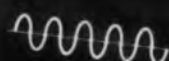
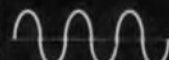


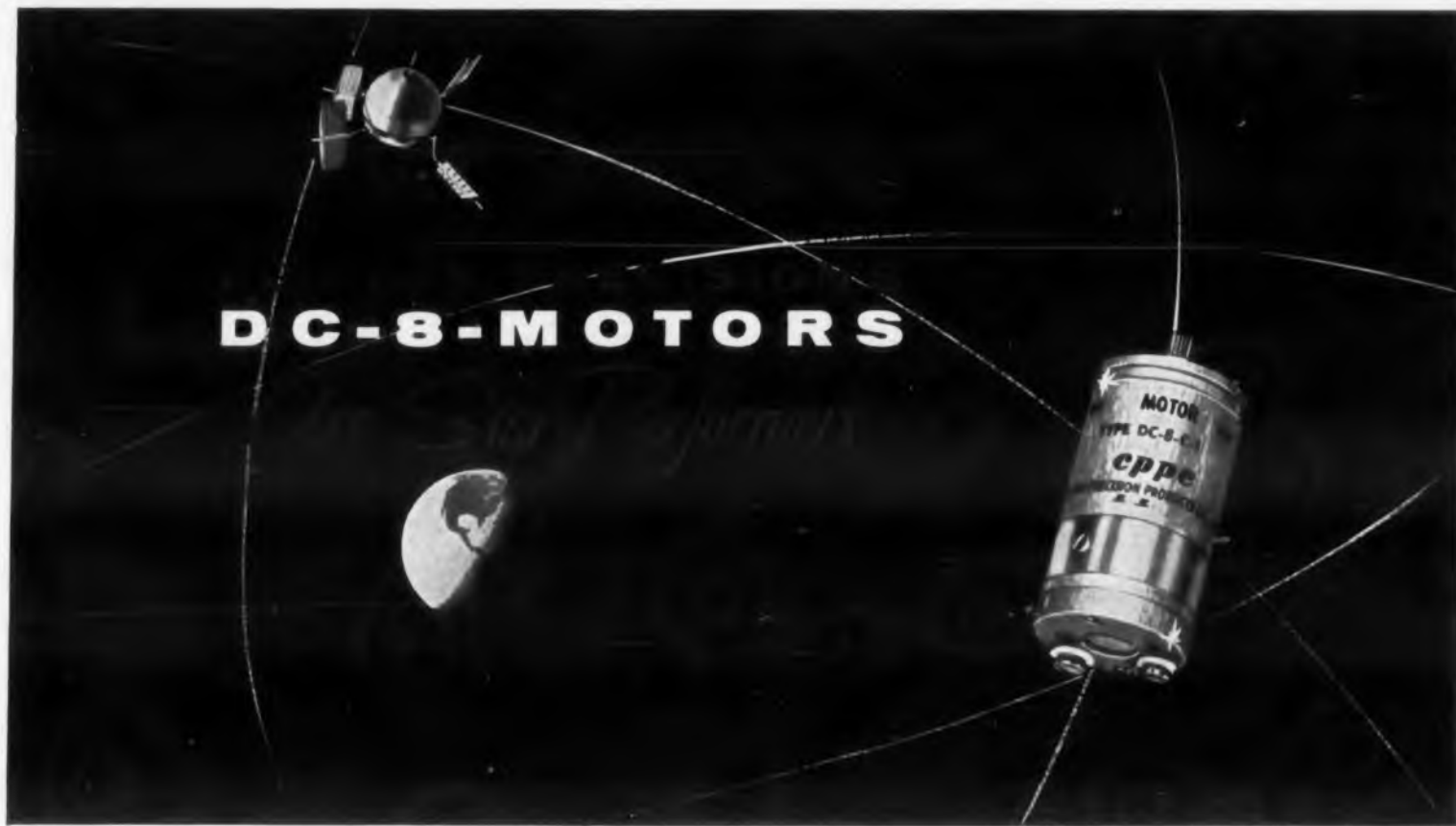
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Family of solid-state microwave sources
serve as paramp pumps p 66



Trends in Microwaves—A Staff Report... p 161



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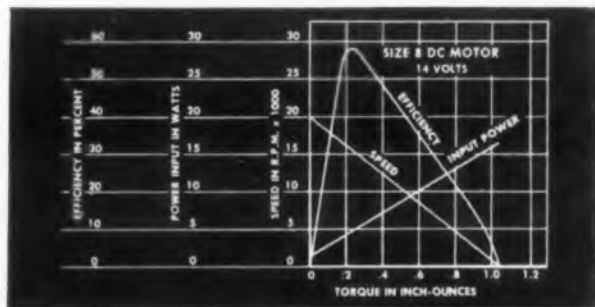
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CIRCLE 1 ON READER-SERVICE CARD



COVER: The white dots on the face of the dominoes on the cover, paired with the graphic representation of the sine curves, show the ability of the new microwave signal source to double, triple, quadruple, and quintuple the device's basic microwave signal. The solid-state source replaces the klystron for any fixed-frequency application requiring up to 4-w output.

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Sidelights of This Issue

Down the Microwave Trail

When *ELECTRONIC DESIGN*'s editors, many months ago, began the microwave report which starts on p 161 of this issue, they found themselves with an embarrassment of riches. Holding down the length of the report, with its attendant frustrations, led them to several conclusions.

The major conclusion they reached was that a special and regular section was necessary to give the field the coverage it requires. That special section starts in this issue and will be a regular feature of *ELECTRONIC DESIGN*, appearing in every second issue.

Microwaves have long been of intense interest to *ED* editors; indeed, nearly two years ago a series on microwave test equipment ran in the magazine. But some aspects of the technology which would have been considered fantastic in those days are state-of-the-art today.

The microwave engineer, as Associate Editor Robert DeFloria points out in his editorial, must wear many hats. He must have a working knowledge of the widely diverse fields which he serves—fields as far apart as meteorology, plasma technology, and plain old home cooking.

We believe this subject is vastly important to the future of all areas of the world's economy and technology. To this end, we are inaugurating the special section called *MicroWaves*.

Send Us Your Design Decisions

On p 185 of this issue appears a fairly brief rundown on a new look in panel meters. As a development, it is no earth-shaker, but it is interesting and helpful.

Over the years, *ED*'s editors have formed the opinion that the interesting ways that small problems are solved add up to a lot of big problems being solved. Hence, our regular Design Decisions department.

If you have put into use a clever and unusual idea of your own, send it along. If we use it, you'll have a double satisfaction—the knowledge that you have helped someone else and the knowledge that you have made some money on the side.



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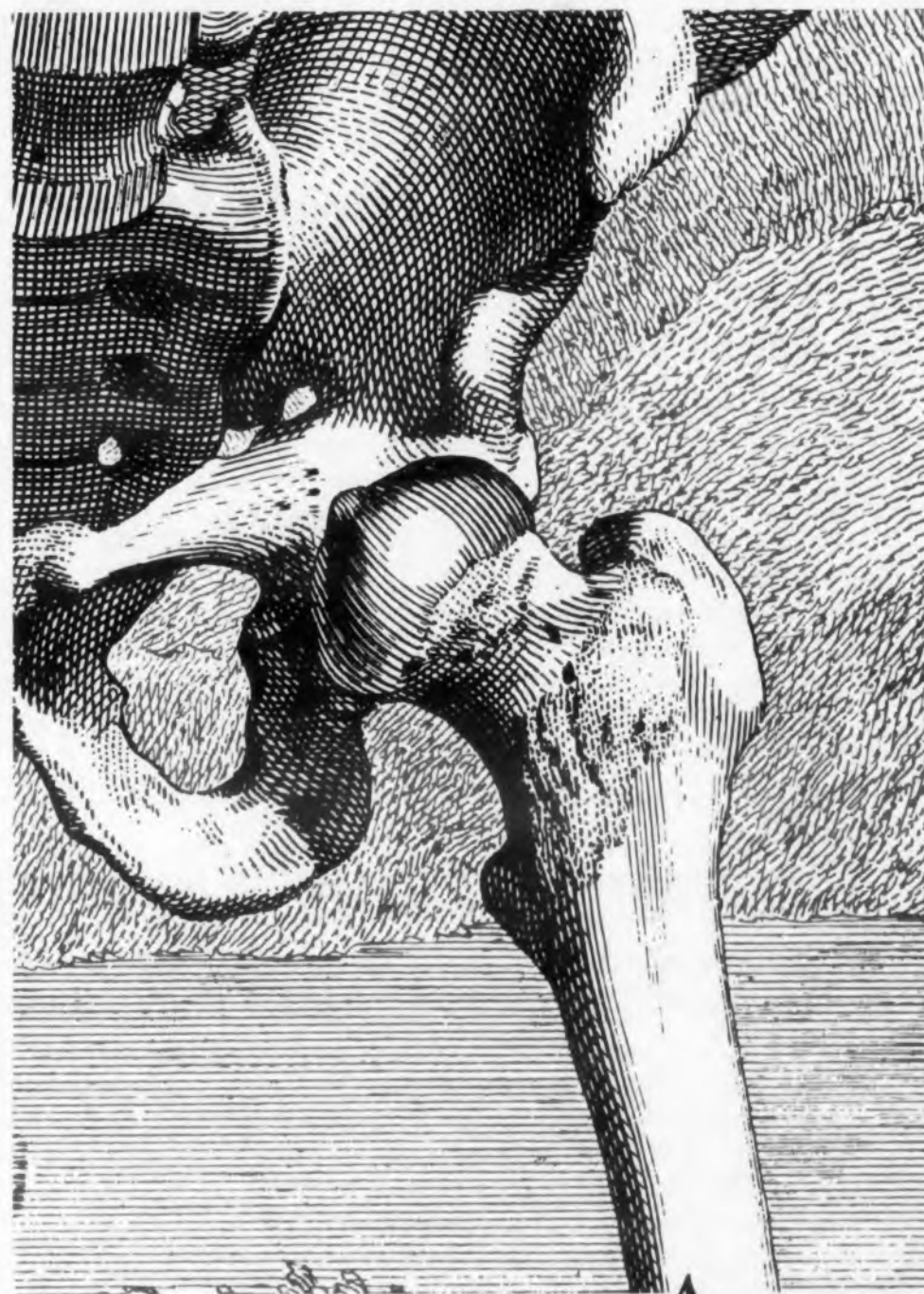
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A ROTARY JOINT THAT'S NEVER BEEN IMPROVED UPON... BUT WE, AT CANOGA, TRY

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CIRCLE 4 ON READER-SERVICE CARD

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Microwave Modulator Under Development

*Work on Light Detector Disclosed at NEREM Meeting;
Device Seen as Missing Link in Optical Communications*

DEVELOPMENT work on a microwave modulator and light detector—the missing ingredient of a true optical communications system—was disclosed by Dr. Nicolaas Bloembergen of Harvard at last week's Northeast Electronics Research and Engineering Meeting in Boston. Dr. Bloembergen outlined the theoretical basis for such a device and described experimental work now under way to establish its feasibility.

Dr. Bloembergen's project bears a close family resemblance to his earlier work in develop-

ing the ruby maser and may, in fact, be employed together with an optical maser to form a complete optical communications system. Other maser experts, including Dr. Arthur L. Schawlow of the Bell Telephone Laboratories, are also experimenting with microwave light modulators, it was learned by *ELECTRONIC DESIGN*.

Dr. Bloembergen emphasized that an operating device has not yet been built and expressed caution as to the early application of the modulator in a communications system. "Microwave

modulation of light will be achieved in the laboratory and will have laboratory applications, but it is a matter of speculation as to how useful it will be in engineering applications," he said. Lest this be unduly discouraging to systems designers, he quickly added that "We are at the point with this where masers were four years ago; engineers would do well to keep an eye on this work."

Three possible techniques for microwave modulation of light were described. They are:

First Super-Power Sonar Goes to Sea

*Long-Range Submarine Sonar Joins Fleet for Trials,
Adding to Navy's Antisubmarine-Warfare Confidence*

WHAT is believed to be the nation's longest-range sonar, Raytheon's BQQ-1 phased-array, combination system, has gone to sea aboard the SSN Tullibee. Because the Tullibee has actually joined the fleet, the sonar, in effect, may be bypassing some normal evaluation stages. Rear Adm. L. M. Mustin, antisubmarine-warfare readiness executive of the Navy, in describing

the growing effectiveness of this country's antisubmarine-warfare efforts, reports that sonar ranges of 30 to 70 miles are looked for in current sea trials.

The 50-ton BQQ-1 is an integral part of the Tullibee's hull, filling most of the bow and displacing the craft's forward torpedo tubes to midship. It is believed to comprise an electronically scanned linear array of lead-zirconate titanate transducers. The array is electronically phased, which provides sharp directivity. This directivity is important in achieving high sensitivity and great range.

The system, which is being developed by Raytheon under a \$30-million contract, is now being fitted into another nuclear submarine.

Admiral Mustin credits advances in magnetic-anomaly detection equipment along with long-range sonars in reporting on the high level of the Navy's ASW capability. He singles out development of total-field magnetometers for MAD systems and the use of data-correlation techniques during MAD operations as important advances. The admiral says data-correlation techniques are making it possible for single Navy planes to tow simultaneously several MAD-containing glider-like birds. In effect, each plane is provided with multiple sensors.

Because of new developments in ships, planes,

and techniques, as well as in electronic equipment, the Navy has a much greater capability in ASW than has any other naval force, the admiral says.

He calls detection the most critical phase of ASW operations, and reports that the Navy's advances in submarines have been much greater than its advances in ASW. This, he says, was partly a result of the Navy's emphasis on submarine offensive capability, however.

The admiral, who, as special assistant for ASW to the Chief of Naval Operations, directs the Navy's developmental activities in ASW, made the following points in an interview with *ELECTRONIC DESIGN*:

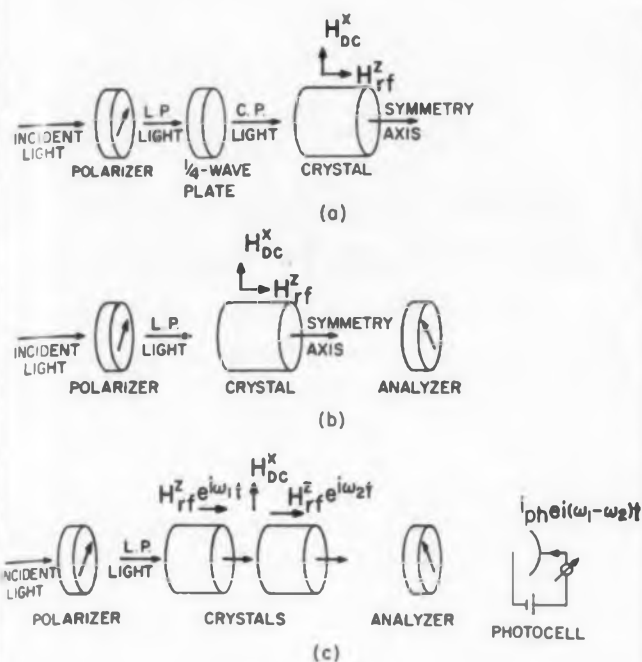
■ Further increases in normal and ASW capabilities of submarines can be expected now that previous standards of assigning space and weight allowances for various functions have been modified.

■ The best way for designers in industry to learn what the Navy needs in ASW is through the National Security Industrial Association and its ASW committee. The Navy plans to continue working as closely as possible with the NSIA.

■ Spending for antisubmarine warfare, which has climbed steadily in recent years, should continue to grow, particularly expenditures for electronics equipment. ■ ■



"This country has a magnificent capability in ASW, with no close seconds. . ." reports Admiral Mustin, the Navy's ASW executive.



Microwave light modulator could employ any of these geometries: (a) microwave modulation of magnetic circular dichroism; (b) modulation by optical Faraday rotation of the plane of polarization; (c) Heterodyne detection of microwave modulation of light. The photocurrent is modulated at an intermediate beat frequency.

- Modulation of circular dichroism in a paramagnetic crystal (such as ruby) by a microwave signal.

- Faraday rotation of the plane of polarization in a paramagnetic crystal by the magnetic field of a microwave signal.

- Faraday rotation of the plane of polarization by the electric field of a microwave signal. This effect is analogous to that in a Kerr cell, but is obtained in a solid (such as di-hydrogen phosphate) rather than in a liquid.

