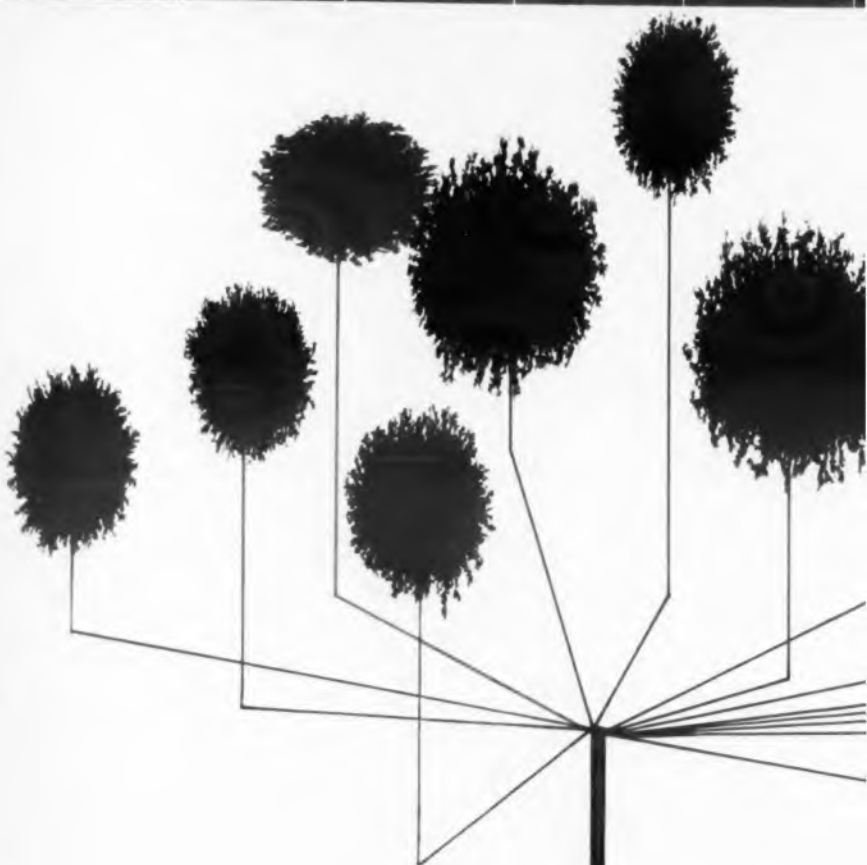
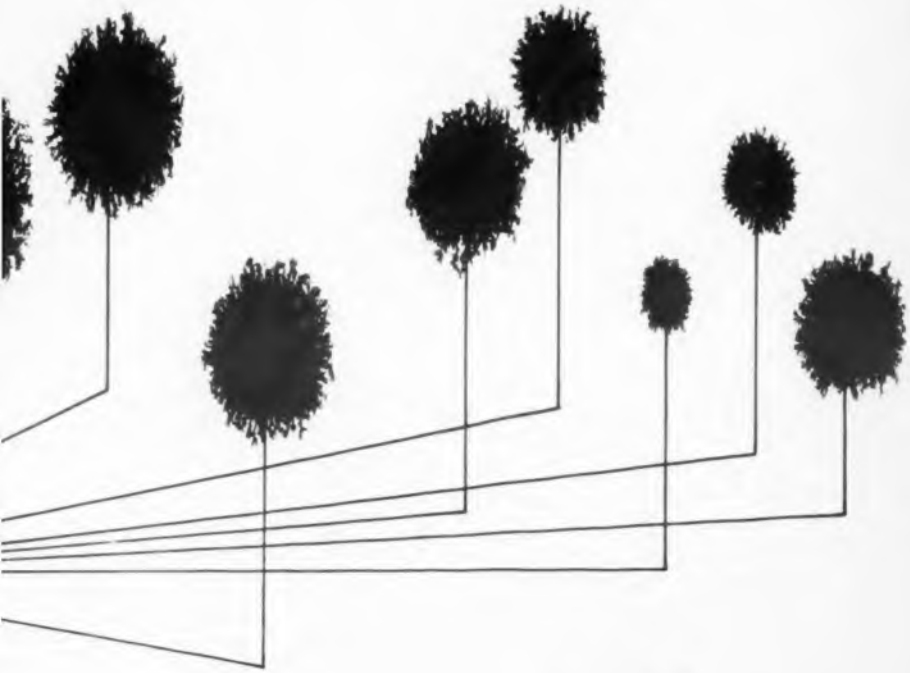
ELECTRONIC DESIGN



Selecting telemetering commutators—

ESIGN



—a staff report... p 40

PULSE TRANSFORMERS FROM STOCK

MINIATURE STABLE WOUND CORE — HERMETIC MIL-T-27A TYPE TF5SX36ZZ

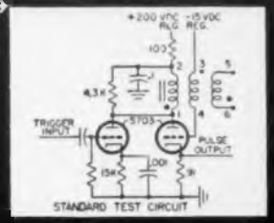
UTC miniature, wound core, pulse transformers are precision (individually adjusted under test conditions), high reliability units, hermetically sealed by vacuum molding and suited for service from —70° C. to +130° C. Wound core structure provides excellent temperature stability (unlike ferrite). Designs are high inductance type to provide minimum of droop and assure true pulse width, as indicated on chart below. If used for coupling circuit where minimum rise time is important, use next lowest type number. Rise time will be that listed for this lower type number . . . droop will be that listed multiplied by ratio of actual pulse width to value listed for this type number. Blocking oscillator data listed is obtained in standard test circuits shown. Coupling data was obtained with H. P. 212A generator (correlated where necessary) and source/load impedance shown. 1:1:1 ratio.

DEFINITIONS

Amplitude: Intersection of leading pulse edge with smooth curve approximating top of pulse.
Pulse width: Microseconds between 50% amplitude points on leading and trailing pulse edges.
Rise Time: Microseconds required to increase from 10% to 90% amplitude.
Overshoot: Percentage by which first excursion of pulse exceeds 100% amplitude.
Droop: Percentage reduction from 100% amplitude a specified time after 100% amplitude point.
Backswing: Negative swing after trailing edge as percentage of 100% amplitude.

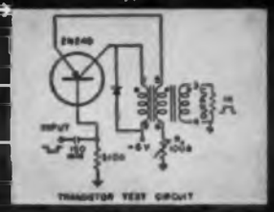
Type No.	APPROX. DCR, OHMS 1-2	3-4	5-6	BLOCKING OSCILLATOR PULSE Width μ Sec.	Rise Time	% Over Shoot	Droop %	% Back Swing	P Width μ Sec.	COUPLING CIRCUIT CHARACTERISTICS Volts Out	Rise Time	% Over Shoot	Droop %	% Back Swing	Imp. in, out, ohms
H-45	3	3.5	4	.05	.022	0	20	10	.05	17	.01	20	0	35	250
H-46	5.5	6.5	7	.10	.024	0	25	10	.10	19	.01	30	10	50	250
H-47	3.7	4.0	4	.20	.026	0	25	8	.20	18	.01	30	15	65	500
H-48	5.5	5.8	6	.50	.03	0	20	5	.50	20	.01	30	20	65	500
H-49	8	8.5	9	1	.04	0	20	10	1	24	.02	15	15	65	500
H-50	20	21	22	2	.05	0	20	10	2	27	.05	10	15	35	500
H-51	28	31	33	3	.10	1	20	8	3	26	.07	10	10	35	500
H-52	36	41	44	5	.13	1	25	8	5	23	.15	10	10	45	1000
H-53	37	44	49	7	.28	0	25	8	7	24	.20	10	10	50	1000
H-54	50	58	67	10	.30	0	20	8	10	24	.25	10	10	50	1000
H-55	78	96	112	16	.75	0	20	10	16	23	.40	5	15	20	1000
H-56	93	116	138	20	1.25	0	25	10	20	23	.6	5	10	10	1000
H-57	104	135	165	25	2.0	0	30	10	25	24	1.5	5	10	10	1000
H-60	.124	.14	.05	.05	.016	0	0	30	.05	9.3	.012	0	0	20	50
H-61	.41	.48	.19	.1	.016	0	0	30	.1	8.2	.021	0	0	15	50
H-62	.78	.94	.33	.2	.022	0	0	18	.2	7.4	.034	0	5	12	100
H-63	1.86	2.26	.70	.5	.027	2	10	20	.5	7.5	.045	0	20	25	100
H-64	3.73	4.4	1.33	1	.033	0	12	25	1	7	.078	0	15	23	100
H-65	6.2	7.3	2.22	2	.066	0	15	25	2	6.6	.14	0	10	20	100
H-66	10.2	12	3.6	3	.087	0	18	30	3	6.8	.17	0	10	20	100
H-67	14.5	17.5	5.14	5	.097	0	23	28	5	7.9	.2	0	18	28	200
H-68	42.3	52.1	14.8	10	.14	0	15	28	10	8.5	.4	0	15	30	200

Vacuum Tube Type Ratio 1:1:1



STANDARD TEST CIRCUIT

Transistor Type Ratio 4:4.1



Units: 0 — Negligible

H-45, 46, 60 thru 68 are 3/8 cube, 1 gram H-47 thru 52, 9/16 cube 4 grams H-53 thru 57, 5/8 cube 6 grams

AND SPECIAL UNITS TO YOUR SPECS

While stock items cover low level uses only, most of UTC's production is on special units to customers' needs, ranging from low levels to 10 megawatts.

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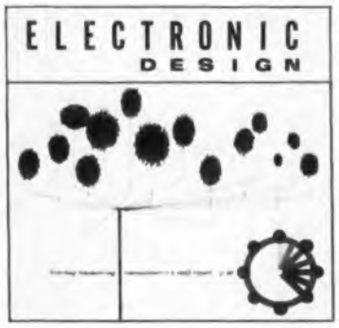

COVER: The design in the lower right portion of the cover represents the artist's view of the sweeping brush found in electromechanical commutators. The more abstract design illustrates the more general concept of scanning. Color is used to highlight the one parameter being monitored at a given instant

Selected Topics In This Issue

◀ CIRCLE 1 ON READER-SERVICE CARD

ELECTRONIC DESIGN · ONE DAY SERVICE

USE BEFORE MAY 10th, 1961

A

Name _____ Title _____

Company _____

Company Address _____ City _____ Zone _____ State _____

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290
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hp Model 938A supplies power from 18 to 26.5 KMC when driven by a 9 to 13.25 KMC source; hp Model 940A supplies power from 26.5 to 40 KMC when driven by a 13.25 to 20 KMC source.

The hp 938A and 940A have the same output versatility as the driving source. These broadband instruments accept cw, pulsed or swept input signals from signal generators, swept signal sources or klystrons.

Each contains a broadband crystal-harmonic generator, plus a dual rotary vane attenuator, for generating and accurately setting the output level 0 to —100 dbm. Output power depends on input power and is typically 0.5 to 1.0 mw when the driving source is an hp 626A or 628A Signal Generator or an hp 686A Sweep Oscillator. Output power is known, even though an uncalibrated signal source is used, since the output monitor is accurate to ± 1 to ± 2 db, depending on model and frequency.

hp 938A/940A conversion loss is approximately 17 db at 10 mw input. Maximum input 200 mw, saturation output 2 mw. Attenuator accuracy ± 2% of reading or 0.2 db (whichever is greater). Attenuator range 100 db; output SWR less than 1.2 at 10 db or more attenuation. hp 938A, $1,500.00; hp 940A, $1,500.00.

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Harris-Hanson Company
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• Dallas 9, Texas
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FL 7-1881 and ED 2-6667

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hp 606A Standard Signal Generator 50 KC to 65 MC

Output adjustable from 3 v full range to 0.1 μv rms (+23 to −120 dbm). Feedback assures power into a 50 ohm load constant within ± 1 db over the frequency range. Reliable internal crystal calibrator permits checking points at 100 KC and 1 MC intervals with an error of less than 0.01%. Very low distortion, broad modulating capabilities. Typical hp speed, ease of operation. hp 606A, $1,350.00.

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hp 608D—10 to 420 MC

Highest stability, low incidental FM and frequency drift. Calibrated output 0.1 μv to 0.5 v throughout range. Built-in crystal calibrator provides frequency check accurate within 0.01% each 1 and 5 MC. Master-oscillator, buffer and output amplifier circuit design. Direct calibration, ideal for aircraft communications equipment testing. hp 608D, $1,200.00.

hp 608C—vhf Signal Generator

High power (1 v max.), stable, accurate generator. 10 to 480 MC. Ideal for testing receivers, amplifiers, driving bridges, slotted lines, antennas, etc. hp 608C, $1,100.00.

UHF SIGNAL GENERATORS

hp 612A—450 to 1,230 MC

Same high output power, low incidental FM, broad modulation capabilities as hp vhf signal generators. Frequency, output directly set on large precisely calibrated dials. hp 612A, $1,300.00.

hp 614A—800 to 2,100 MC

Easy to use, direct-reading, one-dial frequency control, high stability and accuracy. Ideal for measuring receiver sensitivity, signal-noise ratio, conversion gain, SWR, transmission line characteristics. hp 614A, $1,950.00.

hp 616B—1,800 to 4,200 MC

Ruggedly built, compact to save bench space, offers same hp precision, ease of operation, compactness of the other hp uhf instruments. hp 616B, $1,950.00.

SHF SIGNAL GENERATORS

hp 618B—3,800 to 7,600 MC
hp 620A—7,000 to 11,000 MC

These instruments provide the simple, versatile operation and varied pulsing capabilities common in hp signal generators to the lower regions of the shf range. The 618B and 620A may be synchronized with an external sine wave or with positive or negative pulse signals, as may other hp signal generators. hp 618B, $2,250.00; hp 620A, $2,250.00.

CIRCLE 3 ON READER-SERVICE CARD ▶

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hp 626A/628A shf Signal Generators

Instruments bringing high power, wide range, convenience and accuracy to the 10 to 21 KMC range. Frequencies, output voltage directly set and read. Output 10 to 20 db better than previous spot-frequency sets; SWR better than 1.2 at 0 dbm and lower. High power output provides excellent drive for the hp 938A/940A Frequency Doubler Sets. Internal pulse, FM or square wave modulation; also external pulsing or FM'ing. hp 626A, 10 to 15.5 KMC, $3,400.00; hp 628A, 15 to 21 KMC, $3,400.00.

hp 680 Series Sweep Oscillators

Five models offering electronic sweeping for greater flexibility, simplified operation; range from 1 to 18.0 KMC. hp 686A, 8.2 to 12.4 KMC and hp 687A, 12.4 to 18.0 KMC, useful for driving hp Frequency Doubler Sets. hp 682C 1 to 2 KMC, $3,090.00; hp 683C, 2 to 4 KMC, $3,000.00; hp 684C, 4.0 to 8.1 KMC, $2,900.00; hp 686A, $2,900.00; hp 687A, $3,400.00.

Instrument	Frequency Range	Characteristics	Price
hp 608A	50 KC to 65 MC	Output 0.1 μv to 3 v. Full feedback loop, low distortion	$1,350.00 Δ
hp 608C	10 to 480 MC	Output 0.1 μv to 1 v into 50 ohm load. AM, pulse, or CW modulation. Direct calibration	1,100.00 ■
hp 608D	10 to 420 MC	Output 0.1 μv to 0.5 v. Incidental FM less than 0.001%	1,200.00 ■
hp 612A	450 to 1,230 MC	Output 0.1 μv to 0.5 v into 50 ohm load. AM, pulse, CW or square wave modulation. Direct calibration	1,300.00 ■
hp 614A	800 to 2,100 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW or FM modulation. Direct calibration	1,950.00 ■
hp 616B	1,800 to 4,200 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW or FM modulation. Direct calibration	1,950.00 ■
hp 618B	3,800 to 7,600 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW FM or square wave modulation. Direct calibration	2,250.00 ■
hp 620A	7,000 to 11,000 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, FM or square wave modulation. Direct calibration	2,250.00 ■
hp 626A	10 to 15.5 KMC	Output 10 dbm to —90 dbm. Pulse, FM, or square wave modulation. Direct calibration	3,400.00 ■
hp 628A	15 to 21 KMC	Output 10 dbm to —90 dbm. Pulse, FM, or square wave modulation. Direct calibration	3,400.00 ■

Δ Rack mounted instruments $15.00 less.
■ Rack mounted instruments $20.00 additional

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CONTENTS FOR MARCH 29, 1961 VOL. 9 NUMBER 7

ELECTRONIC DESIGN

Hayden Publishing Co., Inc.,
830 Third Avenue, New York 22, N. Y.

Coming Next Issue

The 1961 Institute of Radio Engineers International Show and Convention closed last weekend in a clutter of packing cases, crates and exhausted engineers. But shining from the disarray was this year's collection of scientific developments, product announcements, engineering discoveries and state-of-the-art design and production refinements.

ELECTRONIC DESIGN went to press too late to include a wrap-up of the show in this issue. The next issue, however, will carry a complete report of the doings at the industry's biggest show. All outstanding announcements made during the show will be described and analyzed. Whether or not you were there, watch for our special roundup in the April 12 ELECTRONIC DESIGN.

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CIRCLE 5 ON READER-SERVICE CARD

For Designers: Logic Nets in Transistor Cans

Five Companies Packaging Logic Circuitry In Conventional TO-5, -18 Transistor Cans

Thomas E. Mount
West Coast Editor

LOGICAL microcircuits in transistor cans are now being offered by four major companies Heavy research and production is being pressed by Fairchild Semiconductor Corp., Raytheon Co., Philco Corp., General Instrument Corp., and Sperry Gyroscope's Semiconductor Div.

Fairchild and Raytheon are currently selling evaluation quantities of the first logical elements in their respective six-block lines—a Micrologic flip flop by Fairchild and a NOR logic circuit by Raytheon. Both logical elements are packaged in TO-5 and TO-18 cans. Philco is expected to be in production shortly on preliminary transistor-diode "logic pacs." Sperry Semiconductor Div. is in pilot production on Semi-Net NOR circuits in TO-5 cases. Units are so far only for internal evaluation. A General Instrument Corp. full adder comprising seven TO-5 cans will be available in evaluation quantities during April.

TO-circuit modules will be used as functional blocks to build up logic circuits such as shift registers and adders. A one-bit section of shift register might contain six gate TO-circuits and two flip flops. Three half-adder cans, two half-shift registers cans and a gate can could make a serial full adder.

TO-circuit modules may be made by vacuum deposition techniques or by combining microresistors and other passive components with a transistor, all within the transistor package. Eight pins are standard so far for the TO-circuit package.

Other manufacturers have been pursuing other techniques. TI, Westinghouse and Burroughs, for example, have micro-circuits in a variety of configurations. The TO-circuit represents a different marketing approach.

"Computer manufacturers may soon be able to realize a 90-per-cent reduction in size and a 70-per-cent reduction in cost of the logic section of a computer," states Dr. Robert N. Noyce, vice president of Fairchild Semiconductor Corp.

At the evaluation-quantity price of $120 for a Micrologic flip flop, he points out, the unit is a break-even item. It costs about as much as a conventional flip flop—counting component cost, assembly cost and logic design. But, Dr. Noyce adds, in production quantities the cost of Micrologic elements will fall rapidly, reaching $8.00 or so in a few years.

In the TO-5 can, Micrologic blocks can be used with conventional printed-circuit boards; in the TO-18 package its application will be in welded-wire interconnections.

Fairchild announced the first element of the Micrologic family, a flip flop, at the IRE Show in New York. Other members of the family, to follow within the year, include half-shift registers, gates, buffers, half adders and counter adapters.

Using these six Micrologic elements, the entire logic section of a digital computer or control system could be built. According to Dr. Noyce, Micrologic elements are fundamentally more reliable than conventional computer circuits. The internal interconnections—leads bonded by thermal compression techniques—are more reliable than the analogous printed-circuit-board interconnections.

Fairchild Engineer Dick Anderson shows the size differential between conventionally made logic and the same logic packaged in a TO-18 transistor case. A schematic of a serial full adder, shows a technique promulgated by the company for aiding the designer to design logic circuits. Decals showing the pin location and configuration of the company's Micrologic elements can be pasted on a sheet of paper, lines drawn to connect the pins. Other techniques include prepunching of eight-pin patterns on printed circuit boards to eliminate one drafting stage.

Tailor-Made Layout Eases Logic Design

In an effort to capture the computer market, Fairchild is concentrating heavily on easing the logic designer's load. Micrologic pattern decals are supplied to the designer: all he has to do is peel them off the paper backing and stick them on his drawing paper, then connect the pins as in the photograph.

Arrangements are being made with printed-circuit manufacturers to supply boards drilled with the eight-pin pattern. All the computer manufac-

turer has to do is connect the pins with printed wiring. One complete design step is eliminated.

Fairchild Micrologic cans are supplied according to standard specifications; the engineer must design his circuit according to them. He will not be able to order a variety of off-the-shelf variations except at a premium.

Fairchild's flip flop, for example, requires a supply voltage of +3 vdc ±30 per cent. Power dissipation is typically 30 mw and operates in temperatures from −55 C to +125 C. Input is designed to be driven by any Micrologic element. Load is one Micrologic element. Output can drive up to four other Micrologic elements loads in parallel, the company reports. Fairchild uses npn transistors in DCTL configuration.

Made by diffusing the transistors and resistors for many units into a single slab of silicon, the Micrologic elements are said to have good reliability and are potentially inexpensive. Internal metallic interconnections are deposited on top of the slab and the slab is cut into individual elements.

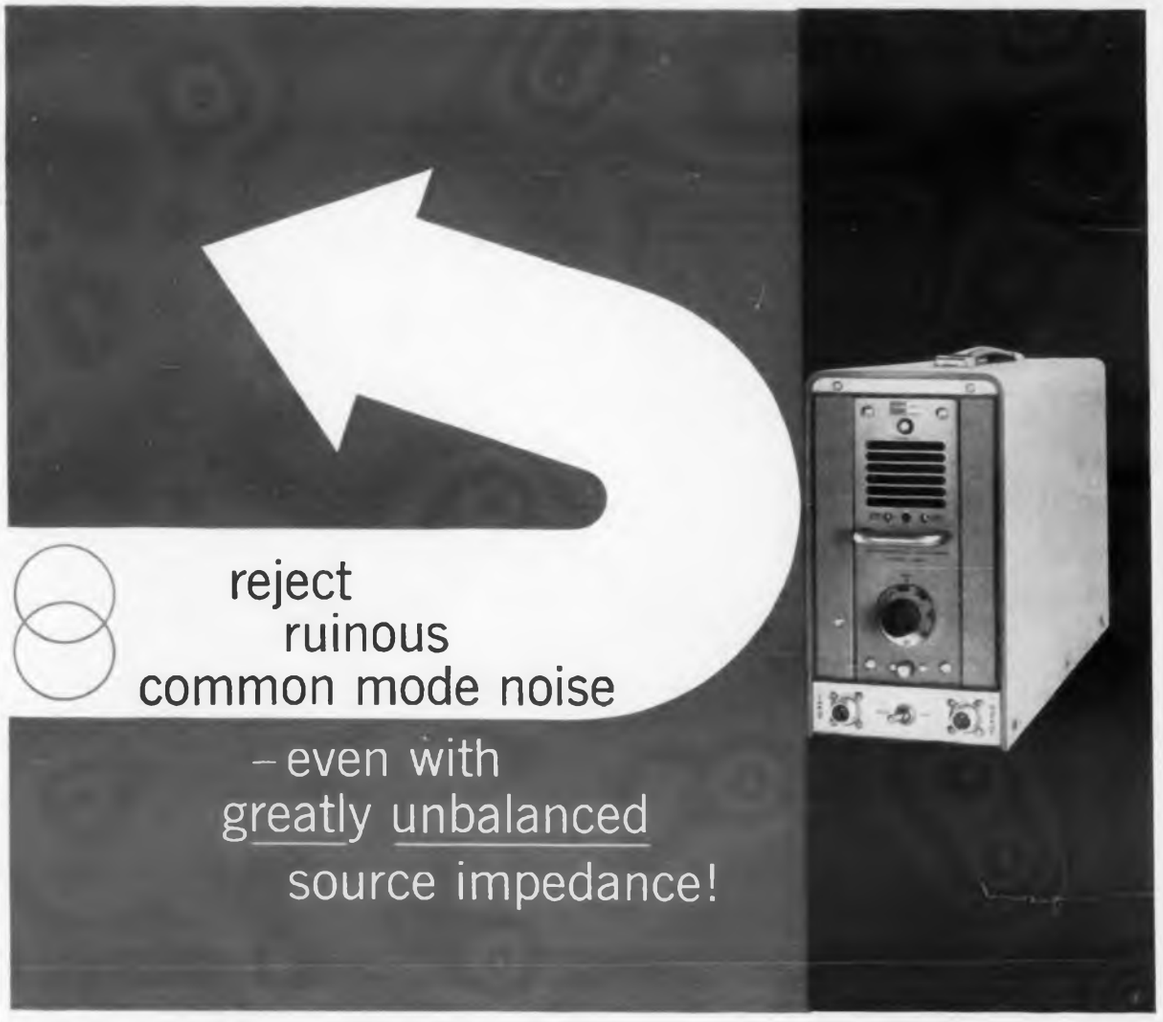
In contrast to Fairchild's theory that low price and maximum effectiveness can be realized only by marketing a standard "take-it-or-leave-it" logic function, Raytheon Co. is planning to sell both standard and special NOR circuits to the computer designer. Currently being sold in evaluation quantities at a "negotiable" price, the Raytheon NOR circuit is packaged in a TO-5 case.

A conventional alloying technique provides the gate diodes; a post-alloy diffusion process is used for the fabrication of the RC network. A bias resistor is constructed from a thin diffused layer. With a cut-off frequency of 30 mc, the npn transistor is loaded by a 1-K resistor.

Philco To Make TO-Circuits By Diffusion or Assembly

According to Philco's Semiconductor R&D Director C. G. Thornton, the company will undertake, on special order, either to microminiaturize existing computer logic circuitry, or, like Fairchild and Raytheon, sell standard diffusion-process units. "The designer just can't take a circuit breadboarded with conventional components and use the same design in diffused silicon microcircuitry," says Dr. Thornton. The semiconductor resistor, for example, may change value with a change in temperature. For the time being, Philco will investigate depositing resistances on a separate substrate. General Instrument Corp.'s technique is to interconnect conventional microcomponents within a TO-5 can.

At Sperry Semiconductor Div., special TO-circuit units are being supplied to the Univac Div. No units are being sold outside the company, according to a spokesman. ■ ■



KIN TEL's 114C Differential DC Amplifier eliminates ground loop problems in grounded thermocouple and strain-gage measuring systems...gives you extremely accurate, stable, drift-free amplification of microvolt level signals in the presence of volts of common mode noise, irrespective of whether load and transducer are grounded or floating, balanced or unbalanced.

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INPUT Z	>30 megs (typically 50 megs)
OUTPUT Z	<0.25 ohm, DC to 500 cps
COMMON MODE REJECTION	180 db DC; 130 db at 60 cps with up to 1000Ω unbalance, 120 db with up to 10,000Ω unbalance
DC LINEARITY	±0.01% of FS (10 volts)
PRICE	$1000.00 in 195 cabinet (shown), $875.00 without cabinet

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CIRCLE 6 ON READER-SERVICE CARD

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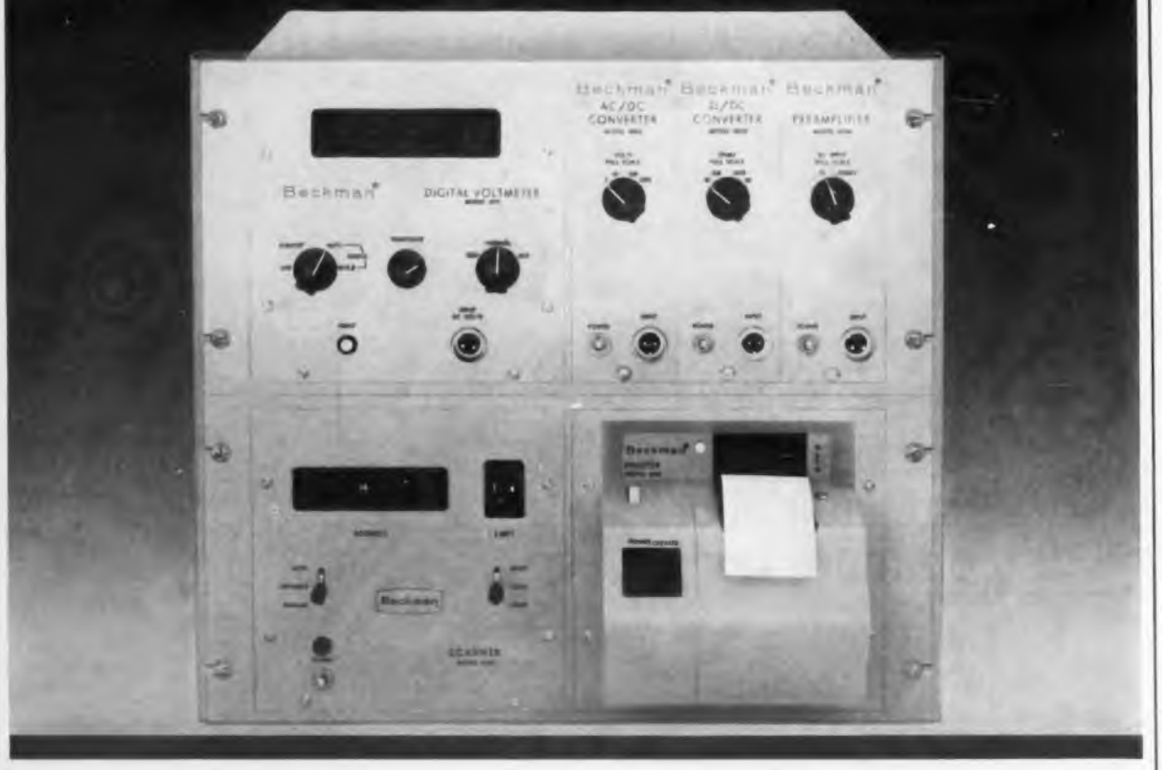
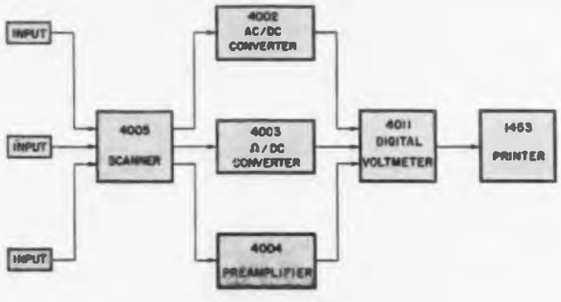
MODULAR DIGITAL MULTIMETER



Picture this self contained, automatic system working for you—the compact Beckman 4011 .01% dvm; together with converters for measuring low millivoltage DC, AC and ohms; a scanner which allows automatic readings of 29 sources of information; and finally, the Beckman solid-state, digital printer to make a permanent, indexed record of all the readings.

Price for the complete system about $4800

For detailed specifications on all these instruments and their use together, write for Brochure A4011.



Beckman 4011 a complete portable dvm is available, as are the other modules shown above, as a portable package.

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CIRCLE 7 ON READER-SERVICE CARD

NEWS

Angle-Diversity Tropo Link to Work at 8 Gc

Over-the-Horizon Communication Experiment Will Use 14 Paths

BY JULY 1 operations are expected to begin on an experimental over-the-horizon communications link that may have important effects on tactical tropospheric scatter systems.

ITT Federal Laboratories of Nutley, N. J., is building and installing a one-way angle-diversity system, AN/FRC-68, that will operate in the 7,125-8,500-mc band, considerably above what is now considered the upper limits for tropospheric scatter communications. If the system proves that multifold angle diversity for tropospheric links has advantages over other diversity systems, one result may be military space-diversity tropospheric systems using one, rather than two, antennas at each terminal.

Most space-diversity systems use one antenna for each path. In the system ITT is building for the Air Research and Development Command, one 28-ft dish antenna will handle up to seven paths at each station.

Seven 2-Kw Transmitters to Send To Two Antennas and 14 Receivers

The transmitting antenna will be fed by seven 2-kw transmitters, the signal from each going to separate feed horns set eccentrically from the focus of the antenna.

Beams formed this way will be offset by a fraction of a degree and will illuminate different volumes of the troposphere. At the other end of the link, 170 miles away, two similar 28-ft dishes will feed 14 receivers, whose signals will be combined in a predetection proportional combiner to form a signal within 1 db of optimum. The losses resulting from use of high-frequency, narrow beams will, in effect, be canceled out.

The experimental system is more complex than a practical system would be, ITT reports, because its purpose is to explore the feasibility of multi-fold angle diversity, to compare this technique with other diversity techniques, and to investigate troposcatter communications.

The system will be operated for a year, linking the New York State towns of Model City and Verona.

Each of the 14 receivers will use ITT-developed parametric amplifiers. Uncooled varactor diodes are expected to give a receiver noise figure of 3 to 3.5 db. Use of cryogenic cooling would

result in a significantly lower noise figure, the company reports.

Predetection, proportional combining of if signals will be used. Phase of the incoming signals will be compared, an error signal generated to control each local oscillator, and the oscillators used to bring each if signal back into lock with the combined signal. This will permit all signals to be added in phase. Similar combining techniques are used in several new over-the-horizon systems.

The new system is being designed so that from two to 14 signals can be added. As many as three combiners will be used simultaneously.

ITT believes that this system, which resulted from studies made for the Rome (N.Y.) Air Development Center, will be the first in which multibeam and multi-fold angle diversity will be used in an over-the-horizon communication system. It is also believed to be the first large-scale angle-diversity system.

Tests are about to begin on the first transmitter, and one antenna has been completed. ■ ■

Telemetry Transmission Planned With a Tenth Usual Power

A new experimental telemetry system, one of a family of communications systems called Synchrolink, is expected to transmit data the same distance as systems now in use with about 1/10 the power requirements.

Developed by General Electric's Missile and Space Vehicle Dept., Philadelphia, Synchrolink is a pulse-code modulation system with phase-shift keying (PCM/PS). An optional feature is an error-correction code that can correct mistakes caused by noise interference. Other features of Synchrolink are:

- Only minor modifications needed to convert existing ground stations to receive Synchrolink signals.
- Transistors used as switches.
- Alteration of channels and combinations of channels to accommodate measurement changes, even in flight.
- Repeated conversion or transmission of data, or long storage, with no loss in accuracy.

The Synchrolink system beams a radio-frequency signal that is switched 180 deg in accordance with a simple coded-pulse series representing space-flight data. The resulting double-sideband-suppressed carrier rf signal is received by a synchronous receiver followed by a correlation detector. Use of the threshold-free synchronous receiver permits detection of the signals at extremely low signal-to-noise ratios, about —10 db, GE says.

Know ye that we, the corporation of Burnell & Co., upon the recommendation of our customers in the electronics industry do hereby inaugurate the esteemed order of Shrinker Cum Laude.

Be it further known that, (without undue modesty), the Shrinker Cum Laude award has been made to Burnell for displaying the highest degree of shrinkmanship in the design and utilization of microminiature, subminiature and miniature toroids, filters and related networks.

The Shrinker Cum Laude award has also been tendered for signal achievement in reducing developmental costs while increasing performance range—a feat accomplished by the designers of the new Burnell high selectivity, high attenuation, 1 kc crystal filter which possesses the following unique characteristics:

Attenuation — 3 db bandwidth — 3.8 cps
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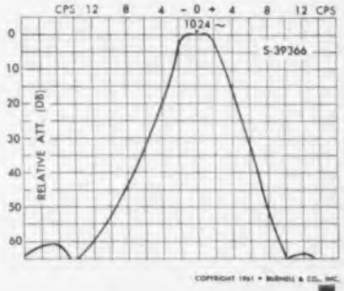
Output Impedance—500,000 ohms
Meets MIL-C 3908 B vibration standards

Other Burnell crystal filters available in frequencies up to 30 mcs with considerable latitude in impedance range. Write for Bulletin XT-455.

Send for membership in Space Shrinkers Club.



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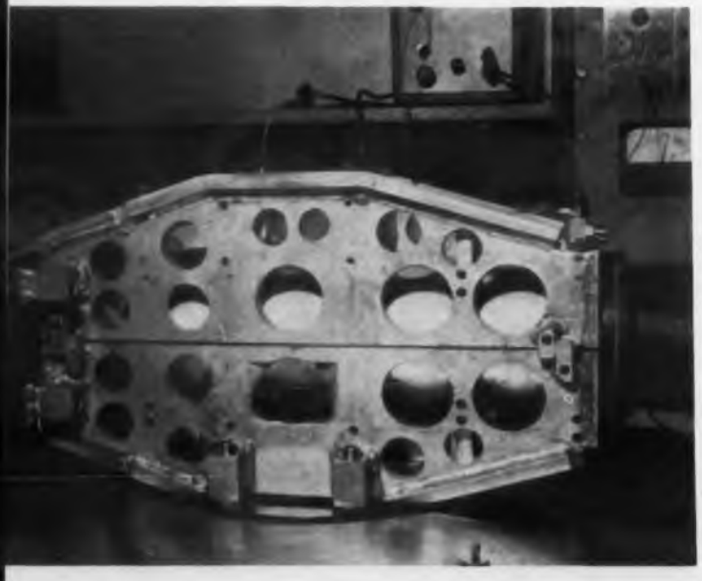
CIRCLE 8 ON READER-SERVICE CARD

Low-Light Image Orthicons Have Many Potential Uses

Low-light-level image orthicon developed by General Electric Co. is loaded into a special camera by Robert W. Brougham, TV-circuits engineer. This tube is capable of operating in light conditions down to 10^{-6} ft-c photocathode illumination. GE is considering use of these tubes in an advanced surveillance satellite for day or night cloud cover observations.

Transistorized television camera to be sent aloft with a balloon-borne telescope uses a developmental C74034 low-light-level image orthicon built by Radio Corp. of America. When used with the 36-in. Stratoscope II telescope, the tube is expected to sight twelfth magnitude stars from its perch 15 miles above the earth's surface. The new tube reported has a 500-A thin-film semiconductor target with gain of about 8 to 10. It uses a tri-alkali photo surface with a rating of 150 μa/lumen. A relatively slow scan rate will be used since the thin-film target has lower lateral leakage than conventional glass types.



Ruggedized image orthicons, which might be used in future satellite systems, are tested by General Electric engineers on this shaketable (far left). Image on screen at right is adjusted by laboratory engineer as ruggedized tube is tested at 5 g with 500-cycle vibration. To eliminate possible jitter in the scene caused by motion of the image transparency rather than the orthicon, the transparency is glued to the tube face. A point source of light directed through a darkened tube supplies illumination. Very little scene distortion results up to the 5-g, 500-cycle level. Image orthicons are much more difficult to ruggedize than vidicons—such as those used in the Tiros weather satellites—because of the Angstroms-thick magnesium oxide targets used. Other potential uses include satellite observation of the earth, astronomy, or closed-ciruit TV systems.

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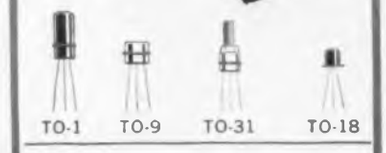
PHILCO MADT®

SWITCHING TRANSISTORS

Working with gossamer-thin magnesium targets requires a delicate touch. The target is assembled here by a General Electric technician in a Snow-White room at the Cathode-Ray Tube Dept. factory in Schenectady. Image orthicons are normally handled with the face of the tube always kept upward, because even a minuscule particle can pierce the film if it drops from the gun end of the tube. Because of this problem, there are extreme difficulties in designing rugged tubes for potential space applications.

Storage capability of GE's GL-7967 low-light-level image orthicon is used to resolve a test chart in light conditions below the range of the human eye. Integration of light is possible because of the low sideways leakage of the thin-film targets in comparison to conventional glass ones. Further development of these tubes includes work on phosphor surfaces especially adapted to particular applications. Infrared-sensitive surfaces might be used, for example, for detecting warm objects, such as tanks or aircraft, under near-darkness conditions.

CIRCLE 9 ON READER-SERVICE CARD ▶



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2N501—Ultra high speed switch
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In TO-9 CASE:
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2N1495—High voltage, high speed, high current switch
2N1499A—High speed, low cost switch (MIL version available)
2N1500—Ultra high speed switch (MIL version available)
2N1754—Very low cost, high speed switch

In TO-31 CASE:
2N1494—High power version of the 2N1204

In TO-18 CASE:
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7½ ips— 75 kc	30 ips—300 kc
12 ips—120 kc	60 ips—600 kc
15 ips—150 kc	120 ips—1.2 mc

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CIRCLE 10 ON READER-SERVICE CARD

New in Tubes: Nuvistor

Tetrode Added to RCA Line Said To Use 50% Less Heater Power

A NUVISTOR tetrode, designed for industrial applications, is now available, reports Radio Corp. of America, Harrison, N.J. Called the RCA-7587 general-purpose, industrial, Nuvistor sharp-cut-off tetrode, the new ceramic and metal tube is designed for mixer, if-amplifier and low-level video amplifier circuits.

Among its advantages are claimed to be extreme ruggedness, the ability to operate at full rating at all altitudes, and high efficiency.

The tetrode is about one-third the size of conventional tetrodes and is rugged enough to perform at any altitude, the company reports.

Heater power consumed by the tube is said to be about half that of standard tetrodes—about 6.3 v at 0.15 amp.

The tetrode is the fifth type of Nuvistor announced by RCA.

Specifications of the Nuvistor tetrode are given as: heater, for unipotential cathode, 6.3 v ±10%, ac or dc, with 0.15 amp current.

Plate-supply voltage is 125 v and plate current is 10 ma. Grid No. 2 supply voltage is 50 v, screen current 2.7 ma.

Characteristics as a Class A_1 amplifier are said to be: plate-supply voltage, 125 v; grid No. 2 supply voltage 50 v; cathode resistor 68 ohms; plate resistance (approximately) 0.2 meg; transconductance 10,600 μmhos; plate current 10 ma; grid No. 2 screen current 2.7 ma; grid No. 1 voltage for plate current of 10 μa, −4.5 v. ■ ■

Nuvistor tetrode now available in industrial version has heater voltage of 6.3 v and current of 0.15 amp. Shell is metal and ceramic.

Tetrode; Dark Heater

Heaters With New Insulation Promise Gain in Reliability

A NEW insulation coating for tube heaters that promises to extend life and improve reliability of a wide range of tube types is being used in the manufacture of receiving tubes about to be included in consumer products marketed by Radio Corp. of America, Harrison, N. J.

The company declines to disclose the nature of the insulation but reports that it permits heater operation at temperatures of up to 350 K less than the 1,500-1,700 K usual with aluminum-oxide heater insulations.

Because the new material is of a darker color than usual for heater materials, RCA presently calls the new development a "dark heater." It is said to radiate heat more efficiently and improve transfer of heat to the cathode more efficiently than "white heaters."

With the new insulation, states the company, optimum cathode temperature may be attained with the heater operating at about 1,350 K.

Heaters coated with the insulation are said to have stable current characteristics, helpful in maintaining a constant cathode temperature.

In addition, effects of ac leakage and hum are reported significantly reduced.

Reduced heater temperature reduces stresses and thermal change during heater cycling, lessening the chances of recrystallization and burnout. Cooler operation minimizes changes in heater shape, which is said to reduce the possibility of heater damage and heater shorts. ■ ■

Dark heater at right operates at 20 per cent lower temperature than conventional heater at left in lab demonstration unit because of new type of insulation used. "Dark heater" tubes are being made by RCA and being incorporated in consumer products.

Tubular Sintered-Anode TANTALEX® Capacitors

Pack High Capacitance In Small Volume

Now designers can get the reliability and performance of Sprague's Type 109D and 130D Tubular Sintered-Anode Tantalex Capacitors *in ratings up to 560 µF.* A new "T" case size permits more ratings in every working voltage. Type 109D capacitors can be operated up to 85 C without voltage derating and up to 105 C with a voltage derating of only 15%; Type 130D to 125 C without derating.

Designed to MIL-C-3965B

These Tantalex Capacitors are designed to meet vibration (2000 cycle), shock, and all other environment requirements of MIL-C-3965B. Outstanding mechanical features include a specially-treated cathode; a double-spun, missile-proven fluorocarbon elastomer high temperature seal; and a special porous sintered tantalum anode developed to give unusually high capacitance per unit volume.

No Shoulders; No Chassis Slots Required

The clean, shoulder-less shape of these capacitors was pioneered by Sprague to simplify printed wiring layout and assembly. It eliminates the need to punch mounting slots of the type required for older shouldered cup designs. Wiring boards can also be stacked more compactly.

For complete technical data on these new Tantalex capacitors, write for Engineering Bulletin 3602A to Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Mass.

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MAGNETIC COMPONENTS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
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CIRCLE 12 ON READER-SERVICE CARD

Next in Computer Systems: Predictive Control?

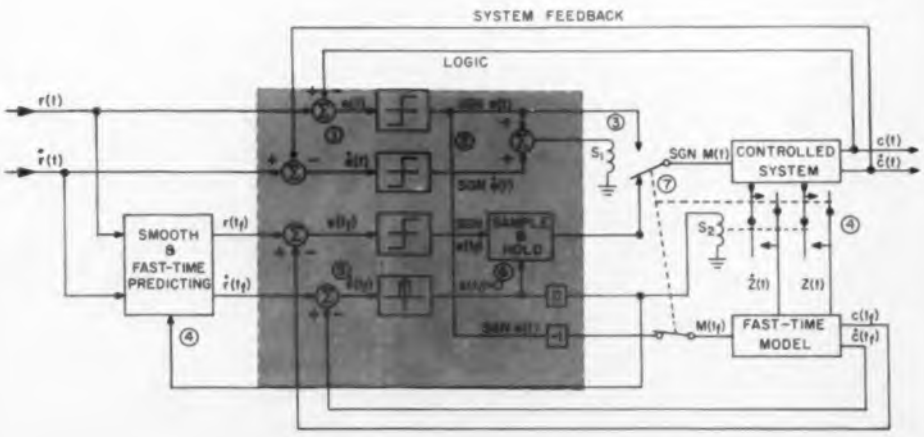
Researchers at Breadboard Stage in Seeking to Eliminate Delays Inherent in 'After-the-Fact' Feedback to Schemes

PREDICTIVE control may prove the next step in sophistication for nonlinear servo systems.

Breadboard models and computer simulations of predictive systems developed at the General Electric Co., Schenectady, N.Y.; Bell Telephone Laboratories, Whippany, N.J., and Cambridge University, England, demonstrate that significant improvements in control are possible.

Both analog and digital mechanizations have been tried successfully, but the researchers believe that the predictive concept is particularly adapable to larger digital computer control systems. This is because most of these systems now use the computer inefficiently. They either attempt, at great cost in memory space, to imitate equations that the "humble" analog computer can do so easily or they relegate the computer to monitoring chores outside the dynamic control loop.

The predictive concept would allow a digital computer to participate directly and efficiently in a dynamic control loop, with improvements in system performance that would justify the computer's cost. It would beget a new class of "truly nonlinear" control systems, according to John C. Lozier, servo specialist at Bell Labora-



GE predictive control uses fast-time model. Steps in the logic program are: (1) Present error e and error rate ė are computed; (2) Their signs are determined; (3) Signs are compared. If the signs are the same, switch S_1 is energized, with the sign of the error being used for the sign of the actuating signal. If the signs are different, the program branches to (4) The present state condition is switched into the model, S_2; (5) The fast-time model predicts the future error trajectory if S_1 were switched at that instant. When the model predicts zero error; (6) The sign of the predicted error is sampled and held; (7) This sign is used to switch S_1. The delay unit after (6) makes a reiterative loop between steps (6) and (4) possible.

tories. Instead of the fixed "summing point" comparison of input and output, typical of linear servos, the computer would be programed to look repetitively at all the pertinent factors and make continuous fresh decisions as to the best control strategy for the next few seconds.

Predictive Control Would Fill Space and Industrial Needs

Researchers say there is a definite need for predictive control, whether analog or digital. The space vehicle must get to its destination quickly, with the least amount of fuel diverted to control maneuvers. The industrial plant must be brought up to its maximum operating point rapidly without overshooting into a danger zone.

Predictive systems of the type being studied at GE show promise of being fast, precise and efficient. They are compatible with the full-on, full-off (bang-bang) actuators that give the fastest system response. Through prediction they give superior switching signals to the actuators for precise following of a desired trajectory.

The GE system (see diagram) on which H. Chestnut, W. E. Sollecito and P. H. Troutman are collaborating, repeatedly estimates the future system error on the basis of a fast-time model working ahead of the real system. When the model's response predicts that reversing the actuators will bring the system to the desired trajectory, the logic gives the switching command.

A result of GE's laboratory simulations of this type of system has been the discovery that certain higher-order systems can be adequately controlled by easy-to-implement prediction mechanisms of a lower order.

The steps in the logic program are rather simple to explan. The logic program repeatedly asks, in effect: "Are the signs of the actual error rate the same or different?" If the same, the logic knows that the system is moving away from synchronization, and it immediately reverses the real-system actuator direction. If different, the logic knows it is too soon to sitwch and causes the program to branch to the predictive routine. In this, the logic keeps querying the fast-time model: "What would happen if the actuator were reversed?" As soon as the model predicts that switching the actuator would bring the real system to the desired trajectory, the logic causes the real-system actuator to be switched.

Thus the fast-time feedback information from the model is used in a feed-forward fashion in the real system.

Analog and Digital Computers Are Under Study at GE

Mr. Troutman has been using an analog implementation and Mr. Chestnut has been using a digital computer. One advantage of the analog

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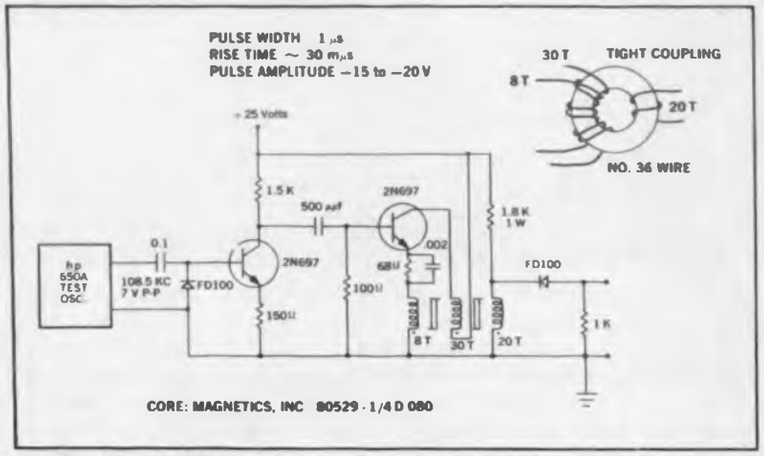
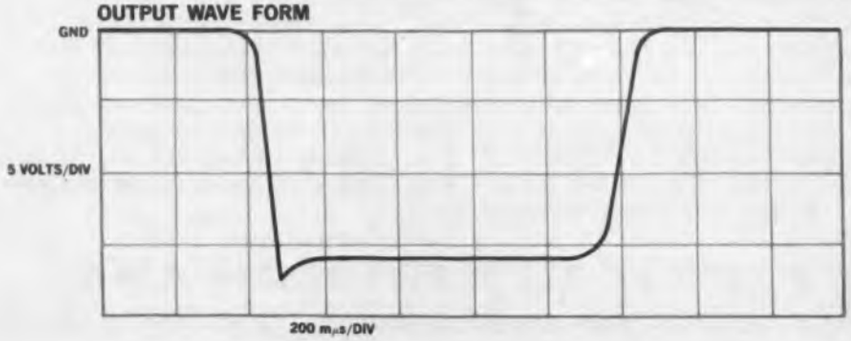


OUTPUT WAVE FORM



CIRCLE 13 ON READER-SERVICE CARD

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CIRCLE 14 ON READER-SERVICE CARD

NEWS

computer, Mr. Troutman says, is that the logic iteration rate can be easily varied, going to smaller steps as the system zeroes in on the desired trajectory.

Compared with other servo systems, the GE engineers say, their system should:

- Be less apt to overshoot the final position than linear servos.
- Require less exact information about the process than final-value servos, as well as being less susceptible to disturbances.
- Require less design effort than adaptive servos, as well as outperforming them in trajectory tracking.

The approach by Mr. Lozier of Bell Laboratories—being explored further on an IBM 650 computer by J. J. Jonsson at the Polytechnic Institute of Brooklyn—is similar to the GE mechanization. But the emphasis is on the small-signal errors caused by the system's tendency to oscillate around the null point.

The practical aspects of John F. Coales' work at Cambridge University have been ahead of those in the United States. A result claimed by Mr. Coales is that he is able to use a 1-hp motor in place of 3 hp. The weight saving in space applications would be important, particularly if the space system had a central digital computer (see *ED*, Nov. 23, p16).

U. S. Gets Speech 'Compressor'

A 13-channel ground-stationed Vocoder, being checked by technician, has been delivered to the Rome (N.Y.) Air Development Center for testing. It condenses speech into its basic sounds to conserve communication bandwidth. The Vocoder can operate in either analog or digital mode. In the analog, it is said to require only a tenth the bandwidth needed for speech transmission by conventional methods. In digital mode, it requires 3 kc of bandwidth, also much less than conventional systems use. The unit, developed by Hughes Aircraft Co., Culver City, Calif., is fully transistorized with the exception of one subminiature thyratron used as a noise source.

1960 Television Set Exports Down, But Picture Tubes Show Gain

Television receiver exports from the United States in 1960 declined to $14.7 million from the $17.6 million of 1959, according to preliminary figures compiled by the Business and Defense Services Administration of the Department of Commerce.

During the same period, the agency reports, exports of TV picture tubes rose from $13.7 million to $21.3 million.

The sharpest increase listed for electronic products was for crystal diodes and transistors. Exports of these components rose from $9.1 million in 1959 to about $15.9 million last year.

Other preliminary figures follow:

EXPORTS

	1960	1959
Radio transmitting equipment	2,354	3,621
TV transmitting equipment	3,223	3,441
Radio and TV audio equipment	1,495	1,463
Television studio equipment	13,766	9,931
Radio beacon transmitters	910	1,493
Automobile radio receivers	1,395	1,782
Radio-phonograph combinations	515	916
Radios, home-type	2,861	4,086
Radio receiver chassis, home-type	876	935
Television receivers	14,713	17,631
Television receiver chassis	3,968	2,901
Electron receiving tubes	14,382	14,671
Television camera tubes	1,468	1,682
Cathode-ray tubes	2,086	889
Parts and accessories for electron tubes	6,796	4,987
Capacitors (condensers)	7,570	6,102
Resistors	5,379	4,175
Inductors (including transformers and coils)	4,092	3,970
Loudspeakers	1,646	2,137
Carrier-current equipment	1,197	2,628
Audio amplifiers and amplifier systems	2,798	3,317
Amplifiers (except audio frequency)	1,695	1,172
Recorders (disc, tape, wire)	12,971	10,986
Other electronic equipment	44,001	38,613
Special category items:		
Radio communications equipment	94,262	90,691
Electron tubes not elsewhere classified	18,055	13,340
Electronic detection and navigation apparatus not elsewhere classified	49,639	44,316

IMPORTS

Television cameras	1,092	227
Television tubes	464	387
Television apparatus	1,946	688
Radio apparatus	92,652	72,724
Photocells and other electron tubes (except TV, X-ray and radio)	2,394	1,358
New classes established Jan. 1, 1960 (Includes electronic testing, recording, instruments and apparatus; radar equipment; microphones; loudspeakers; radio-phono combinations; record players and other sound units utilizing an electronic transducer device)	38,220	—

There are 3 ways to design a klystron. Which is best?

The answer: there is no *one* best way. The design of a klystron must vary to meet specific performance requirements. For instance:

For the 4K50,000LQ, left, *external-cavity* design is best for producing 10 kw power output at 755-985 Mc. (Proof: more than 25,000 hours of near unattended service in troposcatter systems!)

For the 4KP40,000SQ, center, *internal-cavity* design is best for developing 10 Mw pulse output power at 2845-2865 Mc. (Proof: better than 2,500 hours in continuous rf service!)

For the 5K210,000LQ, right, a *combination* of internal and external design is best for achieving 75 kw minimum average power output at 755-985 Mc. (Proof: tested to 100 kw!)

Where will you find klystrons designed all three ways? Where will you find *every* klystron always shaped the best way to meet specific needs? *Only* at Eimac... where unmatched tube-making skills permit complete design flexibility. For more facts, more figures, get your free copy of "Advancing Klystron Performance Through Design Freedom." Write: Eitel-McCullough, Inc., San Carlos, California.

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Type Number	BV_{CEO} (Volts)	BV_{CES} (Volts)	BV_{EBO} (Volts)	V_{I1} (max) Offset Voltage (mV)	I_{I1} (max) Offset Current (mμA)	Price 1 — 99	PRICE 100 — 999
2N1917	—8	—25	—25	1.0	1.0	$ 9.75	$7.50
2N1918	—8	—25	—25	3.0	3.0	7.80	6.00
2N1919	—18	—40	—40	2.0	1.0	12.35	9.50
2N1920	—18	—40	—40	3.0	1.5	8.77	6.75
2N1921	—50	—50	—50	4.0	2.0	5.20	4.00
2N1922	—80	—80	—80	4.0	2.0	6.50	5.00

Write for 16 page Technical Application Bulletin #2107 and new Chopper transistor data sheets on types 2N1917 through 2N1922.

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NEWS

Atomic Clock Might Err By a Second in 1,271 Years

An atomic clock, reportedly so accurate that its maximum error would not exceed 1 sec in 1,271 years, is expected to be in operational use in missiles and aircraft by next year.

The airborne device, developed for the Air Force by the National Co. of Malden, Mass., uses the cesium atom as a power source. The device is technically referred to by the Air Force as an Airborne Atomic Frequency Standard and by National as the Airborne Atomichron.

The 6-1/2-lb clock will replace numerous crystal oscillators used as frequency or time standards in the calibration of airborne communication. navigation, guidance, fire-control, computer and timing devices.

The atomic unit has been simplified to the extent that only a simple on-off switch is required to operate it.

Present oscillators require frequent calibration, often just before take-off or during flight. The new atomic standard does not require calibration, acting as its own primary standard. The operator of the unit needs no special schooling, such as is required on present laboratory units.

The clock can also replace present atomic laboratory units weighing more than 600 lb, the company reports.

Fuel-Cell Research Aiming At Practical Generator

Research on fuel cells and fuels is under way at two companies in St. Paul, Minn., as part of the development of a practical power generator.

The program is being undertaken jointly by Gould-National Batteries, Inc., and the Pure Oil Co. The goal is a generator that will compete on even terms with older forms of power production.

◀ CIRCLE 16 ON READER-SERVICE CARD

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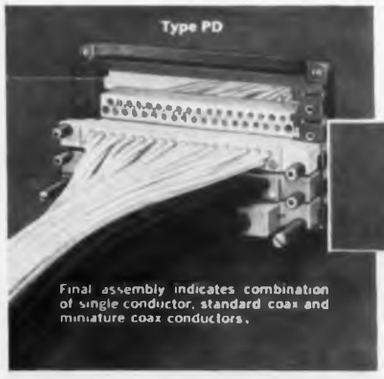
2 COMPLETE ASSEMBLY

Pins and sockets, interchangeable in plug and receptacle, may be inserted before or after inserts are in place. Inserts accommodate 35 single conductor contacts, 21 miniature coax contacts, or 10 standard coax contacts. All contacts are completely crimp-type assuring high reliability of tool-controlled installations. Contacts are individually removable, providing versatility of gang or individual connect and disconnect.



Final assembly indicates combination of single conductor, standard coax and miniature coax conductors.

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This 200 per cent testing, combined with five years of refinements in the manufacturing process, enables us to mass produce these highly reliable PNP germanium transistors with consistent uniformity. And we can supply them to you quickly in any quantity at a low price.

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CIRCLE 18 ON READER-SERVICE CARD

Coherent Light Radar Needs No Shutter

Natural Pulsed Laser Output Used to Eliminate Modulator

DIRECT output from a laser source, without attenuation by a pulse modulator, is achieved in the new Colidar (Coherent Light Detection and Ranging) system developed by Hughes Aircraft Co. (*ED*, March 15, p 17).

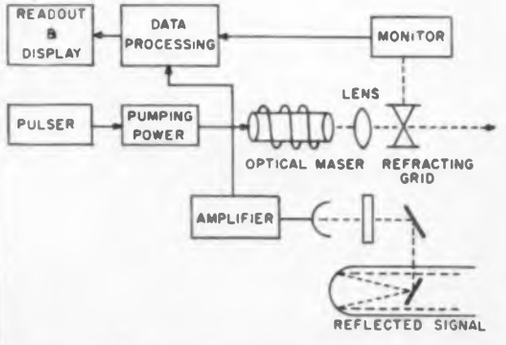
It is accomplished by pulsing the excitation source input and using the characteristic pulse output of the ruby laser without further pulse modulation, according to Hughes' senior staff consultant, Malcolm L. Stitch. The only attenuation of the laser output is a negligible amount occurring in an output collimating lens.

"One of the directions we're pursuing in Colidar development," says Dr. Stitch, "is to obviate the need for light modulators, which, like the Kerr cell, may have a transmission efficiency of as little as 20 per cent."

Microsecond Pulses Generated With Use of Laser Phenomenon

The trick to eliminating the need for a light switch is a phenomenon inherent in the operation of the Colidar's ruby laser. When it is energized by a micro sec-long pulse of light from a bifilar flash tube, the ruby laser emits a stirring of 1 μsec pulses, with spacings of several microseconds.

In the current Colidar lab model the 1 μsec



Operation of the Hughes Aircraft optical radar starts with a pulse network which feeds pumping power—a bright flash of light—to the ruby laser. The resulting deep red coherent light beam passes through a collimating lens and is transmitted. Reflected signal is collected by a Newtonian telescope; passed through a narrow bandwidth filter into a phototube. Present display setup is a dual-trace oscilloscope.

Hughes coherent light detection and ranging equipment avoids use of energy-interrupting modulator at laser output. Colidar can differentiate between two side-by-side tanks at six miles distance.

pulses are uneven in spacing and amplitude, as in the scope traces in the accompanying diagram. But, asserted Dr. Stitch, experiments have shown that as the amplitude of the energizing light flashes is increased and their duration decreased, the pulses emitted from the laser become fewer and of greater amplitude.

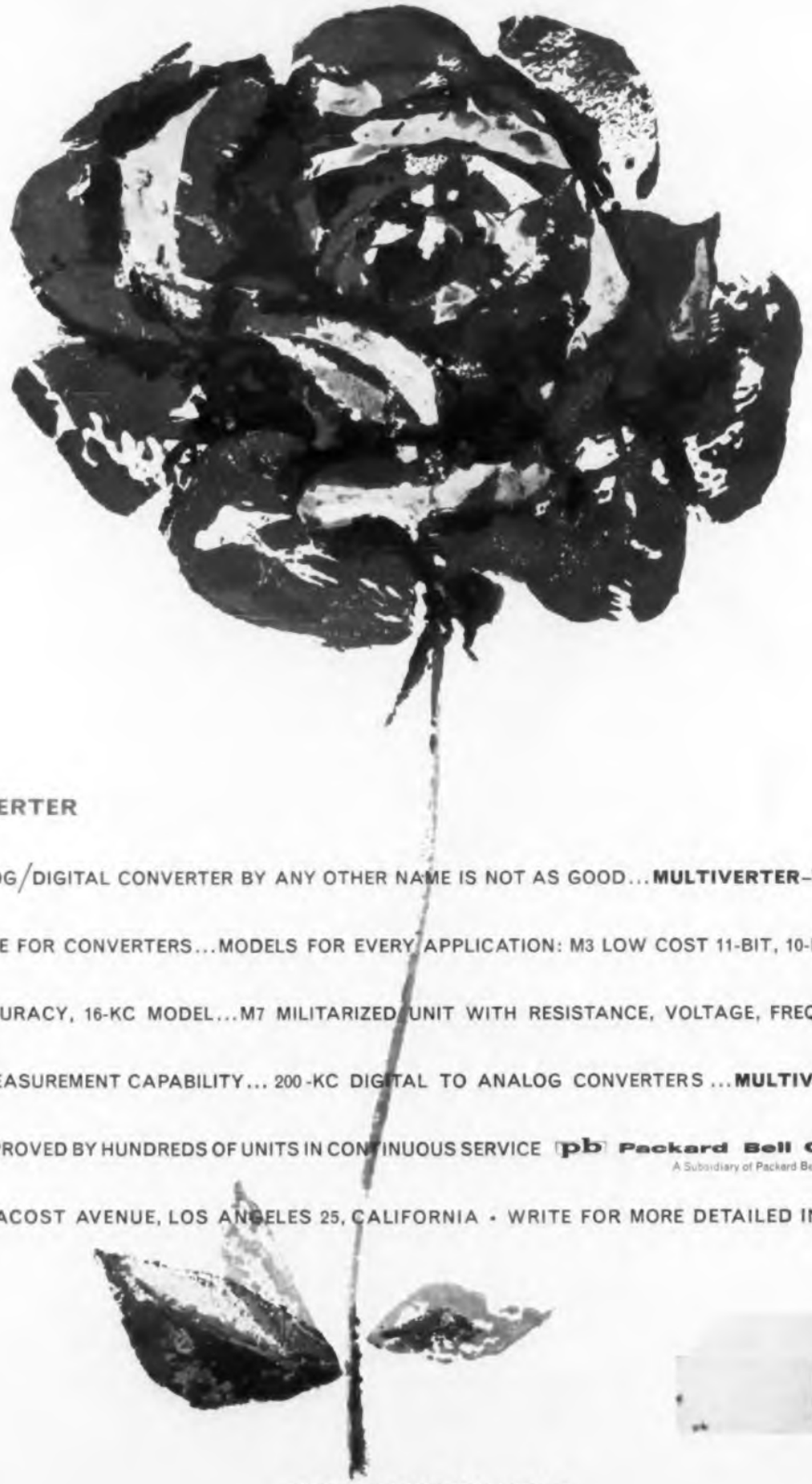
Ultimately Hughes aims to force the laser to generate a single short pulse and to use digital readout for pulse position measuring instead of the current oscilloscope display. In effect, the modulation has been displaced from in front of the lens to the flash-tube pulse circuitry.

Shortening the energizing pulses will increase the life of the flash tube; the single short pulses at the laser output will have substantially higher power. However, achieving very fast, high power flashes thus far poses severe technical problems.

Half-Degree Beamwidth Gives High Resolution

With its half-degree beamwidth, the optical radar can distinguish between two diffuse objects —i.e. reflecting only 10 per cent of the received illumination—only ten feet wide, placed side by side at a distance of about six miles. Spectral line width of the highly collimated beam of red light is less than 0.01 A. Power outputs of over one kv have been observed.

In the Hughes optical radar a pink ruby crystal 3/8 in. in diameter and 1-1/2 in. long—one end heavily silvered, the other partly silvered—is



CIRCLE 19 ON READER-SERVICE CARD

THE TAPE THAT CHANGED TV FOR ALL TIME

leads you right to rugged SCOTCH® BRAND *Heavy Duty Tape*

THE TIE that binds television's top performer to instrumentation tape is strong—and it goes beyond the fact that the same expert team produces the best of both. "SCOTCH" BRAND Heavy Duty Tapes share a common heritage—and uncommon endurance—with "SCOTCH" BRAND Video Tape, the tape that puts a network TV show on the same "clock time" from Maine to California.

Similarities worth noting between the two: a similar high-temperature binder system, famous "SCOTCH" BRAND high potency oxides, a similar ability to resist tremendous speeds, pressures and temperatures while providing high resolution.

Let's look at the record of "SCOTCH" BRAND Video Tape and see what message it has for the user of instrumentation tape. On a standard reel of video tape like that shown here, some 1½ million pulses per second must be packed to the square inch—on a total surface area equal to the size of a tennis court. The tape must provide this kind of resolution while defeating the deteriorating effects of high speeds, pressure as high as 10,000 psi and temperatures up to 250° F.

The fact is that video tape must be essentially perfect. And it's a matter of record that thus far only the 3M experts have mastered the art of making commercial quantities of video tape that consistently meet the demands of the application.

Significantly, the high-temperature binder system developed for "SCOTCH" Video Tape is first cousin, only slightly removed, to that used in the Heavy Duty Tapes. It's this special feature that has given Heavy Duty Tapes their exceptional wear life.

The moral emerges: for tape that provides the best resolution of high and low frequencies under the severest conditions, turn to "SCOTCH" BRAND Heavy Duty Tapes 198 and 199.

They offer the high temperature binder system, plus the same high quality and uniformity that distinguish all "SCOTCH" BRAND Tapes. As the most experienced tape-makers in the field, 3M research and manufacturing experts offer tape of highest uniformity—from reel to reel and within the reel. Check into the other "SCOTCH" BRAND constructions: High Resolution Tapes 158, 159 and 201; High Output Tape 128; Sandwich Tapes 188 and 189; and Standard Tapes 108 and 109.

