model 1800. Power for this unit is supplied by the PS/200/3.5. The test set measures gain, drift, positive and negative voltage swing and response to an internally generated square wave.

Embree Electronics Corp., Dept. ED, 993 Farmington Ave., West Hartford 7, Conn.  
P&A: \$590.00; 4 to 6 weeks.

## Vacuum Ovens

418



High temperature and large capacity ovens have pressure capabilities down to  $10^{-3}$  mm Hg. All joints are heliarc-welded and the door has a quick latching cam lock, with a silicone gasket. The control panel is mounted over the door.

National Appliance Co., Dept. ED, P. O. Box 6408, Portland 23, Ore.

## Static Tilt Tables

469



Available in two models, the No. 201 tables feature a large vernier scale on the outer axis providing setting accuracies to 0.05 deg throughout the 360 deg range. Model 201A incorporates a handwheel with a friction drive, and model 201B utilizes a servo-type worm gear drive.

Micro Gee Products, Inc., Dept. ED, 6319 W. Slauson Ave., P. O. Box 1005, Culver City, Calif.  
Price: model 201A, \$550.00; model 201B, \$695.00.

ELECTRONIC DESIGN • December 6, 1961

**BUILT FOR ROUGH DUTY IN TIGHT SPACES**



MODEL MM5-22 SCREWLOCK CONNECTOR  
SHOWN ACTUAL SIZE

Continental's Series 22 Micro-Miniature Connectors are designed expressly for jobs that demand the ultimate in miniaturization without sacrifice of performance. Their ruggedness is service-proven daily in hundreds of aircraft, missile, computer and other applications where severe shock and vibration are normal environments.

Series 22 Connectors are available in a range of 14 sizes, providing 5 to 104 contacts, to meet virtually every requirement for high density connection in minimum space. All feature glass-filled Diallyl Phthalate moldings, self-aligning phosphor bronze contacts, gold plated over silver, and can

be supplied with beryllium contacts on order. Reversed guide pins and sockets assure positive polarization, and all sizes are available with screwlocks, protective shells and hoods.



### DESIGNERS' DATA FILE

To help you select the micro-miniature connector that best meets your design requirements, Continental's Con-Dex File MM provides complete electrical, mechanical and dimensional data on the Series 22 Micro-Miniature Connectors. Write for your copy to: Electronic Sales Division, DeJur-Amsco Corporation, Northern Boulevard at 45th St., Long Island City 1, New York (Exclusive Sales Agent) RAvenswood 1-8000.

MICRO-MINIATURE • SUB-MINIATURE • MINIATURE • PRINTED CIRCUIT • RIGHT ANGLE PIN & SOCKET • CENTER SCREWLOCK

# CONTINENTAL CONNECTORS

CONTINENTAL CONNECTOR CORPORATION • WOODSIDE 77, NEW YORK  
CIRCLE 82 ON READER-SERVICE CARD



## 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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Magnetic Products Division



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CIRCLE 93 ON READER-SERVICE CARD

88

## NEW PRODUCTS

### Gas Chromotography Instrument 472



Designed for high-explosives compatibility testing. The unit is built to operate in the range of 50 to 250 C. Separate time proportional temperature controllers permit temperature to be maintained to  $\pm 0.03$  C at any temperature in the operating range. Overall size is 25-1/2 x 51-1/2 x 69-1/2 in. The unit requires 115-230 v, 60 cps ac.

Royal Research Corp., Dept. ED, 11824 Dublin Blvd., Hayward, Calif.

### Digital Computers 409

Desk-sized 160 computer has a magnetic core memory of 4,096 words and can handle 60,000 instructions in 1 sec. Model 160-A has a high-speed expandable memory of up to 32,768 words and incorporates program interrupt, buffered input and output, and a flexible list of program instructions.

Control Data Corp., Dept. ED, 501 Park Ave., Minneapolis 15, Minn.

Availability: model 160, immediate; model 160-A, January, 1962.

### Noise Generator 476



Low-frequency noise generator model 310A employs a grid-controlled gas thyatron in a transverse magnetic field as the primary noise source. The noise from the thyatron is passed through a regulator circuit which continuously stabilizes its output against a reference voltage. This output is filtered by a precision network resulting in a band of noise centered about a frequency  $f_0$ . The result is an accurately controlled noise voltage whose spectral density is constant over a specified frequency band and whose amplitude probability distribution is Gaussian.

Elgenco, Inc., Dept. ED, 1555 14th St., Santa Monica, Calif.

## Limit Stops

385



Subminiature mechanical units incorporate a post construction design. Sizes 5 and 8 include stainless steel servo mounting plates, hardened and ground shafts and phosphor bronze traveling nuts. Designed for 0 to 10 turns and 0 to 40 turns, units conform to MIL-E-5272C. Repeatability is within 3 min of arc. Torque ratings on sizes 5 and 8 are 50 and 160 oz-in., respectively.

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

## Pressure Switch

412



Claimed to be the smallest explosion-proof pressure switch on the market, model 610GE is said to be 1/4 the size of similar switches. The switch is listed by Underwriters Laboratories, Inc. for use in hazardous areas.

Custom Component Switches, Inc., Dept. ED, 3137 Kenwood St., Burbank, Calif.  
P&A: \$40.00; 10 days.

## Direct Read-Out Counter

417



Model 3522 has large digits and is reversible. Drums and pinions are molded nylon in this 1-11/16 x 2 x 3-8/16 in. unit. The 0.420 in. high digits, on 1-7/16 in. diam drums, are either hot stamped or silk screened. The unit comes with either oilite or ball bearings.

Haydon Instrument Co., Dept. ED, 17 Brown St., Waterbury 20, Conn.  
Availability: stock to 1 week.

# WORLD'S BEST SELLING OSCILLOSCOPE

\$570<sup>00</sup>



Also available in rack mount model



## DUAL GUN COMPACT — FULLY WARRANTED

The world's largest selling oscilloscope is now available from Packard Bell Electronics in new, improved models. Solartron Laboratories, an international leader in electronic instruments, has sold 7,500 of the original model in the last 18 months. New models 5 Mc-2P/R, manufactured by Packard Bell, offer these outstanding features:

**Compact** 5Mc-2P (portable) 22 lbs. 10½" high x 8½" wide x 13" deep. 5 Mc-2R (rack mount) 5¼" high x 19" wide x 13" deep. **2 Gun** Two separate electron guns in one envelope. **Bandwidth** D.C. to 5 Mc at 100v to 100

mv/cm. (20 Kc at 1 mv/cm.) **Stability** Schmitt Trigger with adjustable threshold both internal and external. **Sweep** 1 sec. to 1 microsec./cm. **Control** All variables including trigger have fixed settings with a continuous adjustment overlapping each range. **Price** Model 5Mc-2P or 5Mc-2R with two leads \$570.00 f.o.b. Los Angeles. Completely warranted for one year including CRT. All prices are subject to change without notice.

For complete information—or a demonstration—or immediate delivery—write: **Oscilloscope Sales.**



## Packard Bell Electronics

P. O. Box 337 Newbury Park, California

Phone MA 9-5051

CIRCLE 84 ON READER-SERVICE CARD

# **FAST** Delivery **WRIGHT Servos**

**24 HOURS**  
400 Cycle Servo Motors  
Motor Tachometers  
Inertia Damped Motors

**10 DAYS**  
MOUNTED WITH  
PRECISION CLASS III  
GEARHEADS

This NEW service on quantities up to 10 standard pieces per item. No specification modifications. Full production quality. Meet all MIL specs. Gearheads not sold separately.

SERVO MOTORS	FRAME SIZE	VOLTS #1	VOLTS #2	STALL TORQUE	SPEED RPM	STALL PWR.#	ACCEL. RAD/SEC <sup>2</sup>
20D633-2C	8	26	26	.22 OZ. IN.	6200	2.5W	106.000
20D633-4C	8	26	36 CT	.22 OZ. IN.	6200	2.5W	106.000
20D632-4C	8	26	36 CT	.35 OZ. IN.	6200	3.1W	99.800
20D627-2C	8	115	115/57	.33 OZ. IN.	6200	3.5W	98.000
20D603-2C	11	115	115/57	.60 OZ. IN.	6200	3.5W	43.300
20D603-4C	11	115	36 CT	.60 OZ. IN.	6200	3.5W	43.300
20D590-2A	15	115	115/57	1.3 OZ. IN.	4800	6.2W	27.800
20D612-2C	18	115	115/57	2.3 OZ. IN.	4800	9.1W	31.000

MOTOR TACHS	FRAME SIZE	VOLTS #1	VOLTS #2	TACH. VOLTS	STALL TORQUE	SPEED RPM	V/1000 RPM	TOTAL NULL	ACCEL. RAD/SEC <sup>2</sup>
20D628-2C	8	115	115/57	26	.33 OZ. IN.	6200	.20	.019V	75.800
20D631-4C	8	26	36 CT	26	.35 OZ. IN.	6200	.20	.019V	80.500
20D634-2C	8	26	26	26	.22 OZ. IN.	6200	.20	.019V	75.000
20D634-4C	8	26	36 CT	26	.22 OZ. IN.	6200	.20	.019V	75.000
20D604-2F	11	115	115/57	115	.60 OZ. IN.	6200	.500	.019V	32.600
20D604-4F	11	115	36 CT	115	.60 OZ. IN.	6200	.500	.019V	32.600
20D593-2A	15	115	115/57	115	1.3 OZ. IN.	4800	3.1	.019V	17.500
20D614-2C	18	115	115/57	115	2.3 OZ. IN.	4800	3.1	.019V	25.900

INERTIA DAMPED	FRAME SIZE	VOLTS #1	VOLTS #2	STALL TORQUE	STALL POWER	SPEED RPM	DAMPING
20D618-2B	8	115	40/20	.30 OZ. IN.	3.5W	6200	40 DYNE CM
20D605-2D	11	115	115/57	.60 OZ. IN.	3.5W	6200	100 DYNE CM
20D613-2C	18	115	115/57	2.3 OZ. IN.	9.1W	4800	750 DYNE CM

## Gear Backlash and Torque

- Size 8:** 30' max. backlash: 1 in. oz. rev. load.  
5 inch ounces operating load torque.
- Size 11:** 30' max. backlash: 4 in. oz. rev. load.  
25 inch ounces operating load torque.
- Size 15:** 30' max. backlash: 5 in. oz. rev. load.  
35 inch ounces operating load torque.
- Size 18:** 30' max. backlash: 10 in. oz. rev. load.  
60 inch ounces operating load torque.

DIVISION OF  
**WRIGHT SPERRY RAND**  
DURHAM, NORTH CAROLINA TEL. 682-8161

"Servos For New Horizons"

CIRCLE 85 ON READER-SERVICE CARD

## NEW PRODUCTS

### Evaporated Coatings

383



Controlled to within  $\pm 5\%$ , films on the order of a few millionths of an inch can be uniformly applied on plastic, metal, glass and ceramic. Coatings used for rf shielding where windows are used on electronic equipment, for solderable and resolderable coatings on glass, for circuit connections to glass, etc. Maximum size limitation on metal coatings is 48 in. square.

Evaporated Coatings, Inc., Dept. ED, Huntingdon Valley, Pa.

### Epoxide Adhesive

407

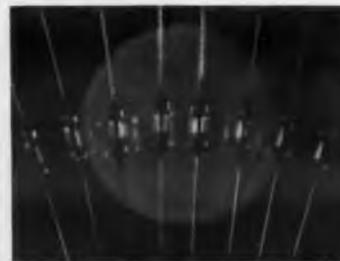
Eccobond 104 is a two-part adhesive for high temperature applications. It is featured by good adhesion at temperatures over 500 F. At 200 C, volume resistivity is  $10^{12}$  ohm-cm, while thermal expansion is  $40 \times 10^{-6}$  per C. Part A of the system is a liquid; part B, a finely divided powder.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

P&A: 1-gal can, \$3.50 and \$4.50 for parts A and B, respectively; stock.

### Germanium Diodes

471



Withstand stresses in excess of 50,000 g. "Super G Diodes" are designed for missile and computer applications and are said to have greater resistance to shock and mechanical stress than ordinary gold-bonded diodes. The devices do not break down or change characteristics when assembled into printed-circuit boards with automatic insertion equipment.

National Transistor Manufacturing, Inc., Dept. ED, 500 Broadway, Lawrence, Mass.



Gamewell made this special completely from scratch.

Every part of this rotary switch was newly designed by Your Engineered Specials service to meet a customer's special requirements. The unit provides bi-directional operation at 160 rpm max. It is rated at 28 VDC, 60 ma ... has high vibration and shock resistance ... and  $-55^{\circ}$  to  $+150^{\circ}$ C.

Although this design called for only six poles and 11 switching segments, many more could have been provided.

Gamewell's YES service has developed answers to hundreds of special "pot" problems. Interested? Write for the full story.

**\*your**  
**Engineered**  
**Specials service**

**yes**

BLISS  
**Gamewell**

THE GAMEWELL COMPANY, POTENTIOMETER DIVISION,  
1429 CHESTNUT STREET, NEWTON UPPER FALLS 84,  
MASS. A SUBSIDIARY OF E. W. BLISS COMPANY.

CIRCLE 86 ON READER-SERVICE CARD

## Pressure Gage

373



All metallic seals are used in model 8007 low pressure gage. Range of this water pressure gage is 0 to 40 in., accuracy and repeatability are  $\pm 1$  in., operating temperature is from  $-65$  F to  $185$  F and the device meets shock and vibration tests of MIL-E-5272C. Measuring 2 in in diam and 3.9 in. long, the indicator weighs 12 oz.

Aero Mechanism, Inc., Dept. ED, 7750 Burnet Ave., Van Nuys, Calif.

Availability: 45 days.

## Circuit Printing Ink

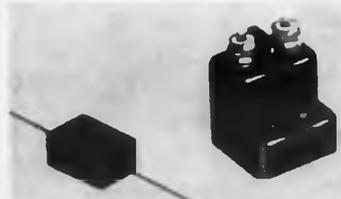
363

Air dries in approximately 30 min or can be force-dried in 5 min when baked at  $200$  F. Designed as an etching resist, No. 211 circuit printing black is suitable for use with any mesh silk or wire screen. Resist can be removed after etching with Xylol or Trichloroethylene.

Naz-Dar Co., Dept. ED, 461 Milwaukee Ave., Chicago 10, Ill.

## Time-Delays

375



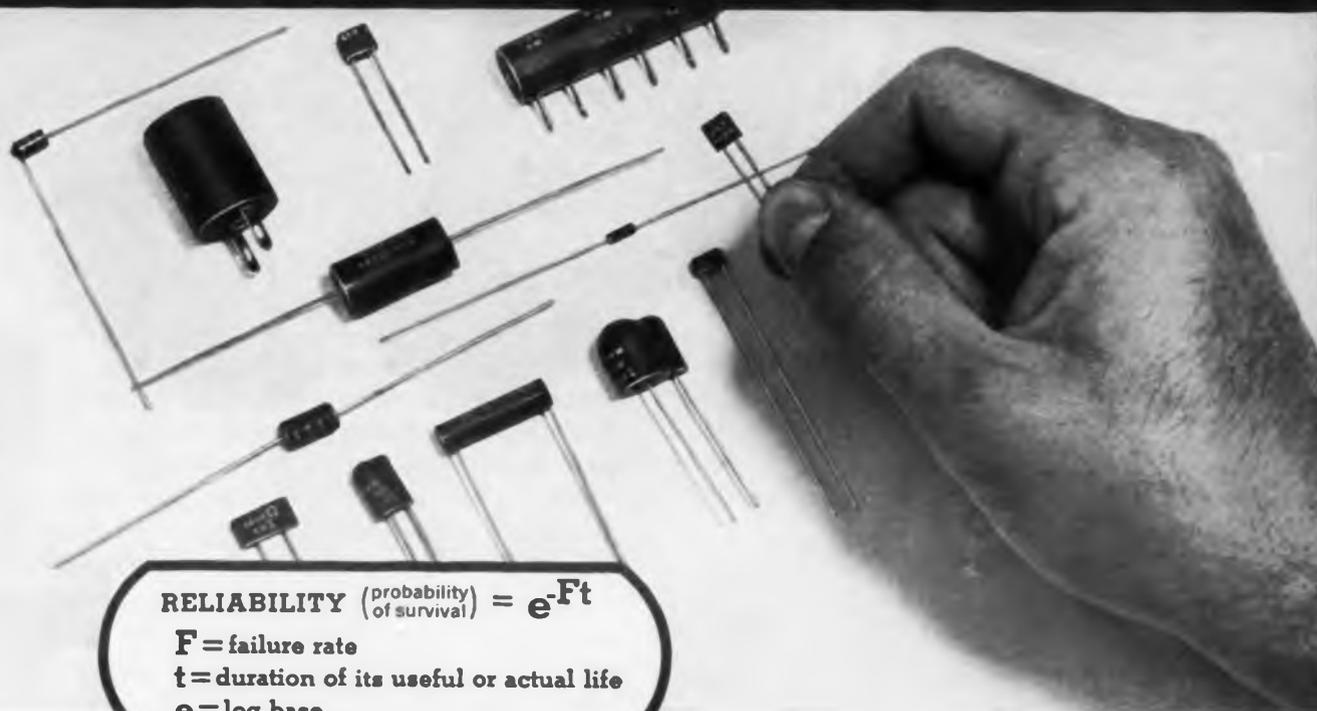
Solid-state units operate over an ambient temperature of  $-55$  to  $+85$  C. Dc voltages are from 14 to 32 v. Units meet requirements of environmental specification MIL-E-5272 and are available with plug-in or solder lug terminals. Standard timings range from 0.01 to 180 sec. The delays may be connected in series with any load.

ADC Electronics, Dept. ED, 1205 S. Santa Fe Ave., Compton, Calif.

P&A: from \$38.00; 10 days.

CIRCLE 87 ON READER-SERVICE CARD ►

# What does RELIABILITY mean in precision resistors?



$$\text{RELIABILITY (probability of survival)} = e^{-Ft}$$

$F$  = failure rate

$t$  = duration of its useful or actual life

$e$  = log base

Reliability is expressed as failure rate per unit operating time. ULTRONIX is specified where reliability requirements are tighter than 0.001% per thousand hours.

More simply, reliability means sound engineering, proper design, carefully controlled manufacturing, strict quality control.

Reliability is proved by test and demonstrated by acceptance. Ultronix is the preferred or sole source where resistor specifications far exceed MIL spec requirements both here and abroad. Ultronix precision resistors and networks are used and specified on major missile programs such as Nike Hercules, Nike Zeus, Polaris, Pershing, Minuteman, Titan, Mace, etc.

*IN PRECISION RESISTORS RELIABILITY MEANS ULTRONIX.*

### MORE FACTS ABOUT ULTRONIX PRECISION RESISTORS

**Temperature Coefficient.** Standard resistor temperature coefficient is zero  $\pm 15$  parts per million per degree Centigrade over entire operating temperature range.

Zero  $\pm 2$  ppm/ $^{\circ}$ C available on special order.

Resistors can also be supplied with any positive temperature coefficient up to  $+0.6\%$  per degree Centigrade for circuit compensation.

**Encapsulation.** Resistors are completely sealed in an alkyd resin by specially developed techniques which produce the outstanding characteristics of close tolerance, low temperature coefficient, high stability and reliability.

For immediate engineering assistance with your precision resistor or network problems, contact the nearest Ultronix rep, located in 21 cities throughout the U.S., or write directly to the factory. Please address Dept. 36.

**ULTRONIX**



111 E. 20th Avenue  
San Mateo, California

Phone: Fireside 5-7921

## NEW PRODUCTS

### Wideband Transformer 369



Insertion loss is less than 1 db in type 1900 transformers. Model 1900 AA is metal cased with a terminal board and two 6-32 spade mounting bolts on the base. Isolated coupling is provided between 75 ohms unbalanced and 1,200 ohms balanced, over range of 200 kc to 50 mc, with secondary balance better than 40 db.

North Hills Electronics, Inc., Dept. ED, Alexander Place, Glen Cove, N. Y.

*P&A: sample quantities, \$14.95 each; stock.*

### Character Generator 390

Writing speeds to 30,000 characters per sec are possible with this 6 x 6 x 9 in. unit. Series 5000 Alpha-dyne character generator consumes less than 7-1/2 w. This unit produces Leroy type symbols of all 10 digits, letters of the alphabet in upper and lower case and letters of the Greek alphabet.

Skiatron Electronics & Television Corp., Dept. ED, 180 Varick St., New York 14, N. Y.

*Availability: 30 to 45 days.*

### Punching Laminate 368



Warm-punch grade of phenolic-paper composition is designated 11601. This laminate meets NEMA specifications for X and P grade materials. Colors are black, natural and chocolate. With thicknesses of 0.020 to 0.150 in., standard sheet sizes are 36 x 36, 48, and 72 in.

General Electric Co., Laminated Products Dept., Dept. ED, Coshoc-ton, Ohio.



Available in 7 JEDEC types.  
Shown above, 2N681 Triode is enlarged 6 times.

## Westinghouse announces new 16-amp "Rock-Top" Trinistor<sup>®</sup> controlled rectifier

Proven "Rock-Top" quality is now available in JEDEC 2N681 Trinistor Controlled Rectifier series! These latest additions to the Westinghouse power semiconductor family incorporate the field-proven design features of the broadest line of medium and high-power switching devices. Such features as hard-soldered junctions and hermetically welded cases provide an extra assurance of reliability at no extra cost. Additionally, each device is 100% tested to maximum ratings. These new devices from Westinghouse, world leader in silicon technology, are backed by production experience with high-power semiconductors for military and industrial applications.

Westinghouse 2N681 series Trinistors are ideal for such applications as: motor speed control ■ temperature control ■ inverters ■ static switching. For more information, or technical assistance, call or write: Westinghouse Electric Corporation, Semiconductor Dept., Youngwood, Penna. *You can be sure... if it's Westinghouse.*

SC-1049

### For prompt delivery, order from these Westinghouse distributors:

#### EASTERN

ACK SEMICONDUCTOR INC. Birmingham 5, Ala./FA 2-0588  
CAMERADIO Pittsburgh, Pa./EX 1-4008  
CRAMER ELECTRONICS, INC. Boston, Mass./CO 7-4700  
ELECTRONIC WHOLESALE, INC. Melbourne, Florida/PA 3-1441  
GENERAL RADIO SUPPLY CO., INC. Camden, N. J./WO 4-8560  
GENESE RADIO PARTS CO. Buffalo, N. Y./TR 3-9661  
KANN-ELLERT ELECTRONICS, INC. Baltimore, Md./TU 9-4242  
MILGRAY ELECTRONICS New York, N. Y./RE 2-4400  
RADIO & ELECTRONIC PARTS CORP. Cleveland, Ohio/UT 1-6060  
SCHWEBER ELECTRONICS Long Island, N. Y./PI 6-6570  
Silver Spring, Md./JU 5-7023

#### MIDWESTERN

E C I SEMICONDUCTORS, INC. Kansas City, Mo./WE 1-0820  
ELECTRONIC COMPONENTS FOR INDUSTRY CO. St. Louis, Mo./WO 2-9916

HALLMARK INSTRUMENTS CORP. Dallas, Texas/RI 7-8933  
INTER STATE RADIO & SUPPLY CO. Denver 4, Colo./TA 5-8257  
LENERT CO. Houston, Texas/CA 4-2663  
MIDLAND SPECIALTY CO. El Paso, Texas/KE 3-9555

RADIO DISTRIB CO. Phoenix, Ariz./AL 8-8254  
SEMICONDUCTOR SPEC., INC. Albuquerque, N. M./CM 7-0236  
S. STERLING CO. Indianapolis, Ind./ME 7-5571  
UNITED RADIO, INC. Chicago, Ill./MA 2-8860  
Detroit, Mich./BR 2-2900  
Cincinnati, Ohio/BA 1-6530

#### WESTERN

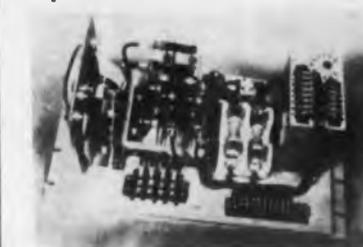
ALMAC ELECTRONICS CORP. Seattle, Wash./PA 3-7310  
ELMAR ELECTRONICS Oakland, Cal./TE 4-3311  
HAMILTON ELECTRO SLS. Los Angeles, Cal./DA 2-9154  
NEWARK ELECTRONICS CO. Palo Alto, Cal./DA 1-7541  
Inglewood, Cal./OR 4-8440

# Westinghouse



## Saturable Reactor Replacement

370



Ac power to 50 kva 3-phase, or 17 kva single phase is supplied from the network of silicon-controlled rectifiers in these units. This device replaces driver magnetic amplifier preamplifier, along with conventional saturable core reactors. There are 17 assemblies in the line for use with standard controllers.

Norbatrol Electronics Corp., Dept. ED, 356 Collins Ave., Pittsburgh 6, Pa.

## Frequency Standard 392

Rubidium vapor frequency standard is stable to  $\pm 2 \times 10^{-10}$  in any 90 day period. Designated Varian X-4700A, the output frequencies are 100 kc, 1 mc and 5 mc simultaneously. Ambient temperature range is 15 to 35 C. Power requirements are 24 to 31 v dc at 2 amp.

Varian Associates, Dept. ED, 611 Hansen Way, Palo Alto, Calif.  
P&A: \$15,900; 90 days.

## Manual Switches

371



Series 1000 Ultra-Switches are for computer and instrument systems. Units are designated 1000-V and 1000-H and are single and double row switch units, respectively. These spdt or dpdt models rated 5 amp, 125 and 250 v ac require less than 5 oz depression force. Inductive dc ratings are: 3 amp, 20 v at sea level; 2.5 amp 20 v at 50,000 ft.

Ultronics Systems Corp., Dept. ED, 7300 N. Crescent Blvd., Pennsauken, N. J.

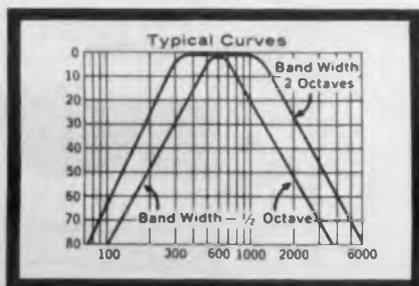
P&A: \$70.00 to \$75.00, small quantities; stock.



An Allison Filter in use at Bell Telephone Laboratories

## Allison Variable Filters cover a frequency range of 1 cps to 640 kcps

Here's the answer for a general purpose, tunable, audio-frequency filter . . . an Allison Variable Filter. Allison Filters may be used as high cutoff, low cutoff or band pass filters. Requiring almost no maintenance, these passive network filters have a dynamic range in excess of 120 db. They are excellent for the analysis of transient noises since they have no internal noise and negligible ringing effect. 11 filter models . . . portable and rack mount . . . direct reading . . . prices start at \$345.00 . . . write today for attenuation curves, complete specifications, and prices.



**FREE CATALOG!** Clip coupon, attach to company letterhead, and mail today for a catalog of Allison analyzing instruments.



NAME \_\_\_\_\_

**ALLISON**  
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**Laboratories, Inc.**  
11301 OCEAN AVENUE, LA HABRA, CALIFORNIA  
proved dependable in years of service

CIRCLE 89 ON READER-SERVICE CARD

## NEW PRODUCTS

### Pulse Transformer

482



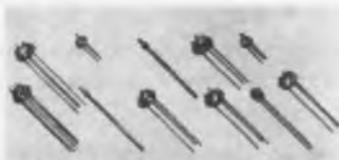
Designed as a plate-coupling or blocking oscillator transformer, this 10-kv pulse transformer is for pulse widths up to 1  $\mu$ sec. Maximum voltage rating is 400 v with interwinding insulation capable of withstanding 10 kv, max. Rise times of less than 0.04  $\mu$ sec are typical. The transformer meets all the specifications of MIL-T-2103A, grade 5, class T, life X.

PCA Electronics, Inc., Dept. ED, 16799 Schoenborn St., Sepulveda, Calif.

P&A: \$10 to \$15 ea; 3 weeks.

### Transistor Bases

413



Hermetically sealed bases include types for TO-5, -9, -18, -33, and -46. Electro-tin and high purity gold finishes are offered, with choices of different terminal configurations and lead lengths.

Electrical Industries, Dept. ED, 691 Central Ave., Murray Hill, N. J.

### Solid-State Counter

353



Decade counting unit is solid-state plug-in type. The DCU-100 counts at speeds of dc to over 200 kc, with less than 3 sec double pulse resolution. Units require less than 10 ma at 6 v for operation. The epoxy glass board, etched circuit has standard 0.157 in. spaced connection tabs and measures 3-3/4 x 2-1/16 x 1/2 in.

Components Corp., Dept. ED, 106 Main St., Danville, N. J.

P&A: \$50.00; stock.



## Flows at Ideal Rate, Leaves No Soldering Residues

Non-corrosive **HYDRAZINE FLUX**,\* used industry-wide in liquid form, has now been incorporated into core solder. This fast, efficient flux vaporizes completely at soldering temperatures. It leaves no residue which would support fungus growth. Will not corrode.

In **H-32** core solder for the first time, **HYDRAZINE FLUX** offers more advantages than ever. When flux is normally applied, far more than is actually needed is used. Now, the exact ratio of flux to solder provides for proper wetting. Thereafter the flux decomposes and is eliminated. Cleaning and production time are saved.

**TEST HYDRAZINE FLUX AND CORE SOLDER** in your own plant. Write for samples of either H-Series Fluxes or H-32 core-solder form and technical literature.

\*U.S. Patent No. 2,612,459

Available only from Fairmount and its sales agents

**Fairmount**  
CHEMICAL CO., INC.  
136 Liberty St., N. Y. 6, N. Y.

CIRCLE 90 ON READER-SERVICE CARD

## Call for Swenson

### Custom Molders of Thermoplastics

Precision custom molding of thermoplastics is our business! We are specialists to the radio, electronics and appliance industries and have the expert know-how and modern facilities so necessary for their exacting demands.

Our special custom molding techniques and production tools assure wide design latitude. Intricate shapes, designs and textures — complex interior bosses, holes, sections, studs — precise thicknesses — critical tolerances, etc., are all expertly custom molded by Swenson.

Submit prints, sketches or samples for engineering advice and quotation.

Write for literature. Call Swenson for custom molded plastics services no other company can match.



**v. H. Swenson co., inc.**  
Engineering in Plastics  
554 Elm Street, Kearny, New Jersey

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ELECTRONIC DESIGN • December 6, 1961

## Silicon-Controlled Rectifier

406



Eight models of series C5 differ by forward breakover voltages which range from 25 v for the C5U to 400 v for the C5D. Units accommodate transient PRVs up to 500 v. Average forward current rating is 1 amp dc at 82 C case temperature. Max gate current to fire is 200  $\mu$ a at 25 C.

General Electric Co., Rectifier Components Dept., Dept. ED, W. Genesee St., Auburn, N. Y.

P&A: \$5.50 to \$22.50; stock.

## Dual-Trace Oscilloscope

414



Rise time is 0.35 nsec. Type 661 shows Lissajous patterns on a 5-in. crt, in addition to dual-trace displays and signals added algebraically. The unit can expand the signal over 100 times vertically or horizontally and drive X-Y plotters or similar readout accessories. The equipment has a uniform, high writing rate at all sweep speeds over the full 8 x 10 cm display area.

Tektronix, Inc., Dept. ED, P. O. Box 500, Beaverton, Ore.

Price: \$1,150.00.

Trying to find manufacturers' sales offices? Phone numbers? See EDC 1961-62.

CIRCLE 92 ON READER-SERVICE CARD ►

Right in the middle of the picture at left are two coils, actual size, each with 250 turns of 56-gauge (.00049") wire and soldered-on leads.

We engineered it.

We made it.

It worked.

Every time.



The picture below gives you a vaguely classified idea of where it is used.

The coils came out of our Miniature Products Division, which utilizes new processes to achieve the ultimate in ampere turns density per cu. mm.

We engineer and manufacture more of all kinds of coils than any company you can buy from; and we love problems that no one else wants.

Some fresh new literature tells quite a bit about us.

Please ask us to send you some.

**WABASH MAGNETICS, INC.**  
FIRST AND WEBSTER STREETS / WABASH, INDIANA





## NEW LITTON TRAVELING WAVE TUBES

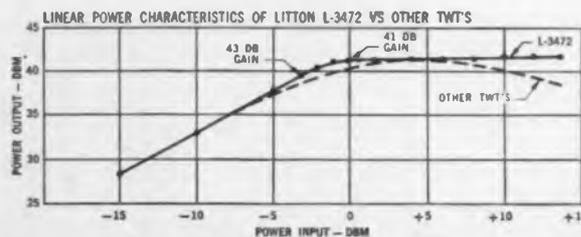
20 mW to 5.5 kW, 400 Mc to 11,000 Mc

Want high performance, high CW power and wide bandwidth from a compact, lightweight TWT? You get just that with the Litton Industries lightweight, undersized family of TWT's that are bigger and better in every other way. For instance, the L-3472 gives you 10 watts in a 12-inch, 2.5-pound package. The 2-watt L-3612 is only 11 inches long and weighs just 1.5 pounds.