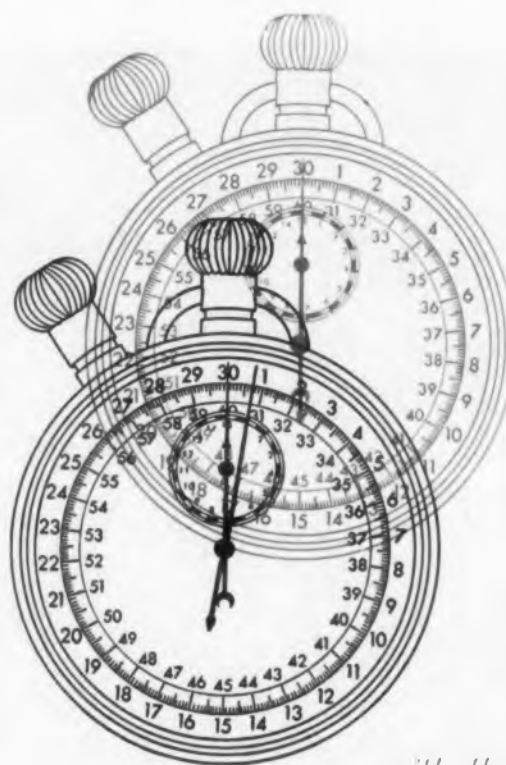
Each of the first two approaches requires liquid helium temperatures. The third method can be operated at room temperature.

Polarization Shift Limited for First Two Methods

In materials examined to date, the polarization shift obtainable by the first two methods is limited. Ruby, for example, permits a maximum shift of perhaps one deg with continuous modulation and a shift of 10 deg with intermittent modulation at durations ranging from 1 msec to 1 μ sec. The effect per watt of power is quite small and increases only as the square root of the applied power. A major limiting condition here is the need for large cryostats to remove the energy due to the large microwave power levels required for polarization shifts.

Accordingly, rare earths in cubic-ion crystals and other materials are being tested in a search for substances having larger inherent polari-

(Continued on p 20)



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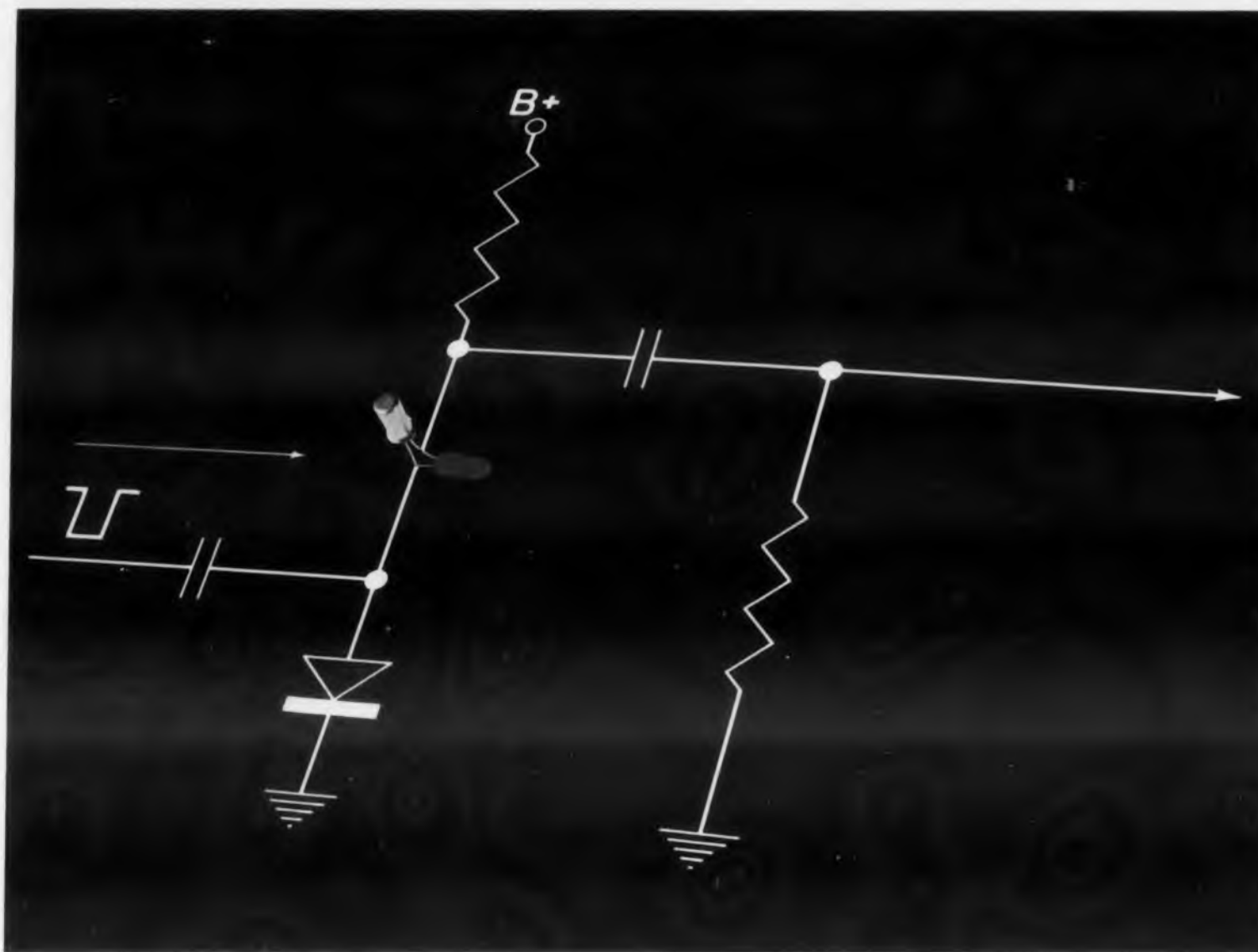
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DC Input Range ± 500 , 50 volts
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NEWS

Clock-Type Masers

Martin's Optically Pumped Maser Employs Argon-Buffered Cesium

AN OPTICALLY pumped microwave maser employing argon-buffered cesium has been successfully operated at the Martin Co., Orlando, Fla. The experimental unit develops about 3×10^{-16} w at 9,192 mc and reportedly has a line width of less than 1 cps.

According to Martin scientists, the new maser is a likely candidate for use in frequency standards and could be an order of magnitude more stable than ammonia masers. Experiments to determine the time coherence of the new unit are now under way. "There is no question that we have achieved maser emission," a Martin scientist told *ELECTRONIC DESIGN*, "but line width is only an indirect measure of coherence, and it is most important that we measure coherence directly by interferometry methods."

Spokesmen for the company were confident that output of a more refined device could be as high as 10^{-7} w. "Our experimental cell was very small and the interior walls were uncoated; a larger device with paraffin-coated walls would give an appreciable increase in output," a Martin scientist said.

Optically Pumped Thallium Maser Also Reported in Development

An optically pumped thallium maser is also reported in development by the company. This device would operate at 22 kmc and may yield higher power outputs than the cesium maser.

In the experimental cesium maser, a quartz cell containing the cesium vapor is mounted in a cylindrical TE_{011} cavity ($Q = 4,000$). Pumping light (8521A) from an Osram cesium-arc lamp is admitted through slots parallel to the current lines. The output is due to population inversion of the cesium atoms between the $F = 4$ and $F = 3$ energy levels, with radiation occurring as the atoms return to the $F = 3$ level.

The inversion process is apparently not well understood, Martin scientists admitted, since maser action was not affected by polarized light, weak magnetic fields, or the presence of light other than 8521A. It is believed that self-absorption in the lamp of two hyperfine components of the 8521A line in different proportions results in a differential of pumping energies that causes population inversion.

Martin scientists responsible for the cesium maser development include V. E. Derr, J. J. Gallagher, R. E. Johnson and A. P. Sheppard. ■ ■

Differ in Technique

'Storage Box' Lined with Paraffin Characterizes Harvard's Device

THROUGH the use of a paraffin-lined "storage box," experimenters at Harvard University have achieved maser action in a stream of atomic hydrogen. The new hydrogen maser will be used in a 1,420-mc time standard which will reportedly be more than 100,000 times more accurate than the best existing atomic clocks. A line width of less than 1 cps is claimed.

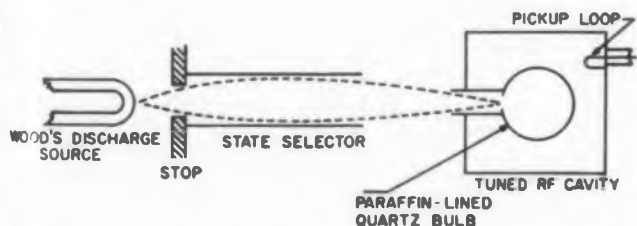
Hydrogen atoms from a Wood's discharge source pass through a six-pole state selector magnet which focuses the high energy atoms into a paraffin-coated quartz bulb. The bulb, which forms the maser chamber, is located in a cylindrical TE_{011} rf cavity ($Q = 60,000$) to which is coupled rf energy at the transition frequency of the atoms.

Paraffin Coating Has Low Interaction With High-Energy Hydrogen Atoms

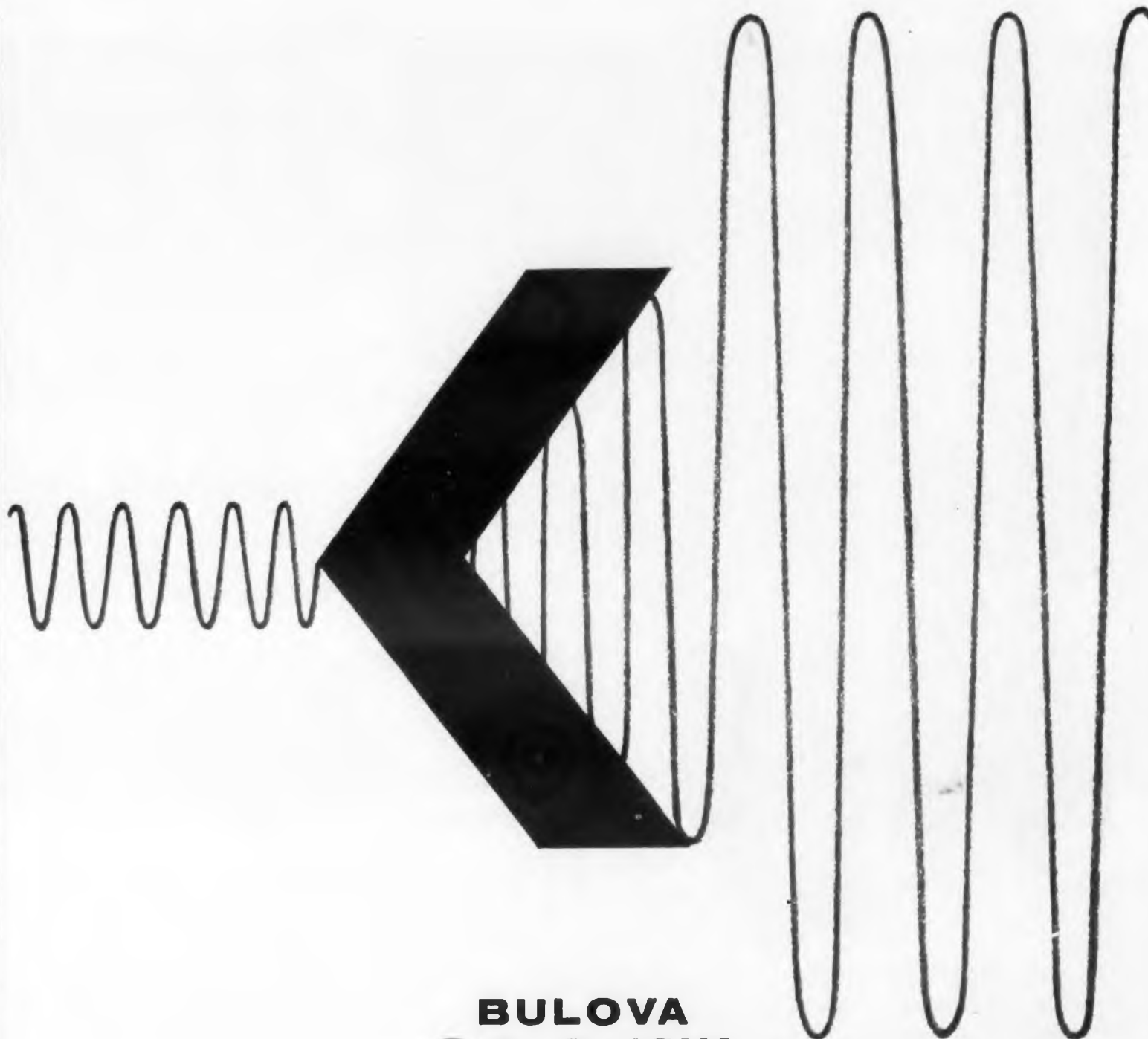
The virtue of the paraffin coating is in its low interaction with the high-energy hydrogen atoms. A sufficient number of high-energy atoms to give a usable output are thus accumulated within the chamber. Interaction times of 0.3 sec with the rf field have been observed. Output power is less than 10^{-12} w. Each hydrogen atom can undergo at least 10,000 collisions with the paraffin without significant loss of energy.

Oscillation and stimulated emission have both been observed. The latter is obtained by suppressing oscillation through such means as shortening the interaction time or loading the cavity. Emission is then triggered by the presence of an rf signal at the transition frequency.

The hydrogen maser was developed by H. M. Goldenberg, D. Kleppner and N. F. Ramsey, all of Harvard, under sponsorship of the National Science Foundation and the Office of Naval Research. ■ ■



Hydrogen maser uses paraffin-lined quartz bulb to accumulate high-energy hydrogen atoms from discharge source and magnetic-state selector. Rf signal in cavity stimulates emission at the 1,420-mc transition frequency of hydrogen.



BULOVA 3.5, 6, 12W SERVO AMPLIFIERS



In addition to their "greater-than" conversions at high temperatures, the new Bulova Servo Amplifiers promise maximum flexibility in systems design with a minimum of ounces and inches.

The all-silicon transistors potted in these amplifiers assure continuous operation from -50°C. to $+125^{\circ}\text{C.}$ and provide maximum wattage output per unit volume and weight. Under varied and severe environmental and operating conditions, Bulova

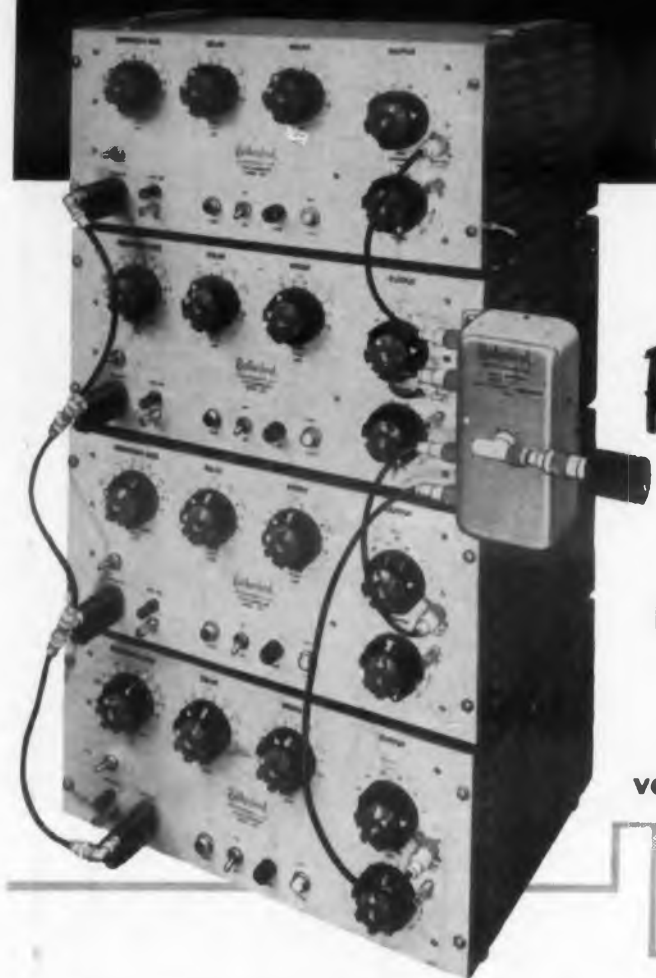
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CIRCLE 7 ON READER-SERVICE CARD

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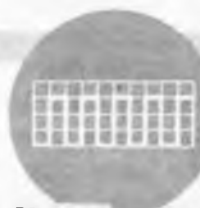
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NEWS

High Aerospace Growth Rate Seen

*Microminiaturization Gain Stressed in AIA Report;
Use of Molecular Concepts to Start in Five Years*

PROJECTED requirements for major classes of electronic equipment in space, missile, and aircraft systems through 1970 are estimated in a report prepared by the Aerospace Industries Association, 7660 Beverly Blvd., Los Angeles, Calif.

The increasing trend to automated systems and electronic techniques presented by the survey, titled "1960 Aerospace Forecast of Technical Requirements," gives an over-all view of a high growth rate for the industry.