Your 3M Representative is close at hand in all major cities. For more information, consult him or write Magnetic Products Division, 3M Co., St. Paul 6, Minnesota.

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SCOTCH BRAND MAGNETIC TAPE

FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY

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3M COMPANY

CIRCLE 20 ON READER-SERVICE CARD

NEWS

used as the laser cavity. Surrounding the ruby is a spiral bifilar flash tube. When the flash tube is discharged, it energizes the ruby cavity. A few microseconds later the highly collimated, monochromatic light is emitted from the partly transparent end of the crystal.

Laser output is fed through a lens system, which reduces the 6-milliradian output beamwidth to 1/3 milliradian.

"We hope better laser crystals will allow us to approach the theoretical laser output beamwidth of 75 microradians," says Dr. Stitch.

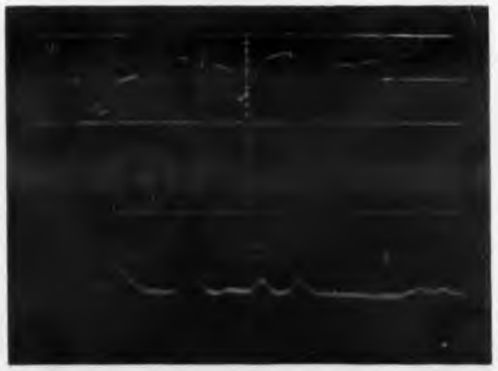
The light beam strikes a target and is reflected. Light arriving back at the Colidar is collected by a Newtonian telescope, where it is focused and fed through a narrow band (15 A) filter. This filter is a multi-layer dielectric interference type, having 70 per cent transmission efficiency at its center frequency.

"We expect to be able to reduce the bandwidth of the filter to around 2 or 4 A's," Dr. Stitch says. This would increase the signal-to-noise ratio.

"In watts per unit area per steradian," Dr. Stitch points out, "the brightness of the Colidar is about a million times the brightness of the sun. But in watts per unit area per steradian per Angstrom, the Colidar is about a million million times brighter than the sun."

When in operation, the collector receives not only the reflected laser energy but also some reflected, diffused or direct sunlight. Narrow-band filtering can reduce this "sunlight noise" to negligible proportions—a big advantage over former pulse-light-arc, noncoherent light radar systems.

Since receiver and transmitter are two separate units—no tr tube or other duplexer switch is re-



Dual-trace display shows transmitted (bottom) and received (top) signals. Time scale on oscilloscope is 2 μsec per division; time disparity between signals is 6 μsec, showing the presence of a small, diffuse target about half a mile away. Turned out to be an oil barrel.

quired—transmitted pulse durations can be any reasonable length and still detect objects at close range. The receiver can receive reflected energy while the transmitter is still sending.

In the present Hughes Colidar model, range is calculated by measuring the time differential between transmitted and received pulses shown on a dual trace oscilloscope. A fine wire grid in the path of the transmitted energy causes enough refraction for the light to be detected on a monitoring photocell, as in the schematic.

Still in its infancy, the Hughes Colidar shows promise of usefulness in relatively short-range space ranging and detection. Colidar range would be in the hundreds of miles in space, where there is no atmospheric absorption. Used as a communications system with receiver and transmitter located at opposite ends of the communication path, Colidar potential range is easily 100,000 miles—if aiming and tracking problems can be solved.

In the atmosphere, maximum range would be limited to the tens of miles: the present model has been tested over a three-mile range, though Hughes expects to use it at six miles "after adjustment." On foggy days or under other conditions of poor visibility, the Colidar is ineffective. Notwithstanding, one of the obvious potentials for the optical radar is tactical combat use.

Major problems remaining include increasing the amplitude and shortening the duration of the flash tube pulse to obtain single pulse emission from the laser; reducing the bandwidth of the optical filter; finding better ruby crystals to achieve narrower beamwidth, and putting the radar into space, where its maximum peacetime effectiveness will be realized. ■ ■

Simple Optical Device Converts Video to Three Dimensions

An optical device that will convert a conventional closed-circuit TV system to a three-dimensional view is now available to industry and the military.

The device, called a Stereo-Captor, is mounted on the lens of a closed-circuit TV camera. A transparent stereo-screen is installed on the front of the receiver, and by wearing stereo glasses, the viewer sees a 3D picture.

Developed by J. F. Butterfield, president of Stereotronics, Inc., of Los Angeles, the device's applications include viewing the handling of radioactive materials; remote observation of difficult production techniques; military and space surveillance, and group viewing of surgical operations.

No electronic changes in existing equipment are necessary, Mr. Butterfield reports.

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VOLTAGE REGULATION:
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RMS RIPPLE:
1% from 12 to 36 vdc; 2% below

TIME CONSTANT (12-36 v.):
full load on: 50 millisec.
full load off: 150 millisec.

A-C INPUT:
115 v. ± 10%, 1-Ph., 60 cps.

AMBIENT TEMPERATURE RANGE:
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PARALLEL OPERATION:
Includes load sharing provision

VOLTAGE SENSING:
Local or remote

VOLTMETER & AMMETER:
2% accuracy, 3½" square

ON-OFF CONTROL:
A-C Switch

PROTECTION:
Magnetic Circuit Breaker

INPUT-OUTPUT ISOLATION:
"+" or "−" may be grounded

COOLING:
Convection (no fan)

AUTOMATIC REGULATOR:
Silicon Controlled Rectifiers

SIZE & WEIGHT:
13⅜" H x 17⅜" W x 15¼" D
100 lbs.

Optional Extras:

AUTOMATIC BATTERY CHARGING & CURRENT LIMITING PROVISION:
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MILITARIZING:
Built to MIL-E-4970A for humidity, salt spray, sand, dust, fungus, rain, sunshine & low pressure. Also shock & vibration category D.
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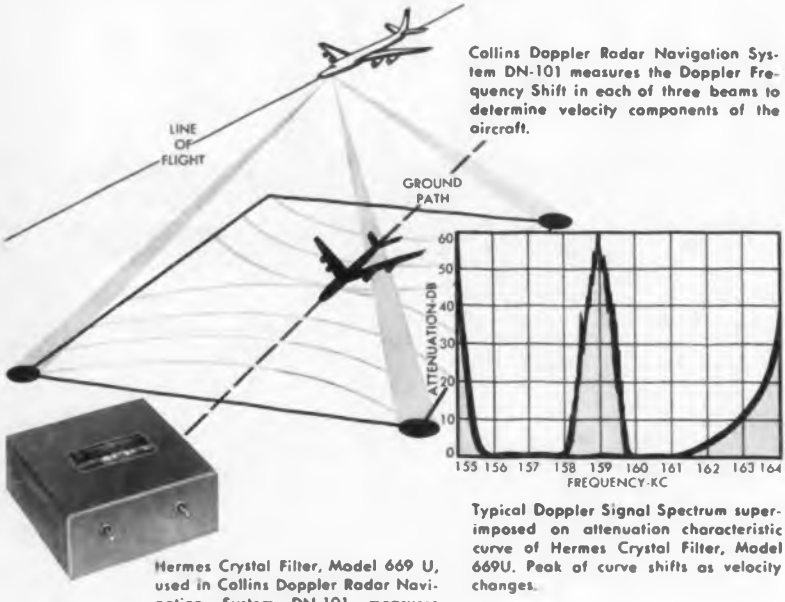
CIRCLE 21 ON READER-SERVICE CARD

FIRST Airborne Doppler Radar Navigation System with Simplified Transistor Circuitry uses HERMES CRYSTAL FILTER



Collins Doppler Radar Navigation System DN-101 measures the Doppler Frequency Shift in each of three beams to determine velocity components of the aircraft.

Typical Doppler Signal Spectrum superimposed on attenuation characteristic curve of Hermes Crystal Filter, Model 669U. Peak of curve shifts as velocity changes.

Hermes Crystal Filter, Model 669 U, used in Collins Doppler Radar Navigation System DN-101 measures 3½" L. x 3¼" W. x 1⅛" H.

Collins DN-101 Doppler Radar Navigation System is an airborne radar transmitting and receiving system which directs three beams of X-band energy towards the earth and then accurately measures the amount of frequency change between the transmitted and reflected signals to determine the lateral, vertical, and horizontal velocities of the aircraft.

In order to eliminate an undesired leakage sideband in the Radar Sensor, a system selectivity with a very sharp cut-off on the lower frequency end of the passband had to be provided. Hermes Crystal Filter, Model 669 U, not only met this requirement by establishing the desired selectivity in the second IF amplifier but also made it possible to reduce the number of transistors in the accompanying circuit. Close cooperation between the engineering departments of the two companies contributed to the rapid solution of this critical selectivity problem. Hermes Crystal Filter characteristics, Model 669U . . . Center Frequency is 159.0 Kc. Bandwidth at 2 db is 6 Kc min. Attenuation increases from 2 db to 53 db in 8.1% of the passband. Insertion Loss is 10 db max. Temperature Range is −40°C to +55°C.

Whether your selectivity problems are in transmission or reception, AM or FM, mobile or fixed equipment, you can call on Itek Electro-Products engineering specialists to assist you in the design of your circuitry and in the selection of filter characteristics best suited to your needs. *Write for Crystal Filter Bulletin.*

A limited number of opportunities are available to experienced circuit designers. Send Résumé to Dr. D. I. Kosowsky.

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CIRCLE 22 ON READER-SERVICE CARD

WASHINGTON REPORT

John J. Christie

BATTLEFIELD ELECTRONICS is due for increased emphasis as a result of the defense policy-makers' current preoccupation with the problem of upgrading U. S. limited war capabilities.

Advanced techniques in tactical communications surveillance and command control are particularly needed to enable ground forces to cope with types of warfare that can range from disorganized Guerilla actions to theater-wide operations involving tactical nuclear weapons. At the recent defense planning symposium sponsored by the Electronic Industries Association, industry's attention was drawn to a host of specific areas of R&D that should pay good dividends.

Deployment of smaller, more widely dispersed units has upgraded tactical communication's requirements for all echelons down to the rifle squad. More range is needed in single channel sets and greater mobility and ruggedness in multichannel sets. Small tactical troposcatter systems are required for use in forward combat areas to avoid the problem of having to install relays in the absence of line-of-sight.

THE CASE FOR THE 24-HOUR SATELLITE as the initial rather than the ultimate in commercial space communications systems was argued eloquently in briefs filed recently by Hughes Aircraft and Radio Corp. of America in response to the Federal Communications Commission request for industry comments on space-ground frequency sharing. The two companies were almost a decade apart, however, in their timetable for high-altitude, synchronous communications satellite systems.

Hughes, having developed an experimental payload, is eager for an early feasibility test. It contends a SCOUT rocket of the National Aeronautics and Space Administration could put the Hughes 33-lb payload into stationary orbit above the equator for as little as $500,000 total cost per launch. It says its system could be in operation next year.

The timing is significant in view of NASA's plan for a mid-1962 launching of RELAY, a low-altitude active communications satellite (and a project on which Hughes is one of 40 prospective bidders). RELAY will be used to evaluate the low-altitude system so strongly favored by American Telephone and Telegraph, whose own experimental system is due to be launched this year.
Authoritative sources at NASA indicate that the space agency sees considerable merit in the Hughes proposal. Although no offer of launching and tracking facilities is currently under consideration, the possibility of NASA assistance cannot be ruled out.

NASA experts, however, have two misgivings about the proposal. They doubt that launchings would be as inexpensive as Hughes calculations indicate, particularly since the SCOUT would have to be augmented by two stages attached to the payload to attain

required orbit. Also, they frown upon absence of provisions for redundancy such as they are requiring for RELAY.

THE HUGHES PAYLOAD represents an attempt to achieve minimum complexity and weight in "a first commercial satellite system." Thus it employs simple spin stabilization instead of full attitude control and achieves further weight saving in power requirements by use of the LAL-1 traveling-wave tube.

"Using solid-state electronics, except for this one tube, required only 12.5 w from the solar cells and small storage battery and led to an unusually good electronic power/weight ratio," Hughes told the FCC in its brief.

Hughes puts the probable payload life at somewhat less than a year on the basis of the 10,000-hour life of the tube. "Since early satellites will quickly become obsolescent, this system need not continue using obsolescent long-life satellites," the company observes.

It is proposed that launchings be made from an equatorial island to permit use of smaller, less expensive boosters than would be required at Cape Canaveral. At Canaveral it would be necessary to provide a greater boost to allow for dog-legging of the trajectory at the equator. Two satellites would be orbited, one operational and one standby. The second would be activated when the first failed, and the third would then be orbited as a replacement.

Assuming that NASA's SCOUT could be used for launchings and that three would be required in a year, Hughes estimates total expenditure for the operational system at $1.5 million. This is based on January, 1960, estimates on production of SCOUTS — with attitude and guidance control — at $361,000 each, plus payload and other costs, for a total of $500,000 per launch.

A 2.5-mc channel in the 450-470 bandwidth is proposed. The bandwidth, with SSB modulation, is said to be adequate for about 300 two-way telephone circuits or for TV "with slightly curtailed picture quality" (as compared with the originally proposed 4.5-mc band). Satellite-to-earth frequency would be in the vicinity of 2,000 mc.

A LONGER RANGE VIEW of the communications satellite is taken by RCA. Its brief takes the position that demand for space communications is not so urgent that it could not await development of a versatile, very-high-capacity synchronous repeater. Such a system, it declares, could be operational in the late 1960's.

RCA calls for a system with a capacity equivalent to 1,000 full duplex telephone circuits per satellite, whether used for telephone, data or TV communications. It proposes that two or three such satellites be positioned above the equator to provide "full and independent access to all international carriers."

The brief contends that "any active satellite relay system must be designed to serve many nations rather than only one" and that "the most practical frequencies for such service, in relation to the bandwidth that will be required, appear today to limit the number of systems that can be operated simultaneously."

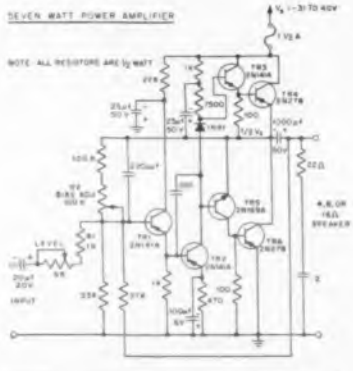
RCA's position is that the most desirable operating frequencies for the high-capacity system it proposes lie between 800 and 10,000 mc. "Where sharing of frequencies is necessary," the brief declares, "we believe that the proposed synchronous satellite system has fewer problems of sharing than a multiple low-altitude satellite system would have."

semiconductor products news

The Fi is Hi but the cost is Lo

. . . with the 2N1414 PNP low current transistor in the seven watt power amplifier circuit shown below, that is. A direct coupled power amplifier with excellent low frequency response, the circuit also has the advantage of a feedback arrangement for current stabilization of all stages. And the sheer beauty of it all is that each G-E 2N1414 in the circuit saves you almost 50% of the cost of the type previously used to do the job. You also get higher reliability in the bargain.

Naturally you'll want a complete description of the circuit, and you'll find it on pages 63 and 64 of the G-E Transistor Manual (the new 5th Edition is now out). Incidentally, for an equally good ten watt power amplifier circuit also using a 2N1414, turn to page 66.



Breathes there the man with soul so dead who never to himself hath said, how can I design this control circuit cheaper? One very good answer for several years now has been the unijunction transistor, which can often replace two conventional transistors in a circuit. But hear this: the price of the 2N1671 Series unijunction transistors has been slashed 41% to make your overall circuit cost savings even greater. For complete details, ask your G-E Semiconductor District Sales Manager, or drop us a line at Section 23C93.

Better yet you get getters

You ask why? Because you get a better product! General Electric puts getters in transistors for the same reason they are used in tubes; the sorption of harmful residual gases and vapors unavoidably bottled up inside transistors when they are sealed (no matter *who* does it or *how* it is done). Atmosphere control experiments begun as early as 1955 demonstrated the fact that getters assure long-term electrical characteristic stability, with the most marked improvement at high temperatures.

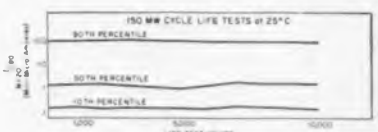
Want a for instance? We took an ungettered 2N40 Series, tested at 135°C storage, and more than half had I_{CBO} increases to 100 microamps within 125 hours. We then took G-E 2N40's *with* getters and tested under exactly the same conditions. They went to 20,000 hours before I_{CBO} increased to the same level. As a matter of fact, additional tests indicate we are closer to 50,000 hours. And remember, this unit is rated at 100°C storage. We test at 135°C.

So compare 125 hours with 50,000 hours, and never again seek to ask for whom the getter toils . . . it toils for thee!

Tunnel Diodes, anyone? The new G-E tunnel diode manual is hot off the press, and if we do say so, it's a beaut! Theory, ratings and characteristics, specific applications, test circuits . . . you name it, you got it. Get your copy today from your Authorized G-E Distributor.

Where there's life . . . there's test data

. . . and the 2N332 NPN transistor series is a good case in point. No less than four 1000-hour life tests are regularly performed (125°C operating, 200°C storage, 25°C cycled power, 25°C shelf), with sample sizes for each test averaging over 50 samples per test per week. Samples are then taken from these groups and testing extended to 10,000 hours. Now, for just one example of the extreme stability demonstrated by these tests, take a look at the chart below showing I_{CBO} for a typical lot. Not bad. Not bad at all!



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AC MEASUREMENT

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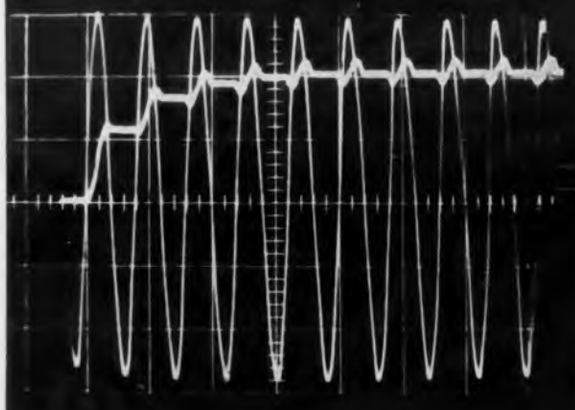

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Superimposed input and output waveforms show the fast response time of Adage's Type ACS1 AC Averager. Short filter time constant allows the steady state value to be achieved quickly.

PRECISE MEASUREMENT

The ripple present in the output waveform does not interfere with the precision of the measurement. Timing circuitry insures that the voltage measured is that value present during the interval when the output is ripple free.

Modern instrumentation systems demand equipment to make fast, precise measurements of AC signal waveforms. This required combination of speed and accuracy is beyond the capability of conventional techniques. For example, a conventional diode-capacitor AC/DC converter requires at least three seconds settling time to make 60 cps measurements. When many different signal sources must be scanned and measured successively, this slow response time limits seriously the overall system speed.

Slow response time is also a disadvantage in AC carrier systems. The transformer-driven diode bridge demodulators conventionally used as phase-sensitive AC measurement instrumentation for these systems have inherent limitations in both speed and accuracy. They tend to compromise the performance of instrumentation systems using them.

There has been, then, a clear need for innovation in the field of AC measurement. Responding to this need, Adage has developed several new AC measurement techniques. Among these is the fast-averaging technique illustrated in the accompanying waveform photographs. This technique offers substantially improved performance both for self-synchronous and phase-sensitive measurements. Response time, for example, is improved by more than a factor of ten to one. Used in conjunction with precision voltage to digital converters, modules implementing these new measurement methods have been successfully applied in many industrial and military instrumentation systems. A typical solid-state, AC Signal Conditioner is comprised of three 5" x 8" epoxy fibreglass circuit modules, easily incorporated in any of the Adage VOLDICON® voltage to digital converters.

Applications notes and technical data describing in detail Adage's AC instrumentation capability is available upon request.

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CIRCLE 24 ON READER-SERVICE CARD

NEWS

Computers Designing 3 Classes of Products

Mass-Produced, Modified Version And One-of-a-Kind Items Affected

COMPUTERS are helping to design three classes of products for American industry: those that are mass produced, modified versions of standard products, and one-of-a-kind items.

This was the substance of a report by E. L. Harder of Westinghouse Electric Corp., Pittsburgh, at the Seventh Annual Data Processing Conference and Exhibit of the American Management Association. The conference was held in New York.

As better computers are developed, their use in design will increase, Mr. Harder believes.

Of the three classes of products now being designed with their help, he notes, mass-produced items require only limited automation of the design process, because the item is redesigned only occasionally. On the other hand, with such items as transformers, switches and controls, each product must be designed to customer specifications. Here, Mr. Harder explains, the design method is standard but the actual design varies. For large, complex products or systems where not even the method of design can be standardized, he went on, the use of computers is limited to specific technical problems.

Mr. Harder reports that all three types of designing can be accomplished with the same computers, most of which may also be used for business purposes.

Many single-design solutions in making relatively standard products can be stored for use in tailoring the products to customers specifications, Mr. Harder says.

In the nonstandardized class of products, he reports, designers are finding it possible, once the design has been completed, to retrieve much of the single-design data and use it not only in manufacturing the products but also in future designing.

As the cost of random-access storage declines, it is becoming more feasible to store information for use in designing, Mr. Harder reports.

Information Retrieval Poses Major Challenge

The problem of finding needed information in a massive accumulation of data was one of the most challenging subjects raised at the conference. Despite great strides in data-processing

equipment and techniques, technological advances have not kept pace with the data-retrieval needs of business and science, it was pointed out.

According to Dr. Mortimer Taube, president of Documentation, Inc., the look-up or data-acquisition problem cannot be solved by brute force (with ever-tighter information densities and faster and faster machines). Data acquisition is not so much a data-processing problem today as it is a management problem, he said. Management, either in business or in scientific explorations, must know what data it needs and how to file and index the data so they are available when needed.

Martin Co. Engineer Gets $500 'Idea of Year' Award

For Roy P. Foerster, group engineer of the Martin Co., a highlight of the IRE Show last week was ELECTRONIC DESIGN's Idea of the Year Award. As winner of the 1960 award, Mr. Foerster received a $500 bill and a plaque from ELECTRONIC DESIGN's editor, Edward E. Grazda, and publisher, Robert E. Ahrensdorf.

Mr. Foerster's winning idea, published during the sixth anniversary of the Ideas for Design section of ELECTRONIC DESIGN, showed how an LC ringing circuit could be used to stabilize triggering points of transistorized blocking oscillators and multivibrators. The engineer said he planned to submit more Ideas for Design and hoped to win one of 1961's seventh Anniversary Awards.

These awards will include $20 for each Idea published, $50 for the Idea voted Most Valuable of Issue, and $1,000 for the Idea of the Year. Details of the Seventh-Anniversary Awards appeared on p 190 of the March 15 issue.

Roy P. Foerster accepts $500 Idea of the Year Award from ELECTRONIC DESIGN's editor, Edward E. Grazda (left), and publisher, Robert E. Ahrensdorf (right).

Down . . . down . . . down to ± 10%. Ohmite now offers this low "K" tolerance as *standard* for all three *commercial*, "hat-shape" slug capacitors.

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Ohmite also supplies the three "hat-shape" sizes—T1, T2, T3—in S and T tolerances according to the latest requirements of MIL-C-3965B, styles CL44 and CL45.

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CIRCLE 25 ON READER-SERVICE CARD

Exclusive new subminiature DIALPOT® for printed circuitry gives instant answers to three basic questions

At one quick glance, this plug-in subminiature pot answers the questions: Where is the slider? At what angle is the pot set? At what percent of voltage is the pot set? The dial is calibrated with equal graduations from 0 to 10 in the 300° winding angle. As an index, there is a scribe line on the base. Mechanical rotational stops are standard. The brush is phased so that the "0" graduation on the dial is in line with the scribe line at 0° functional rotation. Terminals are located on a standard .1 inch grid, as used in printed circuitry. Terminal numbers are clearly marked. Dissipates 1 watt at 40°C. Independent linearity (above 500 ohms.), ±3%. Meets MIL-R-19 and other specifications as applicable. Standard resistances: 50, 100, 500, 1K, 2K, 5K, 10K, 20K. Write for Bulletin APD-261.

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CIRCLE 26 ON READER-SERVICE CARD

NEWS

50% Brighter TV Claimed With RCA Color Tube

Color TV up to 50 per cent brighter, with greater sharpness and contrast, is claimed with a new picture tube.

The tube, a new version of a three-gun shadow mask tube, was developed by Radio Corp. of America's electron tube division of Lancaster, Pa. It also reproduces black-and-white pictures with equally good results, the company says.

Designated RCA-21FBP22, the tube is available to manufacturers in two versions:

1. A conventional type for receivers using separate safety glass.

2. A laminated safety-plate type that eliminates the need for separate safety glass.

Technical features of the color tube are listed as:

- Improved brightness, through the use of more efficient sulfide phosphors.
- Sharper pictures of rapid action, by using matched short-persistence phosphors.
- Equalization of spot sizes, because of better balanced efficiencies of the three phosphors, resulting in "crisper" color and black-and-white pictures.
- Outstanding stability of electron-beam balance and freedom from microphonic effects, because of a novel method of maintaining microscopic spacing accurately between the cathode and control grid of each electron gun.
- Greater tolerance for "beam-to-dot" register, through the use of precise manufacturing controls, with the result that color fields are set up more easily and the need for adjustable field-equalizer magnets is eliminated.
- Use of a single high-voltage terminal at a new location on the bulb, eliminating an external protective resistor formerly required.

Sweden Orders $47.6 Million In Air Defense Electronics

Electronic equipment for Sweden's air defense is being supplied by Marconi's Wireless Telegraph Co., Ltd., under a $47.6-million contract.

Aircraft positions and heights derived from an early-warning radar chain will be filtered and fed to special radar indicators linked to automatic tracking devices. The tracking devices will extract position information in electronic pulses, which will be stored in a central electronic memory.

In addition to providing early warning of enemy attack, the system will use a computer to solve interception problems.

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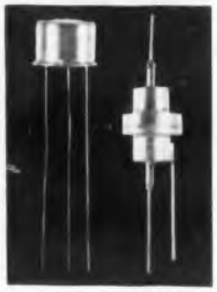

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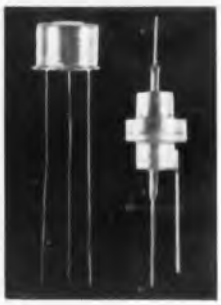
Hughes Semiconductor Division • Box 278 Newport Beach, California

Number one of a series

WHY PNP SILICON ALLOY TRANSISTORS?

Here are the characteristics, applications and key specifications of these unique transistors.



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Why PNP Alloy Transistors?

Soon after the introduction of the transistor, many applications which had formerly utilized vacuum tubes were redesigned to take advantage of the favorable characteristics of the new component. Some of these applications were ideally suited to the germanium transistor. But where high operating temperatures or low currents were involved, silicon (with its substantially lower leakage current) gave the circuit designer hope for his critical applications. ▪ In designing these silicon transistors, semiconductor manufacturers faced a problem. The alloy process which had proved successful for germanium transistors was found to be extremely difficult with silicon. However, even the earliest silicon alloy transistors indicated a uniformity of desirable characteristics which warranted further research and development. NPN transistors did not lend themselves to the alloy process, so most manufacturers turned to an NPN silicon grown junction process. Circuit designers' needs; however, for a reliable PNP silicon alloy transistor still remained. ▪ Some semiconductor manufacturers persisted, and pioneered[1] a PNP silicon alloy transistor. Today it is not only accepted wholeheartedly by the military, but regarded as the "work horse" for high and low level transistor circuitry by electronic design engineers throughout the world. It might be added that PNP silicon alloy transistors are being used in every major missile currently programmed.

Reliability Insurance

In order to insure a stable, reliable product Hughes Semiconductors has established a strenuous test program. Here in detail are two typical environmental tests to which every Hughes silicon alloy transistor is subjected.

Temperature Cycle "Heat-Freeze" Process One hour storage at −65°C, then one hour storage at 200°C alternating the process for 250 continuous hours! All temperature changes take place in less than a minute and are performed automatically in oven-freezers which were designed and built especially for Hughes. Result: Extreme device stability.

Hermetic Seal Test Each transistor is immersed in a liquid detergent with one hundred pounds of pressure applied—and maintained for two hours! Each transistor is then given a thorough leakage current test. Additionally, on a sampling basis, these transistors are subjected to a helium leak rate test. Precautions such as these insure maximum device reliability in your circuits.

Characteristics and Advantage

Dependent upon your specific requirements will obviously be of more importance to Actually, the proper combination of the foll istics will produce a high-quality, general p con alloy transistor. (See Table I for curren types.)

- High Breakdown Voltages
- Symmetrical Breakdown Voltages
- Uniform Gain Vs. Current Characteristics
- Low Saturation Resistance
- Low Input Impedance
- Low Leakage Current
- High
- Low
- Inver
- Low
- Low

Especially worthy of consideration is the low ance, which results in small collector to emitt permitting low level switching not possible other types of silicon transistors. Linear ope alloy transistors is retained even if the collec drops to zero—or to a slightly positive value. voltages (BV_{EBO}, BV_{CBO} and BV_{CEO}) show ture voltages as high as −110V (guaranteed n on some types. In normal configurations, hi ages are possible, making these devices usabl such as relays and magnetic core drivers whe spike" might destroy other transistors. ▪ T trical characteristics and the narrow range o ations also make silicon alloy transistors mos outstanding example of this is their accepta ential amplifiers.[2]

Applications and End Products

Some of the more popular applications for t and dc[2] amplifiers, audio oscillators, low switching, dc choppers and modulators, espec cations operating with elevated or varying atures. Typical end products from the abov lated power supplies, computers, missile g communication and telemetry equipment, an

(1) Hughes Aircraft Company, Semiconductor Divi silicon alloy transistors in early 1964 and have search efforts through the present.

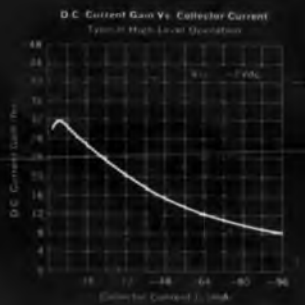
(2) W. Steiger, "A Transistor Temperature Analysis to Differential Amplifiers," IRE TRANS. [illegible] Vol. 1-8, December 1960.

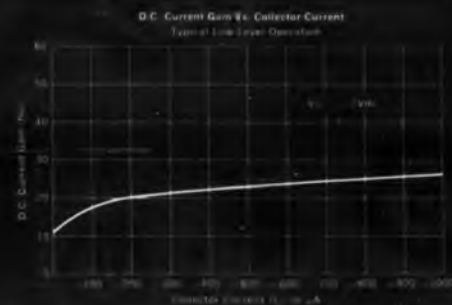
(3) C. D. Todd, "Preamplifier Designed for Minimum tion," ELECTRONICS, Vol. 33, April 29, 1960

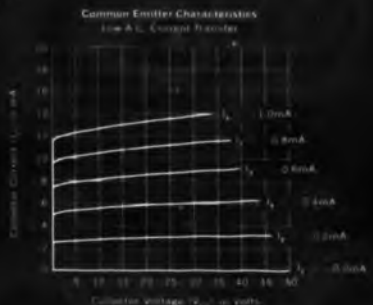
Hughes Silicon Alloy Transistor Families—Table I

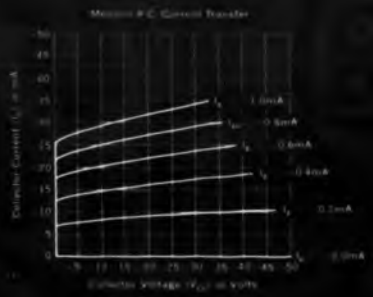
Type	Max Collector Voltage, V_{CB} (V)	Max Leakage Current I_{CBO} (uAdc)	A.C. Current Transfer h_{fe} (Min.)	(Typ.)	(Max.)	D.C. Current Gain h_{FE} (Min.)	(Typ.)	(Max.)	Refer for Detailed Specifications	Comments
2N1238	−15	−0.1	14		32	18				
2N1239	−15	−0.1	28		60	35				
2N1240	−35	−0.1	14		32	18				
2N1241	−35	−0.1	28		60	90				
2N1242	−60	−0.1	14		32	18				
2N1243	−60	−0.1	28		60	35				
2N1244	−110	−0.1	14		32	18				
2N1228	−15	−0.1	14		32	18				
2N1229	−15	−0.1	28		60	35				
2N1230	−35	−0.1	14		32	18				
2N1231	−35	−0.1	28		60	35				
2N1232	−60	−0.1	14		32	18				
2N1233	−60	−0.1	28		60	35				
2N1234	−110	−0.1	14		32	18				
2N327A	−45	−0.1		14		5		32		
2N328A	−45	−0.1		28		15		64		
2N329A	−45	−0.1		50		30		68		
2N1034	−40	−1.0	9		32					
2N1035	−30	−1.0	18		42					
2N1036	−20	−1.0	34		68					
2N1037	−15	−1.0	9		42					

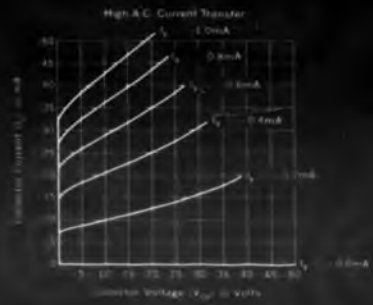
TYPICAL CURVES OF SILICON ALLOY TRANSISTORS @ 25 C











Other factors which are used to insure reliability at Hughes are: a. Rigid visual inspection. b. Mechanical vibration under operating conditions. c. Mechanical shock under operating conditions. d. Thermal shock (temperature cycle). e. Moisture resistance (temperature-humidity cycling). f. Operating and storage life tests at specific temperatures. In each case, load levels are equal to or greater than the rated values for any given transistor design. Specific failure mechanisms associated with each type of load are identified and the device is disqualified if it fails to meet required specifications.

NOTE: A truly reliable silicon alloy transistor uses no tin or low melting solders of any kind, but has alloys which melt at temperatures well above the maximum junction temperature of silicon. For complete hermetic sealing at all temperatures, all joints should be welded, including the final seal.

Package Configurations... choice of two package styles

Most transistors in this series are available in two package styles thus allowing freedom in circuit design based on your individual needs. The rugged, sturdy structure of each case style enables them to pass easily the stringent requirements outlined in MIL-S-19500B.

Coaxial Package The coaxial package is designed so that junction heat is dissipated through the case allowing a rating of 1 watt in free air. Ratings in excess of 5 watts may be obtained by the use of a properly designed heat radiator (See photograph A). ■ Another advantage of the coaxial package is that it can be attached to circuit boards by familiar resistor-mounting techniques, and can therefore be handled by automatic assembly machinery.

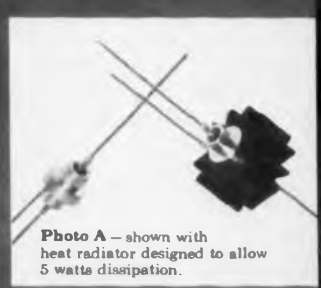


Photo A – shown with heat radiator designed to allow 5 watts dissipation.

TO-5 Package This sturdy package is standard throughout the industry. The TO-5 package is constructed to operate normally at 400mW; however a rating of up to 600mW can be obtained by use of heat radiators such as those shown in photograph B. The major differences between the coaxial package and the TO-5 package, other than power handling capabilities, is that each of the three elements is insulated from the case in the TO-5 design.

Photo B – shown with various types of heat radiators designed to allow 600mW dissipation.

Purchasing Do's and Don'ts

DON'T specify a device that does not exist for your circuits—although this will motivate research and development groups to design better products for the future…the immediate result is long delay in quantity delivery. Be sure you can wait if your requirement is exotic.

DON'T specify inferior products for economical purposes resulting in unreliable circuit performance. This practice creates a vicious reject and replacement cycle between manufacturer and user.

DON'T buy from manufacturers whose facilities are not adequate for testing to rigid military specifications and production quantity delivery is questionable.

DON'T attempt to buy reliability by specifying breakdown voltages far in excess of those required. There may be some exceptions, however, this is a very expensive practice. DO buy reliability—not reliability by safety factor!

DO make sure that the transistors you buy meet the manufacturer's advertising and registered specifications.

DO make sure your 2N transistor type is "registered" with EIA, not "reserved." When using types with a "reserved" status, the manufacturer may alter his specifications at will.

DO make sure the leakage currents are measured at a reverse voltage as high as your present requirement demands.

DO remember that reliability has to be designed in the transistor; it cannot be tested in. No amount of testing will undo poor design. However, it is important that the manufacturer have a sound quality assurance program to insure that the reliability is actually there.

DO make sure that a transistor that is to be used as a switch meets your speed requirements by actual test in your circuit; this is the only true test. Manufacturers often show values for switch-speeds that are optimized.

DO use silicon alloy transistors in applications such as relays and magnetic circuits, where inductive spike might ruin other transistors.

DO be sure to get the saturation resistance you need. Low V_{CE} (sat) parameter does not guarantee low saturation resistance unless the test conditions are given. (I_C and I_B)

DON'T guess what the parameters will be if your circuit is intended for high temperature application, but DO get the proper data from the manufacturer.

Hughes and the Silicon Alloy Transistor

Silicon alloy transistors are here to stay, but the circuit designer is constantly seeking to improve the device—such is Hughes' goal—to achieve a more perfect transistor. Hughes' research engineers are currently working toward the following ideal goals:

- Saturation resistance approaching zero
- Leakage current approaching micro-micro-amps
- More uniform gain for current variation
- Parameter changes independent of temperature
- Infinite life expectancy and reliability
- Microminiaturization
- High gain at microwatt levels

The foregoing information has been gathered from the Hughes Semiconductor Division's reports and results on the silicon alloy transistor, compiled with the cooperation of Hughes' staff of skilled engineers. ■ Pioneer in the semiconductor field, Hughes has continued as a top developer and producer of the most advanced semiconductor devices. The Newport Beach plant, with its third of a million square feet of floor space, houses all of the facilities necessary for every phase of design, development and production of diodes, transistors, rectifiers, special devices and semiconductor materials. ■ *For further information call or write your nearest Hughes Semiconductor Sales Office. Or write: Hughes Semiconductor Division, Marketing Dept. 500 Superior Ave., Newport Beach, California.*

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Computer to Replace Bureaucrat? Why Not, Says IRE Panelist

A suggestion that computers replace bureaucrats in dealings with the public was made at a recent IRE panel discussion in New York City.

The proponent was Prof. John McCarthy of the Massachusetts Institute of Technology, who contended the computer was inherently more flexible than a bureaucrat because its programing could allow for necessary exceptions to the rule.

Later a second panelist, Dr. Herbert Grosch, an authority on the organization and application of computer systems, reported that steps were already in progress to replace some Government officials with machines. Installation of a computer facility is under way in West Virginia, he said, to process the collection of taxes. Within five years, he predicted, all taxable transactions in the United States will be calculated and processed automatically by the Treasury.

Professor McCarthy's viewpoint was disputed in part by two engineers in the audience, Arnold L. Dumey of Data Sciences, Inc., Great Neck, N.Y., and Yale J. Lubkin of Loral Electronics Corp., Bronx, N.Y. While neither doubted that bureaucrats lacked flexibility, both asserted that computers would merely be an additional buffer between the public and public officials, and so, in practice, would do little to foster individuality.

Professor McCarthy argued that the use of computers permitted people to devote their efforts to "more ennobling tasks—the human use of human beings."

"Machines will not regiment us," he said. "On the contrary, I think we can expect a great deal more politeness from machines than we have gotten from humans."

The third panelist was Prof. Isaac Asimov of the Boston University School of Medicine.

Compact Film Projector, PA System Is Developed by Japanese Company

A combination 8-mm film and sound projector, tape recorder, and public-address system the size of a portable typewriter has been produced in Japan.

The Eko-VI, from the Proretran Research Laboratory, is also equipped with a 21-in. screen mounted in its lid. It may be viewed from front or rear and its design is such that it can be viewed in broad daylight.

Film is run through a horizontal projector located inside the unit. If the film has a sound track, the device will record on the film and play back.

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Other reasons for the selection of KEL-F Plastic: its excellent flow properties around the intricate mold configurations necessary to produce these parts . . . its dielectric constant . . . and its outstanding mechanical strength. While not normally exposed to great pressure or mechanical shock, the switch must be designed to meet extraordinary shipboard conditions such as explosion, fire, missile impact, etc. See the "Properties Profile" to the right for more information about KEL-F Plastic . . .

"KEL-F" is a Reg. T.M. of 3M Co.

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	Dielectric Constant	Dissipation Factor
100 cycles	2.65	.0212
10,000 cycles	2.45	.0235
100,000 cycles	2.38	.0200
100 cycles, 30° C.	2.66	.0174
100 cycles, 105° C.	2.86	.005
100 cycles, 152° C.	2.91	.002

Electrical Strength in Oil

Caliper—.01922 in.
1" electrode . . . . . 1,250 vpm
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Compressive Strength (0.2% offset)	4,300 psi
Modulus of Elasticity	132×10^3 psi
Shear Strength	6,400 psi

The plastic may be molded by conventional techniques on standard equipment by injection, compression, extrusion or transfer methods. Parts may be machined to close tolerances, comparable to brass, and may be drilled, punched, polished, buffed or sanded as required.

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CIRCLE 31 ON READER-SERVICE CARD

NEWS

Japanese Fast To Adopt Electronic Developments

SCR's Used In Railway, Appliances; Epitaxial Process Reported in Use

Stuart Griffin
ELECTRONIC DESIGN Japan Correspondent

ALTHOUGH Japanese electronics companies have been increasing efforts in original research, they have also continued to quickly take advantage of advances in other countries.

Yakasukawa Electric Co., Ltd., in Tokyo, for example, is starting to produce printed circuit motors under an arrangement with Societe Electronique Auto-machine of France. Dai Nippon Printing Co. is beginning manufacturing of the circuits using special epoxy and ceramic materials supplied by other Japanese firms.

Silicon-controlled rectifiers are finding wide use here. An ac-dc conversion electric car, Moha 401, has been built by Japanese National Railway Corp. using SCR's to perform the conversion. Domestic production of silicon-controlled rectifiers has been started by Tokyo Shibaura Electric Co., Tokyo. Many varieties of electrical appliances using the SCR's are now in production at Tokyo Shibaura's Fuchu Works.

Silicon monocrystals with impurity levels down to 6 parts in 1 billion, reportedly produced by epitaxial techniques, are now being marketed by Tokai Electric Cathode Co., Ltd., Tokyo. Until last year, when the high purity process was developed, Japanese semiconductor manufacturers depended on such American suppliers as DuPont and Eagle-Pitcher for supplies. The new crystals are believed to be produced by an epitaxial process similar to that now being adopted by many American firms. Tokai Electric is guaranteeing a resistivity of 500 ohm-cm for the crystals.

Tohoku University Scientist Builds Cryotron Calculating Machine

A suitcase-size cryotron calculating machine has been assembled by Futoshi Onodera of Tohoku University's Electric Communications Laboratory in Sendai. Further work on cryotron circuitry is in progress at the university laboratory.

The X-ray image intensifier tube has been put into production by Tokyo Shibaura Electric Manufacturing Co., Ltd., Tokyo. The company had assistance from its Matsuda Research Laboratory, its Tsurumi Works Laboratory, its Fuji Works, and its own Appliance Engineering Dept. in development of the tube. This tube, as with similar

devices in the U.S., increases brightness of an X-ray image many times. It also improves detail perceptibility, so that the 0.7-mm limit in previous fluoroscopy equipment is now raised to about 0.3 mm. Further applications of the tube are expected in such fields as radiography, cineradiography, and nondestructive testing.

Selective Replay Transistorized Phonograph, Microminiature Tape Recorder Marketed

In the commercial products field, Japanese manufacturers continue an imaginative development program.

A phonograph that can replay any selected portion of a record has been put on the market by Tokyo Shibaura Electric Co., Ltd. The portable, transistorized unit sells here for about $80.

Major uses for the Toshiba Replay Phonograph, type TF-52, are expected to be in language training or other educational purposes, recording of plays, or for music fans who like to replay favorite portions of a record.

It has three control buttons, for start, stop, and repeat play. An earphone provided with the set can be plugged in for "one-person" listening. The set weighs about 22 pounds.

A tiny tape recorder with an automatic reversing double-track tape is being sold by Kowa Optical Works, Tokyo. It is produced in the Kowa Electric Laboratory of Kofuku Sangyo Co.

The pocketbook sized, all-transistorized recorder gives 30 min of uninterrupted recording. Accessories include a telephonic pickup, a wristwatch microphone, earphone and speaker. ■ ■

Seagoing Early-Warning Radar

A landlubber while it is undergoing final tests, this seagoing, early-warning radar was developed by Raytheon, Wayland, Mass., under a $7 million Navy contract. The 10-ton system is designed for use aboard Navy picket ships and cruisers. Its 40-ft aluminum antenna has 150 horns that beam and collect invader signals 100 miles away. The radar employs the company's high-power Amplitron tube.

NEW DORSETT "20" SERIES

provides maximum telemetry system flexibility!

- Requires Less Power
- Meets Most Rugged Environmental Conditions
- Die Cast Construction

SOLID STATE COMPONENTS AVAILABLE FOR "20" SERIES PACKAGING

- TR-20 2-watt FM Transmitter, 225 - 260 mc.
- TR-21 2-watt FM Transmitter, 136 - 137 mc.
- O-20A Subcarrier Oscillator
- MVO-20 Millivolt Subcarrier Oscillator
- ACA-20 Low Level AC Amplifier
- DCA-20 Low Level DC Amplifier
- PWM-20 Pulse Width Modulator
- PS-20 Regulated Power Supply

MODULAR PACKAGING DESIGN of the new "20" series line of telemetering components and systems lets you put more telemetering equipment in less space. Every system component has been packaged in compatible modules identical in height (2.25") and width (1.875"), with thicknesses of one, two, or four units (.875" per unit). These standard modules permit a wide range of system configurations, and make future modification of basic systems easy and economical.

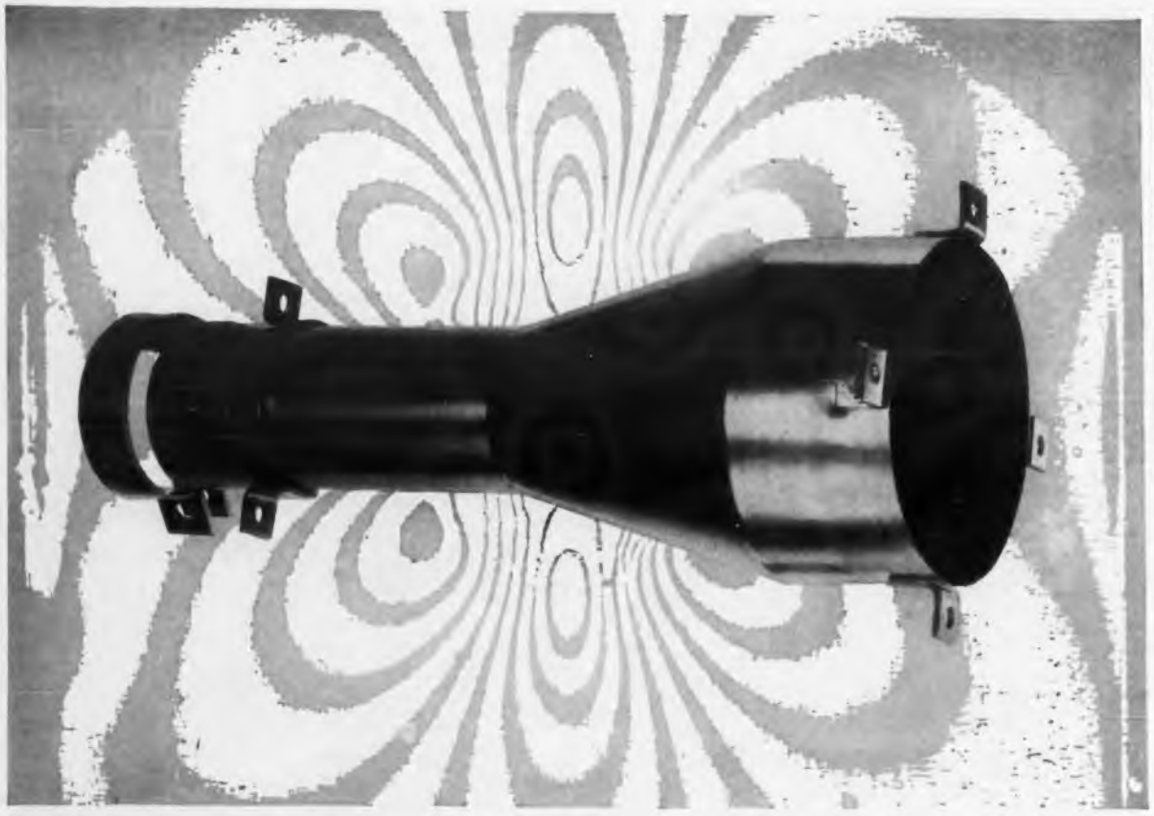
EVERY "20" SERIES COMPONENT utilizes silicon semi-conductor circuitry—no tubes anywhere. The typical "20" series 12 channel system including transmitter, weighs less than 5 pounds, draws less than 20 watts from a 28 volt supply, and exceeds military specifications for reliability and performance throughout extreme missile environments.

FOR YOUR NEXT TELEMETERING REQUIREMENT let Dorsett take the problems out of system packaging with a "20" series telemetry system. Your inquiries or specifications will receive a prompt reply.

DORSETT ELECTRONICS, INC.

P. O. Box 862, Norman, Oklahoma, Ph: JEfferson 4-3750

CIRCLE 32 ON READER-SERVICE CARD



keep your signals clean with engineered magnetic shielding

Keep stray magnetic fields out of your high gain input transformers and cathode ray tubes. Keep your signals free of noise, hum, cross-talk and distortion. You can do it only with *engineered* magnetic shielding.

These high-permeability shields are made from existing tools in a broad variety of single and multiple structures—cylinders, spheres, truncated cones—for applications ranging from dc into the audio range and higher. They can be used with almost all conventional transformer core and coil assemblies to provide any degree of magnetic, electrostatic or RF shielding against undesired signals of all classes. Reduction of field strengths to 100 db and beyond is common.

With Magnetic Metals shielding, both the electrical and mechanical engineering is already done for you. Simply let us know your requirements . . . We'll engineer the exact type of shielding you need. In selection of raw material, design, fabrication, annealing, testing and gaging, Magnetic Metals has amassed a great backlog of shielding experience. For a better understanding of shielding and help in specifying it, write for our informative booklet, "Magnetic Shielding of Transformers and Tubes."

MAGNETIC METALS

MAGNETIC METALS COMPANY
Hayes Avenue at 21st Street, Camden 1, N.J.
853 Production Place, Newport Beach, California
transformer laminations • motor laminations • tape-wound cores
powdered molybdenum permalloy cores • electromagnetic shields

CIRCLE 29 ON READER-SERVICE CARD

NEWS

U. S. Lists Bionic Devices Among Its Wanted Inventions

The Dept. of Defense would like a self-organizing computer able to perform functions analogous to human thinking.

Also desired is a mechanism to transfer automatically oral or handwritten information into digital signals.

Techniques for recognizing patterns and symbols are also sought, with the techniques capable of simulating unusual environments and human perception and processes of judgment.

These devices are in the latest list of developments requested by the Dept. of Defense, through the National Inventors Council of the Dept. of Commerce, and published by the Office of Technical Services.

Power Sources, Transistors and Computer Units Needed

Many other electronic devices are also listed. Some of these are:

- Auxiliary power sources able to produce 100 kw for 15 min, with power densities of 500 w/hr per lb or 19 w/hr per cu in.
- High-frequency transistors able to handle up to 100 w of power.
- A computer memory device with an access time of 10^{-8} sec, capacity of 10^{7} bits and a volume of less than 1 cu ft.
- An analog-to-digital converter to process large volumes of varied data.
- A means of transmitting and receiving high-resolution photographic images via radio link.
- A movie camera with a minimum frame rate of 100,000 frames per sec and exposures of 1 μsec.

New Electrical Equipment, Strain Gage, Tubes Sought

Also, high-powered electric servos; a battery-powered motor that is both electrically and acoustically silent; a low-energy switch capable of at least 100 reliable operations; a strain gage with a 2-to-5-v output; low-voltage vacuum tubes; digital output transducers; heat-to-energy-converters, and a height-velocity sensor accurate to 0.1 of 1 per cent or more.

Also, a nuclear surveillance device; a light reflective substance transparent to rf radiation; infrared transmitting glasses, and a low-speed field-data printer.

OTS suggests that designers with proposed solutions or with ideas for other devices describe their proposals in writing to the National Inventors Council, OTS, Dept. of Commerce, Washington 25, D.C.

Computer Conference Due May 9-11 in Los Angeles

The theme of the Ninth Annual Western Joint Computer Conference, scheduled for May 9-11 at the Ambassador Hotel in Los Angeles, will be "Extending Man's Intellect."

Ten sessions will be held on information retrieval, pattern recognition, automata theory and neural models, problem solving and learning machines, automatic programing, modeling human mental processes, computers in control, simulation, computers in communications and large computer systems. Analog computer sessions are also scheduled.

More than 60 papers will be presented, Dr. C. T. Leondes, program chairman, says.

GE Solid-State Inverter Uses Silicon-Controlled Rectifiers

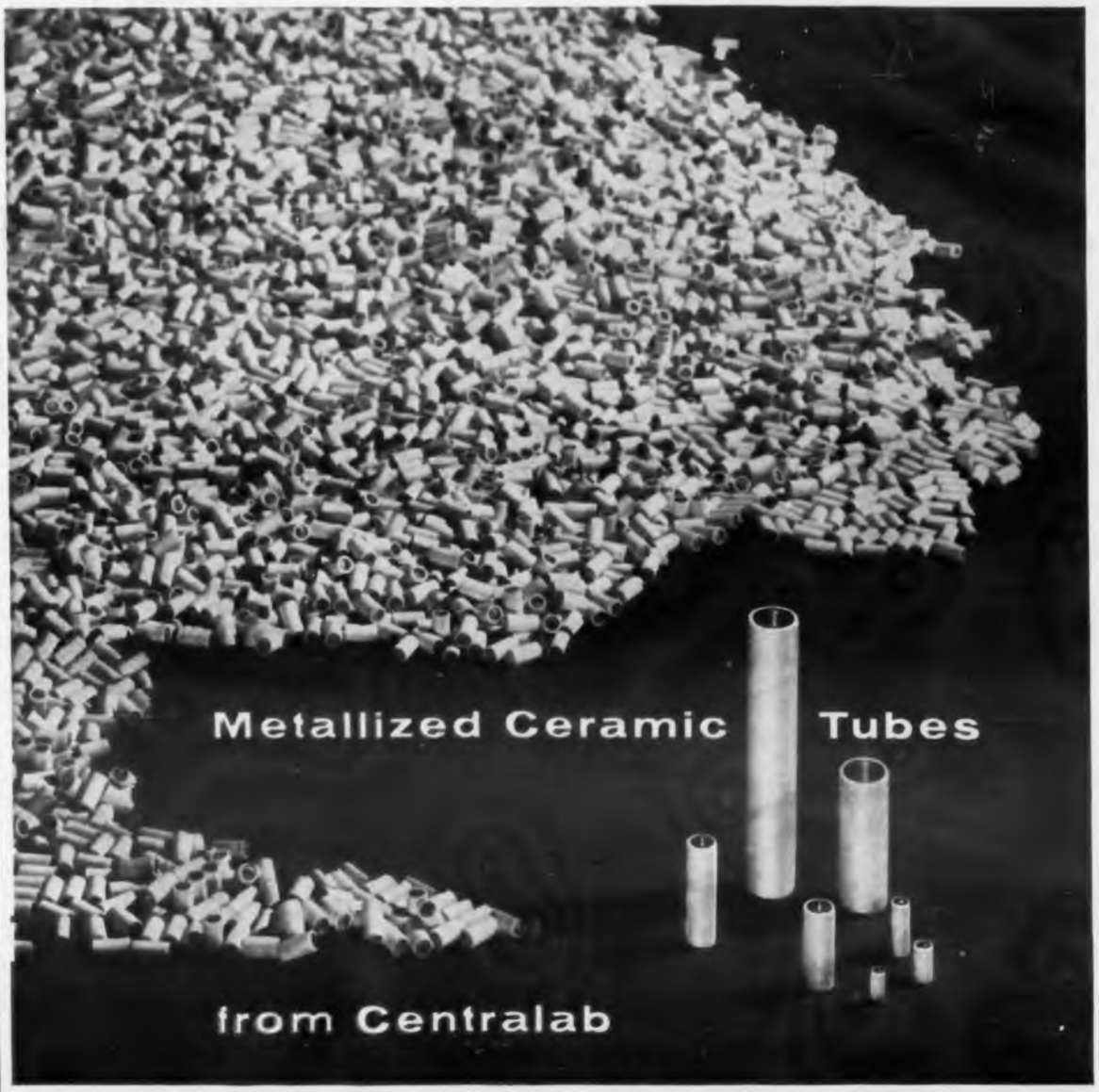
A 50-kva completely solid-state inverter, using silicon-controlled rectifiers, has been developed for converting dc to ac by General Electric Co., Schenectady, N.Y.

The device has no moving parts other than two fans, and it does the work of a 60-hp motor generator set, which is almost three times as heavy. The new inverter has 10 times the power-handling capacity of units of this type previously announced, GE reports.

Actual conversions of power from dc to ac is accomplished by silicon-controlled rectifiers that operate instantaneously without warm-up.

The new inverter, with ac output from 5 to 500 cps adjustable frequency, is designed for use in GE's engineering laboratory.

Silicon-controlled rectifier, used in General Electric's 50-kva solid-state inverter, is examined by researcher. The inverter has no moving parts except for two small fans, and it does the work of a 60-hp motor generator set.



for component hermetic sealing

Capacitors, resistors, transistors, diodes, coils, and other components will more readily meet MIL specifications for temperature, humidity, and vibration when hermetically sealed in CENTRALAB metallized tubes.

Metallized tubes of steatite or high alumina ceramic are available from CENTRALAB in a comprehensive range of standard sizes—many of which can be delivered in 48 hours. Tubes of other dimensions, including smaller sizes, can also be supplied, with initial delivery in 5 to 6 weeks, repeat orders in 3 to 4 weeks.

These tubes are internally metallized on both ends and will generally meet MIL specifications for thermal cycling from —65°C. to +125°C. Technical assistance for production sealing is provided by the CENTRALAB Engineering Department.

The standard sizes are listed in CENTRALAB Engineering Bulletin EP-978, available free on request.

STANDARD SIZE RANGES

Inner Diameters	Outer Diameters	Lengths
.105" to .300"	.156" to .395"	.250" to 2.250"

Centralab

The Electronics Division of Globe-Union Inc.

960C East Keefe Avenue • Milwaukee 1, Wisconsin

Centralab Canada Limited Ajax, Ontario

X—6114

ELECTRONIC SWITCHES • VARIABLE RESISTORS • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS

CIRCLE 30 ON READER-SERVICE CARD

Gyro spin motor shown partially disassembled, produced by Fafnir for B-58 Hustler Bombers

FAFNIR precision bearings help steer the Hustler

Instrument bearing problems? Fafnir has ball bearing engineers who specialize in solving them. But a leading instrument maker recently asked for help of a different order — production of complete gyro spin motors for the inertial guidance systems of Convair B-58 Hustler bombers. By manufacturing the complete "package", Fafnir was able to produce motors that measured up to the precision standards the customer had been seeking.

An unusual assignment for a ball bearing manufacturer. But one that shows the engineering resources Fafnir has at its command. Worth bearing in mind when you have instrument or miniature ball bearing problems! The Fafnir Bearing Company, New Britain, Connecticut.

CONVAIR B-58 HUSTLER, WORLD'S FIRST SUPERSONIC BOMBER

FAFNIR
BALL BEARINGS

CIRCLE 33 ON READER-SERVICE CARD

Industrial Robot Learns Complex Job Procedures

Dynastat Magnetic Memory Drum Records 200 Sequential Movements

A ROBOT capable of remembering a complex work procedure after being led through a sequence only once has been developed by Consolidated Controls Corp. of Bethel, Conn.

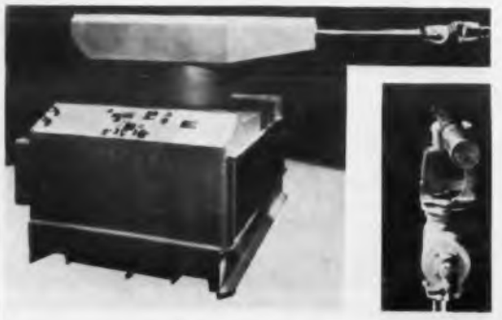
The industrial robot, called Unimate, employs the company's Dynastat magnetic memory drum, which can be read while stationary. Thus it is equally suitable for use with both stepping operations and with continuous processes. The memory, with a capacity of 16,000 bits of information, can record up to 200 different sequential movements. Each movement is controlled by an 80-bit channel on the drum.

The robot has a claw-like hand, which is guided by the operator to the first position in the sequence of movements to be recorded. Shaft-position-to-digital converters generate signals corresponding to this position. The signals are recorded on the drum.

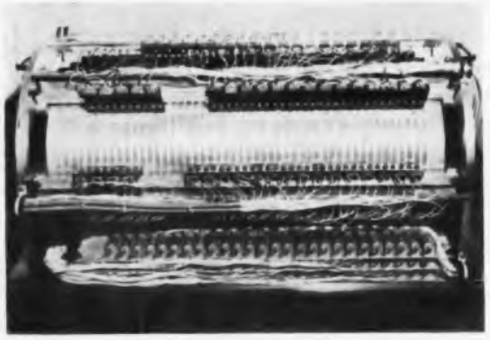
The drum then steps to its next position, ready to receive the pattern corresponding to the next movement of Unimate. This step-and-record sequence may be continued until each of the 200 rows on the drum indicates a movement. The unit is controlled by a difference servo, operating from the workpiece position, and the recorded instructions.

Self-Contained Unit Employs Hydraulically Operated Arm

A box-like base contains all of the control and operating mechanisms. The workpiece is held



Unimate, a new industrial work-handling robot, can perform a task after being led through the motions once. Inset shows broad grippers grasping heavy cylinder.



Dynastat magnetic memory drum, developed by Consolidated Controls Corp., presents stored information independent of speed of rotation. Its ability to be read while stationary makes it equally suitable for use with both stepping operations and with continuous processes.

by a hydraulically operated arm that can telescope in length from 3 ft to 7. In a horizontal plane the arm can sweep 220 deg; in a vertical plane, 60 deg. When fully extended, the arm can reach from within 4 in. of the floor to 90 in. above it. Positioning accuracy is ±0.050 in each dimension.

Connected to the wrist, which can both bend and rotate, is a pneumatically operated hand-claw. (A variety of hands or hand tools designed for particular chores can be fitted on the arm.) The controlled grasping pressure enables the hand-claw to life both fragile and heavy objects.

On completion of a pilot run, the company will accept orders for the self-contained units at $25,000 each. ■ ■

Perceptron-Type Unit Is Digital

Albert I, a general-purpose computing system expected to recognize patterns seen by a flying spot scanner, is nearing completion at Burroughs Corp., Paoli, Pa. Unlike original perceptron, Albert I is all-digital. It will be programed for neural-net logic. Printed-circuit boards being checked are flip-flop representations of neural elements. Ferrite-core elements for a later version are under development at company.

Special Works Memo

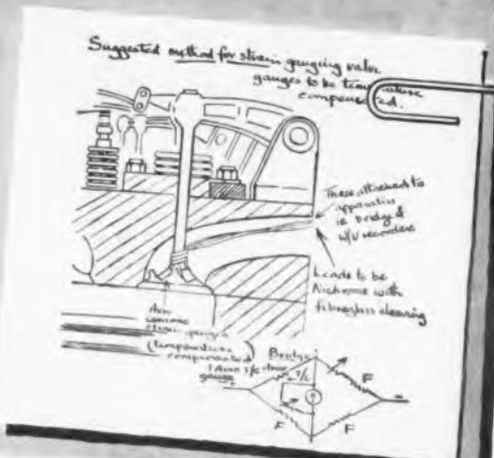
TO Production Engineering and Process Control Depts.

FROM Chief Engineer, Special Projects Division.

Tests have been carried out on two new Armstrong Whitworth Equipment products. Results have been excellent and these items might well be the answer to several of our problems. Preliminary details are:-

(1) Avro High Temperature Strain Gauges

Strain or minute structural variation measurable accurately at temperatures up to 1,000°C. Transverse resistance cross sensitivity negligible due to rectangular grid section design and stray thermo-electric effects nil. Ceramic cement impregnated non-removable fibrecloth backing bends around small radii. Fixing is by proven adhesives. Illustration shows typical hot point use for gauges. Note that temperature compensating thermo couples may be supplied built into each gauge!



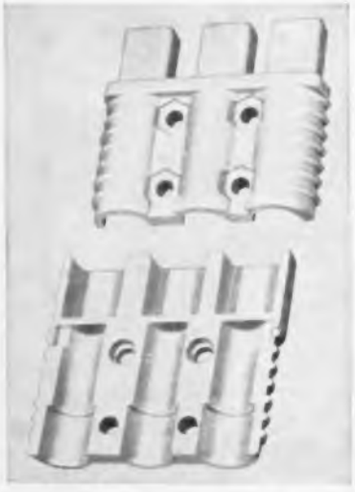
(2) Limited Angle Tacho-Generator

Operates on a 30° angle about a mid position.
Size 1" rotor (2" nominal dia. case 3.75" long). There is also a 3" diameter rotor generator for special order.
Sensitivity 5 volts/radian/sec. ±15%
Load 27 kil-ohms
Frequency response 3 db down at 37 cycles/sec.
Winding resistance 1,680 ohms ±5%
Operating torque 500 gm. cm.
Direct lever drive eliminates gear back lash discrepancies.
Illustration shows use for velocity feed-back measurement on swash-plate pump driving large machine tool.

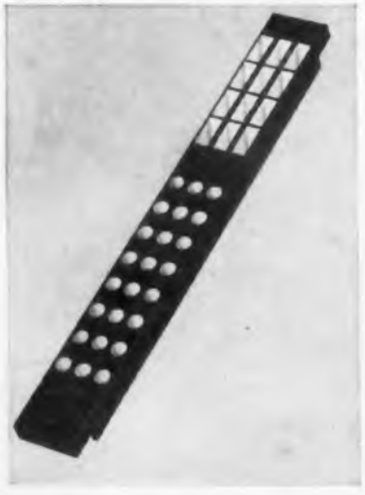
ARMSTRONG WHITWORTH EQUIPMENT, Hucclecote, Gloucester. Telephone: Gloucester 66781
SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD., MEMBER OF HAWKER SIDDELEY AVIATION
CIRCLE 34 ON READER-SERVICE CARD

G-E LEXAN® POLYCARBONATE RESIN

TOUGHEST OF PLASTICS!

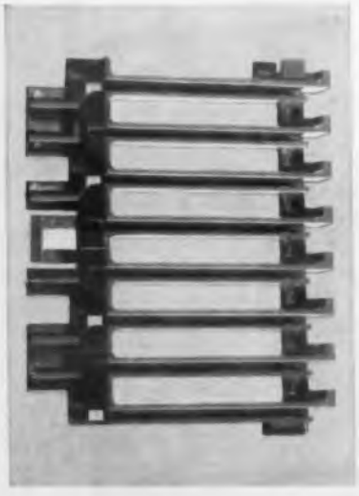


STRENGTH LEXAN resin has an impact strength of more than 12 foot-pounds per inch of notch — higher than any other plastic! This toughness, plus heat resistance and good electrical properties, make LEXAN resin an outstanding choice for 3-pole connectors used in rugged service on electric trucks.



HEAT STABILITY Lampholder terminal block is used inside electronic equipment where heat is difficult to dissipate. LEXAN polycarbonate resin replaced another thermoplastic which melted under severe thermal conditions. LEXAN has a heat distortion point as high as 290°F. Also keeps high strength in sub-zero cold.

ELECTRICAL PROPERTIES A good dielectric, LEXAN resin is non-corrosive even when used with very fine Class F magnet wire. Coil forms must not distort at temperatures above 200°F under stresses caused by tightly wound wire. LEXAN resin provides high heat distortion temperatures under load.



DIMENSIONAL STABILITY Card Guide for business machines is molded to close tolerances . . . must undergo minimum change in dimensions during service. Parts show excellent dimensional stability under moist and high temperature conditions. LEXAN resin meets self-extinguishing requirement.