Most of these tubes are PPM focused. Special helix design and fabrication techniques have raised the saturation gain to within three db of small signal gain. Can be supplied with small signal gains up to 60 db. Input and output circuits are coaxial, providing minimum frequency sensitivity. Bandwidth limited only by combined beam-circuit bandwidth. Optimum voltage for small signal operation same as for saturated operation. Helix isolated from tube body, permitting overload protection, helix modulation, and helix current monitoring.

Guaranteed to withstand Class II military environment. Applications include airborne ECM, power tube driver, radar target repeaters, and voice and data communications systems.

Contact us at San Carlos, California, for more information.



Tube Type Number	Frequency Range Megacycles	Power Output Minimum	Small Signal Gain Minimum	Duty Factor
L-3499	2000-4000	2 W	36 db	CW
L-3663	2000-4000	10 W	33 db	CW
L-3619	2000-4000	20 W	33 db	CW
L-3470	4000-8000	20 mW	36 db	CW
L-3711	4000-8000	1 W	36 db	CW
L-3471	4000-8000	2 W	36 db	CW
L-3657	4000-8000	10 W	33 db	CW
L-3658	4000-8000	20 W	33 db	CW
L-3611	7000-11000	20 mW	36 db	CW
L-3612	7000-11000	2 W	36 db	CW
L-3528	5000-11000	5 W	33 db	CW
L-3472	7000-11000	10 W	36 db	CW
L-3529	7000-11000	20 W	36 db	CW
L-3614	8000-11000	1 kW	36 db	.02
L-3497*	1240-1400	5.5 kW	40 db	.06
L-3674*	400-450	5 kW	37 db	.06
L-3637*	5900-8400	200 mW	30 db	CW

\*In Development

**LITTON INDUSTRIES**  
**Electron Tube Division**  
 MICROWAVE TUBES AND DISPLAY DEVICES  
 CIRCLE 93 ON READER-SERVICE CARD

## NEW PRODUCTS

### Analog Accumulator

415



Model J101A will integrate amplified signals from various transducing elements. The unit can be used with any instrument that supplies an output of 1 ma, full scale and from 10 to 100 v. Accuracy is 1% on this unit with a five decimal digit counter and a 2-1/2-in. meter.

Elcor, Inc., Dept. ED, Falls Church, Va.  
 P&A: \$995.00; 4 weeks.

### Miniature Motors

481



High performance hysteresis, synchronous and induction miniature motors have inputs as low as 1.5 w. The size 11 motors have efficiency up to 25% with bifilar windings. Synchronous motors can be furnished in counter-rotating matched pairs for internal guidance systems and other high precision uses. Units are available for 12, 24, 26, 48 and 115 v in 1, 2 and 3 phases.

Martronics Inc., Dept. ED, 82 Sanford St., Hamden 14, Conn.

### Wire Stripper-Cutter Counter

465



Up to 212 in. of 30 to 42 gage Formvar, nylon or similar insulated wire can be processed each minute by Wire-Matek. The automatic machine requires 115 v ac and ordinary shop air. It cuts fine gage wire precisely to length and counts the pieces. Strip length and cut length accuracy is within  $\pm 0.002$  in. per in. of wire.

Fabri-Tek, Inc., Dept. ED, 1111 E. Excelsior Blvd., Hopkins, Minn.

## Transistor Closures

480



Up to 13 separate leads can be accommodated in a closure conforming to the basic TO-5 transistor configuration. Leads may be grounded or ungrounded, depending on design requirements. Measuring no more than 0.300 in. in body diam, and 0.100 in. high, the header can be supplied with electrically isolated flat forms or "islands" with a common body. Multiple lead configurations in TO-18 and TO-46 packages can also be furnished.

Glass-Tite Industries, Inc., Dept. ED, 727 Branch Ave., Providence 4, R. I.

## Vernier Resolver

466



Model R-17-10-1 utilizes two capacitive pick offs per channel arranged in a balanced bridge circuit. An interwinding capacitance toroidal transformer converts bridge unbalance to a low output impedance audio frequency output. The instrument measures approximately 1.66 in. in diam and 1.80 in. in length.

Giannini Controls Corp., Dept. ED, 1600 S. Mountain Ave., Duarte, Calif.

## Timing Module

462

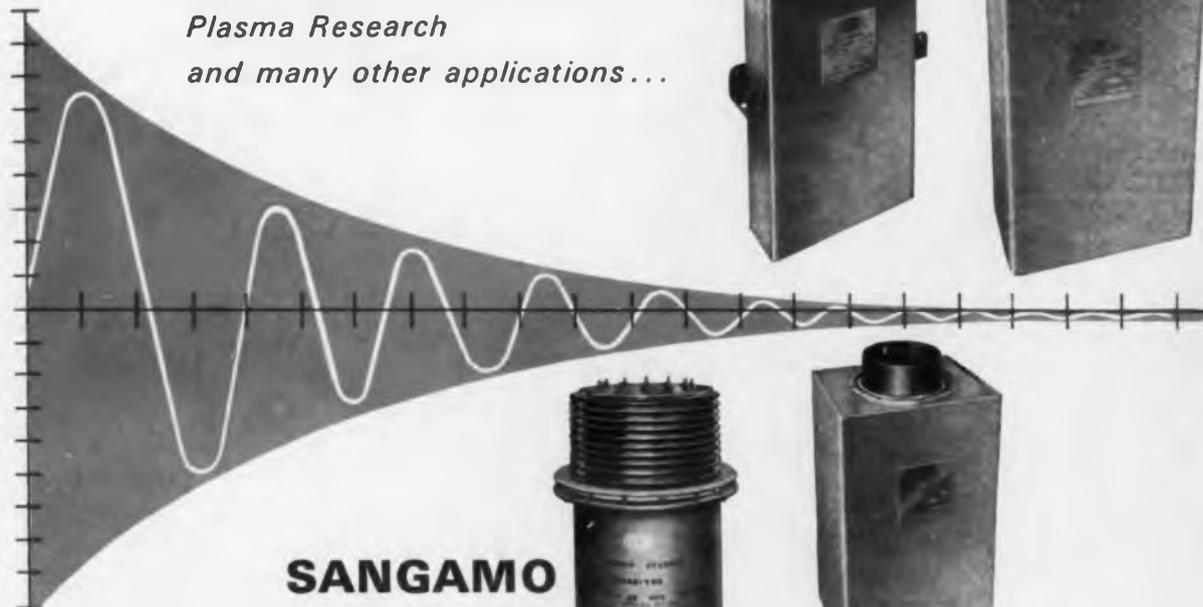


Solid-state unit is capable of switching either a positive or negative voltage and is remotely adjustable from 1 min to 4 hr at 5% accuracy. The device is available for any input from 10 to 32 v dc, with less than 200 mw average power consumption. Hermetically sealed and foamed, the 7-oz unit meets environmental requirements of MIL-E-5272C.

Electronic Products Corp., Dept. ED, 4642 Belair Road, Baltimore 6, Md.

Availability: 2 to 4 weeks.

*For Magnetic Forming  
Hypervelocity Wind Tunnels  
Plasma Research  
and many other applications...*



## SANGAMO ENERGY DISCHARGE CAPACITORS

with **COMPLEX C**<sup>®</sup>

*meet the most demanding electrical and mechanical design criteria*

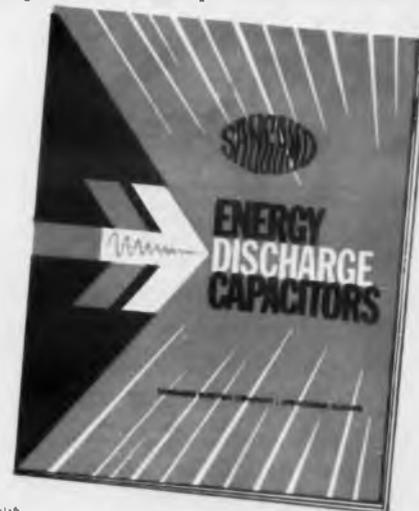
Sangamo *knows* energy discharge capacitors and their application—a Sangamo research team has spent years in establishing detailed design criteria to meet the requirements of every conceivable capacitor bank. The energy discharge units developed by Sangamo meet the exact requirements specified, in order to give you the most for your investment in a large energy discharge capacitor bank.

The most significant advance in this field is the development of Complex C (Sangamo's exclusive dielectric impregnant and fill). The use of Complex C, with all other characteristics and circuit conditions being equal, results in a life expectancy 10 to 100 times that previously possible. The exceptional life expectancy of Sangamo Complex C capacitors will give you the most for both your dollar per joule and dollar per shot investment.

**SEND FOR SANGAMO'S BULLETIN TSC-208  
FOR FULL INFORMATION ON THESE CAPACITORS**

The complete story of the design criteria behind Sangamo high voltage, low inductance, energy discharge capacitors is told in detail in this new bulletin. It contains valuable information on possible circuit applications, methods of determining self-inductance of a capacitor, and standard capacitor listings that represent typical values for your energy discharge applications. Your copy will be sent on request. Address:

**SANGAMO ELECTRIC COMPANY**  
SPRINGFIELD, ILLINOIS



EC61-6

CIRCLE 94 ON READER-SERVICE CARD

## RAYTHEON TRANSFORMER TALK

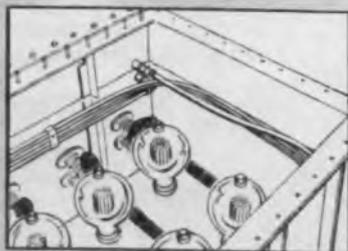
Facts about transformers that have solved equipment design problems • No. 5 in a series.

# Power supply for high-power radar

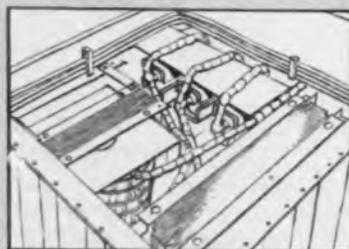
...designed in  
1 week  
delivered in  
6 weeks



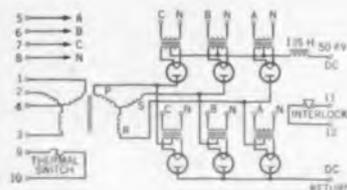
2½ TON POWER SUPPLY delivers 52.5 kVA, is insulated for 70kV and is capable of withstanding heavy short circuit fault currents.



RECTIFIER COMPARTMENT houses six tubes in three-phase circuit. Tubing is for cooling. Entire unit is oil-filled and completely sealed.



MAGNETICS COMPARTMENT—also oil-filled and cooled—includes three-phase plate transformer (lower right), choke (left), and filament transformer stack of six (right).



This 52.5 kVA Raytheon power supply was in the field and functioning perfectly just six weeks after the order was received. Actual electrical design work was completed in seven days.

The 2½ ton power supply provides high voltage for a radar modulator in a National Aeronautics and Space Administration System. This three-phase full-wave rectifier supply is capable of emergency operation on single phase which is an unusual feature for a power supply of this size and output.

Raytheon's capability of designing and building high-voltage power supplies can be put to work for you. Write us today for a descriptive folder on the power supply shown here or for a prompt and expert answer to any dc power requirement from 10 to 100 kV. See how Raytheon's unique experience and facilities expedite the *design* and the *construction* of a unit that meets your exact specifications.

Address Magnetics Operation, Microwave & Power Tube Division, Raytheon Company, Waltham 54, Massachusetts

## NEW PRODUCTS

### X-Y Plotter

427



Digital high-speed plotter accommodates any analytical or discontinuous function and presents the data in graph form, for visual interpretation. Plotting is 1/100-in. increments, at speeds of 200 increments per sec, at 0.01 in. resolution. Power supply is self contained.

Autonetics Industrial Products, Dept. ED, 3400 E. 70th St., Long Beach 5, Calif.

### Power Supply

391

The X-4760 standby power supply is intended for use with the Varian X-4700A rubidium vapor frequency standard. Output is 28 v dc normal, 31 v dc charging, with 5 amp regulated current. Input is 115 v, 60 cps, 500 w. The unit is passively limited to 10 amp.

Varian Associates, Dept. ED, 61 Hansen Way, Palo Alto, Calif. P&A: \$950.00; 90 days.

### Decade Attenuator

367



Two models are designated DA-1 and DA-2. Model DA-1 consists of 3 shielded decades and covers 0 to 111 db in steps of 0.1 db. Model DA-2 has 2 decades from 0 to 110 db, in steps of 1 db. Modular units are offered for custom use.

Industrial Instruments, Inc., Dept. ED, 89 Commerce Road, Cedar Grove, N. J.

Availability: 4 weeks.

EDC 1961-62 contains all New Products that appeared in ELECTRONIC DESIGN from January, 1960 to June, 1961.

◀ CIRCLE 95 ON READER-SERVICE CARD

RAYTHEON

RAYTHEON COMPANY

MICROWAVE AND POWER TUBE DIVISION

## Capacitor Tester

404



Model 1003 capacitance monitoring system combines the model 6150 capacitance-and-dissipation-factor-to-dc converter with a digital printer. Capacity meter has test frequencies of 120 and 1,000 cps and tests capacitances from 0.01 pf to 1,000  $\mu$ f with an accuracy of 0.1% of reading  $\pm 1$  digit. Internal polarizing supply is 0 to 20 v dc.

Electro Instruments, Inc., Dept. ED, 8611 Balboa Ave., San Diego 11, Calif.

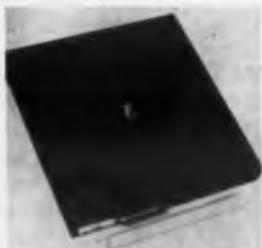
## Magnetic-Tape Certifier 389

Unit inspects magnetic tapes for defects, which could cause loss of information in magnetic-tape systems. One pass at full transport speed checks all channels of the tape with preset densities up to 560 bits per in. Operating power is 115 v, 60 cps, 40 w.

Cybetronics Inc., Dept. ED, 132 Calvary St., Waltham, Mass.

## Magnetostriction Delay Lines

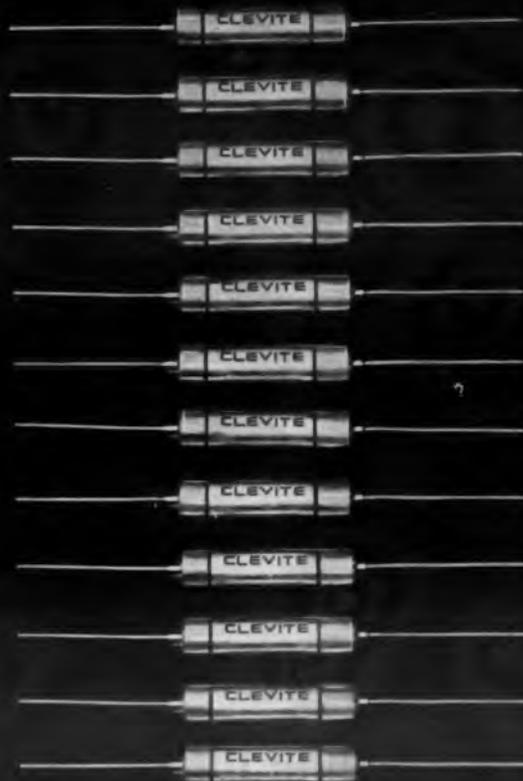
405



Delays up to 16,000  $\mu$ sec. Pulse width is 1 to 5  $\mu$ sec and max bandwidth is 100 to 600 kc. Center frequency range is 100 to 500 kc per sec. Model 6053 is available with up to 100 taps in any position subject to a minimum spacing of 5  $\mu$ sec. This unit operates between  $-50$  to  $+85$  C and has an insertion loss of 40 db + 3 db per msec of delay.

Ferranti Electric Inc., Dept. ED, Industrial Park No. 1, Plainview, L. I., N. Y.

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## MODEL 6db BANDWIDTH

TL-2D5A	2 kc
TL-4D9A	4 kc
TL-6D12A	6 kc
TL-8D16A	8 kc
TL-10D18A	10 kc
TL-16D25A	16 kc
TL-20D32A	20 kc
TL-30D45A	30 kc
TL-40D55A	40 kc
TL-45D60A	45 kc
TL-32E48C	32 kc
TL-50D85C	50 kc

(suffix "A" denotes 455 kc center frequency; suffix "C" denotes 500 kc center frequency)

# Clevite Ceramic Ladder Filters

## Now in stock in 12 bandwidths... 80 db rejection in 0.1 cu. in.

Clevite ceramic ladder filters provide more selectivity for their size than any conventional i-f filter. They are fixed tuned and need no alignment—are non-magnetic and non-microphonic. Leading manufacturers now have Clevite ladder filters in their communications equipment. Improve your newest design with these unique filters. Write now for complete specifications—Bulletin 94012, or for selectivity curves available on each stock model. ■ Dimensions:  $\frac{5}{16}$ " diameter x  $1\frac{1}{2}$ " long. ■ Selectivity: 60 db/6db shape factor from 1.3:1 to 2.6:1. ■ Center Frequency Stability: within 0.2% for 5 years, and within 0.2% from  $-40^\circ$  to  $+85^\circ$  C. ■ Impedance: 1200-1500 ohms. ■ Designed for military environment.

**CLEVITE ELECTRONIC COMPONENTS**  
DIVISION OF **CLEVITE** 232 FORBES ROAD, BEDFORD, OHIO

Field Sales Offices:  
Maplewood, N. J. / Chicago, Ill. / Denver, Colo. / Inglewood, Calif.



Development of **switching tubes** to meet specific needs has long been a Westinghouse specialty. A recent example is the WX-4405. This new tube is a C-band high-power, fast recovery time crystal protector. It is designed for operation with a ferrite circulator in modern pulse doppler radar systems . . . and features a recovery time of 0.1 to 0.2 microseconds. ■ In a life test WX-4405 has operated over 1800 hours at full ratings with a recovery time of 0.15 microseconds, maintaining its original value. ■ For information on your application—standard or special—write on your company letterhead to: Westinghouse Electric Corp., Elmira, N. Y. You can be sure . . . if it's Westinghouse.

#### Characteristics of WX-4405

Waveguide Size	Input 2" x 1" Output 1.5" x .75"	*Recovery Time	0.2 u sec. max.
Frequency	5250-5650 Mc	Insertion loss	0.6 db max.
Peak Power	1 KW	Application	Pulse Doppler Radar
Duty	0.1	Advantages	Combination Pre-TR and crystal protector in one envelope
Special Characteristics	Fast recovery time at high power		

Versions of this tube can be supplied which operate at 3 Watts and at 50 Watts peak power with lower insertion loss, also scaled versions at other frequencies. \*Recovery time is usually measured from the time that the transmitter power has dropped to 10% of its full value, to the time the insertion loss has recovered to within 3db. of its fully recovered value.



## Westinghouse

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## NEW PRODUCTS

### Wiring Raceway

419



Raceway, designated Panel Channel style series VN, is slotted with contoured top openings, for wires to be slipped through. The slots enable wire to be inserted without threading from the inside and make easier the use of wire with attached connectors. Molded of a thermosetting plastic, the channel is flame retardant and comes in black, grey and white, in many sizes.

Stahlin Brothers, Inc., Dept. ED, 378 Maple St., Belding, Mich.

### Three-Phase Transformer

423



Units measure 1 x 1 x 17/32 in. and operate at 400 cps, up to 2 va loading. Hook type terminals, 0.15 in. long, and side mountings are provided in these units which meet MIL-T-27A, grade 5, class S. The temperature range of series SX is -55 to +130 C.

Titan Transformer Co., Dept. ED, 229 Binney St., Cambridge 42, Mass.

P&A: \$40.00, 1 to 9; 2 weeks.

### Solid-State Power Supply

421



Airborne dc to dc power supply is encapsulated in a semi-flexible epoxy, to provide protection against vibration. High and low temperature operation is +185 to -40 F, with design to +260 F on request.

Computer Engineering Associates, Dept. ED, 350 N. Halstead, Pasadena, Calif.

Availability: 8 weeks.

# NEW!

## Sylvania 2N782 TRI-PAK

*offers 50% cost-saving approach to  
epitaxial device testing and evaluation*

Famous Sylvania 2N782 Epitaxial PNP Germanium Mesa Transistor features high-speed switching, low saturation voltage, with exceptional economy. Now you can discover for yourself the many benefits derived from circuits designed around Sylvania 2N782. The new Sylvania TRI-PAK—packaged in a handy book-style folder suitable for reference shelf or desk top—includes (a) 6 Sylvania 2N782 transistors, (b) 12 application circuits, (c) complete data and electrical characteristics.

Now—Sylvania 2N782 transistors are available for engineering evaluation in the TRI-PAK package at 50% below established OEM prices. *Six for the price of three!* Order direct from the Sylvania Franchised Semiconductor Distributor nearest you!

Or write, Sylvania Electric Products Inc., Semiconductor Division, Woburn, Mass.

# SYLVANIA

SUBSIDIARY OF

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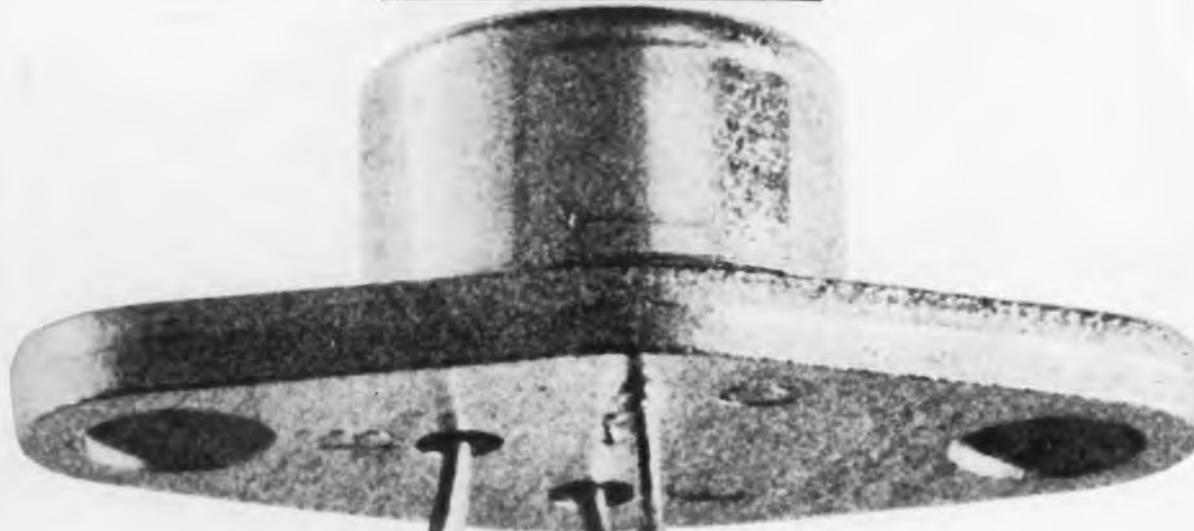
ELECTRONIC DESIGN • December 6, 1961

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- MARYLAND:**  
**BALTIMORE**  
RADIO ELECTRIC SERVICE, 5 N. Howard St.  
LEvington 9-5835 Mr. John J. Baglioni
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COsley 7-5630 Mr. Henri Jappe
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CIRCLE 99 ON READER-SERVICE CARD

# NEW DEVELOPMENT BENDIX® 3-AMP DAP



Designers can count on the new Bendix 3-amp DAP<sup>®</sup> power transistor series for greater efficiency in switching and audio applications. These diffused-base units offer low input resistance, outstanding gain characteristics, and high collector-to-emitter voltages. And every unit is "Dynamically Tested", an exclusive Bendix quality control process that assures uniform reliability. Dimensions conform to JEDEC TO-37 outline with collector electrically connected to case. Write to Holmdel, N. J., for details.

MAIN OFFICE: Holmdel, N. J.—Ph. SH 7-5400 • NEW ENGLAND OFFICE: 114 Wallham St., Lexington, Mass.—Ph. VO 2-7650 • DETROIT OFFICE: 12950 West 8 Mile Rd., Detroit 37, Mich.—Ph. JO 6-1420 • MIDWEST OFFICE: 24565 York Rd., Elmhurst, Ill.—Ph. BR 9-5050 • WEST COAST OFFICE: 117 E. Providencia Ave., Burbank, California—Ph. VI 9-3961 • CANADIAN AFFILIATE: Computing Devices of Canada, P.O. Box 508, Ottawa 4, Ont. • EXPORT OFFICE: Bendix International 205 E. 42nd Street, New York 17, N. Y. • STOCKING DISTRIBUTOR: Contact nearest sales office for local distributor.

Absolute Maximum Ratings:	V <sub>CE</sub> Vdc	V <sub>CEO</sub> Vdc	V <sub>CB</sub> Vdc	I <sub>C</sub> Adc	P <sub>C</sub> <sup>*</sup> W	T <sub>stg</sub> °C	T <sub>J</sub> °C
B-1013	60	30	60	3	5	-65 to +110	110
B-1013A	100	60	100	3	5	-65 to +110	110
B-1013B	200	100	200	3	5	-65 to +110	110

\*P<sub>C</sub> is the maximum average power dissipation. It can be exceeded during the switching time.

**Bendix Semiconductor Division**



CIRCLE 100 ON READER-SERVICE CARD

## NEW PRODUCTS

Life-Test Racks

463



Complete rack consists of 4 independent modules holding five magazines of 20 transistors each, or 400 transistors per rack. Each module has two individual power supplies, a separate control circuit, interlock system and cycling instrumentation. Rack fits 44-1/2 x 78 x 32-1/2-in. space.

Equipto Electronics Corp., Dept. ED, 319 N. Webster St., Naperville, Ill.

Humidity Readout

358

Model PCRC Hygrocon-11 is a precision reader-power controller for use with the PCRC-11/T or PCRC-33/T sensing units. Unit has four 25% expanded scales and one 100% scale. A 1-hp ac or dc output rating for humidification or dehumidification equipment.

Phys-Chemical Corp., Dept. ED, 40 E. 12 St., New York 3, N. Y.  
P&A: \$750.00; 4 weeks.

Angle Counters

477



Center scale angle counters C70-0431, -0432 and -0435 indicate latitude and longitude positions in counts up to 179.9 deg, 179 deg and 59 min, and 179 deg and 59.9 min. Center scale enables counting to proceed from 0 in either direction of rotation. These units are supplied with either odometer or Geneva drives and end or side mounting flanges. Counters are designed for use in navigational, computing and fire control systems.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 Mc Bride Ave., Little Falls, N. J.

## Vacuum Tube Voltmeter

461



Model 222, available in both kit and wired form, measures ac and dc voltages up to 1,500 v in five ranges, and resistances of 0.2 ohms to 1,000 meg in five ranges. Input impedance is 11 meg on dc, 1 meg on ac. Voltage ranges are 0-3, 15, 75, 300, and 1,500. Response is 30 cps to 3 mc; frequencies up to 250 mc can be read with probe.

Electronic Instrument Co., Inc., Dept. ED, 33-00 Northern Blvd., Long Island City 1, N. Y. P&A: kit, \$27.95; wired, \$42.95; 1 month.

## VHF Receiver

459



Frequency range is 55 to 260 mc. The type 501 am, fm, cw receiver has two if bandwidths: 300 kc for am, fm, and cw, and 10 kc for am and cw. Agc is applied to the rf stages to prevent overloading at high signal levels. The unit can be operated on 50-60 or 400 cps without modification.

Communication Electronics, Inc., Dept. ED, 4900 Hampden Lane, Bethesda 14, Md. Price: \$1,550.00 fob Bethesda.

## Elapsed Time Indicator

420



Records total power-off time and duration of off periods. The Atcotrol elapsed time indicator, 5-1/4 x 7-1/4 x 3-1/2 in., is a dual timer for use in any electronic circuit. Both pointers move clockwise when power is off; after power is restored the left one resets to zero, while the right one holds.

Automatic Timing and Controls, Inc., Dept. ED, King of Prussia, Pa.



## WITH PESCO STATIC INVERTERS

Filling the power conversion requirements of America's mighty missiles . . . used on such first-line weapons as Polaris, Mace, and the Centaur space vehicle . . . the Pesco Static Inverter shown above has no moving parts, offers unsurpassed efficiency in d.c. to a.c. inversion, ranging from 250 va to 20 kva. Employing silicon semiconductors and magnetic components with operating temperatures up to 125°C., lightweight Pesco Static Inverters feature single or multi-phase operation . . . are adaptable to any requirement for frequency stability or tolerance . . . permit 100% load unbalance! This "first" in electronic circuitry exemplifies the total capabilities of the Pesco/Borg-Warner research engineering team . . . from creative concept to production units.

For full details, send coupon below, or contact your nearest Pesco sales representative.



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CIRCLE 101 ON READER-SERVICE CARD

FR-100C =  $\frac{P_{max} + S_{min}}{\$}$

## New Ampex FR-100C

Lightweight, single-rack recorder gives maximum performance  
in minimum space for your recorder dollar

**Brand New Modular Solid-State Plug-In Circuits** combined with the world's most proved instrumentation tape transport have enabled Ampex engineers to design an exceptionally high performance recorder with great reliability and economy of operation. The new FR-100C offers:

**Performance:** Frequency response is 300 kc at 60 ips direct record—20 kc with FM record. Fourteen-inch reels provide 24 minutes record time at 60 ips (with 1-mil tape). Tape handling is fully comparable to the Ampex FR-100B.

**Versatility:** Take your choice of direct, FM and PDM recording; six tape speeds; 1" and ½" tape; and up to 14 data channels and one auxiliary channel such as voice log or clocking generator.

**Economy:** Because the new FR-100C features modular plug-in circuits, you can tailor your recorder to your immediate needs. You can specify only the features you need now without sacrificing future flexibility.

**Operation:** Signal inputs and outputs are available both front and back. All connection, adjustment and calibration points are easily accessible from the front. Lightweight single-rack unit takes minimum floor space.

**Ampex Reliability Built In.** In addition to its greater versatility and economy, the fourth-generation FR-100C is designed to the same high standards that have made Ampex recorders the standard of excellence throughout the world. For complete specifications, write . . .

AMPEX INSTRUMENTATION PRODUCTS COMPANY • Box 5001 • Redwood City, California • EMerson 9-7111

**AMPEX**

## NEW PRODUCTS

### Latch Relays

395



**Type HRLR ac latch relays** are designed for machine tool and other control uses where the control circuits must function independently of circuit or power failure. Mechanically held units feature: continuous duty coils on both main relay and latch assembly, unitized convertible poles, and electrical reliability. Relays are available with 2, 3, 4 or 6 normally open or normally closed unit poles.

Ward Leonard Electric Co., Dept. ED, Mount Vernon, N. Y.

### Transistorized Oscillator 425

**Crystal-controlled transistor oscillator** can be used in conventional or printed circuits for missiles and satellites. Output of MB151 is a sine wave, 1 v peak to peak into 4.7 ohm load. Input is 28 v dc  $\pm 2\%$  at 25 ma and storage temperature range is  $-55$  to  $+100$  C. Frequencies vary from 20 kc to 100 mc.

Bulova Watch Co., Inc., Electronics Div., Dept. ED, 40-01 61st St., Woodside 77, N. Y.

### Contact Assemblies

394



**Miniature spring-loaded units** are designed to minimize contact surface contamination and provide cooler operation over a wide range of temperatures in air, vacuum or gases. The assemblies have self-dampening action, a choice of terminal connections and construction materials, wide pressure range, and minimum resistance.

Ostby & Barton Co., Dept. ED, P. O. Box 6267, Providence 4, R. I.

◀ CIRCLE 102 ON READER-SERVICE CARD

## Coil Winder

398



Blu-Red MD 60 is designed for automatically guided winding of clutch and alternator coils. The unit features a floating wire guide, an electromagnetic brake solenoid operated by a predetermining turns counter, and a tailstock equipped with a sliding sleeve for opening and closing coil flanges and pulling-off wound coil.

Associated American Winding Machinery, Inc., 750 Saint Ann's Ave., New York 56, N. Y.  
P&A: \$2,800; 4 months.

## Ceramic Composition

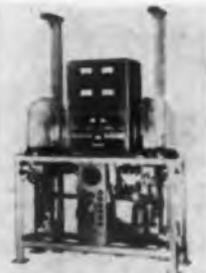
393

Dissipation factor is less than 4% under high ac field conditions. The Glennite HT compositions are designed to have many applications in the field of high-powered underwater sound transmitters.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N. J.