In communications, the report stresses the shift from conventional equipment to microwave systems and also predicts an increase in the use of very low and extremely low frequencies. This prediction is tempered with the comment that despite less relative use of the mid-frequencies, sales should not taper off here because of the over-all increase in communications equipment.

Use of microminiature electronics will begin in a small way in 1961, rising to nearly 20 per cent of airborne electronics by 1970, the report estimates. The use of molecular concepts is expected to start in 1965. A need for parts to operate at temperatures above 125 C

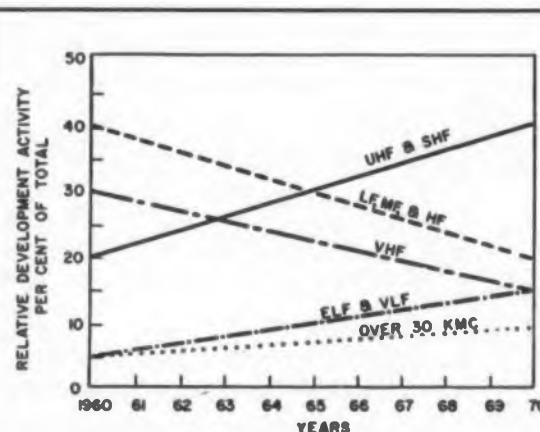
is seen, but even by 1970 this requirement is expected to apply only to about 5 per cent of total airborne electronics, according to the AIA.

Increasing complexity and speed of airborne vehicles will necessitate data equipment capable of handling much more information at faster decision rates. Simultaneously payload restrictions will lead to smaller, more compact computers. Possible approaches that may lead to machines that meet these needs are deposited film circuits, molecular electronics, thin magnetic film memories, and bio-electronics the report predicts.

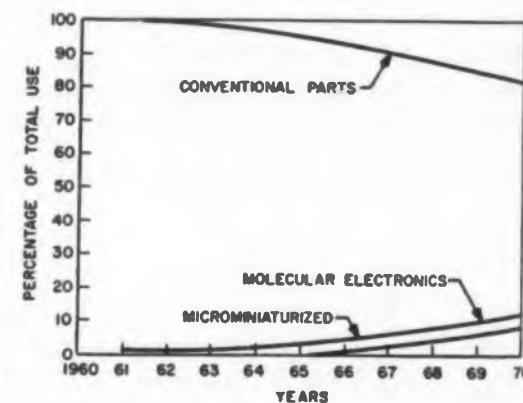
Storage requirements are particularly stressed, and a need for large capacity, inexpensive, random access devices of compact size is cited.

Stepped-up needs for sensors and remote monitors for physiological and environmental factors, along with the necessary telemetry instrumentation to return data to control centers, is seen over the next decade. A steady rise in the use of such equipment until 1966, when requirements are expected to be accelerated.

A decline in the use of conventional dial-pointer type indicators is expected,



Increased bandwidths, higher data rates in telemetry and data links, and ability to pierce the ionosphere are some of the reasons given in the AIA report for the projected increase in relative developmental activity in the higher frequencies.



Gradual shifts toward microminiaturization concepts, starting next year, are predicted in this use-trend comparison for airborne electronics. Planetary exploration in the 1970-80 period will necessitate even further size reductions, the AIA says.

and in general the amount of cockpit panel space devoted to displays should taper off the AIA believes. There will be a shift to panoramic situation displays and other integrated type indicators as airborne systems tend toward automated control by a centralized digital computer system. The use of electroluminescent lighting is expected to take over from conventional lighting, with tri-color E-L displays indicating warning modes.

Surveillance to Improve Radar, IR, TV, Photo Methods

Startling improvements in tracking sensitivity can be expected for surveillance systems over the next decade. Many of the important advances already conceived for radar, infrared, TV and photographic systems have not yet been reduced to practice, the AIA points out, therefore the extent of these advances are somewhat predictable. Major improvements in resolution of both ground and airborne radar systems are expected. Resolution of several microradians is necessary to observe significant details with airborne surveillance systems, the report says.

As resolution improves, the handling of large amounts of high-resolution data will become a vital problem, according to the report.

Present data-storage equipment, such as film or magnetic tape systems, are called cumbersome. Phosphor and electrostatic techniques show promise for needed improvements, the AIA feels.

New wide bandwidth encoding methods, and techniques for transmission of signals with bandwidth over 1 kmc are required. Displays presenting a composite picture synthesized from many measurements is another need cited.

Automated manufacturing test equipment, and in supporting test equipment, is also expected to grow significantly over the next decade. Training equipment needed to prepare men for space missions will also be increasingly required, with a sharp increase beginning in the 1965-66 period, the AIA predicts.

PHILCO ANNOUNCES

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Collector Voltage, V_{CE} -15 volts
Total Device Dissipation at 25°C 60 mw

ELECTRICAL CHARACTERISTICS (T=25°C)

	Min.	Typ.	Max.	
Static Characteristics				
Collector Cutoff Current, I_{CBO} ($V_{CE} = -5v$)		1.0	3	μA
DC Current Amplification Factor, h_{FE} ($V_{CE} = -0.5v, I_C = -10 ma$)	50	90	200	
Base Voltage, V_{BE} ($I_C = -10 ma, I_B = -0.5 ma$)	0.29	0.33	0.36	volt
Collector Saturation Voltage, $V_{CE(SAT)}$ ($I_C = -10 ma, I_B = -0.5 ma$)	.09	0.12	0.16	volt
High Frequency Characteristics				
Output Capacitance, C_{ob} ($V_{CE} = -3v, I_E = 0, f = 4 mc$)		1.9	2.5	$\mu\mu f$
Input Capacitance, C_{ib} ($V_{EB} = -1v, I_C = 0, f = 4 mc$)		6.0	10	$\mu\mu f$
Gain Bandwidth Product, f_T ($V_{CE} = -5v, I_E = 7 ma$)	320	450		mc
Switching Characteristics				
Rise Time, t_r ($\beta_C = 10$)		13	18	$\mu\mu sec$
Noise Storage Factor, K'		39	50	$\mu\mu sec$
Fall Time, t_f ($\beta_{CO} = 10$)		10	18	$\mu\mu sec$

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TRANSISTORIZED
DESIGN GROUP

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION
SC 32-0.5	0-32	0-0.5	0.01%
SC 32-1	0-32	0-1	
SC 32-1.5	0-32	0-1.5	
2SC 32-1.5	0-32	0-1.5	
Dual Output	0-32	0-1.5	
SC 32-2.5	0-32	0-2.5	
SC 32-5	0-32	0-5	
SC 32-10A	0-32	0-10	
SC 32-15A	0-32	0-15	
SC 60-2	0-60	0-2	
SC 60-5	0-60	0-5	
2SC 100-0.2	0-100	0-0.2	
Dual Output	0-100	0-0.2	
SC 150-1	0-150	0-1	
SC 300-1	0-300	0-1	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION
SC 18-0.5	0-18	0-0.5	0.1%
SC 18-1	0-18	0-1	
SC 18-2	0-18	0-2	
SC 18-4	0-18	0-4	
SC 36-0.5	0-36	0-0.5	
SC 36-1	0-36	0-1	
SC 36-2	0-36	0-2	
SC 3672-0.5	36-72	0-0.5	
SC 3672-1	36-72	0-1	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION
PSC 5-2	0-7.5	0-2	0.02%
PSC 10-2	7.5-12.5	0-2	
PSC 15-2	12.5-17.5	0-2	
PSC 20-2	17.5-22.5	0-2	
PSC 28-1	22.5-32.5	0-1	
PSC 38-1	32.5-42.5	0-1	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION
HB-2	0-325	0-200 ma.	0.1%*
HB-4	0-325	0-400 ma.	
HB-6	0-325	0-600 ma.	
HB-8	0-325	0-800 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION
SR 12-50	5-13	0-50	0.1%
SR 28-50	24-32	0-50	
SR 48-30	44-52	0-30	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION
SM 14-30	0-14	0-30	0.1%*
SM 36-15	0-36	0-15	
SM 75-8	0-75	0-8	
SM 160-4	0-160	0-4	
SM 325-2	0-325	0-2	
SM 14-15	0-14	0-15	
SM 36-10	0-36	0-10	
SM 75-5	0-75	0-5	
SM 160-2	0-160	0-2	
SM 325-1	0-325	0-1	
SM 14-7	0-14	0-7	
SM 36-5	0-36	0-5	
SM 75-2	0-75	0-2	
SM 160-1	0-160	0-1	
SM 325-0.5	0-325	0-0.5	

*0.01% REGULATION AVAILABLE



MAGNETIC
DESIGN GROUP

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION
KM236-15A	0.1-36	0-15	0.5%
KM236-30	0.1-36	0-30	
KM236-50	0.1-36	0-50	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION
KM 251	2-14	30A or 240 W.	±1%
KM 252	5-35	12A or 240 W.	
KM 253	20-60	6A or 240 W.	
KM 254	30-90	4A or 240 W.	
KM 255	60-180	2A or 240 W.	

VOLTAGE REGULATED DC POWER SUPPLIES KEPCO



MODEL HB-6M

COMPACTNESS



TWO 4 1/4" SC UNITS
MOUNTED IN RACK ADAPTER RA-2

WIDE VARIETY



MODEL 2SC32-1.5

VERSATILITY



MODEL 400B

FOR DETAILED SPECIFICATIONS
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VACUUM TUBE
DESIGN GROUP

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION
800B	#1 0-600	0-200 ma.	TO 0.01%
	#2 0-600	0-200 ma.	
	Parallel 1 & 2	0-400 ma.	
430D	0-600	0-400 ma.	
	Series 1 & 2	0-200 ma.	
2400B	#1 0-450	0-300 ma.	
	#2 0-450	0-300 ma.	
	Parallel 1 & 2	0-600 ma.	
103	0-450	0-600 ma.	
	Series 1 & 2	0-300 ma.	
	0-900	0-300 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION
400B	#1 0-400	0-150 ma.	unreg- ulated
	#2 0-400	0-150 ma.	
	#3 0-150	0-5 ma.	
730B	0-400	0-150 ma.	
	Parallel 1 & 2	0-300 ma.	
	Series 1 & 2	0-150 ma.	
720B	0-400	0-150 ma.	
	Parallel 1 & 2	0-150 ma.	
	Series 1 & 2	0-150 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION
400B	#1 0-300	0-75 ma.	TO 0.02%
	#2 0-300	0-75 ma.	
	#3	0-5 ma.	
730B	-50 to +50	0-5 ma.	
	Parallel 1 & 2	0-150 ma.	
	Series 1 & 2	0-150 ma.	
720B	0-300	0-75 ma.	
	Parallel 1 & 2	0-150 ma.	
	Series 1 & 2	0-150 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION	
400B	0-400	0-150 ma.	TO 0.01%	
	0-150 Bias	0-5 ma.		
	730B	0-350		0-3 Amp.
720B	0-350	0-2.25 Amp.		
	710B	0-350		0-1.5 Amp.
	700B	0-350		0-750 ma.
780B	0-600	0-3 Amp.		
	770B	0-600		0-2.25 Amp.
	760B	0-600		0-1.5 Amp.
750B	0-600	0-750 ma.		
	605	0-600	0-500 ma.	
	615B	0-600	0-300 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION	
2500	0-2500	0-50 ma.	TO 0.004%	
	1520B	0-1500		0-200 ma.
	1220C	0-1200		0-50 ma.
1250B	0-1000	0-500 ma.		
	KR16	0-150		1.5 Amp.
	KR17	100-200		1.5 Amp.
KR18	195-325	1.5 Amp.		
	KR19	295-450		1.5 Amp.
	KR8	0-150		600 ma.
KR5		100-200		600 ma.
KR6		195-325	600 ma.	
KR7	295-450	600 ma.		
	KR12	0-150	300 ma.	
		KR3	100-200	300 ma.
KR4		195-325	300 ma.	
KR10	295-450	300 ma.		
	KR11	0-150	125 ma.	
		KR1	100-200	125 ma.
KR2		195-325	125 ma.	
	KR9	295-450	125 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION	
2500	0-2500	0-50 ma.	TO 0.004%	
	1520B	0-1500		0-200 ma.
	1220C	0-1200		0-50 ma.
1250B	0-1000	0-500 ma.		
	KR16	0-150		1.5 Amp.
	KR17	100-200		1.5 Amp.
KR18	195-325	1.5 Amp.		
	KR19	295-450		1.5 Amp.
	KR8	0-150		600 ma.
KR5		100-200		600 ma.
KR6		195-325	600 ma.	
KR7	295-450	600 ma.		
	KR12	0-150	300 ma.	
		KR3	100-200	300 ma.
KR4		195-325	300 ma.	
KR10	295-450	300 ma.		
	KR11	0-150	125 ma.	
		KR1	100-200	125 ma.
KR2		195-325	125 ma.	
	KR9	295-450	125 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION	
2500	0-2500	0-50 ma.	TO 0.004%	
	1520B	0-1500		0-200 ma.
	1220C	0-1200		0-50 ma.
1250B	0-1000	0-500 ma.		
	KR16	0-150		1.5 Amp.
	KR17	100-200		1.5 Amp.
KR18	195-325	1.5 Amp.		
	KR19	295-450		1.5 Amp.
	KR8	0-150		600 ma.
KR5		100-200		600 ma.
KR6		195-325	600 ma.	
KR7	295-450	600 ma.		
	KR12	0-150	300 ma.	
		KR3	100-200	300 ma.
KR4		195-325	300 ma.	
KR10	295-450	300 ma.		
	KR11	0-150	125 ma.	
		KR1	100-200	125 ma.
KR2		195-325	125 ma.	
	KR9	295-450	125 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGU-LATION	
2500	0-2500	0-50 ma.	TO 0.004%	
	1520B	0-1500		0-200 ma.
	1220C	0-1200		0-50 ma.
1250B	0-1000	0-500 ma.		
	KR16	0-150		1.5 Amp.
	KR17	100-200		1.5 Amp.
KR18	195-325	1.5 Amp.		
	KR19	295-450		1.5 Amp.
	KR8	0-150		600 ma.
KR5		100-200		600 ma.
KR6		195-325	600 ma.	
KR7	295-450	600 ma.		
	KR12	0-150	300 ma.	
		KR3	100-200	300 ma.
KR4		195-325	300 ma.	
KR10	295-450	300 ma.		
	KR11	0-150	125 ma.	
		KR1	100-200	125 ma.
KR2		195-325	125 ma.	
	KR9	295-450	125 ma.	

NEWS

Infrared Horizon Sensor

System Called Accurate to 0.1 Deg;
Device Similar to Those in Wild Cat

AN INFRA RED horizon sensor said to have an optical field of more than 90 deg and a system accuracy of 0.1 deg is reported in production in model-shop quantities at General Electric's Advanced Electronic Center, Ithaca, N. Y. The device is similar to those in the Wild Cat series of IR horizon sensors under development at GE, the company reports. In this series, gear drives have been eliminated to increase accuracy. Two other sensors in the Wild Cat series are also designed for wide-field-of-view operations. Wild Cat I is said to be able to scan a 360-deg horizon. It has one sensor head, which is used in averaging the effects of horizon discontinuity. To reduce weight, parts, and power consumed by the system, only one channel of electronics is used. However, according to the company, to function properly the sensor must have an unobstructed view of about 260 deg.

Two Sensor Heads Mounted 180 Deg Apart

Wild Cat II is said to be designed with two sensor heads mounted 180 deg apart. A rotating prism in each sensor head produces a conical scan of 90 deg or more. The company reports that although the system requires twice the components than Wild Cat I, it may be incorporated in nearly all vehicles.

In addition to the Wild Cat series GE is reportedly producing several versions of Tom Cat infrared horizon sensors. Tom Cat III,



Tom Cat III infrared horizon sensor being aligned at General Electric is part of the company's Tom Cat series of sensors. Computer box is mounted to left and below the three sensor heads, which are in aluminum housings.

Measures Wide Angle

shown in the photograph and believed being developed under a Lockheed subcontract for the Midas surveillance satellite, consists of three sensor heads and a computer box. Over-all weight is said to be less than 15 lb, and accuracy, greater than 0.5 deg.

Tom Cat I, which contained three sensor heads and which weighed 17 lb exclusive of containers, consumed 10 w, GE states. Accuracy was 1 deg. In Tom Cat II, accuracy is said to have been increased to 0.75 deg.

The company reports that it has under development a Bob Cat series of IR horizon sensors, which will be similar to Wild Cat sensors. The Bob Cat units will have three sensor heads combined into one package. With only one motor the Bob Cat sensor is expected to weigh about 8 lb and require about 8 w of power. ■ ■

Japanese Electronic Parts Show Draws 125 Participating Firms

Some 125 companies in 248 booths took part in the 1961 Japanese Electronic Parts Show held in Tokyo last month. There were 50 more booths at the show this year than in 1960.