TRANSPARENCY Stock shapes and film of LEXAN polycarbonate resin have excellent transparency. Bar stock is easily machined; film can be thermoformed, heat-sealed and solvent-sealed. Combination of clarity, toughness and malleability gives LEXAN resin the design capabilities of a transparent metal!

CIRCLE 35 ON READER-SERVICE CARD

LEXAN OPENS UP NEW OPPORTUNITIES...
Even before LEXAN entered large-scale production, manufacturers, impressed by its exceptional properties, developed and field tested over 300 applications. G.E. participated in these developments. With the opening of new G-E facilities capable of producing millions of pounds of LEXAN per year, the price of this versatile thermoplastic has dropped dramatically – over 40% in a single year. This fact alone has brought many new products within the range of feasibility. Can you afford to overlook the opportunities presented by LEXAN? Send for details on price, properties, applications and G-E's technical assistance program today! General Electric, Chemical Materials Department, Section ED-21, Pittsfield, Mass.

LEXAN®
Polycarbonate Resin
GENERAL ELECTRIC

X-Ray Performance Is

Fivefold Magnification Gain Reported with Picker Unit

AN X-RAY-image amplifying technique, claimed to increase by five times the previous limits of effective fluroscopic magnification, has been developed for use in nondestructive industrial testing.

The unit, developed by Picker X-Ray Corp. of White Plains, N.Y., consists of a rotating anode tube with 6-ma power that produces a focal spot only 0.012 in., or 0.3 mm, wide. It emits radiation from a strictly limited direction over a greater distance, which results in greater magnification and clarity.

In standard X-ray tubes the focal spot is larger and emits X-rays from a wider source, which produces partial illumination, or penumbra, as photons strike the object being inspected from many angles. Thus the object is placed as close as possible to the screen, or input phosphor.

A variety of inspections involving interior defects in parts or assemblies can be made with the Picker device. For example, minute vacuum tubes and wires as small as 0.002 in. wide can be examined without opening the assembly.

The cost of the unit, depending on the type of power generator used, ranges from $15,000 to $20,000. ■ ■

X-ray-image amplifying technique developed by Picker X-Ray Corp. is shown in comparison with a conventional X-ray method. Nuvistor tube at left was enlarged six times with a Picker 0.3-mm focal spot. Nuvistor at right was enlarged six times with a conventional 0.5-mm focal spot. The actual radiographs are clearer, because the pictures here were derived by photographing the radiographs and making contact prints.

Boosted for Industry

Zenith Pulsed System Makes Cineradiographs in 1 μsec

A PULSED X-ray system, capable of making cineradiographs of high-speed phenomena in 1 μsec, has been developed for use in shock and vibration studies, radiation effects, rocketry, medical radiology, ballistics, and crystallography.

Developed by Zenith Radio Research Corp. of Menlo Park, Calif., the pulsed system consists of two compact units: an X-ray console, with the X-ray generating tube, its power supply and control circuits, and an image intensifier console.

The X-ray tube is pulsed with a square-wave voltage pulse 1 μsec in duration, and the rate of application is continuously variable from one to 30 pulses per sec. Amplitude of the square-wave voltage applied to the tube is continuously variable from 0 to 150 kv.

20-Megawatt Beam Focused on Target

When the tube is operated at 150 kv with a beam current of 130 amp, the X-rays are generated by an electron beam of approximately 20 megawatts focused on the conversion target.

The resulting high intensity X-rays have an effective spot size of 1 x 2 mm throughout the life of the tube, and at 1 in. from the target have an intensity rate of 10^7 roentgens per sec.

The high-powered, short pulses of X-radiation are passed through the subject under study and impinge on the X-ray sensitive screen of the Rauland image intensifier tube, housed in the image intensifier console. The Rauland tube amplifies the X-ray image and converts it to visible light, which appears as a bright image on the tube's output phosphor. The image is suitable for direct viewing, closed-circuit TV viewing, or for pick-up by a motion-picture camera.

An additional feature of Zenith's equipment is that a single, 1-μsec X-ray pulse has sufficient energy to permit a radiograph to be taken directly on conventional film. Adequate film density is obtained from a single pulse through 1.5-in. of aluminum at a distance of 6 ft from the X-ray tube.

The system may be fired manually and continuously by the internal variable-rate pulse generator, or may be slaved by any desirable external source, so that stroboscopic slow-motion effects can be obtained. In addition a reference pulse, available from the console, may be used to synchronize auxiliary equipment. ■ ■

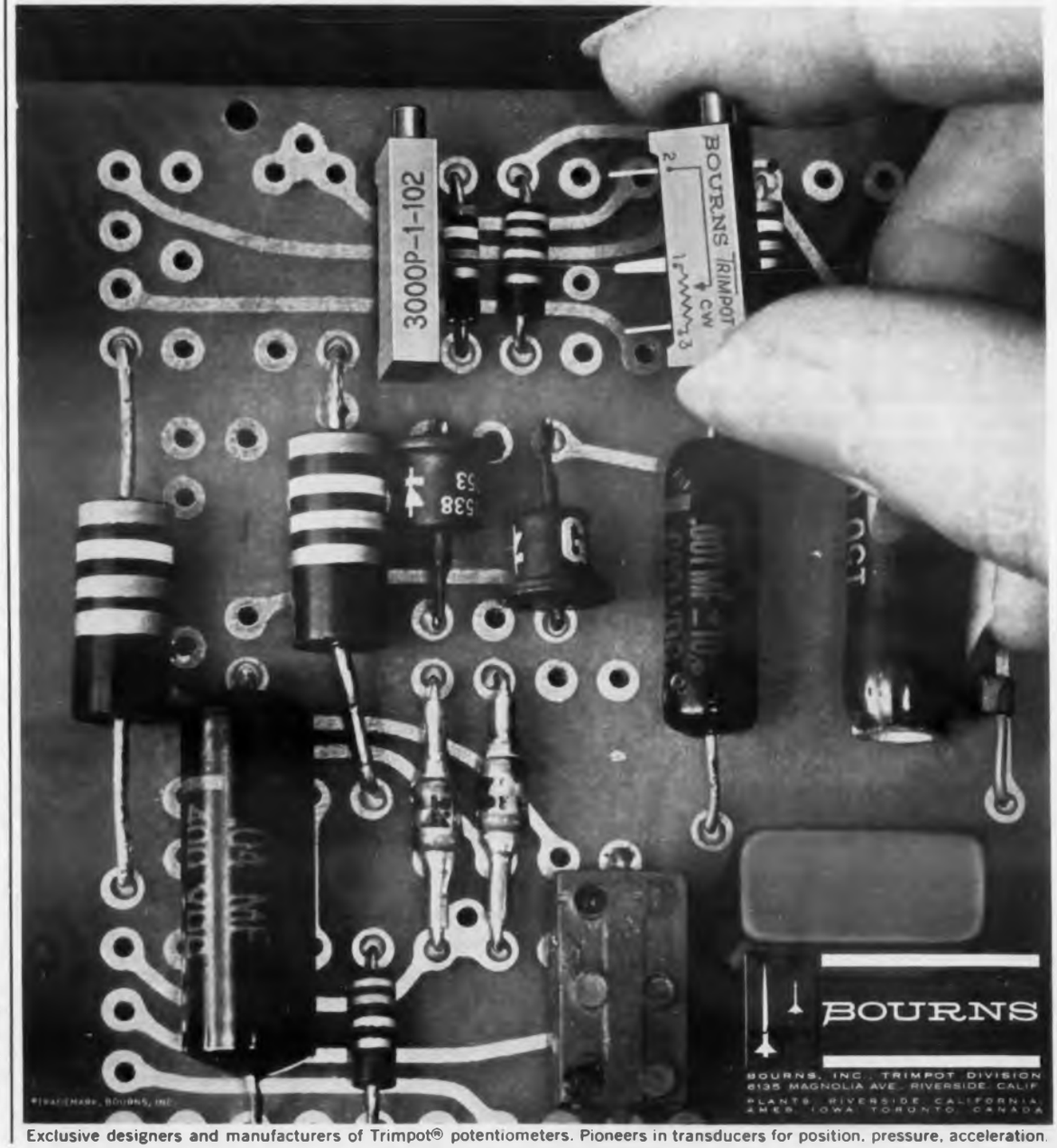
NUMBER 13—NEW PRODUCT SERIES

Now—an Even Smaller High-Temperature Trimpot® Potentiometer

Here, just ¾" in length, is a wirewound potentiometer that is completely humidity-proof and operates at 175°C! Ideal for your printed circuit applications, it withstands 30G vibration and 100G shock, dissipates 0.5 watt at 70°C (0.2 watt at 125°C), and has tapered pins for quick, easy mounting.

Sealed against humidity in a high-temperature plastic case, the Model 3000 exceeds the requirements of MIL-STD-202A, Method 106. The 15-turn screwdriver adjustment permits pinpoint settings and the self-locking shaft keeps them accurate. For maximum stability, the unit incorporates a ceramic mandrel. Reliability is outstanding. The exclusive Silverweld® bond between terminal and resistance wire is virtually indestructible under thermal or mechanical stress.

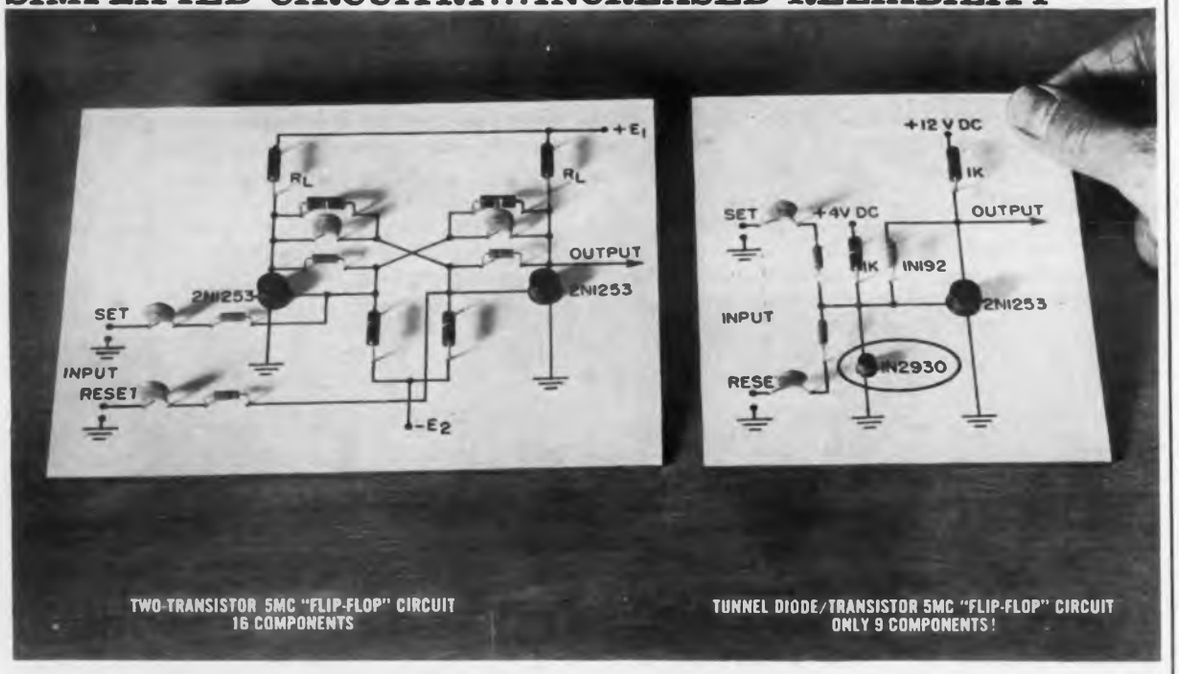
Available within 24 hours from factory and distributor stocks, the Model 3000 is stocked in resistances of 50 ohms to 20K. A Resiston® carbon version, Model 3001, is available with resistances of 20K to 1 Meg. Write for complete data and list of stocking distributors.



Exclusive designers and manufacturers of Trimpot® potentiometers. Pioneers in transducers for position, pressure, acceleration.

CIRCLE 36 ON READER-SERVICE CARD

SIMPLIFIED CIRCUITRY...INCREASED RELIABILITY



TWO-TRANSISTOR 5MC "FLIP-FLOP" CIRCUIT
16 COMPONENTS

TUNNEL DIODE/TRANSISTOR 5MC "FLIP-FLOP" CIRCUIT
ONLY 9 COMPONENTS!

16 COMPONENTS CUT TO 9

Typical Reduction Obtained with Hoffman Silicon Tunnel and Uni-Tunnel Diodes

You can create extremely simple circuits by using Hoffman silicon tunneling diodes. These unique devices greatly enhance reliability by making possible smaller, lighter assemblies with unusually low power requirements. In addition, they help you realize important savings, both in time and money.

HOFFMAN SILICON TUNNEL DIODE CHARACTERISTICS (25°C.)

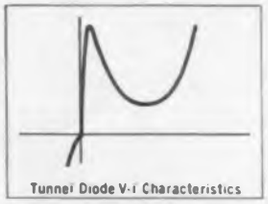
TYPE NO.	I_p (mA)①	I_p/I_v MIN.	−R TYP. (OHMS)	V_f TYP. (mV)
1N2928	47	3.5	470	800
1N2929	1.0	3.5	220	800
1N2930	4.7	3.5	47	800
1N2931	10.0	3.5	22	800
1N2932	22.0	3.5	10	800
1N2933	47.0	3.5	4.7	800
1N2934	100.0	3.5	2.2	800

Operating and storage temp.: −85°C. to +200°C. Package: TO-18.
①Peak current tolerance standard units, ±10%. ±2% tolerance units available, designated with suffix "A" (e.g., 1N2928A).

HOFFMAN SILICON UNI-TUNNEL DIODE CHARACTERISTICS (25°C.)

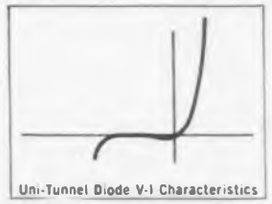
TYPE NO.	I_v MIN. @ .25V (mA)	I_R MAX. (0 to .5V)① (μA)	C(μμF)③ TYP.	C(μμF)③ MAX.
HU-5	0.5	5	14	—
HU-5A	0.5	5	6	10
HU-10	1.0	10	24	—
HU-10A	1.0	10	10	20
HU-25	2.5	25	58	—
HU-25A	2.5	25	30	50
HU-50	5.0	50	76	—
HU-50A	5.0	50	50	70
HU-75	7.5	75	90	—
HU-75A	7.5	75	60	85
HU-100	10.0	100	100	—
HU-100A	10.0	100	70	100

Operating and storage temp.: −85°C. to +200°C.
①Typical V_R at 1mA, .8 volts. ③Measured at 0 mV. C includes capacitance of junction and package.



ONLY SILICON TUNNEL DIODES GIVE YOU:

■ HIGH FORWARD VOLTAGE. V_F values of .8V and V_f values of .45V provide usable output voltages. Gives reliable control of both silicon and germanium transistors. ■ EXCELLENT UNIFORMITY. Units of same type have virtually identical V-I plots. Peak current tolerances of ±10% and ±2% available. ■ TEMPERATURE STABILITY. Stable parameter values from −85°C. to +200°C. I_P temperature coefficient is .05%/°C. ■ WIDE RANGE OF PEAK CURRENTS. JEDEC-registered types from 470 μA to 100 mA.



ONLY SILICON UNI-TUNNEL DIODES GIVE YOU:

■ HIGH CONDUCTANCE AT LOW VOLTAGE LEVELS. I_v min. as high as 10 mA at .25V. HIGH RECTIFICATION EFFICIENCY. Typical efficiency is 70% at 300mc and 100mV. ■ TEMPERATURE STABILITY. Forward temperature coefficient, .04%/°C. from −85°C. to +200°C. ■ LOW LEAKAGE. Guaranteed maximum reverse currents (0 to .5V) as low as 5 μA.

IMMEDIATE DELIVERY IN QUANTITY FROM DISTRIBUTORS OR FACTORY.

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Plants: El Monte, California and Evanston, Illinois

We shall be happy to send you a free reprint of an article titled: "Tunnel and Uni-Tunnel Diode Applications." Reliability report available on request.

CIRCLE 37 ON READER-SERVICE CARD

NEWS

Radio Beacon System Pinpoints Space Vehicles in Sea Landings

Fast location of space vehicles that must be recovered from the ocean is made possible by a radio beacon system called SARAH (Search and Rescue and Homing).

The system, developed by Simmonds Precision Products, Inc., Tarrytown, N.Y., consists of a miniaturized radio-transmitting beacon that begins to transmit at a prescribed altitude. It enables search planes to home in on space craft with pinpoint accuracy. Using the SARAH system, a Mercury space craft was located 21 min after launching.

The SARAH capsule is ejected from the rear of the nose cone prior to impact. It is activated by an explosive charge that releases a coiled-up antenna and switches on the beacon. The signals are received by the searching ships and planes, and are picked up as blips on a cathode-ray tube indicator.

The recovery sequence begins when the capsule is at an altitude of 42,000 ft with the inflation of the first parachute. This parachute drops away at 10,000 ft, and the main recovery parachute, which slows the space craft to a landing speed of about 30 ft per sec, is activated. At this altitude, the beacon begins transmitting.

Continuous uhf transmission by SARAH is pulse-coded to permit positive identification. The power supply is designed to assure continued radio transmissions for approximately 30 hr under all weather conditions.

Capsule (left), with SARAH antenna extended and balloon inflated, was used in Mercury space craft recovery. At a prescribed altitude the capsule is ejected from the rear of the nose cone as it re-enters the earth's atmosphere. SARAH beacon (right), consists of a miniature transmitter, antenna and saltwater battery unit. The system was developed by Simmonds Precision Products, Inc.

Gyro Electrically Suspended

Electrically suspended gyroscope is examined by Minneapolis-Honeywell Regulator Co. technician. Foil-wrapped coils around the prototype gyro create the magnetic fields used to bring the rotor up to operating speed. The coils are then de-energized. This allows the rotor to operate in a "coasting" condition. High-voltage leads carry the current that provides the electric fields in which the gyro's spherical rotor is suspended. The units mounted on each side of the gyro casing are optical pickoffs, which provide information on the gyro's orientation. The gyro, being developed by the Aeronautical Div. of Minneapolis-Honeywell, is scheduled for use in the Polaris submarine navigation system.

High RF Attenuation Cables Developed by Bjorksten Labs

New experimental cables are giving significant increases in attenuation at high frequencies.

The cables, under development at Bjorksten Research Laboratories for Industry, Inc., Madison, Wis., are used to reduce rf interference effects. Attenuation of 1 db per foot at 1 mc represents a thirtyfold increase over that of high-attenuation cables currently available, the company says. In addition the dc resistance of the experimental cables is much lower.

Bjorksten says its cables might be used in place of conventional connecting cables between electronic subassemblies to eliminate a propagation path of rf interference from accidentally firing rockets and other ordnance equipment employing electrical initiators. As a transmission line, passing the carrier frequency but dissipatively attenuating the undesirable high frequencies, the new cables might be used to counteract spurious emission from rf transmitters.

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EDITORIAL

It's Time to Debate

It's time to debate. Unstructured, casual Discussion Panels, the current vogue at Technical Meetings, have become little more than group-therapy sessions for disgruntled souls to shoot off their mouths. Opinions pour forth, facts are submerged. At the last Solid-State Circuits Conference, for example, several discussion sessions degenerated into skirmishes of separate, rowdy duelers riposting only with hearsay and innuendo.

To clarify some of the issues facing electronic engineers the rigors of more formal debate are in order.

The overwhelming aim of our culture to avoid conflict, to reach agreement, to accentuate harmony, rather than differences and discords, has led to acquiescence and disengagement when possible conflict arises.

As a consequence, we all continue in our separate ways, uncritical of what we are doing, and getting paid directly or indirectly by Uncle Sam. It is time to debate, to shoot down dream balloons.

Here are a few debates that would be instructive.

Resolved the Signal Corps micro-module program should receive more support. Isn't it time to draw conclusions regarding the feasibility of automated manufacture of micro-modules?

Resolved that the systems engineer must decide what the optimum throw-away module should be. Can the design engineer decide what is best for a systems application?

Resolved that engineers should boycott vendors who do not specify test conditions for MTBF ratings. What can be done about irresponsible claims?

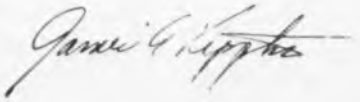
Resolved that separate value analysis groups must be established by manufacturers selling to the government.

Resolved that more funds for testing be spent on general-purpose automatic checkout equipment rather than special types that can be used only with specific systems.

Other areas that should be evaluated by careful debate: all pet projects, any project that smacks of boondoggling, company procedures that suggest waste.

This is only a start. A fuller list should be compiled.

We'd like to get your suggestions. Please send them in. Maybe you can organize a few debates in your own department. Are you really pursuing the right approach or are you protecting some vested interest? Debate the subject.



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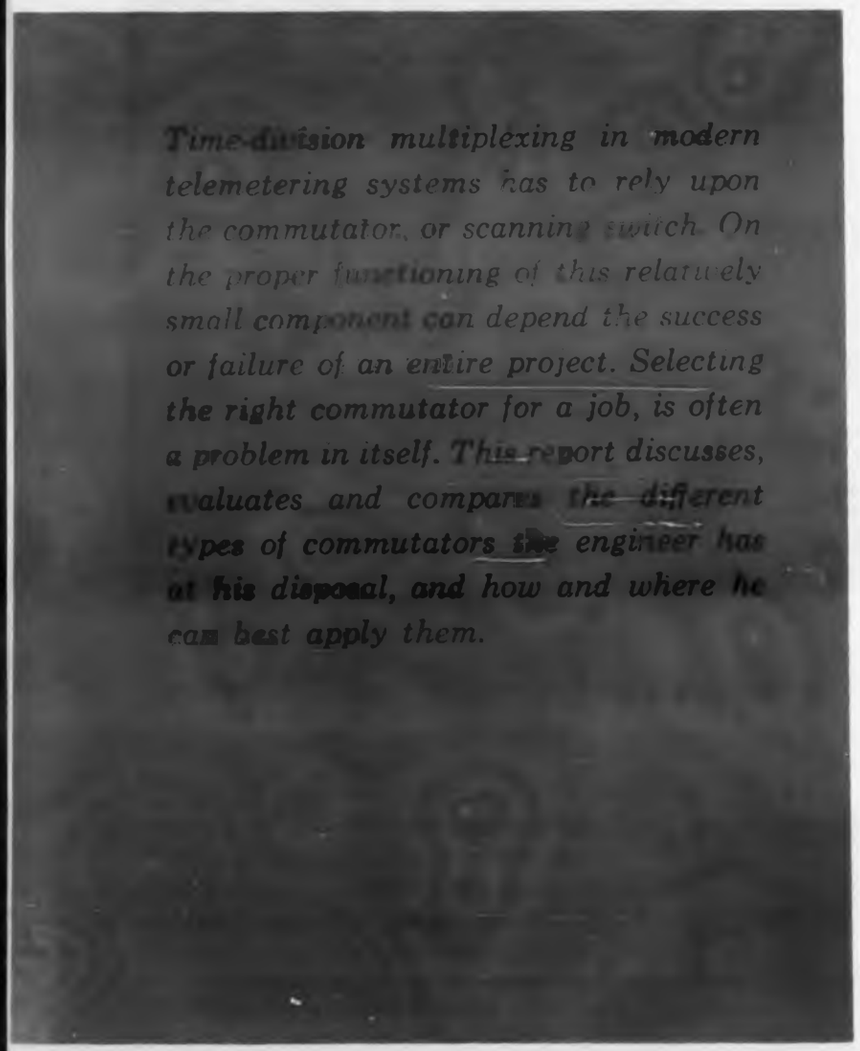
guide to selecting telemetering commutators

An *ELECTRONIC DESIGN* Staff Report



Time-division multiplexing in modern telemetering systems has to rely upon the commutator, or scanning switch. On the proper functioning of this relatively small component can depend the success or failure of an entire project. Selecting the right commutator for a job, is often a problem in itself. This report discusses, evaluates and compares the different types of commutators the engineer has at his disposal, and how and where he can best apply them.

Alfred Rosenblatt
Technical Editor

HOW DO I pick a commutator to fit my system requirements? This is the basic question the engineer designing a commutated system usually asks. And this question immediately leads to others—what are the problems to look out for when a commutator is put into a circuit? Is it really just a passive scanning switch, or will it affect the signal it is sampling? What operating limits with respect to lifetime signal levels, and sampling speeds do commutators have? Is there really a "best" commutator—one that is good enough to be used in any system?

This report tries to supply some of the answers to these, and to other, "commutator questions." In short, its purpose is to help the engineer who must use commutating switches to specify and apply them with greater ability.

Basic Commutator Types Are Electromechanical or Solid State

Many types of commutators have been developed, particularly in the past decade. They fall into two broad categories:

- motor-driven, rotary, electromechanical switches
- completely electronic, "stationary" units.

(Of late, most electronic commutators are composed of solid-state components.)

In all cases, the choice of a commutator is limited to a unit based on these two general operating modes. However, there are certain operating limitations associated with each type. Due to these limitations, several variations in the "conventional" commutator designs were introduced. Thus, because they use a driving motor, the following commutators can be placed in the *electromechanical* category:

1. The mercury-jet commutator which uses a

revolving stream of mercury to complete an electric circuit.

2. The "ball-bearing" commutator in which sequential channel contact is made by a bearing traveling in a circle over the channel segments.
3. The magnetically activated commutator which samples its channels by using a rotating magnet to open and close magnetic reed switches mounted around the circumference of a circle.

And, because they use no mechanically moving elements, the following commutators can be placed in the *electronic* category:

1. The "hybrid" approach which scans and controls mechanical-type channel contacts with electronic circuitry. One such unit is built around the newly-developed Magristor —a magnetically activated switching element whose contacts are immersed in a conducting liquid. Another type uses magnet-reed switches to make the channel contacts.
2. The beam-switching tube commutator. With its 10 distinct outputs, this tube has been used largely as a counter. However, the introduction of an additional element in the Beam-X switch tube (made by Burroughs) is leading to a tube-type commutator which can scan and gate itself.
3. The Hall-generator commutator, although in an experimental stage, represents an interesting approach to the sampling problem.

Each of these commutating devices will be discussed in greater detail subsequently. However, in almost all situations, the commutator will be of either the "conventional" electromechanical or solid-state type.

(continued on p 42)

Commutator Operating Terms Defined

Certain performance characteristics are inherent in the design of electromechanical or electronic commutators. Some of these characteristics are common to both. Others, such as the back current flowing into the data source when electronic commutation is used, are found only in one type and not in the other. The glossary below defines the operating characteristics which must be considered when a commutator is put into a telemetering circuit.

Channel Equivalence—This refers to the likeness in amplitude characteristics for all the channels. If semiconductor devices are used for channel gates, the outputs of the individual channels may be slightly different depending upon the specific elements used in each channel. If the equivalence is expressed in per cent of full scale, this per cent value should refer to the deviation from the nominal design level for all channels. Channel differences may change with the signal level and with temperature in most simple gating circuits.

Cross-Talk—Cross talk is considered to be the change in amplitude on any channel due to the change in amplitude of any other channel. This may be expressed in per cent or in decibels.

Duty Cycle—Channel duty cycle is defined as the ratio of the channel On-Time and the channel period.

Efficiency of Conversion—The conversion efficiency refers to the gain or loss through the switch. It is defined as the ratio of the nominal incremental output amplitude with respect to the input signal.

Off-Current in the Source—This is defined as the current flowing through the source during the period in which its corresponding channel gate is turned off, or is disconnected from the load. If this current flows in the same direction as that produced by a positive signal applied to the switch, it is called a positive current.

On-Current in the Source—The On-Current refers to the current flowing during the time that the gate is turned on.

Paralleling Channels—In mechanical switches more than one contact of a particular contact plate may be connected together to provide two or more samples for each rotation of the mechanical switch. Similarly in the electronic case it is possible to provide means for achieving more than one sample per frame. The technique for paralleling channels is dependent on the gating mechanism employed. Sometimes it is possible to connect the inputs directly together as with the mechanical switch. In other cases separate terminals must be provided in the associated circuitry for making appropriate selections for paralleling channels.

Pedestal—The pedestal is defined as a fixed level in the output signal with reference to some extreme signal value to which the channel amplitude is limited. In standard pam signals this pedestal is used for synchronizing ground decommutation equipment.

Sampling Rate—The sampling rate of an electronic switch is considered to be the number of times a particular channel is sampled in one second. This generally corresponds to the frame rate which is the number of times per second that all channels of the switch are sampled.

Switch Accuracy—Switch accuracy should refer to the measuring accuracy of the switch as a whole. This is expressed in per cent of full scale voltage and should be the arithmetical sum of the maximum amplitude errors produced by any other effect such as those indicated here. Where channels are separately calibrated, one might refer to the channel accuracy separately.

Switch Nonlinearity—This is considered to be the maximum deviation from the best straight line determined by the method of least squares. This deviation applies to all channels of the switch taken together. If the individual channel linearity is to be separately considered as in cases where channels are individually calibrated, the term channel linearity should be used.

Timing Generator—The timing generator or clock is the basic timing device used to effect the switching operation. The period of the clock generally corresponds with the channel period. The clock is often included as an integral portion of the electronic switch. On the other hand, the switch may be operated in synchronism with some external timing source.

Zero Signal Off-Set—This refers to the absolute value of the output level obtained with zero input signal applied to the electronic switch. This refers particularly to the nominal value where all channels are considered together, the difference being taken into account by the expression of equivalence.

These terms are adapted from an article "Electronic and Electromechanical Sampling Devices for Multichannel Instrumentation" by John F. Brinster, President, General Devices, Inc. Princeton, N. J.

COMMUTATORS

Table 1. General Specifications for Missile and Satellite Commutators.

	Missiles	Satellites
Life	300 hrs	25,000 hrs
Shock	30.0 g's	30.0 g's
Vibration	15 g's to 2000 c	8 g's to 2000 c
Acceleration	75 g's	100 g's
Temperature Operating	-30 C to +71 C	-20 C to +50 C
Storage	-65 C to +85 C	-20 C to +50 C
Humidity	5 cycles, 14 hrs 95% relative	
Acoustic Noise	143 db, 150--16,000 cycles	

Table 2. Commutator Characteristics Compared

Characteristics	Electronic General Range	Mechanical General Range	Preferred
Size (Sealed)	1/4 - 3/4 in^3 / channel	1/8 - 1/2 in^3 / channel	Mechanical
Cost	$50 - $100 / channel	$5 - $30 / channel	Mechanical
Accuracy	1/2 - 3%	.05 - 1%	Mechanical
Contact Res.		.10 - 50 ohm	Mechanical
Open Ckt Impedance	1/2 M - 10 M	20 - 10,000 M	Mechanical
Effect on Transducers	Back currents to 1 ma	None	Mechanical
Life at 80 C	1000 - 5000 hr	50 - 2500 hr	Electronic
Power Input	1 - 7 w	1/2 - 20 w	Electronic
Sampling Speed	5 - 20,000 samp./sec	0 - 5000 samp./sec	Electronic
Speed Regulation	0.01 - 5%	0.1 - ±10%	Electronic
Max. Operating Temperature	to 125 C	to 150 C	Mechanical
Min. Operating Temperature	- 55 C	- 55 C	–
Vibration	to 35 g	to 35 g	Electronic
Duty Cycle	10 - 95%	10 - 95%	–
Rise Time	1 - 10%	1/2 - 10%	Mechanical
Phaseability	±1%	±5%	Electronic
Signal Input	0 - ±5 v ±2.5 v	0 - 15 mv, 100 v	Mechanical
Max. Source Impedance	25 K	500 K	Mechanical
Min. Load Impedance	1 Meg	100 ohms	Mechanical
Transfer Characteristic	Close to unity; dependent on cost, environment, circuit impedances	unity	Mechanical
Variation in Transfer Characteristic	Dependent on environment, age, circuit impedances	zero	Mechanical

Direct points of comparison between electromechanical and electronic commutators, showing ranges of commonly available units. (Prepared by M. M. Kranzler, Product Manager, Fifth Dimension, Inc., Trenton, N. J.)

Application is of Prime Importance In Choosing a Commutator

In selecting a commutator, prime consideration must be given to how the unit will be used. Its application will determine which factors are to have the greatest importance in its design. Broadly speaking, there are three areas of application. These are:

1. Industrial (airborne and ground)
2. Aircraft and missiles
3. Satellites

Industrial applications are so varied that it is difficult to define the most important design considerations. Cost is always a factor, but so is life and maintainability. Also the system environment can be extremely important. However, the prime environmental elements will vary from case to case. In one case it may be high temperature, in another vibration, and humidity, or acceleration, and shock.

Almost always commutators must be of minimum size and weight and use as little power as possible. Life must be adequate for the proposed test time.

Several of the possible "key" design considerations are:

1. Life
2. Sampling speed
3. Accuracy
4. Signal input levels
5. Temperature environment
6. Cost
7. Size, weight
8. Power input.

It should be remembered that their relative importance will vary with the application. And often, some are not important at all. An obvious example of this is the commutator to be used in a missile. Cost and long-term life certainly are subordinate to extreme reliability under the rugged environmental conditions. The process of selecting a missile commutator is then quite different from that of selecting an aircraft or industrial sampling switch.

An example of the kind of environmental conditions to which commutators are subjected is shown in Table 1. Two sets of test conditions are presented. They were devised by General Electric Missile and Space Dept.

Once the application is outlined and the salient performance requirements are recognized, the process of choosing a commutator can continue. There are quite a few direct points of comparison between electromechanical and solid-state units. These points are summarized in Table 2. This table presents a range of values for components which are readily available or "off-the-shelf." Specially designed units were not considered. Several of the areas of comparison are discussed in greater detail below.

Input-Output Accuracy

The accuracy of a mechanical commutation system is almost perfect, since the input is connected to the output through a low-impedance switch. When offset is considered, the input-output accuracy of an electronic commutator can approach 1/4 of 1 per cent, over the temperature environment, as a limiting figure. Thus a mechanical commutator is unquestionably more accurate than an electronic commutator. In many instances, however, the basic inaccuracy of the transducers, amplifiers, and subcarrier oscillators may be several orders of magnitude greater than 1/4 of 1 per cent. In these cases, the accuracy of the mechanical system may prove unnecessary.

Signal Level

Signal level can also become a determining factor in the selection of a commutator. Most types of electronic commutators using diode gates have an inherent inaccuracy of between 25 and 50 mv. For transistor gates the figure is about 2 mv. This is due to finite differences in diode matching within and between channels. Mechanical commutation does provide a good means of sampling signals in the low millivolt levels with a high degree of success. Signals in the 0- to 25-mv range have been successfully commutated in both Atlas and Thor nose-cone flights using double-ended mechanical switching.

Power

Mechanical commutators of suitable configuration for the missile environment, for example, require about 2 w of dc power. Electronic commutators of similar capacity require about 1/2 w of dc power, when conventional signal transistors are employed. Electronic commutator power consumption could probably be decreased by redesign with power as the prime consideration. Many electronic commutators are superior to mechanical commutators with respect to power consumption. However, miniature mechanical units lately available or still under development may alter this situation.

Sampling Rates

When sampling rates are considered, electronic commutation should be employed for rates above about 1,000 samples per second if extended life is required. For lower sampling rates, either electronic or mechanical means may be employed. The stability of the pulse rate will be considerably greater in the electronic commutator, since the rate is determined by a driving oscillator, rather than a rotating motor. Future telemetering systems, probably employing pulse code modulation, will use sampling rates in the

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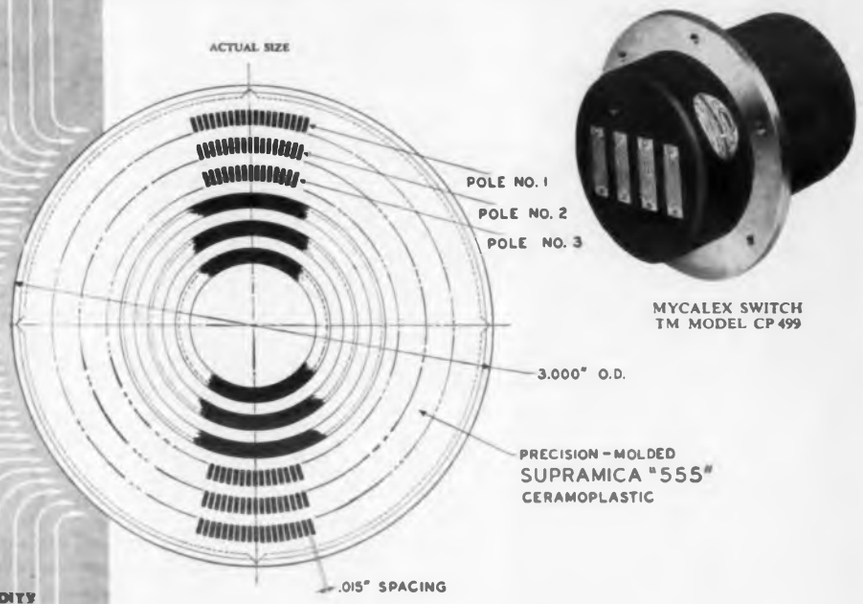

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kilocycle range. Electronic commutation will be employed exclusively in these systems. Ground synchronization circuitry will be simplified as the greater pulse rate stability of the electronic airborne system is utilized more completely.

Cost

Electronic commutators are more expensive than mechanical commutators. If price is the determining factor, the mechanical commutator will be used. In some applications considerable latitude in commutator price can be allowed, since the commutator contributes very little to over-all system costs.

Life

With respect to life, electronic commutators must be considered superior to mechanical commutators. Commutator life in excess of 2,500 hr can be expected from well designed suitably derated semiconductor circuits. A 25,000-hr life unit has already been mentioned. Mechanical commutators may begin to prove unreliable after 300 hr of operation.

"Commutator," "Scanner," "Sampling Switch" Are Equivalent Terms

Perhaps because of its origin, there is sometimes a lack of clarity associated with the word "commutator" when it is applied to what could be more accurately described as a sampling, or scanning switch. While the phrases "sampling switch" or "scanner" may be more descriptive, they, and "commutator", can be used interchangeably.

ELECTROMECHANICAL COMMUTATORS

how they work, their limitations, new design directions

ELECTROMECHANICAL scanning switches have been built for a wide range of sampling rates and many types of input signals. The simplest form uses motor-driven, rotating brushes to "make and break," in sequence, with contacts connected to the data points to be monitored. Thus channel-information signals are brought through the brushes to a common output in time-sequence.

Generally, the scanner contains a switch plate, a gear train, and a drive motor, Fig. 1. The switch plate may consist of a single ring or concentric rings, of metal studs embedded in an insulating block, Fig. 2. Two switching procedures can be used—shorting or nonshorting.

Shorting or Nonshorting Contacts Can Be Designed or Wired

Shorting contacts are frequently described as "make before break" because the brush momentarily connects two adjacent contacts together as it rotates. This is the simplest and most compact type of switch to design and manufacture. However, it cannot be used where shorting adjacent contacts would disturb the pick-ups or measured circuits. This could occur, for example, when two voltage sources are monitored. There are two versions of this type—in one, the brush is sufficiently short so that it cannot bridge the two contacts; in the other an inactive contact is left between every pair of active ones.

The same switch may be used for both shorting and nonshorting operation. In the latter mode, every other segment is left unconnected to a data point. It may be either grounded, or left electrically free. Under this condition, the number of contacts available for data transmission (and hence the number of channels), is only half of the total available when the commutator is operating as a shorting switch. It is also possible, by proper external wiring, to have an electromechanical commutator with a combination of shorting and nonshorting contacts. Or, if several segments are joined by a wire, the sampling rate of a particular channel can be increased.

Other scanning switches have their ring segments mounted around the center circumference of a cylinder. The brushes sample the channels by rotating about the cylinder, in contact with the segments. This construction is used in the smaller size switches. Another design distributes the segments around the inner circumference of a "doughnut," with the brushes rotating within the circle.

Switches have been constructed with up to 500 contacts and with several synchronized poles. However, in such a large unit, size is probably not a prime consideration. The most usual requirement is for less than 100 channels and between two and four poles.

The timing of an electromechanical scanning switch depends on several factors—including the physical dimensions and angular location of the brush and contact pins, and the motor drive system. According to IRIG standards, speed variations of +5 per cent and −15 per cent can be tolerated in the repetition rate of the scanner's pulse train. Under moderate line voltage and environmental variations, driving motors will operate well below these allowable limits.

The phasing of contacts for two or more poles must take into account all the mechanical factors involved including fixed phasing errors due to brush location tolerances, tolerances in contact locations, uncertainty of make and break, etc.

Constant-Speed Drive Motors Hold Sampling Rates Fixed

One of the drawbacks of electromechanical units has been the lack of variable speed control. With fixed-speed driving motors, emphasis is placed on holding speed constant. Governors or regulated power sources are used. Often, however, because the commutator is functioning in an electrical system, it is desirable to be able to vary the motor speed (and sampling rate) in accordance with certain system variations, such as drifting system clock frequency for example. This will soon be possible with a system developed by the Fifth Dimension Corp. of Trenton.

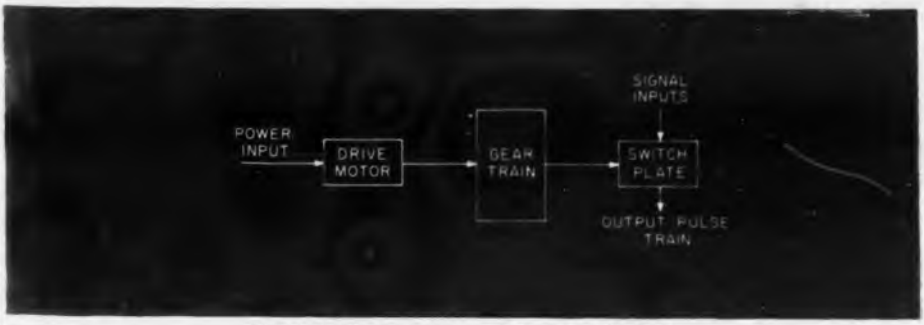
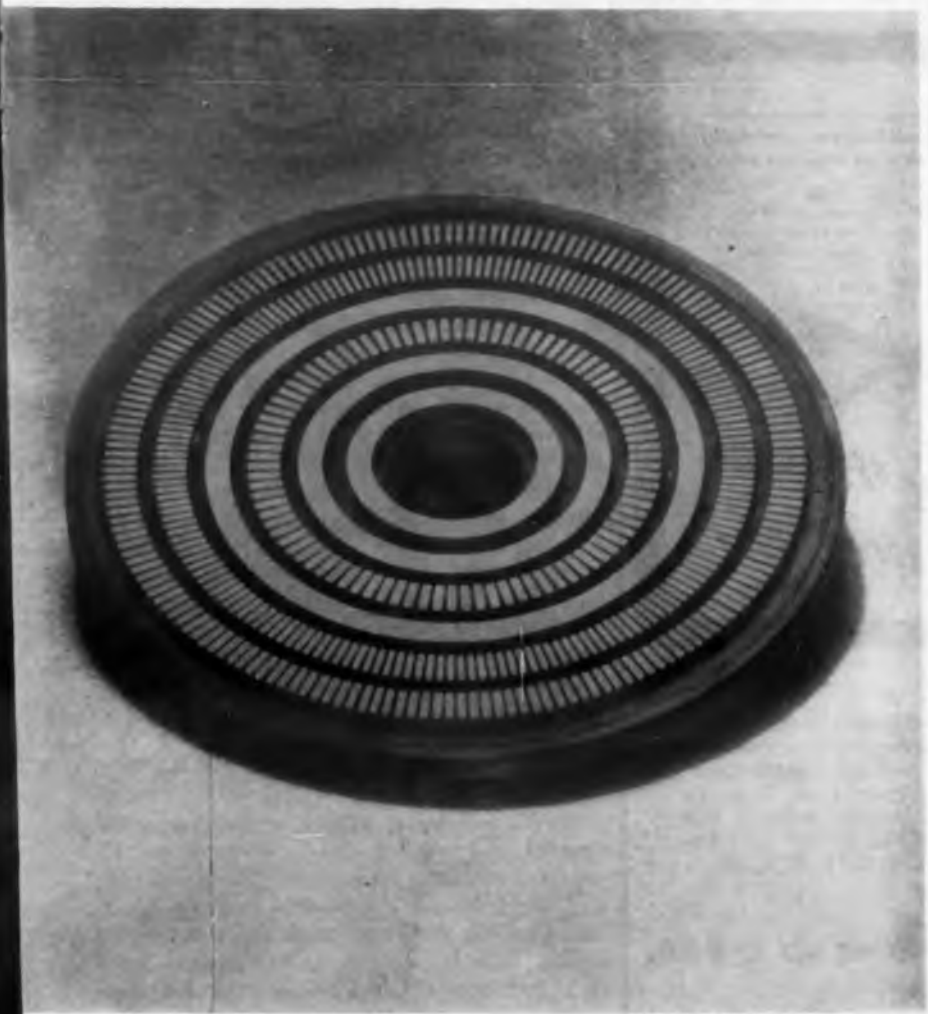


Fig. 1. Basic components of electromechanical commutator are driving motor, reduction gears, and switch plate. (Or, switch plate can be replaced by ring segments mounted on inner or outer walls of a cylinder.)



Mycalex Electronics

Fig. 2. Concentric ring segments of switch plate are mounted on a dielectric material and connected to data points.

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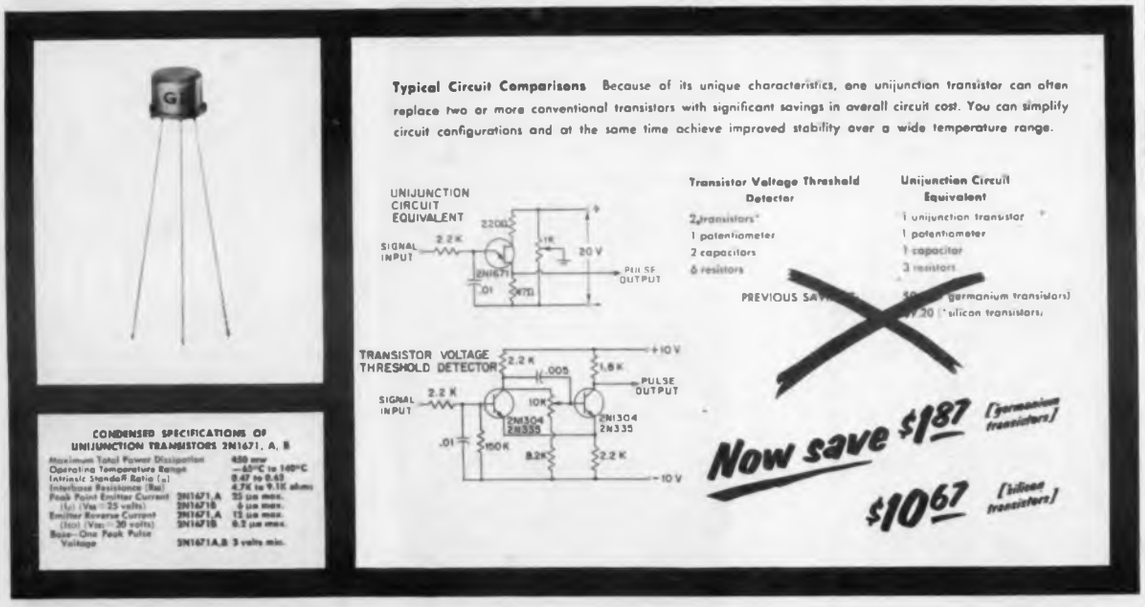

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GENERAL ELECTRIC

CIRCLE 44 ON READER-SERVICE CARD

COMMUTATORS

N.J. In their "Sync Scan" unit, the speed of an electromechanical commutator is controlled by a pulse train, varying in response to deviations in the fundamental pulse frequency. With this technique, rotating commutators can, in effect, be made to "speak the language" of electronic systems.

Sampling rate for scanning switches is best specified in terms of the number of contacts per second since units vary in size and have different brush velocities. Standard switch types can provide reliable sampling up to approximately 5,000 contacts per second. Many applications require rates of 1,000 contacts per second or less.

End of life for an electromechanical commutator usually occurs for one of two reasons. A gradual wearing down of the contacting surfaces and the buildup of wear particles between the channel segments leads to short circuits, increased leakage currents between channels, and the deterioration of the uniformity of the timing intervals. Catastrophic failure will occur when the driving motor burns out.

Drive-motor failure is a particularly difficult problem to cope with because the motors are supplied from outside sources. Thus the switch manufacturers cannot themselves improve the motors by redesign but must rely on their suppliers to do so. Increased motor life, particularly that of governed units, would be most welcome. Currently, most electromechanical units are rated at 300 hours of life, with some guaranteeing as high as 2,500 hours.

Size and Weight

Physical size and weight depend upon the channel and environmental requirements involved. Apart from the necessary number of contacts and poles, the construction must be able to withstand the shock, vibration and temperature conditions to be encountered. In general, however, the sizes of electromechanical and electronic scanners are comparable.

Contact and Intercontact Insulation Resistance

Contact resistance is a function of the wiping mechanism, the nature of the materials used, the

speed of operation, and the currents switched. Variations in contact resistance are apparent by the noise which the switch superimposes on the signal. Values of contact resistance vary from about 0.1 to 10 ohms.

Insulation resistance between active contacts is reduced under operating conditions by the accumulation of wear particles. This effect can limit the measuring accuracy of the switch. Fifty and 100 megohms are typical minimum values of intercontact resistance.

Switching Noise

Except for operation at the lower millivolt levels, no significant generated noise exists in most scanning switches. Noise can easily be kept less than 50 μv, with smaller values also possible. Additional noise can also be introduced by magnetic or capacitive pickup. This type of pickup should be considered when working at millivolt signal levels.

Input Signal Levels

Electromechanical commutators can be designed to accommodate a great range of input signal levels. The same basic design techniques are used for low-level signal sampling as is used for high. In general, they can range from 0 to 15 mv to from 0 to 100 v.

New Scanners Reduce Friction

Probably the worst feature of electromechanical scanning switches is their relatively low life compared to solid-state units. This low life is due largely to two factors—sliding friction wear between the brushes and channel segments, and the early failure of the motor-drive units.

As mentioned previously, switch manufacturers cannot directly improve motor design. However, they have been making efforts to reduce wearing of the switch parts. This is being done by (a) using more wear-resistant materials and (b) designing scanners which decrease, or remove entirely, the need for sliding contacts. Several of these types are described in the following.

Mercury Jet Replaces Brush In Higher Speed Motor-Driven Scanner

The problem of contact friction and wear at higher motor speeds apparently has been overcome in the mercury-jet scanning switch. As its name implies, this interesting device uses a jet of mercury to replace the conventional wipes brush. It incorporates a screw-type scoop which lifts mercury from a sump or pool into a rotating reservoir. Centrifugal force causes this mercury to be ejected from the reservoir in a fine stream through a small nozzle. This stream impinges sequentially upon a circle of contact pins located

HIGHLY REGULATED 5 VOLT INSTRUMENTATION POWER SUPPLY

Volume: 1.3 Cubic Inches. Weight: 1.75 ounces. Voltage: 5.0 V at 200 milliamps or adjustable from 4.0 V to 6.2 V at 200 milliamps. Stability: output voltage varies less than ±0.15% from −20°C. to +80°C. Operational Range: −55°C. to +125°C. completely encapsulated.

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Most Accurate Instrument Available 0.1° absolute, 0.01° incremental accuracy

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Completely human-engineered, the model 1010 features; 0.1° absolute accuracy, 0.01° incremental accuracy, direct reading of phase difference over frequency range of 30 to 20,000 cps., phase range 0 to 360° without ambiguity. The model 1010 has the accuracy-stability of a primary standard while being suitable for field and bench use because of its rugged construction.

This precision phasemeter is the result of a unique patented design which withstands the most rigorous mathematical analyses. The circuitry has been proven by years of field use under adverse conditions. The highest quality materials are selected and continually inspected under rigid quality control proceedures, ensuring reliability for the user . . . Another example of Maxson Electronics Corporation technical contribution to industry and the military.

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The model 1241 is the only commercially-available device featuring wide band coverage 200 mc to 2500 mc, at these high power levels — 40 W at 200-400 mc, 25 W at 400-1050 mc and 10 W 950-2500 mc. This versatile high level signal source is furnished in two rugged transit cabinets. External amplitude modulation or internal amplitude modulation is provided. Another example of Maxson Electronics Corporation precision instrumentation.

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COMMUTATORS

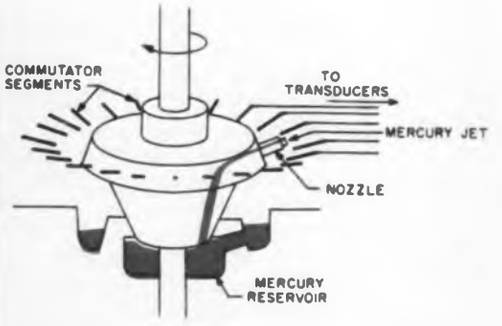


Fig. 3(a). Centrifugal pump action of mercury-jet commutator forces mercury up from reservoir and out of nozzle. As stream rotates, it impinges in sequence upon contacts placed on inner circumference of stationary cylinder.

outside the rotor periphery. As the nozzle rotates, the stream is swept around the circle. The mercury is then returned to the sump by gravity.

During the time the jet stream is in contact with the steel pins, a low-resistance electrical contact is established between the contact and the mercury pool. The pool serves as the common contact. Obviously the switch is free from contact bounce.

Mercury-jet units have been built to sample as many as 120 circuits at speeds of up to 6,000 rpm. As an example, the Delta switch mercury-jet scanner, manufactured by Advanced Technology Laboratories has standard drive motors of 1,200 1,800 and 3,600 rpm, with 64-, 81-, 100- and 120-pin configurations. Multipole operation can be achieved by stacking units and driving them with a common motor. Pole phasing is adjustable. Noise level is primarily a function of switch speed and input resistance. At 3,600 rpm and 100 ohms, noise is approximately 10 μv. The switches can be driven by hystereses synchronous motors supplied from a 115-v, 60-cycle source.

The switches are claimed to be capable of thousands of hours of operation without servicing. After extended use, cleaning of the switch

Advanced Development Labs.

Fig. 3(b). Three-pole mercury jet commutator has three sets of contacts and rotating nozzles mounted above drive motor and mercury reservoir.

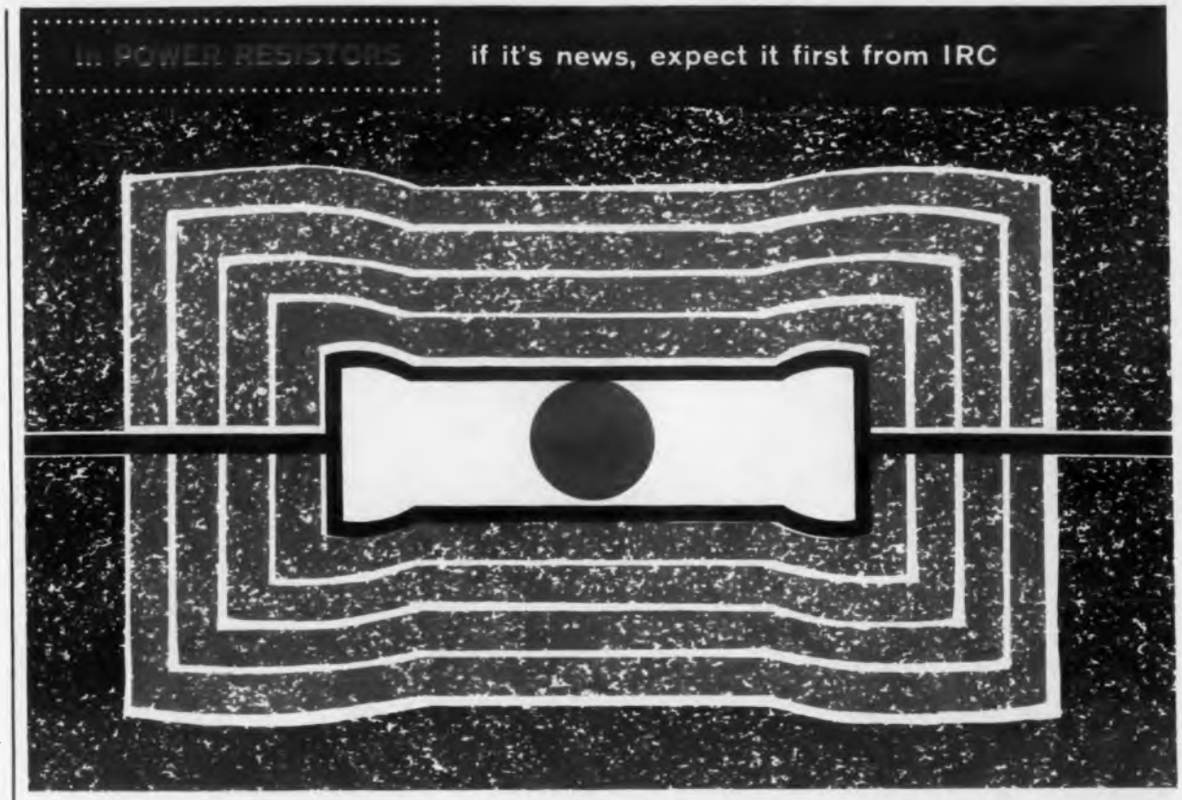
parts and replacement of mercury is normally the only maintenance required. Application of the switches has been in industrial, ground telemetering systems.

Roller Bearing Depresses Foil Layer, Samples Contacts

Rotating contact wear is also decreased in the Rotoflex scanning switch manufactured by Technology Instrument Corp. of Acton, Mass. This switch utilizes a technique previously designed for the firm's line of potentiometers.

A gold-foil diaphragm is suspended over a segmented switch plate, Fig. 4a. An arm is mounted at the center of the Teflon-backed foil and at its end is a miniature precision ball bearing. The pressure of the ball bearing dimples the foil as shown in Fig. 4b. A motor drives the gear, causing the ball bearing to travel in a circle around the foil. The foil dimples in the bearing's path and sequential contact is made between the switch segments and the gold foil.

Sixty channels of information are standard for the unit. But, by adding wafers, up to 360 channels can be accommodated. Sampling rates can be as high as 1,200 per second. Contact resistance



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CIRCLE 48 ON READER-SERVICE CARD

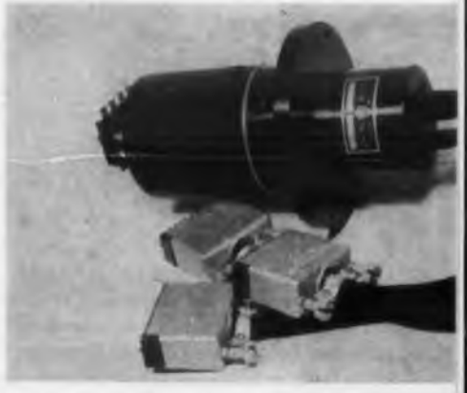
COMMUTATORS

Fig. 4(a). Teflon-backed gold foil of "ball-bearing" commutator is folded over, partially revealing commutator segments.

is said to be less than 0.1 ohm and noise voltage is less than 5 μv. Depending upon the sensitivity of the following equipment, signals as low as 30 μv and as high as 5 v can be scanned. Life of the unit is claimed to be over 1,000 hours, with the drive motor, rather than contact friction, believed to be the life-limiting factor.

Rotating Magnet Activates Magnetic Reed Switches

Magnetic reed switches mounted about the circumference of a circle, are being used to re-



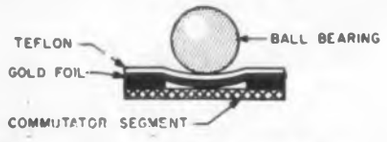


Fig. 4(b). Ball bearing, traveling in circle over gold foil, causes it to dimple and sequentially contact commutator segments.

place the channel segments of the conventional commutator. The individual reed switches are closed and opened in sequence by a magnet rotating in the center of the circle. Mounted on a motor driven rotating shaft, the magnet can be designed to have field configurations to operate the commutator shorting or nonshorting.

Long life-times are expected of these units because of the isolation of the contacts. These are glass-enclosed and hermetically sealed. The unit manufactured by Hathaway Instruments, Inc. of Denver, Colo. is rated at 10,000,000 operations and can be driven at 6,000 rpm. It is very resistant to vibration and shock.

New Mechanical Commutators Also Try to Reduce Size

Reducing the size, and hence the power requirements, of electromechanical commutators is also a concern of switch manufacturers. A recent

Three-pole electromechanical commutator has its sets of contacts brought out to separate connecting blocks. Different pole arrangements can be made by altering segment pattern on commutator switch plate.

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NEW

MEASURES 300 μV to 300 V

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10 cps to 11 Mc

FEATURES: ●Accuracy is % of reading anywhere on scale at any voltage ●Five inch mirror-backed voltage scales of 1 to 3 and 3 to 10, each with 10% overlap; 0 to 10 db scale ●Use as a sensitive null detector 5 cps to 30 Mc ●Use as a stable 60 db wideband amplifier, 2.5 volts max. output ●10,000 hour frame grid tubes used in critical circuits to aid in insuring long, reliable life ●Cathode follower probe has a voltage range of 300 μV to 300 mV, and a high input impedance. It has zero loss from tip to coaxial connector on the voltmeter ●Instrument is average responding type, with or without probe ●Electronically regulated power supply assures stable, accurate results over range of 105 V to 130 V or 210 V to 260 V, 50 to 400 cps. Effect of line transients nil ●Voltmeter input to UHF connector. The Model 617 Binding Post Adapter is a standard accessory. The Model 2317 Probe, 100 X Multipliers, and various shunts are optional ●Available in portable model shown or in 19 inch rack version.

SPECIFICATIONS:

VOLTAGE: 300 μV to 300 V.
FREQUENCY: 10 cps to 11 Mc (As a null detector, 5 cps to 30 Mc).
ACCURACY: % of reading anywhere on scale at any voltage. 20 cps to 2 Mc — 2%; 10 cps to 6 Mc — 4%; 10 cps to 11 Mc — 6%.
SCALES: Voltage, 1 to 3 and 3 to 10, each with 10% overlap. 0 to 10 db scale.
INPUT IMPEDANCE: With probe, 10 megohms shunted by 7 pF. Less probe, 2 megohms shunted by 11 pF to 24 pF.
AMPLIFIER: Gain of 60 db ± 1 db from 6 cps to 11 Mc; output 2.5 volts max. from 460 ohms source.
POWER SUPPLY: 115/230 V, 50 — 400 cps, 70 watts.
DIMENSIONS (Inches): Portable model 13 h x 7½ w x 9½ d. Rack model 8¾ h x 19 w x 8½ d.
WEIGHT: 17 pounds, portable or rack models. Approximately 34 pounds shipping weight.

Price: **$445.**
(With probe **$495**)

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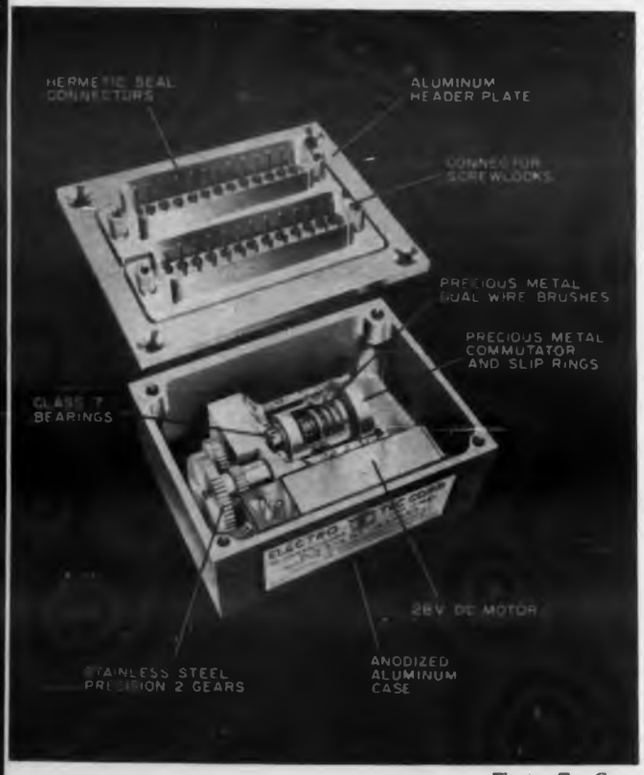
development that has created much interest is the miniature unit developed by the Electro-Tec Corp. of South Hackensack, N.J. Up to 450 commutator segments can be mounted on 5 poles of 90 segments each. Each segment is 0.010 in. wide and is individually mounted on the outer circumference of a plastic core. The brushes rotate around the segments which are spaced 0.0015 in. apart. The completely packaged unit (with driving motor) has a volume of 6 cu in. and weighs 8 oz. A view of the switch showing details of its construction is shown in Fig. 5.



Electro-Tec Corp.

Fig. 5. Brushes rotate around commutator segments in this miniature unit. Segments are only 0.010 in. wide and spaced 0.0015 in. Unit weighs 8 oz. and is 6 in.^{3}.

ELECTRONIC COMMUTATORS

their assets—longer life, faster speeds, but higher cost

ELECTRONIC, or solid-state, commutators are used primarily where high sampling rates and long life are required. With proper circuit configurations, they can sample signals down to millivolt levels at commutation rate orders of magnitude faster than can be achieved with mechanical units.

Solid-state scanners may be thought of as divided into two sections—a gating section, which switches the data points to the common output line, and a channel selection circuit which turns the gates on in a preset sequence. A general block diagram of a solid-state scanner is shown in Fig. 6.

The speed of rotation of the scanner (the scanning rate) is controllable by the clock oscillator frequency. This clock signal can be very easily synchronized to an external trigger. Also, its free-running frequency can be easily set. This means that a solid-state scanner can be adjusted to different sampling rates for different applications. In general, this adjustment cannot be made on mechanical commutators.

Channel Selection Circuitry Use Tubes, Ring Counters, or Matrices

Various circuits can be used to furnish the channel selection pulses. They can be built around multiple output tubes, ring counters, matrices, or combinations of these methods. Multiple output tubes, such as the Burroughs beam-switching unit, can be readily designed into selection circuitry, if the necessary power is available, and the tubes can be tolerated in the system. These tubes have ten distinct outputs; two in cascade can produce 100 discrete states. They have the disadvantage of limited environmental capability, high-voltage power supply requirements, and comparatively high weight and volume.

Ring counter circuits provide a very direct and often a simple, means of channel selection. Bistable elements which can be used in these counters include the unijunction transistor, the Shockley diode, the gas tube, and standard bistable combinations of diodes and transistors. The circuits can be made small, light, and relatively inexpensive. Unfortunately, ring counters have the inherent lack of reliability associated with a series combination of a large number of stages. Failure of a single component may cause the entire unit to fail. And, it is also possible for noise and transient pulses to cause the simultaneous selection of two channels.

Another approach to channel selection uses matrix techniques. Two or more sets of synchronized pulses can be used. With two sets, the "*X*" and "*Y*" pulses can be combined in a rectangular array to select "*XY*" channels.

Still another selection method uses a chain of *N* bistable devices to furnish 2*N* sets of output conditions. This method is fairly simple, reliable, light in weight, and small in size. The circuitry can be readily transistorized and can be very compactly packaged.

Data Points Are Switched By Diode or Transistor Gates

Connections from the sampled data points to the common output line are made through the gating circuits. These gates are not perfect switches; they are composed of either diodes or transistors. Historically diode gates were used first, but switching transistors improved and they are now used predominantly. Diode input commutators are usually cheaper and smaller. However, they are also less accurate than the transistor input unit, which can also accommodate higher switching rates. Basic gating circuits are shown in Fig. 7.

One switching configuration is required for each information channel. The channels are turned on one at a time by sequential gating pulses applied to points A, Fig. 7, by the selection circuitry.

Ideally, the commutator should have no effect upon the signals at samples. However, in practice this is not exactly the case. The individual channel transfer functions will differ from unity and will also differ among themselves. Differ-

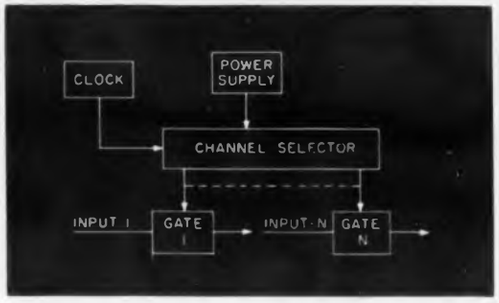


Fig. 6. Electronic commutators, scanning at clock frequency, may be thought of as divided into two sections which perform channel selection and gating functions.

ences in channel characteristics are a much greater problem in solid-state scanners than in electromechanical ones. This is because the solid-state scanners are much more active devices than the electromechanical.