## Vacuum System

400



Dual 12 system is designed to produce a vacuum of  $1 \times 10^{-4}$  mm Hg in less than 10 min and  $5 \times 10^{-5}$  mm Hg in less than 20 min. The electrical system consists of a 2 kva variable transformer and 2 kva step-down transformer. Output of the step-down transformer is connected to permit voltage selection to any of six filament terminals in either bell jar.

Vacuum Equipment and Components Div., Suburban Plastics Co., Inc., Dept. ED, 4041 Ridge Ave., Philadelphia 29, Pa.

High-energy density electron-beam welding techniques, recently developed by the Zeiss Foundation of West Germany and the Hamilton-Standard Division of United Aircraft, markedly improved packaging density and production methods in the field of microelectronics.

In microcircuitry, for example, packaged circuits no bigger than a thumbnail can now be reliably produced. Electron-beam equipment now welds microelectronic components into circuits with pinpoint precision, making intra- and inter-circuit connection, and hermetically encapsulating the completed micromodule.

Only electron-beam welding, performed in a high vacuum, can offer these significant advantages for the field of microelectronics: virtual elimination of contamination; a close control of penetration; low thermal distortion; and close dimensional control. The upper illustration shows weldments of 0.002" thick copper leads to 0.002" thick nickel-plated ceramic substrate. In the field of thin films difficult welds are possible with this revolutionary new equipment such as 0.002" gold tabs to chromium-gold films 3000-A\* thick.

Another important use of electron-beam equipment is the welding of ceramics used in vacuum tubes which

**Electronic  
Giants  
no bigger  
than your  
thumbnail...  
now  
through  
electron-beam  
welding**

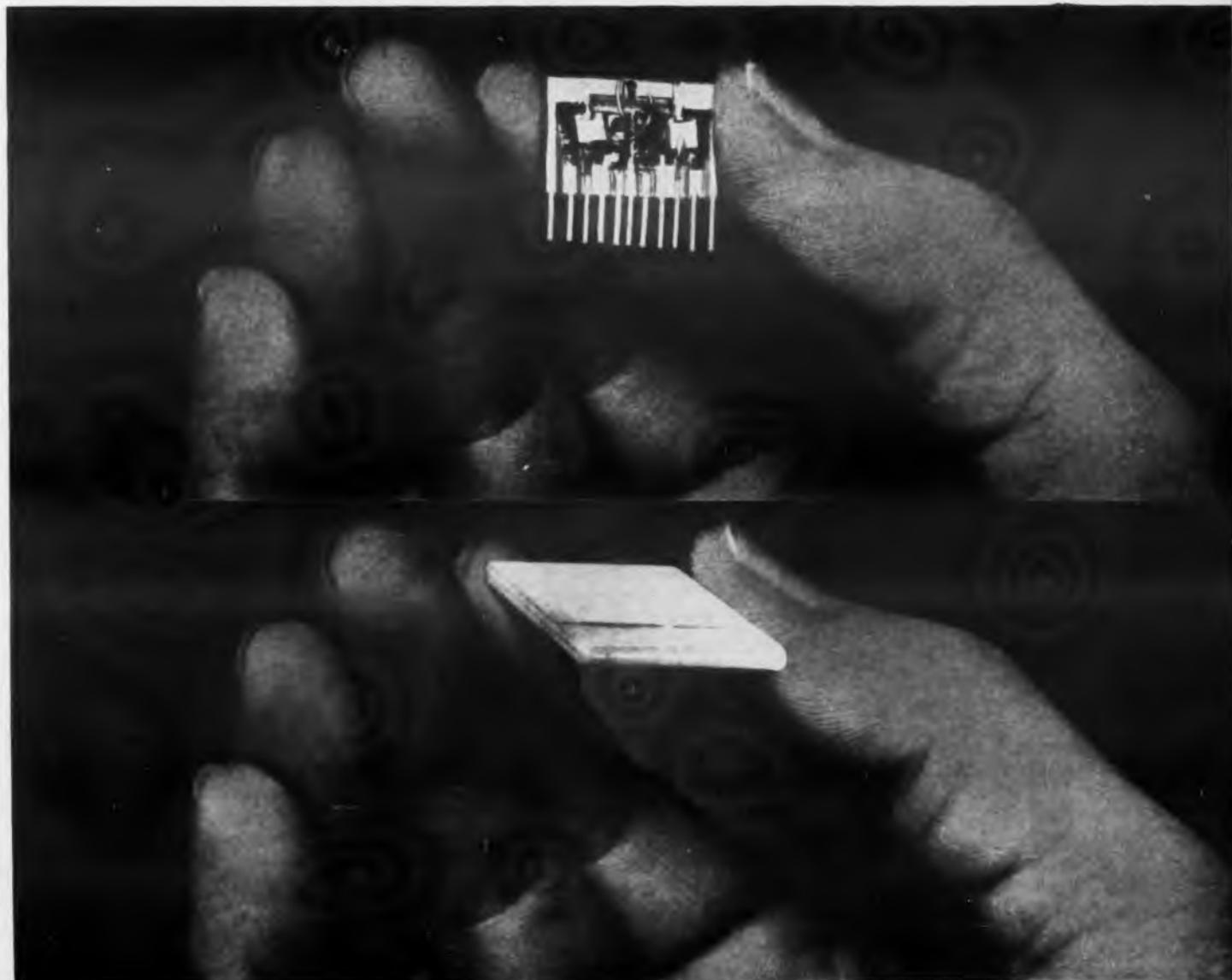


**HAMILTON-ELECTRONA, INC.**

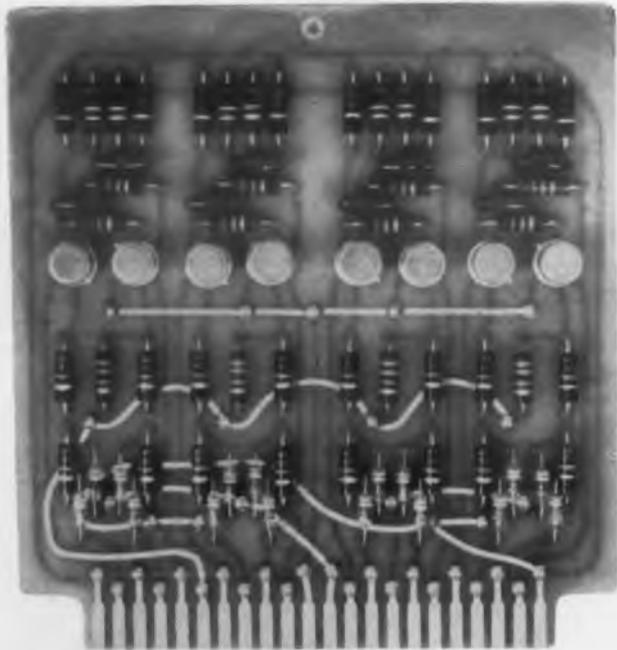
TIME-LIFE BUILDING, ROCKEFELLER CENTER, NEW YORK 20, N. Y.

require extremely high temperature performance. For these procedures, tight ceramic-to-ceramic bonds are necessary — bonds available only through high-energy density electron-beam welding. The lower illustration is a 2 X magnification of two aluminum oxide ceramic wafers  $\frac{1}{2}$ " x  $\frac{3}{4}$ " x .010" thick edge-welded by deflecting the high energy density beam of a Hamilton-Zeiss electron beam welder across the edge surface.

Hamilton-Standard, with over twenty years of metallurgical experience and meeting rigid government specifications, has exhaustively tested the welds produced with Hamilton-Zeiss equipment. The data, which are available for your inspection, demonstrate conclusively that the Hamilton-Zeiss method produces welds in miniature workpieces that are as strong as the original materials themselves. Such results are possible only by the use of high energy density and precision focusing by the Zeiss magnetic lens system which are exclusive features of the Hamilton-Zeiss equipment. Find out what this revolutionary equipment can mean in your business. For full information call Hamilton-Electrona, Inc., exclusive marketing agent for Hamilton-Zeiss equipment in the United States and Canada.



# START RIGHT



Start right when you design a solid-state electronic system. Select the line of digital circuit modules that gives you (1) maximum freedom of design and (2) minimum cost. Ransom Research offers the broadest selection of circuits (well over 100 "off the shelf") and lowest cost per circuit (average 25% less). Specify Ransom. *New Condensed Catalog C now available on request.*

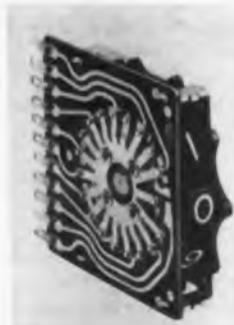


**RANSOM RESEARCH** A DIVISION OF WYLE LABORATORIES  
Box 269, 374 West Eighth Street San Pedro, California Terminal 2-1128  
CIRCLE 104 ON READER-SERVICE CARD

## NEW PRODUCTS

### Thumbwheel Switch

422



Three printed-circuit switch types occupy 1/2 in. of panel space. Type TTS-2722 is all-shortening-but-one, type TTS-27150 is progressively shortening and the progressively unshortening type is TTS-27158. Multi-wafer combinations are also available.

Chicago Dynamic Industries, Inc., Dept. ED, 1725 Diversey Blvd., Chicago 14, Ill.  
P&A: \$4.58 to \$13.50, small quantities; stock.

### Ferrite Pot Cores

376

Tunable cores allow calculation of the untuned assembly to within  $\pm 3\%$  accuracy. Units have a minimum tuning range of 14% with a final adjustment accuracy of 0.02%. Ferrokor Stage IV package employs these cores and adjusting mechanism, but uses clamp-type hardware.

Ferrocube Corp. of America, Dept. ED, Saugerties, N. Y.

### Digital Data Processor

458



DDP-19 is a single address, parallel, binary-stored program machine. The 19-bit machine uses a 5- $\mu$ sec, 4,000 or 8,000 word core memory, with additional memory units available. Memory access time is 2.5  $\mu$ sec, and read-write cycle time between memory accesses is 5  $\mu$ sec. Add time is 3  $\mu$ sec, average multiply time is 36  $\mu$ sec and average divide time, 45  $\mu$ sec.

Computer Control Co., Inc., Dept. ED, 2251 Barry Ave., Los Angeles 64, Calif.

Price: \$120,000 to \$400,000, including peripheral equipment.

## NEW! VAP-AIR STATIC INVERTERS



Lightweight  
DC to AC Sine Wave Inverter.  
Shown: 550 VA; other sizes available.

- fully transistorized
- maintenance-free
- high reliability

New Vap-Air static inverters offer many advantages over rotary-type inverters. Vap-Air inverters are fully transistorized, have no moving parts, need no vibration-shock mounting. They have no bearings, no brushes to wear out and replace . . . require no maintenance. Exceptionally reliable performance, 80% efficiency compared to 55% for rotary-type. Less weight . . . only 19 lbs. Very low noise level.

#### BRIEF SPECIFICATIONS

Rating	550 VA
Output	115 $\pm$ 5% volts, 400 cps, sine wave
Input	25 to 31 VDC, 28 VDC nominal
Size	12" x 10" x 4 1/4"
Weight	19 lbs.
Distortion	Less than 10%
Efficiency	80%
Ambient Temperature Range	-40 to +160° F.

#### VAP-AIR...COMPLETE CONTROL CAPABILITIES

Entire systems and a complete line of sensors, electronic controls and precise power supplies, electro-pneumatic and electro-mechanical valves, advanced in-line air valves and regulators, electric power controllers and heat exchange equipment—for aircraft, missiles, and ground support equipment.

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CIRCLE 105 ON READER-SERVICE CARD

## Subcarrier Oscillator 428



Operating at unlimited altitudes, this low-level subcarrier oscillator is designated type 1274A. Differential floating input allows operation at ground potential, at dc levels to  $\pm 50$  v from ground, or it can be left floating. Input impedance is larger than 90 K and input power for full deviation is less than 1.12 mw. Total volume is 4.5 cu in.

Bosch Arma Corp., Tele-Dynamics Div., Dept. ED, 5000 Parkside Ave., Philadelphia 31, Pa.

## Ceramic Element 365

For solid-state switching devices. The element can displace loads of up to 30-g 1/64-in. in one direction. Reversing voltage polarity can produce equal displacement in the opposite direction. Units can provide these displacements with dc voltages of approximately 125 v.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N. J.

## Pulse Generator 433



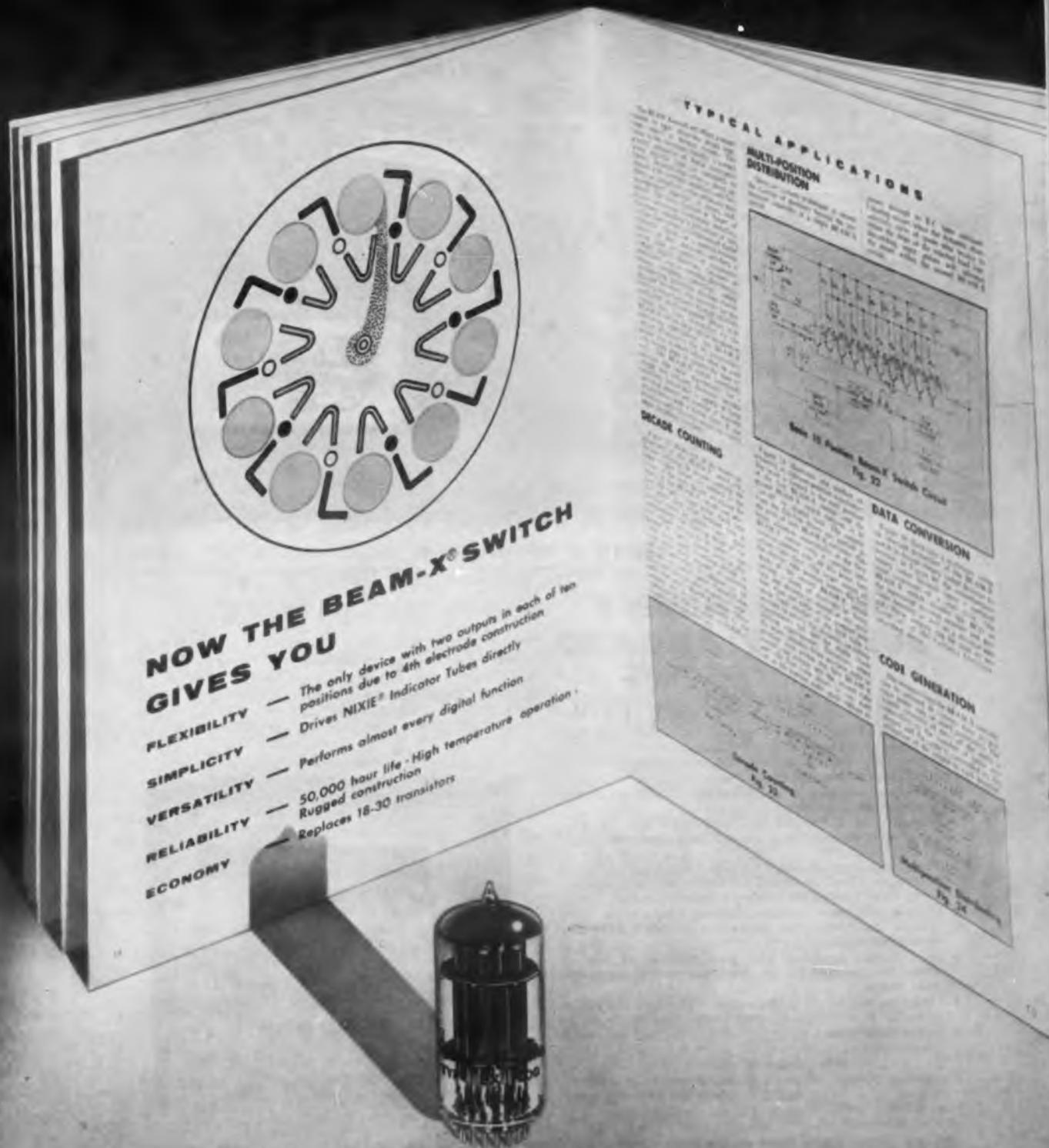
Continuously variable pulse repetition is from 10 cps to 500 kc in the GO 1101 pulse generator. It can be controlled by internally or externally derived trigger pulse. Pulse amplitude is adjustable over the range of 0.5 v to 100 v, positive or negative going, with switched selection of single or double pulse output. Main pulse can be set to any time between 1  $\mu$ sec and 100 msec.

Solartron Laboratory Instruments, Ltd., Dept. ED, Cox Lane, Chessington, Surrey, England.

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# GET THE FULL STORY . . .

## BEHIND THE *Beam-X*<sup>®</sup> SWITCH



### NOW THE BEAM-X<sup>®</sup> SWITCH GIVES YOU

- FLEXIBILITY** — The only device with two outputs in each of ten positions due to 4th electrode construction
- SIMPLICITY** — Drives NIXIE<sup>®</sup> Indicator Tubes directly
- VERSATILITY** — Performs almost every digital function
- RELIABILITY** — 50,000 hour life - High temperature operation  
Rugged construction
- ECONOMY** — Replaces 18-30 transistors

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NEW 28 page Technical Brochure. This fully illustrated brochure contains over 50 diagrams, and covers the entire line of Beam-X switches. Includes: Theory • Design Information & Characteristics • Curves • Applications •

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Formerly Electronic Tube Division

## New Revolutionary Concept In Pushbutton Switch

The newly designed IEE Cue Indicator Switch has the capacity to display twelve different messages on its viewing screen, which is also the "push-button" of the switch. Messages are displayed by the use of a rear-projection display system.

### CUE INDICATOR

### SWITCH

OFFERS 12 INTERCHANGEABLE MESSAGES

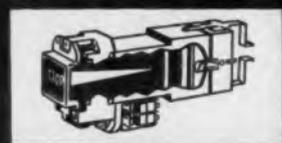
Ability to reduce overall panel space by 1200% may be achieved by combining twelve different messages into one Cue Indicator Switch, resulting in ten Cue Indicator Switches doing the job of 120 conventional switches. Switches with readout communication capabilities employing words, color, numbers, and symbols herald a new era in control applications.

Write today for prices and complete detailed specifications.

Representatives in principal cities.



**INDUSTRIAL ELECTRONIC ENGINEERS, INC.**  
5528 Vineland Avenue • North Hollywood, California



CIRCLE 107 ON READER-SERVICE CARD

## 10MC FREQUENCY COUNTER/STANDARD A NEW CONCEPT IN PRECISION MEASURING

The Model 14-20C 10MC Frequency Counter/Standard combines the features of a precision counter and a high stability frequency standard into an advanced design unit. Specifications are as follows:

- Simultaneous and independent use of both frequency standard and counter.
- Stability of  $1 \times 10^4$  per day and  $5 \times 10^4$  per week as calibrated against the primary time-standard "Atomichron" —  $2 \times 10^{10}$
- Nine standard decade output frequency steps of 0.1cps to 10mc provided by frequency synthesizer. Gate time from 1 millisecond to 100 seconds.
- Counts any one of nine decade frequencies from 0.1cps to 10mc for period and time interval measurements.
- Self checks counting and gate circuits at any of these frequencies in all combinations of available gate times.
- Operates within all ratings over a temperature range of  $-20^\circ \text{C}$  to  $+55^\circ \text{C}$ , and humidities up to 95%.
- Operates from an external 100KC or 1mc reference frequency.

Other features include:

Frequency range 10cps— Input power 115/230v,  
10.1mc 50-60 cps (400 cps opt.)  
Period DC— 100KC  
In-line readout 8 place

PRICE \$2,200



**NORTHEASTERN** ENGINEERING INCORPORATED  
DEPT. 1B, MANCHESTER, NEW HAMPSHIRE  
AFFILIATE OF ATLANTIC RESEARCH CORP.

CIRCLE 108 ON READER-SERVICE CARD

## NEW PRODUCTS

### Impulse Counter

473



Push-button impulse counter Atcotrol 311B requires a low minimum pulse of 50 msec duration. The counter is built with an automatic reset for fast, accurate operation. Five count ranges are available: 1 to 40; 2 to 120; 4 to 240; 5 to 480 and 10 to 960, at count ranges to 500 counts per min. Standard load ratings are 10 amp at 115 v ac; 5 amp at 230 v ac; and 1/4 amp at 115 v dc, non-inductive.

Automatic Timing and Controls, Inc., Dept. ED, King of Prussia, Penn.

Availability: from stock.

### Panel Blower Assembly

378

Multi-purpose all-angle blower needs 3-1/2 in. panel space. This dual unit is suitable for exhaust or supply purposes, or one port for each. Flow control can be set through 230 degs. Unit is cushion mounted for quiet operation and bearings are permanently lubricated.

Western Devices, Inc., Dept. ED, 600 W. Florence Ave., Inglewood 1, Calif.

P&A: \$97.00, 1 to 9; 7 to 10 days.

### Pulse Generator

467



Rise time is approximately 0.2 nsec. Either positive or negative 0.5 v peak pulses trigger the unit at rates up to 100 kc, and the unit may be triggered directly from the sync pulse output of model 185A or 185B sampling oscilloscope. Model 213A pulse generator is suitable for analyzing cable characteristics and determining switching times of transistors, etc.

Hewlett-Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.

P&A: \$215.00; 2 weeks.

EDC contains over 8,700 New Product items which appeared in ED from January, 1960 to June, 1961.

ELECTRONIC DESIGN • December 6, 1961

**Immediate  
delivery!**  
**ELMENCO**  
CAPACITORS  
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COLORADO: Denver Electronics Supply Co., 1254 Arapahoe St., Denver 4.

DISTRICT OF COLUMBIA: Capitol Radio Wholesalers Inc., 2120 14 St., M.W., Wash., D. C.

FLORIDA: Elect. Supply, 1301 Hibiscus Blvd., Melbourne, Elect. Supply, 61 N. E. 9th St., Miami.

ILLINOIS: Newark Electronics Corp., 223 W. Madison St., Chicago 6.

MARYLAND: D & M Distributing Company, Inc., 2025 Worcester St., Baltimore 30; Kama-Elteri Electronics, Inc., 2050 Rock Rose Avenue, Baltimore; Wholesale Radio Parts Co. Inc., 308 W. Redwood St., Baltimore 1.

MASSACHUSETTS: Cramer Electronics Inc., 811 Boylston St., Boston 16; Radio Shack Corp., 730 Commonwealth Ave., Boston 17.

NEW JERSEY: Federated Purchaser Inc., 1021 U.S. Rte. 22, Mountainside; General Radio Supply Co., 600 Penn St., Camden 2; Radio Elec. Service Co., Inc., 513 Cooper St., Camden 2.

NEW MEXICO: Electronics Parts Co., Inc., 222 Troman 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-Nudson Elect. Inc., 236 W. 17th St., N. Y. 17.

NORTH CAROLINA: Dalton-Mege Radio Supply Co., Inc., 938 Burke St., Winston-Salem.

PENNSYLVANIA: Almo Radio Co., 913 Arch St., Philadelphia; George D. Barby Co. Inc., 622 Columbia Ave., Lancaster; George D. Barby Co. Inc., 2nd & Penn Sts., Reading; D. & M. Distributing Co., Inc., 2535 N. 7th St., Harrisburg; Phila. Elect. Inc., 1225 Vine St., Phila. 7; Radio Elec. Service Co., Inc., 701 Arch St., Phila. 6; A. Steinhilber & Co., 2520 N. Broad St., Phila.; Wholesale Radio Parts Co., Inc., 1650 Whiteford Rd., York.

TENNESSEE: Electra Distributing Co., 1914 West End Ave., Nashville 4.

TEXAS: All-State Elect. Inc., 2411 Ross Ave., Dallas 1; Busacker Elect. Equip. Co. Inc., 1216 W. Clay, Houston 19; Engineering Supply Co., 6000 Denton Dr., Dallas 35; Midland Specialty Co., 500 W. Paisano Dr., El Paso; The Perry Shankle Co., 1801 S. Flores St., San Antonio.

UTAH: Carter Supply Co., 3214 Washington Blvd., Ogden.

WASHINGTON: C & E Radio Supply Co., 2221 Third Ave., Seattle.

CANADA: Electro Sonic Supply Co., Ltd., 543 Yonge Street, Toronto 5, Ont.

**ARCO** electronics inc

NEW YORK \* DALLAS \* LOS ANGELES  
Exclusive Supplier of ELMENCO Capacitors to  
Distributors and Jobbers in U.S.A. and Canada

CIRCLE 109 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 6, 1961

**SELECTED BY  
RCA  
FOR  
A HIGH  
RELIABILITY  
\* PROJECT**



**Here is MEASURED RELIABILITY!**

Ten thousand El-Menco high reliability dipped mica capacitors were put on life test at 85°C with 225% of the rated DC voltage applied in accordance with an RCA high reliability specification.

*After 22,000,000 actual test unit-hours no \*\* failures of any type occurred*

The accumulated 22 x 10<sup>6</sup> test unit-hours without any failures can be used to calculate many different failure rates depending upon the confidence level desired. However, we shall explore the meaning of the results at a 90% confidence level.

Assuming no acceleration factor for either temperature or voltage, we have verified a failure rate of approximately .01% per 1000 hours. (Actually, there is a temperature effect and it has been found that, with the DC voltage stress remaining constant, the life decreases approximately 50% for every 10°C rise in temperature. There is also a voltage effect such that, with the temperature stress remaining constant, the life is inversely proportional to the 8th power of the applied DC voltage.)

Assuming no temperature acceleration factor and assuming the voltage acceleration exponent is such as to yield an acceleration factor as low as 100, we have nevertheless verified a failure rate of approximately .0001% per 1000 hours.

Assuming no temperature acceleration factor and assuming the voltage acceleration factor is on the order of 250 (test results are available to confirm this) we have accumulated sufficient unit-hours to verify a failure rate of less than .00005% per 1000 hours!

Note that all the above failure rates are calculated at a 90% confidence level!

*\* The El-Menco high reliability dipped mica capacitors are being supplied to the Radio Corporation of America for a high reliability military ground electronics project.*

**\*\*A failure was defined as follows:**

1. A short or open circuited capacitor occurring during life test.
2. A part whose capacitance changed more than  $\pm 2\%$  and whose capacitance did not fall within the original tolerance of  $\pm 5\%$ .
3. A part whose final dissipation factor exceeded .002.
4. A part whose final insulation resistance measured less than 100,000 megohms.

*Write for a copy of our "Reliability Study of Silvered Mica Capacitors".*



**THE ELECTRO MOTIVE MFG. CO., INC.**

Manufacturers of El-Menco Capacitors

**WILLIMANTIC CONNECTICUT**

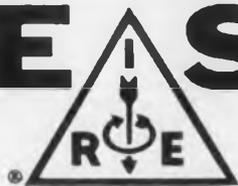
• molded mica • mica trimmer • dipped mica • silvered mica films  
• tubular paper • mylar-paper dipped • ceramic feed thrus • ceramic discs

Arco Electronics, Inc., Community Drive, Great Neck, L.I., New York  
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

**WEST COAST MANUFACTURERS CONTACT:**  
COLLINS ELECTRONIC SALES, INC., 535 MIDDLEFIELD ROAD, PALO ALTO, CALIFORNIA

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CIRCLE 115 ON READER-SERVICE CARD

## NYLON - Bobbins & Coil Forms



### PRINTED CIRCUIT TRANSFORMER BOBBIN

Complete with lugs, for printed circuit transformers. Eliminates cost and assembly of terminal board! The lugs are embedded in nylon for permanent locations especially designed to prevent wire breakage.

### ONE PIECE COIL FORM

Complete with lugs, for printed circuit I. F. and oscillator coils. Integral construction, the tube and base cannot come apart—constant core torque . . . designed to prevent wire breakage.



FREE samples and catalogs. Representatives in major cities. Write to this office for names and addresses.

## AMERICAN MOLDED

### INSULATED LEAD SLOT

Automatically insulates lead and eliminates washers and taping. This revolutionary bobbin speeds up automatic winding.

NO TOOL COST ON STOCK BOBBINS—SPECIAL BOBBINS TO YOUR SPECIFICATIONS

**American Molded Products Company**

2721 WEST CHICAGO AVENUE • CHICAGO 22, ILLINOIS

CIRCLE 111 ON READER-SERVICE CARD

## NEW PRODUCTS

### Program Controller

460



Meets MIL-STD 202B, method 102A and 107A, by providing control at three points. Unit starts on cold cycle and controls at any temperature below 0 to  $-75^{\circ}\text{C}$ , holding the temperature for up to 3 hr. Cycle then heats the chamber up to  $25^{\circ}\text{C}$  for 15 min. Chamber is then heated to any high temperature from  $+50$  to  $315^{\circ}\text{C}$  and held for the same period as the cold cycle, and then is cooled to  $25^{\circ}\text{C}$  for 15 min.

Delta Design, Inc., Dept. ED, 3163 Adams Ave., San Diego 16, Calif.

### Monoplane Switch

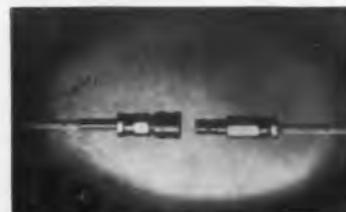
361

The Uniplane multicircuit selector switch makes monoplane switching available in two basic kits, 610 non-shorting, and 611 shorting style. Each provides 528 different switch arrangements, from 1-pole, 2-position to 8-pole, 12-position, with any one of three drive-shaft orientations.

The Ucinite Co., Dept. ED, Newtonville 60, Mass.

### Snap-on Connector

485



"ConheX" design features a hexagonal captivating member made of solid brass over the spring, thereby limiting the extent to which the connector may be bent from the axial dimension of the connection. Units are available in all standard connector types, including both straight and right-angle connectors.

Sealectro Corp., Dept. ED, 139 Hoyt St., Mamaroneck, N. Y.

P&A: \$1.85 (1-49); 2 weeks.

### Accuracy Is Our Policy

The description of model PY 45 temperature control manufactured by Mason Instrument Co., Inc. of New York, should have read: For temperatures as low as  $300^{\circ}\text{F}$ . It was incorrectly described for use to  $-300^{\circ}\text{F}$ . The item appeared in the Oct. 11 issue of ELECTRONIC DESIGN.

## NOW FROM ROME CABLE



## COMPLETE CABLE ASSEMBLIES TO YOUR SPECIFICATIONS

The next time your requirements call for a complete harness or cable assembly, take a look at what Rome's Special Products Facility has to offer.

Rome Cable can supply complete assemblies as well as bulk cable—in prototype or production quantities.

Save time and costs. Order custom cable assemblies ready for installation. To your exact specification we can supply: miniature or heavy-duty assemblies with cable bundles up to 4 inches in diameter, underwater cable and waterproof assemblies, umbilical cable assemblies for missiles, molded and potted connector terminations, molded breakouts, special jacket materials, special connectors and hardware for unusual applications.

Build extra reliability into your electrical system. Call a Rome Cable specialist during the design stage.

For your files, ask for a copy of a 4-page brochure on our Special Products Facility. Write to Rome Cable Division of ALCOA Special Products Facility, 2937 South Tanager Street, Los Angeles 22, California.

**ALCOA**  
**ROME CABLE**  
DIVISION

CIRCLE 112 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 6, 1961

## Reference Voltage Standards

401



Accuracy is better than 10 parts per million. TC series units are available with outputs up to 10 v dc at inputs of 50 to 500 cps at 115 v,  $\pm 20\%$ . Devices are designed to withstand vibration tests of 10 to 60 cps at 2 g for 24 hr, 20 g shock for 11 msec, operational temperatures of +120 F at 20%,  $\pm 5\%$ , and relative humidity for 12 hr.

Jackson Electronic Div., Bellows-Valvair, Dept. ED, 695 Johnston St., Akron 6, Ohio.

## Nameplate and Panel Kit 364

Nineteen-piece kit is for making of aluminum instrument panels and identification tags. Four basic colors of red, black, green and blue are included. Kit comes with chemicals, photosensitive panel materials, processing equipment and layout materials. Nonflammable, low-toxicity processing chemicals are used.

Halmar Electronic Products Co., Ltd., Electro-Kits Div., Dept. ED, 1550 W. Mound St., Columbus 23, Ohio.

## RF Power Meters

403



Feed-thru and vswr meter model VM-2 covers the range from 1 to 30 mc, and model VM-1 covers the range of 10 to 200 mc. Units consist of a voltage divider and a reflectometer. The frequency range of the voltage divider is dc to the upper frequency limit of the instrument.

Electro Impulse Laboratory, Inc., Dept. ED, 208 River St., Red Bank, N. J.

CIRCLE 113 ON READER-SERVICE CARD

Now General Instrument is top source for Mil types for all your transistor, diode and rectifier needs.