The show, as in past years, was dominated by parts and products for consumer electronics.

One highlight was the "mirror phone" speaker shown by Nippon Onkyo Denki Co. This hi-fi speaker is reportedly made with specially designed and produced cone paper.

Another attention getter was a highly reliable, stable-deposited film resistor made by Riken Dengu Seizo Co. The resistor, said to be superior to composition types, is available in 0.5-, 1-, and 2-w sizes. Resistance values are 10 ohms to 1 meg, 10 ohms to 2 meg, and 10 ohms to 3 meg.

A high flux-density material for use in horizontal output transformers was shown by TDK Electronics Co. The material is reportedly able to produce flux densities of 4,300 to 4,800 gauss. According to the company use of the material in TV set transformers results in minimum fluctuation in high-voltage circuits, horizontal amplitude, B voltage, damper current, booster voltage, and in the operational condition of the horizontal output tube. In addition, the horizontal output transformer itself can be made smaller than previously possible because of the material.

An automatic tuner shown by Matsushita Electric Manufacturing Co. uses a variable diode to fine-tune TV set picture and sound.

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This solid-electrolyte Tantalex Capacitor (shown 1 1/2 times actual size) is rated at 4.7 μ F, 10 volts d-c, and is only 1/8" in diameter by 1/4" long.

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Typical of these Tantalex Capacitors is the Type 150D shown above. Its tiny sintered anode is impregnated with a solid, non-corrosive, semi-conductor material which cannot leak under any circumstance. It combines true miniaturization with electrical stability previously unobtainable in an electrolytic capacitor of any type.


Thermal coefficient of these capacitors is sufficiently low and linear so that for the first time a circuit designer can think of an electrolytic in terms of parts per million capacitance change. Nominal value is +500 ppm/°C. The capacitor may be used without derating over a range from -80°C to +85°C, or to 125 °C

with appropriate derating, a temperature at which no other electrolytic has proved useful.

Solid construction permits the Type 150D to withstand the severe shock and vibration encountered in missile and ballistic applications. Hermetic sealing makes it completely immune to humid atmospheric conditions.

Complete performance data covering the wide range of sizes and ratings are in Engineering Bulletin 3520D, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

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CIRCLE 11 ON READER-SERVICE CARD



TRANSISTORIZED
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MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
SC 32-0.5	0-32	0-0.5	} 0.01%
SC 32-1	0-32	0-1	
SC 32-1.5	0-32	0-1.5	
2SC 32-1.5	0-32	0-1.5	
Dual Output	0-32	0-1.5	
SC 32-2.5	0-32	0-2.5	
SC 32-5	0-32	0-5	
SC 32-10A	0-32	0-10	
SC 32-15A	0-32	0-15	
SC 60-2	0-60	0-2	
SC 60-5	0-60	0-5	
2SC 100-0.2	0-100	0-0.2	
Dual Output	0-100	0-0.2	
SC 150-1	0-150	0-1	
SC 300-1	0-300	0-1	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
SC 18-0.5	0-18	0-0.5	} 0.1%
SC 18-1	0-18	0-1	
SC 18-2	0-18	0-2	
SC 18-4	0-18	0-4	
SC 36-0.5	0-36	0-0.5	
SC 36-1	0-36	0-1	
SC 36-2	0-36	0-2	
SC 3672-0.5	36-72	0-0.5	
SC 3672-1	36-72	0-1	

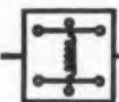
MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
PSC 5-2	0-7.5	0-2	} 0.02%
PSC 10-2	7.5-12.5	0-2	
PSC 15-2	12.5-17.5	0-2	
PSC 20-2	17.5-22.5	0-2	
PSC 28-1	22.5-32.5	0-1	
PSC 38-1	32.5-42.5	0-1	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
HB-2	0-325	0-200 ma.	} 0.1%*
HB-4	0-325	0-400 ma.	
HB-6	0-325	0-600 ma.	
HB-8	0-325	0-800 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
SR 12-50	5-13	0-50	} 0.1%
SR 28-50	24-32	0-50	
SR 48-30	44-52	0-30	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
SM 14-30	0-14	0-30	} 0.1%*
SM 36-15	0-36	0-15	
SM 75-8	0-75	0-8	
SM 160-4	0-160	0-4	
SM 325-2	0-325	0-2	
SM 14-15	0-14	0-15	
SM 36-10	0-36	0-10	
SM 75-5	0-75	0-5	
SM 160-2	0-160	0-2	
SM 325-1	0-325	0-1	
SM 14-7	0-14	0-7	
SM 36-5	0-36	0-5	
SM 75-2	0-75	0-2	
SM 160-1	0-160	0-1	
SM 325-0.5	0-325	0-0.5	

*0.01% REGULATION AVAILABLE



MAGNETIC
DESIGN GROUP

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
KM236-15A	0.1-36	0-15	} 0.5%
KM236-30	0.1-36	0-30	
KM236-50	0.1-36	0-50	
KM 251	2-14	30A or 240 W.	} ±1%
KM 252	5-35	12A or 240 W.	
KM 253	20-60	6A or 240 W.	
KM 254	30-90	4A or 240 W.	
KM 255	60-180	2A or 240 W.	

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MODEL HB-6M

COMPACTNESS



TWO 1/4" SC UNITS
MOUNTED IN RACK ADAPTER RA-2

WIDE VARIETY



MODEL 2SC32-1.5

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MODEL 400B

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SEND FOR KEPCO CATALOG



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FLUSHING 52, N. Y.
IN 1-7000 • TWX #NY4-5196

CIRCLE 10 ON READ-ERSERVICE CARD



VACUUM TUBE
DESIGN GROUP

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
800B	#1 0-600 #2 0-600 Parallel 1 & 2	0-200 ma. 0-200 ma.	} TO 0.01%
	0-600	0-400 ma.	
	Series 1 & 2 0-1200	0-200 ma.	
430D	#1 0-450 #2 0-450 Parallel 1 & 2	0-300 ma. 0-300 ma.	} TO 0.01%
	0-450	0-600 ma.	
	Series 1 & 2 0-900	0-300 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
2400B	#1 0-400 #2 0-400 #3 0-150 Bias	0-150 ma. 0-150 ma. 0-5 ma.	} TO 0.01%
	Parallel 1 & 2 0-400	0-300 ma.	
	Series 1 & 2 0-800	0-150 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
103	#1 0-300 #2 0-300 #3 -50 to +50 Parallel 1 & 2	0-75 ma. 0-75 ma. 0-5 ma.	} unreg-ulated
	0-300	0-150 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
400B	0-400 0-150 Bias	0-150 ma. 0-5 ma.	} TO 0.02%
730B	0-350	0-3 Amp.	
720B	0-350	0-2.25 Amp.	
710B	0-350	0-1.5 Amp.	
700B	0-350	0-750 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
780B	0-600	0-3 Amp.	} TO 0.01%
770B	0-600	0-2.25 Amp.	
760B	0-600	0-1.5 Amp.	
750B	0-600	0-750 ma.	
605	0-600	0-500 ma. 0-150 Bias	
615B	0-600	0-300 ma. 0-150 Bias	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
2500	0-2500	0-50 ma.	} TO 0.004%
1520B	0-1500	0-200 ma.	
1220C	0-1200	0-50 ma.	
1250B	0-1000	0-500 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
KR16	0-150	1.5 Amp.	} 0.1%
KR17	100-200	1.5 Amp.	
KR18	195-325	1.5 Amp.	
KR19	295-450	1.5 Amp.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
KR8	0-150	600 ma.	} 0.1%
KR5	100-200	600 ma.	
KR6	195-325	600 ma.	
KR7	295-450	600 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
KR12	0-150	300 ma.	} 0.1%
KR3	100-200	300 ma.	
KR4	195-325	300 ma.	
KR10	295-450	300 ma.	
KR11	0-150	125 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
KR1	100-200	125 ma.	} 0.1%
KR2	195-325	125 ma.	
KR9	295-450	125 ma.	

NEWS

Infrared Horizon Sensor Me

System Called Accurate to 0.1 Deg;
Device Similar to Those in Wild Cat

AN INFRA RED horizon sensor said to have an optical field of more than 90 deg and a system accuracy of 0.1 deg is reported in production in model-shop quantities at General Electric's Advanced Electronic Center, Ithaca, N. Y. The device is similar to those in the Wild Cat series of IR horizon sensors under development at GE, the company reports. In this series, gear drives have been eliminated to increase accuracy.

Two other sensors in the Wild Cat series are also designed for wide-field-of-view operations. Wild Cat I is said to be able to scan a 360-deg horizon. It has one sensor head, which is used in averaging the effects of horizon discontinuity. To reduce weight, parts, and power consumed by the system, only one channel of electronics is used. However, according to the company, to function properly the sensor must have an unobstructed view of about 260 deg.

Two Sensor Heads Mounted 180 Deg Apart

Wild Cat II is said to be designed with two sensor heads mounted 180 deg apart. A rotating prism in each sensor head produces a conical scan of 90 deg or more. The company reports that although the system requires twice the components than Wild Cat I, it may be incorporated in nearly all vehicles.

In addition to the Wild Cat series GE is reportedly producing several versions of Tom Cat infrared horizon sensors. Tom Cat III,



Tom Cat III infrared horizon sensor being aligned at General Electric is part of the company's Tom Cat series of sensors. Computer box is mounted to left and below the three sensor heads, which are in aluminum housings.

Sensor Measures Wide Angle

shown in the photograph and believed being developed under a Lockheed subcontract for the Midas surveillance satellite, consists of three sensor heads and a computer box. Over-all weight is said to be less than 15 lb, and accuracy, greater than 0.5 deg.

Tom Cat I, which contained three sensor heads and which weighed 17 lb exclusive of containers, consumed 10 w, GE states. Accuracy was 1 deg. In Tom Cat II, accuracy is said to have been increased to 0.75 deg.

The company reports that it has under development a Bob Cat series of IR horizon sensors, which will be similar to Wild Cat sensors. The Bob Cat units will have three sensor heads combined into one package. With only one motor the Bob Cat sensor is expected to weigh about 8 lb and require about 8 w of power. ■ ■

Japanese Electronic Parts Show Draws 125 Participating Firms

Some 125 companies in 248 booths took part in the 1961 Japanese Electronic Parts Show held in Tokyo last month. There were 50 more booths at the show this year than in 1960.

The show, as in past years, was dominated by parts and products for consumer electronics.

One highlight was the "mirror phone" speaker shown by Nippon Onkyo Denki Co. This hi-fi speaker is reportedly made with specially designed and produced cone paper.

Another attention getter was a highly reliable, stable-deposited film resistor made by Riken Dengu Seizo Co. The resistor, said to be superior to composition types, is available in 0.5-, 1-, and 2-w sizes. Resistance values are 10 ohms to 1 meg, 10 ohms to 2 meg, and 10 ohms to 3 meg.

A high flux-density material for use in horizontal output transformers was shown by TDK Electronics Co. The material is reportedly able to produce flux densities of 4,300 to 4,800 gauss. According to the company use of the material in TV set transformers results in minimum fluctuation in high-voltage circuits, horizontal amplitude, B voltage, damper current, booster voltage, and in the operational condition of the horizontal output tube. In addition, the horizontal output transformer itself can be made smaller than previously possible because of the material.

An automatic tuner shown by Matsushita Electric Manufacturing Co. uses a variable diode to fine-tune TV set picture and sound.



This solid-electrolyte Tantalex Capacitor (shown 1½ times actual size) is rated at 4.7 μ F, 10 volts d-c, and is only ¼" in diameter by ¼" long.

Sprague, the pioneer in the production of solid-electrolyte tantalum electrolytic capacitors, now offers prompt delivery on production quantities of all standard ratings. New expanded facilities end production delays in your assembly of minified transistor circuits.

Typical of these Tantalex Capacitors is the Type 150D shown above. Its tiny sintered anode is impregnated with a solid, non-corrosive, semi-conductor material which cannot leak under any circumstance. It combines true miniaturization with electrical stability previously unobtainable in an electrolytic capacitor of any type.


Thermal coefficient of these capacitors is sufficiently low and linear so that for the first time a circuit designer can think of an electrolytic in terms of parts per million capacitance change. Nominal value is +500 ppm/°C. The capacitor may be used without derating over a range from -80°C to +85°C, or to 125 °C

with appropriate derating, a temperature at which no other electrolytic has proved useful.

Solid construction permits the Type 150D to withstand the severe shock and vibration encountered in missile and ballistic applications. Hermetic sealing makes it completely immune to humid atmospheric conditions.

Complete performance data covering the wide range of sizes and ratings are in Engineering Bulletin 3520D, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

★ ★ ★

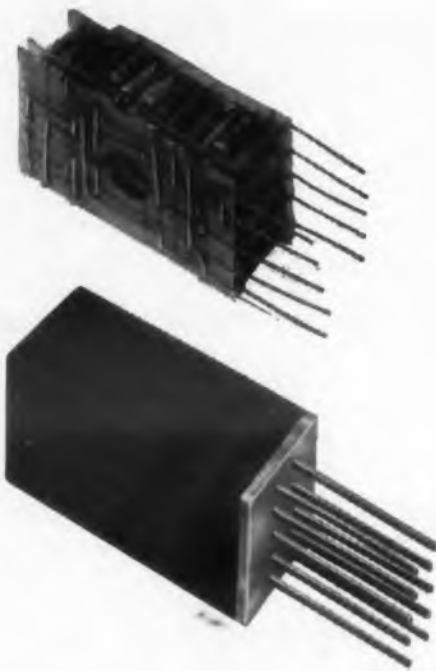
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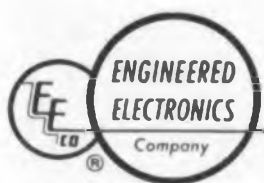
how do you play the numbers game?

The current numbers game consists of seeing how many components you can wedge into a small space. But there's a catch to it.

Some circuit modules may seem small until you string them together and find that interconnections and supporting structure take more space than the modules themselves. That's why it's important, in evaluating miniaturization, not to consider the module size alone, but to be concerned with the **over-all** size, including module, interconnections, and supporting structure.

New EECO MINIWELD circuit modules are designed with **over-all** system size in mind. They offer optimum miniaturization not only of modules, but also of interconnections and supporting structure. Add to this the reliability of proven circuits incorporating readily available standard catalog components rather than hard-to-get specials, the superior strength of welded rather than soldered connections, and you have an unbeatable combination of advantages.

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NEWS



Panel of specialists in nuclear and magnetic resonance techniques at the 13th Annual Conference on Electrical Techniques in Medicine and Biology discuss latest developments in resonance spectroscopy. Right to left: R. S. Codrington, Schlumberger Corp. and chairman of the session; William Hodgson, American Cyanamid; standing is J. L. Ternberg, Washington University; A. A. Bothner-By, Mellon Institute; Walter Gordy, Duke University; Martin Carstens, Naval Research Laboratories, and R. L. Bowman, National Institutes of Health. Dr. Ternberg is explaining that electron-spin resonance has enabled researchers to detect jaundiced liver condition through analysis of liver at atomic level.

Hear Proposal To Map Brain Waves

*Correlation Processing Would Be Used
In System Outlined at Washington Meeting*

A PROPOSED method of mapping neuron activity in the human brain would use signal-processing techniques to locate specific neurons anywhere in the brain. Once located, statistical methods would be used to construct a map of brain activity.

The design of this system was one of many developments described at the 13th Annual Conference on Electrical Techniques in Medicine and Biology, held last month in Washington, D.C.

The brain-mapping system, proposed by W. O. Brooks and H. D. Ervin, Ramo-Wooldridge Div., Thompson Ramo-Wooldridge, Inc., Canoga Park, Calif., would use frequency and phase correlation in conjunction with a precision magnetic delay generator to locate source of neuron signals. The technique has been submitted to the company's patent department for evaluation and may be proposed to outside organizations for support, Mr. Brooks said.

Reference Points on Scalp Would Help Locate Damaged Neurons

One function of the system would be to detect and locate damaged brain neurons with respect to reference points on the scalp surface. Mr. Brooks calls this part of the system NULOR, for Neuron Locating and Ranging. The

other function would be to map out location of damaged neurons and all other points that can be correlated according to frequency and phase. This is called BRAMATEC, for Brain Mapping Techniques.

Basis of the locating system is the neuron-conduction system of the brain. Waveform of the measurable ac voltages generated by the billions of brain neurons constantly discharging is determined by the number of simultaneously discharging neurons and the rate at which they are triggered. Specific and known waveforms may represent normal brain activity or may be typical of certain disorders. Abnormal activity originates from a single or small group of irritated neurons, which can create a miniature explosion in the brain. Signals from this explosion, or other signals, can travel to the scalp by neuron conduction.