Effectively the gates have a forward conduction resistance and a series "offset" voltage, both of which are temperature sensitive. Changes in the conduction resistance are reduced by having

(continued on p 54)

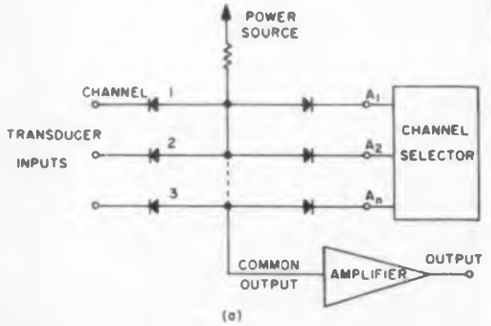
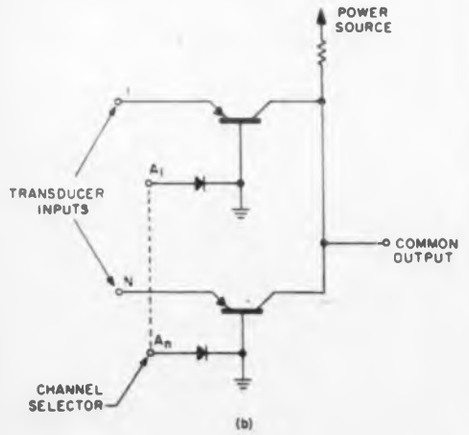


Fig. 7. Basic gating circuits use either (a) diodes or (b) transistors (shown here as diode driven).



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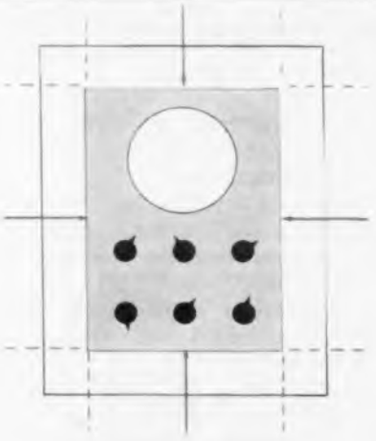

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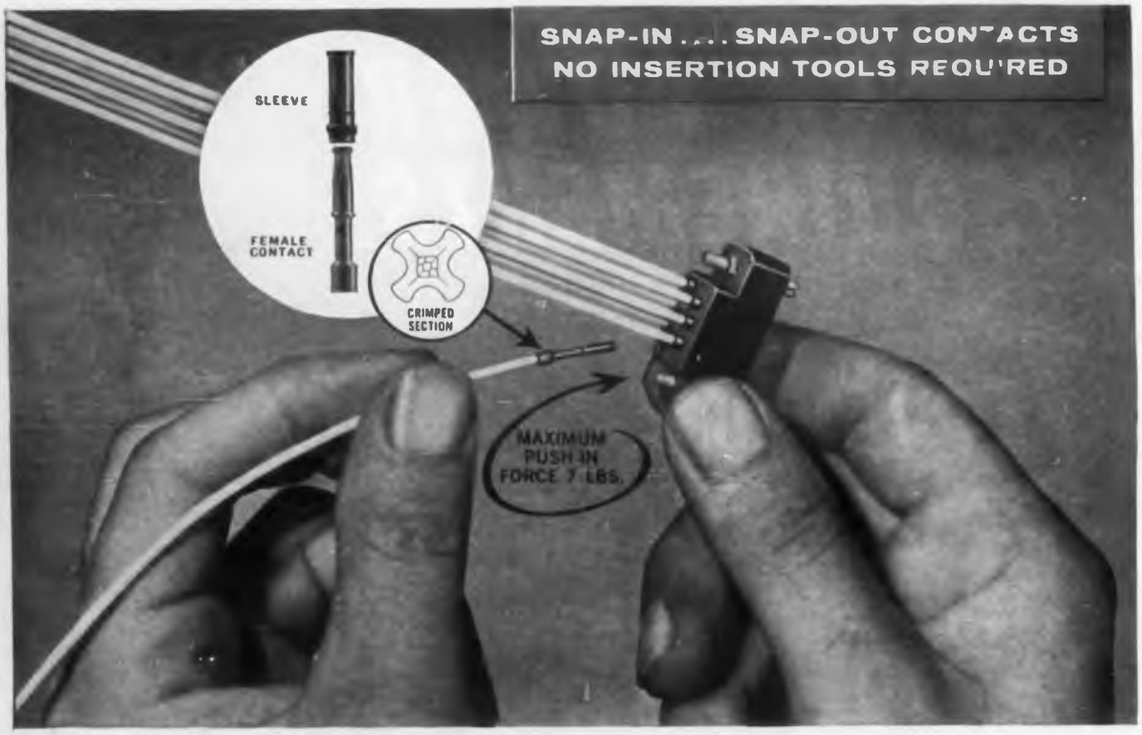

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Patents applied for

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COMMUTATORS

an impedance transforming device that ensures that the commutator is always working into a high impedance load. Thus the output impedance of a solid-state commutator is always low, regardless of the transducer impedance.

The offset voltage is reduced in diode gates by careful matching of the diode pairs. With transistor gates, the offset voltage—which is the transistor saturation voltage—is smaller, more stable, and more nearly equal between units.

Back-Current Effect Can Introduce Errors

There is another effect that is peculiar only to solid-state commutators. This is the back current—a small constant current that flows out of each channel input only during the channel sampling interval. It is of the order of microamperes, and in diode gate units it represents the current required to keep the diodes in conduction. Its magnitude depends on the number of channels and on the sampling speed at which the commutator operates. Back current is always specified for zero signal volts.

Back current also flows with transistor input commutators. This current is made up of the difference between the collector and base currents, leakage current from the channel selection circuitry and current drawn by the output circuit. Its value can be held to only fractions of a microampere.

Back current is important because it produces a small error voltage across the transducer source resistance. If all sources have the same resistance, all inputs will appear to have been slightly offset. Zero and full-scale calibration will normally correct for this effect if the calibrating channel inputs have the same resistance as the data sources. The worst effect of back current with respect to channel-to-channel scatter will occur when the transducers have differing source resistances. The error voltage will then vary from channel to channel. It will also vary as the source resistance varies, as is the case with potentiome-

ter-type of transducers. Thus when a solid-state commutator is used, its effect on the signal source must be considered.

Low-Level Input Signal Require Special Circuits

It is apparent then that because of their inherent operating characteristics, solid-state commutators, as described above, cannot be used to sample signals in the low millivolt range. Special circuit techniques are required.

Several companies have already developed or are in the process of developing low-level commutators. The companies include Radiation, Inc., of Melbourne, Fla.; Data Control Systems, Danbury, Conn.; General Devices, Princeton, N. J., and Applied Electronics, Metuchen, N. J. Their circuit approaches vary, and some concerns are reluctant to disclose them at present. However, the problem all must overcome is that of sequentially sampling the millivolt signals while introducing extremely low levels of switching noise and voltages. Signal inputs must be double ended, and hence the common mode rejection ratio must be very high (80 or 90 db at dc or at 1 kc is a typical value). Also, the differential input impedance of each channel should be high, and the channel-to-channel scatter over the entire operating temperature range must be held within very narrow limits.

The first low-level commutator designs used input transformers on groups of data lines. Channels are sampled at the inputs to the transformers. However, the presence of the transformers makes the unit bulky and limits the channel sampling rates. New designs are eliminating the transformers and are providing for faster, programmed sampling rates.

Paralleling Channels

It is not always possible to parallel channels by connecting their input circuits, as is done with electromechanical units. Leakage currents flowing into the source during channel off-times will accumulate, and they can cause damage or errors in high-impedance transducers.

Designs Improve on Solid State

Electronic commutators can be improved in several areas. With diode and transistor gates, the switch can only approximate the ideal case of zero "on" resistance, infinite "off" resistance, and unity transfer function. The electromechanical commutator can come considerably closer to this ideal.

Cross-talk between channels, and leakage and back currents into the information sources are

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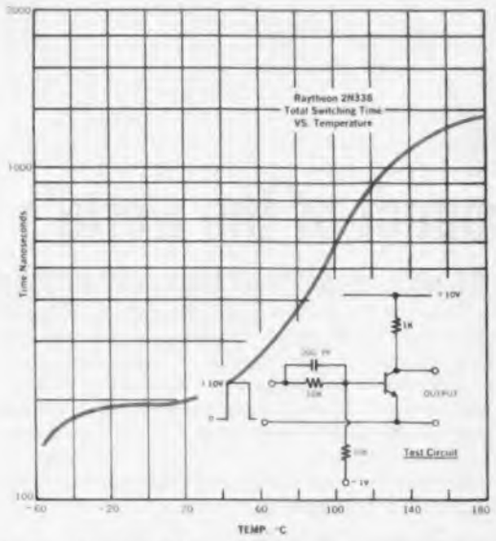

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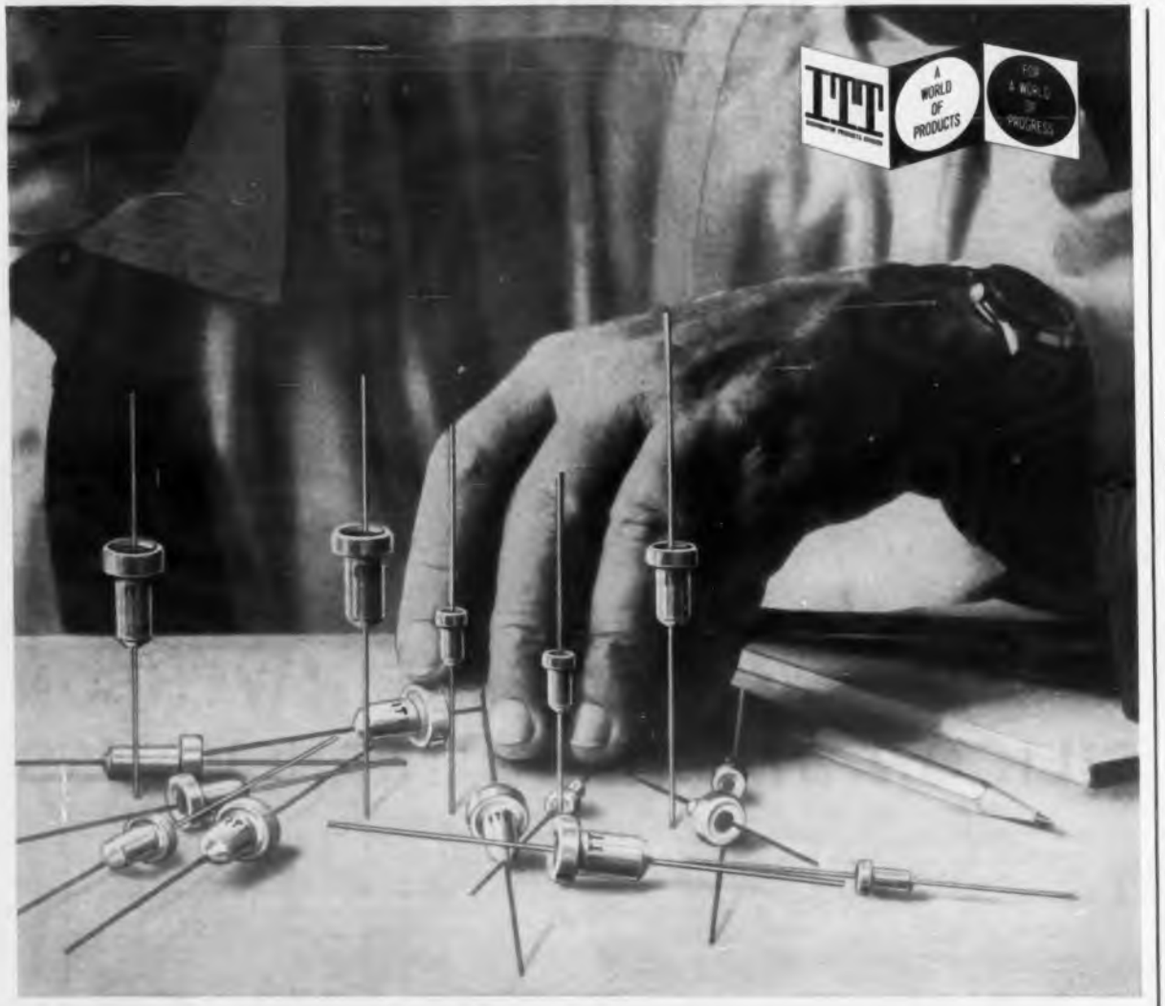

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COMMUTATORS

other undesirable effects present in electronic switches. Perhaps an ideal commutator would be one that incorporated the metal-to-metal contact of the electromechanical, with the rapid, programmed scanning of the electronic. This approach has actually been attempted in two units still in the process of being developed.

In the future, solid-state commutators will find increasing application in satellites. There their low power requirements, reliability and long life (25,000 hours in the unit mentioned previously) will be of great value. Even greater miniaturization will be possible with thin-film switching techniques. However, it is anticipated that comparatively high-level units will be adequate. This is because transducers are now able to deliver sufficiently high-voltage signals. Diode-gate circuits will be adequate for sampling these levels.

Typical scanning rates in satellites, variable with solid-state units, are expected to go as low as 30 samples per min. This rate will be sufficient to detect changes in the data sensed. As an example, some data channels are being sampled as slowly as once every 16 sec.

Microplexer Uses New Magnetic Switch—The Magristor

The Microplexer, designed by Astronetics, Inc. of Santa Barbara, Calif., combines the desirable features of the mechanical commutator (zero back current, high-input impedance) with those of the electronic (long life, variable rate, electronic scanning). It is a 100-channel low-level commutator using a new type of switching element—the Magristor.

Similar to the magnetic-reed switch, the Magristor consists of two contacts immersed in a conducting liquid. These contacts are magnetically activated by completely solid-state circuitry. Due to the magnetic control, the switches are double-ended, with each information channel requiring a Magristor.

Other features of the Microplexer are its input signal ranges of ± 5 mv to ± 100 mv full scale,

and its output noise level of 5 μv. One thousand points can be sampled each second, with the sampling sequence programmable through a patch-board attachment.

Magnetic Reed Switches Also Used in Electronic System

Switching a mechanical contact electronically is also the design concept behind a commutator currently being developed by the Scintilla Division of the Bendix Corp. The switching elements will be magnetic-reed switches electronically activated by magnetic coils. These coils are charged in sequence by beam-switching tubes. The first completed unit is to be a 100-channel device, requiring two switching tubes. It will be able to sample at a rate of 300 samples/sec with input signal ranges of from 0-1 mv, up to 100 v. Power required will be 25 w and its lifetime may be rated in excess of 5,000 hr.

Subsequent development will endeavor to extend the scan rate and reduce size.

Beam-Switching Tube Scans Triode Gates

The beam-switching tube is part of the Burrough's Corp. 10-channel commutator known as the Beamplexer. This unit is designed for displaying 10 separate channels of information on a conventional single-beam oscilloscope.

The operation of the system is shown schematically in Fig. 8. When the targets of the Beam-X switch are nonconducting, their associated triodes are cut-off. Thus, the inputs associated with the cut-off triodes are not coupled to the common output. As the beam is formed and is stepped around the tube by the driver, the triodes are turned on and the signals appear on the output in sequence. Here the beam-switching

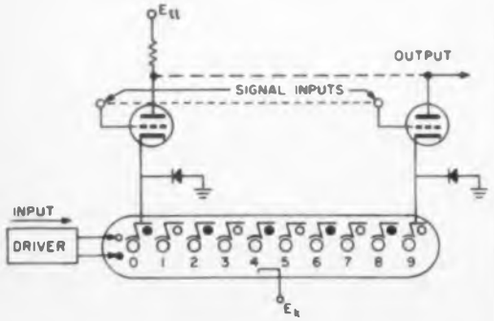
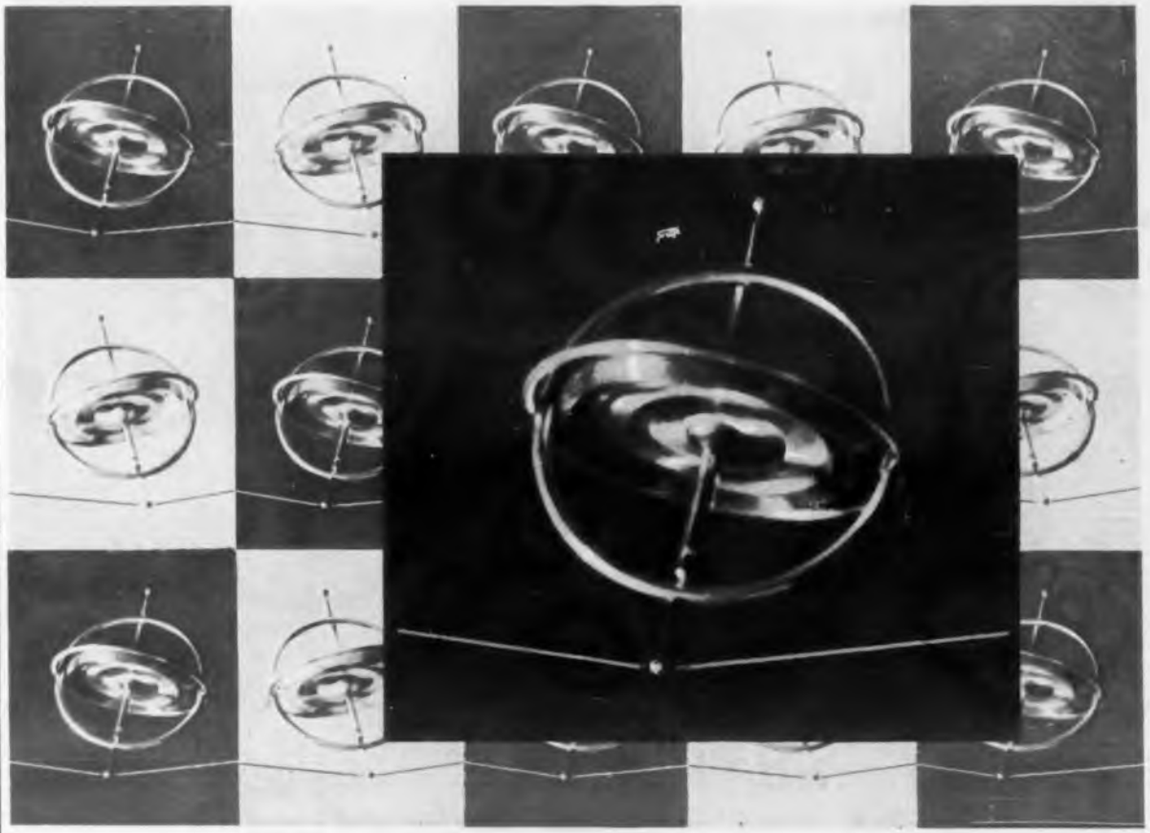


Fig. 8. Ten position, Beam-X switch commutator sequentially gates associated triodes. System being developed will feed signals directly through Beam-X which, in effect, will scan and gate itself.



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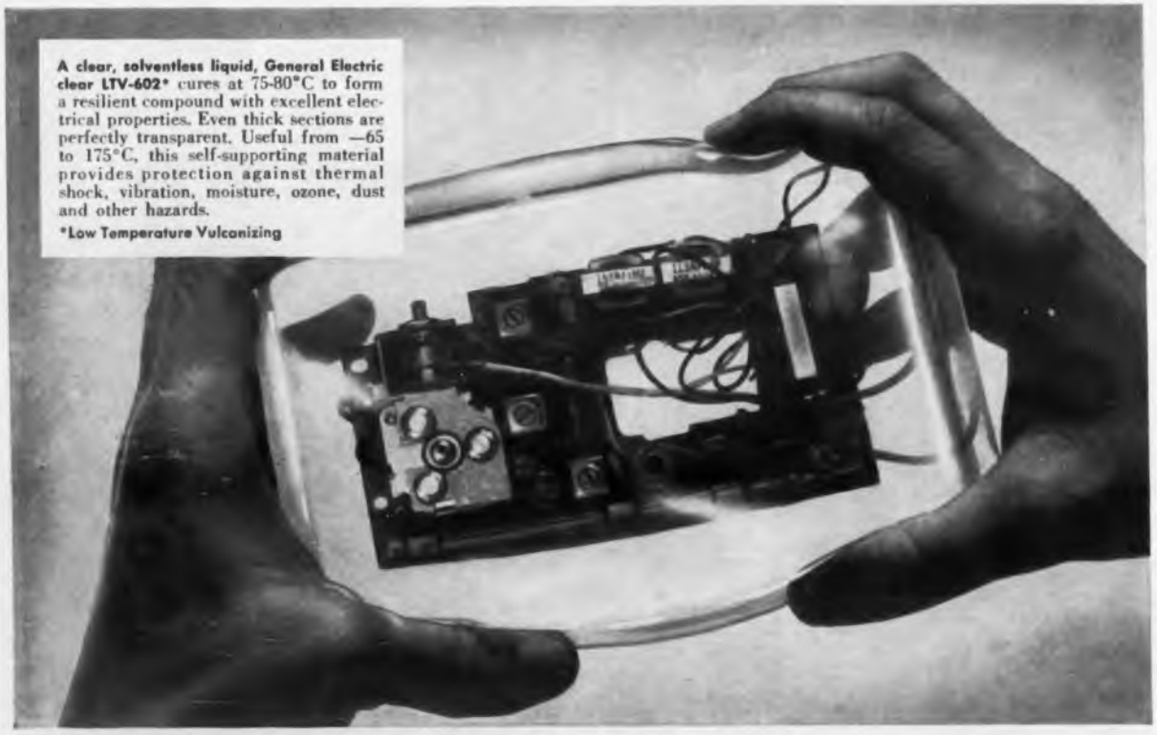

A clear, solventless liquid, General Electric clear LTV-602* cures at 75-80°C to form a resilient compound with excellent electrical properties. Even thick sections are perfectly transparent. Useful from —65 to 175°C, this self-supporting material provides protection against thermal shock, vibration, moisture, ozone, dust and other hazards.

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LTV-602 is easy to work with and easy to repair. To repair parts embedded in LTV, merely cut out and remove section of material, repair or replace defective part, pour fresh LTV into opening and cure. Pot life, with catalyst added, is approximately 8 hours and may be extended with refrigeration. When desirable, LTV may also be cured at room temperature.

Resiliency offers excellent shock resistance. LTV-602 easily meets thermal shock tests described in MIL-STD-202A test condition B which specifies five temperature cycles from —65 to 125°C. Tests indicate that LTV retains protective properties even after 1800 hours aging at 175°C. Other tests confirm LTV's resistance to moisture and water immersion.

LTV-602 is the newest addition to the broad line of G-E silicone potting and encapsulating materials which also include the RTV silicone rubbers. For more information, write to General Electric Company, Silicone Products Department, Section 23C40 Waterford, New York.

GENERAL ELECTRIC

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tube is being used as the counting or selection device. It is also possible to replace the triodes with diodes or transistors.

Burroughs is currently working on a circuit which will use the Beam-X switch, a later model having an additional "shield grid" element, to both scan and gate itself. The data will be sent directly through the tube which will be gated in sequence. This will eliminate the gating triode.

Hall Generators Used in Laboratory Commutators

Hall generators have been used in a commutator designed by the Westinghouse Electric Co., Pittsburgh, Pa. The signal voltages to be sampled are converted to proportional magnetic fields. They appear at the outputs only when the control current circuit is conducting. A Hall gen-

Representative Manufacturers of Commutators

erator is required for each channel. By sequentially pulsing the control currents through each generator, the signal voltages appear at a common output point.

Only a two-input model has been constructed thus far. The sampling rate exceeded 30 kc, but the signal ratio from output to input was only 0.003.

Representative Commutators And Manufacturers Listed

Representative electronic and electromechanical commutators are listed in the following reference tables. These lists are not meant to be used as final ordering charts. Rather they are intended to be used as a reference list of commutator manufacturers and their product lines.

Note that the information presented does not include every point that should be considered when a commutator is selected. Thus, back current and input impedance, as well as temperature range, are not listed. They should, however, be taken into account.

Sampling speed is usually given in the charts as the maximum number of samples per second. However, manufacturers can often supply a range of lower speed units. Duty cycle is also listed as a maximum value, with smaller values obtainable.

(continued on p 60)

Adage, Inc.
292 Main St.
Cambridge, Mass.

Advanced Technology Labs. Div. American-Standard
369 Whisman Road
Mountain View, Calif.

Airflyte Electronics Co.
535-9 Avenue A
Bayonne, N. J.

Applied Electronics Corp. of N. J.
22 Center St.
Metuchen, N. J.

Arnoux Corp.
11924 W. Washington Blvd.
Los Angeles, Calif.

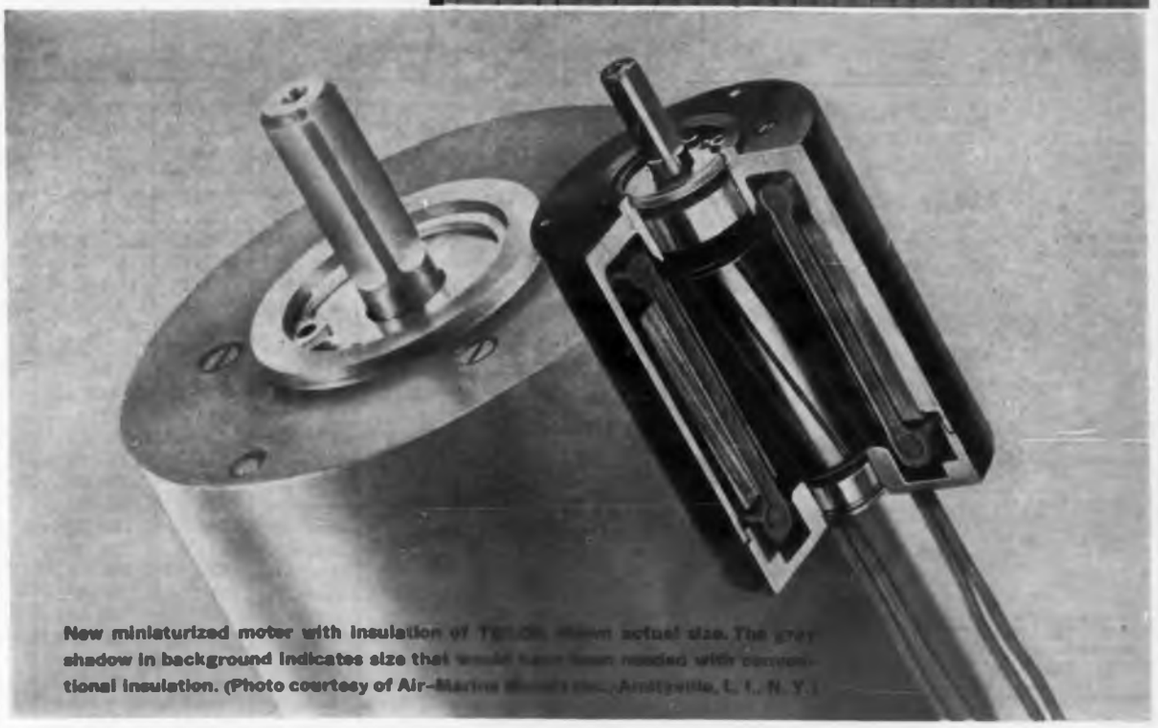
ASCOP Div.
Electro-Mechanical Research, Inc.
P. O. Box 44
Princeton, N. J.

Astrometrics, Inc.
1108 Santa Barbara St.
Santa Barbara, Calif

Communications Control Corp.
14707 Keswick St.
Van Nuys, Calif.

(continued on p 63)

DU PONT TEFLON®



New miniaturized motor with insulation of TEFLON, shown actual size. The grey shadow in background indicates size that would have been needed with conventional insulation. (Photo courtesy of Air-Marine Motors Inc., Amityville, L. I., N. Y.)

Motor meets specs with 70% cut in weight and space ... thanks to insulation of TEFLON®

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In your next application involving wire, cable or component insulation, it will pay you to evaluate the design improvements made possible by TEFLON resins, and the dollars-and-cents savings in installation, replacement, maintenance and extended service life they can afford you.

Space and weight were at a premium in this new motor, designed to drive a camera on a missile-tracking radar antenna. Requirements were for a synchronous motor, 1/40 HP at 8,000 rpm, to withstand 180°C for a minimum of 2,000 hours life. Using conventional insulation (Class F), a unit 3 7/8 inches diameter weighing over 3 lbs. would have been required. By using cell insulation of a Du Pont TEFLON TFE fluorocarbon resin, and magnet and lead wire insulated with TEFLON, the manufacturer is able to meet the specifications called for with a motor 2 inches in diameter weighing less than 1 lb.

The high insulating properties of TEFLON resins, coupled with their high resistance to temperature extremes, make possible the miniaturization of electrical and electronic equipment without sacrifice in performance. In addition, tough insulation of TEFLON is completely inert to virtually all chemicals, assuring maximum reliability under a variety of severe environmental conditions. With the advent of new melt-processible TEFLON FEP resins, the remarkable properties of TEFLON are now available in a variety of complex molded shapes and in long continuous wire insulation. For more information, write to: E. I. du Pont de Nemours & Co. (Inc.), Dept. **ED-329,** Room 2526T, Nemours Bldg., Wilmington 98, Del.

In Canada: Du Pont of Canada Ltd., P.O. Box 660, Montreal, Quebec.

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Table 3. Representative Electromechanical Commutator Manufacturers

Manufacturer	Type or Series No.	No. of Poles	No. of Channels/ Pole	Max. Speed Samples/Sec./ Pole	Signal Duty Cycle - %	Usable Signal Range	Contact Res. Range - Ohms	Noise	Volume in.^{3}	Weight lb.	Applications, Notes
Advanced Technology	DS-I	1	81	2430	50	1 mv - 150v	0.6 - 1	*1 - 10 μv	*40 - 165	*2 - 10	Ground Telemetry.
	DS-IA	1	120	3600	50	1 mv - 150v	0.6 - 1	*1 - 10 μv	*40 - 165	*2 - 10	Data Sampling
	DS-210	1	100	2000	50 & 120	1 mv - 150v	0.6 - 1	*1 - 10 μv	*100 - 200	*3.5 - 12	(Note 1).
Airflyte	AS-2000-0	1	64	128	50	10 mv - 28v	To 1	To 10 mv	*20 - 35	*0.5 - 2	
	AS-2010-0	1	250	2500	75	10 mv - 28v	To 1	To 10 mv	*20 - 35	*0.5 - 2	
	AS-2020-0	1	96	96	80	10 mv - 28v	To 1	To 10 mv	*20 - 35	*0.5 - 2	
	AS-2030-0	1	200	600	75	10 mv - 5v	To 1	To 10 mv	*20 - 35	*0.5 - 2	High Speed Ground Telemetry (Note 2).
	AS-2040-0	1	32	256	50	10 mv - 5v	To 1	To 10 mv	*20 - 35	*0.5 - 2	
	AS-2050-0	1	64	256	50	10 mv - 28v	To 1	To 10 mv	*20 - 35	*0.5 - 2	
ASCOP	507	1-4	90	900	Adjustable	5 mv - 150v	0.01 - 0.1	To 25 μv	•	•	Magnetically Actuated Capsules. Ground Use. Variable-Size Chassis.
	533	1-4	90	900	45-110	5 mv - 150v	0.01 - 0.5	To 50 μv	140 - 250	5 - 10	Individual Channel Modules. Extreme Environments. PAM. PDM, etc.
	550	1-4	45	1350	45-70	5 mv - 150v	0.01 - 0.3	To 50 μv	60 - 80	4 - 6	PAM, PDM, Extreme Environment. Long Life.
	A	2	30	30 - 300	55	50 mv - 10v	0.1 - 1	100 - 500 μv	6 - 8	0.33	PAM. Miniature, High Shock, Vibration.
	B	4	30	30 - 300	55	50 mv - 10v	0.1 - 1	100 - 500 μv	8 - 10	0.5	PAM. Miniature. High Shock, Vibration.
	C	2	20 & 30	1 - 60	55	25 mv - 10v	0.1 - 1	50 - 500 μv	8 - 12	0.5	PAM. Miniature. High Shock, Vibration.
	F	4	30	6-30	55	25 mv - 10v	0.1 - 1	50 - 500 μv	12 - 18	0.67	PAM. Airborne.
	AE	1-3	60	15-1800	55-95	50 mv - 20v	0.1 - 10	50 - 500 μv	24 - 36	1-1.5	PAM. PDM. Multipurpose. Air & Missile-Borne
	TA	2	60	30-300	55	50 mv - 5v	0.1 - 1	100 - 500 μv	18	0.67	PAM. Missile Env. High Stock and Vibration
	AEM	1-3	90	450-1800	55-95	50 mv - 10v	1-5	50 - 500 μv	12 - 18	0.67 - 1	PAM. PDM. High Shock, Temperature, Vibration
	KSM-1	1	45	900	70	To 5v	1-5	50 - 500 μv	60	2	PDM. Missile Env.
	H	1-2	30 - 45	900	70	To 5v	1-5	50 - 500 μv	50	5	PAM. PDM. Ground AC Motor.
Computer Instruments	MG 215	6	30	2250	80	10 mv - 5v	To 0.25	To 20 μv	70	3.5	PAM. PDM.
	MG 315	6	50	3750	80	10 mv - 5v	To 0.25	To 20 μv	95	4	PAM. PDM.
	MG 515	6	80	4000	80	10 mv - 5v	To 0.25	To 20 μv	70	5	PAM. PDM.
Electro - Tec	A	1-5	90	2700	55 - 90	To 20mv, 5v	To 1	To *1%	6	0.5	Noise Varies With Signal Level.
Epsco - West	RMX-356K	1	100	200	84	5 μv - 10v	0.01 - 0.05	1-5 μv	16/ch	0.36/ch	Low Level, Differential. Relay Switching.
Fifth Dimension	•	1-3	60 & 90	2700	55 - 95	To 5v	To 1.0	50 μv - 5 mv	•	•	Extreme Environment. Modular Units can be Assembled in different configurations.
General Devices	901	1-5	60	1800	45 - 95	To 100v	To 1	To 30 mv	30	2.5	Data Display.
	905	5	90	1800	45 - 95	To 10v	To 1	To 30 mv	40	3	PAM. PCM. PDM.
	910	1-2	60	600	45 - 95	To 10v	To 1	To 30 mv	13	1.5	Data Display.
	920	2,4	60	60-900	45 - 95	To 10v	To 1	To 30 mv	22	2.25	PAM. Missile Environment.
	922	1	60	600	45 - 95	To 10v	To 1	To 30 mv	5	0.75	Miniature Data System.
	925	1-3	90	600	45 - 95	To 10v	To 1	To 30 mv	35	3	Data Systems.
	930	2	60	600	45 - 95	To 10v	To 2	To 30 mv	25	2.5	Missile Environment.
	955	1-5	180	900	45 - 95	To 10v	To 1	To 30 mv	120	10	Data Display.
	1212	3	60	10	45 - 95	To 10v	To 1	To 30 mv	15	2	Fault Detection.
	105	3	60	900	45 - 95	To 10v	To 25	To 30 mv	15	2	Data Display.
	108	2	170	300	45 - 95	To 10v	To 25	To 30 mv	200	12	Amplifier Drift Stabilization.
	500	1	30	600	55 - 70	To 10v	To 25	To 30 mv	4.5	0.5	Telemetry.
	6-15	6	60	1200	90	30 μv-5v	To 0.1	To 5 μv	9	1	PAM. PDM.
Instrument Development	1A-F-22V	2	180 & 135	30-5400	50 - 90	10 mv - 5v	To 2.5	To 1% of Signal	30-60	3-4.5	PAM. PDM. Made to IRIG Specs.
	2A-F-22V	1	60	30-1800	50 - 90	10 mv - 5v	To 2.5	To 1% of Signal	20-40	2-4	External Voltage Control Available
Kin-Tel.	453M	1,2,4	100	10	80	10 μv - 1000v	0.01 - 0.03	1 μv - 10 mv	2200	24	PDM Low Level
Lind	LD-301	1	30	30	80	5 mv - 50v	0.4 - 0.6	To 30 μv	8	1	PAM. High Temperature.
	LD-605	1	60	300	85	5 mv - 50v	0.4 - 0.6	To 100 μv	12	1.5	PAM. High Vibration.
	MD-3010	1	30	300	85	5 mv - 50v	0.6 - 0.8	To 60 μv	2.4	0.5	PAM. Consumes Less Than 1 Watt.
	MD-30.2	1	30	2	90	5 mv - 50v	0.6 - 0.8	To 10 μv	1.1	0.25	PAM.
	LD-9010	1	90	900	50 - 95	50 mv - 50v	0.6 - 0.8	To 200 μv	14	2	PAM. PDM.

Table 3. Representative Electromechanical Commutator Manufacturers (cont.)

Manufacturer	Type or Series No.	No. of Poles	No. of Channels/ Pole	Max. Speed Samples/Sec./ Pole	Signal Duty Cycle - %	Usable Signal Range	Contact Res. Range-Ohms	Noise	Volume in.^{3}	Weight lb.	Applications, Notes
Mycalex Electronics	*CP 276	1	36	360	80	To 10v	0.1 - 1	To 25 mv	36	3.2	Radar Chopper Switch. Hermetically Sealed (Note 2).
	*CP 299	1	120	600	35 - 70	To 5v	0.1 - 1	To 10 mv	36	3.5	Hermetically Sealed (Note 2).
	*CP 360	1	180	3600	54 - 67 - 87	To 25v	To 1	To 15 mv	68	4.4	Programing. Hermetically Sealed. (Note 2).
	*CP 378	1	225	4500	54 - 95	To 5v	0.2 - 1	To 1 mv	52	4.2	PDM. Hermetically Sealed. (Note 2).
	*CP 405	1	120	3600	55 - 85	To 6v	0.5 - 1	To 25 mv	14	1.3	Enclosed. (Note 2).
	*CP 423	1	120	1200	55 - 85	To 5v	0.1 - 1	To 1 mv	22	2.8	Down Hole Logging. Hermetically Sealed(Note 2)
	*CP 429	1	100	200	95	To 130v	To 1	To 100 mv	16	1.7	Control. Enclosed. (Note 2).
	*CP 444	1	225	2250	55 - 95	To 24v	To 1	To 25 mv	16	2.1	Programing. Enclosed. (Note 2).
	*CP 461	1	180	225	55	To 5v	0.1 - 1	To 2 mv	8	1.3	Enclosed. (Note 2).
	*CP 468	1	360	7200	55 - 90	To 5v	0.1 - 1	To 10 mv	56	4	Hermetically Sealed. (Note 2).
	*CP 469	1	450	9000	55 - 77 - 95	To 6v	0.1 - 1	To 15 mv	62	4.2	Hermetically Sealed. (Note 2).
Rotary Devices	1500	1	180	3600	50	To 10v	To 0.1	To 10 mv	150	12	Industrial.
	99	1	*28	840	90	To 10v	To 0.1	*	15	1	PDM. PAM. (Note 3).
	892	1	*46	900	50 - 90	To 10v	0.01 - 0.1	To 0.5 mv	50	1-3	PDM (Note 3).
Tele - Dynamics	1512	1	90	10	10 - 90	To 5v	To 0.1	To 20 μv	65	3.5	PAM. PDM. Pressure Sealed.
	1514	1	90	10	10 - 90	To 5mv, 5v	To 0.1	To 20 μv	65	3.5	PAM. PDM. Pressure Sealed.
	1513	1	30	30	10 - 90	To 5v	To 0.1	To 20 μv	15	1.5	PAM. PDM. High Temp. High Vibration.
	973	1	30	30	10 - 90	To 5v	To 0.8	To 20 μv	11	1	PAM. PDM. High Temp.

* Refer to notes in last column.

Note 1. Mercury jet switch. Lower volume and weight figures are for switch alone. Higher figures include motor and mercury. Noise figures are given for "ON" time. "OFF" time noise (10 μv to 10 mv) is function of switch speed and input impedance.

Note 2. All designed to customer specifications.

Note 3. Number of channels includes one sync channel. Noise voltage depends on current and load impedance for Type 99.

Table 4. Representative Electronic Commutator Manufacturers

Manufacturer	Type or Series No.	Max. No. Of Channels	Max. Speed Sample/Sec.	Signal Duty Cycle -%	Usable Signal Range	Load Impedance Ohms	Linearity %	Crosstalk %	Noise	Volume in.^{3}	Weight lb.	Applications, Notes
Adage	MX 7	100	10,000	80	±1v, 100v	* 0	0.01	0.01	100 μv	2	0.1	Drives Error Point in A/D Converter. (Note 1).
	MX 5	30	10,000	80	±1v, 100v	* 0	0.01	0.01	100 μv	2	0.1	Drives Error Point in A/D Converter. (Note 1).
	MX 8	100	100,000	80	±1v, 100v	* 0	0.01	0.01	300 μv	2	0.1	Drives Operational Amplifier. (Note 1).
	MX 6	30	100,000	80	±1v, 100v	* 0	0.01	0.01	300 μv	2	0.1	Drives Operational Amplifier. (Note 1).
Applied Electronics	EC-1	180	900	80	10mv - 5v	100 K	0.1	0.1	5 mv	40	4	Missile Environment. Consumes 2w. (Note 2).
	EC-2	30	900	80	10mv - 5v	100 K	0.1	0.1	5 mv	9	0.5	Satellite and Missile. Consumes 0.5w. (Note 2).
	ECD-1	30	20,000	90	500μv - 5v	100 K	0.05	0.05	500 μv	12	1	Satellite PCM. Consumes 1w. (Note 2).
	ECD-2	90	20,000	90	500μv - 5v	100 K	0.05	0.05	500 μv	32	4	High Accuracy PCM. Consumes 1.5w. (Note 2).
Arnoux	41	90	10,000	50	To 5v, ±2.5v	100 K	0.1	0.1		0.5/ch		
Astrometrics	Micro-plexer	*100	1,000	60	To 5mv, 100mv	100 K	0.1	0.1	5 μv	2700	40	Includes Ten 10-Channel Plug-In Modules, Magristor Switch
Communications Control	CD-100	*100	100,000		±1v	25 K	0.05	0.05	7 μv	784	22	10 Channels Per Module. Relay-Rack Mounted For High-Speed Data Recorders

(*continued on p 62*)

Table 4. Representative Electronic Commutator Manufacturers (cont.)

Manufacturer	Type or Series No.	Max. No. Of Channels	Max. Speed Sample/Sec.	Signal Duty Cycle-%	Usable Signal Range	Load Impedance Ohms	Linearity %	Crosstalk %	Noise	Volume in.^{3}	Weight lb.	Applications, Notes
Data Control Systems	GPC-5	* 96	10,000	100	To 10mv	2 K	0.1	0.1	5 mv	*	*	Panel Mounted Modules
	APC-2	45	10,000	100	To 5v	100 K	0.05	0.05	5 mv	39	1.25	Airborne. Input Impedance > 5 Meg.
	APC-3	90	10,000	100	To 5v	100 K	0.05	0.05 *	5 mv	69	2.2	Leakage < 2 μ amp.
Dynatronics	VMH	512	50,000	*100	To 5v	100 K	0.2	0.1	3 mv	3.5/ch	0.4/ch	Air and Space-borne. Programed input required. Buffer amp included in each 8-channel module. Duty cycle = 33% for 8-channel module.
	VML	512	50,000	*100	To 50mv	50 K	0.5	0.2	30 μv	3.5/ch	0.4/ch	Air and space-borne. Programed input required. Post amplifiers included. Duty cycle = 33% for 8-channel module.
	VMLH	1024	50,000	100	To 50mv	100 K	0.5	0.2	10 μv	6.5/ch	0.8/ch	Air and space-borne. Channel amplifier required.
Electro-Mechanical Research	99	90	900	100	To 5v	1 Meg.	0.015	0.01	10 mv	200	6.25	PDM. Uses beam-switching tube.
	181	100	10,000	100	-5 to +5v	1 Meg.	0.015	0.01	10 mv	132	4.38	
Epsco-West	TMX-015K	120	20,000	99	1mv - 10v	> 2 K	0.005	0.01	100 μv	0.3/ch	0.14/ch	Single-ended. Low input impedance.
	DMX-355K	208	100,000	99	5mv - 20v	> 3 K	0.005	0.01	50 μv	0.4/ch	0.17/ch	Single-ended. Requires voltage-clamped, current-limited source.
General Devices	CHL	*	50,000	100	±5v	100 K	0.02	0.02	5 μv	0.3/ch	0.0125/ch	0.1% accurate PAM, PCM, PDM. High level. No limit on no. of channels.
	CLL	*	25,000	60	±10mv	100 K	0.05	0.1	5 μv	0.3/ch	0.0125/ch	0.1% accurate PAM, PCM, PDM. Low level. 100 db common-mode rejection. No limitation on no. of channels.
	1300	90	2,000	100	To 5v	100 K	0.2	0.1	5 μv	0.2/ch	0.0095 0.0095/ch	High level. High density package. Standard package also available.
	LS-5	5	10,000	100	To 10mv	100 K	0.05	0.1	5 μv	0.2/ch	0.031/ch	Submin. 5-channel module.
Lear	SR10121	20	100,000	50	±10mv - 2v	10 K	1	0.01	*	11	0.7	Noise is at least 40 db below signal level.
Radiation	2-104	6	24,000	100	± 10v	< 1 K	0.02	0.01	10 mv	2000		
	2-100	48	24,000	100	± 10v	< 1 K	0.02	0.01	10 mv	2000		
	2-300	48	24,000	100	±5, 15, 25, 50mv	< 1 K	0.1	0.05	*10 μv	2000		Noise depends on input range.
San Diego Scientific	MPL	*	50,000	100	*To 50 μamp	LOW	0.1	0.05	0.1% signal			Magamp. Delivers 5v full-scale output. No limit on no. of channels.
	MPH	*	50,000	100	To 10mv	15 K	0.2	0.05	0.1% signal			Magamp. Delivers 2.5v full-scale output. No limit on no. of channels.
Servomechanisms	KME600	30	2,000	95	±5mv, 5v	50 K	0.1	0.5, 0.1	10 mv	70	2	Airborne includes low and high level signals.
Sierra Research	M201	7	1,000		± 1.5v	100 K	0.1	0.001	5 mv	9	0.4	Rack Mounted.
	DMT101	62	20		To 5v	1 Meg.	0.1	0.001	10 mv	2480	20	Two-way data link includes command and telemetry.
	DL101	14	250		±2v	100 K	0.1	0.001	5 mv	125	3.5	
Tele-Dynamics	4000C	* 45	900		To 5v		0.1			65	3.25	PDM. Extreme environments. No. of input channels includes two frame sync channels.
	4100	64	50,000		-5 to + 5v		0.1	0.1		83	4.25	

* Refer to last column. Dash (-) indicates information not available.
Note 1. Size and weight figures are given per channel.
Note 2. Temperature range is -20 to +85 C.

Representative Manufacturers of Commutators

(*continued from p 59*)

Computer Instruments Corp.
92 Madison Ave.
Hempstead, N. Y.

Data-Control Systems, Inc.
E. Liberty St.
Danbury, Conn.

Dynatronics, Inc.
Box 2566
Highway 17-92 North,
Orlando, Fla.

Electro-Mechanical Research, Inc.
P. O. Box 3041
Sarasota, Fla.

Epsco-West
Div. Epsco, Inc.
240 E. Palais Rd.
Anaheim, Calif.

Fifth Dimension
P. O. Box 483
Princeton, N. J.

General Devices, Inc.
P. O. Box 253
Princeton, N. J.

Instrument Development Labs., Inc.
67 Mechanic St.
Attleboro, Mass.

Kin Tel
Div. Cohu Electronics
5725 Kearny Villa Road
Box 623
San Diego, Calif.

Lear, Inc.
3171 S. Bundy Drive
Santa Monica, Calif.

Lind Instruments, Inc.
2294 Mara Drive
Mountain View, Calif.

Moore Associates, Inc.
893 American St.
San Carlos, Calif.

Mycalex Electronics Corp.
125 Clifton Blvd.
Clifton, N. J.

Radiation, Inc.
Melbourne, Fla.

Rotary Devices Corp.
20 Jay St.
Englewood, N. J.

San Diego Scientific Corp.
3434 Midway Drive
San Diego, Calif.

Scintilla Div.
Bendix Corp.
Sidney, N. Y.

Servomechanisms, Inc.
200 N. Aviation Blvd.
El Segundo, Calif.

Sierra Research Corp.
P. O. Box 22
Buffalo 25, N. Y.

Technology Instrument Corp. of Acton
533 Main St.
Acton, Mass.

Tele-Dynamics Division
American Bosch Arma Corp.
5000 Parkside Ave.
Philadelphia, Pa.

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CIRCLE 57 ON READER-SERVICE CARD

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DALLAS, TEX.
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4308 Maple
LAkeside 6-8763

DENVER, COLO.
Kimball Distributing Company
1824 California Street
AComa 2-6208

INGLEWOOD, CALIF.
Liberty Electronics Corp.
339 South Isis
ORegon 8-7163

MINEOLA, LONG ISLAND, N.Y.
Schweber Electronics
60 Herricks Road
Pioneer 6-6520

NEW YORK, N.Y.
Time Electronic Sales
373 Broadway
BArclay 7-3922

NORTH HOLLYWOOD, CALIF.
Richey Electronics
10816 Burbank Blvd.
TRiangle 7-2651

PHILADELPHIA, PA.
Aercon, Inc.
2137 Ludlow Street
LOcust 8-5105

SOUTH BEND, IND.
Radio Distributing Company
1212 High Street
ATlantic 8-4664

CANNON ELECTRIC COMPANY, 3208 Humboldt Street, Los Angeles 31, California

CIRCLE 58 ON READER-SERVICE CARD

Coaxial Switch Operates Under Full Waveguide Power

THE TRANSPROBE waveguide switch, utilizing coaxial coupling, will operate under full waveguide power. Successful tests have been conducted on switches using small X-band waveguide (RG-52/U) at 250 kw peak and 160 w average power. RF switching time is less than 10 msec.

First Known Application To Waveguide Switching

While the coupling of waveguides coaxially is a principle used extensively in waveguide transitions and rotary joints, it is believed this is the first application to waveguide switching. RF energy is switched between waveguides by the movement of a lightweight, dielectrically supported metal probe actuated by a plunger-type solenoid. The design can be applied to any waveguide size.

Compact Configurations Are Possible

An outstanding feature of the device, manufactured by Transco Products, Inc., 12210 Nebraska Ave., Los Angeles 25, Calif., is the ability to position the waveguide switches at any angle in 360 deg around the probe. This allows packaging of multipole switches in compact, lightweight configurations not previously feasible with conventional switches. A spdt Transprobe switch for use at X-band will effect a weight reduction of 10 to 1 over standard types. Switches presently available are spdt, sp3t, double-pole transfer and cross-pole transfer types.

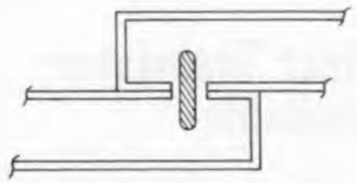
Life is Limited Only By The Solenoid

Mr. George Underberger, Transco Project Engineer, points out several important advantages, including greater flexibility, longer life, ability to switch under full power and fast switching time.

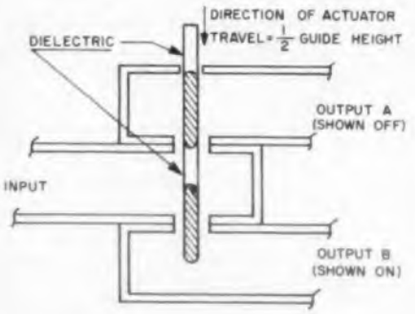
Because the solenoid plunger and the probe carrier are the only moving parts, operating life is limited only by the solenoid which is similar in design to solenoids qualified for 2,000,000 operations.

Insertion Loss Is 0.20 Db Max

Typical performance specifications for the spdt X-band switch are: frequency, 8.2 to 12.4 Gc; vswr, 1.20 max; insertion loss, 0.20 db max; crosstalk, 50 db min; weight, 6 oz; actuator power, 20 w. Ap-



Probe coupled waveguide principle



Probe coupled waveguide principle applied for spdt switch action

plications for the Transprobe are said to be unlimited. A unit is being used for airborne electronic countermeasures antenna switching, packaging flexibility and long life were primary factors for this requirement. Due to its ability to switch under high power, high cross-talk and fast switching time, the Transprobe can be used in applications that previously required ferrite devices.

X-band switches are currently in production and the development of K-band switches is nearing completion. All switches meet the environmental requirements of MIL-T-5422E, Class 1. They are available with 90-day delivery at $275 each in production quantities.

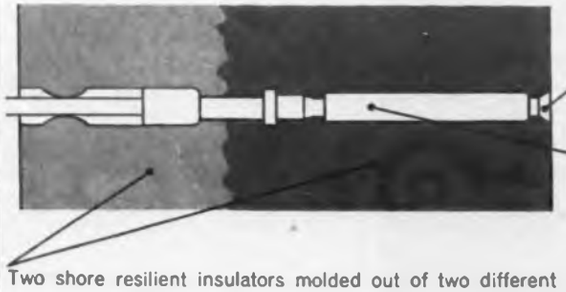
For further information on these long-life, fast-switching, high-power waveguide switches turn to the Reader-Service Card and circle 251.

NEW

CANNON KPT/KSP MINIATURE DESIGNED TO MIL-C-26482

Quick disconnect plugs for aircraft, missiles, and all applications requiring miniature plugs. Our standard solder-pot versions, including hermetic seals, are completely interchangeable with all bayonet-lock plugs designed to MIL-C-26482!

ALSO KPT/KSP PLUGS WITH CRIMP SNAP-IN CONTACTS AND TWO SHORE INSULATOR.



Two shore resilient insulators molded out of two different hardness materials (polychloroprene) into a homogenous piece. The rear portion of the insulator is the softer in order that the conductors can be sealed properly, and the front portion is the harder to retain the snap-in contacts. The two shore insulator insures a continuous moisture and pressure seal from front to back to provide superior electrical performance at high altitudes. This method of sealing and contact retention offers the industry a most reliable crimp series meeting the requirements of MIL-C-26482. Write for catalog KPT/KSP-1 to:

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Drastically reduced in size, the CA17 carrier amplifier provides for total utilization of low-level signals . . . proves itself more reliable in adverse environments than larger and heavier amplifiers . . . assures the precision required in aircraft and space vehicles. The CA17 may be used with any resistance strain gage transducer. *Excitation:* 28V d.c. ± 5% @ 30ma, including built-in transducer power supply. *Output:* 0-5 Volts d.c.

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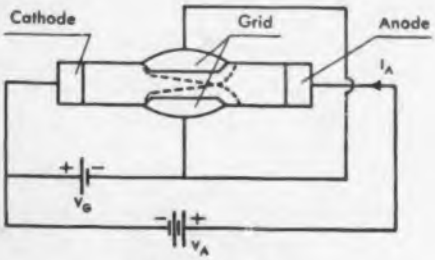
Los Angeles 64, Calif.
GRanite 8-0361/TWX:
West Los Angeles CAL 6602

CIRCLE 60 ON READER-SERVICE CARD



Construction

Symbol

First Field-Effect Transistor Now Available

A SEMICONDUCTOR amplifying device with up to 100-meg input impedance is now available from an American manufacturer.* Crystalonics, Inc., 249 Fifth St. Cambridge 42, Mass., is selling field-effect transistors for $35 to $72 each.

However the price should eventually come down below that for conventional transistors, since the new devices are simpler to make, the firm said.

As a circuit element, the field-effect transistor is similar to a vacuum tube (the manufacturer has adopted "anode," "cathode" and "grid" terminology for the electrodes). The main conduction path (see sketch) is through a bar of n-type silicon with ohmic "anode" and "cathode" contacts at either end. Control is through depletion layers projected by p-n junctions formed on the sides of the main n-type bar. The high input impedance comes from the reverse bias applied to the p-n control "grid" junctions.

The depth of the depletion layers is in turn controlled by the amount of reverse bias on the junctions. In effect, the depletion layers "choke" off the current flow through the main bar, the maximum effect being achieved when they meet in the center.

Crystalonics has listed six amplifier types (designations C610-C615) and four switching types (designations C650-C653). All are supplied in TO-5 packages. Maximum anode currents are 50 ma and maximum power dissipations are 250 mw. The transconductances vary from 100 to 1,200 at normal temperatures. But, unlike transistors, the transconductance increases at lower temperatures. At the temperature of liquid nitrogen a device which has a g_m of 500 at room temperature was reported to have a g_m of 5,000.

The interelectrode capacitances are high, 35 to 50 pf, and do present design problems at frequencies as low as 1 kc. However, the transconductance itself remains constant up to 250 mc so the device can be used in tuned amplifiers up to the kmc region.

Main Amplifier Use Will Be For Input Stages

The field-effect transistor appears most promising for input stages of all solid-state amplifiers. A typical input stage, Fig. 2, would be very close to those used for vacuum tubes. For very low noise amplification Crystalonics recommends using a 3-v supply to keep within the "triode" portion of the characteristics. The 2.5-K output impedance of this circuit would be ideal for a low-noise transistor-following stage. The load resistor would be over 10 K.

Crystalonics says that the minimum signal that can be switched by the new device is limited only by its inherent noise level, which is in the order of 1 μv. With zero "grid" bias, the "on" resistance of the field-effect transistor is 2 K. The "off" resistance is 100 meg. A circuit for bilaterally switching information in and out of a capacitance memory is shown in Fig. 4.

For further information, turn to Reader-Service Card and circle 252.

*French firms have announced field-effect devices.

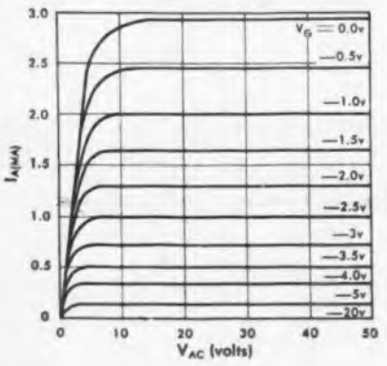


Fig. 1. Input voltage, not current, controls the field-effect transistor's output.

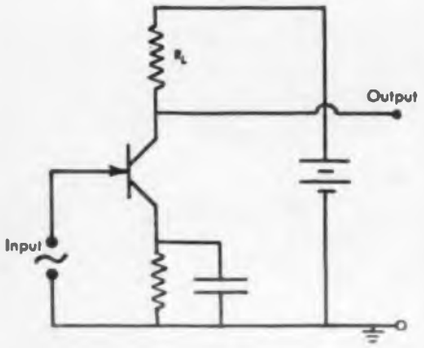


Fig. 2. A field-effect transistor would be used like a vacuum tube in a circuit. Here, for example, the bias is by a cathode resistor and the load resistance is considerably higher than that normally used with transistors.

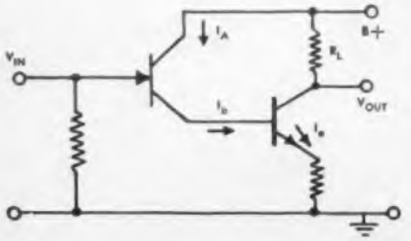


Fig. 3. The field-effect transistor may produce entirely new circuits. Here, the opposite temperature coefficients for conventional transistors and field-effect devices are played against each other to achieve temperature stability.

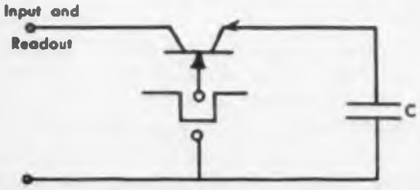


Fig. 4. Low-level choppers and bilateral computer switches based on field-effect transistors may take this form. The switch would be on until a negative pulse turned it off.

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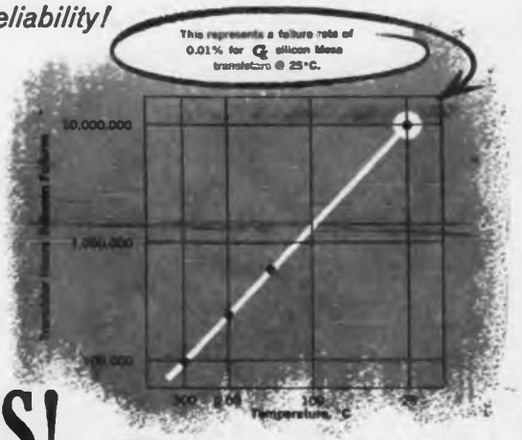

PROOF! Extended life tests at each of temperatures shown above, demonstrate GI superior mesa performance with 0.01%/per 1000-hrs. failure rate at 25°C.

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Available in accordance with MIL-S-19500/99A (GI 2N696, 2N697) and MIL-S-19500/120 (GI 2N706). Contact General Instrument today for more information on these realistically-priced units, and the name of your local authorized stocking distributor.

GENERAL INSTRUMENT NPN SILICON MESA TRANSISTORS

Type	Case	RATINGS BV_{CBO}	RATINGS BV_{EBO}	RATINGS Maximum Dissipation (T_{CASE} = 25°C)	CHARACTERISTICS I_{CBO}	CHARACTERISTICS h_{FE} V_{CE} = 10 v I_C = 150 ma pulsed	CHARACTERISTICS h_{fe} V_{CE} = 10 v I_C = 50 ma f = 20 Mc	CHARACTERISTICS V_{CE} (SAT.) I_B = 15 ma I_C = 150 ma	CHARACTERISTICS V_{CE} (SAT.) I_B = 15 ma I_C = 150 ma	CHARACTERISTICS C_{OB} @ I_E = 0 V_{CB} = 10 v
2N696	TO-5	60 v	5 v	2 watts	@ V_{CB} = 30 v T = 25°C Ambient: 1 μa max T = 150°C Ambient: 100 μa max	20 min 60 max	2 min	1.3 v max	1.5 v max	35 pf max
2N697	TO-5	60 v	5 v	2 watts	@ V_{CB} = 30 v T = 25°C Ambient: 1 μa max T = 150°C Ambient: 100 μa max	40 min 120 max	2.5 min	1.3 v max	1.5 v max	35 pf max
2N699	TO-5	120 v	5 v	2 watts	@ V_{CB} = 60 v T = 25°C Ambient: 2 μa max T = 150°C Ambient: 200 μa max	40 min 120 max	2.5 min	1.3 v max	5.0 v max	20 pf max
2N706	TO-18	25 v	3 v	1 watt	@ V_{CB} = 15 v T = 25°C Ambient: 0.5 μa max T = 150°C Ambient: 30 μa max	V_{CE} = 1 v I_C = 10 ma 15 min	V_{CE} = 15 v I_C = 10 ma f = 100 Mc 2 min	I_B = 1 ma I_C = 10 ma 0.9 v max	I_B = 1 ma I_C = 10 ma 0.6 v max	6 pf max
2N1252	TO-5	30 v	5 v	2 watts	@ V_{CB} = 20 v T = 25°C Ambient: 10 μa max T = 150°C Ambient: 600 μa max	15 min 45 max	2 min	1.3 v max	1.5 v max	45 pf max
2N1253	TO-5	30 v	5 v	2 watts	@ V_{CB} = 20 v T = 25°C Ambient: 10 μa max T = 150°C Ambient: 600 μa max	30 min 90 max	2.5 min	1.3 v max	1.5 v max	45 pf max
2N1420	TO-5	60 v	5 v	2 watts	@ V_{CB} = 30 v T = 25°C Ambient: 1.0 μa max T = 150°C Ambient: 100 μa max	100 min 300 max	2.5 min	1.3 v max	1.5 v max	36 pf max

GENERAL INSTRUMENT
GENERAL TRANSISTOR
GI SEMICONDUCTOR
DIVISION OF GENERAL INSTRUMENT CORPORATION
55 Gouverneur Street, Newark 4, New Jersey

IN CANADA: General Instrument—F. W. Sickles of Canada Ltd., P.O. Box 400, 151 S. Weber Street, Waterloo, Ontario, Canada. Sherwood 4-8101.

CIRCLE 61 ON READER-SERVICE CARD

NEW PRODUCTS

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

Tantalum Capacitors **256**
In Lengths From 0.15 to 0.24 In

"Shorter than the eye of a needle," type TS solid-slug tantalum capacitors come in lengths over insulation ranging from 0.150 to 0.313 in. and diameters from 0.065 to 0.103 in. Service life temperature range is −55 to +85 C, shelf life temperature range is −80 to +125 C. Capacitances and working voltages range from 0.01 μf and 15 v to 20 μf and 4 v. Materials used in construction are inert tantalum, stable oxide and a solid electrolyte that cannot evaporate with time.

Tansistor Electronics, Inc., Dept. ED, West Road, Bennington, Vt.
P&A: From $0.46 to $0.65 ea in lots of 1,000; immediate.

Zone-Refining Apparatus **253**
Uses Electron-Beam Bombardment

With electron-beam floating-zone apparatus model EBZ-93, it is possible to achieve temperature as high as 6,000 F. The unit can be used to purify and grow single crystals of refractory metals, refractory metal compounds and ceramics and for vapor deposition of these metals. It consists of a scanner with automatic drive, fully integrated high-vacuum system and 5-kv power supply. The high-purity specimens produced by the apparatus are smooth, concentric single crystals devoid of bends and bumps.

MRC Manufacturing Corp., Dept. ED, 47 Buena Vista Ave., Yonkers, N.Y.
P&A: $18,500 per unit; 3 to 4 weeks.

Static Inverter Power Supply **255**
For Continuous Power Use

Designed for computer, utility and military applications where continuous emergency standby power is needed, this static inverter converts dc power from a 129-v battery source to 115 v, single phase, 60 cps ac. Output is regulated to ±5%. Efficiency is as high as 80% over a range of from +10% to −18% v dc. During normal operation ac input power is converted by a battery charger to dc which supplies the inverter. A battery is floated on the input to the inverter. When ac power fails, the battery supplies the inverter with no interruption.

General Electric Co., Dept. ED, Schenectady 5, N.Y.
P&A: Approximately $5,000; 14 weeks.

Germanium Switching Transistor 254
Average Switching Time Is 135 Nsec

The PADT-40 ultra-high-speed switching transistor has a gold-doped collector region for lower stored charge. A germanium pnp transistor designed for high- and medium-speed saturated-logic applications, the PADT-40 has an average total switching time of 135 nsec, and a minimum time of 80 nsec. High current gain, $h_{FE} = 30$, voltage ratings, $BV_{cbo} = 30$ v, and thermal dissipation make it possible to rate the units conservatively.

Amperex Electronic Corp., Semiconductor and Special Tube Div., Dept. ED, 230 Duffy Ave., Hicksville, L.I., N.Y.
***P&A:** About $2.50; immediate.*

Epoxy Silver Solder 257
Can Be Used At Room Temperature

A silver conductive epoxy, with a resistivity between 0.01 and 0.0001 ohm per cm, this solder is available in two paste forms. The one-component heat curing paste (as low as 125 C) has a curing time of 4 min at 225 C. The two-component room-temperature cure paste has a curing time of 24 hr. It can be used to make a conductive bond with practically any material. Shear strength of a steel-to-steel bond is 3,200 psi.

Joseph Waldman and Sons, Epoxy Products, Inc., Div., Dept. ED, 137 Coit St., Irvington, N.J.
***P&A:** $10 for a 3-oz sample kit; immediate.*

SM GROUP

Optional 0.1% or 0.01% regulation:

3½" PANEL HEIGHT

0.1% REGULATION MODELS	DC OUTPUT RANGE VOLTS	AMPS	0.01% REGULATION MODELS
SM 14-7M	0-14	0-7	SM 14-7MX
SM 36-5M	0-36	0-5	SM 36-15MX
SM 75-2M	0-75	0-2	SM 75-2MX
SM 160-1M	0-160	0-1	SM 160-1MX
SM 325-0.5M	0-325	0-0.5	SM 325-0.5MX

5¼" PANEL HEIGHT

SM 14-15M	0-14	0-15	SM 14-15MX
SM 36-10M	0-36	0-10	SM 36-10MX
SM 75-5M	0-75	0-5	SM 75-5MX
SM 160-2M	0-160	0-2	SM 160-2MX
SM 325-1M	0-325	0-1	SM 325-1MX

8¾" PANEL HEIGHT

SM 14-30M	0-14	0-30	SM 14-30MX
SM 36-15M	0-36	0-15	SM 36-5MX
SM 75-8M	0-75	0-8	SM 75-8MX
SM 160-4M	0-160	0-4	SM 160-4MX
SM 325-2M	0-325	0-2	SM 325-2MX

HB GROUP

Optional 0.1% or 0.01% regulation:

3½" PANEL HEIGHT

0.1% REGULATION MODELS	DC OUTPUT RANGE VOLTS	MA	0.01% REGULATION MODELS
HB 2M	0-325	0-200	HB 20M
HB 4M	0-325	0-400	HB 40M
HB 6M	0-325	0-600	HB 60M
HB 8M	0-325	0-800	HB 80M

PR GROUP

7" PANEL HEIGHT

MODEL	DC OUTPUT RANGE VOLTS	AMPS
PR 15-30M	0-15	0-30
PR 38-15M	0-38	0-15
PR 80-8M	0-80	0-8
PR 155-4M	0-155	0-4
PR 310-2M	0-310	0-2

SM GROUP

Precise, reliable performance in a wide choice of output ranges.