Diodes-Rectifiers: SigC1N249B

SigC1N250B NAVY1N483B

NAVY1N485B NAVY1N486B

NAVY1N914 SigC1N2135A

JAN1N128 JAN1N198 JAN1N253

JAN1N254 JAN1N255 JAN1N256

JAN1N270 JAN1N276 JAN1N277

JAN1N281 JAN1N457 JAN1N458

JAN1N459 JAN1N538 JAN1N540

JAN1N547 SigC1N643 USAF1N645

USAF1N646 USAF1N647 USAF1N648

USAF1N649 SigC1N658-1N662-1N663

SigC1N1731 SigC1N1733 SigC1N1734

Transistors: JAN2N501A SigC2N706

SigC2N393 SigC2N696 SigC2N697

JAN2N331 JAN2N358A

JAN2N428 JAN2N466

NAVY2N388 NAVY2N396A

USAF2N404 SigC2N416

SigC2N417 SigC2N425 SigC2N426

SigC2N427 SigC2N464 SigC2N465

SigC2N467 SigC2N499 SigC2N1411

**GENERAL INSTRUMENT  
SEMICONDUCTOR DIVISION**

GENERAL INSTRUMENT CORPORATION, 65 GOVERNEUR ST., NEWARK 4, N.J.

# NEW VIBRATION METER



Type 1553-A  
Vibration Meter...\$675

From its ceramic pickup to its "flip-tilt" cabinet, the Type 1553-A Vibration Meter represents a major advance in instrumentation. Expanded ranges are now available for measuring displacement, velocity, acceleration, and jerk — a characteristic which no other instrument can measure. Readings may be made in terms of *true* peak-to-peak (the first vibration meter to measure this characteristic), peak, or average.

- ★ Direct readout of units being measured
- ★ Low-frequency response down to 2 cps
- ★ Pickup sensitivity adjustment (from 30 to 150 mv/g) enables use of low-output, high-response pickups for measurements to 20 kc
- ★ Measures jerk as well as conventional vibration parameters
- ★ Output available for recorders, analyzers, headphones, oscilloscopes, and stroboscopes
- ★ Light-weight (10½ lb.), easily portable, battery-operated, completely self-contained

Measures	Range (peak-to-peak)	Frequency*
Jerk	30-300,000 in./sec <sup>3</sup>	2-20 cps
Acceleration	0.3-300,000 in./sec <sup>2</sup>	2-1200 cps
Velocity	0.03-30,000 in./sec	2-1200 cps
Displacement	{ 0.003-300 in. { 0.00003-30 in.	{ 2-1200 cps { 20-1200 cps

\*With Type 1560-P51 pickup supplied; measurements possible to 20 kc with other accelerometers.

## Accelerometer Calibration Made Easy With The Type 1557-A VIBRATION CALIBRATOR

- ★ Provides accurate in-the-field check of any accelerometer or pickup with a mass of up to 300 grams
- ★ Convenient portability, small size (4" x 8" x 4"), light weight (3¼ lb.)
- ★ Leather carrying case provided
- ★ Transistorized and battery operated (100 hr. life)
- ★ Frequency, 100 cps ±1%
- ★ Output, 1g rms ±10%
- ★ PRICE . . . only \$225



## GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

NEW YORK, WOrth 4-2722  
District Office in Ridgewood, N. J.  
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Silver Spring  
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SYRACUSE  
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CLamson 4-9323

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WHitecliff 8-8233

LOS ANGELES  
Los Angeles  
MOntgomery 9-6201

ORLANDO, FLA.  
Orlando  
CArdon 5-4671

IN CANADA  
Toronto  
CHerry 6-2171

## NEW PRODUCTS

### Silicon Rectifiers

456

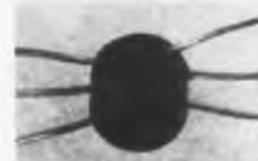


Heavy-duty types BYZ14 and BYY15 are double fused 20-amp power rectifiers mounted in 50-amp cases. Recurrent PIV rating, 400 v, is supplemented by a transient PIV rating of 600 v for BYZ14 and 800 v for the BYY15. Both types are designed for use in industrial power supplies, battery chargers and broadcast transmitters.

Amperex Electronic Corp., Power Tube Div., Dept. ED, 230 Duffy Ave., Hicksville, L. I., N. Y.

### Pulse Transformer

455



Pulse width of 2.5  $\mu$ sec is offered in model PT 861 transformers. The 0.40 in. diam x 0.25 in. units are suitable for space probe and missile applications. The 3 windings, in this 1.5  $\mu$  unit, have a turns ratio of 1:1:2.8.

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

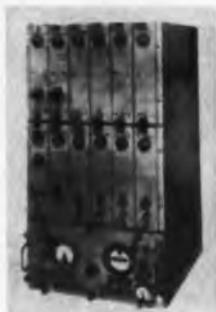
### AC Potentiometer

448



Terminal conformity of  $\pm 0.05\%$  is offered in model, 5B01 size 9, Vernistat ac potentiometer. This 2-oz unit operates on 28 v ac and is suitable for applications as a servo follow-up element. Max output impedance of 160 ohms is combined with 60 K min input impedance. Perkin-Elmer Corp., Dept. ED, Norwalk, Conn.

## Teletype Multiplexer 431



Four channel teletype multiplexer, designated telegraph terminal AN/UGC-1A is designed for land or shipboard installations. Features include fail-safe operation regarding misframes. Distortions of up to 45% in the input signal results in output distortion of 5%; error rate is less than 1 in 50,000 words in each channel. The unit is designed to operate with conventional stop-start equipment at a rate of 60, 75 or 100 words per min. The complete unit weighs 280 lb and has a power consumption of 86 w.

Trak Electronics Co., Inc., Dept. ED, Wilton, Conn.

## Transistor Heat Dissipator 432



For printed-circuit board applications, transistor heat dissipator model 2210 is designed to fit all transistors in the TO-5 case styles. "Positive contact" design provides the optimum heat path between the transistor and dissipator. Tightening the gland nut firmly clamps both sides of the transistor weld flange, the point of maximum heat. Heat is then conducted to the fin area where it is removed by natural conduction or forced air cooling.

Thermalloy Co., Dept. ED, 2130 Irving Blvd., Dallas, Tex.

P&A: \$0.22 ea in production quantities; stock.

Interested in New Products? EDC 1961-62 contains over 8,700 New Products.

FOR MOBILE COMMUNICATIONS EQUIPMENT



FOR FIXED-STATION COMMUNICATIONS EQUIPMENT



# Best Miniature Beam Power Tubes in their Price Class

More performance per dollar is packed into the RCA-7551 and 7558 miniature beam power tubes than in any comparable tubes on the market. With the 7551 and 7558, you can design top-quality communications equipment while keeping costs down.

Either tube gives top performance as a Class C r-f amplifier, oscillator, or frequency-multiplier at frequencies up to 175 Mc. Either may also be used in modulator or a-f power amplifier applications. A pair of either type, in Class AB<sub>1</sub> push-pull a-f amplifier service, can deliver up to 20.5 watts signal power output.

Identical in all respects except for heater ratings, the 7558 has a 6.3-volt heater (for use in fixed-station communications equipment) while the 7551 operates over a fluctuating heater-voltage (12 to 15 volts) such as that encountered in mobile systems operating from 6-cell storage-battery systems. In addition, the 7551 is subjected to rigid controls and tests for heater cycling, H-K leakage, interelectrode leakage, low-frequency vibration, and 500-hour intermittent life—to assure dependable performance in mobile systems.

Features contributing to efficient high-frequency performance of these tubes include:

- Low lead inductance
- Two base-pin connections for both the cathode and the No. 2 grid—to minimize degeneration and facilitate r-f bypassing
- Low interelectrode capacitances
- Low r-f loss and high input resistance—permit use of high grid-No. 1 circuit resistance to minimize loading of the driver stage.

These remarkable tubes help you to design compact communications equipment with assurance of dependable performance and long life. See your RCA Field Representative, or write, Commercial Engineering, Section L-18-DE-1, RCA Electron Tube Division, Harrison, New Jersey.

#### RCA Electron Tube Division Field Offices

EAST: 744 Broad Street, Newark 2, New Jersey, HUmboldt 5-3900 • MIDWEST: Suite 1154, Merchandise Mart Plaza, Chicago 54, Illinois, WHitehall 4-2900 • WEST: 6801 E. Washington Blvd., Los Angeles 22, California, RAymond 3-8361

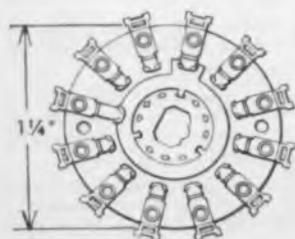


The Most Trusted Name in Electronics

Newest...in the industry's  
most extensive line  
of rotary switches

## CENTRALAB SERIES 600

← 1 1/4" →  
**DIAMETER  
SWITCH**  
WITH 1/32" STRUT CENTERS



P-6129

**SPECIFICATIONS**  
**INSULATION:** 1500V RMS, Steatite, Grade L-5A, MIL-I-10  
1000V RMS, Phenolic, Type PBE, MIL-P-3115  
1500V RMS, Mycalex, Grade L-4B, MIL-I-10  
**TORQUE:** Per MIL-S-3786A.  
**CONTACT RESISTANCE:** 3 milliohms.  
**CURRENT RATING:** 5.5 amps at 12 VDC.  
450 ma at 115 VAC.  
**LIFE TEST:** 25,000 cycles minimum.

Designed to meet MIL-S-3786A, this switch is available with ceramic, phenolic or Mycalex sections. It can be supplied with adjustable or fixed stops with 30° or 60° indexing. The Series 600 switch has up to 12 terminals on each side of the stator of which 8 can be insulated.

Sample delivery is seven days. Production delivery, 4-5 weeks.

For detailed specifications, write for EP-1152.

Many types in stock at CENTRALAB distributors as Series PA-6000 Switches.

THE ELECTRONICS DIVISION OF GLOBE-UNION INC.  
960M E. KEEFE AVENUE • MILWAUKEE 1, WISCONSIN  
In Canada: Centralab Canada Ltd., P.O. Box 400, Ajax, Ontario

# Centralab

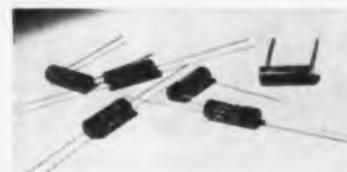
ELECTRONIC SWITCHES • VARIABLE RESISTORS • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS  
CIRCLE 116 ON READER-SERVICE CARD

114

## NEW PRODUCTS

### Wirewound Resistors

489



Stability is better than 10 ppm per year. Absolute accuracies within  $\pm 0.005\%$  of specified value ration and matched sets to  $\pm 0.001\%$  ration tolerance are available. Temperature coefficient is  $\pm 2$  ppm per C over a wide range. Resistors, which are produced in ranges from 100 ohms to 2 meg, are available with axial, radial, printed-circuit, or special leads.

Ultronix, Inc., Dept. ED, 111 E. 20th Ave., San Mateo, Calif.

### Vacuum Pump

424



Capacities in excess of 50 cfm and pressure down to  $1 \times 10^{-4}$  mm Hg are claimed for Duo-Seal 1398. Suggested uses of this pump include electron tube evacuation, vacuum distillation and most other industrial and laboratory uses.

The Welch Scientific Co., Dept. ED, 1515 Sedgwick St., Chicago 10, Ill.

### Subcarrier Oscillator

491



Voltage controlled unit has less than 0.75% distortion. The 1.75-oz device occupies less than 1.3 cu in and is designed to operate from  $-55$  to  $+125$  C. Model TS 54, which requires 28 v dc  $\pm 10\%$ , has an input impedance of 1 meg  $\pm 20\%$  for all IRIG channels. Sensitivity to source impedance change from zero to infinity varies frequency less than 1.0% of design bandwidth.

Vector Manufacturing Co., Inc., Dept. ED, Southampton, Pa.

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For stud-mounted transistors, rectifiers and diodes. Constructed of aluminum, the model HS 8040 is available for stud-mounted semiconductors with 8-32 to 1/4-in. pipe thread. The dull black anodized unit meets applicable MIL specs. The equipment is said to feature a very low contact resistance and has a surface area of 20 sq. in. per in. of length.

Vemaline Products Co., Dept. ED, Franklin Lakes, N. J.

#### Translatory Potentiometers

483



Operating at ambients from  $-55$  to  $+125$  C, wirewound units measure linear motion directly and have a life expectancy approximating 500,000 cycles. Ceramic-metal elements have an ambient temperature range of  $-75$  to  $+200$  C, with 5-million-cycle life expectancy. Resistance ranges in the combined lines vary from 200 to 140,000 ohms per in.

Helipot Div., Beckman Instruments, Inc., Dept. ED, 2500 Fullerton Road, Fullerton, Calif.

#### Thermocouple Controller

490



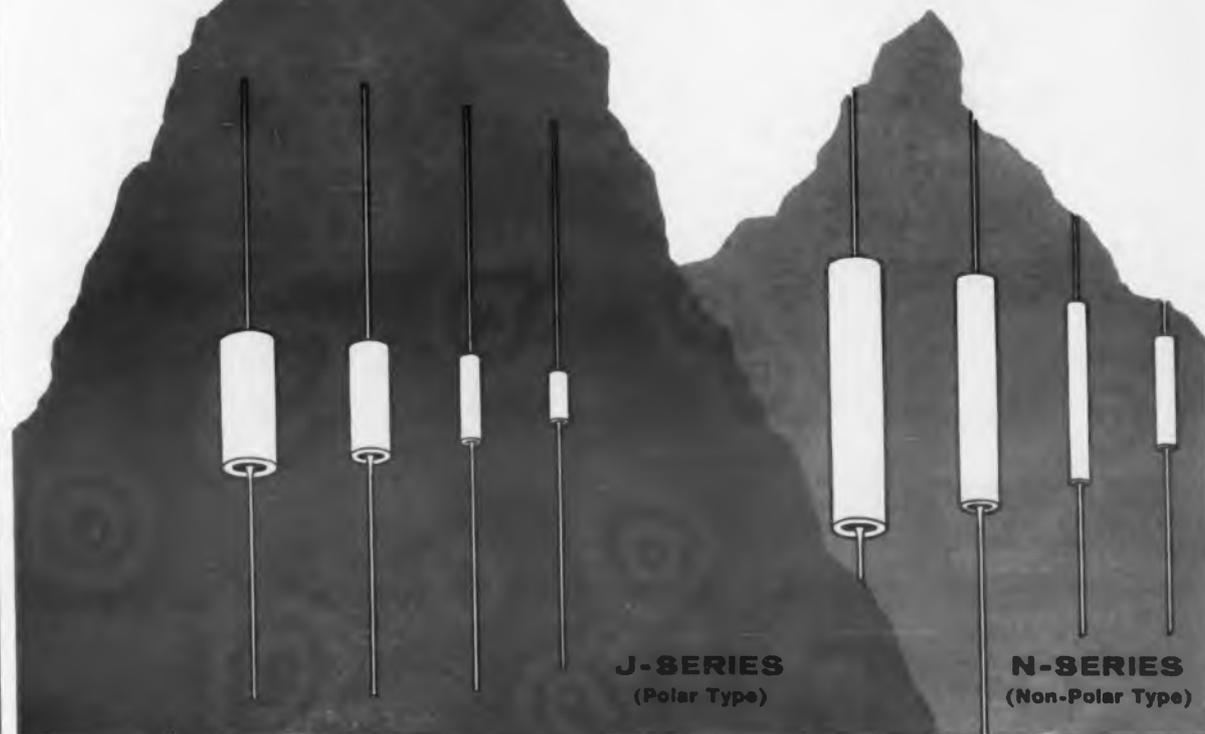
Response time is less than 1/2 sec. Model TC-9 is adjustable over a vacuum of 1 atmosphere to 1 micron, and has 2 control actions per control point. These points are independent and may be used to control a total of 4 loads. Power requirements are 110 v, 60 cps, 25 w.

Vacuum-Electronics Corp., Dept. ED, Terminal Drive, Plainview, N. Y.  
P&A: under \$500.00; 8 weeks.

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

—the "Peaks" you want in High-Voltage

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(Polar Type)

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(Non-Polar Type)

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

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

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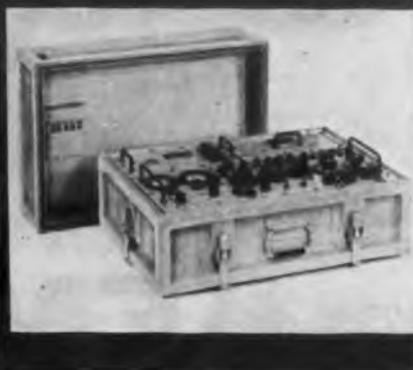
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## NEW PRODUCTS

### Differential Amplifier

523



Current gain ( $h_{FE}$ ) of the 2N2060 is matched to within 10% at 0.1 ma and 1.0 ma collector current. Max base-emitter voltage differential allowed is 5 mv at 0.1 and 1.0 ma. Noise figure of 8 db max is specified for both narrow and wide-band usage.

Fairchild Camera and Instrument Corp., Fairchild Semiconductor Div., Dept. ED, 545 Whisman Road, Mountain View, Calif.

P&A: \$60 (1-99), \$40 (100-999); stock from distributors.

### Shaft Angle Encoders

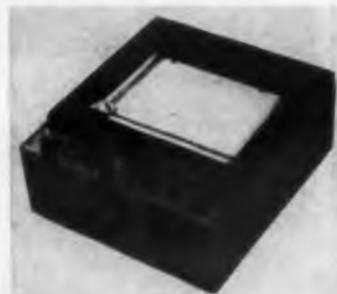
379

Linear and sine-cosine digital shaft-angle encoders make up the Dicotron line. These encoders are said to have an accuracy of  $\pm 1$  bit, including quantizing, mechanical, optical and electrical errors. Some uses of these encoders are in submarine navigation, missile guidance and radar tracking.

Computer Control Co., Inc., Dychro Dept., Dept. ED, 983 Concord St., Framingham, Mass.

### X-Y Recorder

515



Null-seeking, servo type instrument responds to two simultaneous dc input voltages and plots curves in ink in Cartesian coordinates on 8-1/2 x 11-in. paper. The equipment is available in two models: one with a sensitivity of 1 mv per in., and the other with a sensitivity of 10 mv per in. The unit comes equipped with all electronic components, pen, pen carriage, combination ink bottle and filler, and pen cleaner.

Central Scientific Co., Cenco Instruments Corp., Dept. ED, 1700 W. Irving Park Road, Chicago 13, Ill.

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## Servo Motor Generator

520



Size 11 generator in a one-piece housing is available with or without gear heads. Units are designed to meet and exceed the requirements of MIL-S-17806, MIL-S-17807 and MIL-E-5272B. Operation of the motor may be on either 400 or 60 cps and a number of control phase voltages are available.

Instrument Div., Thomas A. Edison Industries, McGraw-Edison Co., Dept. ED, West Orange, N. J.

## Epoxy Resins

411

Stable one-can systems cure at room temperature. Simple polyamine-loaded molecular sieve provides one-year shelf life. If the coating, adhesive, or casting can be heated to 250 to 350 F, a modified polyamine-loaded hardener can be used.

Linde Co., Molecular Sieve Products Dept., Dept. ED, 61 E. Park Drive, Tonawanda, N. Y.

## Silicon Zener Diodes

517



Over 200 type numbers are available with selection of Zener voltages ranging from 2.0 to 145 v and operating ranges from -65 to 200 C. Featuring a subminiature glass package, each diode is factory tested, and shipped in protective packaging which allows the purchaser to test incoming shipments without removing units from the package.

Delta Semiconductors, Inc., Dept. ED, 835 Production Place, Newport Beach, Calif.

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*Bendix Craftsmanship at work for you*

**TYPICAL SPECIFICATIONS**

	Phase Shifter	Y-Circulator	Attenuator
Frequency Range	5700 to 5800 mc	4700 to 5700 mc	4900 to 5800 mc
Insertion Loss	1 db max	0.4 db max	1 db max
Impedance	50 ohms	50 ohms	50 ohms
VSWR	1.38 max	1.70 max	1.75 max
Power Handling Capacity			
Average	5 watts	10 watts	5 watts
Peak	5 kilo-watts	10 kilo-watts	5 kilo-watts
Temperature Range	-55 C to +85 C	-55 C to +85 C	-55 C to +85 C
Diameter	1.12	2.375	1.12
Weight	6 oz	11 oz	6 oz

**NEW BENDIX<sup>®</sup> MICROWAVE FERRITE DEVICES\*** **1** The Electrically Variable Phase Shifter, TFP-1, can produce phase shifts in excess of 90° over a minimum bandwidth of 10%. Chief uses are as phase modulator, fast shift, and in a wide variety of r-f direction finding devices. **2** The Y-Circulator, TFC-1, offers at least 20 db isolation with less than 0.4 db insertion over bandwidth exceeding 20%. Ideal for use with masers, and parametric amplifiers. **3** The Electrically Variable Attenuator, TFA-1, has a range exceeding 25 db over a minimum bandwidth of 15%. Useful in fast AGC circuits and remote level control applications. Write today: Electron Tube Products, The Bendix Corporation, Eatontown, New Jersey.

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Red Bank Division



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117

# NEW from ERIE... GLASS TRIMMERS that operate at 1000 VDCW from -55° C to 125° C

Erie glass dielectric precision trimmers are superbly rugged and reliable!

Design features include:

- Drive screw and piston which never extend beyond trimmer during adjustment. Result: lower overall height.
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- Uniform torque.
- Positive stop at both maximum and minimum capacitance setting which assures no disengagement of piston during adjustment.

Specifications:

Mount:	Panel or printed circuit
Capacitance Ranges:	1.0pf to any of the following: 4.5pf, 8.5pf, 12.0pf, 18.0pf, 30pf
Temperature Coefficient:	400 ±100PPM/°C or 0 ±100PPM/°C
Working Voltage:	1000 VDCW
Operating Temperature Range:	-55°C to +125°C
Insulation Resistance:	1 million meg Ω minimum
Flash Test:	1500 VDC
Life Test:	1500 VDC for 250 hours @ 125°C

Erie Glass Trimmers are available in quantities of less than 1000 pieces from leading electronic distributors.

Write for Bulletin 314-3 for full information.



## ELECTRONICS DIVISION

ERIE RESISTOR CORPORATION

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Sales offices in principal cities of USA, Canada, Europe

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## NEW PRODUCTS

### High Vacuum System

488



Achieves clean vacuum to  $5 \times 10^{-9}$  mm Hg in 4 hr. or less. The "Boostivac" system operates from a single electrical connection and requires no plumbing or liquid nitrogen cold traps. In operation, the equipment is said to minimize the pressure rises which normally occur when other materials are evaporated during bell jar operation.

Ultek Corp., Dept. ED, 920 Commercial St., Palo Alto, Calif.

### Temperature Transducers

360

Platinum resistance sensors have a span of 500 to 600 ohms. Available in weld-on, cement-on, open, and closed probe configurations, all units are interchangeable to within ±1%. Units will measure between the extremes of -435 and 1,500 F with spans as small as 100 F.

Trans-Sonics, Inc., Dept. ED, P. O. Box 328, Lexington 73, Mass.

### Blade Edge Microscope

505



Checks leading and trailing edges of turbine and compressor blades. The unit, equipped with twin illuminators, checks blades up to 2-1/2 in. wide and as long as desired with a total magnification of 20X. The unit inspects the radii of blades as well as the blending of radii with the flanks.

Engis Equipment Co., Engineering and Scientific Instrumentation Div., Dept. ED, 431 S. Dearborn St., Chicago 5, Ill.

## 4¢ photo resist encyclopedia



This 24-page book on the Kodak Photo Resist way to etch dependable circuits tells the whole story about using a simple 6-step KPR routine. Each step is explained so even beginners will catch on fast. The book costs you nothing—only the 4¢ postage on your letter—a tiny investment that could pay the handsome return of more circuits that pass inspection. The 6 KPR steps:

1. Clean the metal. Power brush does it fast.
2. Rinse in acid. A quick way to assure total KPR adhesion.
3. Coat the plate. Dip, whirl, or spray. Stable KPR won't change exposure time even after months of storage, so coating can be done ahead of time.
4. Expose to high-intensity arcs. Always short exposures with KPR, no matter what the temperature, humidity, or storage.
5. Develop. Do it fastest in vapor-spray degreasers. Or in tank or tray.
6. Etch with standard techniques. KPR guards the circuit image in component assembly, strips off clean when panel is skated on tin-lead solder.

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## Subminiature Chassis

518



Chassis boards are said to have closer than 0.0001-in. mechanical precision. Units are available in the following materials: phenolics, nylon, Teflon, fiber, epoxy and silicone glass laminates, and copper-clad laminates. Stampings are suitable for microminiature assemblies, subminiature components, hearing aids, etc.

Die-Tech Corp., Dept. ED, 29 Marble Ave., Pleasantville, N. Y.

## Damped Accelerometers

514



Model F2401-01A is a dc torquer-restrained device which possesses a dynamic measuring range of greater than 20 million. The element consists of a symmetrically located differential transformer pick-off and a pair of force coils mounted in common on the instrument measuring axis.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

## Pocket Comparator

521



Six-power magnification is featured in this comparator which has a glass-etched reticle and is enclosed in a battery operated illuminator. The device checks linear dimensions, diameters, radii, and angles, and gives measurements in decimal inches and mm. The unit is suitable for checking measuring and inspecting small parts and dimensions.

Edmund Scientific Co., Dept. ED, Barrington 70, N. J.

P&A: \$27.45; stock.

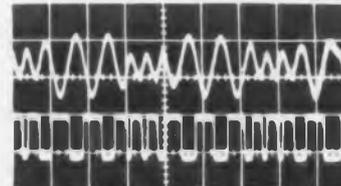


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Conditions:  
350 PPI, phase modulation,  
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61-40 CP

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

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

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

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

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

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

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

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

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

CIRCLE 125 ON READER-SERVICE CARD

## NEW PRODUCTS

### Radiation Monitor

506



Model SBL-2 is a portable scintillation detector and recorder designed for radiation monitoring from low-flying aircraft. The unit measures and records actual gamma dose rate corrected to a distance of 3 ft above ground. Calibrated for a range of 0.2 to 2,000 milliroentgens per hr, the equipment can also be used on the ground for monitoring and recording.

Edgerton, Germeshausen & Grier, Inc., Santa Barbara Laboratory, Dept. ED, P. O. Box 98, Goleta, Calif.

### Audio Amplifier

408

Transistorized model LT-80 has 8-w output with peak power of 20 w. At 8 w, the frequency response is 50 to 10,000 cps  $\pm 1.5$  db and distortion is less than 2.0%. The unit, which has 4-, 8-, 16-, 150- and 600-ohm 70.7-v outputs, uses a 117 v ac, 50-60 cps fused power supply.

Continental Manufacturing, Inc., Dept. ED, 1612 California St., Omaha, Neb.

### Crystal Oven

516



Temperature stability is  $\pm 2$  C from  $-55$  to  $5$  C below operating temperature, or  $\pm 0.5$  or better in limited ambient. Series DFO-923 and 924 will accept one HC/6, HC/13 or HC/18 crystal. Less than 15 min is required for warm-up with a 4 to 15-w current drain depending on temperature range.

Delta-f, Inc., Dept. ED, 113 E. State St., Geneva, Ill.

P&A: \$9.70 to \$9.90 (250-499) fob Geneva; 2 to 3 weeks.

New Products? See EDC 1961-62 New Product Locator section.

# Thermal Evaluation Of High Density Electronic Packages

*A handy nomograph to determine the design limitations on microminiature packages imposed by thermal factors. An example is included.*

**H. C. Kammerer**  
International Business Machines Corp.  
Federal Systems Div.  
Kingston, N. Y.

WITH the concentrated efforts to reduce the size of electronic assemblies, there has evolved a need for a method to facilitate preliminary thermal evaluations of the re-

sulting equipment. The goal to achieve high component density has resulted in increased power density which, in turn, places greater demands on the cooling technique for the package.

The nomograph shown is based on the five basic parameters which constitute the general conduction and convection heat transfer

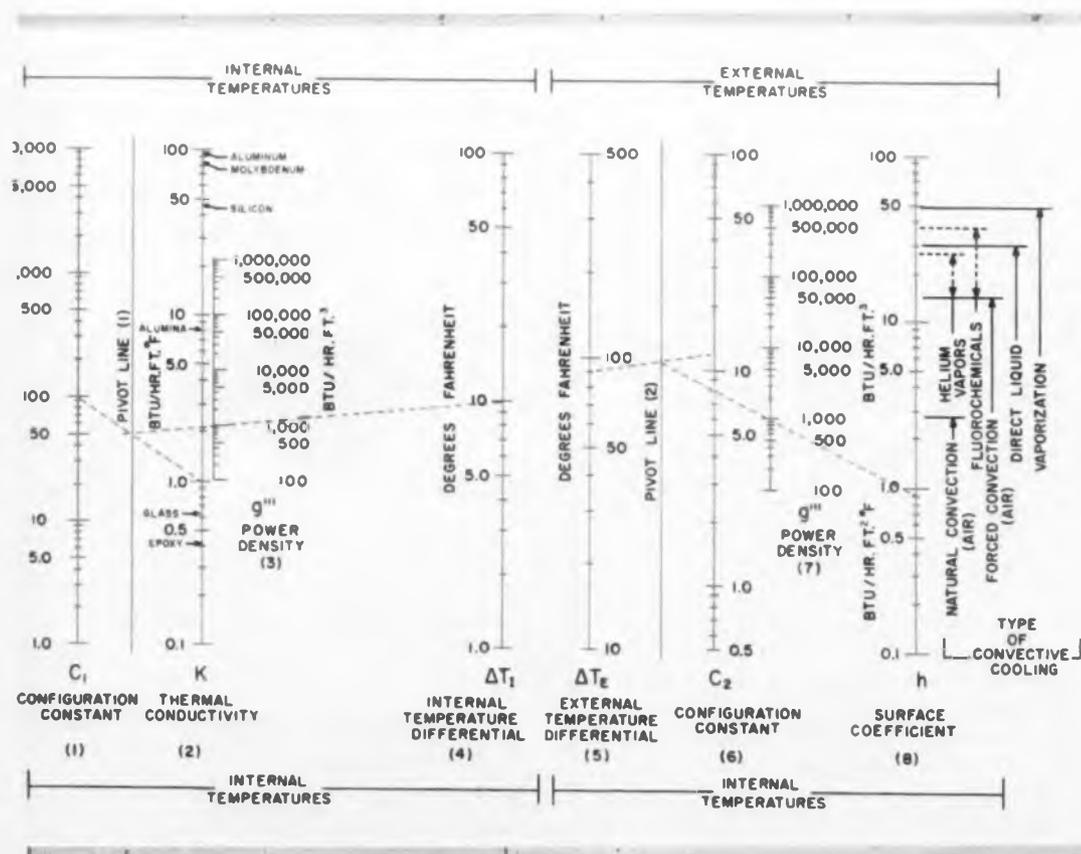
equations. The remaining mode of heat transfer, radiation, is neglected since it requires considerably higher temperature than will be encountered in this study. The five factors are (1) power (heat dissipation/unit time); (2) total temperature differential between ambient environment and center of package (external plus internal); (3) thermal conductivity of package material; (4) cooling technique (surface coefficient of convective heat transfer), and (5) the size and configuration of package. This nomograph is derived from the maximum allowable temperature of the most temperature-sensitive component or circuit function contained in a homogenous, microelectronic package in a steady-state thermal condition which has a uniformly distributed power dissipation. It in no way will predict hot spots or any transient thermal problems associated with the individual electronic elements.

## Typical Example Illustrating Use Of the Heat Transfer Nomograph

Determine the most applicable cooling method, i.e., the surface coefficient of convective heat transfer, for the following characteristics of a microelectronic package:

Package configuration and size:	Sphere (diameter = 5.88 in.)
Temperature limitation of package:	100 F above ambient
Power density (power/unit volume):	0.17 w/cu in. or 1,000 Btu/hr cu ft
Thermal conductivity of package:	1.0 Btu/hr ft F

The package size and configuration must be expressed in terms of two constants,  $C_1$  and



## ENGINEERING DATA

$C_2$ , in order to enter the nomograph. These constants are calculated from the given information and the appropriate equation as obtained from Table 1. For the particular problem given,

$$C_1 = \frac{3,460}{D_2} = \frac{3,460}{(5.88)^2} = 100$$

$$C_2 = \frac{72}{D} = \frac{72}{5.88} = 12.2$$

The following steps are taken to solve the above example with the values shown on the graph as a guide.

1. Enter scale (1), the  $C_1$  scale, at the value calculated,  $C_1 = 100$ .
2. Similarly, the  $K$  factor is entered on

scale (2) at the given value,  $K = 1.0$  Btu/hr ft F.