Signals that find their way to the scalp by passing from one triggered neuron to another can then be detected. However, phase characteristic changes with each new neuron triggered, so the signal arriving at the scalp does not retain its original phase characteristic. It has been shown, though, that in some seizures negligible phase shift occurs over equal distances. This indicates that some signals travel directly from the

(continued on p 14)

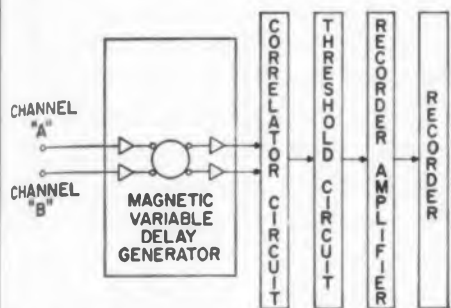
ELECTRONIC DESIGN • November 23, 1960

This is the "New Reliability." It is the goal of the Fairchild Semiconductor Corporation contract from Autonetics, a division of North American Aviation, Inc. Its purpose: to insure infallible guidance in the event that it becomes necessary to use America's most powerful deterrent weapon, the MINUTEMAN ICBM. Autonetics is an associate prime contractor to the Air Force on MINUTEMAN. It has assigned Fairchild the task of achieving unprecedented reliability in silicon transistors.

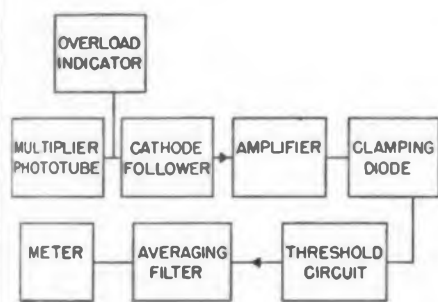
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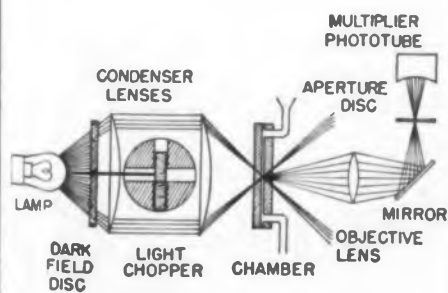
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Proposed system for locating specific neurons in brain receives signals at variable-delay generator. With generator set at zero relative delay, a frequency- and phase-correlatable signal on the two inputs will arrive at the correlator and give an output. The correlator and threshold circuit reject other signals and remove noise. Fine correlation may be made by adjusting the generator to observe the peak of correlation as displayed by the paper recorder. Once signal source is located in terms of points on the scalp, mapping of brain waves is possible.



Blood-cell counter, actually an indicator of particulate concentration, uses an averaging process to measure automatically the fraction of time that particles are present in a volume.



Optical system for blood cell counter inspects sample in chamber, which is dark-field illuminated. Light reaches objective only if scattered by particle in chamber.



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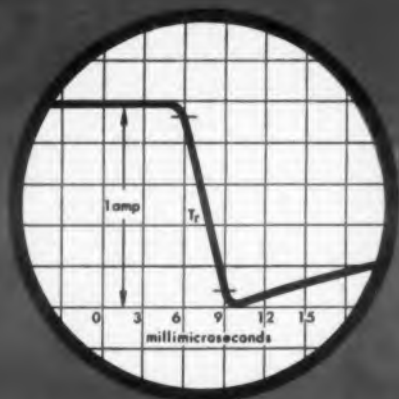
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7548 SOLVES CIRCUIT PROBLEMS NO OTHER TUBE CAN

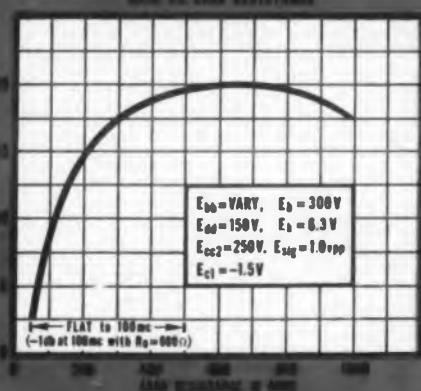
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CIRCLE 13 ON READER-SERVICE CARD

NEWS

(continued from page 12)

source to the scalp, making it possible to measure phase differences of a signal by taking measurements from different positions on the scalp.

Surface Points Receive Signals From a Single Source

In practice, two electrodes placed, for instance, in the center of the forehead and at the peak of the crown, would receive signals from a single source. Through standard correlation techniques and methods of adjusting path-delay differences by variable magnetic-delay generators, all out-of-phase unrelated signals would be ignored.

At the same time it would be possible to correlate identical frequencies with related phase characteristics generated by an irritated neuron. The neuron would generate a repetitive signal. This would make it possible to obtain data well below noise level by long-time-constant filtering and the use of many samples.

Signals measured with electroencephalographs have typical repetition rates of 3 to more than 30 cps. A 3-cps wave would exhibit a correlation function of about 300-msec width. This would represent the widest correlation function, since it corresponds to the lowest frequency.

Mr. Brooks reports that at the present time, only about 10 per cent of data appearing in EEG charts are interpretable. He says that use of the system he and Mr. Ervin propose would clean up EEG charts by eliminating records of useless signals like those resulting from muscle artifacts, hum, spurious signals, and brain waves which cannot be correlated.

Though no great problems are anticipated in designing and producing the equipment for the system, Mr. Brooks reports, an extremely accurate and stable magnetic relay generator would be required.

Short-Range FM Device Developed To Telemeter Physiological Data

Another device described at the meeting was developed to telemeter data from an animal to a recording station. Developed by R. H. Mattson and M. S. Ulstad, Iowa State University, Ames, Iowa, the system has three channels and a range of about 1 mile. The transmitter is worn externally by an animal. It weighs about 1 lb and measures 6 x 4 x 3 in.

The system has three voltage-controlled oscillators, which operate on different frequency ranges so that all three signals can be added to form a single signal for modulating a 105-mc car-

rier signal. This phase-modulated signal is transmitted to a receiver for demodulating and separation of the three channels.

The front end of the transmitter can be changed to provide bandwidths wider than 100 cps, but at the expense of the number of channels. Likewise, the number of channels can be increased by reducing bandwidth.

Accuracy of the system is said to be 5 per cent; battery life is reportedly about 50 hr.

Instrument Is Designed To Count Blood Cells Automatically

Specialists attending the meeting heard a description of an instrument designed to count human blood cells automatically. In effect, the device determines the concentration of particular matter in a sample volume. It was developed by C. J. Brown, T. J. Hayes and J. F. Quinn, of Sanborn Co., Waltham, Mass., and P. L. Frommer, Bethesda, Md.

In the device, which has been built in prototype form, concentration is directly determined by an optical device that measures the average fraction of time that particles are present in a very small inspection volume.

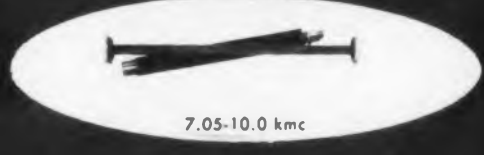
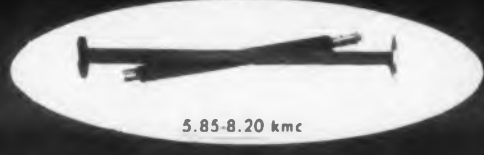
To make determinations, a diluted blood sample is placed in a reservoir, a lever is depressed and within 6 sec, and for a period of 15 sec, the number of blood cells per cubic millimeter is indicated on a meter. The principle of average-time measurement is reportedly unique in this type of sampling instrument.

In the instrument, the inspection volume is dark-field illuminated; no light falling on a monitoring photomultiplier tube means no particles are present. As a particle enters the inspection zone, it scatters light, a portion of which falls on the photomultiplier. The photomultiplier's output is a series of current pulses whose pulse width represents the time that a cell is present in the inspection volume. This time is compared with the time between successive cells to determine the average fraction of time that cells are present. ■ ■

JetStar Has Rollaway Nose Cone



Nose cone of the Lockheed JetStar is built on tracks so it can be rolled forward and backward, making electronics equipment accessible for maintenance.



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Height Inches	2.25	3.00	5.75	11.0
Diameter Inches	1.37	1.75	3.00	4.50

NEWS

Space Digital Computer

Kearfott Engineers' Design Goals Also Include Six-Month Reliability

A MINIATURIZED digital computer aimed at space flight needs two years from now is under early phases of development at Kearfott Div., General Precision, Inc., Clifton, N.J.

Design goals include small size (a 5-in. cube) 6,000-word memory, 50-mc clock rate, 20-w power requirement, and six-month reliability.

Project head Irving J. Lieberman said a variable word length made up of 10-bit blocks will cut the memory waste space down to between 5 and 10 per cent. Full 40-bit words will be programmed for space navigation-accuracy while only a single 10-bit block word (slide-rule accuracy) might be used for lesser vehicle housekeeping tasks. The 3 lb. memory drum will be gas-suspended to withstand acceleration and a smaller "scratch pad" core buffer with 0.1-0.5 μ sec access time will link it to the rest of the computer.

The computer will be designed for real-time control of vehicle functions and will be compatible with Kearfott's inertial systems. Digital transducers and on-off actuators would probably be used in the control loops, Mr. Lieberman said.

Six-Month Reliability Goal Is 99 Per Cent Confidence

The reliability goal is 99 per cent confidence that the computer still be providing adequate vehicle control after a six-month interplanetary journey, Mr. Lieberman said.

The quest for reliability will permeate every step of the design effort, according to Mr. Lieberman. On the logical level, the computer will have a minimum number of commands, fewer than



Irving J. Lieberman, manager of digital-computer laboratory at Kearfott, explains design goals for space-borne computer.

uter
Goals
ability

Will Fit into 5-in. Cube

50. to decrease the compound failures.

At the component level, component derating will be balanced against total number of components. If it can be shown, for example, that it would be better to drive flip-flop transistors harder and do away with output amplifiers, then the transistor will be made on the basis of extensive testing and statistical analysis.

On the system level, self-healing will be achieved by internal failure detection routines and implementation of alternate operation modes. For example, about half the 20 w power will be consumed in driving the "scratch pad" cores (they must be driven hard to achieve speed). But if the power supply falls off, the computer will operate directly from the drum, at a reduced clock rate.

Microwave Problems Will Dictate Interconnection Design

Because the circuits will be running at the sine wave equivalent of 500 mc, noise problems will dictate the design of circuit interconnections. External noise will be shielded by a ferrite envelope but internal cross talk will be a problem, Mr. Lieberman admitted. Wiring will have to be approached as a transmission line problem which will have special attention paid to terminal reflections.

Welded-wire packaging will be used for the power circuits but those developments in micro- and molecular circuits which look as if they might be available within the computer's time schedule will be considered for the logic. ■ ■

Design Specifications

WEIGHT: 10-13 lb

VOLUME: 5 in. x 5 in. x 5 in.

MAIN MEMORY: 6-8,000 words on high-density 3-lb drum.

SCRATCH-PAD MEMORY: Approximately 200 words in magnetic cores.

ACCESS TIME, SCRATCH-PAD MEMORY: 0.1-0.5 μ sec.

WORD LENGTH: Variable, made up of 10-bit blocks with up to four blocks per word possible.

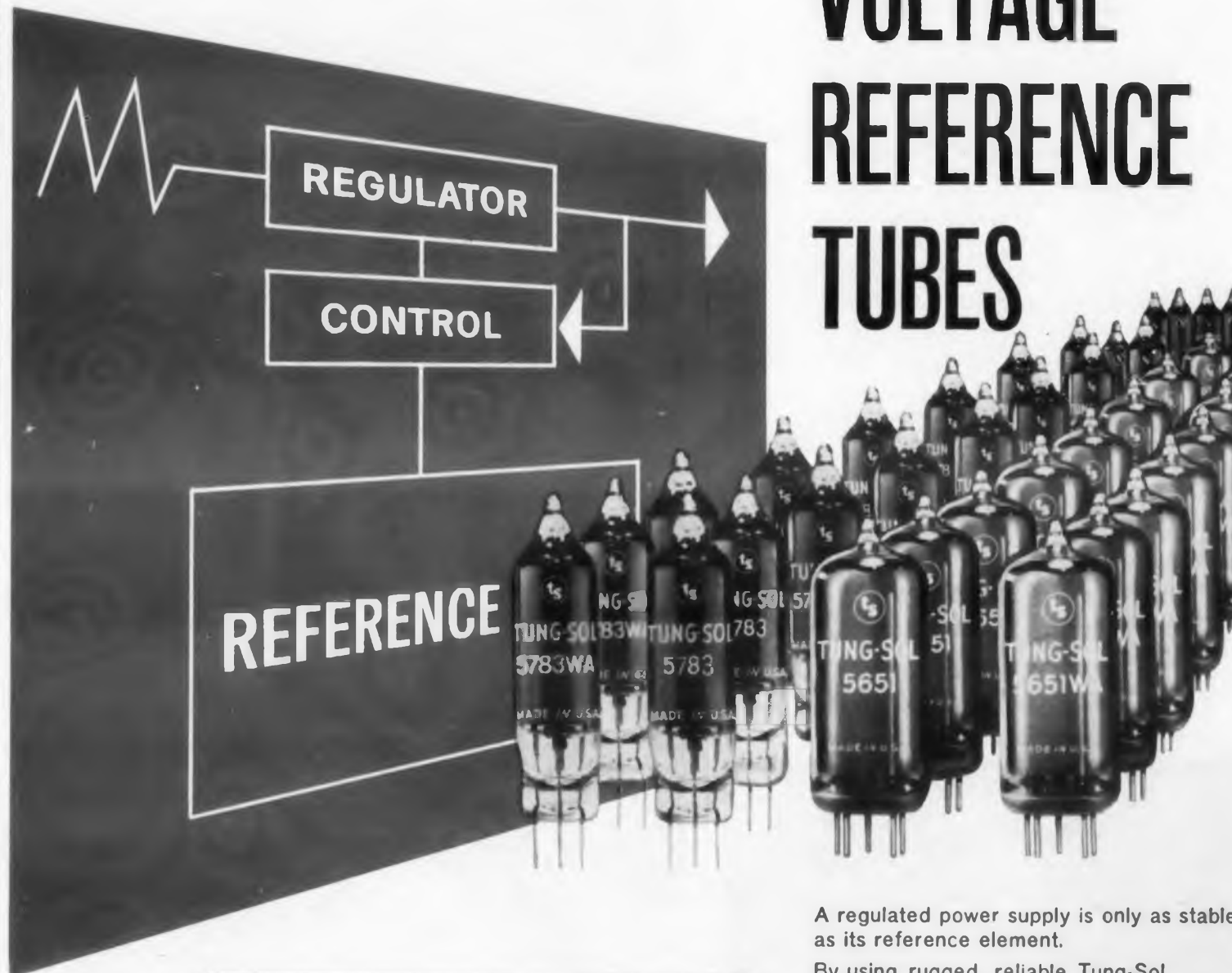
CLOCK: 50 mc

POWER REQUIREMENTS: 20 w.

RELIABILITY: 99 per cent confidence that there will be no failures within six months.

COMMANDS: Fewer than 50 (for reliability).

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CIRCLE 16 ON READER-SERVICE CARD

NEWS

Wavelength of Light Replaces Meter As New Standard of Measurement

The world has adopted a new international standard of length—a wavelength of light—replacing the meter bar which has served as the standard for over 70 years.

The new definition of the meter as 1,650,763.73 wavelengths of the orange-red line of krypton 86 will replace the platinum-iridium meter bar which has been kept at Paris as an international standard for length since 1889 under the Treaty of the Meter.