Three rack sizes: 8¾" H, 5¼" H, and 3½" H. Impervious to operational damage: circuit protection is an inherent function of input transformer and regulator characteristics.

HB GROUP

Exceptional performance: delivers 0-325 v dc at 200, 400, 600 or 800 ma from one standard 3½" H rack-mounting package.

Incorporates many "special" features as standard: **constant current mode, remote programming, remote dc on-off control.**

PR GROUP

A flexible new general-purpose line of semi-conductor power supplies. Adjustable wide-range outputs.

± 1% line regulation; semi-regulated for load. Many standard modifications available.

kepco

makes power supply news for '61

FOR DETAILED SPECIFICATIONS ON MORE THAN 150 STANDARD MODEL POWER SUPPLIES, SEND FOR KEPCO CATALOG B-611

kepco inc.

131-36 SANFORD AVENUE

FLUSHING 52, N. Y.

IN 1-7000 • TWX #NY4-5196

CIRCLE 62 ON READER-SERVICE CARD

NEW PRODUCTS

Silicon Transistors 404

Power gains to 1,000

Silicon npn transistors are available with power gains up to 1,000 featuring low saturation resistance and low thermal impedance. Series WX118X and WX118U have collector-emitter voltages of 50, 100, and 150 v. The WX118X series has a minimum current gain of 400 at 10 amp; the WX118U series has a minimum gain of 100 at 10 amp. The devices are capable of dissipating 150 w at a case temperature of 75 C; maximum permitted junction temperature is 150 C, and thermal impedance is 0.5 deg per w.

Westinghouse Electric Corp., Semiconductor Dept., Dept. ED, Youngwood, Pa.

Price: *WX118U, $87 to $140; WX118X, $148 to $238.*

Availability: *From stock in prototype quantities.*

Dual Mode Discriminator 454

For use as a sensing element

This dual mode discriminator is designed for use as a sensing element in klystron stabilization systems. Signal frequency accuracies of 0.01% can be achieved. The effect of stabilization in the range of 8,500 to 9,600 mc reduces an inherent klystron signal variation of 0.6 to 1.2 mc to variations of 15 to 30 kc.

Frequency Standards, Dept. ED, P.O. Box 504, Asbury Park, N.J.

Price: *$1,200 to $1,400.*

Availability: *30 days.*

NEW FROM WESTINGHOUSE AT YOUNGWOOD

New Westinghouse High Gain Transistor simplifies circuitry, increases reliability, eliminates driver stage components, reduces cost of assembly.

NEW WESTINGHOUSE SILICON POWER TRANSISTOR PROVIDES

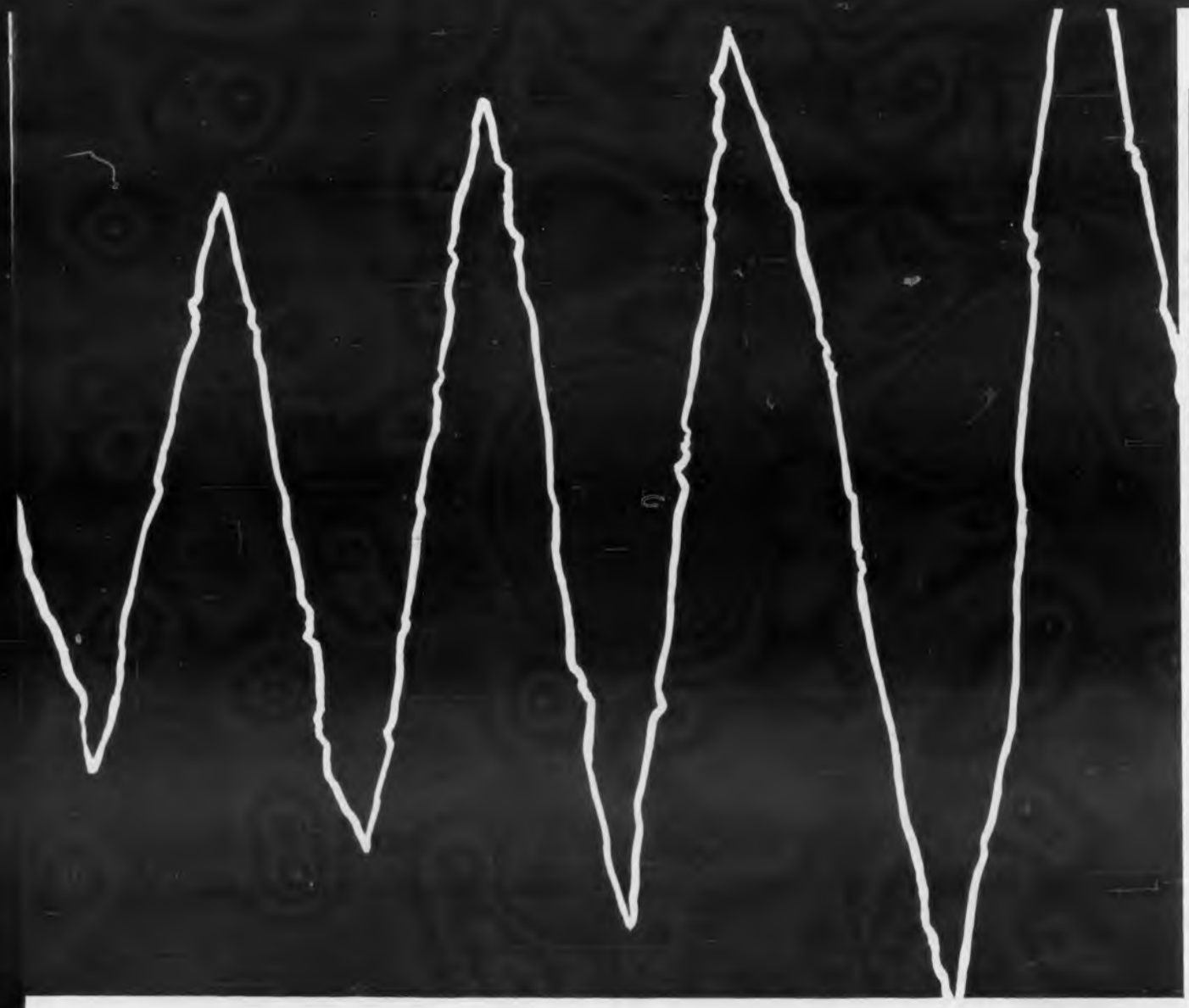
GAIN OF

Westinghouse introduces a complete new family of High Gain Silicon Power Transistors providing a gain of 1000 or more at 2 amps . . . with guaranteed minimum gain of 400 at 10 amps (WX118X series) . . . a guaranteed minimum gain of 100 at 10 amps (WX118U series). These devices can substantially reduce circuit components, increase reliability, save space and weight.

They're ideal for application in high power, high efficiency regulators, amplifiers and switching circuits. For example, 1500 watts of power can be easily controlled with a 50 milliwatt signal! For full information call your nearest Westinghouse representative or write to Semiconductor Dept., Youngwood, Penna. You can be sure . . . if it's Westinghouse. SC-1025

OTHER FEATURES INCLUDE

- **True Voltage Ratings to 150 volts**
- **Power dissipation of 150 watts**
- **Operating temperature to +150°C.**
- **Low thermal impedance: .5°C/watt**
- **Collector current—10 amperes**



1000 AT 2 amps!

Prototype quantities now available. Order from these Westinghouse Distributors.

EASTERN
ACK SEMICONDUCTORS, INC. Birmingham 5, Ala./FA 2-0588
CAMERADIO Pittsburgh, Pa./EX 1-4000
CRAMER ELECTRONICS, INC. Boston, Mass./CO 7-4700
ELECTRONIC WHOLESALERS, INC. Melbourne, Florida/PA 3-1441
GENERAL RADIO SUPPLY CO., INC. Camden, N.J./WO 4-8560
GENESEE RADIO PARTS CO. Buffalo, N.Y./DE 9661
KANN-ELLERT ELECTRONICS, INC. Baltimore, Md./TU 9-4242
MILGRAY ELECTRONICS New York, N.Y./RE 2-4400
RADIO & ELECTRONICS PARTS CORP. Cleveland, Ohio/UT 1-6060
SCHWEBER ELECTRONICS Long Island, N.Y./PI 6-6520

MIDWESTERN
ELECTRONIC COMPONENTS FOR INDUSTRY CO. St. Louis, Mo./WO 2-9917
INTER-STATE RADIO & SUPPLY CO. Denver 4, Colo./TA 5-8257
LENERT CO. Houston, Texas/CA 4-2663
RADIO DISTRIBUTING CO. Indianapolis, Ind./ME 7-5571
SEMICONDUCTOR SPECIALISTS, INC. Chicago, Ill./NA 2-8860
S. STERLING CO. Detroit, Mich./BR 3-2900
UNITED RADIO, INC. Cincinnati, Ohio/MA 1-6530
HALLMARK INSTRUMENTS CORP. Dallas, Texas/RI 7-9385

WESTERN
ELMAR ELECTRONICS Oakland, Calif./TE 4-3311
HAMILTON ELECTRO SALES Los Angeles, Calif./BR 2-9154
NEWARK ELECTRONICS CO. Inglewood, Calif./OR 4-8440

Westinghouse

Reduced Voltage Starter 382

In size 6

A size 6, autotransformer-type reduced voltage starter is offered to meet JIC standards and NEMA requirements. The unit features an operating handle that is permanently attached to the circuit breaker to provide positive indication and control of the circuit breaker with the door open or shut. A type GP 600-amp ac contactor is used.

Westinghouse Electric Corp., Dept. ED, P. O. Box 2099, Pittsburgh 30, Pa.

Traveling-Wave Tube 459

For the 7- to 11-Gc Range

Model Z-3103 traveling-wave tube is a low-noise device for use in the 7- to 11-Gc range. Specifications are: noise figure, less than 10 db; gain, 25 db min; power output, 5 mw across the entire band. It is supplied as a complete package, including permanent focusing magnets, connectors and housing.

General Electric Co., Power Tube Dept., Dept. ED, Schenectady 5, N.Y.

Price: *$2,850.*

Availability: *30 days.*

CIRCLE 63 ON READER-SERVICE CARD

in Southern California

BENDIX-PACIFIC

offers these excellent opportunities

FOR ENGINEERS

"EAGLE" MISSILE PROGRAM
Senior Engineers are required with BSEE or MSEE with design experience in solid state circuitry on the Navy's newest air-to-air missile. Areas of interest include receiver, digital, microwave and servo systems; IF amplifiers, VCOs, discriminators, radar, missile control design, DC power supplies and digital-to-analog circuitry.

SYSTEMS RESEARCH
Engineers with BSEE or MSEE with background in circuit analysis or mathematical analysis.

AIRBORNE RADAR
Senior Engineers with BSEE or MSEE and experience in all phases of microwave and radar transistor circuit design.

MILITARY NAVIGATION
Senior Engineers with BSEE and experience in low frequency electronic circuit design, aircraft instrumentation, MIL specs or transistor techniques.

INSTRUMENTATION
Senior Engineers with BSEE and extensive experience in analog and/or digital telemetry systems and components.

HYDRAULICS
Senior Engineers with ME or BSEE and experience in hydraulic and pneumatic components or systems, and/or electronic experience as it applies to hydraulics.

UNDERWATER ORDNANCE
Senior Engineers with BSEE, MSEE and experience in the design of solid state circuitry, electro-acoustic transducers for ASW applications.

RELIABILITY
Senior Engineers with BSEE and component and application engineering experience.

Please send resume to
W. C. WALKER, Engineering Employment Manager

Bendix-Pacific Division
11604 Sherman Way
NORTH HOLLYWOOD, CALIF.

The Bendix Corporation

CIRCLE 911 ON CAREER INQUIRY FORM, PAGE 135

With Eastman 910 Adhesive...

Strong nylon-to-nylon bonds in 10 seconds

Skeptical? We don't blame you. But the fact is that the A.W. Haydon Co. of Waterbury, Conn., is doing just that. Using a simple jig and a few drops of Eastman 910 Adhesive, Haydon bonds a molded nylon timing gear to a nylon cam. No heat, solvent or excessive pressure is used. Ten seconds later, the unit is ready to be assembled into an automatic telephone switchboard timer.

Eastman 910 Adhesive will form bonds with almost any kind of plastic material (and most other materials).

Still skeptical? Then send $5 for a trial kit and try it on *your* toughest job. Kits and further information are available from Armstrong Cork Company, Industrial Adhesives Division, Lancaster, Pa., or Eastman Chemical Products, Inc., Kingsport, Tennessee.

Here are the types of plastic-to-plastic bonds that can be made with Eastman 910 Adhesive

Among the stronger: *vinyls, polystyrene, phenolics, cellulosics, polyesters, polyurethanes* and *nylon.*

Among the weaker: *polyethylene* and *fluoro-hydrocarbon* plastics (shear strengths up to 95 lbs./in.²).

There is no adhesive like Eastman 910 Adhesive

Sets fast—Makes firm bonds in seconds to minutes.
Versatile—Joins virtually any combination of materials.
High strength—Up to 5,000 lbs./in.² depending on the materials being bonded.
Ready to use—No catalyst or mixing necessary.
Cures at room temperature—No heat required to initiate or accelerate setting.
Contact pressure sufficient.
Low shrinkage—Virtually no shrinkage on setting as neither solvent nor heat is used.
Goes far—One-pound package contains about 14,000 one-drop applications.
The use of Eastman 910 Adhesive is not suggested at temperatures above 175°F., or in the presence of extreme moisture for prolonged periods.

See Sweet's 1961 Product Design File 10d/Ea.

CIRCLE 64 ON READER-SERVICE CARD

NEW PRODUCTS

Differential Gaussmeter 468

For field and absolute values

Transistorized model 2000 differential gaussmeter uses dual Hall-effect probe elements to measure magnetic field gradients and absolute field values. There are 17 ranges, from 0 to 0.1 gauss full scale to 0 to 20,000 gausses. Output for oscilloscope or recorder is provided. Magnetic fields from dc to 400 cps can be measured. Power is ac or battery pack.

Radio Frequency Laboratories, Inc., Dept. ED, Powerville Road, Boonton, N.J.

Frequency Standard 467

Is fully transistorized

A transistorized, portable frequency and time standard, type CAQ uses a 100-kc crystal oscillator with stability of 2 to 5 parts per 100 million per day. Built-in power supply consists of a nickel-cadmium battery and charger. There are 4 sinusoidal output frequencies and positive pulse outputs from 100 cps to 100 kc with 3-μsec pulse duration.

Rohde & Schwarz Sales Co., Dept. ED, 111 Lexington Ave., Passaic, N.J.
Price: $2,700.

Temperature Sensors 455

Range to 4,000 F

This line of thermocouple-type temperature sensors has models usable in oxidizing atmos-

pheres to 4,000 F, and intermittently higher. There are cooled and noncooled types for measuring the temperature of liquids, solids, and gases. The devices are available in a variety of diameters, lengths and connectors.

Aero Research Instrument Co., 315 N. Aberdeen St., Chicago 7, Ill.
Price: $100 to $600.

Rotary Switch 366

Rating is 20 amp 600 v ac

Type C-16 rotary switch is a 20-amp 600 v ac unit of modular design. It can be employed for motor control up to 16 hp at 600 v as well as for instrumentation and control circuits. Two isolated double-break silver-alloy contacts are contained in each stage. Up to 4 columns of 12 stages, arranged in tandem, can be used to control up to 96 double-break contacts from a single control point.

American Solenoid Co., Inc., Dept. ED, U.S. Highway 32, Union, N.J.
Availability: 1 to 2 weeks.

Gas-Actuated Servo 379

Has fast response

The fast forward response and positive reverse stiffness of hydraulic control systems is claimed for this gas-actuated servo control. The three basic parts are gas actuator for hot or cold gases, a servo valve, and a feedback system with a simple mixing network. The system is said to have high positioning accuracy, is lighter and more reliable than hydraulic systems.

Weston Hydraulics, Ltd., Dept. ED, 7500 Tyrone Ave., Van Nuys, Calif.

PUTTING MAGNETICS TO WORK

Sign up for the Magnetics self-improvement course:

Here's free help to enable you to improve yourself—and your position as a magnetic circuit designer. You need it if:

You don't know how to work with $E = n\frac{d\phi}{dt}$ to reduce the size of magnetic amplifier circuits. Most men who design amplifiers for cramped operation in missiles have found it invaluable.

What's more, you may only vaguely remember $H = .4\pi\frac{NI}{\ell_m}$, so how can you use it to cut circuit size by two to ten times, and shorten response time proportionately?

It's quite possible that you, like many engineers, may have bypassed or been bypassed by magnetic circuit theory *as a working tool* while you were in school. Yet this science has opened frontiers of static control which makes an understanding imperative if you are to do your job—and further your career. For your sake (and for ours, too, because we manufacture and sell high permeability tape wound cores and bobbin cores which are used in amplifier circuits), we have started this course. Lesson 1, "How to Reduce Magnetic Circuit Size and Response Time," will be on its way to you immediately if you use the coupon below.

MAGNETICS inc.®

MAGNETICS INC., DEPT. ED-86, BUTLER, PA.
Please enroll me in your free self-improvement course, and send me "How To Reduce Magnetic Circuit Size and Response Time."

name_____
title_____
company_____
address_____

CIRCLE 65 ON READER-SERVICE CARD

NEW PRODUCTS

Battery Charger 368

With automatic cut-off

Solid-state battery charger is designed to meet the charging requirements of silver-zinc alkaline cells. Complete cut-off of charging current occurs automatically when the cells' terminal voltage reaches recommended maximum. Charging currents up to 1 amp can be set. Size is 5-1/4 x 3 x 2-1/4 in.

All-American Engineering Co., Dept. ED, P.O. Box 1247, Wilmington 99, Del.

Silicon Diode 473

Replaces 24 EIA types

Type 1N658A, a fast-switching, ultra-low-leakage silicon diode will replace 24 EIA types. Reverse current max is 0.025 μa at −50 v, 25 C. Reverse recovery time is 0.3 μsec max, peak inverse voltage 120 v and power dissipation 200 mw. The diode is hermetically sealed in a subminiature glass package and is tested per Mark X.

Rheem Semiconductor Corp., Dept. ED, 350 Ellis St., Mountain View, Calif.
P&A: $4 ea, 1 to 99; from stock.

Resistance Bridge 469

For temperature measurement

The Triple-bridge is designed for use in temperature measurement with variable-resistance temperature probes. The bridge suppresses lead variations of 0 to 5 ohms so that effect does not exceed 0.1% of full scale. The basic 10-channel unit has 10 plug-in bridge sections permitting convenient change of full scale.

Rosemount Engineering Co., Dept. ED, 4900 W. 78th St., Minneapolis 24, Minn.

Rexolite® and Brand-Rex Technical Service Answer Most Microwave Insulation Problems

Across the microwave spectrum, from anode toppers to timing blocks; from antennas to duplexer pins, to filament cores, to light pipes, phaser assemblies and probe insulators; from slot arrays to slip ring disks and sweep arms, to transformer locks and cores, to timers and tubes . . . Rexolite plastic dielectrics and Brand-Rex technical service have teamed to stamp "solved" on a long list of complex microwave insulation problems.

And, it's an impressive reason why! Rexolite thermosetting materials offer a wide range of UHF electrical properties and advantages . . . low loss factor, low dielectric constant, and exceptional resistance to radiation. Pure research into dielectrics at the Enka Research Center in North Carolina and applied research and development by the Technical Development Group at the Acton, Mass., plant have resulted, and will continue to result, in significant new Rexolite types. Adding to its usefulness, Rexolite is available in rods and both plain and copper clad sheets which can be machined into an infinite number of simple or complex shapes.

BRAND-REX
REXOLITE

A few minutes spent with samples and comprehensive Rexolite technical data will most surely be a profitable investment for you. Brand-Rex technical service engineers will gladly help, too. A note or call from you is all we need.

BRAND REX

WILLIAM BRAND-REX DIVISION
American ENKA Corporation
DEPT. R, 39 SUDBURY ROAD, CONCORD, MASSACHUSETTS

Telephone: EMerson 9-9630

Vinyl, Teflon, Polyethelene, Nylon and Silicone Rubber Wires and Cables
Electrical Tubing and Sleeving — UHF Cast Plastics — Plastic Extrusions

CIRCLE 66 ON READER-SERVICE CARD

BRAND-REX
TURBO
INSULATING
SLEEVINGS

To spot the insulation materials that will solve your problem, just glance through this list of Turbo tubings and sleevings:

Applicable Specifications	Operating Temperature
TURBO† Varnished Cotton and Rayon	
MIL-I-3190A NEMA VSI-1957, Type 1 A.S.T.M. D-372	−10° to +105°C
TURBOGLAS† Varnished Glass	
MIL-I-3190A NEMA VSI-1957, Type 2 A.S.T.M. D-372	−10° to +130°C
TURBOTUF† Vinyl Coated Glass	
MIL-I-21557 MIL-I-3190A NEMA VSI-1957, Type 3	−10° to +130°C
TURBONITE† Isocyanate Coated Glass	
CLASS F MATERIAL	−10° to +155°C
TURBOSIL† Silicone Varnished Glass	
MIL-I-3190A NEMA VSI-1957, Type 4	−10° to +200°C
TURBO 117† Silicone Rubber Coated Glass	
NEMA VS2-1957 TYPE 5*	−73° to +200°C
TURBOTHERM 105† Vinyl	
U/L A.S.T.M. D-922 GRADE C	−17° to +105°C
TURBOLEX 105† Vinyl	
MIL-I-631C GRADE C	−20° to +105°C
TURBOLEX 85† Vinyl	
A.S.T.M. D-922 GRADE A	−32° to +60°C
TURBOLEX 76† Vinyl	
MIL-I-631C GRADE A	−39° to +80°C
TURBOLEX 40† Vinyl	
MIL-I-22076	−55° to +80°C
TURBOZONE 40† Vinyl	
MIL-I-7444B	−67° to +75°C
TURBOTEMP Teflon	
MIL-I-22129A* AMS-3653 B**	−300° to +250°C

**Also meets applicable performance requirements of MIL-I-631C and MIL-I-3190A
*Meets performance requirements of MIL-I-3190A
†Registered trade mark

Turbo Tubings are available in all sizes from #24 to 2½". Write for complete information.

BRAND REX
WILLIAM BRAND-REX DIVISION
American EnKa Corporation
SUDBURY ROAD, CONCORD, MASS.

CIRCLE 67 ON READER-SERVICE CARD

Thyratron Tubes 465

Give failure warning

Life-indicating thyratron and diode tubes change color from normal blue to neon red about 300 hr before failure, allowing time for replacement. Tests are said to indicate that tube life has been doubled by design techniques. Tubes are available in 2.5- and 6.4-amp ratings, pin or lug base.

Reliance Electric and Engineering Co., Dept. ED, 24701 Euclid Ave., Cleveland 17, Ohio

Finishing Process 462

The B finish improves printability and other adhesion requirements of silicone and epoxy laminated plastics. The process produces a dulled surface which holds all types of inks commonly used to print panel boards and other laminated parts.

Taylor Fibre Co., Dept. ED, Norristown, Pa.

Welding Electrodes 458

Miniature welding electrodes for fabrication and packaging of components measure 1/8 in. in diameter by 2 in. long. Tip diameters range from 0.025 to 0.090 in., in 5 configurations. There are four basic electrode materials.

The Sippican Corp., Dept. ED, Box 537, Marion, Mass.

Power Amplifier 364

For use up to 500 mc

A forced-air cooled, external-anode tetrode, type 7609 rf power amplifier is designed for use at frequencies up to 500 mc. It is manufactured to withstand stringent environmental conditions. Maximum plate voltage is 2,000 v up to 150 mc; plate current is 250 ma. The cathode is unipotential type, operating at 26.5 v.

Amperex Electronic Corp., Dept. ED, 230 Duffy Ave., Hicksville, L.I., N.Y.

REC's.....

Precision Temperature Probes.....at off the shelf prices!

Want low cost temperature probes on short notice – without sacrifice in quality? Rosemount Engineering Company now offers high-performance platinum resistance temperature sensors from stock.

MODEL 179A

Sensing element fully supported, mounted in ceramic insulation. Stainless steel guard tube with additional support at the element tip gives maximum protection from flow.

MODEL 179A

MODEL 152T

MODEL 152T

Sensing element supported by a light cage and exposed to working fluid to give extremely fast response in fluids which are not electrical conductors. Element protected by stainless steel guard tube with additional support at the element tip.

Fourteen stem lengths and 6 different fittings of each model available. These immersion probes have wide application in research, development and industrial process controls. Recommended for use in most hydrocarbons, gaseous or liquid air, oxygen, nitrogen, hydrogen or helium. Sensing elements, of precision platinum, are calibrated at liquid helium point and the ice point. General specifications:

- Temperature Range – from –435°F to 500°F
- Stability – Stable within 0.20°F at 32°F
- Pressure – 6,000 psi maximum
- Element Length – from 1⅛" to 2¾", in ⅛" increments
- Time Constant – 152T – 0.2 seconds) Dow Corning No. 200
  179A – 0.5 seconds) 1.5 CTSK Oil
- Resistance at 32°F – 152T – 200 ohms
  179A – 500 ohms

For additional information write for advance bulletin number 5603.

Plus Circuit Modules

Rosemount also offers a series of preassembled circuit components, featuring small size and durability. Built to meet environmental requirements of MIL-E-5272 and MIL-E-8189.

- General purpose amplifier, Model 510A, 40 db voltage gain minimum, 10 cps to 100,000 cps, –55°C to 125°C.
- High impedance input amplifier, Model 511A, 20 db power gain, input impedance greater than 1 x 10^6 ohms, 10 cps to 50,000 cps, –55°C to 125°C.
- Power supply, Model 531A, 117 volts, 400 cps; 20 volt DC regulated, 10 milliamperes, 0.1 percent ripple, –55°C to 125°C.
- Rectifier-filter, Model 532A, diodes and RC filter for two full wave DC supplies. Rated 30 volts DC each at 0.1 percent ripple, –55°C to 125°C.

(Size 1 x 1 x 1 Inch)

For additional information write for advance bulletin 46028.

ROSEMOUNT ENGINEERING COMPANY

4900 West 78th Street, Minneapolis 24, Minn.

CIRCLE 68 ON READER-SERVICE CARD

OUR SEMICONDUCTORS GO... This is the 20,000 G radial acceleration test. It's a part of the rigorous Military Specification test procedure which Saratoga Semiconductors go thru to assure the quality levels required for Military applications.

In Saratoga we get results . . . results which demonstrate why the Saratoga Semiconductor is called "The Thoroughbred of Semiconductors."

Send for our new catalog SS-2001 outlining details, specifications, and applications of Saratoga silicon zener regulators* and silicon power rectifiers.*

SARATOGA SEMICONDUCTOR DIVISION, Saratoga Springs, N.Y.

ESPEY MFG. & ELECTRONICS CORP.

* Meet all requirements of MIL S-19500B

CIRCLE 69 ON READER-SERVICE CARD

NEW PRODUCTS

Power Supplies 351

Current regulated

High-stability current-regulated power supplies have current output which maintains regulation of better than 0.02%. The power supplies utilize two separate control circuits which function independently, are self-adjusting and compensate for slow and fast variations resulting from dynamic input or output changes.

Automation Industries, Inc., Dept. ED, 1090 Mills Way, Redwood City, Calif.

S-Band Isolators 460

Insertion loss is less than 1 db

Series X-173 ultraminiature, S-band isolators are designed for missile and satellite use. Model X-173-A, covering 2.6 to 3.3 Gc, has an isolation greater than 10 db with 18 db at band center. Model X-173B, 2.7 to 2.9 Gc, has an isolation greater than 14 db. Model X-173C, 2.95 to 3.25 Gc, has an isolation of greater than 14 db. All have insertion loss of less than 1 db and vswr of 1.2:1. They are 3.5-in. long and weigh 6 oz.

Melabs, Dept. ED, 3300 Hillview Ave., Palo Alto, Calif.

***Price:** Model A is $175; models B and C are $155.*

***Availability:** From stock.*

Immediate delivery at factory prices . . . from Mallory industrial distributors

TANTALUM CAPACITORS Industry's broadest line. Microminiature to high capacity: 0.33 to 1300 mfd. Sintered wet slug, solid and foil types. Temperature ratings —55 to +200°C.

SELECTOR SWITCHES Push-button, lever action, rotary, wafer, multi-section. Phenolic or ceramic insulation.

VITREOUS ENAMEL RESISTORS Complete line of fixed and adjustable wire-wound resistors including MIL types. 5 to 200 watts, resistances to 100,000 ohms.

CERAMIC DISC CAPACITORS All standard temperature coefficients. Ratings from 50 volts general purpose to 6000 volts. Made by Radio Materials Company, a Mallory division.

SUBMINIATURE SNAP-ACTION SWITCHES Milli-Switch line of precision push-button switches; toggles and auxiliary actuators for slide or cam action. Temperature ratings to 300°F. Also hermetically sealed types.

HIGH-CAPACITY, HEAVY-DUTY ELECTROLYTICS High-capacity HC type and non-polarized NP type. Plastic case. Compact, leak-proof design. High ripple current rating, cool operation. From 3V, 6700 mfd. to 450V, 88 mfd.

Wherever you may be, a Mallory Industrial Distributor near you can supply you with Mallory original equipment parts from stock at factory prices. You'll profit by his prompt delivery on all your small-lot orders . . . for research, maintenance, or short production runs. Each of the organizations listed below specializes in industrial electronic supply. Call them for your rush orders . . . they're ready to serve you.

Distributor Division

Indianapolis 6, Indiana

P. R. MALLORY & CO. Inc.
MALLORY

These Mallory industrial Distributors stock the lines indicated by numerals:

Key: 1—Tantalum capacitors
2—Selector switches
3—Vitreous enamel resistors
4—Ceramic disc capacitors
5—Snap-action switches
6—HC-NP capacitors

Standard Radio Parts	1						Tucson, Ariz.
Newark Electronics		2				6	Inglewood, Calif.
California Electronics	1	2				6	Los Angeles, Calif.
Federated Purchaser		2				6	Los Angeles, Calif.
Kierulff Electronics	1	2		4	5	6	Los Angeles, Calif.
Radio Product Sales	1	2				6	Los Angeles, Calif.
Brill Electronics						6	Oakland, Calif.
Elmar Electronics	1	2		4		6	Oakland, Calif.
Zack Electronics	1	2	3		5	6	Palo Alto, Calif.
Elwyn W. Ley		2				6	Paramount, Calif.
Electronic Supply	1	2				6	Pasadena, Calif.
Shanks & Wright					5		San Diego, Calif.
Peninsula Electronics							San Jose, Calif.
Denver Electronics	1					6	Denver, Colo.
Westconn Electronics	1						Bridgeport, Conn.
Capitol Radio	1					6	Washington, D.C.
Electronic Indus. Sales	1	2				6	Washington, D.C.
Electronic Equipment						6	Miami, Fla.
East Coast Radio	1		3	4		6	Orlando, Fla.
Thurow Distributors	1						Tampa, Fla.
Allied Radio	1	2				6	Chicago, Ill.
Chauncey's, Inc.				4			Chicago, Ill.
Newark Electronics	1	2				6	Chicago, Ill.
Melvin Electronics						6	Oak Park, Ill.
Bruce Electronics			3				Springfield, Ill.
Graham Electronics	1	2	3	4	5	6	Indianapolis, Ind.
Radio Supply					5		Wichita, Kansas
D & H Distributing						6	Baltimore, Md.
Kann-Ellert Electron.		2					Baltimore, Md.
Radio Elec. Serv.	1				5		Baltimore, Md.
Cramer Electronics	1	2	3	4		6	Boston, Mass.
DeMambro Rad. Sup.	1	2			5	6	Boston, Mass.
Lafayette Radio	1	2	3			6	Boston, Mass.
Radio Shack		2					Boston, Mass.
Radio Specialties		2					Detroit, Mich.
Northwest Radio	1	2		4			Minneapolis, Minn.
Burstein-Applebee		2				6	Kansas City, Mo.
Walters Radio						6	Kansas City, Mo.
Olive Electronics	1				5		St. Louis, Mo.
General Radio		2				6	Camden, N. J.
Eastern Radio		2				6	Clifton, N. J.
Atlas Electronics	1	2				6	Perth Amboy, N. J.
Federated Purchaser	1	2				6	Mountainside, N. J.
Aaron Lippman & Co.		2					Newark, N. J.
Lafayette Radio	1					6	Newark, N. J.
State Electronics		2		4		6	Whippany, N. J.
Federal Electronics		2				6	Binghamton, N. Y.
Acme Electronics		2					Brooklyn, N. Y.
Radio Equipment		2					Buffalo, N. Y.
Wehle Electronics	1					6	Buffalo, N. Y.
Greylock Electronic		2					Kingston, N. Y.
Peerless Radio						6	Lynbrook, L.I., N.Y.
Bruno-New York		2				6	New York, N. Y.
Electronic Center						6	New York, N. Y.
Harrison Radio	1	2	3	4		6	New York, N. Y.
Harvey Radio	1	2				6	New York, N. Y.
Lafayette Radio	1	2	3			6	New York, N. Y.
Milo Electronics		2				6	New York, N. Y.
Terminal HudsonElec.	1	2				6	New York, N. Y.
Higgins & Sheer Elec.		2					Poughkeepsie, N.Y.
Morris Electronics						6	Syracuse, N. Y.
Valley Indus. Elec.		2					Utica, N. Y.
Westchester Electron.	1	2		4			White Plains, N.Y.
Dalton-Hege Radio	1						Winston-Salem, N.C.
Akron Electronic Sup.		2					Akron, Ohio
United Radio	1		3	4			Cincinnati, Ohio
Pioneer Electronics	1					6	Cleveland, Ohio
Thompson Radio		2		4			Columbus, Ohio
Whitehead Radio			3				Columbus, Ohio
Allied Supply	1		3	4			Dayton, Ohio
Srepco, Inc.		2					Dayton, Ohio
Servex Electronics				4			Marion, Ohio
Engineering Supply	1						Tulsa, Okla.
Eoff Electric				4			Portland, Ore.
Television Parts			3	4			New Brighton, Pa.
Cameradio Co.					5		Pittsburgh, Pa.
Radio Parts	1	2				6	Pittsburgh, Pa.
Almo Radio		2				6	Philadelphia, Pa.
Herbach & Rademan	1						Philadelphia, Pa.
Phila. Electronics	1	2				6	Philadelphia, Pa.
Radio Elec. Serv.		2				6	Philadelphia, Pa.
Geo. D. Barbey Co.						6	Reading, Pa.
West Chester Elec.				4			West Chester, Pa.
Electra Distrib.	1	2					Nashville, Tenn.
Engineering Supply	1			4		6	Dallas, Texas
McNicol, Inc.				4			El Paso, Texas
Harrison Equip.	1					6	Houston, Texas
Lenert Co.	1					6	Houston, Texas
Rucker Electronic	1	2	3	4		6	Arlington, Va.
F. B. Connelly Co.	1	2	3	4	5		Seattle, Wash.
Radio Parts			3				Milwaukee, Wis.
Canadian Elec. Sup.	1						Montreal, Que.
Wackid Radio	1						Ottawa, Ont.
Alpha Aracon Radio	1						Toronto, Ont.
Electro Sonic Sup.	1						Toronto, Ont.
Wholesale Radio	1						Toronto, Ont.

CIRCLE 70 ON READER-SERVICE CARD

MICRO/G® diode lying on the head of a pin illustrates the extreme smallness—0.040" diameter, 0.060" body length—of the glass hermetic package.

FIRST IN A NEW GENERATION OF SILICON DIODES

TI-2 AND TI-6

MICRO/G®

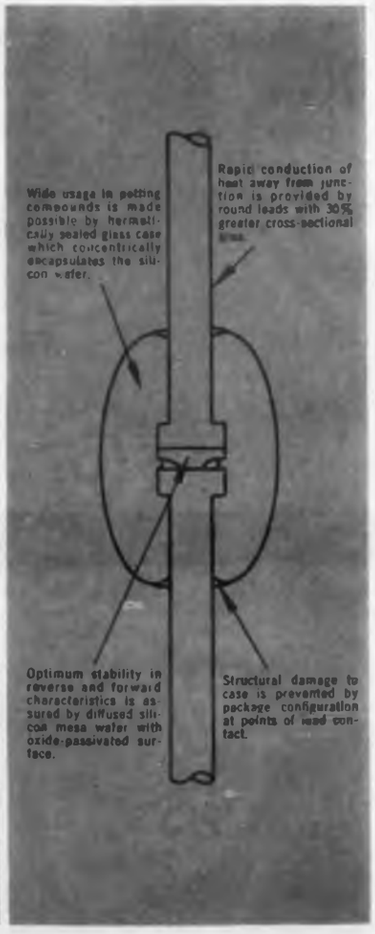
MESA DIODES FOR YOUR COMPUTER APPLICATIONS

New *MICRO/G* diodes — smaller in diameter than the head of a pin — give you electrical characteristics equal or superior to those of conventional-size computer diodes . . . in 1/50 the volume! ● The TI-2 and TI-6 capitalize on diffused silicon mesa wafers whose surfaces are *oxide-passivated* for optimum stability and reliability. The solid construction and extreme simplicity of the smallest hermetic computer microdiodes in the industry represent a revolutionary achievement in high-density packaging. ● *MICRO/G* diodes are priced competitively with their larger counterparts . . . contact your authorized Texas Instruments distributor or nearest TI Sales Office for evaluation samples today.

**Trademark of Texas Instruments*

ACTUAL SIZE

MAXIMUM RATINGS	TI-2	TI-6	UNITS
V_F Fwd. Voltage Drop at 25°C	1 at I_F=10 ma	1 at I_F=5 ma	v
C Capacitance at V_R=0 Vdc at 25°C	4	10	μμf
I_R Reverse Current at 10 v at 25°C	0.025	1.0	μa
t_{rr} Reverse Recovery Time (10 ma I_F, 10 ma I_R Recovery to 1 ma reverse)	10	100	nsecs
V_R Reverse Voltage	40	20	v



SEMICONDUCTOR-COMPONENTS DIVISION

TEXAS INSTRUMENTS

LIMITED
DALLAS ROAD • BEDFORD, ENGLAND

INCORPORATED
P. O. BOX 5012 • DALLAS 22, TEXAS

NEW PRODUCTS

Frequency Synthesizer 461

Range is 300 to 1,000 mc

The FD-3 frequency synthesizer has a fundamental frequency range of 300 to 1,000 mc with crystal source accuracy and stability. Harmonic range, with additional mixer, is up to 30 Gc. The FDS-3 "Syncriminator" permits phase locking of klystrons and backward wave oscillators to the accuracies of the FD-3. Uses include telemetry, test of microwave frequency meters and calibration of microwave signal generators.

ITT Industrial Products Div., Dept. ED, 15191 Bledsoe St., San Fernando, Calif.

***Price:** FD-3 is $10,000; the FDS-3 is $2,500.*

Spectrum Analyzer 474

Range to 100 Gc

The model DA-70 spectrum analyzer covers the frequency range from 50 to 100 Gc. One tuning unit provides complete frequency coverage. Dispersion is continuously adjustable from 50 to 1,000 mc. Frequency differences are measured to within 0.1%.

Polarad Electronics Corp., Dept. ED, 43-20 34th St., Long Island City 1, N.Y.

See at Show Booth 3301-07.

◀ CIRCLE 71 ON READER-SERVICE CARD

Waveguide Switches 475

Isolation is more than 60 db

Waveguide switches in seven sizes cover the frequency range from 3.95 to 40.0 Gc. Full waveguide operation is obtained with a vswr of 1.10 max and an isolation greater than 60 db. Model 378-E covers the range from 3.95 to 5.85 Gc while model 1078-E covers the range from 26.50 to 40.00 Gc. Five other models cover the intermediate ranges.

Waveline, Inc., Dept. ED, Caldwell, N.J.

Nickel Ferrite 476

For high power use

Nickel ferrite KN 201, for use in the C band and above, was developed for high power applications where linearity is important. It is claimed to have excellent properties in resonance isolators and Faraday rotation devices. Since it has a Curie temperature of 590 C, it may be used at high ambient temperatures. Line width is 800 at 9.3 Gc; resonance field is measured at 9.3 Gc. Front to back ratios in excess of 100:1 may be obtained. Stock dimensions are 1/2 x 1 x 6 in.; special sizes and shapes can be provided.

General Precision, Inc., Kearfott Div., Microwave Products, Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

Tuning Head 484

Range to 84.2 Gc

The model RE-T rf tuning head extends the range of the model R receiver to 84.2 Gc. The plug-in head has a frequency dial accuracy of ±1%. It can receive am, fm, cw, modulated cw, and pulse signals. Trigger output, video, audio, and recorder outputs are provided.

Polarad Electronics Corp., Dept. ED, 43-20 34th St., Long Island City 1, N.Y.

See at Show Booth 3301-07.

FREQ STDS.

AND TUNING FORK OSCILLATORS

TYPE 10, ACTUAL SIZE

SIZE, 1-3/8" x 1-3/8" x 3/8"

This frequency standard (360 or 400 cy.) is accurate to ± 25 parts per million at 10° to 35°C. The tuning fork is made from Iso-elastic alloy and is approximately 1 inch long. Fork aging has been greatly minimized. Compensation in the circuit provides a minimum rate change throughout the useful life of the power cell (over a year). External power of 1.4 volts at approximately 6 microamperes can also power the unit. An hermetically sealed model, Type 15, is also available.

For more than 20 years, this company has made frequency standards and fork oscillators within the range of 30 to 30,000 cycles for applications where consistent accuracy and rugged dependability are demanded. A few examples are shown and described here.

Some users integrate these units into instruments of their own manufacture. Others rely on our experience and facilities to develop complete operating assemblies to meet their special needs.

You are invited to submit any problems within the area of our activities for study by our engineering staff.

TYPE K-5A FREQUENCY STANDARD

Size, 3½" x 3" x 1¾"
Weight, 1½ lbs.
Frequency: 400 cycles
Accuracy: .03%, —55° to + 71°C
Input: 28V DC ±10%
Output: 400 cy. approx. sq. wave at 115V into 4000 ohm load (approx. 4W)

TYPE 2007-6 FREQUENCY STANDARD

Transistorized, Silicon type
Size, 1½" dia., x 3½" H., Wt., 7 oz.
Frequencies: 360 to 1000 cy.
Accuracies:
2007-6 ± .02% (—50° to +85°C)
R2007-6 ± .002% (+15° to +35°C)
W2007-6 ± .005% (—65° to +85°C)
Input: 10 to 30V DC at 6 ma.
Output: Multitap, 75 to 100,000 ohms

TYPE 25 PRECISION FORK

Size, ⅝" dia. x 2¾"
Weight: 2 ounces
Frequencies: 200 to 1000 cy. (specify)
Accuracies:
R-25T and R-25V ± .002% (15° to 35°C)
25T and 25V ± .02% (—65° to 85°C)
For use with tubes or transistors.

TYPE 15 FREQUENCY STANDARD

Similar to Type 10 (illustrated) except with silicon transistor, hermetically sealed and vibration resistant.
Size, 1" x 2" x 2" high
Tolerance, ± .01% from —40°C to + 71°C
Output: .IV at 50,000 ohms source impedance.

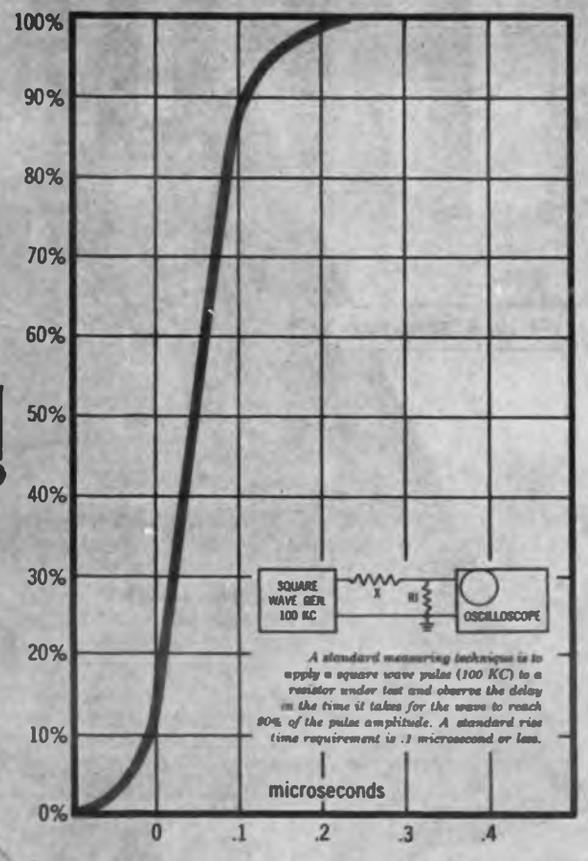
ATP

AMERICAN TIME PRODUCTS, INC.

61-20 Woodside Ave., Woodside 77, L.I., N. Y.

CIRCLE 72 ON READER-SERVICE CARD

Now- Fast Rise Time Resistors for Computers!



DAVEN'S new High-Speed resistors!

Daven has developed a new **wire wound** resistor for applications requiring exceptionally fast rise time. By controlling the winding techniques and the geometry of the form on which the resistor is wound, high frequency resistors can be made approaching... **and often equalling**... carbon and metal film units.

This high frequency operational capability, plus high resistance accuracy, low temperature coefficients, long term stability, zero voltage coefficients and low noise characteristics, make Daven's new High-Speed resistors ideal for a wide variety of fast rise-time applications. Examples: pulse circuits, AC (broad band) networks, AC (broad band) computers, AC voltage dividers, precision wide band attenuators, AC decade boxes, video amplifiers.

Type	Diameter*	Length	Min. R	Max. R	Tolerance
1301	¼	½	5K	150K	1% to .1%
1302	⅜	¾	5K	150K	.05%
1303	¼	¾	5K	250K	1% to .1%
1304	⅜	¾	5K	250K	.05%
1305	¼	1"	5K	500K	1% to .1%
1306	⅜	1"	5K	500K	.05%
1307	⅜	1½	500K	1 Meg	1% to .05%

*Diameter ± 1/64"

For complete details on the new High-Speed resistors, write today!

THE DAVEN COMPANY, Livingston, New Jersey

RESISTORS

A SUBSIDIARY OF GENERAL MILLS

TODAY, MORE THAN EVER, THE DAVEN (D) STANDS FOR DEPENDABILITY

NEW PRODUCTS

Microwave Isolators 477

For X and Ku Bands

These miniaturized isolators are designed for X- and Ku-band use. Characteristics for the X-band models are: frequency, f_o ±50 mc; isolation 15 db min; insertion loss, 0.3 db max; vswr, 1.20 max; length, 0.5 in. Characteristics for the Ku-band models are: frequency, f_o ±50 mc; isolation, 25 db min; insertion loss, 0.3 db max; vswr, 1.20 max; length, 0.7 in.

General Precision, Inc., Kearfott Div., Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

Varactor Multiplier 478

Replaces tube stages

Model FM-6 varactor multiplier uses printed-strip transmission line resonators at a frequency of 150 mc. It replaces the usual tube stages of the exciter multiplier chain of a transmitter, and the local oscillator chain of the receiver. Characteristics are: input frequency, tunable from 145 to 165 mc; output frequency, tunable from 870 to 990 mc; max input power, 2 w; output bandwidth, 30 mc.

Micromega Corp., Dept. ED, Venice, Calif.

◀ CIRCLE 73 ON READER-SERVICE CARD

AVAILABLE FROM STOCK!

C. I. C.
PRECISION FILM POTS

You can have any of these precision film pots on their way to you within hours. No need to wait for "custom" pots.

LINEAR SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Linearity
1/2"	1K	± .5%
	10K	± .5%
	50K	± .5%
7/8"	1K	± .5%
	10K	± .5%
	50K	± .5%
	1K	± .25%
	10K	± .25%
	50K	± .25%
1-3/32"	1K	± .5%
	10K	± .5%
	50K	± .5%
	1K	± .25%
	10K	± .25%
	50K	± .25%
2"	5K	± .25%
	20K	± .25%
	50K	± .25%
	5K	± .1%
	20K	± .1%
	50K	± .1%
3"	5K	± .1%
	20K	± .1%
	50K	± .1%
	5K	± .05%
	20K	± .05%
	50K	± .05%

SINE-COSINE SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Conformity
1-3/32"	10K	± .75%
	20K	± .75%
2"	10K	± .25%
	20K	± .25%
3"	10K	± .15%
	20K	± .15%

LINEAR MOTION FILM POTENTIOMETERS

Size	Resistance	Stroke	Linearity
1" Sq.	10K	1" Stroke	± .5%
	20K	1" Stroke	± .5%
	10K	2" Stroke	± .25%
	20K	2" Stroke	± .25%
	10K	3" Stroke	± .1%
	20K	3" Stroke	± .1%

WRITE OR CALL IN YOUR ORDER! POTENTIOMETERS WILL BE IN YOUR PLANT WITHIN 24 HOURS!

FIRST IN FILM POTS

COMPUTER INSTRUMENTS CORPORATION
92 MADISON AVE., HEMPSTEAD, L. I., N. Y.

CIRCLE 74 ON READER-SERVICE CARD

the "EYE" in the tail of every S.A.C. B-52

Constantly on guard . . . The C.I.C. Commutator—Film Pot assembly, rotating at 625 rpm in the defense search-radar antenna, indicates instantaneous direction of attacking enemy aircraft, bringing total defensive fire-power to bear accurately on the intruder. C.I.C. is the only source of this vital component with a proven field record of low-noise, high-accuracy operation for more than 54 million revolutions . . . reliable operation 3 times the design specification.

You can take advantage of C.I.C.'s 10 years of design and production experience in precision commutators to meet your requirements. We invite your inquiries for . . . .

RELIABLE COMMUTATORS for SWITCHING & TELEMETERING.

COMPUTER INSTRUMENTS CORPORATION
92 MADISON AVENUE • HEMPSTEAD, L.I., NEW YORK

Commutators by CIC

CIRCLE 75 ON READER-SERVICE CARD

VERSATILITY

with economy

in low-level d.c. amplification

For several dependable jobs of low-level amplification, consider the versatile Model 516A. Three different plug-in front ends make the basic unit three amplifiers in one. Economical circuit modification for several specific applications, which formerly required three special purpose amplifiers, are made easily and inexpensively from the front panel.

For Both Differential and Single-Ended Input, the Model 51-1 Attenuator provides 10K ohms single-ended or 25K ohms differential input impedance. Noise is 14μv over the 40-KC bandwidth.

For Single-Ended Input, the Model 51-2 Attenuator offers input impedance of 1 megohm with only 6μv of noise over the same bandwidth.

For Differential Input, the Model 51-3 Attenuator gives an input impedance of 1 megohm with a noise level under 8μv over the total bandwidth.

Stability And Accuracy

In addition to the economy offered by this flexible design, important performance characteristics have been improved—frequency response to 40KC, output impedance less than 0.05 ohm, drift less than 4μv, linearity better than 0.02%, common mode rejection 120db. Our field engineers will gladly answer your technical questions concerning these and other characteristics. Send for catalog literature today.

MODERN MODULAR CONSTRUCTION

Printed circuit plug-in boards are functionally separated for easy maintenance. Quality components insure long life and trouble-free operation.

ALINCO

See our exhibit at the National Telemetering Conference in Chicago • May 22-24 • Booths E-14 and E-15

Allegany Instrument Co. DIVISION OF TEXTRON ELECTRONICS, INC.

Main Offices and Factory in Cumberland, Maryland. Sales Offices in: Atlanta; Boston; Dallas; El Paso; Los Angeles; Palo Alto, California; Salt Lake City; Washington, D. C.

CIRCLE 76 ON READER-SERVICE CARD

NEW PRODUCTS

Sine-Wave Oscillator 367

Stability is ±2%

Subminiature sine-wave oscillator model G58 is available in frequencies of 30, 60, 100 and 400 cps. Frequency stability is ±2% max for all conditions within operating environment. Maximum distortion is 3%; output amplitude is 3 v rms min into 100 K. Operating temperature is −25 to +75 C.

Alto Scientific Co., Inc., Dept. ED, 855 Commercial St., Palo Alto, Calif.
Price: $265.

Digital Phase Meter 372

For direct reading

Digital phase meter type 524 is designed for direct reading of phase angle in degrees between two alternating voltages. Fluctuation of signal amplitude or continuous variation of signal frequency does not affect accuracy of phase reading. Phase difference of 0.1 deg can be read directly. Frequency response is 20 cps to 20 kc; relative accuracy is ±0.1 deg.

Ad-Yu Electronics Laboratory, Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N.J.
P&A: $3,965 ea; 2 to 3 weeks.

Photorelay System 457

Model 8PL2 photorelay system consists of matching light source and receiver, each measuring 2-1/2 x 3-1/2 x 4-1/2 in. The system will switch a 3-amp, 120-v resistive load at least 2 times per sec, with units up to 20 feet apart.

Sigma Instruments, Inc., Dept. ED, 170 Pearl St., S. Braintree 85, Mass.

Now—faster service on complete line of top quality Hipersil® cores

Eight stocking locations for Hipersil cores give fastest possible service: Greenville, Pa.; Boston; Chicago; Cleveland; Dallas; Hillside, N.J.; Los Angeles; Minneapolis. Line includes new EIA, RS-217 sizes.

- TYPE C: 12, 4, 2 and 1 mil sizes, in single- and 3-phase, fraction of ounce to 300 pounds.
- RING CORES: Untreated, edge bonded, impregnated and epoxy resin-coated Polyclad.
- SPECIAL CORES: To any specification and shape requirements.

Top quality: Performance of Hipersil cores in "iron-core" components is guaranteed to meet or exceed specifications.

Write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa., for *new* catalog.

You can be sure...if it's

Westinghouse

J-70954

CIRCLE 77 ON READER-SERVICE CARD

Copper-Clad Laminate 584

For microwave use

Intended for microwave and uhf printed circuitry, Tellon 3A is a completely isotropic material with a dielectric constant of 2.36 ±0.01 and a dissipation factor of 0.0002. It can be cold-punched, drilled, or machined, and soldered by conventional techniques. Operating temperatures are 250 F, continuous, and 500 F, intermittent. It is made in sheets to 14 x 18 in. with thicknesses from 0.020 to 0.125 in.

Tell Manufacturing Co., Military Electronics Div., Dept. ED, 520 Cary St., Orange, N. J.

Microwave Oscillators 479

Stable to ±0.1 db

Power stability approaching ±0.1 db over a 1-hr period is claimed for the series 814 microwave oscillators. The K-band unit, operating to 26 Gc, has a short-term frequency stability of 0.05 ppm and a long-term stability of 1 ppm. Models are also available for the S, C, and X bands. Power outputs range from 50 mw to 1.5 w.

Laboratory For Electronics, Inc., Instrument Div., Dept. ED, 714 Beacon St., Boston 15, Mass.

Price: From $4,350 to $7,500.
Availability: 2 weeks to 3 months.

Radar Range Calibrator 480

Is lightweight, portable

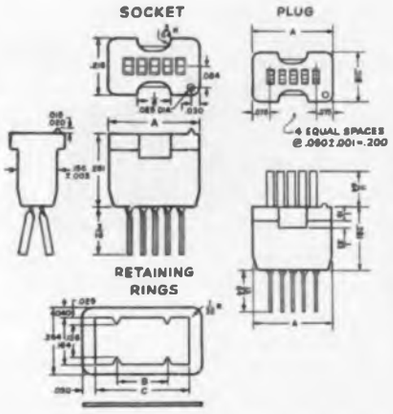
A portable test set for radar range calibration, the model 984-1001 provides calibrated marker pulses at fixed time intervals of 12.2, 122 and 1,220 μsec for ranges of 1, 10 and 100 nautical miles. A crystal-controlled oscillator provides an accuracy of ±0.02% for all markers. Output impedance, for trigger and video, is 75 ohms. The set weighs 29 lb, is about 16 x 8 x 11 in. and draws 70 w at 115 v, 50 to 60 cps.

Loral Electronics Corp., Dept. ED, 825 Bronx River Ave., New York 72, N.Y.

Price: $1,280.

CIRCLE 78 ON READER-SERVICE CARD ➤

NEW FROM CINCH.



Low-Cost SUBMINIATURE PLUGS and SOCKETS *for low-current circuits*

ACTUAL SIZE

DIMENSIONS

No. of Contacts	A	B	C
3	.350 ± .003	.194	.360
4	.350 ± .003	.194	.360
5	.350 ± .003	.194	.360
6	.400 ± .003	.244	.410
7	.450 ± .003	.294	.460

for interconnecting low current circuits where miniaturization is important... electrical ratings conform to EIA standards

NOMENCLATURE

PLUG	RECEPTACLE	RETAINING RINGS
3 contacts 204-92-03-047	131-13-12-095	441-00-11-082(105)
4 contacts 204-92-04-048	131-14-12-096	441-00-11-082(105)
5 contacts 204-92-05-049	131-15-12-097	441-00-11-082(105)
6 contacts 204-92-06-050	131-16-12-098	441-00-11-083(105)
7 contacts 204-92-07-046	131-17-12-099	441-00-11-084(105)

Molded of low-loss, mica filled phenolic insulation (type MFE per MIL-4-14E) with beryllium copper contacts, .00003 Min. Sel-rex gold plated. Available also, with glass-filled Diallyl Phthalate insulation (type SDG per MIL-M-18794).

May be swaged into metal chassis, cemented into Bakelite chassis, mounted with retaining ring or potted.

ELECTRICAL RATINGS

Maximum Rated Voltage AC-RMS
Contact to contact ..... 300 volts
Contact to ground ..... 500 volts
Capacitance
Measured from one contact to all other conducting parts ... 1.5 m.m.f. (Max.)
Insulation loss factor
Maximum ..... 0.50 Dry
Insulation Resistance
Measured from one contact to all other conducting parts ..... 50,000 Megohms (Min.)
ContactResistance 0.50 Ohms (Max.)
Safe Operating Temperature
Maximum ..... 80 C
Initial Insertion and Extraction Force
3 contact (Max.) ..... 6 lbs.
4 contact (Max.) ..... 7 lbs.
5 contact (Max.) ..... 8 lbs.
6 contact (Max.) ..... 9 lbs.
7 contact (Max.) ..... 10 lbs.
Individual Contact Retension Force
Minimum Gauge Weight ... ½ ounce

WRITE FOR FULL INFORMATION TODAY! **Complete engineering data and detailed specifications on this line of low cost plugs and sockets is available. Yours for the asking, or phone NE 2-2000.**

CINCH MANUFACTURING COMPANY
1026 South Homan Avenue, Chicago 24, Illinois
Division of United-Carr Fastener Corporation, Boston, Massachusetts

DOT ELECTRONIC ASSEMBLIES

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California, and St. Louis, Missouri

NEW

ANOTHER GLOW LAMP FIRST FROM SIGNALITE

DARK STARTING EFFECT ~~REDUCED~~ *Eliminated*

The advantages of this major breakthrough in the art of Glow Lamp manufacture will soon be available in all Signalite Glow Lamps. They are presently available to you in Type numbers as shown at right.

	Breakdown Voltage, DC	Maintaining Voltage, DC
LT2-27-1R	104-112	64-74
T2-27-1R100	66-74	52-59
T2-27-1WR760	170-200	70-75

Write today for complete technical information

Signalite INCORPORATED

NEPTUNE NEW JERSEY • TWX A PK 275

CIRCLE 79 ON READER-SERVICE CARD

NEW PRODUCTS

Tunnel-Diode Amplifier 453

Has 15-db gain

A tunnel-diode amplifier, the SS-500 has a gain of 15 db over frequencies from 1,275 to 1,325 mc. Noise factor is 6 db max. The amplifier has excellent stability and does not require a pump. A circulator is required to isolate the output terminal from the input. Variants of the models, having the same performance in 50-mc bandwidths, can be supplied over the frequency range of 800 to 1,500 mc.

Radio Corp. of America, Electron Tube Div., Dept. ED, Harrison, N.J.

DC Amplifier 463

Model 516A wide-band differential dc amplifier has 3 plug-in front ends. Economical circuit modifications may be easily made from the front panel. Frequency response is 40 kc, output impedance less than 0.05 ohm. Drift is less than 4 μv; common-mode rejection is 120 db.

Textron Electronics, Inc., Allegany Instrument Co. Div., Dept. ED, 1091 Wills Mountain, Cumberland, Md.

Price & Availability: *$680; delivery from stock.*

Centrifugal Fans 466

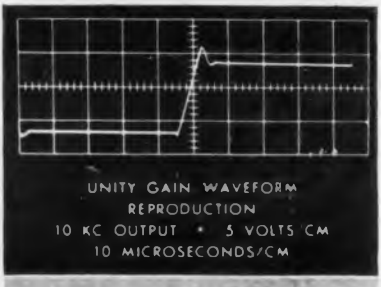
Are double-scroll type

Double-scroll centrifugal fans are available in two sizes. The units are equipped with double-ended motors that reduce over-all unit size, requiring less cabinet space. Air deliveries range from 200 to 400 cfm at moderate pressures. Special mounting brackets and filter cabinets are made.

Robbins & Myers, Inc., Propellair Div., Customer Service Dept., Dept. ED, Springfield, Ohio

FAST

ALL SOLID STATE DC AMPLIFIER



UNITY GAIN WAVEFORM REPRODUCTION
10 KC OUTPUT • 5 VOLTS CM
10 MICROSECONDS/CM

HALF USUAL COST

If you have applications requiring a miniature DC amplifier with *fast* frequency response, there's a good chance RIG's new DIFFERENTIAL OPERATIONAL AMPLIFIER MODEL A-2 can cut your amplifier costs 50% or more. Until now, only far higher priced transistorized amplifiers exhibited rise time characteristics comparable to the A-2. Check *and compare* these specifications:

OPEN LOOP GAIN — 100,000. **GAIN-BANDWIDTH PRODUCT** Short Circuit Stable — 200 KC. **RISE TIME** — Less than 10 microseconds at unity gain, and at gain of ten; less than 100 microseconds at gain of one hundred. **DRIFT REFERRED TO INPUT** — Less than two millivolts over 75°F to 120°F change of ambient; less than 100 microvolts over eight-hour period at constant temperature.

Request RIG-AMP Technical Bulletin for complete details.

ALSO AVAILABLE. Companion, plug-in Power Booster for use with Amplifier A-2 in driving heavy instrument systems, rotary amplifiers, and small DC servos.

RIDGEFIELD INSTRUMENT GROUP
a Schlumberger division
Ridgefield, Conn., P.O. Box 337, IDlewood 8-6571

SPECIAL-PURPOSE ANALOG COMPUTERS FOR DATA HANDLING AND CONTROL, ELECTRONIC COMPONENTS, NMR AND ESR SPECTROMETERS, MAGNETIC RESONANCE ANALYTICAL SERVICES

CIRCLE 80 ON READER-SERVICE CARD

Maximum reliability is built into every foot of "Foamax" — Royal's new Foam Dielectric Cable, manufactured to meet highest quality and performance standards. Write for a sample length and technical data.

ROYAL ELECTRIC CORPORATION
301 Saratoga Avenue
PAWTUCKET • RHODE ISLAND

ROYAL ELECTRIC ... an associate of

CIRCLE 81 ON READER-SERVICE CARD

Silicon Mesa Transistor 472

Rated at 175 v

Silicon mesa transistor RT5202 is rated at 175 v collector-base breakdown. Designed to replace high-voltage relays, the device will dissipate 5 w. Alpha cut-off is 30 mc; small signal beta range is from 20 to 100. The unit can be operated in common base with a constant current characteristic to its maximum rated voltage and will switch up to 250 v in avalanche condition. It is available in TO-5 or TO-18 package.

Rheem Semiconductor Corp., Dept. ED, 350 Ellis St., Mountain View, Calif.
P&A: $33 ea, 100 to 999; from stock.

Molding Compounds 471

Reinforced diallyl phthalate

Three reinforced diallyl phthalate molding compounds conforming to military specifications are available. RX 1260 is a flame-resistant, mineral-filled diallyl phthalate, free from magnetic particles. The material offers outstanding electrical properties even after exposure to high humidity. RX 1280 is similar, but compounded for temperature resistance to 500 F. RX 1380 is a glass-fiber reinforced material in the isophthalate group, also with temperature resistance to 500 F.

Rogers Corp., Dept. ED, Rogers, Conn.

Antenna Tower 470

Height to 450 ft

Heavy-duty communication tower No. 55 provides heights up to 450 ft with a wind-load rating of 30 lb per sq ft. When properly guyed, the tower can hold 12 sq ft of antenna at maximum height. The 10-ft sections are constructed on an 18-1/2 in. equilateral triangle pattern.

Rohn Manufacturing Co., Dept. ED, 6718 W. Plank Road, Peoria, Ill.

Flexible Resistances 464

Thin, flexible resistance films have been developed to provide regulated heating for motors, carburetors, fuel and hydraulic systems in extreme weather conditions. Close tolerances make the material suitable for aircraft de-icing applications.

Rogers Corp., Dept. ED, Rogers, Conn.

Infrared Lenses 456

Production of achromat lenses providing high resolution in the infrared spectrum has been extended to include the 8- to 14-micron range. The Servocon lenses are made to customer specifications.

Servo Corp. of America, Dept. ED, 111 New South Road, Hicksville, L. I., N. Y.

YOU CAN *Pack 'em in!*

A COMBINATION OF GOOD-ALL TYPES 663UW AND 663F CAPACITORS offer great flexibility in component placement. Case is a "skin-tight" Mylar* wrap, and cubic space is used to MAXIMUM efficiency. These GOOD-ALL ty, .s are widely used in the very finest instrumentation. Ratings are conservative and both are capable of being produced to HIGH-REL specifications.

SPECIFICATIONS

Temperature Range — Full rating from —55°C to +85°C and to +125°C with 50% derating.

Insulation Resistance — Greater than 100,000 megohm-mfds. at 25°C — See curve below.

Life Test — 250 hours at +85°C and 125% of rated voltage.

Dielectric Strength — Twice rated voltage for one minute.

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

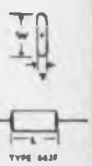
Humidity Resistance — Far exceeds requirements of EIA-Spec RS164 Para. 2, 3, 8.

Tolerance — Standard ±20% ±10% ±5% thru ±1%.

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

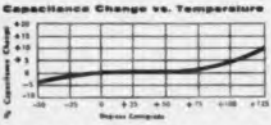
DIMENSIONS (100 Volt Rating)

CAP. MFD.	663UW D	663UW L	663F T	663F W	663F L
.001	.156 x	1/2	—	—	—
.01	.156 x	1/2	—	—	—
.022	.203 x	5/8	.156 x	.297 x	5/8
.047	.234 x	3/4	.219 x	.328 x	3/4
.1	.281 x	7/8	.219 x	.359 x	7/8
.22	.328 x	1	.328 x	.547 x	1
.47	.468 x	1 1/4	.359 x	.672 x	1 1/4
1.00	.593 x	1 1/2	.453 x	.859 x	1 1/2

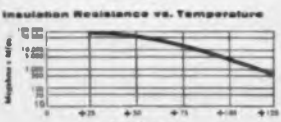


TYPE 663F

Capacitance Change vs. Temperature



Insulation Resistance vs. Temperature



* DuPont's trademark for polyester film.

Good-All CAPACITORS

Write for detailed literature

GOOD-ALL ELECTRIC MFG. CO. Ogallala Nebr.

CIRCLE 82 ON READER-SERVICE CARD

Tuning breakage, backlash, and accelerated wear are among the problems you encounter in a trimmer capacitor whose core *rotates* during tuning.

What is a direct traverse trimmer and why?

That's why we took the rotation out of our trimmer capacitors. Our core runs up and down its tube without turning.

That's why direct traverse tuning curves are all smooth lines, utterly devoid of capacitance reversals.

That's why direct traverse trimmers tune so smoothly, without a snag to cause breakage just when you think the circuit is complete and ready to go.

That's why tuning cores never work loose and become microphonic.

That's why direct traverse capacitance values never change . . . even when you shock or vibrate the trimmer.