3. Connect these two points with a straight line.

4. Enter scale (3), the power density, at the given value,  $q''' = 1,000$  Btu/hr ft<sup>3</sup>.

5. Draw a straight line between the intersection on the pivot line (1) (as located by the line between  $C_1$  and  $K$  scales) and the  $q'''$  value on scale (3). An extension of this line will then intercept the internal temperature differential scale (scale 4) at the 10 F value.

6. Now, since the maximum allowable temperature differential is 100 F and the  $\Delta T_i$  is 10 F, the difference between these values will be the  $\Delta T_E$  maximum value.

$$\Delta T_E = \Delta T_T - \Delta T_i = 100 - 10 = 90 \text{ F}$$

7. The  $\Delta T_E$  value of 90 F is then located on scale (5).

8. Using the calculated value of  $C_2$ , enter scale (6) at  $C_2 = 12.2$ .

9. Draw a straight line between  $\Delta T_E$  and  $C_2$  which intercepts the pivot line (2).

10. Enter scale (7) at the same value of  $q'''$  as used for scale (3) ( $q''' = 1,000$  Btu/hr ft<sup>3</sup>).

11. Connect the intersection of the pivot line (2) and the  $q'''$  value, with a straight line, which when extended, crosses the  $h$  scale at the required value.

The value of the surface coefficient will then indicate the cooling technique most applicable for package under study. For this problem, the value of the surface coefficient is less than 1, hence natural convection would suffice since undoubtedly it would be the most economical.

Since the nomograph is a function of five independent variables, any combination of four known factors is sufficient to evaluate the solution to a problem. Hence, the sequence of steps can be taken in any order providing the normal rules of nomographs are followed. With this in mind, one can visualize that several approaches are possible, depending on the known characteristics of the package under thermal evaluation. Hence, such factors as optimum package sizes and configuration, maximum allowable power density and minimum thermal conductivity of the package can be readily predicted from the appropriate given information. ■ ■

Table 1.

### Constants for various configurations.

Shape (Dimensions in Inches)	Exposed Cooling Surfaces	Constants	
		$C_1$	$C_2$
Sphere (D = diameter)		3,460	72
		$\frac{S^2}{D}$	$\frac{S^2}{D}$
Cube (S = edge length)	six sides	2,245	58
		$\frac{S^2}{S}$	$\frac{S^2}{S}$
	four sides	1,800	42.5
		$\frac{S^2}{S}$	$\frac{S^2}{S}$
	two sides (opposite)	1,150	24
	$\frac{S^2}{S}$	$\frac{S^2}{S}$	
	two sides (adjacent)	450	21.2
	$\frac{S^2}{S}$	$\frac{S^2}{S}$	
	one side	288	12
	$\frac{S^2}{S}$	$\frac{S^2}{S}$	
Cylinder (D = diameter)	cylindrical surface only	2,300	48
		$\frac{D^2}{D}$	$\frac{D^2}{D}$
Parallelepiped (Rectangular) (T = thickness & W = width, W T)	all sides or top and bottom surfaces only	1,150	24
		$\frac{T^2}{T}$	$\frac{T^2}{T}$
	top or bottom only	288	12
		$\frac{T^2}{T}$	$\frac{T^2}{T}$
	edges only	1,800	42.5
		$\frac{W^2}{W}$	$\frac{W^2}{W}$

If  $W = T$ , use cube with four exposed surfaces

## You Deserve More Money!

Perhaps you have come across an article on the Cadillac study which found that over 7 out of 10 of our electronics applicants were not receiving an income commensurate with their proven ability. In all probability YOU deserve a better job and larger salary in the electronics field. The best way to find out is to contact Cadillac. We can evaluate your true worth and offer you a choice of the nation's top positions (with over 500 companies). Our service is absolutely confidential and without cost to you (client companies pay all expenses).

### Free Opportunities Bulletin

If you wish to receive a monthly bulletin of the finest available electronic opportunities, simply send us your name and home address (and if you wish, a review of your qualifications)—Our services are without cost to you through our Chicago office and our Los Angeles subsidiary, Lon Barton Associates.



LON D. BARTON,

President

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Than Anywhere Else in the World"

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Bodine offers:

...the largest selection  
of small synchronous  
motors



More than 385 sizes and capacities... 1/2000 to 1/6 h.p. Two basic types of motor construction... RELUCTANCE in split phase—permanent split capacitor—and three-phase... with or without speed reduction. HYSTERESIS in permanent split capacitor—and three-phase. You receive ADE (After Delivery Economies) from all Bodine motors.

NEW—ask for 20-page Bulletin #1036  
"Bodine Synchronous Motors."

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fractional/horsepower  
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Bodine Electric Co., 2528 West Bradley Place, Chicago 18, Illinois

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## NOW Standard MINIATURE MODULE CASES

**Cut Costs  
Speed Production**

Grayhill MOLDTRONICS is now making available a wide assortment of stock-mold Module Cases for miniature transformers, transistors, crystals and, potting of other miniature components,—all uniform, highest quality, fully inspected and ready for your assembly lines. They will save you tooling costs and get you into production faster. Molded of electrical grade phenolic, diallyls or epoxy.

Full details in Bulletin 1200.  
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ALSO CUSTOM MOLDED CASES  
TO YOUR SPECIFICATIONS

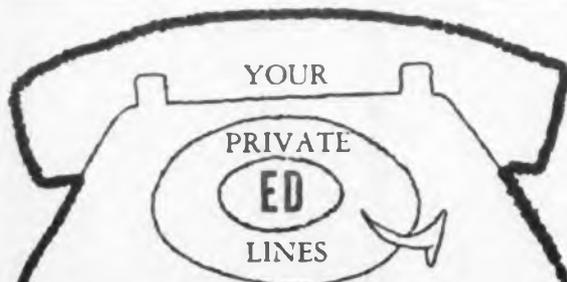


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MOLDTRONICS, INC. . . . miniature thermosetting plastic custom molding

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Use the Career Inquiry Service Form, and the Reader Service Card when job hunting. They're your *private lines* to employment opportunities . . . another service for you from **ELECTRONIC DESIGN**.

## NEW LITERATURE

### Electrical Tapes 260

An electrical insulation selection chart is available which contains actual samples of 15 different insulating tapes, as well as physical and electrical data on each. Chart DB-70A gives insulation class, tensile strength, elongation, thickness, dielectric breakdown point, electrical resistance, etc. Johns-Manville, Dutch Brand Div., 22 E. 40th St., New York 16, N. Y.

### Environmental Equipment 261

A complete line of controlled environmental equipment is described in this 128-page catalog. The fully illustrated catalog contains complete specifications, descriptions and prices. A 12-page section is devoted to accessory instruments for recording, programming and control. Electric Hotpack Co., Inc., Cottman Ave. at Melrose St., Philadelphia 35, Pa.

### Technical Information

A wide array of scientific and technical information in libraries and information centers across the country would be made available to researchers faster under a 13-page proposal, entitled "Considerations and Recommendations for Developing a Materials Information Processing Capability." Send \$0.50 for No. AD 258 643 to OTS, Dept. ED, U. S. Dept. of Commerce, Washington 25, D. C.

### Wirewound Resistors 262

A 20-page catalog covers the firm's complete line of precision wirewound resistors and includes performance characteristics, and MIL spec information. A separate section presents general characteristics under such headings as environmental tests, resistor calibration and temperature coefficient of resistance. Hi-Q Div., Aerovox Corp., 1100 Chestnut St., Burbank, Calif.

### Synchro Accessories 263

An 8-page, two-color, illustrated booklet entitled "Synchro Accessories and Mounting Instructions" is available from the company. The brochure includes tables, specifications and diagrams. Muirhead Instruments, Inc., 441 Lexington Ave., New York 17, N. Y.

## NEW solder discovery!



Two outgassed solders. Left, standard solder. (Note degree of oxides present.) Right, ALPHA Vaculoy solder is bright, clean, oxide free!

ALPHA Vaculoy® bar solder cuts printed circuit joint rejects from 1-in-50 to 1-in-5,000. No other solder does this because no other is made this way!

Above is an unretouched photograph of two solder specimens—both outgassed. Left, is a standard printed circuit solder. Note presence of impurities on surface—a sure sign of undesirable oxides. Right, is ALPHA Vaculoy. Its bright, clear surface indicates freedom from oxide-forming elements. Result? ALPHA Vaculoy bar solder cuts cross, improves wetting, produces brighter connections, increases bath life, reduces inherent inclusions and insures reliable electrical connections. Meets Fed. Specs. QQS-571C. Get all the facts. Write for data today!

\*Formerly called "ALPHA AAA"

When dependability counts!

## alpha metals, inc.

58A Water St., Jersey City 4, N. J.

In Los Angeles, Calif.: 2343 Saybrook Ave.

In Chicago, Ill.: ALPHALOY Corp., 2250 S. Lumber St.

Other ALPHA products: Fluxes • Solder Preforms • High Purity Metals

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## ANNOUNCING! SEMICONDUCTOR COOLING MODULAR PACKAGE of MAXIMUM EFFICIENCY ...at low cost

Delta-T modular concept obtains thermal resistances as low as 0.3° C/W per semiconductor, full utilization of air flow with no costly transition pieces, complete accessibility and no mica wafers.

Extremely low head loss per unit length and electrically isolated quadrants allow you new and wide design latitude. Delta-T utilizes extruded aluminum quadrants to cut costs



in half and greatly increase efficiency per unit weight. Specific designs to accommodate both shelf-mounted and stud-mounted semiconductors. Write for Model 800 Bulletin. Also available, "Semiconductor Cooling Handbook", devoid of advertising, filled with engineering facts.

**Delta**  SEMICONDUCTOR COOLER DIVISION  
WAKEFIELD ENGINEERING, INC.  
WAKEFIELD, MASSACHUSETTS  
Phone: 345-5900 (Area Code 617)

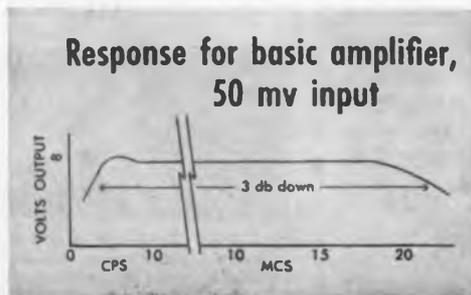
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## NEW CECO HIGH OUTPUT SOLID-STATE VIDEO AMP (8 VOLTS, 18 MCS)

### SPECIFICATIONS

45 db gain  
25 db gain control range  
5 cps to 18 mc  $\pm 5$  db  
2% maximum overshoot  
2% maximum tilt on  
60 cps sq. wave  
20 nano sec. rise time  
8.2 db noise figure  
75 ohms in and out  
8 volts output peak to peak  
1.0 volts maximum input  
19" rack, 3½" high  
117 V, 50-60 cps power in

Equalization units are supplied  
to compensate for any length of  
cable up to one mile of RG-11/U  
or 8000 feet Foam 11,  $\pm 5$  db to  
8 mc.



### WRITE FOR BULLETIN 1019

Other wide band amplifiers and low  
noise preamplifiers to 1000 mcs.

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Engineering  
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# S-696 ALUMINA

a 96% ALUMINA CERAMIC for  
high-temperature, high-strength applications

Here's a superb, all-purpose alumina that  
can be extruded, wet pressed or dust  
pressed into cores, blocks, tubes and  
other specialty shapes for electrical and  
electronic applications. Machined, glazed  
and/or centerless ground to specification.  
Tolerances:  $\pm .0005$ .

O.D. - .020" to 1.50"  
Lengths to 60"  
White or colors



Data sheet available  
on request

**Saxonburg**

**CERAMICS, INC.**  
500 3rd AVE.  
SAXONBURG, PA.

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## NEW LITERATURE

### Preferred Circuits Handbook

This fourth supplement to Handbook of Preferred Circuits contains four new transistor circuits and revises five of the vacuum tube circuits to include data for use of subminiature as well as miniature tubes. Forty-eight page supplement No. 4 is in looseleaf format. Send \$0.35 for publication NAVW-EPS 16-1-519 to Superintendent of Documents, U. S. Government Printing Office, Dept. ED, Washington 25, D. C.

### Calibration and Certification 264

Instrument repair, calibration and certification is the subject of a 16-page brochure entitled "Why Calibration." The fully illustrated report includes a listing of the firm's standards laboratory as well as other useful information. Cook Electric Co., 2700 N. Southport Ave., Chicago 14, Ill.

### Industrial Process Instruments 265

Forty-eight pages of information on the firm's instruments and systems for measuring, recording and controlling industrial processes are included. A typical product page includes a photograph, a clear description with primary specifications, price range and literature reference. Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Philadelphia 44, Pa.

### Special Purpose Tubes

"Five-Star and Special Purpose Types" contains more than 700 pages covering high-reliability, industrial, metal-ceramic, lighthouse and planar, small thyatron, and photoconductive tubes. Manual, \$6; supplement service, \$2.50 per year in U. S. Write to Tube Manual Operation, General Electric Co., Dept. ED, Owensboro, Ky.

### Ceramics and Crystals 266

This set of bulletins entitled "Technical Ceramics and Crystals" contains information on high alumina ceramics (bulletin T-3), alumina vessels (T-7), metallized ceramics (T-8), and high alumina custom shapes (T-11). Complete lists of properties and specifications are included. Electro-Ceramics, Inc., 2645 South 2nd West, Salt Lake City 15, Utah.

## HIGH PURITY METALS AND ELECTRONIC MATERIALS

### METALS AND ALLOYS

ALUMINUM	ANTIMONY
ARSENIC	BISMUTH
CADMIUM	GOLD
INDIUM	LEAD
SILVER	TIN
	ZINC

High purity alloys are made  
from these metals to customer  
specifications.

### COMPOUND SEMICONDUCTORS INDIUM ANTIMONIDE

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circles, rings and other shapes  
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BARS	SHOT
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discs, dots, washers, squares  
and spheres. Enquiries are  
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# NOW!

## ELECTRONIC MEASUREMENTS HALF-RACK

### Power Supplies are portable, too

Talk about small size, this portable Electronic Measurements Power Supply measures just 7 $\frac{1}{2}$ " W x 5" H x 6 $\frac{1}{2}$ " D. Yet it has all the features of much larger E/M Semiconductor Power Supplies . . . vernier as well as main voltage control, continuous current limiting control, remote programming, 0.1% regulation and more.

Ask for Catalog 1901-1.



#### BRIEF SPECIFICATIONS

MODEL	VOLTS DC	CURRENT
TR018-1	0-18	0-1AMP
TR036-0.2	0-36	0-200MA
TR036-0.5	0-36	0-300MA
TR212A	0-100	0-100MA



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ELECTRONIC DESIGN • December 6, 1961

### Chart Recorder 267

The Rockwell-Republic MP-12 Analogger, a one to four pen, 12-in. circular-chart pneumatic receiver-recorder, is described in an eight-page bulletin (201.11). Information on integrators and other accessories, specifications, operating data and other material are presented. Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Ill.

### Switches and Thermostats 268

Forty-two representative Klixon precision switch packages and thermostat packages are shown in each of two eight-page technical bulletins. Included are photographs and dimensional drawings of representative packages produced by this firm's special packaging group. Metals & Controls Inc., Div. of Texas Instruments Inc., 34 Forest St., Attleboro, Mass.

### U-Band Oscillators 269

Complete information on two-cavity U-band oscillators for parametric amplifier pumping and Doppler radar applications is provided in a four-page brochure. Complete specifications, operating characteristics, and other pertinent data are included. Sperry Rand Corp., Electronic Tube Div., Gainesville, Fla.

### Precision Instrument Switches 270

A 24-page booklet entitled "Guide to Choosing Precision Instrument Switches" is available without charge from this precision switch manufacturer. Langevin Division, Sonotec Inc., 503 S. Grand Ave., Santa Ana, Calif.

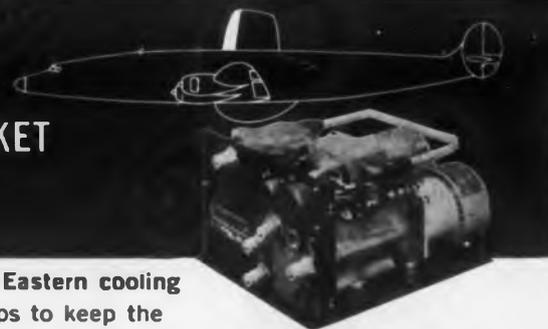
### Power Supplies 271

A notebook-size, fold-out "Master Power Supply Chart" contains specifications on all laboratory dc power supplies and ac line regulators produced by the firm. It lists output, regulation, price, etc. Perkin Electronics Corp., 345 Kansas St., El Segundo, Calif.

### Photo Recording Materials 272

An 8-page illustrated booklet gives information and applications on oscillograph recording papers, duplicating oscillograms, processing chemicals, etc. Ansco Div., General Aniline and Film Corp., Binghamton, N. Y.

## ABOARD A RADAR PICKET PLANE



. . . a new Eastern cooling system helps to keep the Philco APS-103 search radar on the lookout for bogies and bandits. The liquid cooling unit has a capacity of 1600 watts, but weighs only 15 lbs., and fits into a compact 5-9/32" x 9-7/8" x 7-7/8" volume. Designed for operation to 50,000 feet, it features an ingenious internal manifold which makes for simplicity, reliability, and which eliminates most internal connections. If you need efficient, miniaturized light weight cooling units for airborne electronics cooling, call on Eastern. Eastern is your perfect source for liquid tube cooling units for capacities from 50 to 20,000 watts.



**EASTERN INDUSTRIES**  
100 Skiff Street, Hamden 14, Conn.

West Coast Office:  
4203 Spencer St.,  
Torrance, Calif.

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## WHAT'S YOUR TRANSISTOR COOLING PROBLEM?

Whatever it is, you can probably find the solution with a Birtcher Radiator. Available in sizes and designs to most efficiently cool all popularly used (and many special) transistors. Test reports show up to 27% more transistor efficiency!

AVAILABLE FROM AUTHORIZED BIRTCHER DISTRIBUTORS



**NEW!**  
TRANSISTOR  
RADIATOR  
CATALOG 1-HR

Just off the press - write for it

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745 S. MONTEREY PASS ROAD, MONTEREY PARK, CALIFORNIA

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POWER  
SUPPLIES

VALUE

QUALITY

RS305A



@ \$55.50

For original use . . . For incorporation into laboratory equipment . . . In 55- to 400-cycle systems. The Trans Electronics Model RS305A Power Supply provides voltage regulation of .05% load and .05% line over the entire 225- to 325-volt range. Operating current range 0-50 ma, continuous duty, with filament output of 6.3 volts CT AC @ 3 amps. Units feature low ripple and noise (5 mv peak to peak); fast recovery time (25 to 50 microseconds). Three versions of Model RS305A offer, respectively, modular construction in package 5 x 4 1/2 x 6 1/2 inches; rack-mounting; and rack-mounted models with 3 1/4-inch meters, in case with 3 1/2-inch panel height. Input is 105-125 volts AC.

#### SPECIFICATIONS

model*	voltage range	current ma	filament volts/amps	price
RS-110	0-100	0-100	6.3/3	\$108.00
RR-110				133.00
RM-110				169.00
RS-205	150-225	0-50	6.3/3	55.50
RR-205				80.00
RM-205				115.00
RS-217A	150-225	0-175	6.3/8	87.50
RR-217A				112.50
RM-217A				147.50
RS-305	225-325	0-50	6.3/3	55.50
RR-305				80.00
RM-305				115.00
RS-317	225-325	0-175	6.3/8	87.50
RR-317				112.50
RM-317				147.50
RR-450	+300-400	0-50	6.3/2	155.50
RM-450	—300-400		6.3/1.5	196.00
DUAL TRACKING			6.3/1.5	
RR-473	+300-400	0-25	6.3/2	140.00
RM-473	—300-400		6.3/1.5	175.00
DUAL TRACKING			6.3/1.5	
RS-505	300-5002	0-50	6.3/3	81.50
RR-505				106.50
RM-505				141.50
RR-303	0-300	0-500	6.3/15	320.00
RS-303	0-300	0-500	6.3/15	360.00
RR-550	300-500	0-500	6.3/15	310.00
RM-550	300-500	0-500	6.3/15	350.00

**TRANS ELECTRONICS, DIV.**  
Burton Manufacturing Company

8910 Winnetka Avenue  
Northridge, California Diamond 1-4400

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## NEW LITERATURE

### Laminates and Fibres 273

Engineering data is included in an eight-page, two-color 1962 condensed catalog on laminated plastics and vulcanized fibre. The catalog is useful in selecting and applying these materials in electrical, electronic and mechanical applications. Taylor Fibre Co., Norristown, Pa.

### Semiconductor Products 274

This four-page bulletin is designed to aid buyers and engineers in the selection of Westinghouse silicon power rectifiers, silicon power transistors, and thermo-electric coolers. It describes applications of the devices and delineates their ratings in quick-reference tabular form. Schweber Electronics, 60 Herricks Road, Mineola, L. I., N. Y.

### Plugs

The major specifications of Cannon Plugs, available under the new "CAPS" program for this firm, are presented in a 20-page booklet. Items are grouped by area of application to aid buyers and engineers in their selection. Write on company letterhead to Schweber Electronics, Dept. ED, 60 Herricks Road, Mineola, L.I., N. Y.

### Data System Instruments 275

Twelve-page bulletin SCE-2 describes a series of instruments featuring double-level isolation in which both chassis and circuitry are isolated from each other and from ground. Computer Engineering Associates, Susquehanna Sciences, Inc., 350 N. Halstead, Pasadena, Calif.

### Communications Equipment 276

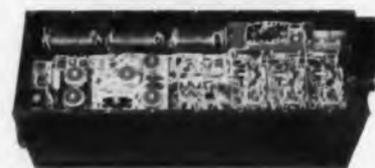
Information and specifications on a large variety of communications and photographic equipment is included in this huge collection of technical bulletins released by this company. Semler Industries, Inc., 6919 Lankershim Blvd., North Hollywood, Calif.

### Subminiature Switches 277

A catalog featuring standard, high current, dry circuit, long life, high temperature, and high precision switches is available with complete technical information and specifications. U. S. Switch Corp., 7 Jefry Lane, Hicksville, N. Y.

**Now!**  
**Kidde "know-how"**  
**delivers**  
**pre-engineered**  
**static frequency**  
**changers with...**

- CUSTOM DESIGN
- LOW COST
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Kidde Electronics Laboratories now offer static frequency changers on a "custom" basis at lowest cost. Utilizing the extensive experience gained in the design and production of working units, Kidde static frequency changers employ any of the three principal design techniques—intermediate DC link; phase modulation, straight-through method; and switch modulation, straight-through method.

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Static Frequency Changers, Static Inverters, Static Converters (DC to DC), Static Power Supplies.

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## NEED AC-OPERATED MILITARY RELAYS?



For reliable switching  
... try "Diamond H"  
Series RA and SA  
relays with a-c coils

These relays for 400 cps and 60 cps operation are identical in size and weight to Hart's widely specified Series R and S d-c relays and meet the same specifications\*. They provide the same shock resistance (to 50G), the same vibration resistance (to 20G-2000 cps), and the same performance under temperatures ranging from  $-65^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . Contact ratings from dry circuit to 10 amps, 115 volts a-c resistive and 30 volts d-c resistive.

The "Diamond H" line includes hundreds of standard models and special variations are possible. Ask for literature and specification list.

\*Like the R and S series, they meet the requirements of MIL-R-5757C. Models are also available to fill the requirements of MIL-I-6181.



**THE HART**  
MANUFACTURING COMPANY  
210 Bartholomew Avenue  
Hartford 2, Conn.  
Phone Jackson 5-3491

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### Large Parabolic Antennas 278

Eight-page catalog D covers large parabolic antennas, including specifications on 28- and 60-ft diam reflectors and information on antenna feeds, reflector surfaces, supports, mounts and radomes. Andrew Corp., P. O. Box 807, Chicago 24, Ill.

### Electronic Procurement Guide 279

A 32-page booklet entitled "Electronic Procurement Guide & Directory" is available. The brochure lists components for commercial and military use, and gives interpretations of MIL spec numbers, tables, charts, formulae and terminology. Lafayette Industrial Electronics Div., 165-08 Liberty Ave., Jamaica 33, N. Y.

### Testing and Test Equipment 280

A 46-page publication entitled "Testing and Test Equipment" describes the various tests for synchros, resolvers, servo motors, servo motor generators, gyros and accelerometers to verify operational parameters and characteristics. Kearfott Div., General Precision, Inc., 1150 McBride Ave., Little Falls, N. J.

### Copper-Zirconium Alloy 281

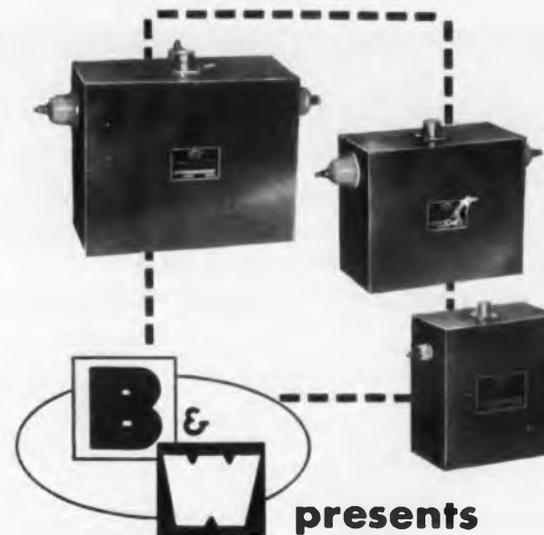
A 36-page technical handbook containing charts, graphs, tables, photomicrographs and pictures is available describing the nature of "Amzirc." The publication describes its fabrication, room temperature properties and its elevated temperature properties. American Metal Climax, Inc., 1270 Ave. of the Americas, New York 20, N. Y.

### Servo Motors and Synchros 282

Theory, performance, application, construction and testing are detailed in a 60-page booklet entitled "Technical Information For The Engineer—Servo Motors, Motor Generators, Synchros." Kearfott Div., General Precision, Inc., 1150 McBride Ave., Little Falls, N. J.

### Planar Process 283

The technology of the Planar process is described in detail in this 12-page, full-color brochure. Given also are performance characteristics and a Planarmesa performance comparison. Fairchild Semiconductor, 545 Whisman Road, Mountain View, Calif.



## a Series of Broadband High-Frequency Matching Transformers

Frequency range 2 to 30 mc . . . low insertion loss . . . low SWR . . . good balance.

Power ratings: 1KW, 5KW and 20KW.

These high frequency transformers are ideal for matching unbalanced radio transmitter outputs to balanced amplifiers and balanced antennas. Standard impedance transformations: 50 to 70 ohms unbalanced to 150, 300 or 600 ohms balanced as required. Other impedance ratios available on special order.

Pioneers in the development of baluns and unique RF coupling devices B&W again sets a standard.

Drop us a card requesting Spec Sheet.



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A few other B&W products: I. F. TRANSFORMERS • COMMUNICATIONS EQUIPMENT • AUDIO PHASE SHIFT NETWORKS • TEST EQUIPMENT • and many types of standard and special electronic components and equipment.

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Here's How TO GET GAINS UP TO  
1,000,000  $Z_m$ , and  
detect 1 MICRO-MICROWATT DC . . .



WITH  
**acrostat**  
LOW-LEVEL MAGNETIC AMPLIFIERS

This brand-new series of ACROSTAT second harmonic magnetic null pre-amplifiers give gains up to 1,000,000  $Z_m$ , with null balances to one micro-micro-watt, DC. One microampere of DC control gives one volt of DC output. Operates from 115 volts  $\pm$  10%. Ideal for thermocouples, strain gauges, null detectors, meter pre-amplifiers.

For full details, send for Technical  
Bulletin No. 10



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REMOTE DATA RETRIEVERS, EVENT AND DATA RECORDERS

117.50  
121.00  
122.99  
127.99

**PRINT AND PLOT  
SIMULTANEOUSLY**

HOGAN FAXimile recorders are available with up to 2000 individual styli for simultaneous recording. A wide range of stylus spacings is offered—up to 100 to the inch for high-speed facsimile, television and radar recorders and high resolution printers and plotters. Chart widths to 30" and feed rates to 50" per second.

Hogan specializes in electrolytic techniques for event, spectrum analysis, oscillograph and facsimile recording, frequency time analysis and special purpose binary and gray scale record applications. Hogan electrolytic recording papers provide a permanent high contrast black on white record which is reproducible on most conventional office duplicators.

Whatever your recording problem may be—contact HOGAN FAXimile, a subsidiary of TELautograph Corporation, 635 Greenwich Street, New York 14, N. Y.

HOGAN FAXimile Corporation • 635 Greenwich St., New York 14, N. Y.  
A SUBSIDIARY OF TELAUTOGRAPH CORPORATION

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## NEW LITERATURE

### Polycarbonate Resins 284

The advantages of Lexan polycarbonate resin for electrical and electronic components is discussed in six-page brochure CDC-397. It gives complete technical data on electrical properties, details physical properties and describes typical applications. Chemical Materials Dept., General Electric Co., 1 Plastics Ave., Pittsfield, Mass.

### Recorders 285

A full line of direct- and servo-operated, switchboard and portable recorders is described in 12-page bulletin GEA-6933A. The bulletin relates information on 19 different types of single and multi-pen, ink and inkless, strip and round chart recorders. General Electric Co., Schenectady 5, N. Y.

### Gyro Data 286

"Technical Information For The Engineer—Gyros", a 60-page manual, details the theory, performance, application, construction, and testing of such units as rate, rate-integrating, free, vertical, and directional gyros, as well as stable platforms and accelerometers. Kearfott Div., General Precision, Inc., 1150 McBride Ave., Little Falls, N. J.

### Nomograph for Pickups 287

This nomograph enables users of electromagnetic pickups to quickly calculate: gear sizes needed for the required voltage/frequency to be generated by the pickup; gear surface speeds from rpm; and expected voltages and/or frequencies generated at various speeds. A bulletin showing a complete line of magnetic pickups is also available. Electro Products Laboratories, Inc., 4500 N. Ravenswood Ave., Chicago 40, Ill.

### Capacitors 288

An 86-page catalog in nine sections includes a facilities brochure and eight tabulated divisions covering capacitor construction, utilizing metallized paper, metallized Mylar, Mylar and foil, Kraft-Mylar-interleaf and high stability capacitors. Electrical and environmental data, application notes, and complete sets of performance curves are included. Electron Products, 430 N. Halstead St., Pasadena, Calif.

# APT

ASTATIC PANCAKE TORQUE-TUBE



Actual Size APT-1  
\*Pat. Pending

### BETTER BASIC MECHANISMS

The APT-1 is an entirely new concept in a permanent magnet moving coil mechanism designed specifically to exceed the performance of the best available comparable devices. Typical improvement factors in major performance categories include:

Torque . . . increased 275%

Weight . . . reduced 30% (in moving coil system)

Torque-to-Weight . . . increased 400%

Compass Influence . . . not measurable under standard test conditions

Vibration . . . substantial elimination of resonant phenomena and greatly improved endurance are assured by dynamic symmetry of moving coil system and 400% increase in T/W ratio

Acceleration . . . indicator errors produced by acceleration forces are very sharply attenuated

Linearity . . . improved accuracy and linearity are an assured consequence of the fundamental design, which has over 75% of the copper winding working in a high energy air-gap composed of coplanar surfaces, providing greater averaging of a more uniform magnetic field

APT-1 characteristics offer distinctly improved performance in all airborne indicating systems and control applications. The APT-1 is available in a wide range of electrical and dynamic characteristics with conventional jewel and pivot suspension, and in a limited range of electrical characteristics with Elgiloy flexure suspensions.

For information on the application of these mechanisms, write Ammon Instruments, Inc., 345 Kelley Street, Manchester, N. H.

# AMMON

INSTRUMENTS, INC.

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"The light touch . . .  
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Photoconductor



Illustrated, an  
extremely sensi-  
tive cadmium  
selenide type  
from the 1/2 watt  
500 series.

A  
Circuit  
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Controlled by  
LIGHT

For tabulated technical  
data on 25 different  
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Guide
- Electronic Design  
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"and new facilities . . . for growing needs"  
8 W. 30th St., New York 1, N.Y. MU 4-0940  
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### Transformer Color Codes 289

EIA color codes for transformers are provided on a compact wall chart. Color codes for power, audio, output and if transformers, as well as connection codings for loudspeaker leads and plugs, are shown. Stancor Electronics, Inc., 3501 Addison St., Chicago 18, Ill.

### Transistors and Diodes 290

A four-page folder aids buyers and engineers in their selection of Fairchild planar transistors and diodes. Applications, construction, and specifications are outlined in quick-reference, tabular form. Schweber Electronics, 60 Herricks Road, Mineola, L.I., N. Y.