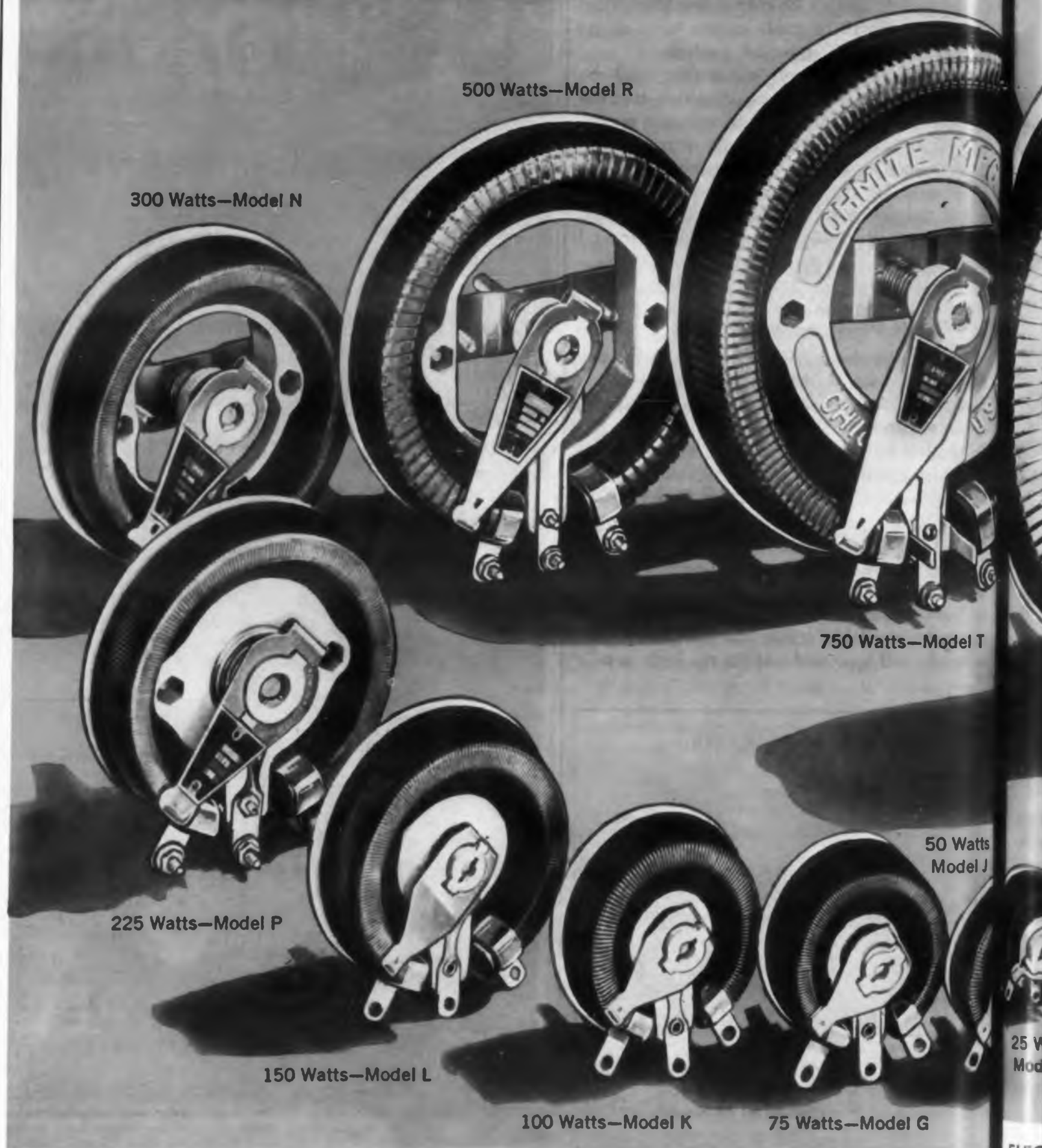
The announcement was made from Paris by Dr. A. V. Astin, Director of the National Bureau of Standards, U.S. Dept. of Commerce. The action was taken by the 11th General Conference on Weights and Measures, which met recently in Paris.

The new definition of the meter relates it to a constant of nature, the wavelength of a specified kind of light, which is believed to be immutable and can be reproduced with great accuracy in any well-equipped laboratory. Thus it is no longer necessary to return the national standards of length at Paris at periodic intervals in order to keep length measurements on a uniform basis throughout the world. Also it is possible to measure some dimensions more accurately in terms of the new definition than was possible before.



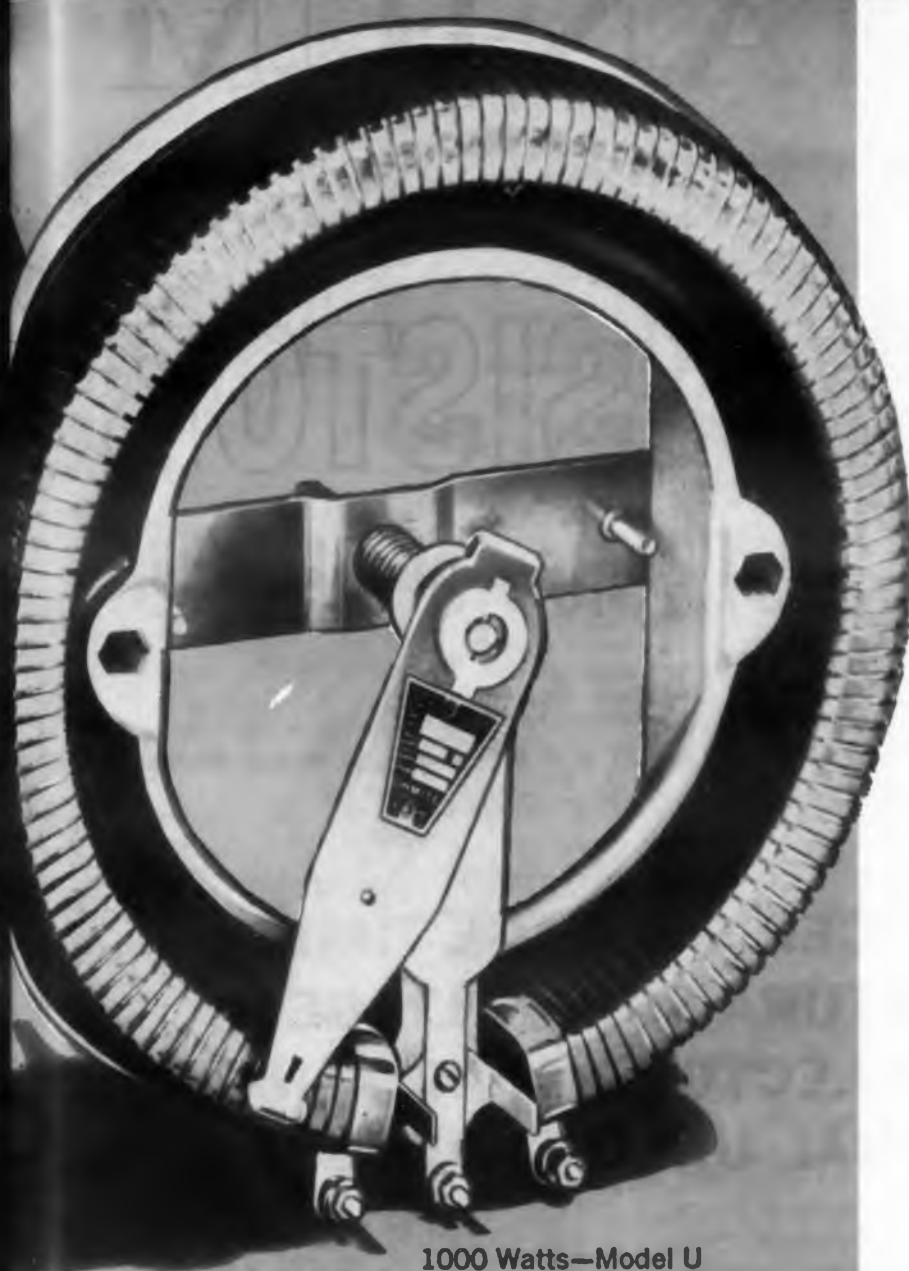
A krypton-86 lamp in its liquid-nitrogen bath is adjusted by a National Bureau of Standards scientist. The wavelength of the orange-red light emitted by the lamp has been adopted as the international standard of length. The lamp is operated at the triple point of liquid nitrogen, 63 K, to increase the stability of the standard wavelength.

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Model H

Japanese Raise Electronic Goals In Five-Year Production Plan

The Japanese electronics industry is expected to produce 82 per cent more by value in 1960 than it produced in 1959, according to the Dept. of Commerce.

The BDSA reports that the Japanese Ministry of Trade and Industry has estimated over-all production of the electronic industry in Japan to be worth about \$1.8 billion by 1964. An earlier five-year estimate, made by the ministry in May of this year, indicated a growth of only 32 per cent from the level of 1959.

In the ministry's estimate, significant increases were made in the projected production of industrial electronics, tubes, semiconductors, and tape recorders and other audio equipment.

The production of color television sets is expected to rise sharply while that of black and white TV sets is expected to drop.

The ministry anticipates that exports of transistor radios will grow steadily. More than 27 per cent more such sets are expected to be exported next year than were sent abroad this year. The increase of 1962 over 1961 is expected to be 10 per cent. An annual rise of 5 per cent a year is looked for in 1963 and 1964.

Production of color TV sets is expected to rise to 12,000 units in 1961 from 4,000 in 1960. In 1962 production is expected to rise to 30,000 sets; this will double in 1963 and reach 100,000 sets in 1964.

Computer production is expected to rise sharply in the next five years in Japan. From 50 digital computers produced in 1960, production of 120 is looked for in 1961, 200 in 1962, 300 in 1963, and 430 in 1964. The five-year figures for analog computers are: 77, 96, 106, 117 and 129.

Emphasis on Data-Processing

Japan currently is importing about \$13 million worth of data-processing and automatic-control equipment, according to the Japanese Ministry of Trade and Industry. This is about 60 to 80 per cent more annually than the \$13.0 and \$7.1-worth imported in the 1957-58 and 1958-59 periods.

In the latest revision of Japan's five-year program for electronics development, the ministry is emphasizing development and production of computing and control equipment. Money spent on research in data processing and automatic control is already about three times that spent on imports of such equipment and is expected to grow. From the \$12.3 million spent on such R&D in 1957-58 and \$18.1 million spent in 1958-59, about \$29 million was spent in the 1959-60 period.

CIRCLE 17 ON READER-SERVICE CARD

NEWS

(Continued from p 5)

zation shifts. Cerium-doped barium fluoride is among the materials under study. Di-hydrogen phosphate, operating at room temperature, presents a less difficult cooling problem and may prove to be the most suitable material for the modulator.

A proposed design for a laboratory-type modulator would have the following configuration. A pink ruby crystal at 1.6 K is placed in a dc magnetic field of about 10,500 oersteds perpendicular to the c-axis in the x-direction. The ruby is in a TE_{011} cylindrical cavity, again with the c-axis parallel to the cavity axis. Cavity volume is about 1 cc and has an unloaded Q_0 of 30,000. Measurable effects would be obtained at 50 kmc with a 10-mw input. Dissipation of this heat would require a pump speed of 0.35 liter per sec at the cryostat.

Another possibility suggested by Dr. Bloembergen is the use of microwave ultrasonic signals to vary index of refraction by acoustical strain. Here again, low temperatures would be required because of ultrasonic attenuation. However, emphasis at Harvard is on cubic ion rare earth crystals for dichroic and magnetic Faraday rotation, and on di-hydrogen phosphate for electrical Faraday rotation.

Two Crystals in Series Proposed by Developer

Detection of modulated light is possible by inverting each of the proposed schemes. Dr. Bloembergen proposes the use of two crystals in series, the first energized by a 50-kmc signal and the second by a 50.03-kmc signal. The light passing through these crystals is detected by a conventional photocell. Output of the photocell would be 30 mc modulated in accordance with the incoming light intensity.

This roundabout detection scheme is due to the inability of conventional photocells to follow light fluctuations at rates greater than 10 kmc. Dr. Bloembergen suggests, however, that faster photocells could be developed.

The modulation schemes proposed by Dr. Bloembergen are generally not dependent upon either the frequency of the light used or of the modulating signal. Devices along these lines could thus be useful over a wide range of radio and optical frequencies. One application proposed is as a phase reference for microwave communications.

It may also be possible to combine an optical maser and Dr. Bloembergen's modulator into the same crystal, or alternatively, employ an optical maser as the source of modulating rf, thereby modulating one light frequency at a second light frequency. ■ ■

EPITAXIAL GERMANIUM

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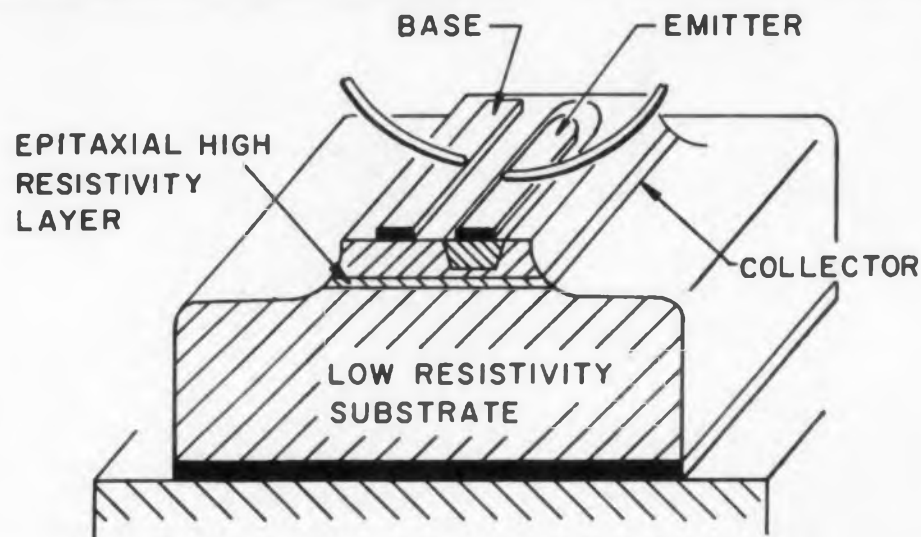
SYLVANIA EPITAXIAL GERMANIUM DIFFUSED-BASE MESA TRANSISTORS offer all the advantages of conventional diffused-base mesa transistors *plus* significant reductions in switching time and high-current saturation voltage.

FIRST NEW TYPES to utilize *epitaxial* techniques are two PNP units—SYL-2300 and SYL-2301 in the TO-18 package with the collector internally tied to the case. The Sylvania *epitaxial* structure uses a main body collector region of very low resistivity material with a thin, high resistivity *epitaxially* grown region. This allows a reduction of collector series resistance (saturation voltage) and an increase in switching speed (less excess stored

charge) through the use of the low resistivity main body region. Also, collector capacitance is reduced through the use of the high resistivity *epitaxially* grown region. The Sylvania *epitaxial* technique simplifies manufacturing processes, enables extraordinarily tight design control to provide significantly improved uniformity of characteristics.

LEARN MORE about the important performance advantages of Sylvania *Epitaxial* Diffused-Base Germanium Mesa Transistors from your Sylvania Representative. Contact him, too, for price and delivery information. For technical data, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 1811, Woburn, Mass.

ELECTRONIC DESIGN • November 23, 1960



EPITAXIAL DIFFUSED TRANSISTOR CONSTRUCTION

Sylvania epitaxial transistor is fabricated by diffusing a base region into a thin, high resistivity layer. This thin layer is vapor grown in epitaxial fashion onto a low resistivity collector substrate. The single crystal structure of the substrate is continued into the thin film.

PNP EPITAXIAL DIFFUSED-BASE GERMANIUM MESA TRANSISTORS

ABSOLUTE MAXIMUM RATINGS: (at 25°C)	SYL-2300	SYL-2301	UNIT
Collector to Base Voltage.....	-15	-12	V
Collector to Emitter Voltage.....	-15	-12	V
Emitter to Base Voltage.....	-2.5	-1.0	V
Collector Current.....	-50	-50	mA
Power Dissipation (free air).....	150	150	mW
Power Dissipation (case at 25°C).....	300	300	mW
Storage Temperature.....	-65 to +100	-65 to +100	°C
Junction Temperature.....	+100	+100	°C

ELECTRICAL CHARACTERISTICS AT 25°C:

Symbol	Conditions	SYL-2300		SYL-2301		UNIT
		Min.	Max.	Min.	Max.	
BV_{CBO}	$I_C = -100 \mu A, I_E = 0$	-15		-12		V
BV_{EBO}	$I_E = -100 \mu A, I_C = 0$	-2.5		-1.0		V
BV_{CES}	$I_C = -100 \mu A, V_{BE} = 0$	-15		-12		V
h_{FE}	$I_C = -10 \text{ mA}, V_{CE} = -0.22 \text{ V}$	25				-
	$I_C = -10 \text{ mA}, V_{CE} = -0.25 \text{ V}$			20		-
V_{BE}	$I_C = -10 \text{ mA}, I_B = -0.4 \text{ mA}$	-0.34	-0.44	-0.34	-0.50	V
I_{CBO}	$V_{CB} = -5 \text{ V}, I_E = 0$		-3.0		-3.0	μA
$V_{CE} \text{ (Sat.)}$	$I_C = -10 \text{ mA}, I_B = -0.4 \text{ mA}$		-0.22			V
	$I_C = -10 \text{ mA}, I_B = -0.5 \text{ mA}$				-0.25	V
	$I_C = -50 \text{ mA}, I_B = -2.5 \text{ mA}$		-0.25		-0.35	V
$t_d + t_r$	$V_{BE(0)} = 0.5 \text{ V}, I_{B(1)} = -1 \text{ mA}$		70		90	μSEC
t_s	$V_{CC} = -3.5 \text{ V}, R_C = 300 \text{ ohms}$		45		60	μSEC
t_f	$I_{B(2)} = 0.25 \text{ mA}$		70		95	μSEC

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Explorer VIII Probes Ionosphere; 60-90-Day Life Seen for Telemetry

Greater understanding of the ionosphere should be provided by the recently orbited Explorer VIII satellite. Eight experiments in the 90-lb vehicle's payload were originated by the Goddard Space Flight Center. Launching from Cape Canaveral was handled by NASA's George C. Marshall Space Flight Center.