Plus the properties of glass. We've added to this direct traverse design the many values of glass. No other material combines such high reliability with such low TC. Or such precision at such low cost. Let the specs speak for themselves:

TC	±50 to ±100
DC volts	1000
Dielectric strength	1500
Megohms, IR	10^6
Q factor, 50 MC	500

Four models. Where space is no problem, you'll look immediately for our standard direct traverse trimmers. They range from .5-3.0 to 1-12 uuf. Approximately 0.6 uuf change per turn.

When space is tight both in front of and behind your panel, you'll appreciate our petite mini-trimmers. Not only are the over-all dimensions small, but we throw in fixed cavity tuning which keeps the screw enclosed at all times. These range from 1-4.5 to 1-18 uuf with approximately 0.40 uuf change per turn.

For printed circuits you can get trimmers with the same specs as the mini-trimmers, but designed specifically for board mounting.

When you want to really get short *behind* the mounting panel, look at our precision direct traverse trimmers. Hardware in front is slightly longer than with the mini-trimmers, but we more than make up for this with a short back-panel dimension. All the way from .8-4.5 to 1-30 uuf with about 0.50 uuf change per turn.

Try a direct traverse trimmer in your next circuit and see the difference for yourself. You can get complete specifications by writing to us at Corning Glass Works, 540 High Street, Bradford, Pa.

For orders of less than 1,000, you can get fast service from your local Corning distributor.

CORNING ELECTRONIC COMPONENTS
CORNING GLASS WORKS, BRADFORD, PA.

CIRCLE 83 ON READER-SERVICE CARD

NEW PRODUCTS

Reflex Klystron 481

Is electrically tunable

The MXK-23 klystron is an electrically tunable, reflex klystron with a tuning range greater than 400 mc. It is for use in the X-band region. Typical characteristics are: frequency, X band; tuning voltage, less than 25 v; tuning power, less than 10 w; output power, greater than 15 mw.

Metcom, Inc., Dept. ED, 76 Lafayette St., Salem, Mass.

12-in. Traveling-Wave Tube 482

Weighs 3 lb, 8 oz

A periodically focused X-band traveling-wave tube, the STX-264 is 12 in. over-all and weighs 3 lb, 8 oz. Of metal-ceramic construction, it is suitable for applications in broadband or multiple frequency systems, noise generators, and nanosecond switching devices. Rated power output is 1-w min, with a small-signal gain of 30 db nominal. Input-output isolation is 75 db min. It will withstand vibration of 10 g at 5 to 2,000 cps and tolerate shock of 15 g for 10 msec. Performance is normal to altitudes of 70,000 ft.

Sperry Rand Corp., Sperry Electronic Tube Div., Dept. ED, Gainesville, Fla.

Waveguide Assemblies 483

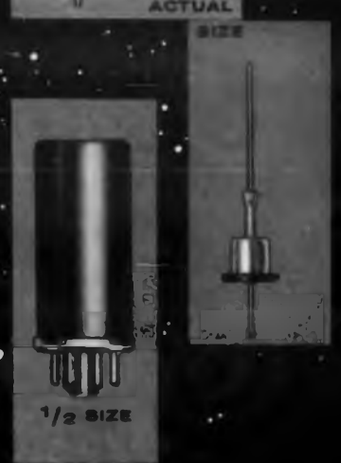
In copper or aluminum

Standard waveguide assemblies, either copper or aluminum, are available in "E" and "H" plane standard bend and twist blanks. They are ready for immediate cutting to length and brazing of any flange arrangement.

Waveguide, Inc., Dept. ED, Costa Mesa, Calif.

CIRCLE 84 ON READER-SERVICE CARD ▶

INVITATION TO INVENTION IN CIRCUIT DESIGN



WHERE HIGHEST QUALITY IS IN VOLUME PRODUCTION

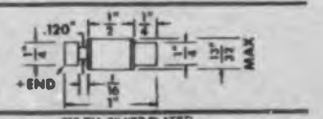
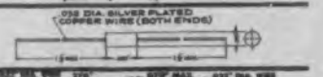
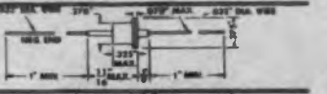
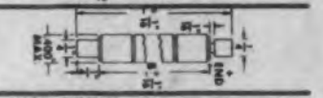
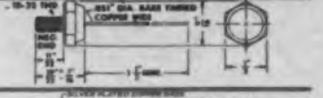
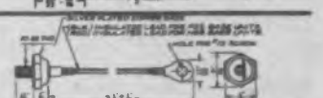
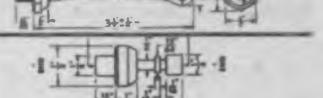
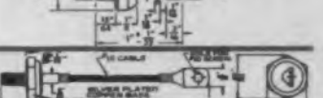
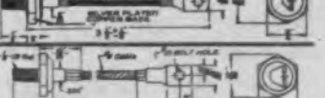
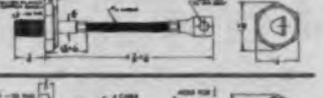
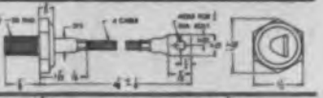
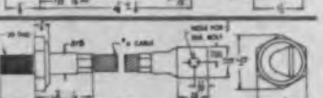
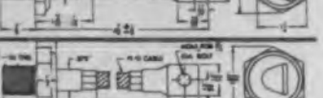
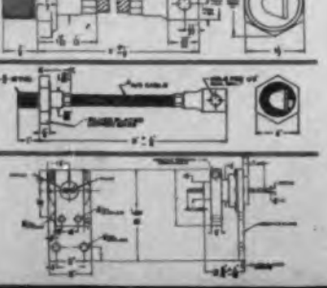
Listed below are silicon rectifiers representative of the Tarzian line. They are available in production quantities, at realistic prices, for both commercial and military applications.

Of particular importance in simplifying your power conversion circuitry assemblies are small size, high efficiency, mounting versatility and wide range of ratings offered by the Tarzian line.

In addition, the entire line features extremely low junction current density for maximum reliability and operating life. This is due to the special Tarzian alloy process with supported junction that produces the largest junctions available.

Altogether, the qualities and availability of the units cataloged here are invitations to invention in circuit design. Application engineering service is also available without obligation. Call the Sarkes Tarzian representative near you, or write Sarkes Tarzian, Inc., for complete catalog information.

SILICON RECTIFIERS

	amps. DC (100°C)		peak inverse voltage	max. RMS volts	Max. amps. recurrent peak	Max. amps. surge 4MS	Tarzian Type	Jedec No.	Tarzian Type	Jedec No.	dimensions
Typical LOW CURRENT units	0.5		200	140	5	30	20M	1N1082			
			400	280	5	30	40M	1N1084			
			600	420	5	30	60M	—			
	0.5		200	140	5	75	F-2	1N2482			
			400	280	5	75	F-4	1N2483			
			600	420	5	75	F-6	1N2484			
	0.5		200	140	5	75	20H	1N2485			
			400	280	5	75	40H	1N2487			
			600	420	5	75	60H	1N2489			
	0.45		800	560	4.5	27	80SM	1N1108			
	0.4		1600	1120	4	24	160SM	1N1110			
	0.35		2400	1680	3.5	21	240SM	1N1112			
	0.325		2800	1960	3.25	19.5	280SM	1N1113			
Typical MEDIUM CURRENT units	1.5		200	140	10	100	20J1	1N1618			
			400	280	10	100	40J1	1N1620			
			600	420	10	100	60J1	—			
	10		200	140	50	150	20J2	1N1622			
			400	280	50	150	40J2	1N1624			
			600	420	50	150	60J2	—			
	12		200	140	72	150	20J3	—			
			400	280	72	150	40J3	—			
			600	420	72	150	60J3	—			
	2		200	140	30	100	20LA	1N1086			
			400	280	30	100	40LA	1N1088			
			600	420	30	100	60LA	—			
							NEGATIVE		POSITIVE		
Typical HEAVY CURRENT units	20		200	140	120	200	20R3N		20R3P		
			400	280	120	200	40R3N		40R3P		
			600	420	120	200	60R3N		60R3P		
	35		200	140	210	350	20S3N	—	20S3P	—	
			400	280	210	350	40S3N	—	40S3P	—	
			600	420	210	350	60S3N	—	60S3P	—	
	50		200	140	300	500	20T3N	—	20T3P	—	
			400	280	300	500	40T3N	—	40T3P	—	
			600	420	300	500	60T3N	—	60T3P	—	
	100		200	140	600	1000	20V3N	—	20V3P	—	
			400	280	600	1000	40V3N	—	40V3P	—	
			600	420	600	1000	60V3N	—	60V3P	—	
	150		200	140	900	1500	20W3N	—	20W3P	—	
			400	280	900	1500	40W3N	—	40W3P		
			600	420	900	1500	60W3N	—	60W3P		
	250		200	140	1500	2500	20Y3N	—	20Y3P		
			400	280	1500	2500	40Y3N	—	40Y3P		
			600	420	1500	2500	60Y3N	—	60Y3P		
	350		200	140	2100	3500	20G3N	—			
	1000		200	140	6000	10000	20Z8	—			

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HIGH VOLTAGE SILICON CARTRIDGE RECTIFIERS

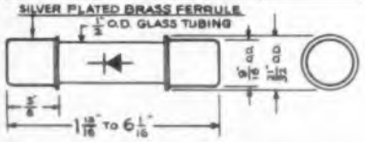
Each of the two series of Tarzian Silicon Cartridge Rectifiers shown below includes 18 different types with operating temperatures ranging from —55°C to 150°C ambient. Both the ferrule mounted series and the axial lead series feature low voltage drop and low reverse current. Tarzian High Voltage Cartridges are manufactured to meet standard Jedec classifications.

FERRULE MOUNTED SERIES—This high voltage series is equipped with a ferrule type mounting of silver plated brass and is available in both hermetically sealed glass or phenolic tubing in voltages ranging from 1000 to 10,000 peak inverse volts.

AXIAL LEAD SERIES—This high voltage series is available in units ranging in size from ½" to 2½" and lead lengths varying from 1" to 2½". Peak inverse voltage ratings are available from 1500 to 16,000 volts.

FERRULE MOUNTED SERIES

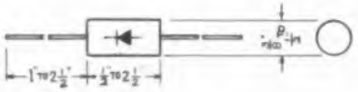
Operating Temperature Range —55°C to 150°C Ambient		Max. Ratings Half Wave Res. Load at 75°C Ambient	
Jedec Type	Sarkes Tarzian Type	Peak Inverse Volts	Max. Rectified DC Output MA
1N1133	S-5490	1500	75
1N1140	S-5497	3600	65
1N1143A	S-5501	6000	65
1N1146	S-5504	8000	45
1N1148	S-5506	14000	50
1N1149	S-5507	16000	45



When ordering phenolic tubing as a substitute for glass tubing, add the letter "P" to S.T. Type No.

AXIAL LEAD SERIES

Operating Temperature Range —55°C to 150°C Ambient					
Jedec Type	S.T. Type	Peak Inverse Volts	Max. RMS Input Volts*	Max. Rect. DC Output (MA) 25°C	100°C
1N1730	S-5518	1000	700	200	100
1N1731	S-5519	1500	1050	200	100
1N1734	S-5522	5000	3500	100	50
1N2375	S-5525	1500	1050	200	100
1N2379	S-5529	4000	2800	100	50
1N2385	S-5535	10000	7000	70	55

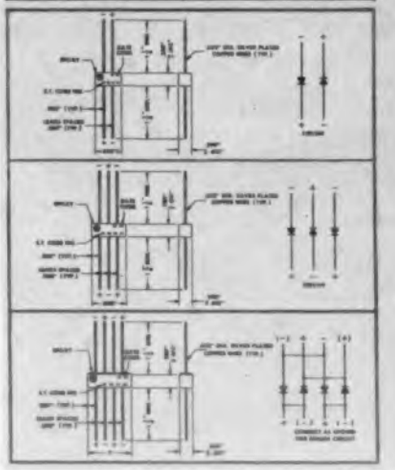


*Derate 50% for capacitive load in half wave circuits. For capacitive, motor, or battery loads, derate DC current by 20%.

MODULAR SILICON RECTIFIERS

Modular Silicon Rectifiers can be used individually—as open bridges—or in a variety of circuit combinations, and are designed for printed circuits on terminal strips. Each of the units illustrated and tabulated below is only one of a series of six in the 18-unit Tarzian line.

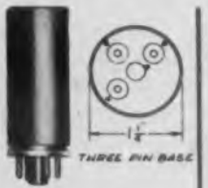
Tarzian Code Number	Individual Diode Current Rating	Circuit Connections	Piv
S-5541	500MA	Center tap, Doubler	600
S-5549	500MA	3 phase Half Wave	600
S-5467	500MA	Bridge	600



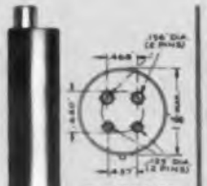
TUBE REPLACEMENT SILICON RECTIFIERS

Tarzian tube replacement rectifiers, in addition to being directly interchangeable with over 95% of all popular vacuum tube rectifiers, are smaller, more compact, and carry dc current ratings as much as three times as great as the tubes they replace. They have proved highly satisfactory in applications requiring high efficiency, long life, rugged construction and wide temperature ranges. Tarzian solid state rectifiers are available in ten standard models, with special designs and modifications on request. Special tube replacement units designed by Tarzian engineers include special designs with peak inverse voltages to 19,000 volts.

S-5018
Pin Connection
Pin #8 (Cathode)
Pin #4 and #6 (Anode)
Replacement for types 5AU4, 5AW4, 5AZ4, 5T4, 5U4, 5V4, 5W4, 5Y3, 5Z4, 5931, 6087, 6106.

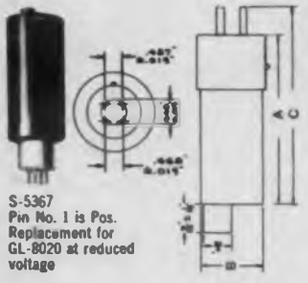


S-5019
Pin Connection
Pin #8 (Cathode)
Pin #6 and #4 (Anode)
Replacement for 5R4



S-5130
Pin No. 1 is Pos.
Replacement for 866, 866A, 3B28

S-5207
Pin Connection
Pins #1 and #6 are A.C. (Anode)
Pin #7 is Pos. (Cathode)
Replacement for 6X4, 6063, 6202.



S-5367
Pin No. 1 is Pos.
Replacement for GL-8020 at reduced voltage

Tarzian Type	JEDEC Number	Max. Peak Inverse Voltage	Max. RMS Voltage	Max. Peak Current (ma)	Max. DC Current (ma)	Circuit	Type Load	Max. Ambient Temp.	Dimension "A" (inches)	Dimension "B" (inches)	Dimension "C" (inches)
S-5018	1N-1238	1,600	1,100	8,000	750	F.W.	Any	100°C	2 21/32	1 1/8	3 1/32
S-5019	1N-1239	2,800	1,950	5,000	500	F.W.	Any	100°C	3 3/4	1 3/8	4 5/16
S-5130	—	10,400	*7,400	3,000	300	H.W.	Res.-Ind.	100°C	4 7/16	1 7/32	8 1/8
S-5207	1N-2490	1,600	1,100	5,000	500	F.W.	Any	100°C	1 1/2	13/16	1 3/4
S-5367	—	19,000	13,400	2,500	250	H.W.	Res.-Ind.	100°C	6	2 1/16	6 19/32

*For capacitive loads derate input voltage 50%, and current 20%.

SARKES TARZIAN SILICON VOLTAGE REGULATORS

¼ WATT REGULATORS
Specifications 25°C.

Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)	Jedec Type
.25T5.6	5.6	25	3.6	1N708
.25T6.2	6.2	25	4.1	1N709
.25T6.8	6.8	25	4.7	1N710
.25T7.5	7.5	25	5.3	1N711
.25T8.2	8.2	25	6.0	1N712
.25T9.1	9.1	12	7.0	1N713
.25T10	10	12	8.0	1N714
.25T11	11	12	9.0	1N715
.25T12	12	12	10	1N716
.25T13	13	12	11	1N717
.25T15	15	12	13	1N718
.25T16	16	12	15	1N719
.25T18	18	12	17	1N720
.25T20	20	4	20	1N721
.25T22	22	4	24	1N722
.25T24	24	4	28	1N723
.25T27	27	4	35	1N724
.25T30	30	4	42	1N725
.25T33	33	4	50	1N726
.25T36	36	4	60	1N727
.25T39	39	4	70	1N728
.25T43	43	4	84	1N729
.25T47	47	4	98	1N730
.25T51	51	4	115	1N731
.25T56	56	4	140	1N732
.25T62	62	2	170	1N733
.25T68	68	2	200	1N734
.25T75	75	2	240	1N735
.25T82	82	2	280	1N736
.25T91	91	1	340	1N737
.25T100	100	1	400	1N738

1 WATT REGULATORS
Specifications 25°C.

Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)	Jedec Type
1T5.6	5.6	100	1.2	
1T6.2	6.2	100	1.5	
1T6.8	6.8	100	1.7	
1T7.5	7.5	100	2.1	
1T8.2	8.2	100	2.4	
1T9.1	9.1	50	3.0	
1T10	10	50	3.5	
1T11	11	50	4.2	
1T12	12	50	5.0	
1T13	13	50	5.8	
1T15	15	50	7.6	
1T16	16	50	8.6	
1T18	18	50	11	
1T20	20	15	13	
1T22	22	15	16	
1T24	24	15	18	
1T27	27	15	23	
1T30	30	15	28	
1T33	33	15	33	
1T36	36	15	39	
1T39	39	15	45	
1T43	43	15	54	
1T47	47	15	64	
1T51	51	15	74	
1T56	56	15	88	
1T62	62	5	105	
1T68	68	5	125	
1T75	75	5	150	
1T82	82	5	175	
1T91	91	5	220	
1T100	100	5	260	

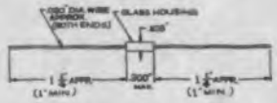
10 WATT REGULATORS
Specifications 25°C.

Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)	Jedec Type
10T5.6	5.6	1000	1	1N1803
10T6.2	6.2	1000	1	1N1804
10T6.8	6.8	1000	1	1N1805
10T7.5	7.5	1000	1	1N1806
10T8.2	8.2	1000	1	1N1807
10T9.1	9.1	500	1	1N1808
10T10	10	500	2	1N1351
10T11	11	500	2	1N1352
10T12	12	500	2	1N1353
10T13	13	500	2	1N1354
10T15	15	500	2	1N1355
10T16	16	500	3	1N1356
10T18	18	150	3	1N1357
10T20	20	150	3	1N1358
10T22	22	150	3	1N1359
10T24	24	150	3	1N1360
10T27	27	150	3	1N1361
10T30	30	150	4	1N1362
10T33	33	150	4	1N1363
10T36	36	150	5	1N1364
10T39	39	150	5	1N1365
10T43	43	150	6	1N1366
10T47	47	150	7	1N1367
10T51	51	150	8	1N1368
10T56	56	150	9	1N1369
10T62	62	50	12	1N1370
10T68	68	50	14	1N1371
10T75	75	50	20	1N1372
10T82	82	50	22	1N1373
10T91	91	50	35	1N1374
10T100	100	50	40	1N1375

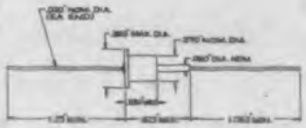
NOTES: Standard tolerance is ± 10%, however, closer or wider tolerances are available on request.
Also available on request: (a) Special voltage ratings. (b) Symmetrical double anode types (for clippers).

The full line of constant voltage devices tabulated here are used to control output voltage of power sources and as voltage reference elements capable of operating over a wide temperature range. Hermetic sealing and mechanical ruggedness provide long term reliability even under the most adverse conditions. These three power classifications cover a wide range of applications. The regulators also are available in production quantities. Call your nearest Tarzian representative for application assistance.

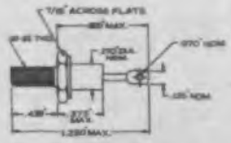
¼ WATT



1 WATT



10 WATT



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Model 538-A is a high-speed, transistorized relay for teletype machines and telegraph repeaters. It plugs directly into the type 255-A socket without modifications. Response is distortion-free up to 200 bits per sec. The unit operates on any standard telegraph transmission line. Input is purely resistive. Maximum switched output is 100 w.

TREPAC Corp. of America, Telegraph Engineering Dept., Dept. ED, 28 W. Hamilton Ave., Englewood, N.J.

Price: *$86.*

Availability: *in production quantities.*

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Gives 10 kw at 2 frequencies

Designed for research laboratory and semiconductor processing, this rf generator provides 10 kw at frequencies of 450 kc or 4 mc. Changeover is quickly accomplished. The 4-mc tank is remote from the main cabinet, offering versatility in process method. Meters are provided for dc plate current, dc excitation current, rf tank current, and ac filament voltage. Full load input is 25 kva at 95% pf, 3-phase, 60 cps, 220/440 v. Either saturable reactor, thyratron, or powerstat control is available.

Westinghouse Electric Corp., Industrial Electronics Dept., Dept. ED, 2519 Wilkens Ave., Baltimore 3, Md.

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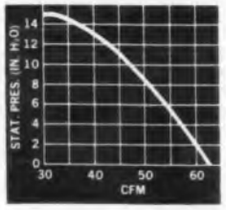

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Fractional, sub-fractional. Induction and hysteresis types with associated gear reductions. Available in 50, 60, 400 cycles, single, dual and variable frequency, dual voltage. Single-, two-, three-phase operation. Horsepower from 1/3500 to ½. Dia. from 1" to 6⅝".

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From 1" to 6⅝" diameters. Power to 1000 VA. Wide frequency range. Low harmonic content. Sine waves with maximum 2% total distortion. Single-, dual- (sine-cosine), three-phase. Dual frequency units, for special applications, produce a combination of frequencies.

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Stud-Mounted Rectifiers 400

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Series MP stud-mounted rectifiers are capable of handling up to 40 amp at 150 C in half-wave circuits. The devices have double-diffused silicon junction construction. Inverse voltage capability is from 50 to 800 piv. In full-wave circuits, currents up to 60 amp can be obtained.

Trans-Sil Corp., Dept. ED, 55 Honeck St., Englewood, N.J.

Availability: *7-day delivery.*

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Lamp ballast No. 670-164 is claimed to be the most efficient two-lamp, 40-w rapid start ballast available. Constant-wattage operation provides reliable starting, automatic current regulation to lengthen lamp life, and protection against heat rise.

Sola Electric Co., Dept. ED, Elk Grove, Ill.

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With ¼% accuracy

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Trio Laboratories, Inc., Dept. ED, DuPont Drive, Plainview, N.Y.

Signal Simulators 425

For telemetry systems

The 300 series of signal simulators provides a selection of pam, pam-non-return-to-zero, and pdm units for calibration and checkout of telemetry ground stations, data-transmission systems and data-reduction equipment. The units have eight channels of subcommutation; other channels can be added up to 1,054 per frame. Preprogramed patch panels are available which permit programing reference pulses, missing pulses, calibration pulses, and externally modulated pulses into either the main frame or the subcommutated frame.

Telemetrics, Inc., Dept. ED, 12927 S. Budlong Ave., Gardena, Calif.

Prototype Chassis 376

Mount 14 or 24 tubes

Heavy-gauge aluminum alloy prototype chassis provide mounting for standard electronic components. Model 14B has a universal transformer mounting, a full-length amplifier strip, and two oscillator stages with full copper shielding. Mountings for 14 tubes in any combination of octal- or 7- or 9-pin sockets are provided. Model 24 has mounting holes for 24 tubes. Model 8B, for subminiature components, provides 16 transistor sockets, plus a grid pattern of 140 holes.

Wittek Products Co., Dept. ED, 14750 Keswick St., Van Nuys, Calif.

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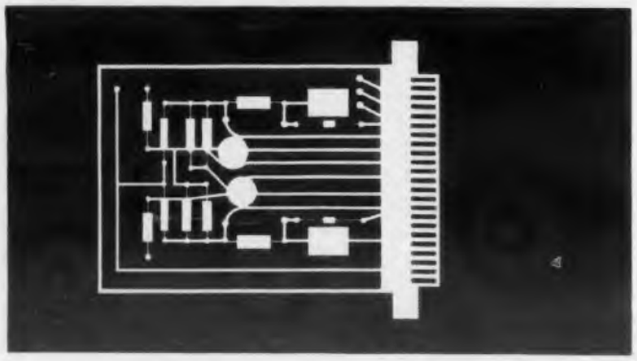
does it again with *another first*

AUTOMATIC LOGIC CIRCUIT TESTING



AUTOMATICALLY EVALUATES PERFORMANCE AND FAILURES iN PACKAGED MODULE CIRCUITS

From the *leader* in automatic circuit testing comes an entirely new concept in circuit analysis . . . AUTOMATIC LOGIC CIRCUIT TESTING. The first equipment of this type, the new DIT-MCO Model 720 automatically tests operating characteristics of logic circuit modules, memory boards, component cards and similar units—with speed, precision and dependability.

The Model 720 rapidly performs static and dynamic tests on active and passive modular circuits.

Tests that can be performed with the new Model 720 include:

- Logic circuit response to all logical combinations of DC input levels.
- Margin tests to evaluate logic modules under conditions of lowered or raised supply levels in combination with lowered or raised signal input levels.
- Complete tests of conversion matrices for proper logic, levels.

The DIT-MCO Model 720 will accurately test variables which are required to maintain ± 0.5% accuracy, and 3 digit tolerance values can be programmed. Provision is made for programming AC or DC sources and external signals through the tester.

Automatically yours

DIT MCO

DIT-MCO, INC. • 911 BROADWAY • KANSAS CITY 5, MISSOURI • HArrison 1-0011
LOS ANGELES AREA, ORegon 8-6106 • NEW YORK CITY AREA, Murray Hill 2-5844

CIRCLE 88 ON READER-SERVICE CARD

NEW PRODUCTS

Portable Potentiometer 427

In marproof case

The Pyrotest portable potentiometer will check any thermocouple-actuated indicator, controller or recorder, measure temperature, and check other potentiometers. Included are nine interchangeable, direct-reading scales for use with any type of thermocouple. The instrument is housed in a marproof plastic case. Guaranteed accuracy is 1/6 of 1%. Size is 12-1/4 x 9 x 8-1/2 in.; weight is 12 lb.

Technique Associates, Dept. ED, 1413 N. Cornell, Indianapolis 2, Ind.
Price: *$315.*

Ceramic Cement 411

Temperature or strain-gage transducers may be bonded to metallic or nonmetallic surfaces with type 64CP ceramic cement. Strength and major electrical properties are maintained from −320 to 1,800 F.

Trans-Sonics, Inc., Dept. ED, P. O. Box 328, Lexington 73, Mass.

Heat Dissipators 389

For semiconductors

Convection heat dissipators type 6071 provide 150 sq in. of radiating surface. Hole patterns for the most commonly used transistors, diodes and rectifiers are available. The device is 3-1/16 in. wide, and mounts on 4-1/4 in. centers. A variety of finishes per military specification is available.

Vemaline Products Co., Dept. ED, 551 Commerce St., Franklin Lakes, N.J.
Price: *$1 ea.*
Availability: *delivery from stock.*

Particle Detector 452

For heavy particles

Solid-state particle detector is sensitive to alpha particles, protons, and other heavy particles. The device uses silicon with resistivity above 10 K per cm. Alpha particle energy detection is in the range of 0.5 to 10 million electron volts with operating voltage of 100 v max. Resolution is below 4%; signal-to-noise ratio is 15:1 min. Pulse rise time makes the detector suitable for use with all standard linear amplifier systems.

Semi-Elements, Inc., Dept. ED, Saxonburg Blvd., Saxonburg, Pa.

Price: *$50 ea.*

Availability: *delivery from stock.*

Ultrasonic Deburring 412

An ultrasonic generator has been developed for removing burrs from screws, precision castings, and other machine parts. In 2 to 6 hr, stainless steel screws are deburred, cleaned, textured, and polished, with a symmetrical radius created on rough threads.

Ultrasonic Systems, Inc., Dept. ED, 2255 S. Carmelina Ave., Los Angeles 64, Calif.

Collapsible Tower 394

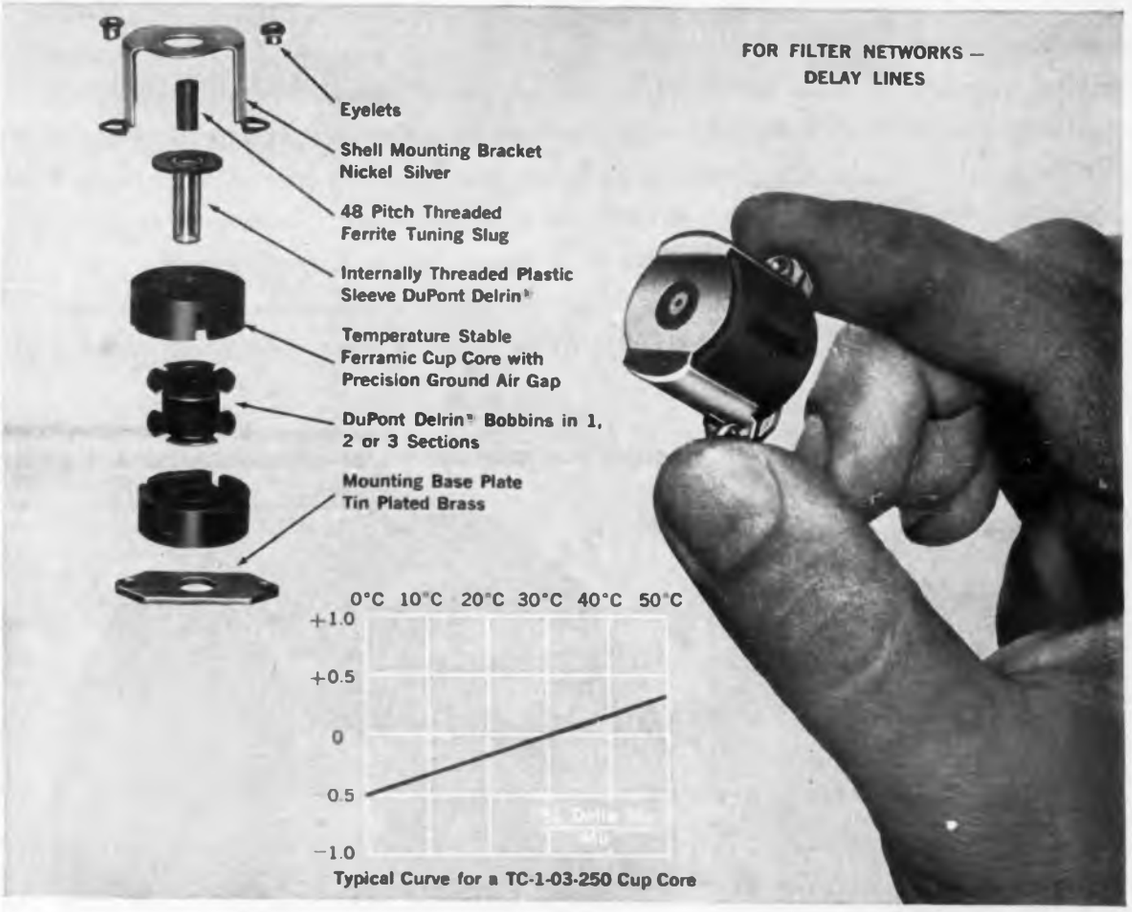
Of octahedral sections

With two basic parts, struts and ball joints, octahedral sections can be assembled to form an easily erected tower. The sections nest for storage in a space about 1/7 the height of the tower. Sections may be added or removed as desired. Erection time is substantially less than that required for conventional towers. Material is aluminum, steel, or fiberglass.

Up-Right Towers, Dept. ED, 1013 Pardee St., Berkeley, Calif.

Have you sent us your subscription renewal form?

From General Ceramics Division of
INDIANA GENERAL CORPORATION



FERRAMIC® Cup Core Assemblies with Unmatched Stability 0° C to 50°C

(International Series)

FEATURES THAT PAY OFF IN PERFORMANCE AND COST

- Seven sizes from stock .599" to 1.425" O.D.
- Frequencies — 1KC to 1MC
- "Q" values to 750
- Standard Gapped Inductance Values 40 to 1000 MH/1000 turns
- Extreme temperature stability
- Trimmer for minimum of 12% adjustment
- Complete assembly available

Now, a complete line of in-stock cup core assemblies designed for electronic coil applications requiring inductance and permeability having exacting temperature stability and linearity.

The high "Q" factor exhibited by these temperature compensated cup cores is engineered to meet the most rigid coil design requirements.

TC permeability stable units combine optimum operating performance in the smallest possible space providing complete design flexibility at low cost.

For exact recommendations and fast off-the-shelf deliveries, write, wire or phone today — ask for Bulletin 28.

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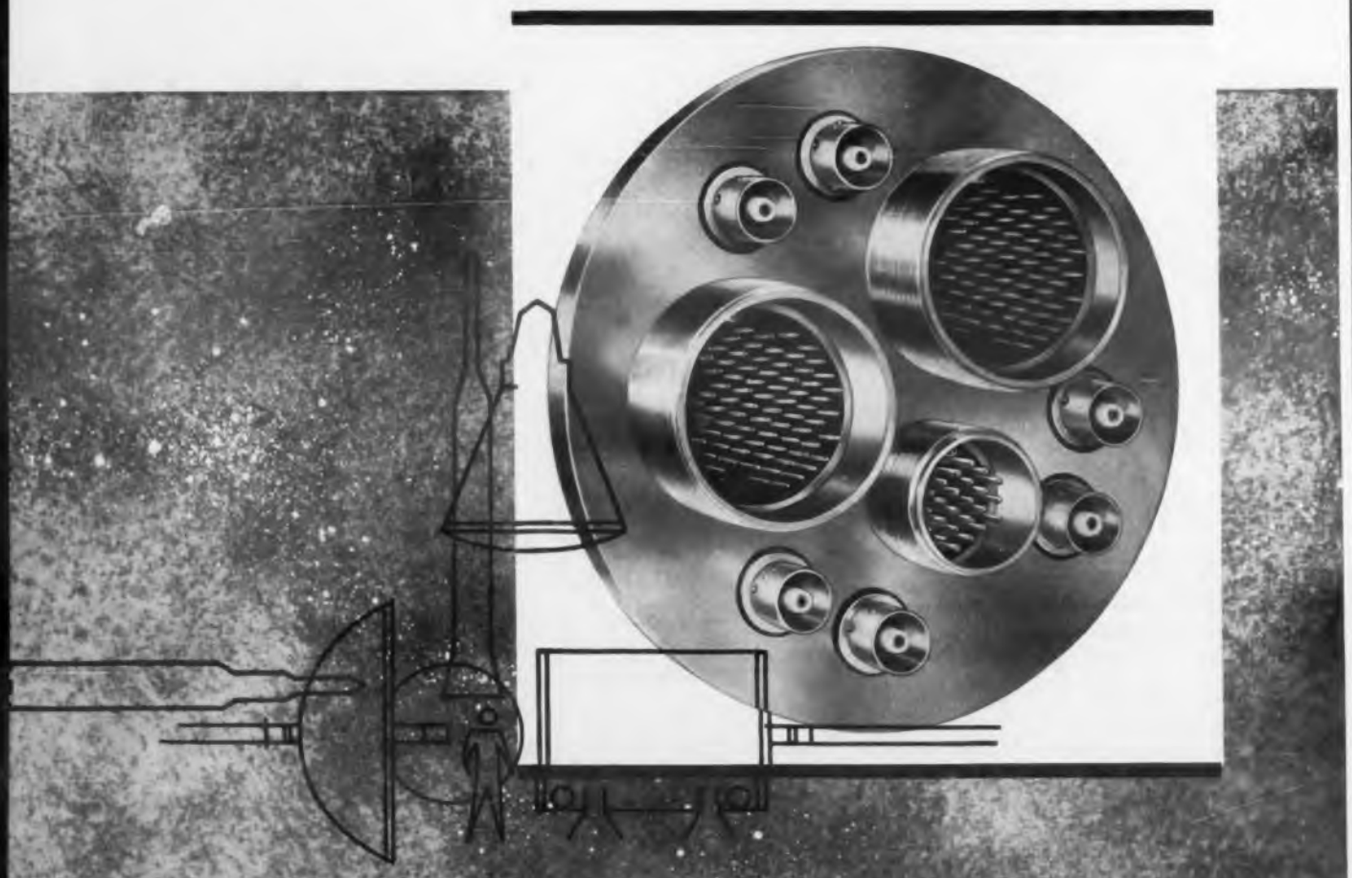
KEASBEY, NEW JERSEY, U. S. A.

TECHNICAL CERAMICS, FERRITES AND MEMORY PRODUCTS

CIRCLE 89 ON READER-SERVICE CARD

hermetic seal · leakage rate · 1 x 10^{-9} cc/sec

AMPHENOL can do it. Sealed electrical penetrators for space simulator chambers are currently being produced with a leakage rate lower than 1x10^{-9} cc/sec. AMPHENOL Interstage and other missile connector types are also being provided for every major missile program. Connectors up to a foot in diameter with 175 individually sealed contacts have been manufactured for ultra-reliable systems. AMPHENOL For less exotic applications, AMPHENOL supplies every type of hermetically sealed electrical connectors: MS-type receptacles with AMPHENOL-developed "Identoseal" contact identification, ⅜" square Micro Mod receptacles with 12 contacts on .075" centers, and a wide variety of special and general purpose connectors. Maximum permissible leakage rate in standard connectors is 1x10^{-6} cc/sec. Write for full information on AMPHENOL'S capabilities in this highly important field.



AMPHENOL CONNECTOR DIVISION

1830 S. 54TH AVE • CHICAGO 50, ILLINOIS • Amphenol-Borg Electronics Corporation

NEW PRODUCTS

Strain-Gage Accelerometer 436

Weighs 4 oz

Model A507TC unbonded strain-gage linear accelerometer weighs approximately 4 oz. The unit is gas damped and compensated for temperature changes. Ranges are ±25 g through ±100 g. Damping is relatively constant from −65 to 250 F,. without a heater jacket. Excitation is 5 v dc or ac rms through carrier frequencies. Full output is about ±20 mv at 5 v.

Statham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Square-Wave Generator 450

Rise time is 2 μsec

Square-wave driving unit type SW98 provides a driving signal for repetitive analogs. A square wave at line frequency is provided, or the unit may be driven by external sine waves from 50 cps to 10 kc. Rise time is about 2 μsec. Minimum external signal is 2-v peak; output is continuously adjustable from 0 to 50 v peak-to-peak independently of the input amplitude.

Feedback Ltd., Dept. ED, Crowborough, Sussex, England.

◀ CIRCLE 90 ON READER-SERVICE CARD

O-Ring Knob 403

For sealed instruments

A miniature O-ring knob is offered for use on sealed precision instruments such as potentiometers, thermostats and adjustable timers. It seals tubes with OD from 0.080 in. to 0.120 in. The seal withstands pressures up to 35 psi, and has been tested for over 100,000 rotations.

Joseph Waldman & Sons, Dept. ED, 133 Coit St., Irvington, N.J.

DC Null Voltmeter 447

Has 13 ranges

Model 413A dc null voltmeter has 13 zero-centered ranges, from 1 mv to 1 kv end scale. Impedance of the floating input is 10 to 200 meg. Measurement accuracy is within 2% of end scale. With input terminals isolated from ground, the instrument can be operated up to 500 v dc or 130 v ac above ground potential.

Hewlett-Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.

***Price:** $350, cabinet; $355, rack mount.*

Wire Contact Relays 405

With 4, 6 and 12 poles

Wire contact, plug-in relays are available with 4, 6 and 12 poles. Contacts are rated at 0.5 amp resistive, 40 v dc; expected contact life is 3,000,000 operations. Operate time is 4-1/2 msec. Coils are supplied for 48 v dc and 115 v dc.

Wheelock Signals, Inc., Dept. ED, 273 Branchport Ave., Long Branch, N.J.

***Price:** $4.50 to $16.00.*

***Availability:** Delivery from stock.*

CIRCLE 91 ON READER-SERVICE CARD ➤

ENGINEERING NEWS - #8

SIX PUSHBUTTON SWITCHES

CHECKED *[signature]*	ENGR. *[signature]*	CONTROL SWITCH DIVISION

SUB-SUBMINIATURE

B7000 is only 11/32" diameter, 1 1/64" total length. Available with a bushing or flange mounting. Flange can be engraved. Anodized aluminum case, plastic plunger cap and solder lugs. Rated 1 amp at 28 VDC. The perfect pushbutton for subminiaturized instruments and control panels.

MOISTURE-PROOF, 6 CIRCUIT TYPES

W100 is available at S.P.S.T. (N.O. or N.C.), S.P.D.T., 2-circuit, and 3-terminal (N.O. or N.C.). Designed to MIL-S-6743, MS-25089. Completely moisture-proof and enclosed in anodized aluminum case with silicon rubber boot. Available with any of 8 mounting adapters (Adapter P shown) to meet any mounting or panel requirement. Rated 10 amps at 28 VDC resistive.

LOW COST, U.L. LISTED

B2000 series switches are considerably smaller than standard 1/2 amp momentary pushbuttons, yet cost much less and actually are U.L. rated at 8 amps, 120 VAC. Select S.P.S.T. circuit either N.O. or N.C., with solder lugs or pigtail leads. Mounts in 1/2" dia. hole.

WITH OR WITHOUT LIGHT

WC1500 is a very small moisture-proof switch (designed to MIL-S-6743) with a minimum life of 25,000 operations at rated load. Available with or without indicator light in pushbutton, and rated at 2 amp ind. or 4 amp res., 28 VDC. D.P.D.T. or 4-circuit. Mounts in 5/8" diameter panel hole.

MOISTURE-PROOF, ALTERNATE ACTION

J3136 is a new moisture-proof switch originally designed for military ground support and aircraft equipment. Two-circuits, rated at 5 amp ind. or 10 amps res. at 28 VDC; 5 amp (.75 P.F.) ind. or 10 amp res. at 120 VAC. Life is 25,000 operations min. at rated load. Anodized aluminum case with solder lug terminals, and 8 styles of mounting adapters available. Mounts in 5/8" dia. hole.

20 AMPS., PUSH-PUSH

J100 is a S.P.S.T. switch rated 20 amps res. at 28 VDC; 10 amps res. at 115 VAC. Ruggedly built to give compactness and durability under crictical operating conditions. Weighs only 1 oz. Total plunger travel is only 1/4". Overall size: 1" diameter, 2 15/32" long.

The switches shown above are merely samples from the full line of CONTROL SWITCH pushbuttons. Perhaps one of these is a solution to a switching problem you face. If not, write for your **free** copy of CATALOG 100 for details on the wide range of switches available, including basic switches, toggles, lighted pushbuttons, indicator lights and many other types.

CONTROLS COMPANY CC OF AMERICA

CONTROL SWITCH DIVISION

1406 Delmar Drive • Folcroft, Pennsylvania • Telephone LUdlow 3-2100 • TWX SHRN-H-502

Manufacturers of a full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading parts Distributors.

ENGINEERING NEWS--Pushbutton Switches

NEW PRODUCTS

Power Amplifier 408

Solid state

Model 1021SS is a solid state rf power amplifier designed for continuous operation. Specifications are: power input, 250 mw; power output, 2 w; frequency, 136 mc; input impedance, 50 ohms; output impedance, 50 ohms; efficiency, 35%; supply voltage, 28 v dc.

Airtronics, Inc., Dept. ED, 5522 Dorsey Lane, Washington 16, D.C. *P&A: $498.50 ea; 3 weeks.*

Insulation Tester 358

Provides up to 50 kv at 2 kva

Insulation materials tester model 4510 is designed to test both liquid and solid insulating materials to ASTM and Federal specifications. Test potential is continuously variable from 0 to 50 kv at 2 kva ac. Rate of rise is motor-driven and fully adjustable from 300 to 3,000 v per sec.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

Frequency Standard 409

Power level is 4 w

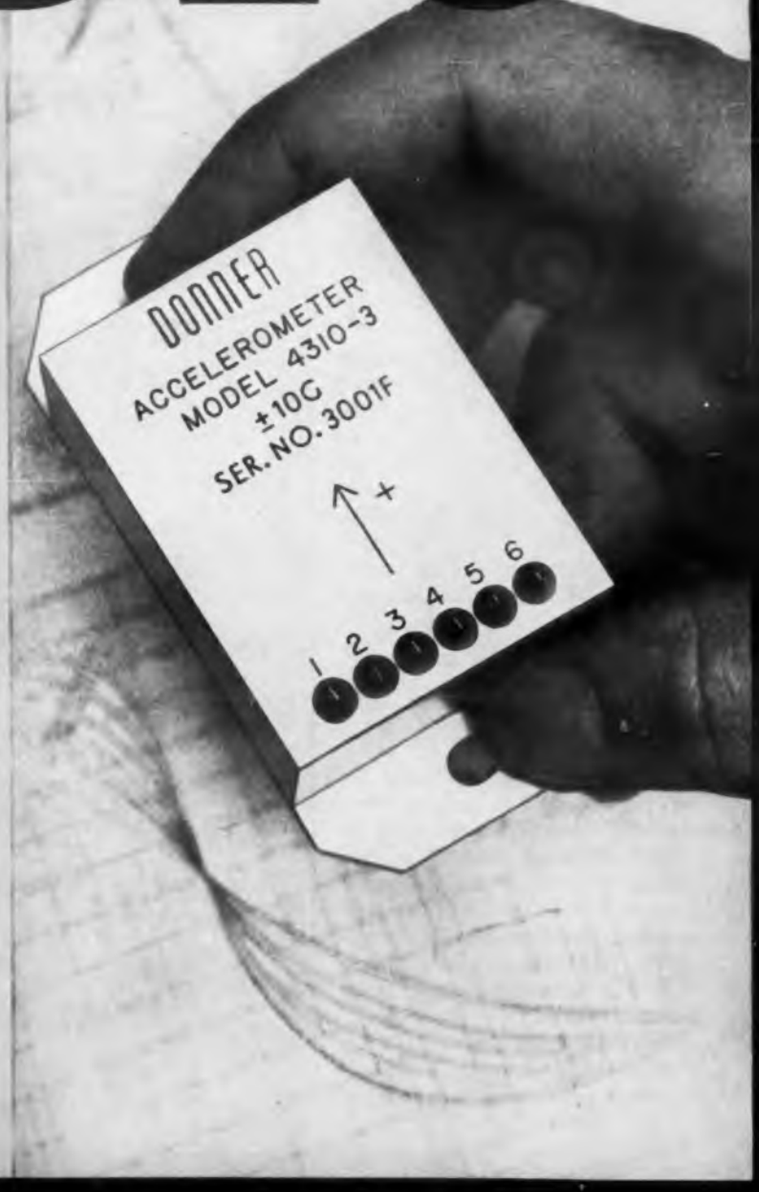
Frequency standard K-5A is a compact, light package source of 400 cps frequency at a power level of 4 w. Specifications are: input, 28 v dc ±10%; temperature, 55 to 71 C; accuracy, ±0.03%; output voltage, 100 to 135 v rms into 4,000-ohm load; size, 3-1/2 x 3 x 1-3/4 in.; weight, 1-1/2 lb.

American Time Products, Inc., Dept. ED, 61-20 Woodside Ave., Woodside 77, N.Y.

ACCELEROMETER RELIABILITY IS

4310

Three years and 3000 accelerometers later, the solid state Donner Model 4310 0.1% force balance servo accelerometer is still "state of the art." And it is the only precision instrumentation accelerometer with proven reliability—reliability defined by experience.



A TRANSISTORIZED SERVO TRANSDUCER WITH A RECORD 4310

First introduced in the fall of 1957, Donner Scientific Company's Model 4310 linear accelerometer has been successfully applied to the problems of missile and aircraft dynamics. Applications include telemetering, servo stabilization, gyro erection, acceleration switching, and short range inertial guidance. Polaris, Mercury, Atlas, Minuteman and Pershing are typical missile projects where the 4310 has played an important role. Engineering programs for both the Boeing 707 and DC-8 jet transports used the Donner 4310 as part of their test instrumentation.

9 REASONS WHY THE DONNER 4310 IS A STANDARD OF EXCELLENCE

1. High output, ±7½v dc standard, up to ±60v dc special. High output virtually eliminates signal to noise ratio problems, the need for an additional amplifier to drive voltage controlled oscillators in telemetry applications, and provides sufficient power to drive a recorder directly.

2. Use of the oil filled Model 4310 eliminates the need of filter networks for dc or low frequency applications.

3. No regulated power supply required. Standard Donner 4310's operate from a ±15 or +28v dc power source ±15%. Power drain is so low that they can be operated from miniature battery packs.

4. Overall weight can be reduced. The air filled unit weighs but 3.2 ounces; the oil filled, 7.5 ounces.

5. Available in split case to meet limited space requirements. Sensing element is in one case, electronics in the other.

6. For the measurement of broadband accelerations, the high natural frequency of the electronically damped unit provides flat response from dc to over 100 cps in most ranges.

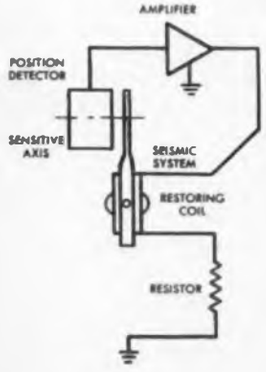
7. "Infinite" resolution.*

8. Performance. Linearity, 0.05% f.s. Hysteresis, 0.02% f.s. Repeatability, 0.01% f.s. Null indeterminacy, 0.02% f.s.* Statistical summation of probable errors from these factors, $3\sigma < 0.06\%$.

9. Price $450 for an 0.1% instrument. Almost five times better accuracy than any proven accelerometer available at a comparable price.

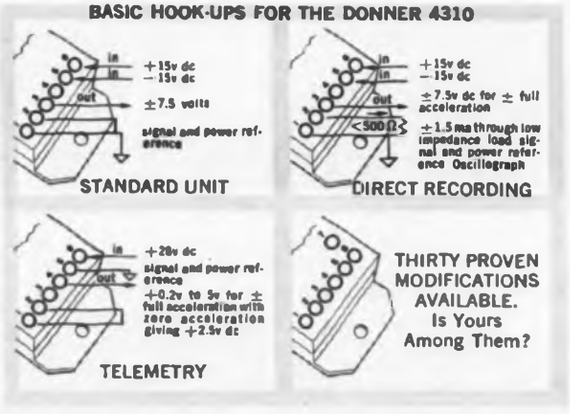
*Next time your Donner sales engineer calls, ask him to explain.

HOW IT WORKS



The Donner accelerometer operates as a subminiature servo system, responsive to input linear acceleration along its sensitive axis. Under an acceleration, the acceleration sensitive mass tends to move. As movement occurs, the position-error detector and servo amplifier generates a feedback signal which is returned as current through the restoring mechanism. The electromechanical servo action results in a balance between the input force created by the acceleration and the feedback force proportional to the current in the restoring coil. The restoring current, or the voltage it develops across a series resistor, is the output of the accelerometer and a precise measure of input acceleration.

BASIC HOOK-UPS FOR THE DONNER 4310



NEW 6 PAGE TECHNICAL BROCHURE READY NOW. For complete information, write for our bulletin, "The Donner 4310 Linear Accelerometer, A Standard of Excellence." Please address Dept 36.

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CONCORD, CALIFORNIA
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Challenging career opportunities available for engineers and scientists. Please contact us.

33

Antenna Mount 422

For ground or shipboard use

Model 11 antenna pedestal and tracking servo system is designed for ground-based or shipboard applications, with array-type antenna systems requiring high angular velocity and acceleration characteristics. Minimal inertia permits greater accelerations for a given azimuth drive motor. Versions are available with and without slip rings.

TEMEC, Inc., Dept. ED, 7833 Haskell Ave., Van Nuys, Calif.

Display Module 451

With 64 Characters

Alphanumeric display module type IL-2000 can display 64 individual characters when operated from a six-bit binary input, or 16 characters on a four-bit input. Display will change from 1 character to any other within 50 msec. The 5.5-oz unit is 4.5 in. long, 1.1875 in. high, and 1.0 in. wide. Characters measure 0.5 in. high and 0.3125 in. wide; viewing angle is 90 deg. Any desired combination of letters, numbers or symbols is available.

Servomechanisms/Inc., Dept. ED, 200 N. Aviation Blvd., El Segundo, Calif.

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Introducing General Electric's New Line of

Precision Regulated Transistorized DC Power Supplies

- **Convection cooled to eliminate all moving parts**
- **Unique "Constant Watts" circuit protects series transistors**
- **Standard ratings from 1.5 to 100 V.D.C. up to 20 amps.**

Whatever your application, here's a newly-designed series of precision regulated transistorized DC power supplies—for better electrical performance.

"Constant Watts" circuit protects against overloads, short circuits, misadjustments, line voltage variations.

Plug-in printed circuits and 25 percent fewer components increase reliability and reduce maintenance.

Economically priced. Contact your G-E Sales Engineer for information, or write for Bulletin GED-4184, to Section 535-03, General Electric Company, Schenectady, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

NEW PRODUCTS

Sample Changer 402

Holds 50 radiation samples

The SC-100 sample changer accommodates 50 alpha, beta or gamma emitters, of any size up to 2 in. Samples are transported on a horizontal, heavy-duty drive. Any type of detector may be used. The changer has individual drive motors for both the sample drive and positioning mechanisms. Size is 20-3/4 in. deep, 22 in. wide, and 7-1/2 in. high.

Tracerlab Inc., Dept. ED, 1601 Trapelo Road, Waltham 54, Mass.

Slip-Ring Assembly 434

With 15 to 30 rings

Designed for instrumentation applications, this packaged slip-ring assembly has from 15 to 30 rings. Current capacity is 2 amp at 250 v, 60 cps. The 3-lb unit is 8-3/4 in. high, 4-1/2 in. in diameter. It will operate up to 1,200 rpm.

Superior Carbon Products, Inc., Dept. ED, 9115 George Ave., Cleveland 5, Ohio.

Transistor Heat Sinks 410

Free convection type

Model 2700 series heat sinks increase transistor performance by optimizing the effect of the heat transfer coefficient available in free convection. The growth of boundary layers has been considered and the fins designed to permit optimum free air flow. Thermal resistances are: model 2701, 28 C per w; model 2702, 23 C per w; model 2703, 18 C per w.

Astro Dynamics, Inc., Dept. ED, 200 Sixth St., Cambridge, Mass.

◀ CIRCLE 93 ON READER-SERVICE CARD

Voltage Controller 352

Output is adjustable

Automated voltage controller model 402A produces an adjustable and externally programable regulated output voltage for a variety of industrial and military uses. Performance data include: input voltage, 50 to 135 v ac; output voltage, adjustable and programable from 0.5 to 135 v ac; output current, 20 amp; regulatoin, adjustable to 2% over output range. Response time is adjustable to 14 v per sec; external program input is 2,000 ohms per v.

Automation Development Corp., Dept. ED, 5979 W. Third St., Los Angeles 36, Calif.

P&A: $980 ea; six weeks.

DC Milliammeter 448

Clip-on type

A clip-on dc milliammeter, model 428B has full scale readings from 1 ma to 10 amp. Any current within the range is measured by clamping the probe jaws around the wire. The meter can measure the sums and differences of current in separate wires. An adjustable, calibrated output is available at a front-panel jack for driving recorders or making current measurements over a dc to 300 cps bandwidth.

Hewlett-Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.

Price: $550, cabinet or rack mount.

CIRCLE 94 ON READER-SERVICE CARD ➤
TO BE PLACED ON MAILING LIST

SILICON CONTROLLED SWITCHES . . . *from* SSPI

. . . Offering efficient switching in the 1-200 mA range and peak pulse current capability to 10 amperes, in the miniature TO-18 package.

Now in TO-18

- High sensitivity . . . 20 µA firing
- Close firing control . . . within ± .08V
- Voltage ratings to 200V
- MIL-S-19500 capability

Type	Maximum Anode Voltage (DC or Peak AC) ± Volts	Maximum Average Forward Current 75°C mA	Maximum Gate Current to "Fire" µA	Gate Voltage to Fire + Volts	
				Min.	Max.
2N884	15	200	20	.44	.60
2N885	30	200	20	.44	.60
2N886	60	200	20	.44	.60
2N887	100	200	20	.44	.60
2N888	150	200	20	.44	.60
2N889	200	200	20	.44	.60

Available for the first time in the miniature TO-18 case, these units offer the same high sensitivity and close characteristics control introduced by SSPI in pioneering PNPN devices for control and logic applications.

The precise firing characteristics of these devices make them ideal for timing and time delay circuits, voltage limit detectors, high gain static switching, logic circuits, and related applications.

With the high surge capability of this series, squib firing systems requiring pulse currents up to 5 amperes can be greatly miniaturized without sacrificing design margin. In addition, the low 1 mA holding current level is particularly useful in many programming, control and logic circuits.

Designed to meet the requirements of MIL-S-19500, these units are subjected to extensive temperature storage and cycling, as well as 100% acceptance testing, as a regular part of the manufacturing procedure.

Write for Bulletin C420-03.

CIRCLE 95 ON READER-SERVICE CARD

PROVEN LEADERSHIP IN *PNPN* TECHNOLOGY . . . *from* SSPI

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PIONEER 5-2800

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ENGINEERING

REPORT

ON BENDIX COMPONENTS

HOW MUCH CAN BENDIX SAVE YOU IN ANTENNA PEDESTALS?

GET OUR SPECIFIC ENGINEERING PROPOSAL

Bendix experience in ground radar pedestal design, manufacture and installation can benefit *you*. It can meet your requirements without delay. Since basic design and tooling have already been accomplished, modifications, for your prototype needs, can be made quickly—and with important savings—or, we can design a completely new pedestal to meet your specific needs.

Bendix ground-installation radar pedestals are lightweight, compact, air transportable. They possess a high degree of accuracy, and have been completely proved in the field. Bendix also is widely experienced in airborne radar systems for weather and target tracking purposes.

If these demonstrated radar capabilities meet your needs, write today for further information, including a *specific engineering proposal*. What are your requirements?

EXAMPLES OF APPLICATIONS:

Weather Radar • Storm Detection • Meteorological Tracking • Mortar Tracking • Electronic Countermeasure • Satellite Tracking • Drone Surveillance • Telemetering

Eclipse-Pioneer Division
Teterboro, N. J.

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District Offices: Burbank, and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D.C.
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

CIRCLE 96 ON READER-SERVICE CARD

NEW PRODUCTS

Copper-Clad Laminate 380

For printed circuits

Micarta Grade 65M24, a copper-clad, epoxy resin and paper base laminate, is made for printed circuit and other applications requiring high strength and consistent electrical properties over a wide range of humidity levels. It can be punched at room temperature. Flexural strength, bond strength, and solder resistance are high. Dissipation factor is 0.034 at 1 mc; dielectric constant is 4.5 at 1 mc after 24-hr immersion in water at 50 C.

Westinghouse Electric Corp., Micarta Div., Dept. ED, Hampton, S.C.

Potentiometer Dials 529

Developed for precision potentiometers, Revodex 1-7/8-in. and 1-in. dials have positive locking and easy mounting. There is no backlash; life is 1/4 million cycles. They are made of devices with 10 turns or less.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

Availability: *3 weeks.*

See at Show Booth 2428-32.

Drive Motor 383

For radioactive environments

Model 36V58RP143 is a Weir drive motor for radioactive environments. Input is 115 v, 3-phase, 400 cps; output is 150 oz-in. at 12 rpm. Temperature rise is 40 C max. Motor measures 1.5 in. in diameter by 3.31 in. long, less shaft extension. Weight is 15 oz.

Western Gear Corp., Electro Products Div., Dept. ED, 132 W. Colorado Blvd., Pasadena, Calif.

ENGINEERING
REPORT
ON OTHER BENDIX COMPONENT PACKAGES

PRECISION DATA AND CONTROL SYSTEMS FOR LARGE RADAR ANTENNAS

Through intensive research and development for major programs, Bendix offers a wealth of design experience in both digital and analog radar control and data systems. We can:

1. Develop *complete systems or subsystems* to comply with any customer requirement.
2. Provide a wide range of installation options, i.e.: one antenna or a battery; control of one radar by another; digital or analog control. Systems with accuracies of .005° or better can be offered.

Manufacturers of

GYROS • ROTATING COMPONENTS
RADAR DEVICES • INSTRUMENTATION
PACKAGED COMPONENTS

Eclipse-Pioneer Division

Bendix

Teterboro, N. J.

Tape Reader 430

30 characters per sec

The Raeden paper tape reader is a small unit with a speed of 30 characters per sec. It is useful for tape-to-card conversion, analog-to-digital conversion, direct telephone transmission of data, and other systems uses. It can read 5, 6, 7, or 8 channels via bifurcated contacts operated by star wheels. Cost is low.

Systronics, Dept. ED, 3673 Newton St., Torrance, Calif.

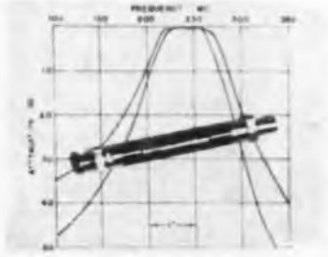
Probe Thermistor 413

With a diameter of 0.060 in., this glass probe thermistor has a dissipation constant of 0.6 mw per deg. Time constant is 6 sec. The device combines the characteristics of bead and glass probe thermistors.

Victory Engineering Corp., Dept. ED, 519 Springfield Road, Union, N. J.

Band-Pass Filters 421

For telemetry service



Miniature band-pass filters type TBP are designed for use with telemetering systems. Center frequencies are available from 200 to 2,000 mc with band-pass widths of 2.5% to 20%. The unit shown has three sections and covers the 220- to 260-mc band. Bandwidth is 40 mc; insertion loss is less than 0.5 db and rejection at 430 mc is over 50 db. Filters operate to 100 C and are made to withstand severe environments.

Telonic Engineering Corp., Dept. ED, 775 Broadway, Laguna Beach, Calif.

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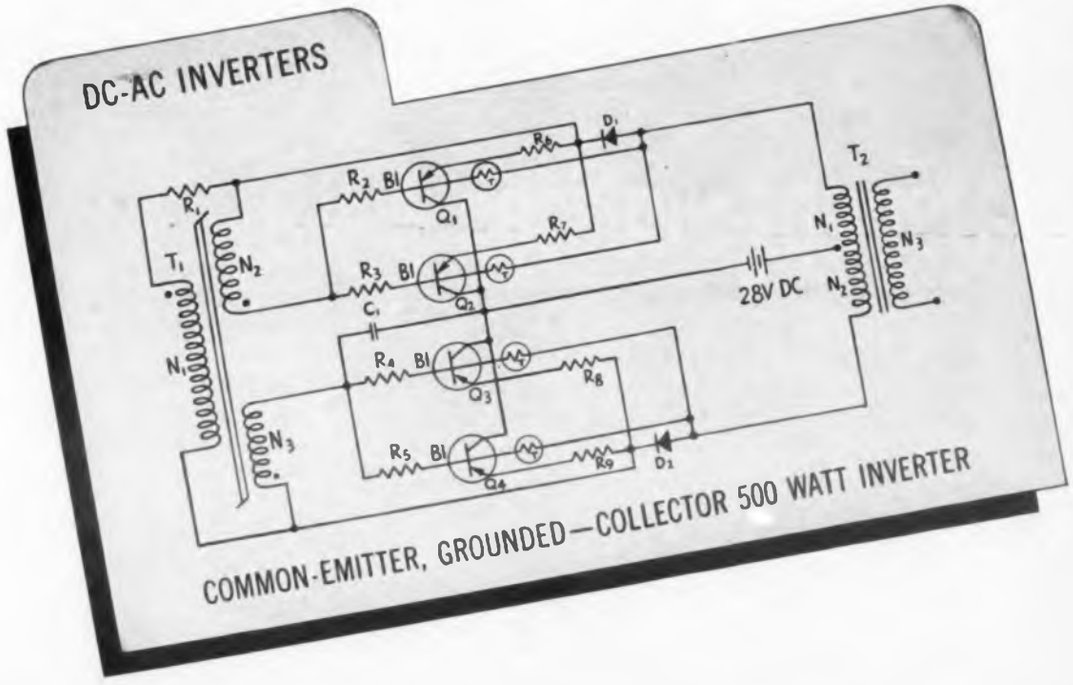
CIRCUIT IDEA FILE

A Honeywell Service Featuring

New Transistor Applications



Are you looking for high-power square wave from DC? Here is what Honeywell Power Tetrode Transistors can give you in an inverter circuit:

- 500 Watts output—higher outputs can be achieved by further paralleling.
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- 75% or better *overall* efficiency—the result of square-wave operation with switching times of less than 5μ sec.
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- Uses the Honeywell-developed two-transformer square-wave oscillator circuit.

Power Transistors used are also available in a single-ended modified TO-36 case. For full details, send the coupon below to: Honeywell, Dept. ED-3-86, Minneapolis 8, Minnesota.

Sales and service offices in all principal cities of the world.

COMPONENTS

R_1—20 ohm Q_1-Q_4—Honeywell 3N46 or 3N50
R_2-R_5—3.3 ohm C_1—0.5 μfd.
R_6-R_9—0.05 ohm D_1&D_2—35 amp. rectifiers
ww—20 ohm @25°C 1N1183 or equivalent
± 3.3 ohm @ 80°C
T_1—¼" stack of 1DU Orthonic
N_1—250T #26, N_2&N_3—29T #18
T_2—Square core Hypersil "C" #H-14
N_1&N_2—15T #12, N_3—as required

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Kindly check one or both of the following:

☐ Please send me your Application Note AN5A detailing solid-state square-wave oscillator Power Inverters.

☐ Please have a Honeywell field engineer call on me at my convenience.

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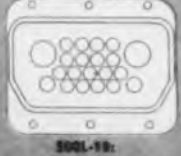
NOW FOR THE FIRST TIME you can have a rack and panel connector with contacts made in accordance with MIL-C-26636 . . . an exclusive CEC feature. And they are available in six configurations . . . Die-cast aluminum shells in accordance with MIL-QQ-A-591A and insulator blocks of high-strength glass-filled diallyl phthalate per MIL-M-19833. Check these configurations with your requirements:

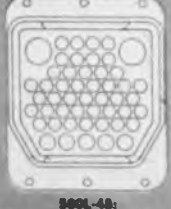
500L-15:
13 size 20 contacts,
2 size 16 contacts.



500L-19:
17 size 20 contacts,
2 size 16 contacts,
2 standard RG58/U
coaxial contacts.

500L-28:
25 size 20 contacts,
3 size 16 contacts.

500L-38:
28 size 20 contacts,
5 size 16 contacts,
5 standard RG58/U
coaxial contacts.



500L-48:
43 size 20 contacts,
5 size 16 contacts,
2 standard RG58/U
coaxial contacts.

500L-63:
59 size 20 contacts,
4 size 16 contacts.

For more information, write for Bulletin CEC 4006-X10

Electro Mechanical Instrument Division

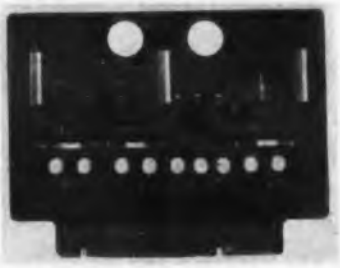
CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

NEW PRODUCTS

Pulse Generators 374

Range from 4 μsec to 20 sec



Plug-in module MP-3 contains 3 independent one-shot multivibrators and 3 independent amplifiers that can be connected to either output of any one-shot. Capacitors can be selected to provide pulse widths in the range of 4 μsec to 1 sec. Externally mounted capacitors increase the pulse width range to 20 sec.

Abacus, Inc., Dept. ED, 3040 Overland Ave., Los Angeles 34, Calif.

High-Purity Anodes 416

Impurities are limited to as little as 0.02% of bismuth and antimony in these tin-lead solder anodes. Available in extruded form, the anodes come in three shapes: round, elliptical and flat.

Alpha Metals, Inc., Dept. ED, 56 Water St., Jersey City 4, N. J.

Headset 423

Impedance is 200 K

The Mark III headset has a maximum impedance of 200 K; frequency response is 50 to 9,000 cps. Sensitivity is 120 db at 1 kc, 1 mw input. Designed for comfort, the 12-oz headset is rugged, tamperproof and sterilizable. It is adaptable to all types of boom microphones.

Telex, Inc., Communications Accessories Div., Dept. KP, Dept. ED, 1633 Eustis St., St. Paul, Minn.

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Triaxial Accelerometer 355

Potentiometer type

Potentiometer-type triaxial accelerometer model 620 is designed to provide high-level signals proportional to component accelerations along the mutually perpendicular axes. Specifications are: range, each axis, 1 to 50 g; dynamic error band, to ±0.6%; resistance, 1 to 10 K; cross-axis acceleration error, 0.01 g per g max; basic size, 2 x 3 x 2-3/4 in.