### Vacuum Metallizing 291

The vacuum metallizing process, its advantages and its applications, are described in 16-page bulletin 584. Included are complete specifications for latest designs of this firm's vacuum metallizing equipment. F. J. Stokes Corp., 5500 Tabor Road, Philadelphia 20, Pa.

### Pressure Transducer 292

The model 176 Teledyne Pressure Transducer, for sensing dynamic pressures in high speed chemical reactions and tests of rocket, jet or turbine engines, is described in a two-page bulletin P-61176. Also available is an eight-page service manual. Taber Instrument Corp., 107 Goundry St., North Tonawanda, N. Y.

### Miniature Gears 293

A wide line of stock gears in Precision I, II and III is described in 256-page catalog 6A. Also covered are anti-backlash, and mechanical slip-clutches, one-piece flexible shaft couplings, clamps, bearings, shafts, retaining rings, and other components and parts. Perfect Gear and Instrument Corp., 339 S. Isis, Inglewood, Calif.

### Neutron Generator 294

Engineering data and specifications on the Norelco 14 MeV neutron generator are provided in a six-page bulletin. Numerous typical applications are listed, and a variety of accessory units are described. Philips Electronic Instruments, 750 S. Fulton Ave., Mount Vernon, N. Y.

# AUGAT BATTERY HOLDERS

Accommodate Every Popular  
Size and Make of Zinc,  
Mercury and Alkaline  
Type Batteries

Here is a new, complete line of battery holders, specifically designed to withstand the shock and vibration normally encountered in portable equipment.

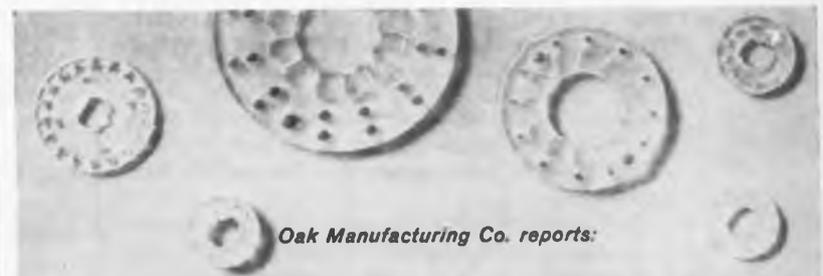
These holders are manufactured from steel or beryllium copper and include nylon insulated, silver plated contacts. Insulators are color coded so that battery polarity is clearly indicated.



Write today for Data Sheet No. 3-61. It lists all the important specifications, and a rapid reference chart aids you in choosing the correct holder for a particular battery.

**AUGAT INC.** 31 Perry Avenue  
Attleboro, Mass.

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Oak Manufacturing Co. reports:

## CLOSER TOLERANCES AT LOWER COSTS WITH CUSTOM KEL-F ROTARY SWITCHES

By changing from other materials to Booker & Wallestad's custom molded Kel-F® in rotary switches, Oak Manufacturing Company brought its prices into line, and achieved closer tolerances while maintaining electrical and heat requirements.

This is another example of Booker & Wallestad's ability to work with unusual compounds having highly desirable properties (and often reputations of being "difficult" to mold). Booker & Wallestad have developed special methods for molding compounds such as Kel-F® and Teflon®. Costs of molds have been substantially reduced. You can justify a limited quantity of quality parts for development work, and when volume production is required, you benefit proportionately.

For specialized experience in custom molding of unusual plastics—and for low-cost precision molding in any quantity, call Booker & Wallestad first.

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DIVISION OF THERMOTECH INDUSTRIES, INC.

Unusual SKILL and ECONOMY in custom plastics molding . . .  
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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 147 ON READER-SERVICE CARD

## NEW LITERATURE

### Aircraft Instruments 295

A variety of ac and dc panel instruments, aircraft current transformers and ground maintenance equipment is described in 12-page bulletin GEA-6788A, including specifications, schematics and other pertinent data. General Electric Co., Schenectady 5, N. Y.

### Terminals and Assemblies 296

A 28-page catalog provides full data on Ceramaseal alumina ceramic-metal high-temperature terminals and assemblies. Stock terminals and bushings, installation instructions, data on semiconductor housing and high-pressure seals, and many other sections are included. Ceramaseal, Inc., P. O. Box 25, New Lebanon Center, N. Y.

### Cable Support Systems 297

A 52-page booklet, No. 106, enables the user to select and install the right section, type of bend or component part for supporting power cables, communication cables and automatic control or hydraulic line cables. Chalfant Products Co., 11525 Madison Ave., Cleveland 2, Ohio.

### Slide Rule 298

Circular rule, the "Scoparator," permits comparison of effect of reactance on square wave signals at various frequencies by three types of resistors: low resistance, carbon film trace and conventional precision wire-wound. Curves made film scope traces of the various resistor types may be superimposed for comparison. Components Inc., 14621 Armita St., Van Nuys, Calif.

### Metal-Bonded Ceramics 299

Described in an 11-page brochure are custom-made metal-bonded ceramics used as hermetic seals in equipment for rugged service conditions. The Carborundum Co., Refractories Div., Latrobe, Pa.

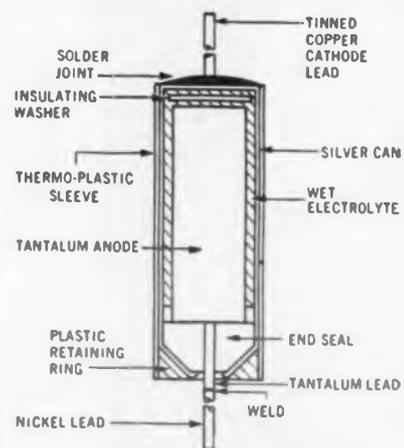
### Ball Bearings 300

A 48-page catalog provides a broad range of information on miniature and instrument ball bearings and contains complete descriptions of the company's engineering and production facilities. New Departure Div., General Motors Corp., Bristol, Conn.

# NEW STRAIGHT WALL TANTALUM CAPACITOR CAN'T LEAK

Meets MIL C 3965-B, Style CL-64, CL-65.

A new space-saving approach to the design of wet tantalum capacitors ends mounting problems encountered with flanged types and yet will not leak.



ITT's compact, sintered slug tantalum capacitor features a wedge-shaped seal held under compression by an epoxy retainer ring formulated for thermal characteristics inverse to those of silver. Ordinary, straight-wall capacitors leak along the lead when elastomer compression is reduced as the silver can expands. Not so with the new ITT design!

This new, compact capacitor conforms to specifications MIL C 3965-B, Style CL-64, CL-65 and provides both the compactness and rugged reliability required in missile, airborne and mobile equipment. For details, write today requesting Bulletin No. 610.



**CAPACITOR DEPARTMENT  
COMPONENTS DIVISION**

INTERNATIONAL TELEPHONE AND TELEGRAPH  
CORPORATION, PALO ALTO, CALIFORNIA

CIRCLE 148 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 6, 1961

# NEW!

## Speedomax<sup>®</sup> H

# AZAR

## Recorder



This L&N Speedomax H AZAR (Adjustable Zero, Adjustable Range) Recorder provides a new level of recording versatility for research and development work. With any calibrated span between 0.67 and 100 mv, and any zero suppression between -50 and +50 mv, it can plot virtually any physical or electrical quantity that can be converted into d-c millivolts. This flexibility is achieved with six switch-selected spans and five steps of zero suppression, plus continuous adjustment of each span and zero step.

List No. — 3-961-000-186-6-360 Speedomax H AZAR Recorder.

**Measuring Circuit**—D-C potentiometer with automatic gain control.

**Electrical Span**—Switch selected: 2, 5, 10, 25, 50 or 100 mv. Continuously adj. span attenuator on each position reduces span to 1/5 of position.

**Electrical Zero**—Continuously adj. 10 mv, 10-turn potentiometer slidewire, fixed step switch to add 0, 10, 20, 30 and 40 mv to slidewire. Key provides "zero -", "zero +" and a "calibrate" position which calibrates the span.

**Span Step-Response-Time Rating**—One second.

**Chart**—Calibrated 0 to 100 in 6".

**Chart Speed**—360° per hour.

**Power Requirements**—Operates on 120 v, 60 c.

**Price** — \$995.00 f.o.b. Philadelphia or North Wales, Pa. (subject to change without notice). Use List No. 3-961-000-186-6-360 when ordering from L&N, 4908 Stenton Ave., Phila. 44, Pa.



Pioneers in Precision

**LEEDS & NORTHRUP**

CIRCLE 149 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 6, 1961

### Infrared Materials 301

The properties of 15 infrared transmitting materials are described in a four-page bulletin. Transmission curves and detailed properties are included, such as long wavelength transmission limit in microns; index of refraction; maximum size; and relative cost. Servo Corp. of America, 111 New South Road, Hicksville, L.I., N. Y.

### Null Balance Recorders 302

A complete line of single and multi-pen null balance recorders and recorder-controllers is discussed in the 12-page brochure, GEA-6887A. The publication includes dimensions, specifications, applications and information on features. General Electric Co., Schenectady 5, N. Y.

### Power Supplies 302

Over 3,000 models of both standard and custom engineered power supplies, ranging in size from 50 w to 5,000 kw, are listed and described in this 44-page, 2-color catalog. Write on company letterhead to American Rectifier Corp., Dept. ED, 95 Lafayette St., New York, N. Y.

### Graphite 303

A six-page bulletin, "Graphite for Rectifiers and Power Tubes," provides information on properties of graphite, design hints for anodes, and a table of recommended graphite grades for anodes and related parts. Carbon Products Div., Speer Carbon Co., St. Marys, Pa.

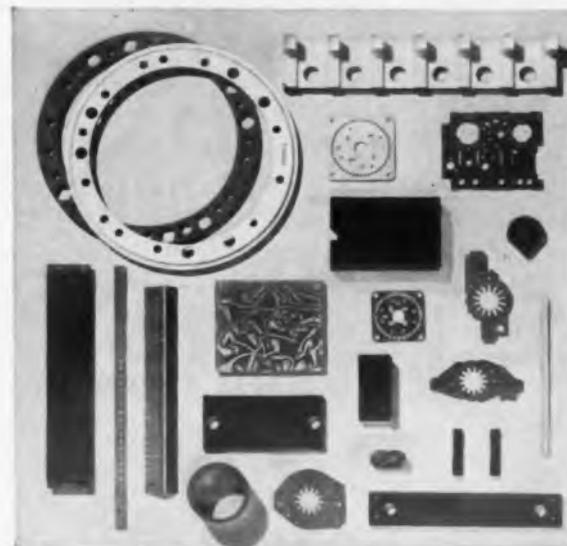
### Crossbar Scanners 304

"Crossbar Scanning Systems" is a six-page bulletin covering the SD series of crossbar scanners. Information is provided on the basic module, how it works, how it may be modified for "level scanning" and how capacity may be enlarged to 1,200, 1,800 or more poles. James Cunningham Son & Co., Inc., 33 Litchfield St., Rochester, N. Y.

### Semiconductors 305

The manufacture of high quality transistors, diodes, and other semiconductor devices is described in a 12-page illustrated booklet. This firm's semiconductor facilities at Woburn and Wakefield, Mass., and Hillsboro, N. H., are highlighted. Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y.

## RELIABLE Laminated Plastics for Electrical & Electronic Parts



### An Example of Synthane You-shaped Versatility

Here, from one reliable source, you can satisfy all your requirements for laminated plastic materials or fabricated parts. High temperature laminates, flame-retardant laminates, copper-clad laminates as well as all the widely-accepted electrical grades. Complete facilities for quality-controlling desired properties and for environmental testing. For parts fabricated to your specifications we are equipped with a complete tool room for specialized dies and fixtures.

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



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

HEINEMANN ELECTRIC COMPANY, 2616 BRUNSWICK PIKE, TRENTON 2, N. J.

6A-2487

CIRCLE 165 ON READER-SERVICE CARD

## NEW LITERATURE

### Boxes and Covers 306

Supplement/catalog B60, 8 pages, describes aluminum boxes and covers available from stock for packing electronic components or instruments. New sizes range in width by length from 1-5/8 x 3-3/8 to 28-1/4 x 28-1/4 in., in a variety of alloys and thicknesses. Zero Manufacturing Co., 1121 Chestnut St., Burbank, Calif.

### Round Connectors 307

Catalog BHB contains 32 pages of comprehensive data on miniature round connectors that conform to MIL-C-26482. Indexed for easy reference, the catalog includes specifications, dimensional drawings, tables and shell styles for eight sizes. Burndy Corp., Norwalk, Conn.

### Voltage References 308

Miniature solid-state voltage references are the subject of 4-page bulletin PS 200-1. The illustrated brochure

includes all technical data on six models now available from the firm. Dynage, Inc., 390 Capitol Ave., Hartford, Conn.

### Semiconductors 309

Low, medium and high power silicon rectifiers, rectifier assemblies, silicon power transistors, transistor controlled rectifiers, thermistors, and thermoelectric coolers and generators are described in this eight-page catalog. Illustrations, ratings and other data are provided. Westinghouse Electric Corp., Semiconductor Dept., Youngwood, Pa.

### Multi-Function Tube 310

Information on 35 types of "Compactron" devices now available as engineering samples for designers of radio, television and other equipment is included in publication ETC-2734. This 16-page brochure includes information on reliability, life expectancy, power, and sensitivity of these 12-pin multi-function devices. General Electric Co., Owensboro, Ky.

## HIGH-VOLTAGE BRIDGE RECTIFIERS



### Typical Unit

- 3000 Volts Peak Inverse Voltage
- 500 ma Average Rectified Current
- Matched Thermal Coefficient of Expansion
- Less Than 0.25 Cubic Inches
- Packaging To Customer's Requirements

### Applications

- Klystron Power Supplies
- High Voltage D-C Power Supplies
- Plate Power Supplies for Transmitters
- D-C Power Supply for Traveling-Wave-Tubes

For Additional Information write or phone



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SPECIAL PRODUCTS DIVISION

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CIRCLE 181 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • December 6, 1961

## Nuclear Equipment 311

A 40-page catalog illustrates and describes a broad range of radioisotope detection and measuring instruments and accessories for use in research, educational, medical and industrial applications. Radiation Equipment & Accessories Corp., 665 Merrick Road, Lynbrook, N. Y.

## Industrial Gas Data 312

A 48-page, pocket-sized booklet No. ADE-890, bound in leatherette for durability, lists physical and chemical properties of oxygen, nitrogen, argon, etc., and the medical gases. It contains useful charts, diagrams and conversion tables. Air Reduction Sales Co., 150 E. 42nd St., New York 17, N. Y.

## Waveguide Components 313

A variety of products including flexible and rigid waveguides, elbows and twists, waveguide components and numerous specialty items,

are described and illustrated in a 16-page brochure. Also provided are data on the facilities of this firm. Microtech, Inc., 1425 Milldale Road, Cheshire, Conn.

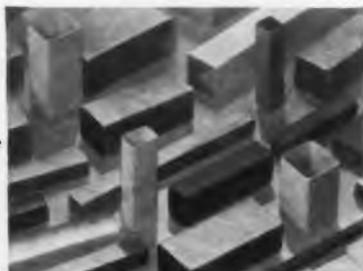
## Special Products 314

More than 100 different special products are described in the firm's 44-page brochure. Schematic diagrams and lead configurations of transistor-diode multiples, are included. Fairchild Semiconductor, 545 Whisman Road, Mountain View, Calif.

## Relays 315

A six-page short-form catalog provides specifications, operating information, ordering information and application data on a line of general-purpose, plate-circuit, industrial-control, telephone, printed-circuit, sensitive, digital-counter, antenna, power and plug-in relays. Hilburn Electronics Corp., 55 Greenpoint Ave., Brooklyn 22, N. Y.

If  
Dielectric or  
Corrosion  
Problems are  
Causing  
Coil  
Trouble...



### PRECISION can help eliminate them

Precision specializes in square, rectangular, round or special shaped coil forms... kraft, fish paper, acetate, DuPont Mylar, Johns-Manville Quinterra, Resinite impregnated, other high dielectric materials or combinations... to help you solve any dielectric or corrosion problem. Forms can be made to your exact specifications in all sizes from  $\frac{1}{16}$ " square to 8" square with wall thicknesses of from .010 to .125.

Precision Paper Tubes are available in standard or exclusive patented DI-FORMED construction for greater crush resistance, high tensile strength and extreme dimensional stability.

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CIRCLE 166 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 6, 1961

# 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  $\frac{1}{2}$  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  $\frac{1}{2}$  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  $1\frac{17}{32}$  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.

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**GENERAL ELECTRIC**

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just set the range switch



and the correct scale appears



**AUTOMATICALLY**

in the new **B&K** VOM and VTVM

You see only the scale you want—and read the answer directly. Full-size individual scale for each range. No reading difficulties, no multiplying, no chance of error.

Try it in your plant or lab without obligation, under our performance guarantee. We will gladly submit either or both instruments for your own evaluation.

### VOMATIC 360

AUTOMATIC VOLT-OHM-MILLIAMMETER  
WITH BURN-OUT PROOF METER

Sensitivity: 20,000 ohms per volt DC; 5000 ohms per volt AC. Accuracy  $\pm 3\%$  DC;  $\pm 5\%$  AC; (full scale). DC Volts in 6 ranges 0-6000. AC Volts in 6 ranges 0-6000. AF (Output) in 4 ranges 0-300. DC Current in 5 ranges 0-10 amps. Resistance in 4 ranges 0-100 megohms. Meter protected against extreme overload. Polarity reversing switch. Automatic ohms-adjust control. Mirrored scale. Complete with batteries, test leads, and easy-viewing stand. Net. \$59.95



### DYNAMATIC 375

AUTOMATIC VACUUM-TUBE VOLTMETER

Accuracy  $\pm 3\%$  full scale AC and DC. Sensitive 100 microampere meter movement. DC Volts in 7 ranges up to 1500 volts. AC Volts (rms) in 7 ranges up to 1500 volts. AC Volts (peak-to-peak) in 7 ranges up to 1500 volts. DC Current in 3 ranges up to 500 ma. Ohms in 7 ranges up to 1000 megohms. Utilizes single DC-AC ohms probe and anti-parallax mirror. Swivel stand converts to carry-handle. Includes  $1\frac{1}{2}$  volt battery. Operates on 117 volts 50-60 cycle AC. Net, \$89.95



Send for Bulletin IND38-H or write Industrial Division



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Canada: Atlas Radio Corp., 50 Wingold, Toronto 19, Ont.  
Export: Empire Exporters, 277 Broadway, New York 7, U.S.A.

CIRCLE 166 ON READER-SERVICE CARD

## NEW LITERATURE

### Microwave Components 316

Complete data on over 200 standard precision microwave components, covering a range from 1.70 to 40.0 Gc, are provided in an eight-page catalog. All units are calibrated on instruments traceable to the National Bureau of Standards. Microwave Components and Systems Corp., 1001 S. Mountain Ave., Monrovia, Calif.

### DC Power Supplies 317

A 24-page two-color, profusely illustrated catalog lists and describes the firm's line of dc power supplies. The booklet includes information helpful to the designer as well as prices, dimensions, and specifications. Dressen-Barnes Electronics Corp., 250 N. Vinado Ave., Pasadena, Calif.

### Metal Forming 318

A 20-page illustrated brochure is available describing techniques in precision metal forming, including

information on hydroforming, deep drawing and metal spinning. C. B. Kaupp & Sons, Inc., Newark Way, Maplewood, N. J.

### Data Processing 319

Redesigned and enlarged with additional data processing applications for its sixth edition, the booklet, "IDP Products in Action," presents 32 pages of systems applications of tape-operated business machines. Friden, Inc., 97 Humboldt St., Rochester 2, N. Y.

### Solder Connectors 320

Miniature solder connectors are featured in catalog BSB which contain 24 pages on connectors which conform to MIL-C-0026482A (WEP). The multi-colored catalog includes specifications, dimensional drawings; tables, shell styles and termination devices for nine shell sizes. Burndy Corp., Norwalk, Conn.

## JANCO MINIATURE Rotary Selector Switches



ACTUAL SIZE

SERIES 1900

All Janco switches are designed and built to exceed MIL-S-6807A. Possessing long-life with a high degree of reliability, they exceed the operational and environmental requirements of shock, vibration, altitude, and explosion. Because of their design and construction, all Janco switches are ideally suited for dry circuit and signal level switching applications.

#### SPECIFICATIONS

**Electrical Rating:** Make, break, and carry  
Up to 5 amps 115V AC and 28V DC resistive,  
and 2 amps 28V DC inductive

**Contact Positions:** 2 to 12 positions

**Index:** 30°, 36°, 45°, 60°, and 90° indexing

**Decks:** 1 to 16 decks (single pole)

Write today for complete detailed specifications.

**JANCO CORPORATION**  
3111 Winona Avenue, Burbank, California

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ELECTRONIC DESIGN • December 6, 1961

### Accelerometer Testers 321

A seven-page catalog describes static and dynamic test equipment for complete evaluation of gyros, accelerometers, and similar instruments. The literature includes technical data sheets on static tilt tables, linear acceleration tables and oscillating rate tables. Micro Gee Products, Inc., 6319 W. Slauson Ave., Culver City, Calif.

### Coated Products 322

A four-page brochure on coated products for temperature Class H applications is now available. The publication lists typical applications, operating temperatures, thicknesses and tensile and electrical strengths of the materials. Irvington Div., Minnesota Mining & Manufacturing Co., 900 Bush Ave., St. Paul 6, Minn.

### Noise Control 323

"The Why and How of Noise Control" discusses fundamentals of industrial noise control. The 16-page

booklet shows how to set up a noise control program to achieve safe and efficient working conditions. H. H. Scott, Instrument Div., Dept. P, 111 Powdermill Road, Maynard, Mass.

### Protective Coatings 324

A useful chart, No. C-503, provides thermal, physical, chemical and electrical characteristics of the company's protective coatings for electronic applications. A selector table enables the user to select the type best suited for the property most desired for his application. Columbia Technical Corp., Woodside 77, N. Y.

### Heat Transfer Surfaces 325

Panelcoil, produced by welding together two metal sheets, one or both of which may be formed with flow channels for heat transfer, is described in detail in 28-page bulletin 356. Design and application data, charts, formulas and other information are included. Dean Products, Inc., 1042 Dean St., Brooklyn 38, N. Y.

more than  
1000  
types



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ELECTRICAL  
PARTS delivered  
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Wire Forms from Stock  
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now

# 4 NEW SOLID STATE POWER SUPPLIES



## ELECTRONIC WELDING High Resolution Dual Range Circuits

— LOW — **2** — HIGH —  
POWER SUPPLIES IN 1  
for fine resolution in thin film lead attachment and whisker wires. for precisely controlled energy levels in joining heavier wires up to 0.040

By employing two entirely separate circuits, these new solid state units give best resolution in both ranges. Attaching fine wire whiskers and joining micro components are among the many applications where this fine degree of resolution assures production weld consistency.

The high range is designed for standard lead materials in high density component packaging. Voltage regulation, to within 0.5% for input variation between 100 and 130 volts is standard on Models 1049 and 1059. Immediate delivery on all models. For more information, write Weldmatic Division/Unitek, 950 Royal Oaks Drive, Monrovia, California.

### PICK THE MODEL THAT BEST FITS YOUR NEEDS—

- MODEL 1039—**  
Energy Storage Range  
Low: .04 to 3 watt-seconds  
High: .2 to 15 watt-seconds
- MODEL 1049—With Voltage Regulation**  
Energy Storage Range  
Low: .04 to 3 watt-seconds  
High: .2 to 15 watt-seconds
- MODEL 1058—**  
Energy Storage Range  
Low: .04 to 9 watt-seconds  
High: .2 to 45 watt-seconds
- MODEL 1059—With Voltage Regulation**  
Energy Storage Range  
Low: .04 to 9 watt-seconds  
High: .2 to 45 watt-seconds



### THEN TEAM IT WITH A POWER-MATCHED WELDMATIC HEAD

Patented pure force-firing action, absolute linear electrode movement, and fastest follow-up are among the many outstanding features that make these heads the best choice for any precision bonding assignment.

**WELDMATIC DIVISION / UNITEK**

CIRCLE 171 ON READER-SERVICE CARD

135

# IDEAS FOR DESIGN

## Antenna Coupling Modulates RF Signal 748

During some development work we had to modulate an rf signal without inserting a modulation source directly into the circuit. Since the rf oscillator was tightly coupled to an antenna, and to the space around the antenna as well, the following scheme to "free space modulate" the generator proved of value.

The waveform produced by generator  $G_1$  continually switches  $D_1$  on, causing a low-impedance (almost a short with a good diode) to be placed across the terminals of antenna 1. Thus, any energy intercepted by the antenna during this time will be reradiated.

However, when  $D_1$  is nonconducting, resistor  $R_2$  matches the antenna's impedance and dissipates most of the energy that antenna 1 picks up. If this antenna is coupled tightly to antenna 2 with proper polarization and placement, the changes in impedance of antenna 1 show up as a changing load on the rf oscillator. Thus, its cw output is modulated.

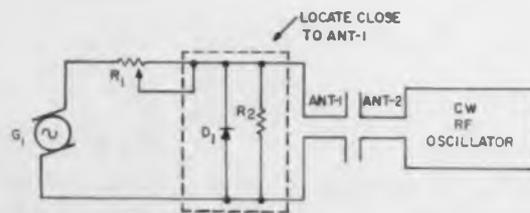
Thus, referring to the figure:

$R_1$ , with antenna coupling, adjusts modulation.

$R_2$  provides a matched load for ANT-1.  $G_1$  is a variable frequency generator.

$D_1$  a low-threshold diode (other diodes with an added bias source might be used).

This diode should possess good front-



Tight coupling of the antennas allows output of generator circuit to modulate continuous-wave rf oscillator.

to-back ratio and low forward impedance at the operating frequency of the rf generator.

ANT-1 and ANT-2 act as a coupling device to insert the modulation signal.

*Leeland Hogue, Staff Assistant, Sandia Corp., Sandia Base, Albuquerque, N.M.*

If this Idea is valuable to you, give it a vote by circling Reader-Service number 748.

## Double-Exposure Reveals Zener's Zero-Temp Coefficient 747

Here is an easy method we have been using to determine the Zener diode current at which the unit's voltage-temperature coefficient is zero. This zero coefficient is a characteristic of Zener diodes of about 5 v that are operated at low currents.

Our equipment consists of a curve tracer, a Polaroid camera and a hot-air blower. It is used as follows:

### \$50 "Most Valuable of Issue" Award for Zener-Voltage Compensator

Theodore Byles, project engineer with Motorola, Inc., Franklin Park, Ill., has won ELECTRONIC DESIGN's sixteenth \$50 Most Valuable of Issue Award.

Mr. Byles receives the award for his Idea for Design, "Compensating Voltage Reduces Zener Diode Variations," which appeared in the September 27 issue. The idea described a technique for compensating a Zener diode so that the variation of its internal resistance with input voltage is reduced.

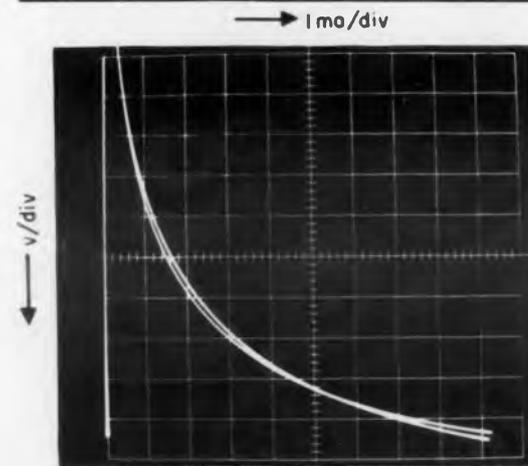
### Vote for Ideas Valuable to You

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?



Point at which Zener-diode temperature coefficient is zero can be read off from intersection point of characteristic curves. (Photographed at two different temperatures).

1. Photograph the characteristic of the Zener at ambient temperature.
2. With the blower, heat the Zener to a higher temperature.
3. Expose the film once more, photographing the new characteristic at the higher temperature.

The desired value of current is found, from the developed photo, from the intersection point of the two curves. To increase the resolution, suitable bias may be applied for zero suppression (For a 5-v Zener, a 4.5-v bias was found to be sufficient).

*Raphael Mor, Research Engineer, Scientific Dept., Ministry of Defense, Tel-Aviv, Israel.*

If this Idea is valuable to you, give it a vote by circling Reader-Service number 747.

## SEVENTH ANNIVERSARY AWARDS

# IDEAS-FOR-DESIGN

*Entry Blank*

### How You Can Participate

#### Rules For Awards

Here's how you can participate in Ideas for Design's Seventh Anniversary Awards: All engineer readers of **ELECTRONIC DESIGN** are eligible.

Entries must be accompanied by filled-out Official Entry Blank or facsimile. Ideas submitted must be original with the author, and must not have been previously published (publication in internal company magazines and literature excepted).

Ideas suitable for publication should deal with:

1. new circuits or circuit modifications
2. new design techniques
3. designs for new production methods
4. clever use of new materials or new components in design
5. design or drafting aids
6. new methods of packaging
7. design short cuts
8. cost saving tips

#### Awards:

1. Each Idea published will receive an honorarium of \$20.
2. The Idea selected as the most valuable in the issue in which it appears will receive \$50.
3. The Idea selected as the Idea of the Year will receive a Grand Prize of \$1,000 in cash.

The Idea of the Year will be selected from those entries chosen Most Valuable of the Issue.

Most Valuable of the Issue and Idea of the Year selections will be made by the readers of **ELECTRONIC DESIGN**. The readers will select the outstanding Ideas by circling keyed numbers on the Reader-Service cards. Payment will be made eight weeks after Ideas are published.

Exclusive publishing rights for all Ideas will remain with the Hayden Publishing Co.

Ideas-for-Design Editor  
**ELECTRONIC DESIGN**  
850 Third Ave.  
New York 22, N. Y.

**Idea** (State the problem and then give your solution. Include sketches or photos that will help get the idea across.)

*(Use separate sheet if necessary)*

I submit my Idea for Design for publication in **ELECTRONIC DESIGN**. I understand it will be eligible for the Seventh Anniversary Awards—\$20 if published, \$50 if chosen Most Valuable of Issue, \$1,000 if chosen Idea of the Year.

I have not submitted my Idea for Design for publication elsewhere. It is entirely original with me and does not violate or infringe any copyrights, patents or trademarks or the property rights of any other person, firm or corporation. Hayden Publishing Company, Inc. shall have the exclusive publication rights to these Ideas for Design selected for publication in **ELECTRONIC DESIGN**. This right extends to the subsequent use of the Idea for Design by Hayden in any of its other publications. Honorariums, if any, for subsequent publication shall be solely in the discretion of Hayden Publishing Company, Inc.