Mercury batteries should power the instrumentation payload for two to three months.

The experiments being conducted include:

- A radio-frequency impedance probe to measure electron concentration. Measured capacitance of a dipole antenna, with 10-ft arms, will be compared to free space capacitance value as the dipole radiates a small amount of energy. This can be related to electron concentration.

- A single-grid ion trap to determine ion concentration and mass distribution. A grid in front of the collector has its voltage swept from -5 to +25 v, and data are derived by comparing collector current with sweep voltage.

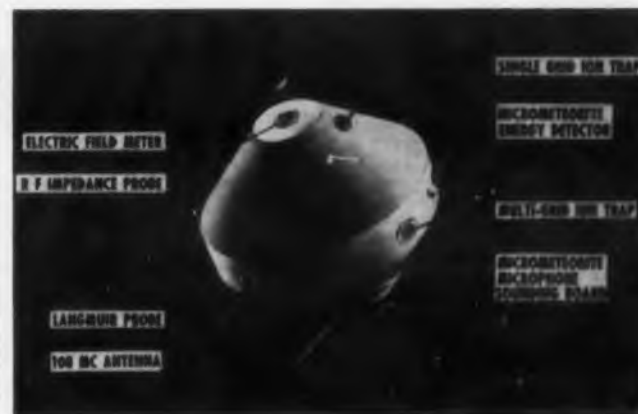
- Four multiple-grid ion traps to perform the same measurements. Comparison of multi- and single-grid data will be used to evaluate the effects of the ion sheath around the vehicle.

- A Langmuir probe experiment to measure electron temperature.

- An electron field meter to measure the distribution of charge which collects on the vehicle. It is a rotating-shutter type field meter which can measure fields from 50 to 10,000 v/m.

- A micrometeorite photomultiplier to measure the light energy given off by micrometeorites striking the satellite, which can be related to kinetic energy of the particle, and to determine corrosive effects. A conventional 6199 photomultiplier with a thin layer of aluminum on the front is used.

- A micrometeorite microphone experiment to measure frequency and momentum of impacts.



Eight experiments in Explorer VIII will provide measurements of the positive ion and electron composition of the ionosphere, along with energies, fields, and temperatures involved. The 90-lb satellite is 30 in. high and 30 in. in diameter.



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Weight: 11 lbs. (with case)
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800A-2	0-36	0-1.5	x	x	Yes	Dual Output	580.00
800B-2	0-36	0-2.5	x	x	Yes	Low Cost Medium Current Supply	339.00
802B	0-36	0-1.5		x	Yes	Dual Output Remote Sensing	580.00
806AM	0-20	0-2.0		x	Yes	Remote Sensing Remote Programming	350.00
808A	0-36	0-5		x	Yes	Constant E/Constant I	425.00
810A	0-50	0-7.5		x	Yes	Remote Sensing	895.00
812C	0-32	0-10		x	No	Remote Sensing	550.00
855	0-18	0-1.5	x	x	Yes	Can be connected in series or parallel	175.00
880	0-100	0-1.0	x	x	Yes	Wide Voltage Span	375.00

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CIRCLE 20 ON READER-SERVICE CARD

WASHINGTON REPORT



Ephraim Kahn

MORE MONEY FOR DEFENSE will be urged by the new Administration. President Eisenhower's last budget—to be submitted to Congress before Inauguration Day—will ask for funds hike of \$1 to \$2 billion. This is now little more than a pro forma figure; it is clear that additional money will be sought—perhaps as much as \$2 billion. Biggest gainers from the additional funds will be sophisticated weapons systems, Army modernization, and space-related projects.

PRIME CONTRACT CANCELLATION during fiscal 1960 showed little change in pattern from the preceding year. At the end of the period, some 1,500 cases were in process of termination, about 5,000 had been dropped for the convenience of the government, and approximately 5,550 termination claims had been settled. Value of items covered by contracts was nearly \$1.1 billion, and \$755 million was paid out in settled termination cases. Pending cases were worth another \$1.1 billion. Of the settlements in fiscal 1960, more than 80 percent were made without cost to the government. The government paid out almost \$46.5 million in settlement costs—about 13 per cent of the contract value of fixed-price contract terminations completed during the period.

ARMY R&D CONTRACT CRITERIA have been summed up in a "simple rule" offered by its R&D chief, Lt. Gen. Arthur G. Trudeau. In selecting the type of arrangements to be made with contractors—and the extent to which they will have design as well as managerial responsibility—the following six factors are considered: the need for speed, comparative costs, full utilization of the talents of private industry, the location and caliber of technical know-how and "the need for sustaining reasonable government competence to supervise all research and development."

EARLY COMMAND AND CONTROL SYSTEMS PLANNING must be improved, with greater stress placed on the technical and economic feasibility of new systems before they even get to the design stage. Maj. Gen. Kenneth P. Bergquist, boss of the Air Force's Command and Control Development Division, thinks that industry should get more guidance from the Air Force when it is about to be given a design job. Though industry "most likely will continue to serve as the actual developer of the implementation phases," he should be told beforehand of what is desired in terms of both inter-system compatibility and design emphasis. Gen. Bergquist's comments echoed the feelings of the

ter Study Group" that was formed to evaluate planned and existing command and control systems.

PATENT-POLICY ADOPTION by the Federal Aviation Agency sheds some light on the possibilities for liberalizing overly restrictive patent rules of some government agencies during the next Congress. FAA has formally adopted and will use, in all contracts for R&D which are thought to have commercial potential, a system of keeping a "fair share" of rights to data and patents. The system—which has provoked no Congressional criticism and a few favorable murmurs—is designed to return the agency's development costs. Rights retained by the government are supposed to be "in reasonable proportion to the respective contributions of the agency and the contractor." FAA already has \$12 million worth of contracts which call for payments of royalties of up to 7.5 per cent on commercial sales and sales to other governments, and one-third of royalties derived from licensing. FAA formerly operated under a patent policy closely akin to that of the Defense Department. Being developed under the new patent policy, which, it is understood, calls for royalty payments by the developer as well as other firms, are a general aviation transponder and an electronic ground-speed indicator.

LAST-DITCH PITCH for stability in military spending has been made by Defense Secretary Gates. He calls for appropriation of military money "on a balanced, sensible and timely basis for the long pull." The U.S. must be kept in first place "regardless of cost," and the "feast-and-famine policies of the past" should not be allowed to resume. In what seems like a mild departure from customary official statements, Gates asserts that defense "must come first in dollars, regardless of the level of our gross national product or the status of our annual income and expenditures." Professional military men, aware that a review of the "long pull" funding philosophy is the least that can be expected of the incoming Administration, tend to think of stable funding as a minimum. They see money availability trending upward, perhaps to \$50 billion or more a year by 1970.

PERFORMANCE AND PROMISE of defense contractors will be carefully scrutinized by the Air Force as part of its continuing cost-cutting effort. Though the Air Force Deputy Chief of Staff, Lt. Gen. Mark E. Bradley Jr., has indulged in some scary talk about "score sheets" for companies, this is not to be taken literally. But when it is found that a contractor "consistently overruns on cost-plus and underruns on incentive"—this will be given due weight in the evaluation of future proposals. The Air Force plans to "insist even more vigorously that incentives are earned on the basis of improved management and engineering, not the result of overstated prices." Special attention will be paid to: (1) overstatement of costs under incentive contracts; (2) understatement of target figures under cost-plus-fixed contracts; (3) poor judgment in subcontracting and make-or-buy decisions; and (4) excessive subcontracting with sole sources.

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CIRCLE 22 ON READER-SERVICE CARD

NEWS

Electronic Audio-Monitor Device Aids Brain Surgeons in Operations

An electronic device, the audio-monitor, developed at a London hospital, enables surgeons to hear changes taking place in a patient's brain while he is on the operating table.

Invented by Dr. S. Pampiglione and his technical assistant, N. Picton-Robinson of the Institute of Child Health, the device allows the surgeon and anaesthetist to give their undivided attention to the patient by eliminating the need to watch the encephalograph for signs of sudden circulatory disturbances.

Instead, signals are transmitted to them by means of a loudspeaker or small earphone giving warnings before any clinical change takes place, and thus allowing a better opportunity for remedial action.

Accuracy is Our Policy . . .

Metal film resistors being developed by International Resistance Co. for the Minuteman reliability program will meet a reliability specification of 0.0004 per cent per 1,000 hours. Due to a typographical error an incorrect figure of 0.004 per cent appeared in the Aug. 3 issue, p 50, and also appeared in the Sept. 14 issue, p 4.

The New Literature item appearing on page 135 of the Oct. 26 issue referred to a "Guide Book to Thermal Strips." The correct title of the brochure is "Guide Book to Terminal Strips." It is issued by the Mandex Manufacturing Co., Inc., 2614 W. 48th St., Chicago, 32, Ill.

CHANGES IN PRICE AND AVAILABILITY

SCOTCH BRAND VIDEO TAPE has been reduced 10 per cent in price by Minnesota Mining and Manufacturing Co. of St. Paul. The 10 per cent reduction includes all sizes and price brackets. The price of a roll of standard hour-long tape has dropped \$22.84, from \$228.41 to \$205.57, when bought in lots of 48 or more. The latest price, along with three earlier cuts, represents a total price reduction of nearly 33 per cent since the first video tape was marketed by 3M in 1956.

CIRCLE 89 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960

Accuracy is Our Policy . . .

Some errors appeared in Part 2 of "All-Pass Networks" in the October 26th issue of *ELECTRONIC DESIGN*. On p 71, pulse droop is the parameter that is little affected by the other transformer parameters, not pulse *fall*. In the third column on p 72, the peak ripple with the overcompensating network is 10 per cent of the final amplitude. On p 73, the duopole parameters were given for the undercompensated case only. For the overcompensated case, $a = 1$, $r^2 = 2.5$. In the subsequent paragraph, the response intended is the time-domain response.

■ Captions for two photographs were switched in the picture spread "Complexity a Feature of Courier Satellite" (*ED*, Oct. 26, p 9). The photograph at the top of the page shows the acquisition transmitter; the bottom photograph is the tape recorder.

■ The microwave modulator made by Narda Microwave Corp. (*ED*, Aug. 3, 1960, p 144) has a pulse generator output variable from 180 to 3,000 pps. This was stated as 180 to 300 pps.

■ In the Aug. 31 issue, p 54, the flow h_i in Fig. 2 is incorrectly shown from i_i to V_i . Further, the sixth paragraph of the article incorrectly reads, "Because some generators in an equivalent circuit represent dependent variables . . ." It should, of course, read, ". . . represent independent variables . . ."

■ Two errors appeared in C. Walter Johnson's article "How to Account for Voltage Drops in Conducting Logic Diodes" (*ED*, Sept. 28, p 56). Near the top of the third column of p 58, a_m should equal 0, not -1. Also, labels for the subfigures of Fig. 5 were inadvertently omitted. These should appear as follows. Figs 5a and b are above and below the caption, respectively; c is above d which is above e in the second column of subfigures; and f is above g in the third column.

■ Several pieces of erroneous information managed to appear in our Product Feature "Ultra-High Regulation Featured in All-Transistor Supply" (*ED*, Aug. 3, 1960, pp 102-103). The supply, manufactured by the Krohn-Hite Corp., Cambridge, Mass., can operate from standard voltage sources of 115 ± 10 v and 230 ± 20 v. Its temperature coefficient is 0.01 per cent per deg C, or 1 mv (instead of the 7 mv given) per deg C whichever is greater.

Motor insulated with paper



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Motors insulated with "Mylar"® run trouble-free 50 to 100% longer

Humidity, physical stress and heat are three major causes of motor failure. Insulation of "Mylar"® polyester film helps overcome them . . . gives motors 50 to 100% longer trouble-free service.

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ly cost no more than those using other common types of insulation.

Whether you manufacture or buy electrical products, you can get improved performance with Du Pont "Mylar". Figured on a square-foot basis, "Mylar" will often cost you less than your present material. For full facts on "Mylar", write for free booklet. E. I. du Pont de Nemours & Co. (Inc.), Room #14, Film Department, Wilmington 98, Delaware.

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*"Mylar" is Du Pont's registered trademark for its brand of polyester film.



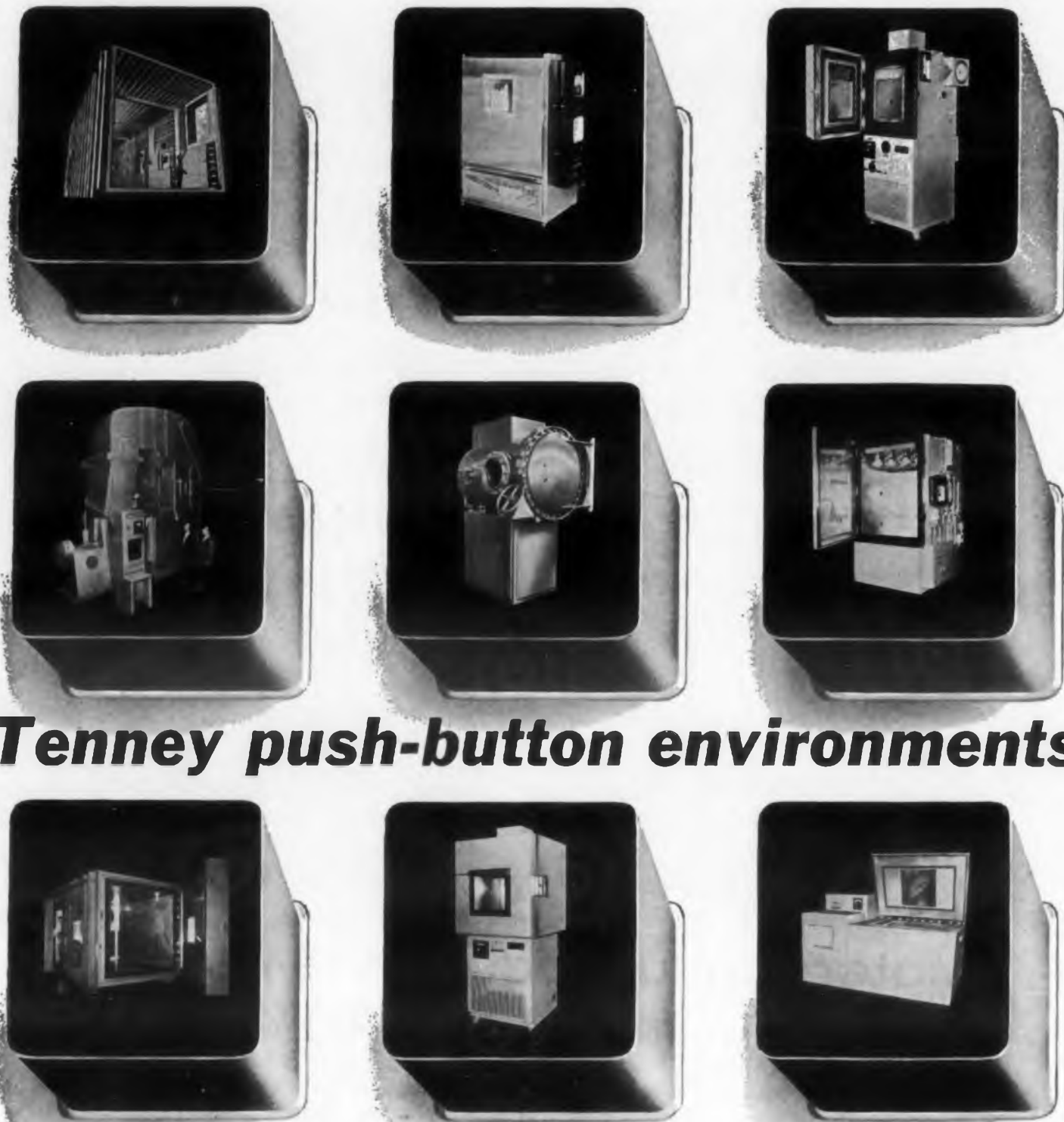
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CIRCLE 24 ON READER-SERVICE CARD



NEWS

Factorial Test Design

Procedure Expected to Give Data Faster, With Greater Completeness

THE Signal Corps' electromagnetic environment test facility at the Army's electronic proving ground near Fort Huachuca, Ariz., may be the site of one of the first engineering applications of factorial experiment design.