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

Pre-Trigger Pulse Generator 426

With 100-kc repetition rate

Type 111 pulse generator provides both output and pre-trigger pulses. Output pulses, at amplitude of 5 v, range in duration from 2 to 100 nsec. Rise time is less than 0.5 nsec. Repetition rate is continuously variable from 10 pps to 100 kc. Pre-trigger pulses can be set to occur from 30 to 250 nsec ahead of each output pulse, with amplitude of 10 v, duration of 250 nsec, and half-amplitude rise time of 4 nsec.

Tektronix, Inc., Dept. ED, P. O. Box 500, Beaverton, Ore.
Price: $365.
Availability: *Immediate.*

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. . . . can mass produce ceramic-to-metal products

Ceramics International is establishing a new level of superiority in ceramic-to-metal products. Components with exceptional electrical characteristics and greatly improved reliability are produced in a completely unique facility — the only existing plant engineered for contamination-free quantity manufacture.

At Ceramics International, personnel highly skilled in metallizing techniques and precision processes apply new production methods under carefully controlled conditions. Capabilities exist for the manufacture of both miniature and standard size ceramic-to-metal parts . . . but at Ceramics International emphasis is placed on miniature envelopes for diodes, transistors and relays.

Ceramics International products feature:

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Expert Ceramics International technology also produces custom parts to specification.

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CAPACIBILITY*

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ELECTROLYTIC CAPACITORS

Available right now—from Aerovox—*electrolytic capacitors with useful life expectancies of better than 10 years!* Premium materials and precisely controlled manufacturing processes result in extra long life especially adaptable to the needs of critical equipments such as computers and telephone systems. Units are rated for operation at temperatures from —20°C to +85°C where operation above 65°C does not exceed 15% of total operating time.

TYPE AFT. Twist-prong mounting ears and pillar type mounting terminals. Bossed terminals and special vent construction are molded in can cover. Corrosion-resistant paint finish. Available in voltage ratings from 6 to 450 VDC in wide range of capacitance values including dual and triple sections.

TYPE QE. Drawn aluminum cases in four diameters and one standard height (4½" over insulating tube). Ideal for ganging in banks. Available in wide range of capacitances at voltage ratings from 5 to 450 VDC. Screw type terminals for bus bar connections.

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AEROVOX CORPORATION

NEW BEDFORD, MASS.

CIRCLE 102 ON READER-SERVICE CARD

NEW PRODUCTS

Sine-Wave Generator 384

Range is 1 cps to 1 mc

Range of the 401F sine-wave generator is 1 cps to 1 mc. Output is 20 v, open circuit, and 10 v into a 600-ohm load. Any value load may be connected without effect on waveform. A five-step decade attenuator and a fine output control are provided. Dial accuracy is ±2%; frequency stability is ±0.5% to ±2%.

Waveforms, Inc., Dept. ED, 6 Cornelia St., New York 14, N.Y.

Price: *$250.*

Availability: *Stock.*

All-Metal Seal 415

The Bar-X seal, for dynamic applications, performs at temperatures from −425 to 1,200 F, and pressures from vacuum to 6,000 psi. The all-metal device requires low installation force and has practical breakout torque requisites for shaft seal uses.

Wiggins Connectors, E. B. Wiggins Oil Tool Co., Inc., Dept. ED, 3424 E. Olympic Blvd., Los Angeles 23, Calif.

Two-Lamp Transformer 445

With independent circuits

A two-lamp parallel mercury transformer keeps one lamp burning should the other fail. Lamps are electrically independent, with negligible interaction. A constant-wattage design provides a regulated, safe power flow to the remaining lamp, and limits starting current during lamp warmup. Stable lamp operation is maintained despite voltage dips as great as 30%.

Sola Electric Co., Dept. ED, Elk Grove, Ill.

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MODEL 100
For accurate measurements of pressures taken in tight locations under severe environmental conditions.

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MODEL 200
Ruggedized and electrically flexible version of basic SP-2 unit. Offers close calibration and accuracy tolerances necessary for standardization.

rugged reliable

MODEL 300
Originally designed for measuring rocket nozzle pressures; has survived many rocket firings. Now widely used outside rocket field wherever extremely sturdy pickup needed.

SP2 pressure transducers

MODEL 600
Especially designed for differential measurements at full pressure. Monitors without using reference medium, yet small and rugged for missile and rocket applications.

are described in

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STANDARD CONTROLS INC.

1130 Poplar Place • Seattle 44, Washington

CIRCLE 103 ON READER-SERVICE CARD

Shaft-Angle Encoder 396

In size 18

A noncontacting shaft-angle encoder, this device provides accurate readout at 10,000 rpm and has exceptionally low starting and running torque. The size 18, synchro mount unit has a nonambiguous Gray code and is mechanically interchangeable with brush-type encoders. It is available in clockwise or counter-clockwise rotation.

United Aircraft Corp., Norden Div., Dept. ED, Norwalk, Conn.

Snap-In Connector 393

Withstands 500 F

Able to maintain electrical properties up to 500 F, these connectors insert and mate with a hand force of 7 lb, and disconnect with a hand pull of 20 lb min. Phosphor-bronze contacts in both parts meet or exceed MIL-C-26636. Contact surfaces are gold over silver or nickel. The connectors accept wire sizes 26 through 18, and are available in 13 sizes ranging from 7 to 123 contacts. Wires are crimped in with hand-operated or automatic tools.

U. S. Components, Dept. ED, 1320 Zerega Ave., New York 62, N.Y.

CIRCLE 104 ON READER-SERVICE CARD ➤

TAKEN FROM TOMORROW

BIPCO™ Modules — Built-In-Place Components In Modular Form . . .

The Burroughs Corporation announces the commercial availability of tomorrow's techniques . . . today. BIPCO modules combine the reality of performance, low cost and immediate availability, to signal a major transition in the state of the art.

Thin Film Memory Planes and Solid State Multi-element Modules are the first of the BIPCO module family. The Thin Film Memory is capable of storing 20 words of 8 bits each for a total of 160 bits of information, and has a cycle time of 0.2 microsecond. The Solid State Module is a binary coded decimal to decimal diode converter which utilizes 40 diodes in matrix logic.

Burroughs Corporation's breakthrough in Built-in-Place Components is made possible by the unique combination of two major new techniques. First, multi-element components are simultaneously fabricated within a single device. Second, these elements are placed in a predetermined pattern in such a manner as to facilitate complex internal connections.

This combination of techniques has resulted in BIPCO Modular Devices with simple inputs and outputs which perform functions normally requiring myriads of elements and connectors.

Write for BIPCO Module Technical Brochure.

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Burroughs Corporation

ELECTRONIC TUBE DIVISION

Plainfield, New Jersey

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SPIRAL WOUND
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Spiral Wound
PAPER TUBES
Speed and Improve
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ANY SIZE—SQUARE OR RECTANGULAR

PARAFORMED paper tubes simplify coil winding operations and speed production, *yet cost no more.* In the exclusive PARAFORM method of tube making, no artificial heat or pressure is used—*Paraforming* takes place at the time of spiral winding. Hi-Dielectric. Hi-Strength. Kraft, Fish Paper, Acetate, Red Rope or any combination wound on automatic machines. *Produced from stock arbors or special sizes engineered for you.* Can also be supplied in regular or with slight bow.

- No sharp outside edges to cut wire
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- Permits winding coils to closer tolerances
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Manufacturers of Paper Tubing for the Electrical Industry Since 1931

Write on company letterhead for
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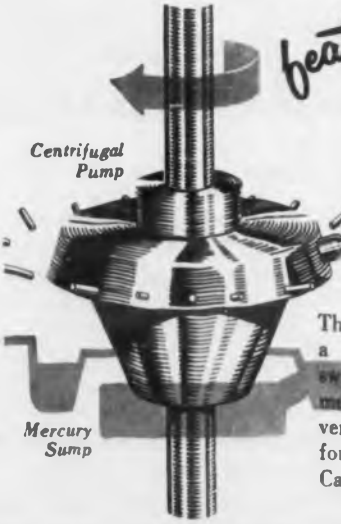
A HIGH SPEED MERCURY COMMUTATING SWITCH



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NO "CONTACT BOUNCE"
LOW NOISE LEVEL
HIGH SAMPLING RATE
ONLY MAINTENANCE-CLEANING

The DELTASWITCH is a unique commutating switch in which a jet of mercury replaces the conventional wiper arm. Send for more details. Ask for Catalog ATL-19.

ADVANCED *Technology* LABORATORIES
A DIVISION OF AMERICAN-Standard

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CIRCLE 106 ON READER-SERVICE CARD

NEW PRODUCTS

Circuit Breaker 375

With auxiliary switching

The CB-3700 circuit breaker contains a separate circuit for auxiliary switching. Isolated from the tripping circuit, it may be used to activate relays, energize other gear or provide a warning when the breaker trips. Ratings range from 1/2 to 50 amp. Life expectancy is over 10,000 cycles. The breaker will withstand shock to 25 g, and is resistant to contamination.

Wood Electric Corp., Dept. ED, 244 Broad St., Lynn, Mass .

Price: *$9.50, 1 to 9.*

Availability: *4-week delivery.*

DC Power Supply 449

Is remotely programable

Model 723A dc power supply provides a regulated output of 0 to 40 v at 0 to 500 ma. Output voltage may be changed by changing the value of an external resistance. Noise and ripple are less than 200 μv. Voltage change is less than 0.1% for load variations from 0 to 500 ma. A front-panel meter monitors either voltage or current. Current limit control is variable. Output terminals are isolated from the chassis and power-line ground.

Hewlett-Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.

Price: *$225.*

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CRYSTAL
BANDPASS
FILTERS
1 MC THRU 21 MC

The Keystone KCF Series of crystal filters is available in 3 standard case styles covering the frequency range from 1 MC through 21 MC. Higher frequencies and special case sizes are also available to conform to individual custom requirements. Compact, ruggedized packaging meets all applicable Mil specs. The KCF series has particular applications in Doppler Radar, Receiver IF, Comb Filter sets or wherever filters of high stability factors and narrow bandwidths are required.

Write for complete technical data.

KEYSTONE: FIRST IN FREQUENCY CONTROL

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Subminiature component ovens • crystal ovens • crystal filters and discriminators • quartz crystals—100 KC thru 150 megacycles or higher upon request

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From the NEW convenience-styled L&N line...

9834 NULL DETECTOR features high d-c sensitivity, low noise, low drift

Uniquely equipped with a guarded circuit to permit operation with guarded or unguarded potentiometers or bridges, this d-c null detector—one of a family of brand-new L&N instruments—is rugged, portable, line-operated . . . a significant advance in null-indicator design.

Sensitivity—*Four switch-selected ranges: 1, 10^{-1}, 10^{-2}, 10^{-3}. Maximum sensitivities (at least as high as stated) are:*

Source Resistances (Ohms)	Sensitivity (Position 1)	
	μv/mm	μv/scale div.
Up to 20,000	0.2	0.30
20,000 to 50,000	0.3	0.45
50,000 to 100,000	0.5	0.75

Period—*Less than 2 sec. for source resistances up to 1000 ohms, increasing to 4 sec. at 100,000 ohms.*

Noise—*Less than ± 0.1 microvolt.*

Zero Shift—*After initial warm-up, total shift at maximum sensitivity is no greater than ± 2 scale divisions. After 1 hour, rate of shift does not exceed ½ div./hr.*

Input Impedance—*40,000 ohms.*

Meter Response—*Non-linear. Essentially linear for 20% deflection either side of zero.*

Guarding—*Detector guard-circuit connects to shield of 2-conductor input cable (2 ft) supplied with detector.*

Case—*Metal, 9¼" (h) x 6½" (w) x 14" (l). Weight, 16 lbs. Operates on 120 volts, 60 or 50 cycles.*

Price—**$295** *(subject to change without notice), f.o.b. Phila. or North Wales, Pa.*

Specify List No. 9834 when ordering from nearest L&N Office or 4908 Stenton Ave., Philadelphia 44, Pa.

LEEDS Instruments **NORTHRUP** Automatic Controls • Furnaces

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Commutation Simulator 424

For telemetry systems

ESS 305 is a telemetry commutation simulator for pulse-amplitude and pulse-duration modulated signals produced by telemetry systems. Commutation rate range is 10 to 10,000 channels per sec in 6 bands. Information accuracy is within ±0.15% of full scale; simulator output linearity is within ±0.10% of full scale for incremental data changes. Output stability is ±0.15% of full scale. Pulse rise and fall is 0.50 to 3.0 μsec.

Telemetrics, Inc., Dept. ED, 12927 S. Budlong Ave., Gardena, Calif.

Ribbon Cable 414

Ribbon cable is available in widths to 1 in., 20 conductors, wire sizes 28 through 10. The multicolored, plastic-insulated wires are arranged in a parallel construction. Advantages claimed are space saving, ease of installation, and low cost.

Westwood Cable Corp., Dept. ED, 3440 Overland Ave., Los Angeles 34, Calif.

Particle Detectors 442

Are subminiature

Subminiature, solid-state particle detectors have wide application. The NPS series has models with sensitive areas 5-mm and 10-mm sq. Minimum base resistivity ranges from 200 to 5,000, with operating voltages from 25 to 100. The units detect such particles as electrons, protons, alphas, heavy ions and fission fragments. The package plugs into a standard transistor socket.

Solid State Radiations, Inc., Dept. ED, 9925 W. Jefferson Blvd., Culver City, Calif.

Price: *$25 to $230.*

Availability: *delivery from stock.*

. . . style 314 ideal for the most demanding military or industrial applications

To meet the production needs of computer and instrument manufacturers, new Erie Style 314 miniature CERAMICONS® are ideally suited for automatic insertion into printed wiring boards or automatic lead cutting and forming. This molded phenolic case CERAMICON is supplied in "Reel Paks," "Ribbon Paks," or in bulk. Use it where space is at a premium.

Erie's "Reel Pak" and "Ribbon Pak" give you a continuous strip of Style 314 miniature CERAMICONS completely compatible with standard insertion-machines for printed wiring boards and for automatic feed into lead cutting and forming machines.

The Style 314 is 100% electrically tested during manufacture. Let us demonstrate the advantages of this new miniature CERAMICON . . . packaged to meet your requirements. Write today for latest literature . . . Bulletin 503.

* Shown actual size: .185" diameter, .450" length

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Test Instrumentation Specialists

Now you can have the precision voltage and phase indicator that meets military specifications for advanced ground support systems

NAVAPI

NAVAPI, North American's Voltage And Phase Indicator, is designed for highly accurate measurement of voltage and phase in 380- to 420-cps signals. It has had more than six years of proven in-plant use on precise electronic and electromechanical systems and is currently in use on highly sophisticated ground support systems.

NAVAPI operation is fast and simple. You just adjust two potentiometers and set a few simple switches to obtain null between test signal and reference voltage.

In-phase error is less than 0.1% of maximum reading per range; quadrature error less than 1.0%. NAVAPI offers a high resolution reading accuracy: in-phase, 0.008% of maximum reading per range; quadrature, 0.08%.

Immediate delivery is available now. Complete unit includes input and output amplifiers, summing circuit, in-phase and quadrature voltage circuits, and power supply. Write for NAVAPI catalog with full information.

NOTE: for an instantaneous response to your TWX inquiries, use TWX CPT-6137.

Autonetics
DIVISION OF NORTH AMERICAN AVIATION
Industrial Products
3400 East 70th Street, Long Beach, California
CIRCLE 110 ON READER-SERVICE CARD

NEW PRODUCTS

Signal Amplifier 439

Weighs 4.25 oz

CA17 signal amplifier weighs 4.25 oz and occupies 4 cu in. It may be used with any resistance strain-gage transducer. Potentiometers are provided for zero and sensitivity adjustments. Signal output of the carrier amplifier is isolated from the power supply input. Output is —0.5 to 5 v dc, with a power requirement of 35 ma at 28 v dc ±5%. Frequency response is flat ±4% from 0 to 2,000 cps. Unit operates with transducers with rated sensitivity from 1.5 to 10 mv per v. Combined nonlinearity and hysteresis are less than ±0.3% of full scale.

Statham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Low-Pass Filters 429

In small cases

Miniature low-pass filters cover a frequency range of 200 cps to 20 kc at impedance levels of 1 K, 5 K, 10 K, and 50 K, and from 300 cps to 20 kc at the 500/600-ohm impedance level. Case size of hf units is 1-3/16 x 1-3/16 x 1-1/4 in. The hermetically sealed filters reach an attenuation of 30 db min at a frequency 2.2 times the 3-db cut-off frequency. Passband ripple and insertion loss are low.

T T Electronics, Inc., Dept. ED, P. O. Box 180, Culver City, Calif.

Price: $16 to $23 ea.
Availability: Stock.

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YOUR HIDDEN HELPER

—eliminates the old bugaboo of cable entanglement which damages tubes and components in lower chassis each time the one above is withdrawn for service and returned to position.

Our new Cable Retractor's double action maintains constant tension and correct suspension of cable at all times—permits ample cable length for full extension and tilting of chassis without hazard of snagging.

For use with all types of chassis or drawer slides, adjustable to fit varying chassis lengths, simple to install, inexpensive, proven thoroughly reliable in operation.

Mounts on rear support rails on standard 1¾" hole increments. Cadmium plated CRS.

Write for Bulletin CR-100E
ORegon 8-7827

WESTERN DEVICES, INC.
600 W. FLORENCE AVE., INGLEWOOD 1, CALIF.
CIRCLE 111 ON READER-SERVICE CARD

CIRCLE 112 ON READER-SERVICE CARD

Decade Ratio Transformers 356

Accuracy is 0.001%

Decade ratio transformers, series A 102 R/TRAN are designed for laboratory use as voltage-ratio standards. Absolute ratio accuracy is 0.001%, full scale; resolution is 5 ppm. Useful frequency range is 25 cps to 10 kc.

Astrosystems, Inc., Dept. ED, 220 E. 23rd St., New York 10, N.Y.
Availability: *30 days.*

Telemetry Discriminator 407

Solid state

Single-channel telemetry discriminator, type 42-7952, is completely solid state. A rack panel 8-3/4 in. high will mount 18 units to cover the standard IRIG channels. Specifications are: f_o, all IRIG channels 1 through E; frequency deviation, standard ±7.5% or ±15% IRIG deviations; input impedance, at least 43 K; linearity, ±0.25% or better of bandwidth.

Airpax Electronics Inc., Dept. ED, Fort Lauderdale, Fla.
P&A: *$640 to $800; 3 to 6 weeks.*

Radar Beacon 357

For C-band use

Radar beacon checkout unit RBCC-1 is designed for multiple functions in relation to C-band beacons. Included are threshold, power output, countdown and beacon delay. The unit was designed for operation at 5.6 Gc but is also available in ranges from 1 to 12 Gc operation. Test time, including set-up and calibration does not exceed 45 sec. The unit measures 19 x 18 x 12 in. and weighs under 60 lb.

Astronautics, Inc., Dept. ED, Melbourne, Fla.

RCA announces
a major advance
in Tube Technology,
assuring

IMPROVED PERFORMANCE AND LONGER LIFE IN RECEIVING TUBES...

THE "DARK HEATER"

From RCA—which in recent months has brought you the revolutionary nuvistor tube, the dramatic Novar receiving tube, new super-strength metallized ceramics, the vacuum-melted cathode, and S-311 high-dissipation plate material—now comes the latest in a proud list of contributions to tube making: "DARK HEATER".

The "DARK HEATER" is a key to greatly extended life and improved performance of receiving tubes.

The "DARK HEATER" operates at greatly reduced temperatures—as much as 350°K below the 1500 to 1700°K of the "White" heater. The unique dark surface radiates heat more efficiently and improves the transfer of heat to the cathode. Thus the required cathode temperature is attained with the heater operating temperature lowered to approximately 1350°K.

For more information on what this dramatic advance in heater design can mean to you in your equipment, see your RCA Field Representative.

SPECIFIC ADVANTAGES TO YOU INCLUDE:

EXTENDED HEATER LIFE—Heater wire strength is much greater at lower operating temperatures. For example, a reduction of 350°K in operating temperature results in a 50% increase in ultimate tensile strength of the wire, and a reduction of as much as 25% in internal stresses which may occur during heater cycling.

REDUCED LIKELIHOOD OF HEATER FAILURE—The smaller thermal change during heater cycling, and the greatly reduced operating temperatures minimize the tendency toward recrystallization and burnout.

CONSTANT HEATER CURRENT—The "DARK HEATER" exhibits an exceptionally stable current characteristic throughout its life. This feature is especially desirable in maintaining a constant cathode temperature.

REDUCED HEATER-CATHODE LEAKAGE AND HUM—AC leakage and hum are significantly reduced through the use of the "DARK HEATER". This improvement is most startling because it eliminates "spike" or pulse leakage currents sometimes present in other heaters. In addition, the reduction of heater temperature serves to reduce both AC and DC leakage from heater to cathode, and heater emission to other tube electrodes.

IMPROVED MECHANICAL STABILITY—The cooler operation of the "DARK HEATER" minimizes changes in heater shape during life, reducing the possibility of heater damage and heater shorts.

GREATER SAFETY IN VOLTAGE RATINGS—Cooler heater operation provides a greater margin of safety in present H-K voltage ratings.

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RADIO CORPORATION OF AMERICA

RCA FIELD OFFICES: East: 744 Broad St., Newark 2, New Jersey, HUmboldt 5-3900
Midwest: Suite 1154, Merchandise Mart Plaza, Chicago 54, Ill., WHitehall 4-2900
West: 6801 East Washington Boulevard, Los Angeles 22, Calif., RAymond 3-8361

Nose Cones Plated with Sel-Rex Bright Gold* Recovered From Space Orbits

President Eisenhower holds American flag which was in recovered capsule during its flight through space. Capsule shown was electroplated with patented Sel-Rex Bright Gold Process.

finding the golden needle in the haystack...

Space capsule Discoverer XIV was plated with Sel-Rex Bright Gold. So was its predecessor, Discoverer XIII, which had been rescued earlier from the Pacific Ocean.

This patented plating process was applied by Philadelphia Rust-Proof Co., Inc. to provide maximum heat reflectivity and emissivity, under sub-contract from General Electric Company Missile and Space Vehicle Department. Sel-Rex precious metal plating processes, in fact, are included in the original specifications of many advanced Space Age projects.

Sel-Rex sales and service technicians throughout the Free World are ready to serve you with unmatched professional precious metal plating services. Technical literature free on request.

* *Patented*

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Electrically conductive epoxy cement...

ends soldering!

Eliminate high-heat soldering problems with EPOXY PRODUCTS' new electrically conductive epoxy cement. Silver-filled epoxy cement is fast, safe, foolproof! **The bond is better than solder,** quality can be closely controlled—and, of course, it is highly conductive. Perfect for transistors, potentiometers, tantalum capacitors, diodes, etc. Available to cure at room temperatures (2 component system #3022) or low heat (1 component system #3012).

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NEW PRODUCTS

Connector Plug 433

With molded construction

Connector plug type ST-152 has integral molded construction designed to eliminate shorts. Cable strain relief is provided. The plug is available molded to shielded or unshielded two-conductor cable. Plugs with up to six prongs are available. Pins are brass tube, nickel plated.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

Noise Generator 420

Provides 175 db

A wideband noise generator, the Stentor 205, generates, in a 64-cu-ft chamber or plane-wave tube, sound pressure levels of 175 db and rms sound pressure levels of 168 db. Noise band is 20 to 16,000 cps; mass air flow is 6.7 lb per sec. Two or more overlapping rotors with different speeds provide a sequence of rectangular pulses with variable widths and spacing.

Tenney Engineering, Inc., Acoustics Div., Dept. ED, 1090 Springfield Road, Union, N. J.

Decade Counter Tube 365

Cold-cathode type

Type Z302C, a cold-cathode, gas-filled decade counter tube provides an output pulse of such magnitude that interstage coupling amplifiers are

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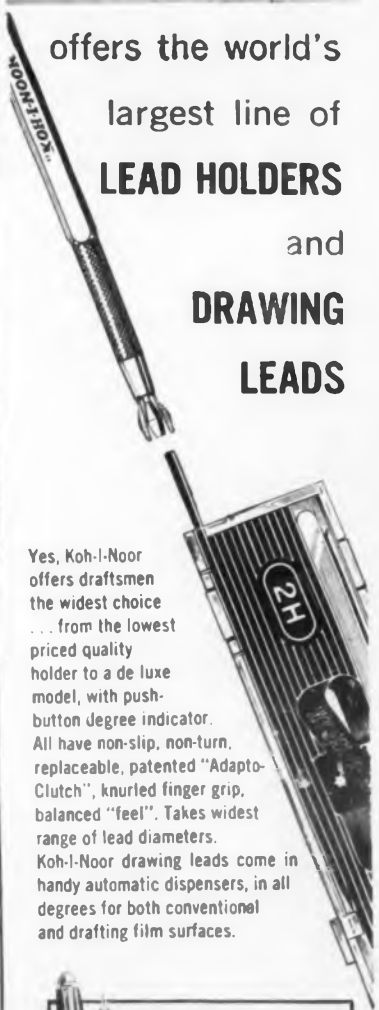
offers the world's largest line of **LEAD HOLDERS** and **DRAWING LEADS**



Yes, Koh-I-Noor offers draftsmen the widest choice . . . from the lowest priced quality holder to a de luxe model, with push-button degree indicator. All have non-slip, non-turn, replaceable, patented "Adapto-Clutch", knurled finger grip, balanced "feel". Takes widest range of lead diameters. Koh-I-Noor drawing leads come in handy automatic dispensers, in all degrees for both conventional and drafting film surfaces.

NOW... 2 KOH-I-NOOR *RAPIDOGRAPH* Technical Fountain Pens

in 7 "Color-Coded" precision line widths: 00, 0, 1, 2, 2½, 3, 4. Uses India (or regular) ink for ruling, lettering, tracing, writing, etc.

Model No. 3065: A new model with 7 interchangeable drawing point sections, each complete with airtight refillable ink cartridge. Comes in handy desk top container.

Model No. 3060: The regular Koh-I-Noor Rapidograph "Technical" Fountain Pen with self-contained automatic filling system, and pocket clip.

Write for Descriptive Literature

KOH-I-NOOR
INCORPORATED
Bloomsbury 24, New Jersey

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There's really not much to custom-designing rotary switches...

It's a matter of routine . . . when you have talented engineers with lots of experience... first quality materials... and advanced manufacturing techniques.

Fortunately, The Gamewell Company has all three. When customers' specifications come in, our engineers get busy. The precious metal ring, heart of a Gamewell Rotary Switch, is designed with as many segments as required. Brushes are provided which assure smooth, trouble-free action with either MAKE-BEFORE-BREAK or BREAK-BEFORE-MAKE contacts. Then a highly versatile arrangement of terminals connecting to ring segments is devised for the periphery of the switch housing. And so on, depending on requirements.

The end result is a highly versatile, reliable switching component. Cased in special plastic, it's inherently fungus resistant and stable at high temperatures. It can be used with confidence over a wide range of environmental conditions.

Gamewell is well qualified to design rotary switches for circuit sampling, programming, digital generators and various electronic data processing systems. *Your* specs will receive prompt attention.

Write to THE GAMEWELL COMPANY, 1399 Chestnut Street, Newton Upper Falls 64, Massachusetts. *A Subsidiary of E. W. Bliss Company.*

The Gamewell SG-270 Switch is available with diameters of ⅛", 1¼", 1⅝", 2", 3" and 5" in various mounting styles.

BLISS Gamewell

PRECISION POTENTIOMETERS

"INTEGRALS OF HIGH PERFORMANCE"

CIRCLE 116 ON READER-SERVICE CARD

not needed. It is inoperative during standby periods and is free from photoelectric effects. It will operate at speeds up to 4 kc.

Amperex Electronic Corp., Dept. ED, 230 Duffy Ave., Hicksville, L.I., N.Y.

Panel Meters 418

To military specifications

Circular panel meters models 25 and 35, designed to meet or exceed MIL-M-10304B, are available in all military specification ranges. The meters may be mounted from front or back of panel. Rectangular model 145 measures about 2-3/4 x 5 in., with a scale length of 4 in. It is available in dc ranges from 10 μa full scale, and in ac ranges from 100 μa full scale.

Rowan Controller Co., Dept. ED, 30 Bridge Ave., Red Bank, N. J.

Voltage Monitor 432

Repeatability is 0.01%

Voltage monitors VM 701 and VM 702 are solid-state devices occupying less than 1 cu in. Repeatability is better than 0.01% under fixed conditions; power drain is low. Units are supplied at any ac or dc voltage, single or double-ended, or with external adjustments for voltage limits. The VM 701 has dpdt contacts rated at 2 amp; VM 702 has an ouput capable of driving a relay solenoid.

Syracuse Electronics Corp., Dept. ED, P. O. Box 566, Syracuse 1, N. Y.

***Availability:** 2 to 4 weeks.*

Don't miss an issue of ELECTRONIC DESIGN; Return your renewal card.

dynamic new concept of vibration testing produces

NEW PRIME ACCELEROMETER CALIBRATOR

Here's further proof of the advantages of ITT's dramatic new approach in air-suspended, lateral motion accelerometer calibrators: the ST-200 vibration exciter. Developed at the request of a major Government facility for their *prime* standard, the ST-200 will provide *double the accuracy* of other known standards.

The unique concepts of air-suspension and lateral motion that provide the performance features of the new ST-200 are also an integral part of other ITT vibration exciters for secondary and routine accelerometer calibration. These same techniques are easily adapted to other special vibration and shock testing requirements.

For complete information, applications data and performance curves, contact your ITT representative or write for Data File ED-1469-1.

Other ITT vibration exciters for accelerometer calibration may be integrated into your present system design or can be ordered as part of complete, self-contained ITT testing systems.

ST-110 for secondary standards

ST-115 for routine calibration

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a new standard of precision in AC VTVMS

now measure both complex and sine waves with 0.25% accuracy

'Til now, no VTVM has been able to measure complex waves with high laboratory standard accuracy. Average-reading and peak-reading instruments are subject to significant distortions created by spikes and harmonics.

New **triolab** Model 120 achieves direct-reading, true RMS values of both sine and complex waves with deflection directly proportional to the square of the current—by use of a special dynamometer movement.

- **DIRECT-READING**
  No knobs to twist or tedious balancing.
- **INSTANT MEASUREMENT**
  No sluggish, thermo-couple response.
- **HIGHEST LEGIBILITY**
  Full 7" custom-calibrated, mirror scale.
- **CONSTANT OVERALL GAIN**
  For long life.
- **DIAMOND BEARINGS**
  For perfect balance, smooth scale motion.

Ranges: 10MV to 500V rms, full scale. Input impedance: 1 meg. Fundamental freq. response: 50-2000 cps. Accuracy (above 50% electrical deflection): ¼% f.s. at 400 cps; ½% f.s. at all other frequencies. Power: 115 VAC, 50-400 cps.

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TRIO LABORATORIES, INC., Plainview, L. I., N. Y.
Export Dept: EMEC, 127 Grace St., Plainview, N.Y.

CIRCLE 118 ON READER-SERVICE CARD

NEW PRODUCTS

AC Brake 438

Ratings to 1,000 ft-lb

The 46,000 series brake operates on ac and is flange mounted. It is available completely enclosed, with torque ratings of 500, 750, and 1,000 ft-lb. Unitized construction is used; design allows easy maintenance. Manual release and automatic reset are included. Standard motor shaft lengths or through shafts can be accommodated.

Stearns Electric Corp., Dept. ED, 120 N. Broadway, Milwaukee 2, Wis.

Reed Relays 435

With up to 12 poles

Miniature, encapsulated reed relays with up to 12 poles are housed in a package 2-1/8 in. long, including leads, by 19/32 in. deep and 1-25/32 in. wide. Operating units are dry reed switches glass-sealed in an inert gas. Any combination of normally open or normally closed contacts can be obtained. Relays mount on 0.1-in. grid centers. Standard units have 6 v dc operating coils and require about 0.2 w per pole. Contacts are rated for 5-w resistive load.

Struthers-Dunn, Inc., Dept. ED, Pitman, N.J.

Transistor Heat Sink 530

Designed to provide positive cooling of power transistors by radiation and convection, the UP series heat dissipator has conventional mounting-hole patterns for cases such as T03, T06, T08, T015, D05, and others. The device offers maximum heat dissipation in minimum space and weight.

International Electronic Research Corp., IERC Div., Dept. ED, 135 W. Magnolia Blvd., Burbank, Calif.

See at Show Booth 1522.

Pressure Pulse Calibrator 354

Accuracy is 0.1%

Portable pressure pulse calibrator is designed for calibration of complete dynamic pressure recording systems. It provides 3 msec rise-time from atmospheric to the calibration pressure which can be set from a few inches of water to 1,000 psi. Various scales on the Bourdon gage are available ranging from 0 to 15 to 0 to 1,000 psig. Accuracy and linearity are better than 0.1%.

Atlantic Research Corp., Dept. ED, Alexandria, Va.

Relay 353

Telephone type

Telephone-type relay type B is designed for a variety of applications such as telephone circuits, calculating machines, and electronic control circuits. Available with fixed or adjustable residuals, it is equipped with a nickel-silver backing plate, designed to prevent residual sticking. Pile-up forms are from A through E, allowing a total of 36 springs.

Atlee Corp., Dept. ED, 10 Third Ave., Joliet, Ill.

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CIRCLE 120 ON READER-SERVICE CARD ➤

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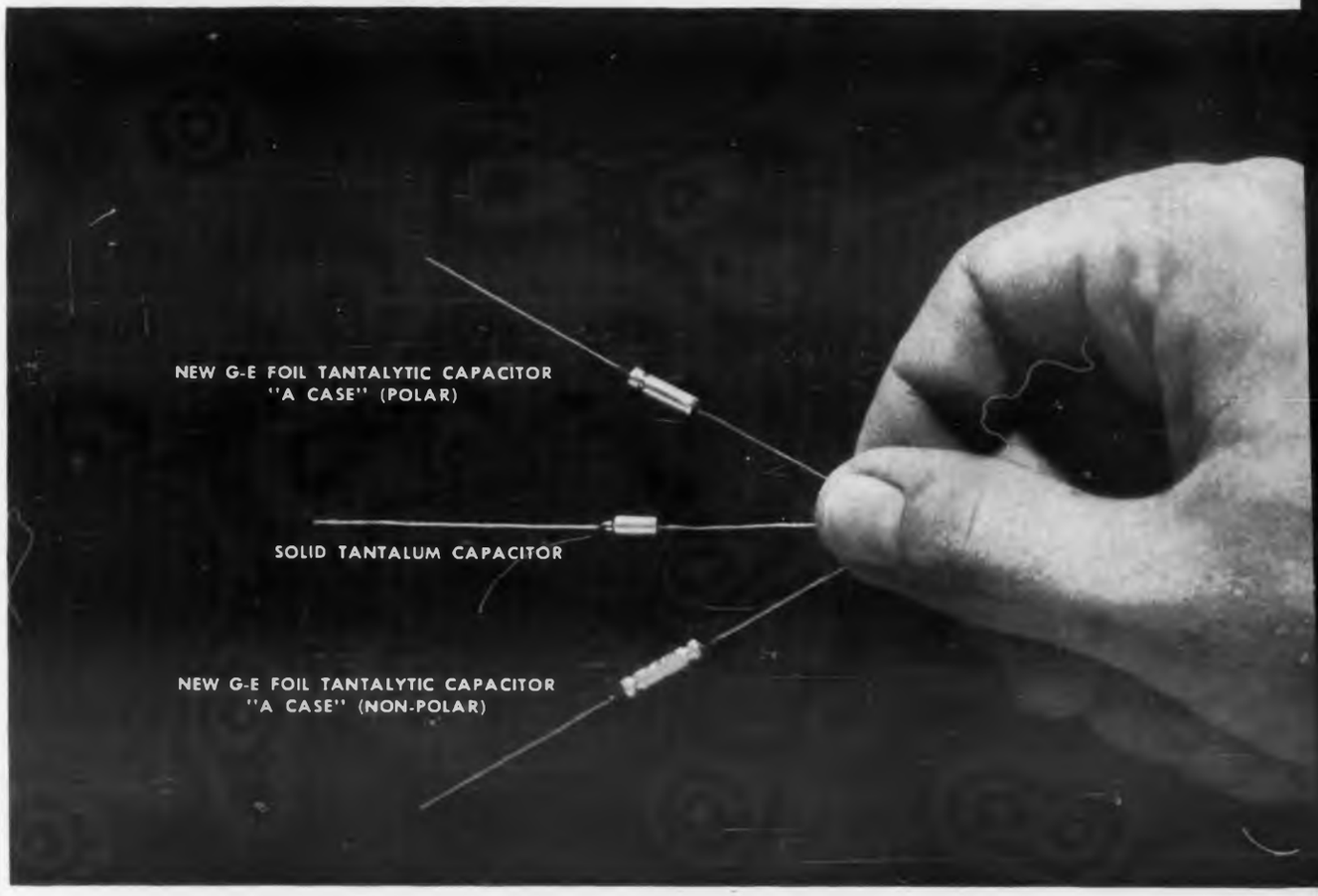

NEW smaller size foil Tantalytic* capacitors pack foil advantages in near solid dimensions

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 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.

* Reg. Trade-mark of General Electric Co.

430-03

Progress Is Our Most Important Product

GENERAL ELECTRIC

General Electric also offers these reliable Tantalytic capacitors

HIGH-RELIABILITY FOIL AND SOLID CAPACITORS Bulletin GEA-7227

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125C KSR* TANTALYTIC CAPACITORS Bulletin GEA-6766

HIGH-VOLTAGE TANTALYTIC CAPACITORS Bulletin GEA-7065

125C CYLINDRICAL TANTALYTIC CAPACITORS Bulletin GEA-7085

WHAT THIS UNUSUAL AC-DC "PLUG-IN" TRANSISTORIZED POWER SUPPLY DESIGN GIVES YOU...

One piece finned aluminum extrusion, achieving high heat dissipation. Most units need no external heat sink to 55° C ambient. All units have adjustable output. Platform mounted standardized subassemblies and components enable quick delivery of a wide range of voltages and currents.

Specifications:

Input: 105 to 125V AC, 45 to 420 cps, single phase
Regulation: 0.1% (line or load)
Stability: Better than 0.25% for 8 hours
Ripple: 0.02% rms
Response time: less than 100 microseconds
Low dynamic impedance

Designed primarily as a component power supply, units are widely used in computors, electronic instrumentation, production test equipment, and quality control check out systems. Best of all, the unique design makes these units available at the lowest possible cost to you.

(Unit pictured above: Model #1R 90-.1; 85-95 V; 0-100 ma. Price $145.00) Prices on other units range from $100 to $200.

All solid state — zener diode reference; transistor amplifiers and regulator
Output Voltages: from 2.0 to 300V DC
Output Power to 30 Watts
Reliable short circuit protection
All components readily accessible

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CIRCLE 121 ON READER-SERVICE CARD

NEW PRODUCTS

Card Reader 431

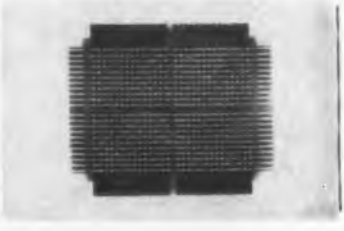
Small and economical

Designed for general systems use, the Raeden tabulating card reader is small and inexpensive. Size is 6 x 9 x 11 in. It is available as a single-card reader, or with a hopper holding 500 cards. Ease of maintenance and flexibility of programing are claimed for the device.

Systronics, Dept. ED, 3673 Newton St., Torrance, Calif.

Matrix Board 440

For general use



Matrix printed-circuit board is useful in experimental and prototype work as well as full production of network modules. Pattern provides a set of perpendicular connections on both sides of the board. Holes are provided at each intersection for wiring. Boards fit 22- or 28-contact receptacles on 0.156-in. centers.

Spec-Tronics, Dept. ED, 13901 Saticoy St., Van Nuys, Calif.

Silicon-Controlled Switches 443

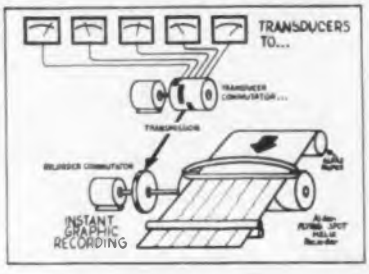
In TO-18 case

Silicon-controlled switch series 2N884 through 2N889 offers firing control within ±0.08 v, 20-μa firing sensitivity, and surge capability to 10 amp. Case size of the p[illegible]on devices is TO-18. Holding current level is 1 ma; the switches handle peak

INSTANT GRAPHIC PRESENTATION OF TELEMETERED DATA

"Nothing So Simple as Recording with **Alfax Paper**"

For that "quick see" instant graphic readouts of telemetered data, consider the use of the remarkable ALFAX PAPER and ALDEN "FLYING SPOT" HELIX RECORDERS to show relative readings from a vast variety of transducers *on one recorder* in one easy-to-read record.



"It's as Simple as This"—

With ALFAX PAPER—electricity is the ink—all you need is to pass current through the paper to get a mark.

USING ALDEN "FLYING SPOT" HELIX RECORDERS, you simply rotate a commutator attached to the Helix drive shaft in the ALDEN Recorder phased and in synchronization with the remote transducer commutator. Necessary scale lines can be imprinted at the same time. This principle uses a commutator sweep length for each transducer as a scale. All necessary channels used are shown side by side.

FOR EXAMPLE

One type is shown above—another typical example is the ALDEN Recorder used with Raytheon's Rayspan spectrum analyzer to record telemetered data.

The drive shaft on the ALDEN *"Flying Spot"* Recorder is coupled directly to a sensor shaft sweeping 420 band-pass filters at 60 times per second. Sensor signal fed through the ALDEN Tone Shade Amplifier to the *"Flying Spot"* helix provide instantaneous and continuous analysis of complete wave forms as frequency vs. time on the sensitive ALFAX Paper.

ALFAX PAPER is available without restriction to user, designers, and manufacturers of all types of recording systems. **ALDEN "Flying Spot" RECORDERS** 2, 5, 8, 11, 19-inch width) with external shafts for attachments of your commutator and drives, are available to instrument system designers, manufacturers, and individual laboratories.

Write today for literature on the ALDEN *"Flying Spot"* Helix Recorders, and for the booklet "ALFAX OPENS NEW HORIZONS IN INSTANT GRAPHIC RECORDING."

ALDEN Electronic & Impulse Recording Equipment Co., Inc.

ALDEN Research Center, Westboro 5, Mass.

CIRCLE 122 ON READER-SERVICE CARD

153
GOOD REASONS WHY YOU SHOULD NOT TRY TO MAKE AN INSTRUMENTATION CABLE LIKE THIS ONE

This particular telemetering cable was *designed* by project engineers of a major aircraft manufacturer, for guided missile work.

But when it came to the actual *making* of the cable, they came to a cable specialist—Rome Cable Division—for 153 good reasons.

As a start, take conductors. There are 111 of them, each precisely controlled to be absolutely uniform in size and conductivity. That takes know-how and facilities; and it's just a start.

Now add 37. That's the number of individually insulated triplets, each twisted with fillers, *covered* with a tinned copper shielding braid and jacketed with Synthinol. Then note that the partial assembly is *taped* with laminated Fiberglas and that, finally, the whole works is *covered* with heavy-duty Rome Synthinol.

Adding the conductors, triplets, and a point each for filler, braid, jacket, tape and outer jacket, you come up with 153 good reasons—skill, experience, and specialized equipment—why you should take your next cable problem to a cable specialist, such as Rome.

Inquiries invited. Write to Rome Cable Division of Alcoa, Dept. 25-31, Rome, N. Y.

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DIVISION

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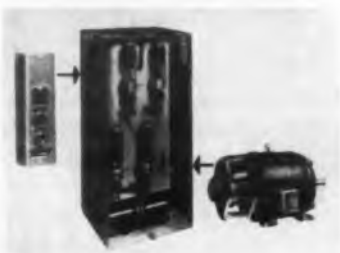
recurrent pulses of 5 amp, making possible miniaturization of squib firing circuits with no sacrifice in design margin.

Solid State Products, Inc., Dept. ED, 1 Pingree St., Salem, Mass.
Availability: *Stock.*

Adjustable Drive 437

Speed range 2:1 to 100:1



An adjustable-speed drive with a speed range from 2:1 to 100:1 features reduced maintenance and close speed regulation. A pair of grid-controlled thyratrons and diode tubes provide full-wave rectified voltage to the drive motor armature. Supply is ac, single phase. Designated Class 8833 Type BG, system includes controller, push-button station and drive motor. It is available in ratings from 3/4 through 4 hp.

Square D Co., Dept. SA, Dept. ED, 4041 N. Richards St., Milwaukee 12, Wis.

Solid-State Relay 444

With 2-μsec actuation

Model SSR-1285-5050 is a silicon-transistor, static-switching relay with no moving parts. Actuation time is 2 μsec, dropout time 5 μsec. Actuation frequency can be as high as 50 kc. Contacts are rated at 50 ma, 50 v. The device is capable of over 1 trillion operations. Epoxy encapsulation is used. Volume is 1 cu in.; temperature range is −55 to 125 C.

Solid State Electronics Co., Dept. ED, 15321 Rayen St., Sepulveda, Calif.
Price: *$125 ea.*
Availability: *7-day delivery.*

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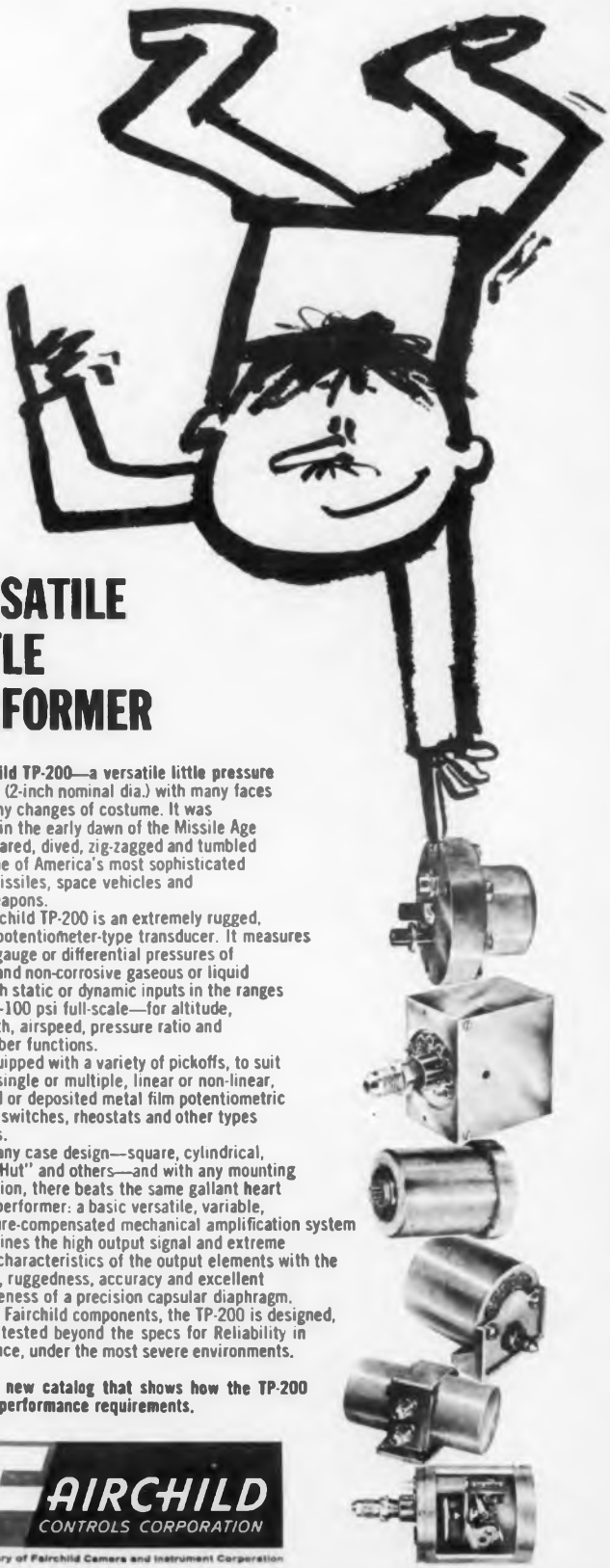

A VERSATILE LITTLE PERFORMER

The Fairchild TP-200—a versatile little pressure transducer (2-inch nominal dia.) with many faces and as many changes of costume. It was conceived in the early dawn of the Missile Age and has soared, dived, zig-zagged and tumbled within some of America's most sophisticated aircraft, missiles, space vehicles and special weapons.

The Fairchild TP-200 is an extremely rugged, precision potentiometer-type transducer. It measures absolute, gauge or differential pressures of corrosive and non-corrosive gaseous or liquid media, with static or dynamic inputs in the ranges of 0-5 to 0-100 psi full-scale—for altitude, water-depth, airspeed, pressure ratio and Mach number functions.

It is equipped with a variety of pickoffs, to suit its role—single or multiple, linear or non-linear, wirewound or deposited metal film potentiometric elements, switches, rheostats and other types of pickoffs.

Within any case design—square, cylindrical, "Quonset Hut" and others—and with any mounting configuration, there beats the same gallant heart of a true performer: a basic versatile, variable, temperature-compensated mechanical amplification system that combines the high output signal and extreme accuracy characteristics of the output elements with the reliability, ruggedness, accuracy and excellent responsiveness of a precision capsular diaphragm.

Like all Fairchild components, the TP-200 is designed, built and tested beyond the specs for Reliability in Performance, under the most severe environments.

Write for new catalog that shows how the TP-200 fits your performance requirements.

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CIRCLE 124 ON READER-SERVICE CARD

NEW Grades in Laminated Plastics

An Example of

Synthane *You-shaped* Versatility

There are 7 new much-wanted grades of Synthane laminated plastics. Four are flame-retardant—Grades FR-1, FR-2, FR-3, and FR-4. Three are the new high-temperature grades G-3HT, ARF-HT and AA-HT.

These grades add versatility to the variety of Synthane grades offered for your convenience and from which you may now choose with the same confidence you have always had in Synthane as a source of supply.

You-shaped Versatility makes Synthane a Better Buy in Laminates.

SYNTHANE CORPORATION OAKS, PENNA.

Synthane Corporation, 42 River Rd., Oaks, Pa.
Gentlemen:
Please send me your Engineering Bulletins on:
☐ New Flame-retardant Grades ☐ New High-temperature Grades

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CIRCLE 125 ON READER-SERVICE CARD

NEW PRODUCTS

Survey Meter 386

Is transistorized

Model 489, a transistorized portable survey meter, has interchangeable G-M or scintillation probes for detection and measurement of alpha, beta and gamma radiation. Three full-scale ranges correspond to 0 to 0.2, 2.0, and 20 milliroentgens per hour of radium. The meter is powered by four flashlight cells. Weight is 4 lb excluding probe.

The Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

Capacitors 360

Feed-through type

Feed-through capacitors, specifically designed for broadband, radio interference applications, are constructed to operate as theoretically ideal capacitors. They have a continuous current rating of 10 amp with rated voltages from 100 to 600 v dc. At 85 C the 400-v units are capable of operation at 125 v ac, 60 to 400 cps; the 600-v units are capable of operation at 250 v ac, 60 to 400 cps.

Astron Corp., Dept. ED, 255 Grant Ave., East Newark, N.J.

Ultrasonic Equipment 397

With 3 tanks

High ultrasonic power is simultaneously applied to three or more containers in this line of

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RELAYS

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GENERAL PURPOSE Open Type Relay. Up to 3PDT, 5 or 10 amp contact rating. Voltages up to 230 volts, AC or DC. Details in Bulletin 10.

GENERAL PURPOSE Plug-In Type Relay. Contact arrangements up to 3PDT. 5 or 10 amp contact rating. Voltages up to 230 volts, AC or DC. Details in Bulletin 10.

PRINTED CIRCUIT Open Type Relay. Up to 3PDT. 5 or 10 amp contact rating. Voltages up to 230 volts, AC or DC. Details in Bulletin 11.

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Phone: ORange 2-8200

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cleaning equipment for use in small parts production and in research laboratories. In a production process, each container can be filled with a different fluid for wash, rinse, and final rinse. In laboratory use, the unit may be used for simultaneous observation of the effect of ultrasonic energy on different materials.

Ultrasonics Corp., Dept. ED, 10909 Venice Blvd., Los Angeles 34, Calif.

Multipoint Recorder 377

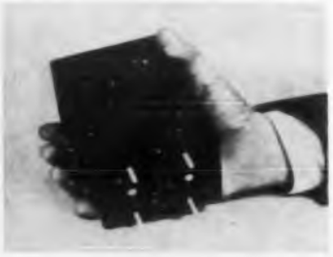
Panel height is 8-1/2 in.

Model M11A will scan and measure two to 12 input sources at the rate of 5 sec per point. Calibrated chart width is 11 in. The compact, rack-mounting device has a panel height of 8-1/2 in. Plug-in range change modules permit quick changes to other temperature spans or from temperature to millivolt spans. No thermocouple wire is used. Number of printing points may be reduced; 6 printing colors may be used.

Westronics, Inc., Dept. ED, 3605 McCart, Fort Worth 10, Tex.

DC Power Supply 392

In small package



Model AMSF-50-5 delivers 50 v at 500 ma; package measures 2.5 x 3.5 x 5 in. Load regulation is 1 mv, line regulation 0.5 mv. Ripple is less than 1 mv; transient response is 20 μsec. Input is 105 to 125 v, 400 cps. The unit weighs 2 lb 4 oz max. A rack panel mounting four of the packages in a panel height of 5-1/2 in. is available.

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.
Availability: 2 to 4 weeks.

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Whatever you need a data printer for, Clary has a proven model to do the job

At Clary you'll find the world's largest selection of solenoid actuated digital data printers.

These include Parallel Entry Printers, Printing Timers, Time-Data Printers, and Serial Entry Printers. All are reliable, proven printers... printers whose simple circuitry, low cost, small size, desk top mounting, and modern design have made them the most "asked for" printers in the world.

Clary Printers are now being used in the following applications:

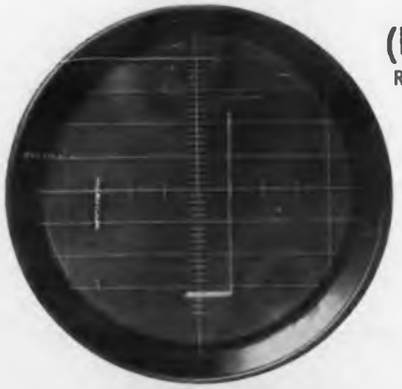
Automatic Checkout Systems
Recording Scale Systems
Digital Voltmeter Readout
Logging of Time Signals from Digital Clocks
Shaft Position Readout
Instrumentation Data Recording
Logging of Time and Origin of Alarm Signals
Automatic Engineering Data Recording
By-Product Accumulation of Office Machine Operations
Process Control Data Recording

Clary

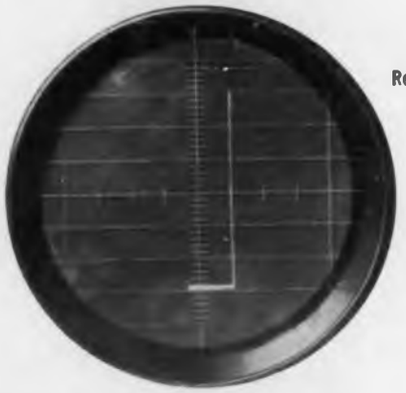
ELECTRONICS DIVISION
SAN GABRIEL, CALIFORNIA
Computing Devices of Canada, Ltd., Ottawa

Manufacturer of output printers, computers, electronic data-handling equipment, aircraft and missile components.

CIRCLE 127 ON READER-SERVICE CARD



(before)
Reverse leakage tracing before immersion in H_2O_2.



(after)
Reverse leakage tracing after immersion in H_2O_2, dried without washing (virtually no change).

Here's proof !

No increase in reverse leakage when you etch diodes in

BECCO Hydrogen Peroxide!

To test the effect of impurity-free Becco Hydrogen Peroxide across an unsealed diffused silicon junction diode, the following "torture test" was performed: 600 volts AC were applied across the diode, and the reverse leakage current depicted on an oscillograph. Then, the diode was immersed in Becco 30% Reagent Grade Hydrogen Peroxide. The diode, without being washed in any way, was placed on a hot plate and the H_2O_2 was evaporated.

The voltage was re-applied and the tracing produced was virtually identical (see above)—proof that no impurities that could affect the diode exist in Becco Hydrogen Peroxide.

Of course, you'll use Becco H_2O_2 at a different stage—when you etch the diode. And, of course, good practice still dictates that you wash the diode in pure water following the etch. Nevertheless, this test proves that you need not be too concerned with your wash when you etch in Becco H_2O_2, since the peroxide itself, made by an inorganic method, can not deposit any impurities of its own on the diode.

Becco packages its Reagent Grade H_2O_2 in returnable or non-returnable polyethylene containers to insure its purity when it arrives at your plant. Write us for further information or specifications, analysis, prices, etc. Address: Dept. ED-6.

BECCO®
BECCO CHEMICAL DIVISION
Food Machinery and Chemical Corporation
fmc

CIRCLE 128 ON READER-SERVICE CARD

NEW PRODUCTS

Disk Thermostat 419

Differential under 8 F

Therm-O-Disc type 11T, spst or spdt, can now be supplied with a differential which will not exceed 8 F. The snap-acting, bimetal disk thermostat has a calibration range from 125 to 180 F. Temperature calibration is factory preset and nonadjustable. Type 11T is rated at 25 amp resistive, or 1 hp inductive, at 120 or 240 v ac.

Therm-O-Disc, Inc., Dept. ED, Mansfield, Ohio.

White Noise Diode 441

Produces 18-v output

The Sounvistor is a solid-state device capable of producing random noise across the white noise spectrum from 2 to 20,000 cps. The diode, measuring 3/8 in. long, has been integrated into a generator producing up to 18-v output.

Solitron Devices, Inc., Dept. ED, Norwood, N.J.

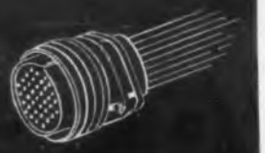
Contact Connectors 370

Crimp type

Removable, crimp-type, contact connectors are available in 34 to 104 contacts inclusive in miniature-rectangular, regular rack and panel, external and environmental designs. In locked-in position each contact will resist 50-lb push-out force.

Airborn Connectors, Inc., Dept. ED, P.O. Box 13251, Dallas 20, Tex.

BENDIX MS-R
ENVIRONMENT RESISTANT
Connectors



Bendix MS-R series are the small, lightweight, more efficient and compatible environment resisting class of connectors as specified in the latest version of MIL-C-5015.

Main joint and moisture barriers at solder weld ends have integral "O" rings. Grommet design of "slippery rubber" is sealing medium for individual wires. This provides easier wire threading and friction-free travel of grommet over wires.

Many other features are described in MS-R Bulletin. Send for your copy today, or

Call your Avnet Applications Engineer

For dependable service and immediate delivery
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AVNET•5877 Bodes Bd., Los Angeles 16, Cal.-UP 0-6141
AVNET•45 Wiun St., Burlington, Mass., BR 2-3060
AVNET•4180 Kettering Blvd., Dayton 39, Ohio-AX 8-1458
AVNET•2722 N. Mannheim Rd., Melrose Park, Ill.-GL 5-0160
AVNET•1262 N. Lawrence Sta. Rd., Sunnyvale, Cal.-RE 6-0300

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NOT AFFECTED by magnetic fields.

BIG LOOK panel meters

SELF-SHIELDED DC MECHANISMS FOR GREATER RELIABILITY

SELF-SHIELDED DC MECHANISM is one of the big built-in features you get with General Electric d-c BIG LOOK panel meters. Self-shielding eliminates special calibration problems . . . allows more flexibility in locating meters on panelboards through minimizing interaction.

Here's why: Unlike many other designs, the BIG LOOK's core is around the magnet . . . *where it belongs* . . . and shields the entire d-c mechanism. This means that interaction is eliminated, even when meters are cluster-mounted. Also, stray magnetic effect is minimized!

For the complete AC and DC BIG LOOK panel meter story, just contact your nearby General Electric Apparatus Sales Office or distributor; or write for bulletin GEA-7034 direct to General Electric Company, Section 597-02, Schenectady 5, New York.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

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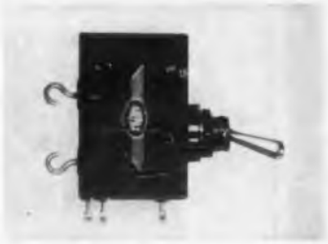
Circuit Breakers 369

For remote indicators



Series 500-R circuit breakers are miniature, magnetic, hermetically sealed units designed for use with remote indicators and alarms. Auxiliary contacts have spdt switching action and are rated for 1 amp, 110 v rms. Specifications are: voltage rating, 50 v dc and 120 ac rms, 60 or 400 cps; current rating, 50 ma to 10 amp; time delay, 3 to 30 sec; trip level, 125% of rated current for time delay, 150% for instantaneous type.

Airpax Electronics, Inc., Dept. ED, Cambridge, Md.

Availability: 1 to 3 weeks.

Glass Epoxy Laminate 417

Glass epoxy laminate FF-91 has a thickness tolerance of 0.004 in. on 1/16-in. sheets. The laminate was developed as plug-in connector material for electronic computers. It is available in 36 x 42 in. and 36 x 84 in. sheet sizes with copper-clad or unclad surfaces.

American Cyanamid Co., Formica Corp., Dept. ED, Cincinnati, Ohio.

Wide Band Amplifier 373

Noise level less than 4 μv

Miniature amplifier A102H measures 1-3/4 x 3-1/2 x 4 in. It is self-powered and completely transistorized. Specifications are: frequency response, 1 cps to 750 kc for 3-db bandwidth; distortion, less than 0.5% at 1-v peak-to-peak output; noise level, 4 μv with 10-K source impedance at 200 kc; output impedance, 600 ohms; amplification, 100 at 1 kc.

Ad-Yu Electronics Laboratory, Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N.J.

P&A: $185 ea; from stock.

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World-famous CASTELL #9030 Lead spans the whole complex of creative genius—because it gives you density saturation for a crisp, bold image ■ Chisel point or needle-point, CASTELL #9030 lays down black, lightproof lines that don't flake, feather or "burn out" ■ Draws perfectly on all surfaces, including Cronar and Mylar base films ■ Strikes a perfect balance between coverage and easy erasability ■ Produces highest number of Diazotypes or blueprints ■ Consistently uniform degrees, 7B to 10H, each as precise as a machine tool. In plastic tube with gold cap ■ When your brain is in high gear, CASTELL #9030 doesn't hesitate.

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Catalog sent on request.

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500 Third Ave.
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NEW PRODUCTS

Precision Potentiometer 385

Meet military specifications

Precision potentiometers are made in the following designs: 2-in. ball bearing, 2-in. sleeve bearing (both with mounting plates), and 2-in. threaded bushing; 1-in. servo mount and 7/8-in. threaded bushing mount. All parts and materials meet military specifications; all housings are anodized aluminum. Standard and special resistance values with switch sections are available. Units may be ganged and interchanged.

Voltronics, Inc., Dept. ED, 7746 W. Addison St., Chicago 34, Ill.

Recorder Footswitches 388

In single and dual types

A variety of switching arrangements is available in the DA series of footswitches for dictating machines and all types of office and business machines. Single types are supplied spdt or dpdt; dual types have two spdt stages. Switches are rated at 7 amp, 125 or 250 v ac. Minimum life is 500,000 operations.

Vemaline Products Co., Dept. ED, 551 Commerce St., Franklin Lakes, N.J.

Power Pentode 363

Has two frame grids

An output pentode, type 7534 has two frame grids, one a control grid, the other a screen grid.

COMMUTATING SWITCHES

HIGH SPEED ROTARY SWITCHES FOR TELEMETERING, SAMPLING, PROGRAMMING AND ANALOG-DIGITAL CONVERSION.

Airflyte's production facilities are geared to produce standard and non-standard commutators at "off-the-shelf" prices. Featuring noise-free performance through the use of solid gold alloy commutating surfaces . . . and exclusive drum construction for maximum life, uniform wear and close angular tolerance. We will supply packaged units (as illustrated) or component commutators and/or brush blocks. All products designed to meet MIL-E 5272 and MIL-E 5400 and other special environmental specifications.

3X

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"DRESSES-UP" your panels, switchboards, other products.

BIG LOOK panel meters

MODERN DESIGN IMPROVES END PRODUCT APPEARANCE

Now, General Electric's BIG LOOK panel meter styling can help improve the appearance of your switchboards, panels and other equipment. BIG LOOK *styling* is the result of careful planning, development and field testing. It represents more than 28 years of General Electric leadership in creative panel meter design.

Now, BIG LOOK panel meters are available in your choice of seven attractive color windows to complement the appearance of your products or equipment.

For the complete AC and DC BIG LOOK panel meter story just contact your nearby General Electric Apparatus Sales Office or distributor; or write for bulletin GEA-7034 direct to General Electric Company, Section 597-04, Schenectady, New York.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

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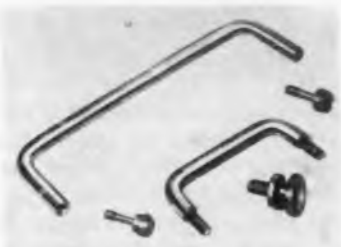
It is intended for use in exacting military and industrial applications. Specifications are: transconductance, 25,000 μmhos; screen grid current, 4 ma; peak voltage, 6 kv; cathode current, 300 ma; harmonic distortion, 5%.

Amperex Electronic Corp., Dept. ED, 230 Duffy Ave., Hicksville, L.I., N.Y.

Panel Handles 387

In variety of styles



Rack-and-panel handles are available in clear anodized aluminum, brushed finish, and in stainless steel. Round and oval styles are made; round handles can be supplied with a 30-deg bend. Folding handles are made in 90-deg and 180-deg styles. A heavy-duty handle with outside threading is also available.

Vemaline Products Co., Dept. ED, Franklin Lakes, N.J.

Pressure Standard 428

Accurate to ±0.1%

Model 4-400 Aceducer is an integrally packaged pressure pick-up providing a linear dc output voltage measurement of pressure input. It is temperature-controlled at 125 F and provides over-all accuracy to within ±0.1%. Ranges are 0 to 5 to 0 to 5,000 psi. Output is 0 to 5 v dc, output impedance less than 5 K. Power required is 105 to 125 v, 60 cps, 20 w. Dimensions are 9 x 6 x 9 in. Weight is 10 lb.

Tavis Engineering Div., Edcliff Instruments, Dept. ED, 1711 S. Mountain Ave., Monrovia, Calif.

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ēlin AC calibration instruments offer 3 versatile concepts to meet most applications!

ELIN Model VC-555 ($895.00)

VC-555, a flexible unit, rugged, portable, for production line calibration of new-type differential voltmeters.

APS-50, used with Primary Transfer Standards requiring continuously variable frequency and voltage outputs at 50 VA.

ELIN Model APS-50 ($2,975.00)

ELIN **Model DK-102** ($395.00 each) Precision Power Oscillators in modular systems function independently. Each unit gives single frequency and voltage with precise, highly stable outputs. Shown in digital voltmeter calibration work at Hughes Aircraft Corp., Culver City, California. (Hughes Photo). **Write for catalog, today!**

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INTERNATIONAL ELECTRONIC RESEARCH CORPORATION

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MOLDED CHOKE COILS

MILLER QUALITY PRODUCTS

ACTUAL SIZE
10,000 UH

Nicknamed the "Micro Mite", these reliable, rugged coils exhibit high Q, very low distributed capacity, all concentrated into an amazingly small package.

Miller's new "Micro Mite" coils are perfect for use where weight, space and high Q considerations are involved. Their volumetric reduction ranges up to 80%, with current ratings approximately 75-300 millamps and standard series values up to 10,000 uh.

The "Micro Mite" coil construction permits miniaturization without the use of ferrite materials, thus maintaining temperature stability to 125° C. These hermetically sealed molded coils conform to MIL-C-15305A.

ASK FOR OUR MICRO-MITE BULLETIN

J. W. MILLER COMPANY • 5917 So. Main St., Los Angeles 3, Calif.

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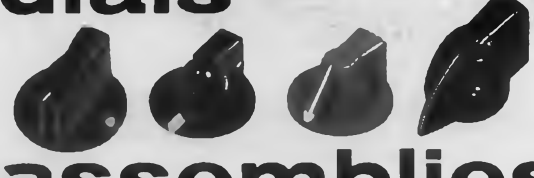
STANDARD

knobs

dials



assemblies

. . . in any thermosetting plastic material. No tooling cost. Most parts meet military specs. Write for complete catalog.

kurz-kasch

1421 South Broadway, Dayton 1, Ohio

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NEW PRODUCTS

Band-Rejection Filter 371

Range is 215 to 225 mc

Band-rejection filter model 220 is designed to protect communications equipment from interference in the 215- to 225-mc range. Attenuation in the rejection band is —60 db. Signals in the 118 to 150 band are passed with less than 1-db attenuation and less than 2 db between 240 and 400 mc. Power-handling capability is 100 w.