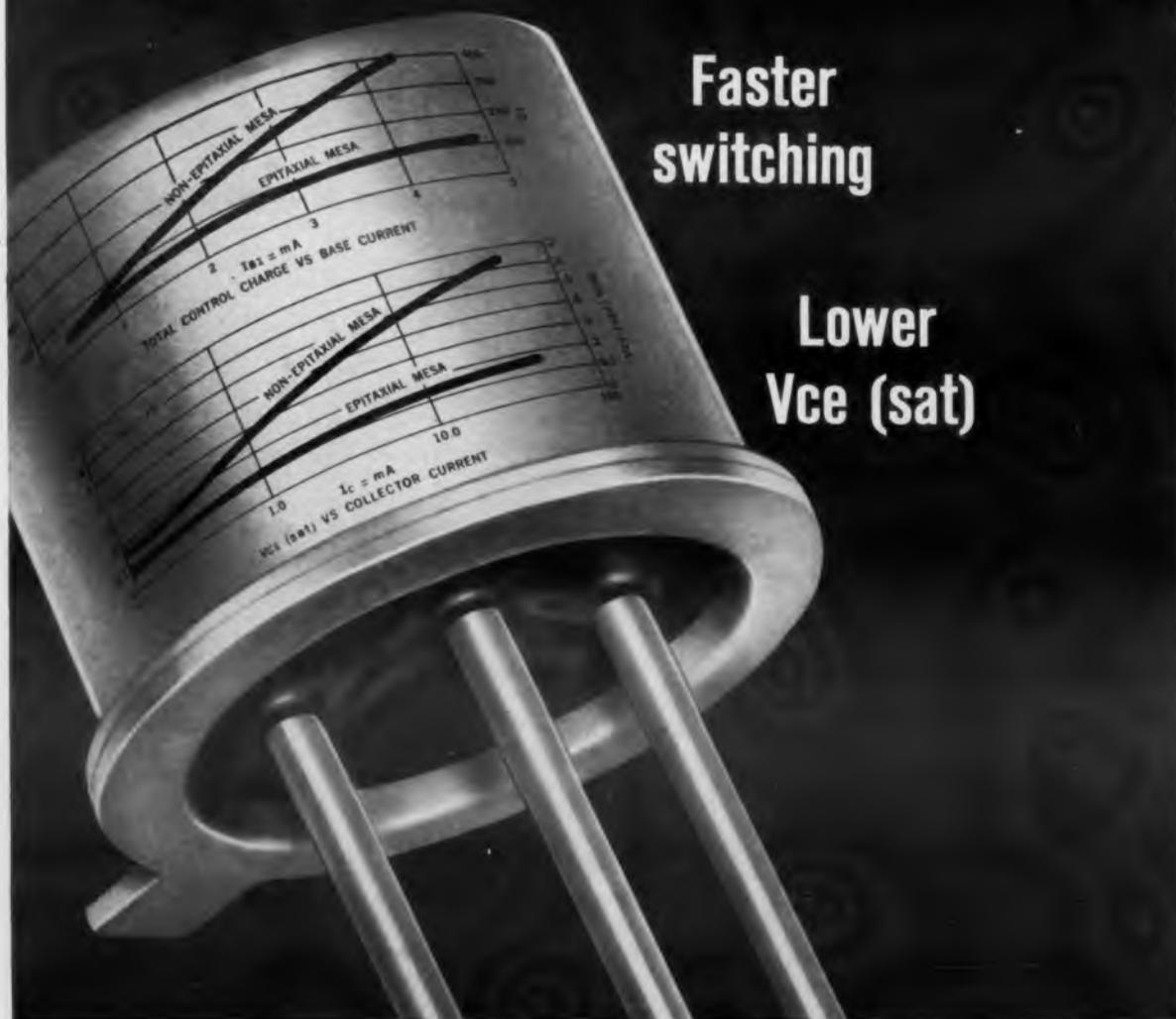
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RAYTHEON

## IDEAS FOR DESIGN

### Unijunction Transistor Attenuates AC With DC

745

The volume of an audio signal is usually controlled by a potentiometer acting as an ac voltage divider and adjusted to give the desired output. However, a control operating on dc would offer some very useful advantages.

When the volume control is situated at a remote position and long interconnecting wires are required, the system can suffer from noise pick-up. The amount of noise can be reduced if low-impedance circuits are used. But, low-impedance circuits often waste power and it becomes necessary to compromise between noise pick-up and power dissipation.

A volume control operated with direct current could be filtered on both ends of the interconnecting wires. It could eliminate noise without any loss in power. This dc control can be accomplished with a unijunction transistor.

In the unijunction, the resistance between the two bases (base-to-base resistance) changes when a direct current is injected into the emitter. The higher the current, the more carriers are injected in the base material and the lower is its resistance. This increases the conduction. Thus, if the dc is increased, the audio is divided down by resistor  $R_1$  and the base-to-base resistance of the unijunction, and the ac output voltage decreases, Fig. 1. Output can be controlled by the dc voltage flowing through potentiometer  $P_1$ . Attenuations as high as 40 db in voltage, with 1 per cent max distortion, have been obtained.

This same characteristic can be used for the audio agc system shown in the block diagram of Fig. 2. Both circuits are non-regenerative devices.

Although these circuits operate at audio frequencies, the unijunction also can be used as an attenuator for radio frequencies. This

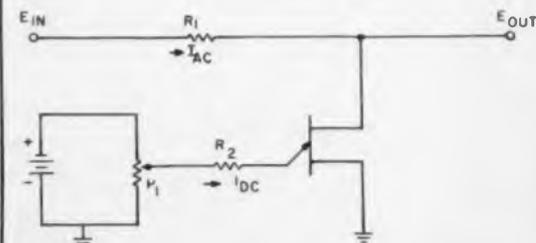


Fig. 1. Ac output voltage is controlled by varying base-to-base resistance of the unijunction from a dc source.

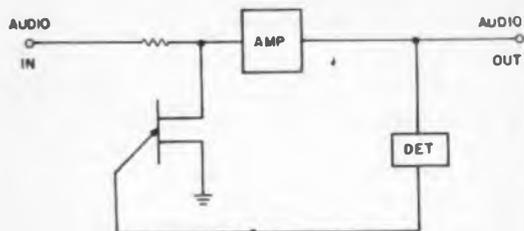


Fig. 2. Variable resistance affect of unijunction is used in audio agc system.

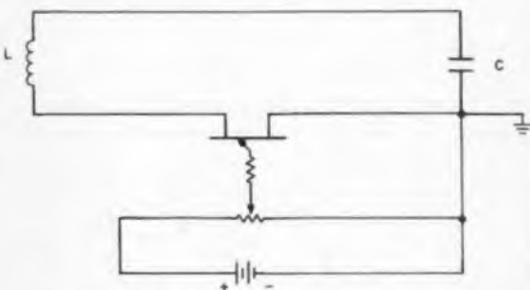


Fig. 3. Unijunction also can be used to automatically adjust tuned-circuit Q.

is because conduction in the base material is by majority carriers, allowing high-frequency operation. In the emitter, conduction is by minority carriers. Thus, the frequency at which the attenuation can be changed is less than the frequency of the wave to be controlled. Nevertheless, since this is usually the case encountered in practice, the limitation causes no difficulty.

The unijunction transistor can also be used for variable coupling of tuned circuits and to help in the automatic adjustment of "Q". This last application is shown schematically in Fig. 3.

*Silvio Soares, Assist. Project Engineer, Avionic Products, Bendix Radio Div., Baltimore, Md.*

If this idea is valuable to you, give it a vote by circling Reader-Service number 745.

## PNP Circuit Supplies 746 Constant-Current Into Load

A 1-amp constant-current source was required that would operate with a voltage swing of about 30 v. Further, election flow had to be from the source into the load.

These specifications were obtained by applying current feedback around a pnp power transistor as shown in Fig. 1.

The simplest solution, Fig. 2, would have been to use an npn power transistor and

# Electronic Products **NEWS**

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## Critical Hermetic Sealing Problems Solved with metal-bonded CERAMIC-TO-METAL ASSEMBLIES and METAL-BONDED CERAMICS

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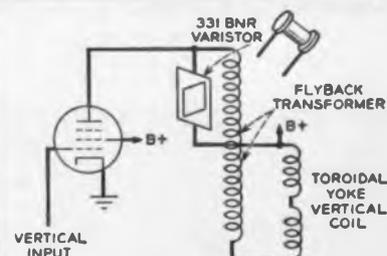
## "On Spec." yields of semi-conductor components improved with BORON NITRIDE jigs

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## Flyback Transformer Voltage controlled by Carborundum Varistors

Under some operating conditions such as high line voltage, the output from the flyback transformer in a TV vertical circuit can reach 2500 volts. This far exceeds the voltage needed for normal operation and can puncture winding insulation, cause flashover at tube pins, and can damage other components.

A simple solution is the installation of a Carborundum Type 331 BNR Varistor. The voltage-sensitive resistance characteristic of the Varistor holds the flyback output to a safe 1500 volts.

Data Sheet on the reduction of induced transients using Carborundum Varistors and Bulletin GR-2 giving characteristics will be sent on request. Write Dept. EDV-121, Global Plant, Refractories Div., Carborundum Co., Niagara Falls, N. Y.

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## IDEAS FOR DESIGN

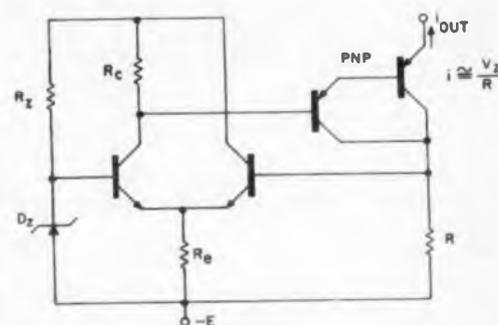


Fig. 1. Pnp power transistor with current feedback furnishes constant amp current into load, operates 30 v with voltage swing.

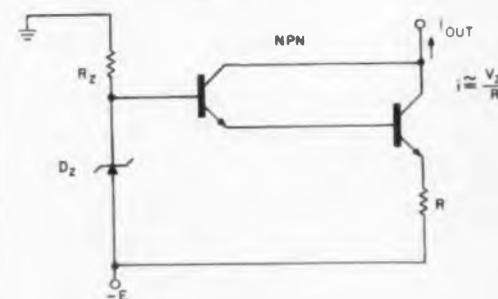


Fig. 2. Simpler, more costly, circuit would have used npn power transistor and Zener diode.

Zener diode in a grounded-base circuit. This was ruled out, however, because of the cost and relative scarcity of such npn units.

In the pnp-feedback circuit, the Darlington connection of the power transistor and its pnp driver yield a high current gain. The base current as well as the collector current of the output transistor are delivered to the load. Their level is controlled by the feedback circuit. Thus, the output current does not depend upon  $V_{be}$  of the transistors as it would with the circuit of Fig. 1. And, because of the large amount of feedback, the negative supply need not be regulated.

*Charles Wesley Rhodes, Project Engineer, Tektronix Inc., Beaverton, Ore.*

If this idea is valuable to you, give it a vote by circling Reader-Service number 746.

## Balanced Magnetic Fields 744 Determine Pulse Amplitudes

In the design of magnetic memory systems it is often necessary to measure accurately the amplitude of current pulses. Recently,

Tektronix introduced a probe that clips onto a current-carrying wire and allows the current pulse to be displayed on a scope. The following technique was devised to increase the accuracy of measuring the current-pulse amplitude with this probe.

The wire carrying the unknown pulse is placed in the mouth of the probe and displayed on the scope— $I_m$  in Fig. 1. A second wire, carrying a calibrating current pulse,  $I_c$ , is so placed in the probe mouth that its current direction opposes that of the current pulse to be measured. The amplitude of the calibrating current is adjusted until the scope shows a net zero current during the time the "unknown" current pulse is present. This indicates that the amplitudes of the calibrating and the unknown pulses are equal, as shown by the composite waveform of Fig. 1.

By increasing the gain of the scope, the calibrating current pulse can be adjusted very accurately for zero net current during the presence of both pulses. Under these conditions  $I_c = I_m$ .

A circuit for generating the current calibrating current pulse is shown in Fig. 2. The output circuit is an emitter follower that is normally "off." The current calibrating pulse is generated when  $Q_1$  is turned "on" and saturated. While  $Q_1$  is "on," essentially 10 v is applied to its resistive emitter circuit. By adjusting the trimpot  $R_1$ , the current calibrating pulse can be varied from approximately 50 to 100 ma. The amplitude

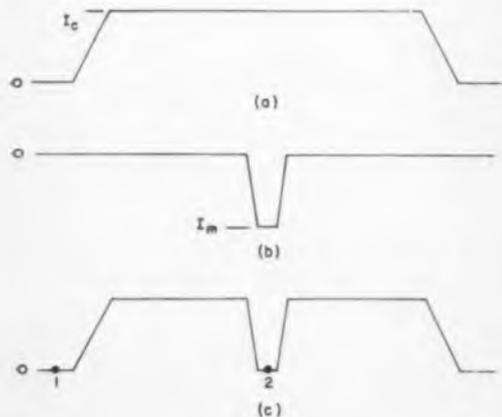


Fig. 1. Current pulse amplitude is measured by balancing magnetic field of known amplitude pulse against the unknown and displaying resulting waveform on scope.

- (a) Current pulse to be measured  
 (b) Calibrating current pulse  
 (c) Composite current pulse displayed on scope. When points 1 and 2 are aligned,  $I_c = I_m$ .

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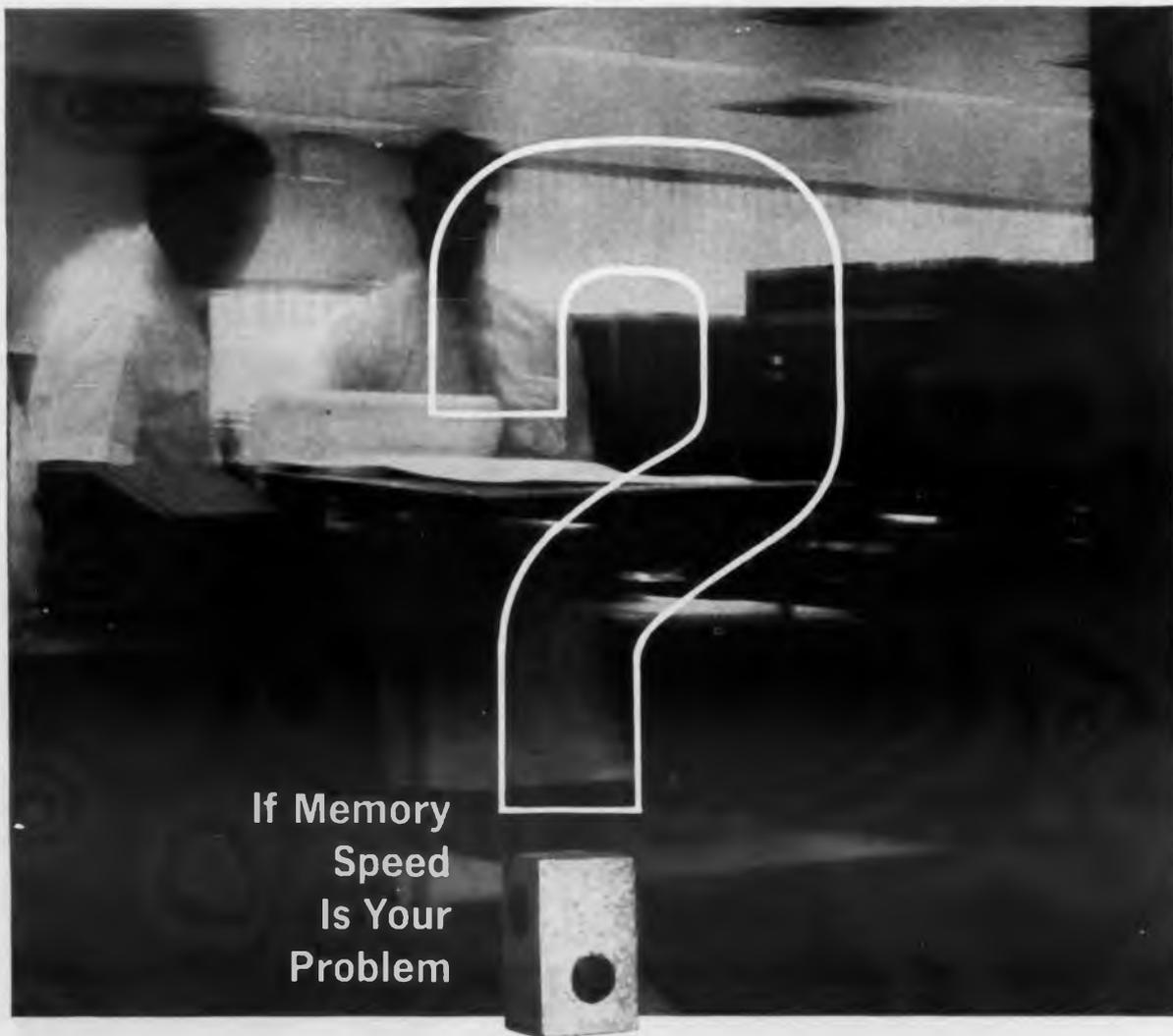
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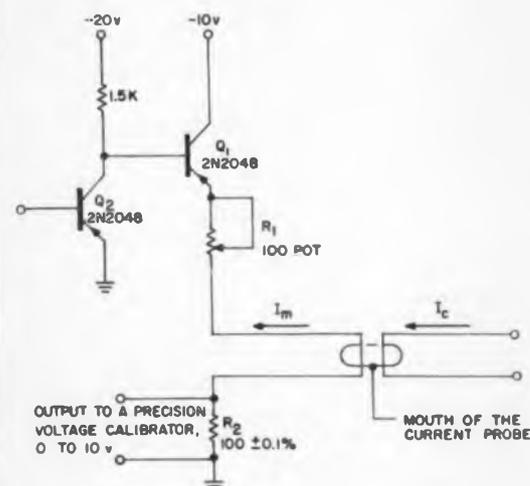


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CIRCLE 155 ON READER-SERVICE CARD

## IDEAS FOR DESIGN



**Fig. 2.** Circuit for generating the calibrating pulse which is balanced against the unknown in the mouth of the current probe.

of the current calibrating pulse is measured across the precision resistor  $R_2$  with a precision voltage pulse calibrator.  $Q_2$  is used to switch  $Q_1$ .

The accuracy of this technique depends primarily on how accurately points 1 and 2 in Fig. 1c can be aligned, the tolerance of the precision resistor  $R_2$ , and the accuracy of the voltage pulse calibrator. However, it is not unreasonable to measure the amplitude of current pulses with an accuracy of  $\pm 1$  per cent.

*Samuel J. Osler, Jr., Senior Engineer, Philco Computer Div., Willow Grove, Pa.*

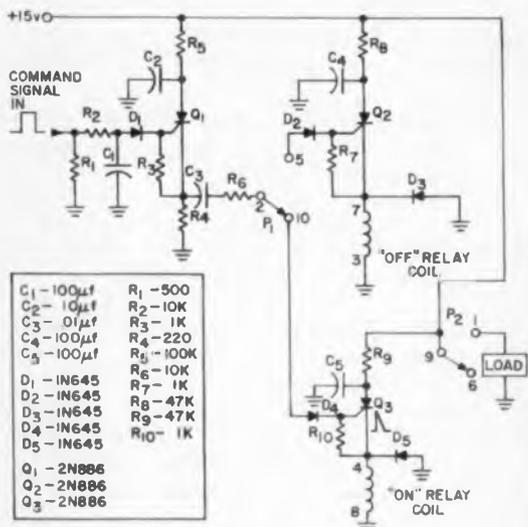
If this Idea is valuable to you, give it a vote by circling Reader-Service number 744.

## SCR Relay Flips, Flops 749 On Consecutive Commands

Recently, we needed a circuit that would allow a load to be switched ON and OFF by consecutive commands with a minimum of power. The circuit we designed uses three silicon-controlled rectifiers and a double-pole, double-throw magnetic latching relay.

The SCR circuits are designed for a "starved" condition. When an SCR is turned ON, the dc holding current is insufficient for the SCR to remain ON. When the anode capacitor discharges, it is reset.

The circuit is shown in the ready-ON



Three-SCRs and a magnetic latching relay allow the load in this circuit to be switched ON and OFF by consecutive command pulses.

state where pole 1 is thrown to contact 10 and pole 2 to contact 6 (load disconnected). A positive pulse is applied to  $R_1$  and the current through  $R_2$  turns  $Q_1$  ON for approximately 5 msec (discharge of  $C_2$ ). The output positive pulse from  $Q_1$  goes through contact 10 to the ON relay driver  $Q_3$ .  $Q_3$  is turned on for about 30 msec (discharge of  $C_4$ ). This time is sufficient to pulse the ON relay coil, causing the poles  $P_1$  and  $P_2$  to switch. The relay latches magnetically to the new pole positions (1 and 5), connecting the load to  $B^-$  and placing the circuit in the ready-OFF state.

When another pulse is applied, the load is switched OFF by the firing of  $Q_2$  (energizing the OFF relay coil) and the circuit flips to the ready-ON state.

The filter network of  $R_1$ ,  $R_2$ ,  $C_1$  is added to desensitize the circuit to random noise spikes. Here the command step has to be applied for approximately 2 sec to allow  $C_1$  to charge to the firing level of  $Q_1$ .

For the parameters shown, the circuit has a quiescent steady-state power drain of 0 w and a pulse power of 0.9 w for 30 msec. The power-handling capabilities depend only on the type of relay used.

John N. Libby, Justin C. Schaffert, Flight RF System Branch, Goddard Space Flight Center, Greenbelt, Md.

If this idea is valuable to you, give it a vote by circling Reader-Service number 749.

Chemical Division **3M** COMPANY



## FC-75 takes the heat off "Skybolt's" guidance system

The "Skybolt" ballistic missile under development by Douglas Aircraft will be launched from B52-type bombers. It will blast to a trajectory above the atmosphere, and race at hypersonic speed to a pre-determined target. 3M Brand Fluorochemical Liquid FC-75 will keep the inertial guidance system cool on the trip.

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Electrical Strength	35KV	40KV
Dielectric Constant (1 to 40 KC @ 75°F.)	1.86	1.86
Dissipation Factor (1000 cycles)	0.0005	0.0005

#### TYPICAL PHYSICAL PROPERTIES

	FC-75	FC-43
Pour Point	$< -100^\circ\text{F}$ .	$-58^\circ\text{F}$ .
Boiling Point	212°F.	340°F.
Density	1.77	1.88
Surface Tension (77°F.) (dynes/cm)	15	16
Viscosity Centistokes	0.65 Min.	2.74
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Chemical Stability	Inert	Inert
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## PATENTS

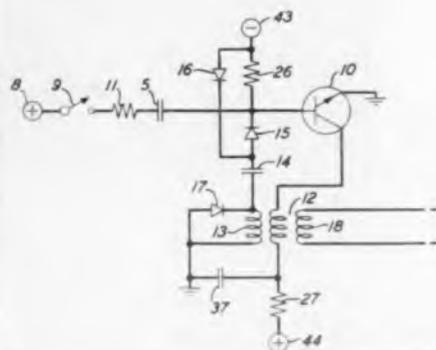
Benjamin Bernstein

### Transistor Trigger Circuit

Patent No. 2,999,172. W. A. Lawrence.  
(Assigned to Bell Telephone Laboratories, Inc.)

Two diodes added to a conventional blocking oscillator circuit improve the trigger sensitivity and decrease the recovery time.

Diode 15 isolates feedback capacitor 14 and winding 13 from pulse source 8. All of the trigger pulse is applied to the base of transistor 10. Capacitor 14 discharges quickly to the base voltage through diode 16.

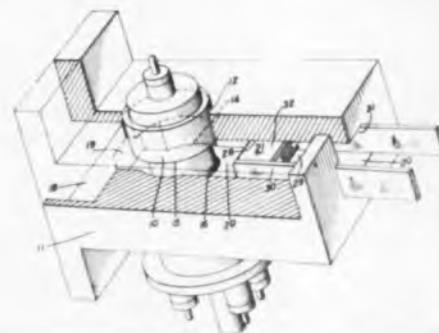


### Electromagnetic Wave Tuner

Patent No. 3,002,167. E. W. Houghton  
(Assigned to Bell Telephone Laboratories, Inc.)

A microwave cavity is tuned by coupling energy at the dominant mode into a side waveguide. An adjustable termination at the end of the guide couples back a susceptance that modifies the cavity's resonant frequency.

Klystron 10 has a cavity 14 containing a concentric magnetic field extending into guide 20, terminated by maze 21. The maze's longitudinal dimension



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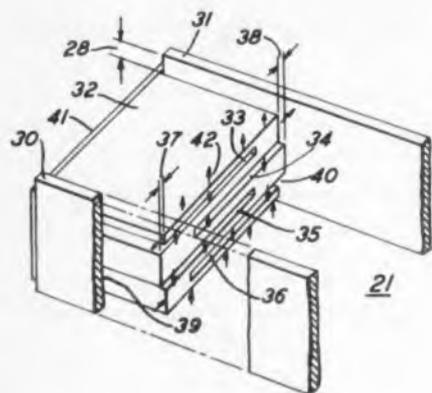
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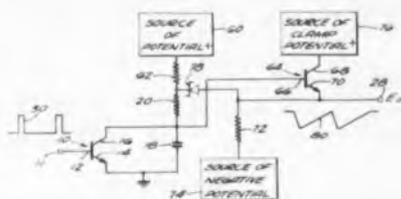


is one-quarter wave-length and consists of slots 33 to 36. The standing wave pattern creates a short at 41, positioned by the location of the maze structure. Wiping contacts 30 and 31 are in regions of low electric field and low wall current.

#### Linear Ramp-Voltage Wave Shape Generator

Patent No. 2,998,532. J. C. Smeltzer (Assigned to Thompson Ramo Wooldridge, Inc.)

A linear voltage waveform is generated by using a Zener diode to main-



tain the voltage drop across a resistor in series with a charging capacitor.

Input pulse 30 causes transistor 10 to conduct and to discharge capacitor 18. Thereafter, the capacitor charges through resistor 20 and the applied voltage is clamped by Zener diode 78. Transistor 70 limits the voltage across the capacitor to the magnitude of clamp potential 76.

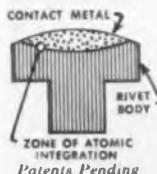
#### Power Supplies

Patent No. 3,001,120. A. B. Bereskin (Assigned to Baldwin Piano Co.)

In a transformerless low-cost ac-to-dc converter, each ac line to a full-wave rectifier contains a capacitor in series with a resistor. The capacitor provides dc isolation and the resistor reduces the amount of current-limiting required.

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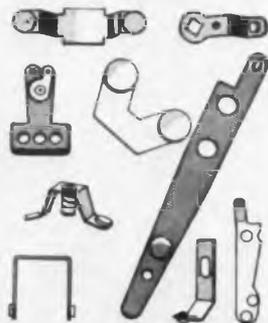
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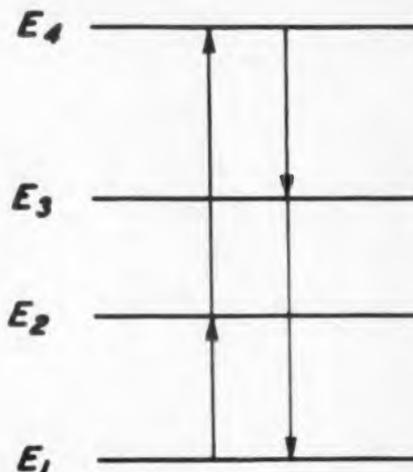
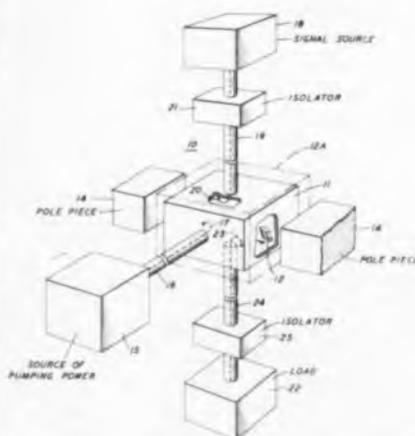
## PATENTS

### Solid-State Maser

Patent No. 3,001,142. W. B. Minis (Assigned to Bell Telephone Laboratories, Inc.)

In a maser, a steady magnetic field in the crystal produces a spacing of the energy levels so that applied signals higher than pump frequency are amplified.

Alumina crystal 12 doped with chro-

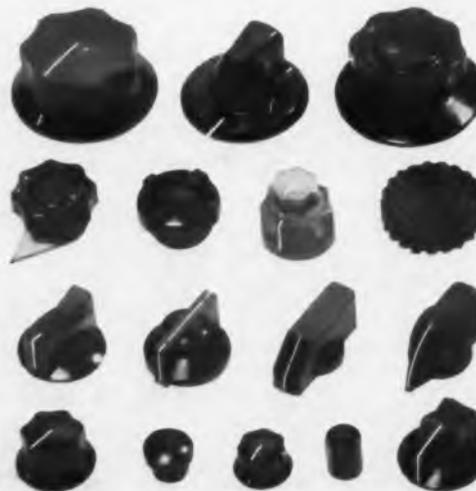


mium, is placed in cavity 11 which is resonant to both pump and signal frequencies. The magnetic field is oriented 60 deg to the crystal axis. The spacing of the energy levels correspond to  $E_2$  and  $E_4$ , separated twice the interval between  $E_3$ , and  $E_1$ . Pumping inverts the population between levels of  $E_3$  and  $E_1$ .

In a specific case, pumping at 14 kmc permits amplification at either 16.6 kmc or 26.3 kmc, depending upon temperature and concentration.

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### Apparatus for Operation of Gas-Filled Multicathode Character Display Device

Patent No. 2,982,880. D. L. Klipstein  
(Assigned to Illinois Testing Labs).

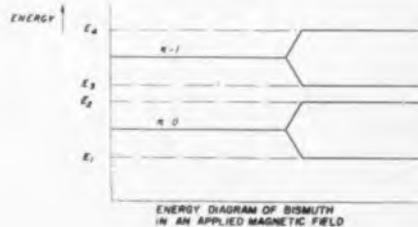
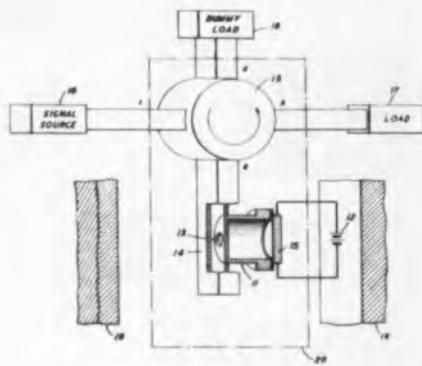
In a multicathode, gas-tube display device each cathode may be individually switched to conduction by a 1-v control signal applied between the emitter-base electrodes of a transistor in series with the designated cathode. The cathodes, as well as the control circuits, are isolated by diodes.

### Pumped Solid-State Maser

Patent No. 3,002,156. W. S. Boyle and G. E. Smith (Assigned to Bell Telephone Laboratories, Inc.)

A semi-metal such as high purity monocrystalline bismuth, arsenic or antimony is suitable for a maser when pumped by an electric field. The population between two energy levels can be inverted so that an applied signal is amplified by stimulating radiative transitions between these levels.

Crystal 15 is a sidewall of cavity 11. The cavity couples through aperture 13 into waveguide 14 connected to circulator 15. The magnetic field independently causes levels  $n=0$  and  $n=1$  due to orbital splitting. The electric field splits



these levels into  $E_{11}$ ,  $E_{21}$ ,  $E_{31}$  and  $E_{41}$ . The electric field can produce a transition between levels  $E_{11}$  and  $E_{21}$ , or  $E_{11}$  and  $E_{31}$ , so that energy from signal source 16, corresponding to the difference between levels  $E_{21}$  and  $E_{11}$ , is amplified by maser action.



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## REPORT BRIEFS

### Network Synthesis

An electrostatic analog computer was built that can approximate the real part, the imaginary part and the amplitude of the required function. The approximating function is described in terms of its pole and zero locations and a multiplicative constant. They are moved around in the conducting medium until the desired imittance is obtained. The method is one of trial and error, but the amount of computational work compared to that normally encountered in the analytical approach to the approximation problem is greatly reduced. *Solution of the Approximation Problem of Network Synthesis With an Analog Computer, Stanley Lehr, Microwave Research Institute, Polytechnic Institute of Brooklyn, New York, June 18, 1953, 40 pp, \$3.60. Order PB 157274 from OTS, Washington 25, D. C.*

### Wide-Band Amplifiers

An attempt was made to establish rigorously the ultimate limitations on gain and bandwidth of transistor wideband amplifiers. The amplifiers worked with were either completely or approximately unilateral. Results are obtained for unilateral common-base and common-emitter amplifier cascades. Two examples of transistor amplifier interstage design are presented. They show how closely one can estimate performance in a given situation using the derived limitations. Gain-bandwidth limitations for Esaki-diode linear amplifiers are also derived using the same techniques as for transistor interstages. *Theoretical Limitations of Gain and Bandwidth in Wide-band Transistor and Esaki Diode Amplifiers, J. S. Logan, Stanford Electronics Laboratories, Stanford University, Calif., Sept. 20, 1960, 121 pp, \$10. Order PB 152251 from OTS, Washington 25, D. C.*

### X-Band Recorder

A specialized field intensity recording receiver designed to operate in the X-band (9.1 Gc) portion of the radio spectrum is described and its operational characteristics presented. The receiver normally operates on a fixed frequency of 9,100.1 mc but may be

operated at  $\pm 100$  mc intervals from the nominal, in the band 8.5 to 9.6 Gc. It displays an extremely narrow bandwidth of 45 cps, held by a stable and flat crystal filter. The narrow bandwidth (approximately  $5 \times 10^{-7}$  per cent at the X-band frequency) makes possible a high signal-to-noise figure, a desirable characteristic for a receiver used in tropospheric research. The application of the receiver is primarily for remote, unattended operation. *A Fixed Frequency, 9.1 Gc, Field Intensity Recording Receiver With Extremely Narrow Bandwidth*, R. W. Hubbard and J. V. Cateora, National Bureau of Standards, Boulder, Colo., June, 1961, 83 pp, \$0.75. Order PB 161608 from OTS, Washington 25, D. C.