Adams-Russell Co., Inc., Dept. ED, 200 Sixth St., Cambridge 42, Mass.

Axial Blower 401

Delivers at 40 cfm

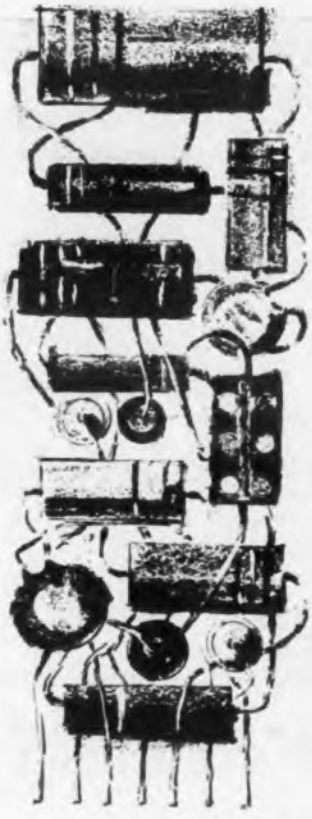
Designed for electronic cooling, the MSA-10605 axial blower delivers 40 cfm at a static pressure of 0.10 in. of water (standard density). Power is 115 v, 60 cps. Dimensions are 7.62 in. high, 6.32 in. wide, and about 4.87 in. deep.

The Torrington Manufacturing Co., Specialty Blower Div., Dept. ED, Torrington, Conn.

Decade Counter 378

Frequency range is 75 kc

The WE-140, a compact, four-decade frequency meter and counter, has a frequency range



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Available immediately from stock... The broadest selection of encapsulated, transistorized Digital and Logic Circuit Modules . . . in many configurations of PROVED RELIABILITY... Also Custom Packaging to your specifications.

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UP TO 28 PERCENT increase in scale length improves meter readability.

BIG LOOK panel meters

DESIGNED FOR AT-A-GLANCE READABILITY

In designing the BIG LOOK panel meter, engineers placed particular emphasis on achieving an important balance between distinctive appearance and excellent readability.

This balance of aesthetic and functional design values makes BIG LOOK panel meters *easier to read*, relieves eye tension and stress—and reduces reading error.

Accurate, at-a-glance readability is a prime requisite for panel meters. To achieve it, G-E first eliminated the problem of shadows by designing a cover to admit light from top, sides and bottom. The color area of the window completely hides the distraction of the moving internal mechanism. This gives you exactly what you want . . . a clear uncluttered view of the scale and an accurate reading.

For the complete AC-DC BIG LOOK story just contact your nearby G-E Apparatus Sales Office or distributor; or write for bulletin GEA-7034 direct to General Electric Company, Section 597-05, Schenectady 5, New York.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

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of 75 kc. Time base is provided by a temperature-compensated crystal oscillator, accurate to 0.002%. Glow transfer tube counting and indication are used. Input range of 50 mv to 120 v permits the device to be used with a variety of transducers.

Westport Electric, Dept. ED, 149 Lomita St., El Segundo, Calif.

Vacuum Accessory 391

Collar for evaporators

A series of collars has been designed for insertion between the bell jar and base plate of most commercial evaporators. The collar provides a number of ports with identical flange fittings; to each port may be connected a flange and feedthrough. Available feedthroughs include: high and low voltage and current, cooling water, rf heating, nude ionization, discharge and thermocouple gages, and a controlled leak.

Equipment Div., Vacuum Technology, Inc., Dept. ED, 7933 Gloria Ave., Van Nuys, Calif.

Recording Simulator 359

For system analysis

Analysis of any digital drum, disk or tape recording system at frequencies up to 600 kc is possible with this recording simulator. It will record signals at amplifier impedances from 50 to 2,000 ohms, power sources from 5 to 50 v with currents to 270 ma.

General Instrument Corp., Magne-Head Div., Dept. ED, 3216 W. El Segundo Blvd., Hawthorne, Calif.

Don't miss an issue of ELECTRONIC DESIGN; Return your renewal card.

now to prove moisture resistance!

Up-up! It's just not worth housemaid's knee to prove you *might* have a pot that can pass Procedure 106-A! Oh, it might take the steamin', alright — but just wait 'til it "breathes" when it's cold! And if you want the acid test — add a dash of polarizing voltage!

But you *can* count on one pot to withstand the moisture and temperature cycling of MIL-STD 202A: — ACEPOTS have had the engineering design to pass 106-A with ease, even with polarizing voltage! For example, the terminal header is of our exclusive epoxy-impregnated fibreglass, with special case locking to keep out moisture. The shaft end is sealed with high-temperature silicone rubber O-rings bearing seals. Inside, special bronze bearings and precious anti-oxidizing winding and contact metals guard against corrosion. So if moisture-resistance tests make you damp and dour — see your ACErep!

This 7/8" ACEPOT®, as with all our pots, incorporates these exclusive moisture- and corrosion-resistant features.

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DURACOM

- Long reliable, service-free life.
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- Low contact resistance throughout life.
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- Less power required.
- Meets all IRIG PAM/PDM standards.

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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

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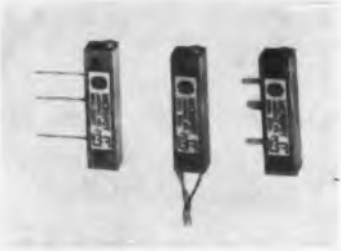
CHEMICAL CO., INC.
136 Liberty St., N. Y. 6, N. Y.

CIRCLE 143 ON READER-SERVICE CARD

NEW PRODUCTS

Trimming Potentiometers 362

Three series



Three series of trimming potentiometers are offered. Series 2800 is a wirewound unit rated at 1 w at 110 C with a range of 10 ohms to 50 K; dielectric strength is 500 v ac. Series 992 is a wirewound unit with a range of 10 ohms to 50 K; power is rated at 1 w at 40 C, derated to 0 at 105 C. Series 993 features deposited carbon elements. Standard resistance is from 20 K to 1 meg. Resolution is infinite. Power is rated at 0.5 w at 40 C, derated to 0 at 105 C.

Amphenol-Borg Electronics Corp., Borg Equipment Div., Dept. ED, 120 S. Main St., Janesville, Wis.

Frequency Deviation Meters 361

Expanded scale type

Four models of expanded-scale deviation meters are designed to indicate the frequency of 60- and 400-cps power lines. Model PI-111-60c has a meter size of 3-1/2 in. and model PI-112-60c has a meter size of 4-1/2 in.; both have a frequency range of 57 to 63 cps. Models PI-111-400c, 3-1/2 in. meter and PI-112-400c, 4-1/2 in. meter, have a range of 380 to 420 cps. All models have a resolution of 0.05% and 0.1% accuracy.

Anadex Instruments Inc., Dept. ED, 14734 Arminta St., Van Nuys, Calif.

P&A: $85 ea; 2 weeks.

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LATEST DATA ON ULTRASONIC DELAY LINES!

THIS NEW CATALOG

gives you up-to-date specs on the industry's most complete line of ultrasonic delay lines for missiles, MTI, radar countermeasures and computer applications. Send for it today.

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LABORATORY FOR ELECTRONICS, INC.
Computer Products Division
1079 Commonwealth Avenue
CIRCLE 144 ON READER-SERVICE CARD

EASY-TO-READ panel meter scale is nearly 4 inches long.

BIG LOOK panel meters

NOW INCLUDE NEW 4½-INCH DESIGN

Designed with modern BIG LOOK styling, this new General Electric 4½-inch panel meter features a snap-on, snap-off cover for easy access to the scale face.

Improved readability, even at extreme distances, results from its expanded scale length . . . *ideal* for multi-scale applications on portable test instruments and panelboards. DC models of this new meter feature the same self-shielded mechanism available on 2½- and 3½-inch designs.

For the complete AC and DC BIG LOOK panel meter story just contact your nearby General Electric Apparatus Sales Office or distributor; or write for bulletin GEA-7034 direct to General Electric Company, Section 597-10, Schenectady 5, New York.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

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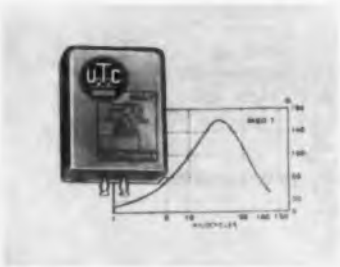
Toroidal Inductors 395

With high Q



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Valpey Crystal Corp., Dept. ED, Holliston, Mass.

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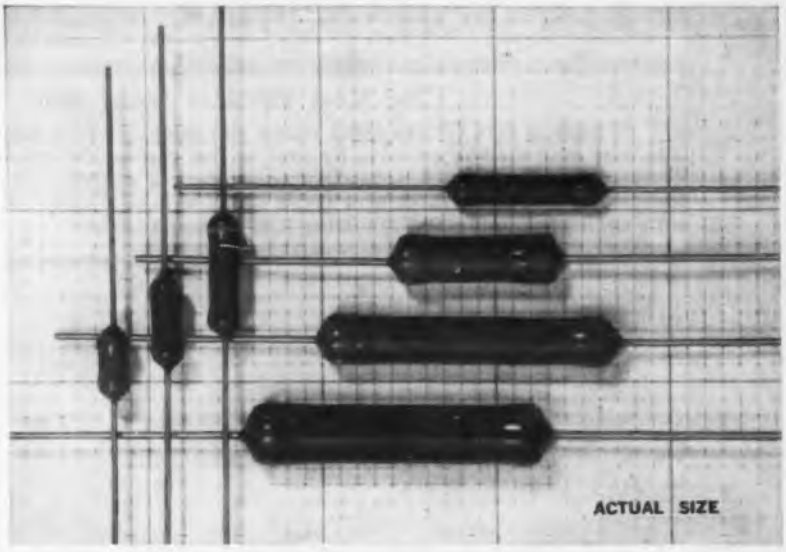
The Army's electronic proving ground at Fort Huachuca, Ariz., is not yet accepting for RFI tests equipment not in the Army's inventory. In an article on the proving ground in the Nov. 23 issue of *ED* it was stated that equipment from noncontractors was being accepted for tests.



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3	3X	0.1	10,000	1/2	3/16
4	4X	0.1	15,000	11/16	3/16
5	5XM	0.1	20,000	13/16	3/16
7	7X	0.1	25,000	1	5/16
10	10XM	0.1	50,000	1 3/4	5/16
12.5	12.5X	0.1	75,000	1 3/4	3/8

*Less leads.

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

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Demodulator Helps Measure Distortion In AM Transmitters

742

An inexpensive demodulator, easily constructed from readily available components, was found to be extremely valuable in studying the audio characteristics of amplitude modulated radio transmitters.

The circuit, Fig. 1, was used successfully with radio transmitters ranging from 2 to 247 mc.

It was especially useful in determining the amount of audio harmonic distortion when used with distortion analyzers such as the Hewlett Packard Model 330B. Because the circuit uses 1N34 crystal diodes, it requires no external power source Further, no adjustment or tuning is necessary since it has an untuned antenna circuit and an audio filter. The latter is a low-pass, constant-K type designed for a cut-off frequency of approximately 60 kc. This keeps the audio response substantially flat over a large passband and yields a true measurement of the harmonic content present in the transmitted audio envelope. Some advantage might be obtained in the vhf range by replacing the 2.5-mh choke in the antenna circuit with a vhf choke in order to overcome any loss of impedance by distributed capacity. However, this refinement was not tried since the purpose of the design was to develop a more universal accessory.

The 2.5-mh choke in the antenna circuit is shunted by a 1-K resistor and crystal diode to keep its load constant on both positive and negative halves of the rf wave. It is important to keep the polarities of the crystals as shown in the schematic. The constant-K filter is designed for a 1-K input and output impedance. Fortunately, standard 2.5-mh chokes fitted very nicely into the filter design. Those used were rated at 250 ma (about 17 ohms dc resistance). Actually, the current normally passed through them is only a few milliamperes, but these chokes were chosen because their low resistance would result in improved filter characteristics.

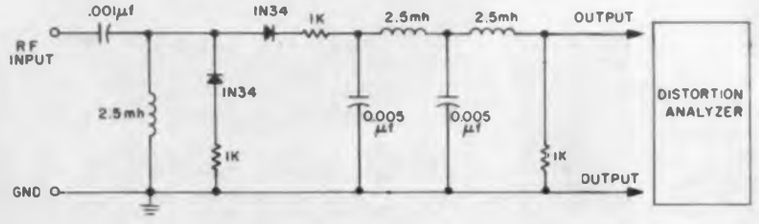

Fig. 1. Demodulator circuit is used for observing the audio harmonic distortion of am radio transmitters.

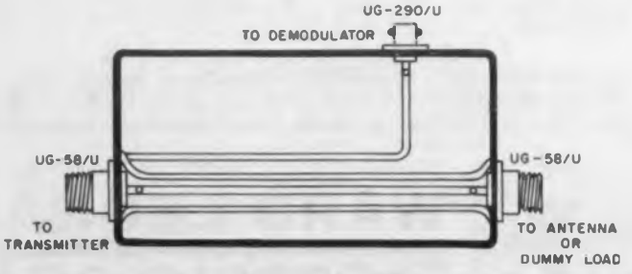

Fig. 2. With coaxial transmission lines demodulator circuit can be connected to antenna using a wall outlet box and appropriate connectors.

Circuit Couples Directly To Antenna

Coupling this device to the transmitter is very simple. For the usual case, a single wire held in the proximity of the transmitter antenna terminal will suffice. Or, depending upon the amount of radio frequency power being transmitted, a small dipole can be used. In order to read distortion directly on the Hewlett Packard Model 330B, enough rf energy must be fed to the demodulator to obtain at least one volt of audio from the output terminals at the fundamental audio frequency. However, for weaker signals, satisfactory results were achieved with the Set Balance control adjusted for 1 v on the meter scale (10 per cent) and the audio input control of the analyzer cut back accordingly. The per-cent distortion observed was then multiplied by 10 to obtain the true figure. On this basis, audio output as low as a tenth of a volt would suffice.

For the vhf range where coaxial transmission lines are used, a method published in the RCA Field Support Material pamphlet has been used successfully. A modified version of this is shown in Fig. 2. A wall outlet box with a UG-58/U connector at each end was used. A stiff, heavy wire (AWG #10) is connected between the center terminals of the UG-58's. Similar wires soldered to the ground sides of the UG-58's were spaced about 1/8 in. from the center conductor to keep the vswr low. A pick-up loop consisting of a similar wire grounded to the box at one end was run parallel to the center conductor and spaced about 1/8 in. from it for approximately three quarters of the length of the box, then terminated in a UG-290/U connector.

Paul K. Johnson, U. S. Army Signal Material Support Agency, Fort Monmouth, N.J.

Reprinted from ED, *Feb. 15, p 216.*

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. Ideas judged Most Valuable of Issue will receive $50.
3. The Idea judged to be Idea of the Year will receive the Grand Prize of $1,000 in cash.

The Idea of the Year will be selected from amongst those judged to be Most Valuable of Issue.

Most Valuable of Issue and Idea of the Year will be selected by the readers of ELECTRONIC DESIGN. Votes will be cast by circling keyed numbers on 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.

Note to Previous Contributors

Ideas already submitted to the Ideas for Design department, but not yet published, will be eligible for the Seventh Anniversary Awards.

For Additional Entry Blanks, circle **750** on Reader-Service Card.

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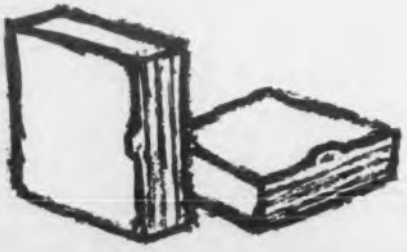

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IDEAS FOR DESIGN

Pulse-Selection System Uses Analog Techniques 743

In various systems that employ a pulse coder, a device is needed to generate and select a specific number of in-sequence pulses. The circuit described uses the cut-off and saturation properties of transistors, in which the base potential changes from a voltage that is higher than that of the emitter, to a lower value.

A two-gate system is shown in Fig. 1, where, if the base has a higher voltage than the emitter, the transistor is cut off, and no current flows in the collector. When the base voltage becomes lower than that of the emitter, the transistor saturates, and the collector voltage becomes almost equal to the emitter voltage.

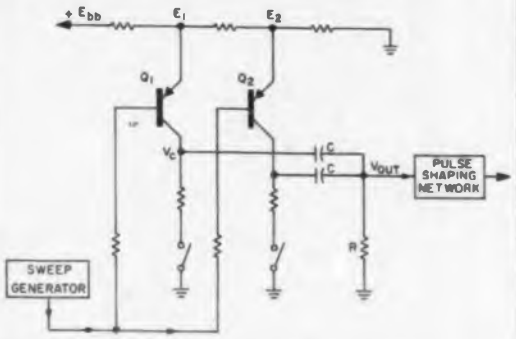

Fig. 1. Pulse selector uses cut-off and saturation properties of transistors Q1 and Q2.

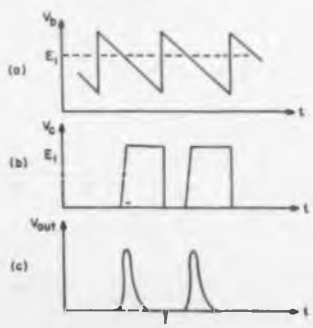

Fig. 2. Waveforms at the sweep-generator output (a); at the collector of the pulse-forming transistor Q1 or Q2 (b); and at the differentiated output to the pulse shapes (c).

This step function is differentiated by the *RC* circuit connected to the collectors, and a pulse is obtained. The voltage divider from the dc source to ground allows different emitter voltages to produce a timed sequence for the pulses. Switch positions facilitate "gate ON" and "gate OFF," so the pulses can be selected. If the collector resistors are large enough, and the voltage divider between the dc source and ground is a low impedance, the switching off of one transistor will not affect the others.

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Fig. 1 shows only two gates, but any number of pulses can be obtained, provided they do not load the sweep generator (in which case an emitter follower should be used as a buffer). The sweep generator is a simple sawtooth oscillator providing the necessary voltage change in the bases of *Q1* and *Q2*.

Fig. 2 shows the waveforms of: (a) sweep generator; (b) collector of one of the pulse-forming transistors (*Q1* or *Q2*); (c) output caused by that particular transistor. Sweep flyback will generate a pulse in the opposite direction, but if a small flyback time is provided, it can be neglected. Besides, if a wave-shaping circuit is used, as shown in Fig. 1, it will completely eliminate this pulse.

The wave-shaping circuit must be used when the pulse specifications are very severe, as was the case in the application for which this development was made; it is a one-shot multivibrator, triggered by pulses formed in *Q1* and *Q2*.

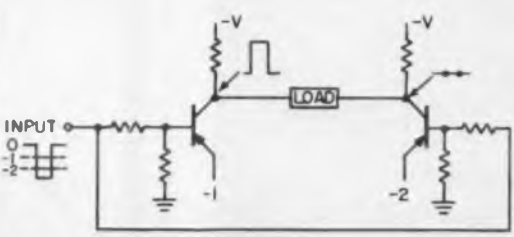
Silvio Soares, Engineer, Avionics Products Dept., Bendix Radio Div., Baltimore, Md.

Biased Transistor Pair Monitors Within Set Limits 744

We needed a voltage level detector to provide an output when the input was between two preset limits. The detector we designed used two transistor pulse amplifiers connected as shown in the figure.

Each transistor was back-biased to one of the desired reference levels. Thus, there would be an output between the two collectors only when the input signal was between the reference voltages set by the emitter biases.

As an example, assume that an output is to be provided when the input is between −1 v and −2 v. When the input is in this range, transistor 2 will be cut off. However, transistor 1 will deliver a current pulse through the load. If the input is greater than −2 v, the collectors will rise and fall in phase, and no load current will be provided.



Level detector provides output only when input level is between levels set by emitter voltages.

Joe Klarl, Development Engineer, Motorola, Inc., Chicago, Ill.

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IDEAS FOR DESIGN

Tank Circuit Helps Stabilize Quick-Starting Gated Oscillator 746

Many circuit applications require sine waves or pulses, which must maintain a definite time relationship with the signal which caused them to be generated.

A free running sine-wave oscillator may be synchronized, but this usually requires complex circuitry. Another disadvantage of this method is the fact that the synchronizing signal frequency may vary.

The circuit in Fig. 1 is a gated 200-kc oscillator. In its quiescent state, the control signal causes *Q1* to saturate. The current through *Q1* is limited primarily by *R2*. It flows through germanium diode *CR1* and tank inductor *L1*. The *Q*

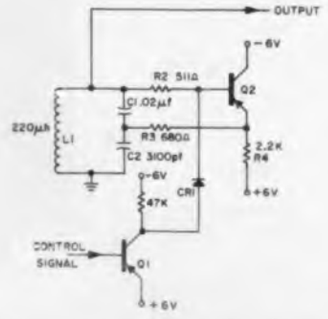

Fig. 1. When control signal turns *Q1* off, energy stored in tank inductor *L1* starts oscillations within 1 μsec.

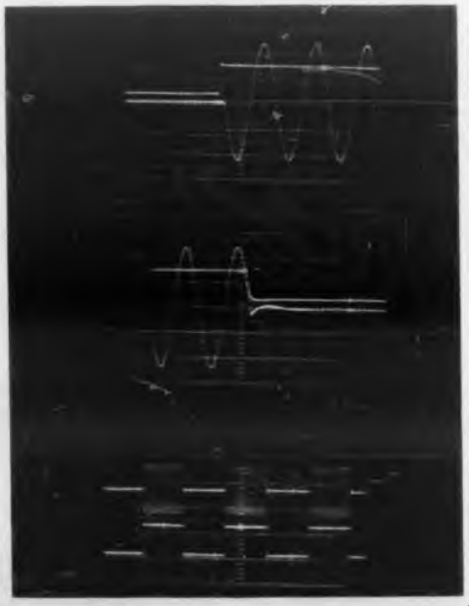

Fig. 2. Waveforms show how quickly and accurately control pulse turns oscillator on and off. Upper two waveforms are shown with scope calibrated at 2.5 v/cm and 2.5 μsec/cm. Lower photo has calibrations at 5 v/cm and 50 μsec/cm.

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of the tank is thus sufficiently lowered, so oscillations can not exist.

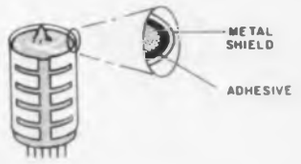
When the control signal causes *Q1* to stop conducting, the energy stored in *L1* produces immediate oscillations. The oscillations are sustained by feedback through *R3* and *C1*. The control signal in this application causes the oscillator to be active for 20-μsec intervals. The output can be taken directly from the tank, but the impedance of the circuit that it drives must be high.

The oscillator described has the following characteristics: Frequency: 200 kc ±0.02 per cent from a temperature of 0 C to 50 C. Time required to start oscillator: Less than 1 μsec. Output amplitude: 10 v peak-to-peak.

Jack McGruder, Circuits Section, Hughes Aircraft, Fullerton, Calif.

Metal Foil Sticks To Tube, Conducts Heat 747

Heat can be rapidly conducted from the glass walls of a vacuum tube by applying a recently developed, adhesive-coated metal foil wrapper. Available through Shawmut, Inc., of Brockton, Mass., the wrapper can be formed to fit snuggly around the tube and is held fast by a high temperature resistant adhesive. The thin layer of adhesive, which has a thermal conductivity many times that of air, holds the wrapper in intimate contact with the glass surface and eliminates the film of air present when an ordinary metal heat shield is used. A metal clamp can be used to support the tube and serve as a heat sink. In addition to improving the conduction of heat from all portions of the tube surface, the wrapper also acts as an electrical shield, while the adhesive film serves as a cushion to damp vibration and shock.



Metal foil sticks firmly to glass walls of vacuum tube, conducts heat away. Slits are made so that foil will stick tightly to irregular surface.

R. H. Wyner, President, Shawmut, Inc., Stoughton, Mass.; Dr. M. Mark, Consulting Engineer, Cambridge, Mass.

Reprinted from ED, Feb. 15, p 219.

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.001 thru .01	.3	.15	.125
.05	.52	.25	.20
.10	.52	.3	.3

Cap. Tol. = GMV, ±20%, ±10%
P.F. = 2% Max.
Working Voltage = 100 VDC to 125° C.
Series Resistance <.25 ohms at 8 to 10 mc.
Leads axial #22 gauge 1½" long (fine silver)

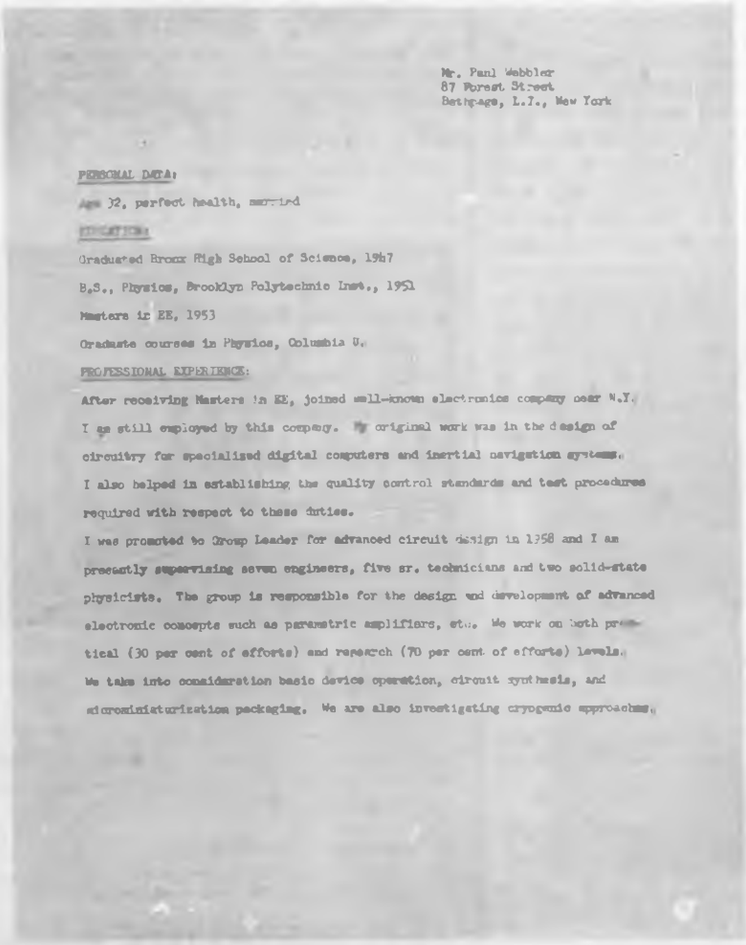
For full specifications, prices, or delivery dates, please write to Statnetics Corp., Department ED-3.

1/S **STATNETICS** *Corporation*
5121 WEEKS AVENUE, SAN DIEGO 10, CALIFORNIA

CIRCLE 156 ON READER-SERVICE CARD

If You Answer an Employment Ad, Don't be Disappointed by a Form-Letter Reply

Don't expect the man who writes that irresistible engineers-wanted ad also to answer your letter. If you do, the details of a recent survey will open your eyes.



Mr. Paul Webbler
87 Forest Street
Bethpage, L.I., New York

PERSONAL DATA:

Age 32, perfect health, married

EDUCATION:

Graduated Bronx High School of Science, 1947

B.S., Physics, Brooklyn Polytechnic Inst., 1951

Masters in EE, 1953

Graduate courses in Physics, Columbia U.

PROFESSIONAL EXPERIENCE:

After receiving Masters in EE, joined well-known electronics company near N.Y. I am still employed by this company. My original work was in the design of circuitry for specialized digital computers and inertial navigation systems. I also helped in establishing the quality control standards and test procedures required with respect to these duties.

I was promoted to Group Leader for advanced circuit design in 1958 and I am presently supervising seven engineers, five sr. technicians and two solid-state physicists. The group is responsible for the design and development of advanced electronic concepts such as parametric amplifiers, etc. We work on both practical (30 per cent of efforts) and research (70 per cent of efforts) levels. We take into consideration basic device operation, circuit synthesis, and microminiaturization packaging. We are also investigating cryogenic approaches.

Fig. 1. The resume was "engineered" to represent the type of engineer that the 100 firms had been "breathlessly" advertising for.

AN ENGINEER who answers one of those glowing, engineers-wanted ads should be prepared for a bleak form-letter reply. This was the conclusion which came out of a recent survey by Equity Advertising Agency, New York, in which 100 resumes, Fig. 1, were sent out in response to as many urgently phrased, electronic-engineers-wanted advertisements.

The 85 replies which came back, some fast, some slow, Fig. 2, over the 25 days following the mass-mailing had one thing in common; they were as colorless and impersonal as the original

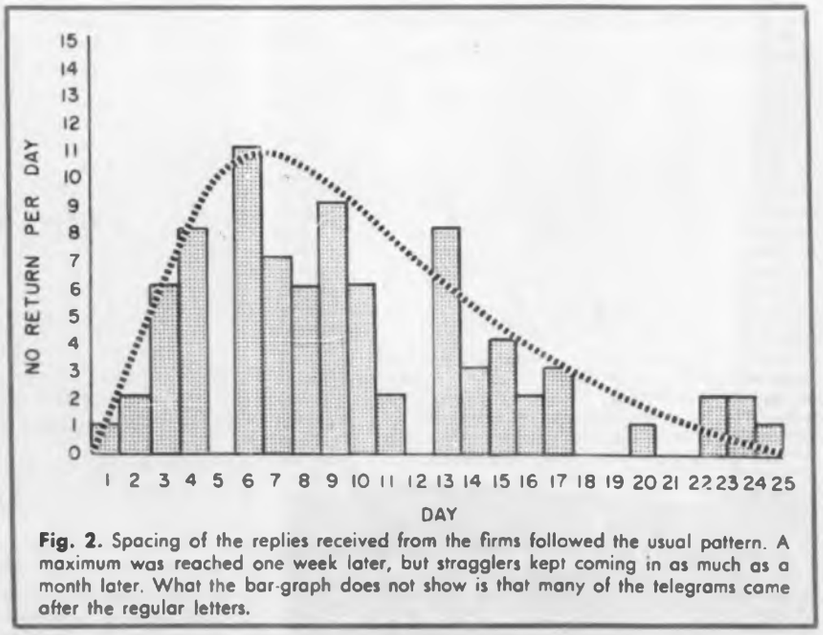


Fig. 2. Spacing of the replies received from the firms followed the usual pattern. A maximum was reached one week later, but stragglers kept coming in as much as a month later. What the bar-graph does not show is that many of the telegrams came after the regular letters.

Table A. The titles of the persons signing the replies indicated that only three were from the engineering department.

Personnel Dept.	
Director	5
Asst. Director	2
Manager	26
Asst. Manager	1
Supervisor	6
Administrator	6
Coordinator	3
Specialist	1
Associate	1
Representative	2
No Title	30

Engineering Dept.	
Engineering Manager	1
Asst. V.P. Engineering	1
Staff Engineer	1

ads were provocative and promising.

Mechanically reproduced form letters were actually used for 18 per cent of the replies. But most of the hand-typed letters seemed as stereotyped as the mechanically reproduced ones. Only five or six of the letters made any attempt to approach the job-seeker on a personal basis.

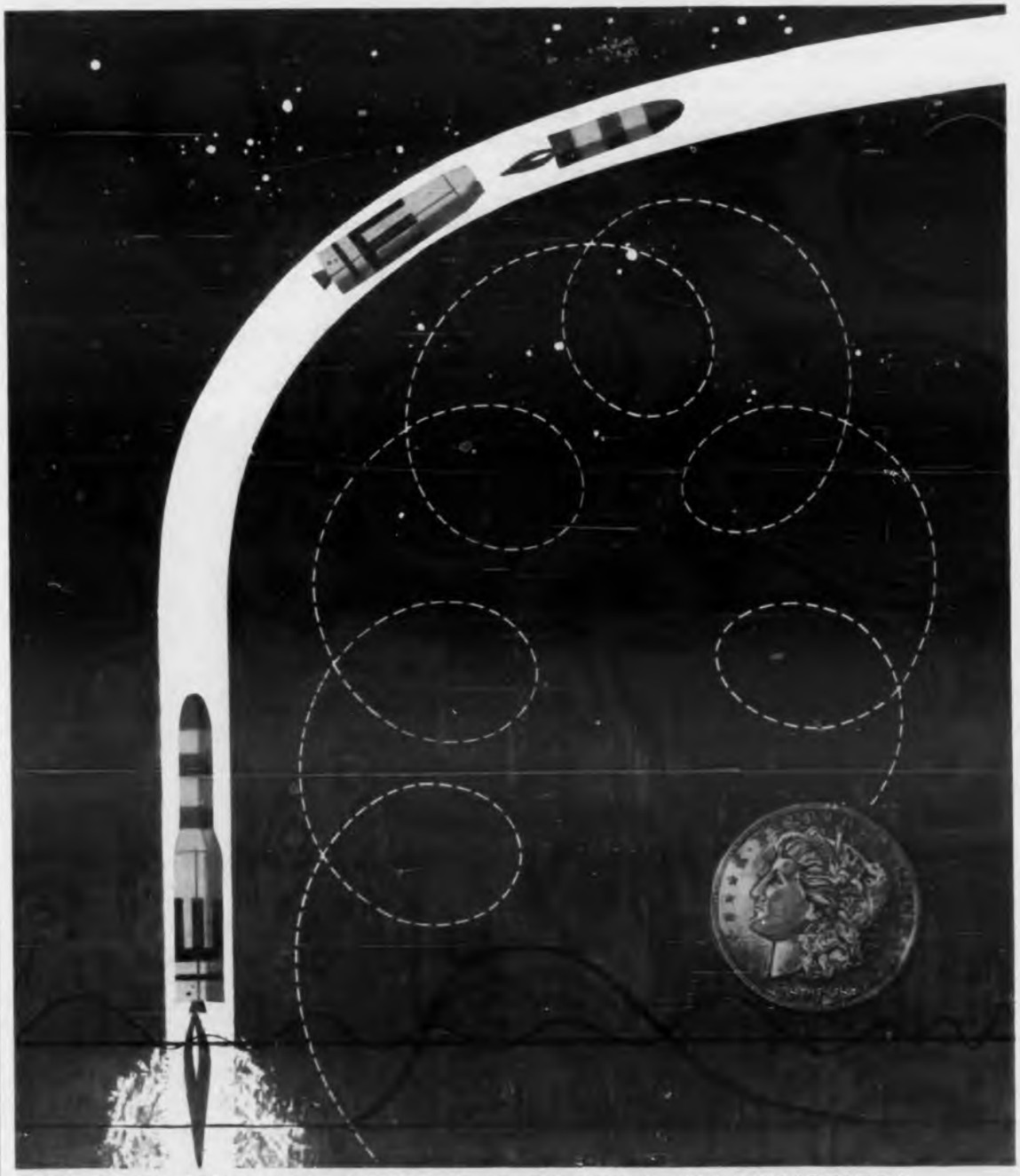
Probably the most discouraging reply for a job-seeker was the post card from a large firm whose advertisements are well-known to most engineers. Upon the post card was the terse statement that the firm would be "in contact with the applicant in the near future."

Company Waited Three Weeks, Then Sent Telegram

Fig. 2 shows the number of replies which came in each day over the 25-day period for which an exact count was kept. Discounting the fact that the original advertisements each had an air of urgency, there was nothing unusual in the distribution. The lack of correlation between how soon a reply came in and the method by which it was sent was, however, remarkable. The 17 telegrams, for example, were scattered, in time, among the regular mail.

Personnel Dept., Not Engineers Answer Inquiries

The most glaring comedown from the high professional appeal of the original ads was the



BUT, MONSIEUR BERTRAND, OUR COINS HAVE MEMORIES!

You said, "A coin has neither a memory nor a conscience." The reliability of our inertial guidance systems depends on their having both. Thus our reliability engineers must go beyond your venerable formulae in developing dependable guidance packages for missiles like Titan.

If the application of existing theory into usable reality challenges you, and if you have a BS, MS or PhD in EE, ME, Physics or Math, please contact Mr. F. G. Allen, Director of Scientific and Professional Employment, 7929 S. Howell, Milwaukee 1, Wisconsin.

AC SPARK PLUG ❀ THE ELECTRONICS DIVISION OF GENERAL MOTORS

CIRCLE 901 ON CAREER INQUIRY FORM

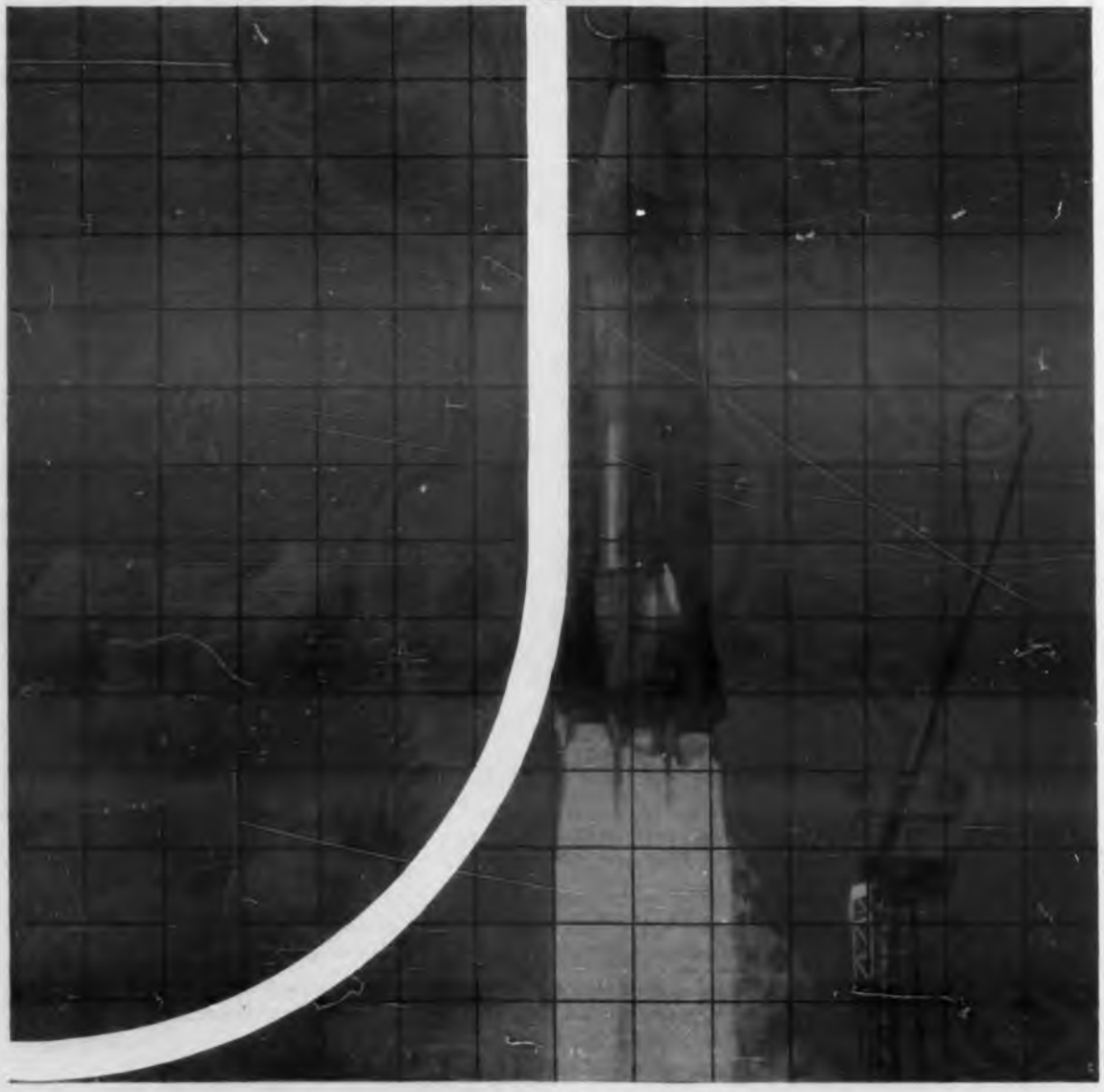
The first six years of **S**pace **T**echnology **L**eadership

Since 1954, when the Air Force ballistic missile program was accorded top national priority, Space Technology Laboratories has been engaged in virtually every major phase of research, development, testing and technical management of missile and space systems • STL's contributions have hastened the day of operational capability for Air Force ballistic missiles, and have been applied as well in satellite projects and space probes • Today, as STL's activities expand in significance and scope, STL offers exceptional opportunity to the outstanding scientist and engineer whose talents and training will add to, and benefit from, the accumulated experience that has enabled STL to conceive and accomplish major advances in the state-of-the-art • STL's creative flexibility, anticipating and responding to the demands of space progress, ranges in application from abstract analysis to complex hardware fabrication for military and civilian space projects • STL invites scientists and engineers to consider career opportunities in the atmosphere of Space Technology Leadership. Resume and inquiries will receive meticulous attention.

SPACE TECHNOLOGY LABORATORIES, INC. P.O. BOX 95005K, LOS ANGELES 45, CALIFORNIA

a subsidiary of Thompson Ramo Wooldridge Inc.

Los Angeles • Santa Maria • Edwards Rocket Base • Cheyenne • Cape Canaveral • Manchester, England • Singapore • Hawaii



DESIGNING YOUR FUTURE

fact that not only were the replies mostly from the personnel departments, but many were signed by secretaries (Table A). Three of the 85 replies were obviously signed by secretaries and at least ten more had been signed by secretaries for their "bosses." One letter was not signed at all. Could these people evaluate a technical man?

Apparently, after taking pains to write ads carefully aimed at the professional aspirations of engineers, the firms did not follow through with professionally oriented replies. The natural desire of a professional man to deal directly with men on his own, or higher levels, in the engineering department, was disregarded. The titles of those replying indicated an assortment of levels in the personnel departments. Only three of the 85 letters came from engineering departments.

Probably the only satisfactory reply, from the standpoint of an engineer, came from the engineering manager of a small firm. The letter was lengthy, but it said a lot. It told first of the company's plans for the future and then it went on to describe in detail the areas in which the applicant would work should he join the company.

This "one good reply" accentuated another finding of the survey, that smaller firms do a better follow-up job than the larger corporations. In addition to more personalized replies, the smaller firms responded faster and had fewer forms to fill out.

Engineers Don't Have Time To Fill Out All the Forms

Some of the firms apparently thought the engineer had little to occupy his time for they sent along complicated employment forms with the first letter. Obviously they had not heard that when an engineer starts actively looking for a job he contacts an average of 25 firms per week. The man who knows he is in demand will not spend time filling out 25 forms, at least not until he has an idea of which firms are really interested in him.

One reply not only included a complicated job application form but a security blank and a college transcript release. This package also contained an expensive-looking recruiting brochure, a benefits pamphlet, four magazine reprints, and two folders on the company's "mission." Unfortunately for the mail-room effort behind this package, it came after 83 others had been received. Would an engineer read all this?

Conclusion: Engineer Should Not Let Form Letters Govern His Fate

What conclusions should an engineer draw from this survey? First, he should not be dis-

couraged by the routine replies he receives in response to answering ads. He should neither be over-impressed with the telegrams which say "contact us immediately," but come three weeks later and are signed by a secretary, nor completely discouraged by the firms which despite constant frantic calls for engineers in their ads, reply, "sorry, no positions available which will use your talents."

If he receives one of these form letters from the personnel department he should evaluate it for no more nor less than it is—a coarse screening. If he really wants to be with a particular firm, he should make every effort to get through, on a person-to-person basis, to executives in the engineering department or wherever the actual decision will be made.

The survey which produced these conclusions was made by Equity Advertising Agency, Inc., New York, to see how its clients (and others) were using their expensive engineers-wanted ads.

Equity used the "straw man" approach. It first noted which of the firms were advertising the most, then "engineered" a resume to suit just what these firms appeared to be looking for.

Equity was shocked at the results. In the advertising field, they said, when someone wants talent as much as the electronics firms appear to want certain types of engineers, they really go after their man, following up their ads on a personal basis. ■ ■

Recruiters Have Their Side, Too

There are reasons for the form letters received by engineers who answer ads, John Whitton, Personnel Dept., Kollsman Instrument Corp., New York, said.

"For one thing, 60 per cent of the engineers won't answer you back, no matter how personalized a letter you write," he said. But mainly it's just a matter of the personnel departments being too small, too rushed, to take the time to track down the man in the engineering department who has the authority to write a meaningful "personalized" reply. This man is either away traveling or too busy with his engineering duties. Mr. Whitton uses a "form" telegram sent within a day or two.

Sometimes the ad agencies themselves are at fault. *ED* knows of a large ad for engineer to supervise development of "intelligent machines" which was run by mistake months after the position had been filled.

GENERAL DYNAMICS | ELECTRONICS

General Dynamics / Electronics, the electronics arm of General Dynamics Corporation, comprises the Stromberg-Carlson Division in its entirety, plus the separable electronics operations of other General Dynamics Divisions. It is engaged in the research, development and production of electronic products and systems in the military, industrial and commercial fields. In addition, the research operation of General Dynamics / Electronics is actively engaged in both pure and applied research in many advanced electronic techniques.

A FEW POSITIONS ARE AVAILABLE IN THE FOLLOWING AREAS:

NUCLEAR REACTOR & PROCESS CONTROLS
SINGLE SIDEBAND COMMUNICATIONS
DIGITAL COMMUNICATIONS
SPACE ELECTRONICS & NAVIGATION
GROUND SUPPORT EQUIPMENT
HYDROACOUSTICS
ELECTROACOUSTICS
SOLID & PLASMA STATE
STOCHASTIC PROCESSES
BASIC DATA COMPONENTS

With the establishment of a stronger electronics identity for General Dynamics Corporation, growth is expected in all areas. And greater flexibility will allow General Dynamics/Electronics to move rapidly into new and profitable fields.

• If you are interested in furthering your career in any of the areas listed, forward a resume to M. J. Downey.

GD

GENERAL DYNAMICS | ELECTRONICS

A DIVISION OF GENERAL DYNAMICS CORPORATION

1452 N. GOODMAN ST. • ROCHESTER 3, NEW YORK

CIRCLE 902 ON CAREER INQUIRY FORM

DEFENSE SYSTEMS DEPARTMENT

PROFESSIONAL EMPLOYMENT BULLETIN *MARCH, 1961*

On a regular basis, General Electric's Defense Systems Department publishes opportunities of special importance to experienced Systems Engineers and/or degree Engineers interested in developing their skills to the point of Systems Engineering in its broadest sense.

ANALYTICAL SYSTEMS ENGINEERS

To apply mathematical and engineering techniques to creative analysis of physical systems, modular development, classic mechanics, statistical analysis, non-linear systems analysis. Investigations are both analytical and numerical.

Areas of effort encompass Upper Atmospherics, In-Orbit Trajectory Corrections, Redundant Measurements (real-time and post flight), Error Analysis Studies (pertaining to redundant time and position measurements), Acquisition and Evaluation Studies, Probe Tracking, Planetary - Terminal - Midcourse Guidance, Space Tracking (analytical determination studies), and In-Orbit Corrections.

ELECTRONIC SYSTEM TEST ENGINEERS

To establish test objectives and accomplish planning and scheduling for test programs . . . implement programs, evaluate results and initiate required corrective action as a result of gross analysis.

Your response to this Bulletin will be expedited to the appropriate technical managers at DSD for prompt, personal attention and a confidential reply, generally within one week. Address:
Mr. E. A. Smith,
Box 3-C

DSD DEFENSE SYSTEMS DEPARTMENT
A Department of the Defense Electronics Division

GENERAL ELECTRIC

Northern Lights Office Bldg., Syracuse, New York

CIRCLE 904 ON CAREER INQUIRY FORM

FREE "Geographic" Monthly Electronics Opportunities Survey

Now by popular request—Cadillac, the nation's largest Executive and Professional Placement Service, issues the Monthly Electronics Opportunities Survey on a regional basis.

Cadillac represents 508 "Blue-Chip" electronics firms who have openings ranging in salary from $6,000 to $75,000. Because so many excellent positions are available each month, the survey now lists positions by all major areas: East—Midwest—West—South.

Both the Survey and our COMPLETELY CONFIDENTIAL Placement Service are available to you absolutely FREE OF CHARGE.

* * * * * * * * *

For your free Survey, each month listing America's Best Electronic jobs, send your name and home address to:

JACK L. HIGGINS
Vice President
CADILLAC ASSOCIATES, INC.
29 East Madison Building
Chicago 2, Illinois

CIRCLE 886 ON READER-SERVICE CARD

Microwave Manager

This position should present a real challenge to a creative Senior Microwave Engineer interested in trail blazing activity with a company whose phenomenal growth (from 11 engineers to 1600 employees in 9 years) is based on original technical achievements such as TRI-PLATE (r) microwave components and techniques, FLEXPRINT (r) flexible printed circuits and PANAR (r) radar.

The man selected must be capable of both technical and administrative supervision. He will have an extensive microwave systems design background and be able to direct engineering activities in microwave systems for radar and missile applications—standard components and stripline techniques including antenna systems and stripline modules. At the same time, he will be expected to spark and direct sales activity in the microwave field.

If this opportunity sounds like your type of job, send a brief resume indicating salary requirements to R. W. McCarthy.

SANDERS ASSOCIATES, INC.
NASHUA, NEW HAMPSHIRE

(r) registered trademark

CIRCLE 905 ON CAREER INQUIRY FORM

Politechnics

Politics plus Engineering equals New Design Directions. Want inside information on how politics and engineering in the nation's capital will affect your design directions? Read these facts and more in John Christie's Washington Report in each issue of ELECTRONIC DESIGN.

John Christie: ELECTRONIC DESIGN's very own *full-time* on the spot Washington reporter. John's 25 years of journalism experience enable him to uncover trends, sift and evaluate facts and happenings which will have an impact on you—the design engineer. His full time coverage and keen insight make for an exciting and important column.

Keep Posted Read WASHINGTON REPORT!

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!

ELECTRONIC DESIGN CAREER INQUIRY SERVICE

USE BEFORE MAY 10, 1961

(7)

After completing, mail career form to *ELECTRONIC DESIGN*, 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below.

(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

(F101, AIR FORCE PHOTO)

National has had many years' experience making significant contributions to the defense effort, including airborne components.

COMPARE THIS OPPORTUNITY

WITH WHAT YOU ARE NOW DOING!

HERE'S WHAT *National's* NEW MILITARY RESEARCH AND DEVELOPMENT PROGRAM OFFERS.

This operation will interest any engineer or scientist possessing enough self-confidence—ability and experience—to develop projects initially and carry them through to completion.

WHO WE'RE LOOKING FOR

National is looking for military-oriented scientists and engineers who hold a B.S. degree or advanced degrees. You should be working in electronic, electro-mechanical, mechanical, physics, optics, mathematics, or other related areas. Preference will be given to those who have had several years' experience dealing with prime contractors and government agencies.

As a member of National's New Military Development Team—you will be working initially with our Military Proposal Group. As proposals become specific projects, your responsibility will continue through the contractual stage for technical liaison, fulfillment of contractual obligations including hardware development, meanwhile retaining sufficient flexibility to continue your proposal efforts.

WHY YOU SHOULD INVESTIGATE

National's new Military Research and Development Program offers you unusual latitude in responsibility. It offers you the chance to participate in military projects from start to finish. Furthermore, you now have the opportunity to join an operation still in its formative stage with one of the world's most successful . . . most reputable corporations.

COMPLETE INFORMATION is yours by sending your résumé to Mr. T. F. Wade, Technical Placement Section G31. The National Cash Register Company, Dayton 9, Ohio. All correspondence will be kept strictly confidential.

THE NATIONAL CASH REGISTER COMPANY, *DAYTON 9, OHIO*

ONE OF THE WORLD'S MOST SUCCESSFUL CORPORATIONS

77 YEARS OF HELPING BUSINESS SAVE MONEY

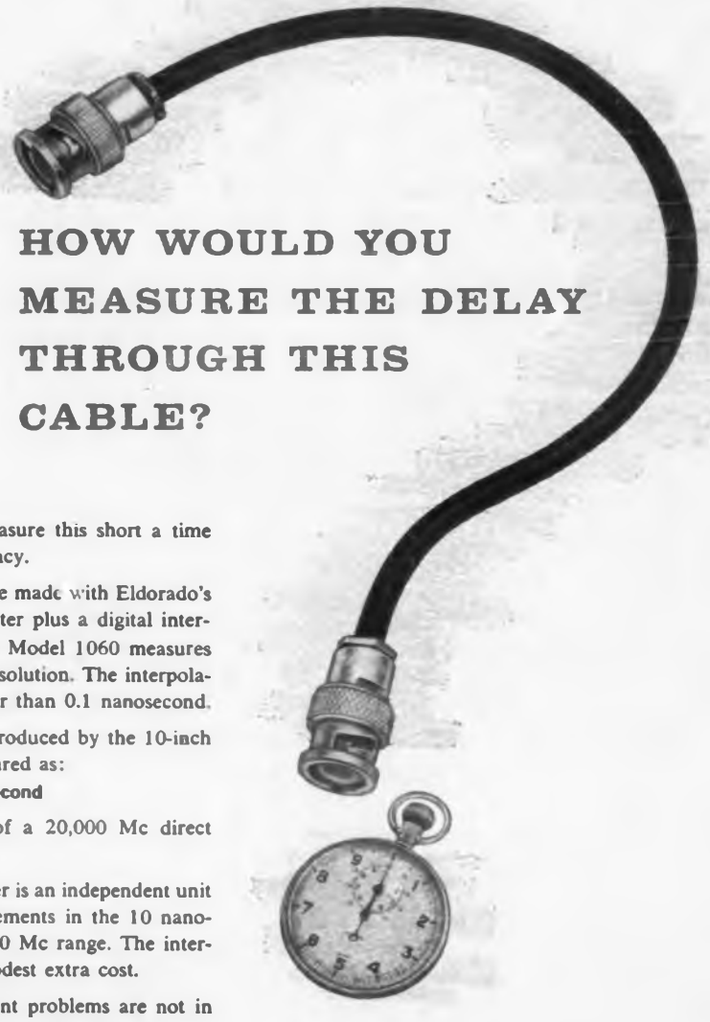
CIRCLE 912 ON CAREER INQUIRY FORM

ADVERTISERS' INDEX

March 29, 1961

**Manufacturers' catalog appears in 1960-1961* ELECTRONIC DESIGNERS' CATALOG

*Manufacturers' catalog appears in 1960-1961 ELECTRONIC DESIGNERS' CATALOG



HOW WOULD YOU MEASURE THE DELAY THROUGH THIS CABLE?

Until now it was impossible to measure this short a time interval with sub-nanosecond accuracy.

Now, this measurement can easily be made with Eldorado's new Model 1060 Time Interval Meter plus a digital interpolator. Solid state throughout, the Model 1060 measures time interval with 10 nanosecond resolution. The interpolator improves the resolution to better than 0.1 nanosecond.

Using this equipment, the delay introduced by the 10-inch cable plus its connectors was measured as:

1.43 ±.05 nanosecond

This resolution is the equivalent of a 20,000 Mc direct counting time interval meter!

The Model 1060 Time Interval Meter is an independent unit suited for all time interval measurements in the 10 nanosecond range or counting in the 100 Mc range. The interpolator accessory is available at modest extra cost.

Even though your time measurement problems are not in the area of cable delays, but rather in the fields of radar ranging and calibration, high speed velocity measurement, rocket sled timing, shock waves, ultra-high speed photography, satellite tracking, ballistic missile studies, or any field where data is gathered in the form of a time interval measurement, this new technique may offer the solution you have been seeking.

For specific details on the Model 1060 and the interpolator, and for assistance in applying them to *your* problems, contact your Eldorado engineering representative or drop us a line at the factory. Please address Dept. 36.

BASIC DATA MODEL 1060 COUNTER-TIME INTERVAL METER

Time Interval Meter

MAX. TIME INTERVAL: 10 seconds • RESOLUTION: 10 nanoseconds
TYPICAL START/STOP PULSE REQUIREMENT: —4 volts into 50 ohms
OSCILLATOR STABILITY: 0.0001% • READOUT: Nixie inline and output for printout.

Counter

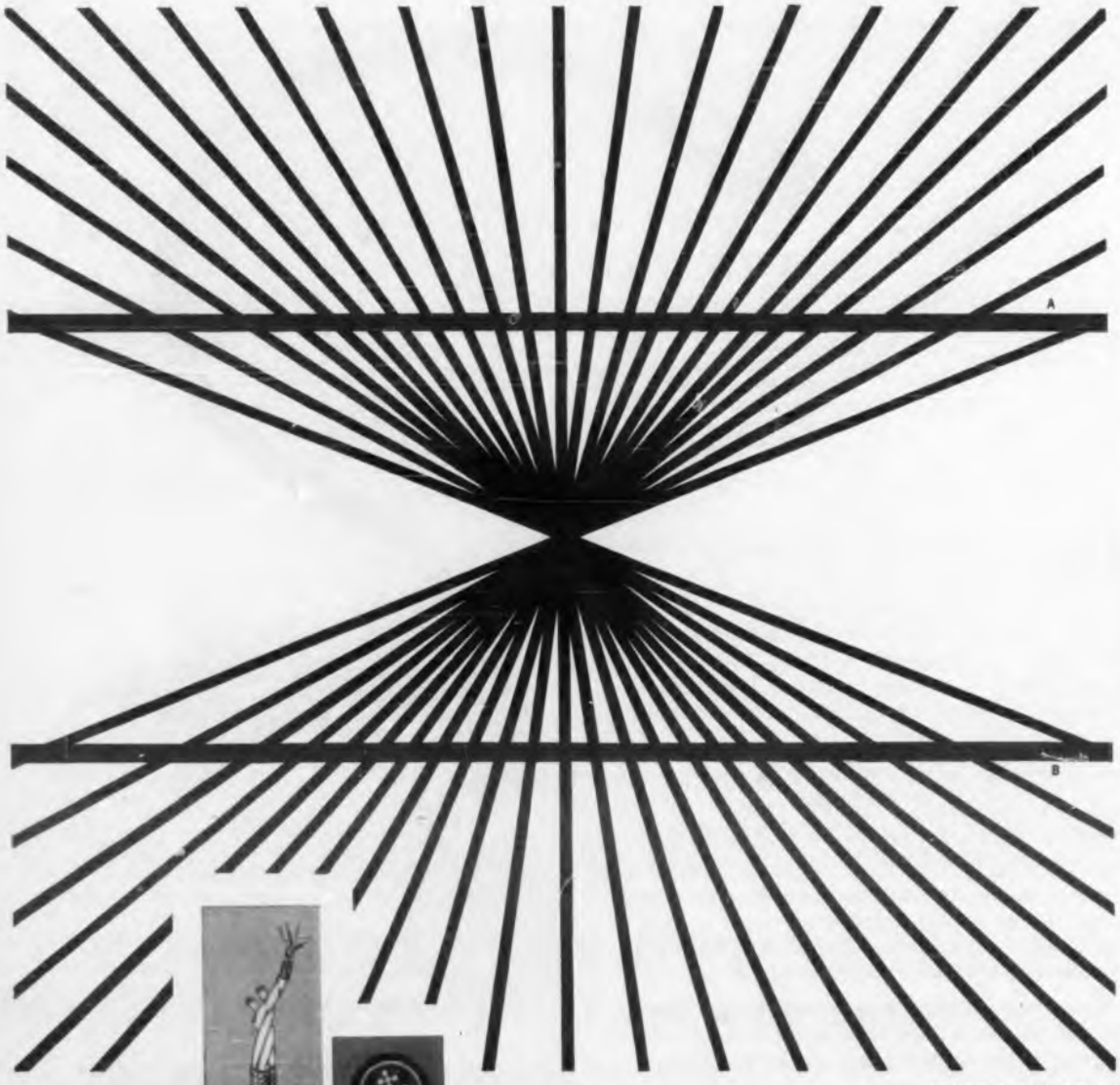
STORAGE: 10^9 counts • MAX. COUNTING RATE: 100 Mc/s
TYPICAL INPUT PULSE REQUIREMENT: +4 volts into 50 ohms
DELIVERY: 45 days.

Eldorado Electronics

2821 TENTH STREET
BERKELEY 10, CALIFORNIA
PHONE: THORNWALL 1-4613

21

CIRCLE 148 ON READER-SERVICE CARD



Are lines A and B parallel?

At Hitemp–Quality is not an illusion

Examine with the naked eye and handle several different brands of wire and cable. They look and feel identical, don't they? Their similarity with regard to quality, however, is just as much an illusion as the art form above.

Though different brands may be made with similar materials and equipment, one brand of wire and cable will outlast, outperform all others. That brand is Hitemp.

Why? Because Hitemp has the greatest store of experience in the industry—two modern production facilities that are second to none—and more than one-fourth of its entire work force devoted solely to inspection and quality control.

Hitemp products are for you, the wire and cable user who requires quality and reliability that is fact, not illusion.

Hitemp is a Division of Simplex Wire & Cable Co.

HITEMP WIRES CO.

1200 SHAMES DRIVE, WESTBURY, NEW YORK
1532 S. CALIFORNIA AVE., MONROVIA, CALIF.

CIRCLE 161 ON READER-SERVICE CARD

Advertising Representatives

Adv. Sales Manager: Bryce Gray, Jr.

Sales Service Supvr.: Alvin D. Ross

New York: Robert W. Gascoigne, Richard Parker, Blair McClenachan, James P. Quinn, Donald J. Liska, Charles J. Stillman, Jr., Kenneth M. George, John N. Weber, 830 Third Avenue, Plaza 1-5530

Chicago: Thomas P. Kavooras, Berry Conner, Jr., Fred T. Bruce, 664 N. Michigan Avenue, Superior 7-8054

Los Angeles: John V. Quillman, Wayne Stoops, 3275 Wilshire Blvd., Dunkirk 2-7337

San Francisco: Stanley I. Ehrenclou, 292 Walter Hayes Drive, Palo Alto, Davenport 1-7646

Southeastern: Pirnie & Brown, Morgan Pirnie, Harold V. Brown, G. W. Krimsier, 1722 Rhodes-Haverty Bldg., Atlanta, Ga., Jackson 2-8113

London EC4: Brad Nichols, 151 Fleet Street

Tokyo: Karl H. Bachmeyer Associates, 27 Morimoto-cho, 1-chome, Azabu, Minato-ku

ELECTRONIC DESIGN · ONE DAY SERVICE

USE BEFORE MAY 10th, 1961

C

Name ______ Title ______

Company ______

Company Address ______ City ______ Zone ______ State ______

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290
1	11	21	31	41	51	61	71	81	91	101	111	121	131	141	151	161	171	181	191	201	211	221	231	241	251	261	271	281	291
2	12	22	32	42	52	62	72	82	92	102	112	122	132	142	152	162	172	182	192	202	212	222	232	242	252	262	272	282	292
3	13	23	33	43	53	63	73	83	93	103	113	123	133	143	153	163	173	183	193	203	213	223	233	243	253	263	273	283	293
4	14	24	34	44	54	64	74	84	94	104	114	124	134	144	154	164	174	184	194	204	214	224	234	244	254	264	274	284	294
5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205	215	225	235	245	255	265	275	285	295
6	16	26	36	46	56	66	76	86	96	106	116	126	136	146	156	166	176	186	196	206	216	226	236	246	256	266	276	286	296
7	17	27	37	47	57	67	77	87	97	107	117	127	137	147	157	167	177	187	197	207	217	227	237	247	257	267	277	287	297
8	18	28	38	48	58	68	78	88	98	108	118	128	138	148	158	168	178	188	198	208	218	228	238	248	258	268	278	288	298
9	19	29	39	49	59	69	79	89	99	109	119	129	139	149	159	169	179	189	199	209	219	229	239	249	259	269	279	289	299
300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	491	501	511	521	531	541	551	561	571	581	591
302	312	322	332	342	352	362	372	382	392	402	412	422	432	442	452	462	472	482	492	502	512	522	532	542	552	562	572	582	592
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304	314	324	334	344	354	364	374	384	394	404	414	424	434	444	454	464	474	484	494	504	514	524	534	544	554	564	574	584	594
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306	316	326	336	346	356	366	376	386	396	406	416	426	436	446	456	466	476	486	496	506	516	526	536	546	556	566	576	586	596
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601	611	621	631	641	651	661	671	681	691	701	711	721	731	741	751	761	771	781	791	801	811	821	831	841	851	861	871	881	891
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606	616	626	636	646	656	666	676	686	696	706	716	726	736	746	756	766	776	786	796	806	816	826	836	846	856	866	876	886	896
607	617	627	637	647	657	667	677	687	697	707	717	727	737	747	757	767	777	787	797	807	817	827	837	847	857	867	877	887	897
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609	619	629	639	649	659	669	679	689	699	709	719	729	739	749	759	769	779	789	799	809	819	829	839	849	859	869	879	889	899

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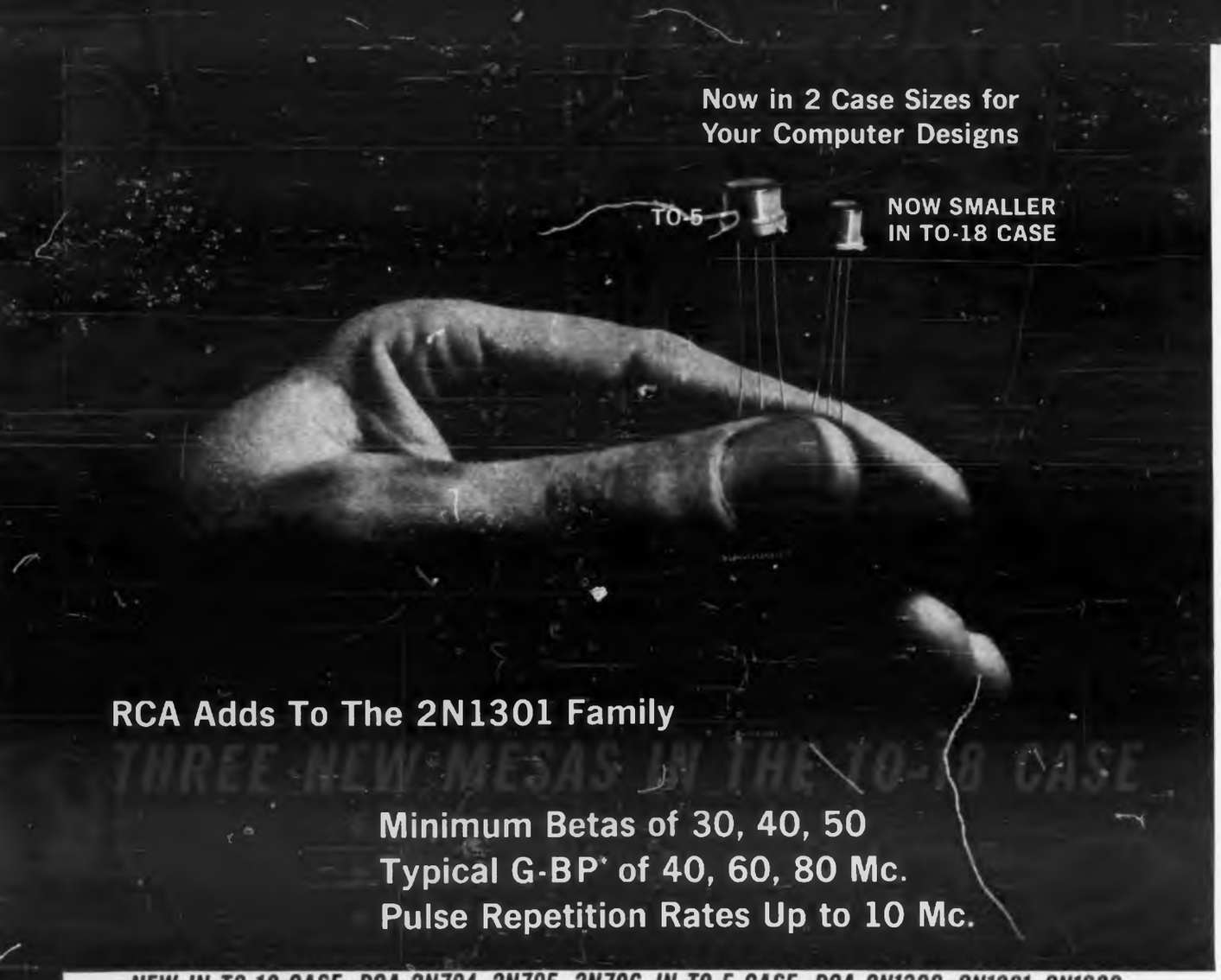

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