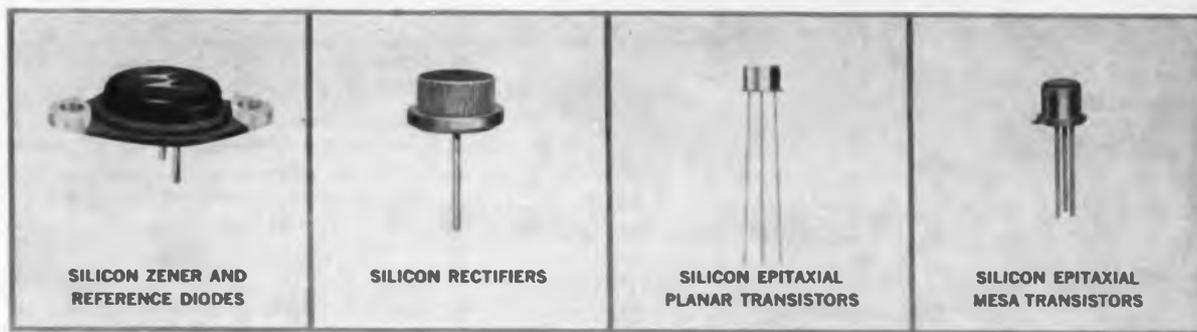
### Ring-Type Pulse Generator

A transistorized ring-type pulse generator was developed which yields a repetitive sequence of high-power timed pulses in separate output circuits. The output circuits are electrically insulated from the rest of the circuit, so that either positive or negative polarity may be obtained. The timing interval is based on the time required for a given transformer core to change from negative to positive saturation. This circuit is applicable wherever sequenced pulses at fixed time intervals are required or for timing or delay applications. *Transistorized Ring-Type Pulse Generator*, J. M. Marzolf, Naval Research Laboratory, Washington, D. C., Aug. 14, 1961, 4 pp, \$0.50. Order AD-261 200 from OTS, Washington 25, D. C.

### Switch Power Amplifier

Research is described on the use of switches as power amplifiers. The switches are controlled by a signal to produce a duration-modulated pulse train that is then passed through a low pass filter to recover the amplified signal. The method can convert dc source power to signal power with an efficiency approaching 100 per cent (with lossless switches). The distortion is low if the pulse repetition rate is sufficiently higher than the cut-off frequency of the filter, and if the signal modulating the pulse train is in the filter pass band. *Research Directed Toward the Study of Linear Amplification Using Switches*, A. W. Carlson, Transistor Applications, Inc., Boston, Mass., May 31, 1960, 12 pp, \$0.50. Order AD-258315 from OTS, Washington 25, D. C.

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REPORT BRIEFS

**Microwaves**

Field emission effects, in devices for microwave amplification and harmonic generation, where the high current densities and minute dimensions of field-emission cathodes are especially desirable are discussed. The characteristics of field-emission diodes are expressed in terms of parameters dependent upon paraboloidal geometry for the emitter and collector. An application of the emission modulation properties is given in the design of a microwave 2-cavity amplifier, including the operating characteristics and expected performance. *Field-Emission Cathode Microwave Devices*, J. Fontana, Microwave Laboratory, Stanford University, Calif., 206 pp, \$14. Order PB 157687 from OTS, Washington 25, D. C.

**Distributed Amplifiers**

Emitter degeneration is used to raise the input impedance of transistors so that their use in a distributed amplifier follows along vacuum tube lines. A particular form of degeneration impedance is found that allows the direct interchange of gain for bandwidth. Design equations for the conventional constant-k distributed amplifier are presented and the experimental results are compared with the theoretical. *Transistor Distributed Amplifier*, P. H. Rogers and L. H. Enloe, Applied Research Laboratory, University of Arizona, Tucson, Feb. 1, 1959, 35 pp, \$3.60. Order PB 154393 from OTS, Washington 25, D. C.

**S-Band Isolator**

Development and design information is presented for a high-power, resonance-absorption ferrite isolator operating in the frequency range of 2,700 mc to 3,700 mc. The theory underlying recent broadbanding techniques, as well as some waveguide transmission properties, are presented. Their applications are illustrated graphically. Other phases of the art of ferrite isolator design are also considered. *Development Of a High Power S-Band Isolator*, B. J. Duncan and D. R. Taft, Sperry Microwave Electronics Co., Clearwater, Fla., 41 pp, \$1.25. Order PB 171935 from OTS, Washington 25, D. C.

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## Broadband Amplifiers

A study was made of broadbanding techniques using local feedback in transistor amplifiers. Primary interest is given to low-pass video signal amplification. Attention is focused on the broadbanding effect of feedback rather than on other properties. A simplified model of the transistor is used to develop simple analysis and design formulas. It is shown that these feedback techniques are superior in gain-bandwidth product in comparison with shunt-peaked amplifiers. *A New Feedback Broadbanding Technique For Transistor Amplifiers*, M. S. Ghauri and D. O. Pederson, Electronics Research Laboratory, University of California, Berkeley, Aug. 24, 1960, 17 pp, \$0.50. Order PB 171937 from OTS, Washington 25, D. C.

## Transistorized Power Converters

Investigations were continued on: (1) methods of voltage regulation; (2) methods of voltage sensing; (3) methods of obtaining multiple output voltages, and (4) methods of obtaining multiple output power levels. At least 2 approaches in each topic were made with the advantages and disadvantages in the modular concept discussed. A typical modular system is presented which illustrates the flexibility of the modular concept. A breakdown of the concept results in a total of 188 different power supplies. *Study and Development of Transistorized Modular Power Converters*, Hamilton Standard Div., United Aircraft Corp., Broad Brook, Conn., 47 pp, Aug. 14, 1961, \$5.60. Order AD-261 173 from OTS, Washington 25, D. C.

## Feedback Amplifiers

This report studies the analysis and design of the shunt-series-pair feedback amplifier. An approximate unilateral model is used for the transistors. The amplifiers are designed for wide-band video applications such as two-pole, maximally flat transmission characteristics. Experimental verification of the theory is given for medium-frequency alloy-junction transistors and for high-frequency mesa transistors. *Analysis and Design of the Shunt-Series Feedback Pair*, M. S. Ghauri, Electronics Research Laboratory, University of California, Berkeley, Aug. 16, 1960, 21 pp, \$0.75. Order PB 171938 from OTS, Washington 25, D. C.



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- Resists the softening effect of varnishes containing hot aromatic naphthas such as toluol and xylol.
- Stickers or adhesive cements containing acetone or methyl ethyl ketone can be used with Beldure.

Ask your Belden sales engineer for additional information about Beldure magnet wire.

*Other Belden Magnet Wire:* Beldenamel\*, oleoresinous • Beldsol\*, polyurethane-nylon • Beldbond\*, polyurethane-bonding agent • Beldtherm\*, polyester • Celenamel\*, cellulose acetate • Formvar, vinyl acetal • Nylclad\*, vinyl acetal-nylon • Epoxy

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electronic wire • control cables • automotive replacement  
wire and cable • aircraft wire



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is now engaged in designing and developing computer-based command and control systems which collect, sort, transmit, and display information vital to those who make command decisions. SAC's Command and Control System, SAGE, BMEWS, NORAD, MIDAS and other urgent military programs are all within the scope of MITRE's system integration work.

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- Radar Systems and Techniques
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- Advanced System Design
- Computer Technology
- Mathematics
- Air Traffic Control System Development
- Antenna Design
- Microwave Components

Write in confidence to: VICE PRESIDENT — TECHNICAL OPERATIONS, THE MITRE CORPORATION,  
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CIRCLE 901 ON CAREER INQUIRY FORM

## YOUR CAREER

### New Booklet Helps Plan For Military Call-Ups

A new booklet to help employers identify personnel subject to military call-up, has been developed by the Engineering and Scientific Manpower Commission.

The 14-page "Employer's Inventory of Critical Manpower," provides forms and instructions for a quick analysis of the probable draft liability of male employees, especially those having critical occupations.

The booklet is available for \$1 from the Engineering Manpower Commission of the Engineers Joint Council, 345 E. 47 St., New York 17, N. Y.

### Bill Would Broaden Education Tax Deduction

A bill to make the costs of education or training deductible as trade or business expense, when they are incurred to get a new or better job, was introduced in Congress by Rep. Thomas B. Curtis (R, Mo.). Under present Internal Revenue and court rulings, an engineer can deduct costs of education necessary to maintain his status in his present field of employment, but not to enter a new field, such as law. Under the Curtis bill, he could deduct expenses for study in any field.

### Engineers Queried On Seminar Formats

A survey designed to help plan seminars for engineers, has revealed that over a six-month period engineers attend from one to 20 meetings.

Twenty-one of the 46 respondents said they attend seminars that go beyond present work, 11 attend those related directly to work and 14 prefer both.

The survey was conducted by the Vernon Pope Co., and results were based on an evening seminar sponsored jointly by Lafayette Radio Corp. and Texas Instruments Inc.

It was found that most engineers prefer a combination of theory and design applications, with emphasis on the latter.

There was a split vote on the program: 22 prefer a speaker plus general discussion; 19 seminar speakers only, and one suggested a speaker only with no discussion. There were suggestions for an outline of topic and en-

ELECTRONIC DESIGN **CAREER INQUIRY SERVICE** USE BEFORE JAN. 18, 1962

After completing, mail career form to ELECTRONIC DESIGN, 850 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below.

25

(Please print with a soft pencil or type.)

Name \_\_\_\_\_ Telephone \_\_\_\_\_

Home Address \_\_\_\_\_ City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

Date of Birth \_\_\_\_\_ Place of Birth \_\_\_\_\_ Citizenship \_\_\_\_\_

Position Desired \_\_\_\_\_

Educational History				
College	Dates	Degree	Major	Honors

Recent Special Training \_\_\_\_\_

\_\_\_\_\_

Employment History				
Company	City and State	Dates	Title	Engineering Specialty

Outstanding Engineering and Administrative Experience \_\_\_\_\_

\_\_\_\_\_

Professional Societies \_\_\_\_\_

Published Articles \_\_\_\_\_

Minimum Salary Requirements (Optional) \_\_\_\_\_

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924  
925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949

## Advancement Your Goal?

## Use CONFIDENTIAL Action Form

ELECTRONIC DESIGN's Confidential Career Inquiry Service helps engineers "sell" themselves to employers—as confidentially and discreetly as they would do in person. The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—the same day the resume is received.

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

- All forms are delivered unopened to one reliable specialist at ELECTRONIC DESIGN.
- Your form is kept confidential and is processed only by this specialist.
- The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
- All original applications are placed in confidential files at ELECTRONIC DESIGN, and after a reasonable lapse of time, they are destroyed.

If you are seeking a new job, act now!

Philco WDL has immediate and challenging engineering positions open in Discoverer, Midas and Advent programs in these categories:

- Data systems engineering
- Technical Staff — communications and data systems
- Systems test planning
- Systems reliability analysis
- Design Engineering — surface and vehicle electronics
- Human factors and operations analysis
- Field tracking station activation
- Tracking and control systems design
- Logistics and station support
- And others

*U.S. citizenship or current transferable Department of Defense clearance required*

### *if your future is for growing...*

People at Philco's Western Development Laboratories are proud of their achievements, secure in the steady growth of their company, enthusiastic about their future.

In just four years, Philco WDL has expanded from a staff of 18 to more than 2,000. At the end of this year WDL will open a new 250,000-square-foot facility which will accommodate a continually expanding complement of engineers, scientists and supporting staff members.

Philco WDL, the space organization which designed and built the Courier satellite, conducts an ever-growing development program in tracking, satellite instrumentation, communications, data processing and command—moving hand in hand with the federal government in space exploration and space age defense.

Your growth with a growing company, ideal living on the Northern California Peninsula, professional and monetary advancement commensurate with your own ability—these are some of the advantages and satisfactions of working at Philco Western Development Laboratories.

If yours is one of the fields listed at the left, write today to Mr. W. E. Daly, in confidence, of course, Department D-12.

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CIRCLE 902 ON CAREER INQUIRY FORM

## YOUR CAREER

engineering uses, plus a question and answer period.

Men preferred meetings away from company premises, and they believe an evening seminar should last about an hour. There was divided opinion as to whether refreshments should follow or precede the meeting.

When quizzed on the Lafayette Semiconductor Seminar, most agreed it had been helpful. Most men said the material was well presented, but many engineers suggested use of more examples, and some felt the material was too wide in scope for an evening's presentation. Some respondents said they would like summaries of remarks or other printed material on the seminars to take home.

\* \* \*

**Dr. Gordon J. Murphy**, professor and chairman of Northwestern University's electrical engineering dept., was named one of Chicago's Ten Outstanding Young Men of 1961. The award, sponsored by the Chicago Junior Association of Commerce and Industry, was given for Dr. Murphy's record in research and education.

A specialist in automatic feedback control (with application for guided missiles and controlling body processes), Dr. Murphy's research greatly increased the number of graduate students in this field. His proposal to use control theory for production and warehouse problems won him the first research grant of the Foundation for Instrumentation Education and Research.

His two textbooks, "Basic Automatic Control Theory" and "Control Engineering," are used by about 20 engineering schools in the U.S.

Dr. Murphy organized, and was first chairman of, the Chicago Chapter of the Professional Group on Automatic Control, Institute of Radio Engineers.

\* \* \*

**So fast you can't see them:** Recently, one of ELECTRONIC DESIGN's editors was handling some samples of a new high-speed switching transistor. Faster than anything before it, he was told. Curious, he subjected them to the fastest square waves he had available (a miserable 1 mc) and looked at his scope for results: nothing. Other experiments failed to provide any output so the editor concluded that this nanosecondish device worked only with nanosecondish inputs.

The next day the public relations man who had given out the transistors said, "Oh, didn't

you know, they were dummies, just leads sticking out of a case filled solid with potting compound."

\* \* \*

**Seventh Law of Tacking**—Reader Robert D. Rodenroth, Warner Robins, Ga., writes:

"I greatly enjoyed your article in the July issue of 'Johnson's Six Laws of Tacking.' Being somewhat of a tacker myself, I have been noticing with renewed interest the work of my colleagues along these lines. I am very happy to report that, in general, they are doing a fine job of abiding by the rules. However, occasionally some poor misguided soul comes along and perverts the entire spirit of the laws by—of all things—INSULATING.

"Any dyed-in-the-wool tacker knows the consequences of this; beautiful putty-like solder joints (Law 4) hidden by spaghetti, the artistic geometric forms (Law 3) growth-stunted by close running, unbent conductors, and the complete absence of the crisp odor of hot phenolic as your favorite one-of-a-kind resistor gives up with a faint sputter.

"Truly, insulating is unforgivable.

"I therefore propose to Mr. Johnson the addition of a Seventh Law—No Insulating."

## ENGINEER-IMPROVEMENT COURSES AND SEMINARS

**Systems Analysis Course**  
Willow Grove, Pa., Dec. 26-30; Mar. 5-9

A one-week course for systems analysts on installation of large electronic data-processing systems will be held at Philco Computer Center, Willow Grove, Pa., Dec. 26-30 and March 5-9.

Speeds, capabilities and specifications of personnel, the seminar will deal with large computer equipment and programming systems will be covered in an effort to set up the most economical and efficient use of a computer.

For information, write *C. A. Leventhal*, manager of computer education, Philco Computer Div., 3900 Welsh Road, Willow Grove, Pa.

**Electrical Engineering Course**  
University of Wisconsin, Jan. 11-12

A two-day basic refresher course in Electrical Engineering will be conducted at the University of Wisconsin, Jan. 11 and 12, 1962. Registration fee and tuition is \$25. Contact: *Engineering Institutes, University Extension Div., Wisconsin Center, University of Wisconsin, Madison 6, Wis.*



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Still further pioneering and expansion are planned in advanced areas of phased array radar, pulse doppler radar systems, space radar and communications systems, creating positions for Engineers interested in and qualified for working at the threshold of the state of the art.

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**RECEIVER DESIGN ENGINEERS**

For design and development of receivers for military applications. Experience should include design of low noise front ends, IF strips, AGC circuitry and application of image rejection techniques — all transistorized. BS in EE or Physics with 3 to 8 years experience.

**CIRCUIT DESIGN ENGINEERS**

To translate conventional wire circuits into flexible and/or rigid printed circuitry and to design circuitry layout and approaches for printed circuits. EE, ME or ChE with printed circuit background.

**TRANSMITTER DESIGN ENGINEERS**

For design and development of transmitters (VHF, UHF and microwave), tubes, pulse modulators, power in excess of 1 kilowatt — for military and airborne applications.



Resumes should be addressed to R. W. McCarthy.

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**Lists and Describes 8700  
Recent Electronic Products**

The new EDC makes it easier than ever before to locate and obtain information about recently released electronic products. Improvements suggested by readers include:

- *Simplified code and reference numbers, for new products.*
- *Bold category heads on each page make it easier to find products listed in the locator.*
- *Improved cross references.*
- *An entirely new section—"Index to New Products by Manufacturer." Use it to scan a given company's new product activity.*

EDC is Electronic Design's 27th Issue.

## YOUR CAREER

### PAPER DEADLINES

**Dec. 15:** Deadline for 500-word abstracts to be presented at the **Bay Area Symposium on Reliability and Quality Control**. This will be held at the U. S. Naval Post Graduate School, Monterey, Calif., on **May 4 and 5, 1962**.

The theme will be "Today's Reliability Challenge." Papers should pertain to such areas of reliability as components—micro-miniaturization, semiconductors, effects of space, new developments, accelerated life tests; new techniques—methods employed for determining reliability and maintainability requirements and predictions of systems and components; achievements—ground systems, airborne systems, aero space.

Abstracts should be sent in triplicate to **Frank B. Durand, 553 Connemara Way, Sunnyvale, Calif.** Authors will be notified by Jan. 15 of acceptance or rejection of their papers.

**Feb. 1:** Deadline for reproducible copies of abstracts for the **Third Symposium on Engineering Aspects of Magnetohydrodynamics** to be held at the University of Rochester, Rochester, N. Y. on **March 28 and 29, 1962**. It will be sponsored by AIEE, IAS, IRE and the University of Rochester.

The following subjects are being considered for session topics and papers are requested in these areas: Communications and Diagnostics, dealing with the transmission and receiving of information or energy from plasmas under various conditions; Flight Applications, dealing with the propulsion or control of aerodynamic or space vehicles by MHD interaction between the vehicle and its environment; Fusion, dealing with the extraction of energy through controlled thermonuclear fusion of light nuclei; and Power Conversion, dealing with the extraction of electrical energy from hot flowing plasmas or conducting liquids.

Send papers on **Communication and Diagnostics** to **Prof. Sanborn C. Brown, Physics Dept., MIT, Cambridge 39, Mass.**; on **Flight Applications** to **Dr. Harry Harrison, Space Propulsion, NASA, 1520 "H" Street NW, Washington 25, D. C.**, on **Fusion** to **Dr. Richard F. Post, Lawrence Radiation Laboratory, Livermore, Calif.**, and on **Power Conversion** to **Dr. Stewart Way, Westinghouse Research Laboratory, East Pittsburgh, Pa.**

ELECTRONIC DESIGN • December 6, 1961

CAREERS



## No two are the same

And the molecules in any two elements are never the same either. At Cal Tech's Jet Propulsion Laboratory, these molecular differences will soon add up to a better understanding of what the Moon is made of.

When the first Surveyor spacecraft soft-lands on the Moon in 1963, it will drill into and extract samples from the Moon's surface. After an electric oven decomposes these samples, their molecules in the form of burned-off gas will pass through a column to a detector. The detector response rate—and the amount of molecules—will be recorded and transmitted to earth.

Since JPL scientists and engineers know what mole-

cules cause what kinds of responses (fingerprints), they will then know what elements are on the Moon. Most important, they may detect pre-life molecules on our satellite—a first clue to life in outer space.

At JPL it takes many good, curious, searching, dedicated minds to determine what instruments will measure what on the Moon and planets. Many many minds that work as one. Minds such as yours, perhaps. Will you write us today? If you have a mind to?

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Minimum desirable background includes B.S. in E.E. with 5 years or more of experience in design analysis of advanced communications systems, high powered transmitters, antennas, R.F. transmission lines and propagation.

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To act as project leaders in research activity for the development of phased array antenna systems and for advanced design of radar and communications systems. Minimum desirable background M.S. in E.E. with 8 years or more of direct experience.

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Please send resume to: North American Aviation, The Professional & Technical Employment Office, Box ED-418, 4300 East Fifth Avenue, Columbus 16, Ohio, Attn: H. Keever, Manager

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.



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ASST. TO PRESIDENT Plus stock option. Microwave exp. desirable.	..... \$18,000
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THEORETICAL PHYSICIST Solid State.	..... \$17,500
DESIGN ENGINEER Amplifiers.	..... \$14,000
RADAR SYSTEMS	..... \$12-14,000
SR. PROJECT ENGINEER Surveillance Systems.	..... to \$25,000
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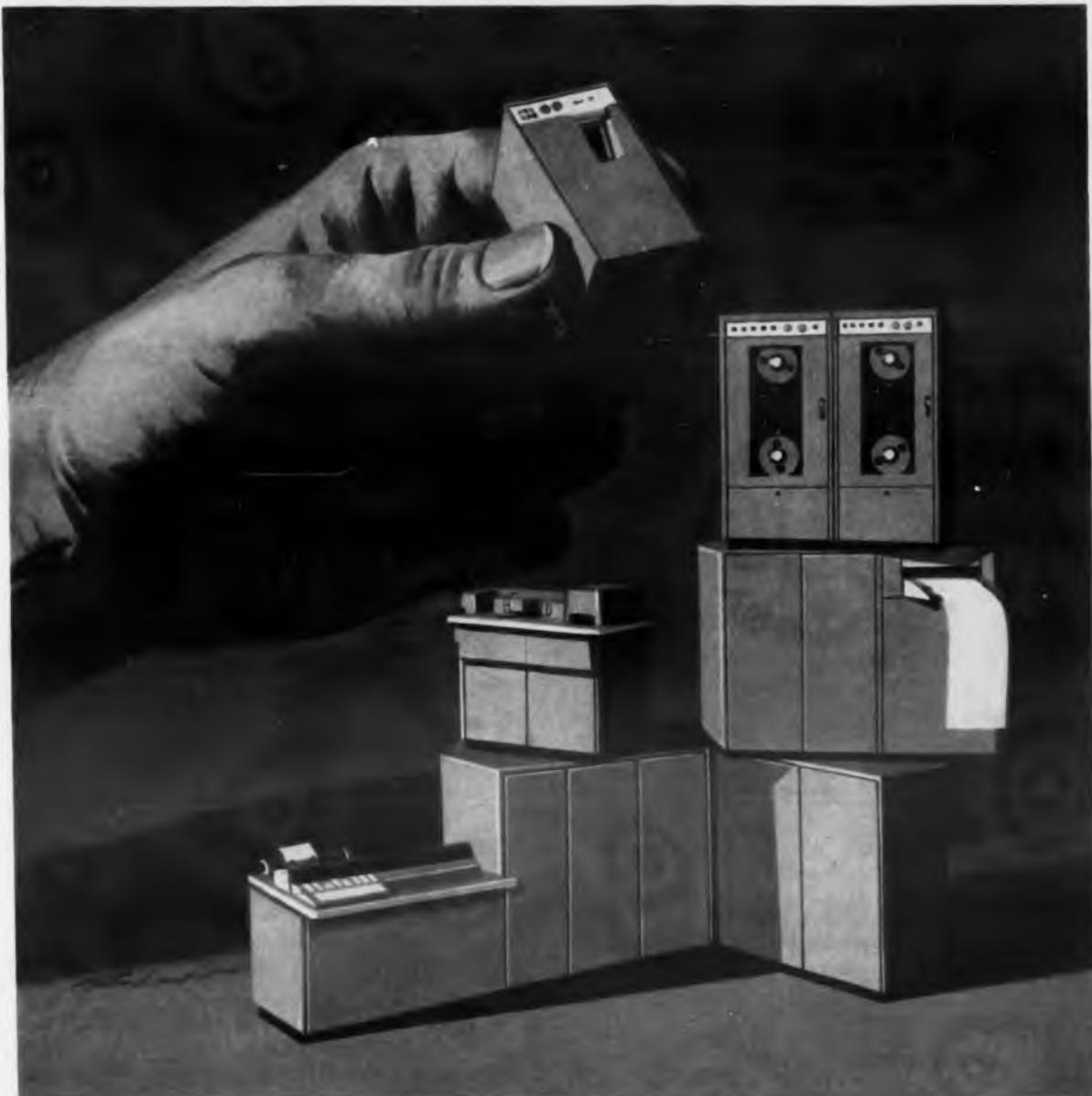
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\*Manufacturers' catalog appears in 1962 ELECTRONIC DESIGNERS' CATALOG



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Interviews at the Eastern Joint Computer Conference, Washington, D.C. For an appointment, call Norval Powell, during the conference, at the Sheraton-Park Hotel, Columbia 5-2021.

Interviews will also be held during the Solid State Circuits Conference, in Philadelphia. Please send your resumé immediately to Norval Powell at the address below.

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CAREERS

# TOLERANCE BE DAMNED

You won't see this statement framed and hung on the walls. You won't find it tacked to a designer's board, or spoken aloud in the die shops. "Tolerance be damned" is not a slogan.

It's an attitude.

In precision machining, tolerance is an allowance for error. Someone stakes out a fence; within it you have permission to go wrong.

At Republic, the Special Products division—designers, tool makers, engineers—have a frank disrespect for what's merely allowable. They worship the absolute. They stay up nights shooting for it.

Take the SPG-51, employing a plastic radar reflector. Raytheon's specifications: that the reflector be operable in winds up to 120 knots, that it operate immediately after a total shock load of 80 tons, that its weight not exceed 400 pounds, that its front surface be within  $\pm .026$  of a true parabola, that it not take more than 8 weeks to produce.

Two weeks before deadline Raytheon was invited to inspect the finished reflector. Their findings: for a start, it would operate in hurricane force winds, would recover instantly from 80 ton shocks.

Then came the dividends.

Republic's reflector weighed 51 pounds less than the limit. The entire mold surface trued to .018 of an absolute parabola. This was eight one-thousandths of an inch more accurate than tolerance requirements.

The SPG-51 reflector went into production—three a month. As an extra fillip, the Special Products group lopped another 25 pounds off weight, without reducing structural integrity. Nobody asked them to, they simply didn't give a damn for tolerance.

Special Products and Services will research, design, test and produce radar reflectors, antennas, and radomes from undersea to outer space. They do the same for mechanical and electrical assemblies of any nature. They're a part of Republic, where everyone shoots for the absolute.

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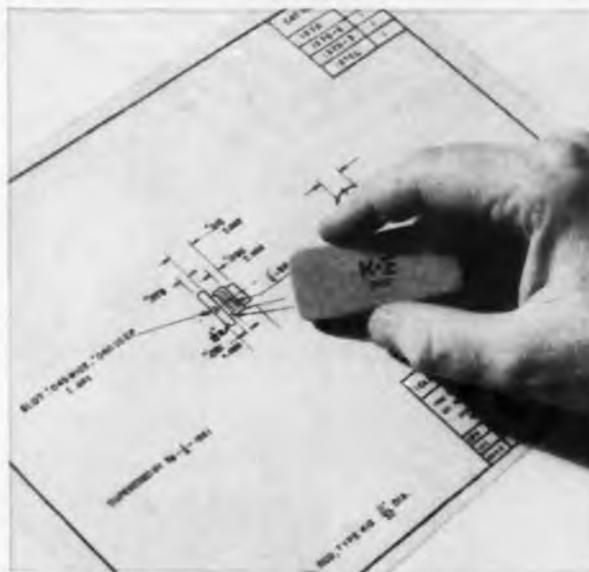
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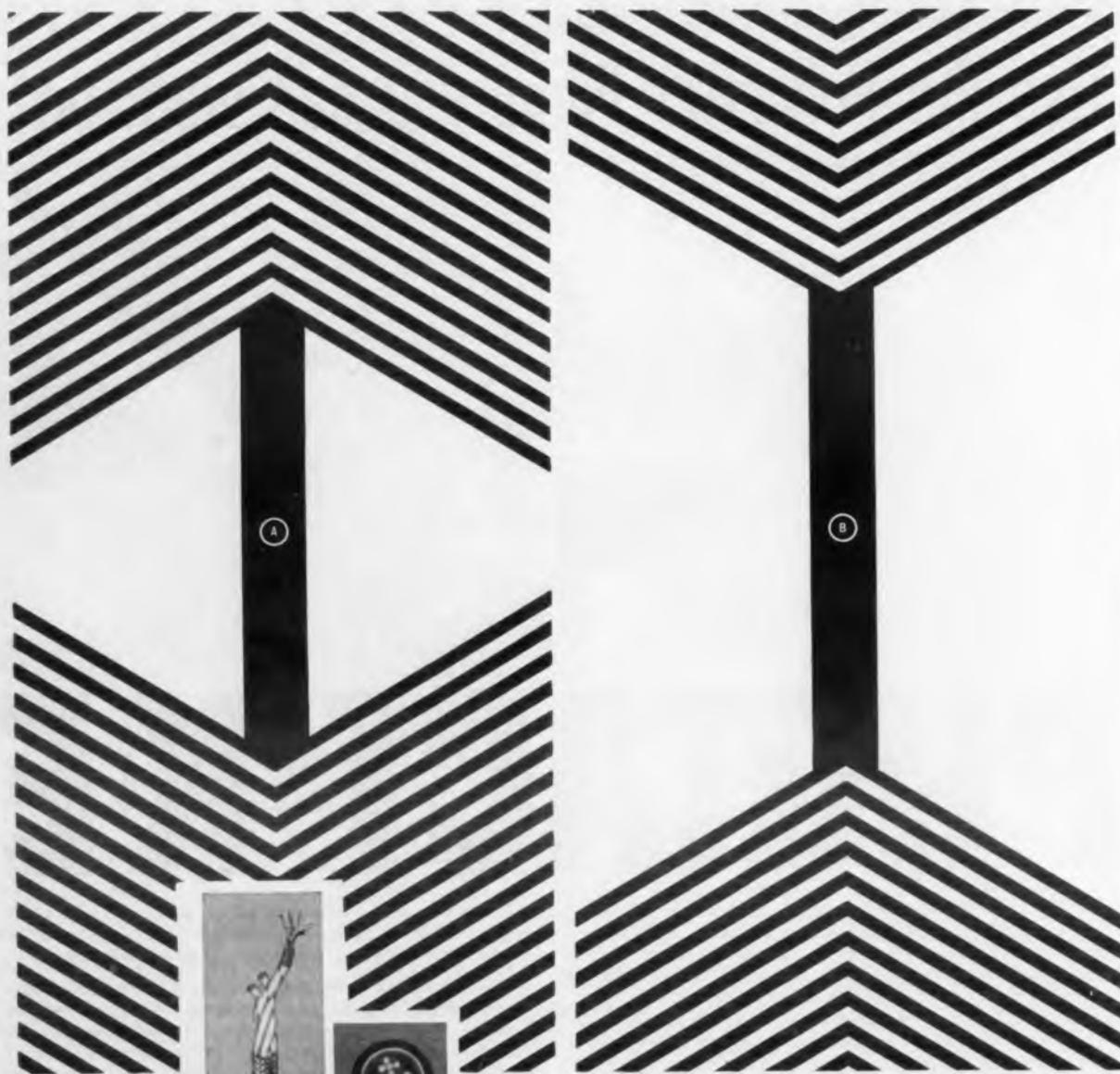
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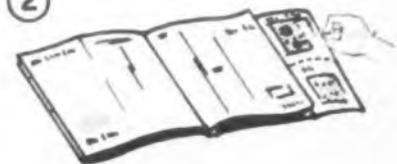
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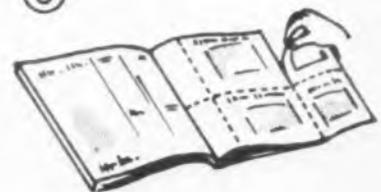
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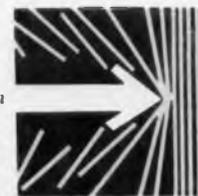
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$V_{CE}(\text{sat.})$	$I_C = 10 \text{ ma}; I_B = 1 \text{ ma}$	.22 volts max.
$V_{BE}(\text{sat.})$	$I_C = 10 \text{ ma}; I_B = 1 \text{ ma}$	.3 volts max.
$t_s$	$I_C = 10 \text{ ma}; I_{B1} = 10 \text{ ma};$ $I_{B2} = 10 \text{ ma};$	25 nano-seconds max.
$t_{\text{fall}}$	$I_C = 10 \text{ ma}; I_{B1} = 3 \text{ ma};$ $I_{B2} = 1 \text{ ma}; V_{CC} = 3 \text{ volts}$	40 nano-seconds max.
$t_{\text{off}}$	$I_C = 10 \text{ ma}; I_{B1} = 3 \text{ ma};$ $I_{B2} = 1 \text{ ma}; V_{CC} = 3 \text{ volts}$	75 nano-seconds max.

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