This test procedure, now used in non-engineering sciences like medicine and agronomy, is expected to provide data on electronic equipment under test faster and with greater completeness than present techniques. With the statistical procedures used in factorial-type experimentation it is said to be possible to collect useful data on individual factors by varying many or all of the parameters involved simultaneously. In traditional testing, usually only one parameter is varied. Designers using the electromagnetic environment test facility to check their equipment could expect to get results through use of factorial methods much faster than previously.

Although the Signal Corps' test facility is presently operating with traditional test procedures, scientists at Fort Huachuca expect to make use of factorial techniques as soon as their research into the method gives them sufficient confidence in the procedure. In testing a piece of equipment for compatibility with the complement of devices making up the equipment's environment (the main purpose of the test facility), so many combinations of conditions are said to be possible because of the large number of devices present in a battle group that varying many or all parameters simultaneously is almost necessary for efficiently produced, valid results.

Environmental Facility To Be Automated by 1965

According to Dr. Robert Frese, deputy for scientific affairs at Fort Huachuca, up to 75,000 potential emitters may be present in the 100 x 100-mile area occupied by a field army. A modern corps contains about 14,000 potential emitters, of which as many as one-quarter may be operating at one time.

W. L. Plicato, assistant manager of program management of Bell Aerosystems at Fort Huachuca, who is working as a subcontractor with prime contractor Pan American World Airways in completing the test facility, believes that a four-factor experiment design, in which four parameters would be simultaneously varied, would be the most complicated necessary to effectively

Design May Be Used by Army

isolate sources of interference. A three-factor, two-level factorial experiment has already been run in a simulation at Fort Huachuca.

The electromagnetic environmental test facility (EETF) near Gila Bend, Ariz., in the Fort Huachuca area, is being built for the Signal Corps by Pan American, in conjunction with Bell Aerosystems, under an \$18.8 million contract. By the time the range is instrumented for automatic control, recording and analysis of tests in 1965, a total of \$90 million will have been spent.

Three separate installations constitute the EETF:

- A 150-mile long main facility called the electromagnetic environment is designed for radio interference investigations.

- A Common Test Facility at Fort Huachuca will provide and correlate common communication and test facilities to support tests conducted by the various departments of the proving ground.

- A Drone Test Facility for flight-testing and evaluation of advanced airborne combat surveillance systems is the third installation. This range stretches 250 miles adjacent to the Electromagnetic Environment.

The environment facility has five goals according to spokesmen at the Ft. Huachuca proving ground:

- To reveal the incompatibilities of existing Army equipment and systems.

- To suggest modifications to existing Army equipment to reduce interference.

(continued on p 28)

Got an RFI Problem?

The United States Army Electronic Proving Ground at Fort Huachuca is accepting equipment for test from non-contractors as well as from contractors. Companies interested in having an equipment tested for interference problems can procure a Program Requirement Document from the proving ground. When filled in, this detailed questionnaire will contain all information needed to run a test. If the test is considered appropriate for the proving ground by the Chief Signal Officer and the Continental Army Commander, the Fort Huachuca representatives will negotiate nuclear or impractical requirements and make the test.



Model 187B-SL

COMPLETE LINE



Model 187B-S

OF VERSATILE, EFFICIENT



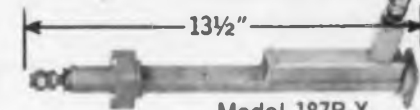
Model 187B-C

WAVEGUIDE WATER LOADS

for SL, S, C, XB and X Frequency Bands



Model 187B-XB



Model 187B-X

- Five models covering five bands
- Three models useful in pressurized systems
- VSWR less than 1.10
- Can handle 2-20 kw average power
- Low rf radiation
- Calibration heaters in all models

These Sierra high-power waveguide terminations are extremely useful as dummy loads in calorimetric power-measuring systems. They feature rugged construction, with rigid plastic water tube mounted in waveguide section, diagonally oriented for impedance matching. Chokes and shielding minimize rf leakage, and a heater element built into each model permits rapid, accurate calibration of a calorimetric power-measurement system against a low-frequency standard.

CHECK ALL THESE SPECIFIED ADVANTAGES!

Model Number:	187B-SL	187B-S	187B-C	187B-XB	187B-X
Frequency Range:	1.7 to 2.6 kmc	2.6 to 4.0 kmc	5.8 to 8.2 kmc	7.0 to 10.0 kmc	8.2 to 12.4 kmc
VSWR:	< 1.10 to 2.4 kmc < 1.15 to 2.6 kmc	less than 1.10	less than 1.10	less than 1.10	less than 1.10
Power Average: (Unpressurized)	20 kw	10 kw	5 kw	3 kw	2 kw
Peak Power:	2 megawatts	1 megawatt	500 kw	250 kw	150 kw
Max. Air Pressure:	*	*	45 psig	45 psig	45 psig
Waveguide:	RG-105/U	RG-75/U	RG-50/U	RG-51/U	RG-52/U
Connector:	UG-437A/U	UG-584/U	UG-344/U	UG-51/U	UG-39/U
Recommended Water Flow:	2 gpm for 10 kw	2 gpm for 10 kw	1 gpm for 5 kw	0.6 gpm for 3 kw	0.4 gpm for 2 kw
Pressure Drop at Rated Flow:	10 psi	10 psi	10 psi	10 psi	10 psi
Max. Water Pressure:	80 psig	80 psig	80 psig	80 psig	80 psig
Water Temperature:	0 to 70° C	0 to 70° C	0 to 70° C	0 to 70° C	0 to 70° C
Water Capacity:	18.5 cu. in.	3.5 cu. in.	0.85 cu. in.	0.42 cu. in.	0.20 cu. in.
Water Renewal at Rated Flow:	Once per 2.5 sec.	2 times per sec.	4.3 times per sec.	5.3 times per sec.	7.4 times per sec.
Heater Resistance:	4.5 ohms	9 ohms	14 ohms	20 ohms	20 ohms
Heater Rating:	10 kw at 2 gpm	5 kw at 1 gpm	3 kw at 1 gpm	1 kw at 0.6 gpm	1 kw at 0.4 gpm
Length:	50 in.	32 in.	20 in.	17.25 in.	13.5 in.
Price:	\$600.00	\$500.00	\$425.00	\$400.00	\$375.00

*Not pressurized

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

For complete details, see your Sierra Representative or write direct.

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NEW! Sierra also offers its Model 186 Series Coaxial Water Loads, covering dc to 4 kmc.

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6807

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SERIES F TARZIAN Silicon Rectifiers

Tarzian Type	Amps. DC (85° C)	PIV	Max. RMS Volts	Max. Amps.		Jedec Equiv.
				Recurrent Peak	Surge (4MS)	
2F4	.20	400	260	2.0	20	---
F-2	.75	200	140	7.5	75	1N2482 } 1N2069 }
F-4	.75	400	280	7.5	75	1N2483 } 1N2070 }
F-6	.75	600	420	7.5	75	1N2484 } 1N2071 }



0.2" maximum diameter
0.4" maximum length

How many?

100? 1,000? 10,000? 100,000? 1,000,000?

If Series F units meet your design requirements, then you can specify with full assurance of availability in any quantity.

These Series F units are widely useful. They combine small size, low cost, high performance and Tarzian reliability. They are interchangeable with many other rectifiers. Junctions are oversize—handle inrush currents far beyond normal circuit requirements. Temperature rise is low and reliability is increased.

The insulated body of the Series F units presents no mounting problems. And low cost with high quality results from Tarzian production methods.

For additional information about Series F rectifiers, call your Sarkes Tarzian sales representative, or write Section 5760. Sarkes Tarzian is a leading supplier of silicon, tube replacement, and selenium rectifiers. Practical application assistance is always available.



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CIRCLE 26 ON READER-SERVICE CARD

NEWS

(continued from p 27)

- To provide a firm basis for the establishment of realistic standards for new Army equipment.
- To test Army frequency assignment plans.
- To test all newly developed electronic and other communication equipment prior to its acceptance by the Army.

Work in instrumenting the range is proceeding in three phases: providing for testing of company communications equipment in a battle group environment; providing for corps equipment, and providing for division equipment.

Testing began in July under phase-one conditions. Manual tests were made on fm walkie-talkie and jeep-mounted communications gear planned for company use. About 100 tests have reportedly been made so far.

The range is expected to be used by the three military services eventually. Simultaneously with its construction, scientists at the proving ground are attempting to develop a mathematical model of the electromagnetic environment of an army battle group. Test results from the field facility will be used to create and validate the mathematical model. This model will include data on equipment and propagation characteristics and the equations that relate them. The model is expected to permit specialists to extend the interference information gathered in the test facility to types of terrain, climate and deployment that cannot be duplicated in the proving ground area.

British Radio Propagation Study Features 1959 Data from IGY

Studies of propagation properties for the purpose of aiding space and long-range communications programs, have been published by the British Department of Scientific and Industrial Research.

These studies, covering 1959, are based on analysis of data collected during world-wide cooperative programs of the International Geophysical Year. Still in progress, these studies promise to unravel such propagation mysteries as transmission blackouts in the polar regions and structure and movements in the ionospheric layers. Such knowledge is vital to the accurate tracking of missiles and space vehicles and to reliable long-range communications.

The results of the IGY findings are applied to: space research, radio measurements and standards, ionosphere and radio-transmission conditions, radio-wave propagation through the troposphere, and semiconductors and ferrites.

U.S. Invites Foreign Countries To Take Part In Tiros Experiments

The U.S. has invited foreign governments to participate in meteorological research connected with the next Tiros satellite. The National Aeronautics and Space Administration and the Weather Bureau, which are conducting the Tiros experiment jointly, extended the invitation in letters sent to scientists of 21 nations. It was suggested that if the Tiros experiment is a success, weather agencies abroad might obtain "useful synoptic results by intensifying standard meteorological observations, or by arranging for special observations, coordinated in time with passes of the satellite."

Such world-wide cooperative efforts are part of NASA and the Weather Bureau's program of encouraging international cooperation in space research and in meteorology. Meteorologists will have an opportunity to correlate cloud-cover data as observed from both below and from high above the clouds. In addition, it will give NASA and the U.S. Weather Bureau a wide collection of meteorological research data.

NASA will provide orbital information to participants in the project to assist cooperating groups in timing local weather observations. After processing, Tiros cloud-cover photos will be forwarded to participants for comparison with their supplementary observations.

Rockets With 35-Ton Payload Predicted in Orbit by 1967

"Given the developmental program, there is no reason why a nuclear rocket could not put payloads as great as 35 tons in orbit within seven years. Within the 35-ton payload electrical power systems of over 1,000 kw could be carried." So said J. W. Simpson, vice president, atomic power division of Westinghouse Electric Corp., in a speech before a recent meeting of the Pittsburgh chapter of the American Society of Military Engineers.

Military efforts in space to date are aimed at improving techniques in navigation, communications and reconnaissance and are being achieved through the use of chemical rocket propellents, Mr. Simpson said.

The next generation of military applications, however, will probably come with the advent of more powerful rocket boosters and space auxiliary power systems. Mr. Simpson said. Atomic power will play a vital role in supplying these, Mr. Simpson added, while pointing out that atomic powered rockets offer twice the efficiency of chemical rocket systems.



From concept to countdown

Pesco creative engineering
meets the challenges
of space!



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steel and chemicals; (middle)
agriculture; industrial ma-
chinery; aviation; (bottom)
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equipment.



Imaginative concepts are translated into reality at Pesco . . . where engineering ingenuity combines with production proficiency to create specialized components for the aerospace industry. And Pesco extends its total engineering capabilities through a close working relationship with the Borg-Warner Research Center! Advanced design principles to meet tomorrow's needs are embodied in many Pesco products now specified for an impressive list of operational air vehicles. Current projects include electronic and hydraulic power packages, environmental cooling systems, cryogenic pumps . . . plus research programs in electrical control actuation, thermo-electric infra-red sensor cooling and thermo-electric power generation. Write today for information about Pesco's integrated design-and-build capabilities.

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Power low noise figure TW tubes



Alfred Model 252 and 253
Microwave Power Supplies.

with one ALFRED supply!

This compact ALFRED ELECTRONICS microwave power supply provides electrode voltages for nearly all medium and low noise figure TW tubes. Companion solenoid supplies for electromagnet focused TW tubes are available. Here are the major advantages of this precision ALFRED supply:

☆ FLEXIBILITY

One electrode supply operates most presently known tubes. It will operate new tubes as they become available. Cover present and future needs with *same* supply.

☆ INTERCHANGEABILITY

Build all your low noise amplifiers around standard unit. Simplify servicing. Stock parts for only one type of supply.

☆ LOCAL OR REMOTE OPERATION

Model 252 design permits remote operation of TW tube as may be required with broad-band preamplifiers. Heater supply has extra wide voltage range to compensate for cable IR drop.

☆ SIMPLE OPERATION

Only two controls on front panel for day-to-day operation. Set-up controls are on recessed subpanel. All voltages and currents are internally measured using front panel meter and recessed selector switch.

☆ STABILITY

Electrode supplies are well-regulated and designed for minimum drift. Use of dc heater power reduces spurious amplitude modulation.

☆ 50 TO 450 CPS INPUT

Wide band power input permits use with almost any available power source.

☆ ECONOMY

Separate solenoid supplies are available. Purchase only the supply you need when you need it.

KEY SPECIFICATIONS FOR MODEL 252

Helix: Voltage, 75 to 1400 v; Ripple, less than 20 mv pk-to-pk; Regulation, $\pm .03\%$ line. Collector: 0 to +300 v relative to helix. Four Anodes, ranging from -100 v to +900 v relative to cathode. Heater, 0 to 11 v DC at 0 to 1 amp with 2% regulation. All electrode supplies internally metered.

Two low ripple Solenoid Supplies are available. Both are adjustable over a wide range providing adequate power for most TW tube focusing magnets. Model 253 is unregulated; Model 254 is current regulated.

KEY SPECIFICATIONS FOR MODEL 253

0 to 105 v DC at 0 to 7.5 amp or 0 to 110 v at 6 amp. Ripple, .5% pk-to-pk.

KEY SPECIFICATIONS FOR MODEL 254

0 to 100 v DC at 0 to 7.5 amp or 0 to 105 v at 6 amps. Ripple, .5% Regulation, $\pm 1\%$ for $\pm 10\%$ line change or 30% load change.

PRICES: Model 252, \$890; Model 253, \$200; Model 254, \$350.

WRITE FOR MORE DATA—Contact your ALFRED engineering representative for more details, or write us directly at Dept. 36.

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CIRCLE 39 ON READER-SERVICE CARD

NEWS

'Clipped-Wing' Evaluator Missile Stays Behind to Record Falcon Flight

There is a Falcon air-to-air guided missile that fires, but never launches—a weapon-system evaluator missile with "clipped wings." This device always stays behind to record the performance of its more destructive mates.

The evaluator missile, or WSEM, is the only system that checks compatibility between the Hughes Aircraft Co.'s Falcon missiles and interceptor armament control during a simulated air attack.

Essentially, the WSEM is a standard configuration Falcon with a signal recorder set packaged in a cylinder in the aft section in place of the rocket engine and control surface servo positioners. Each version has a complete combat ready Falcon Guidance system.

WSEM's are installed in an interceptor armament bay in the same manner as standard Falcons. They can be used exclusively on simulated missions or included with a load of live Falcons to record actual firings.

New Rheem Positioning Controls Said to Give Automation Advance

Reported advances in automation are being demonstrated in a new system employing specially designed positioning controls and a precision boring machine.

Using Rheem Numerical Positioning Controls and an Ex-Cell-O Numera Trol precision boring machine, the system is believed to be the first in the automation field to achieve automatic control of tool position while the spindle is in motion. According to W. C. Leone, vice president and general manager of the Rheem Electronics Div. of Los Angeles, Calif., the position of the boring tool has a resolution of 0.0001 in., under tape control.

In using the system an operator loads parts into a fixture on the table. The "tape reader" in the control console reads the tape, sends signals to the distributor, which in turn transmits the information to the controls. The electronic control positions the table accurately into place, controls the rate of "feed," precisely positions the table horizontally in respect to the boring spindles during the cutting operation and automatically controls the radius of the cut. Thus the system provides an accurate automatic positioning of four axes simultaneously.

'Homemade' Electronic Tester May Save Hundreds of Man-Hours

An electronics tester, built of spare parts in a technician's spare time, will save hundreds of man-hours in building the 2,000-mph B-70 bomber, according to the plane's builders.

The machine, called the "Universal Test Panel," was designed and built by Ernest Sweeney, a quality-control specialist at the Los Angeles Div. of North American Aviation, Inc. Mr. Sweeney was aided in the design and construction of his panel by several associates at North American.

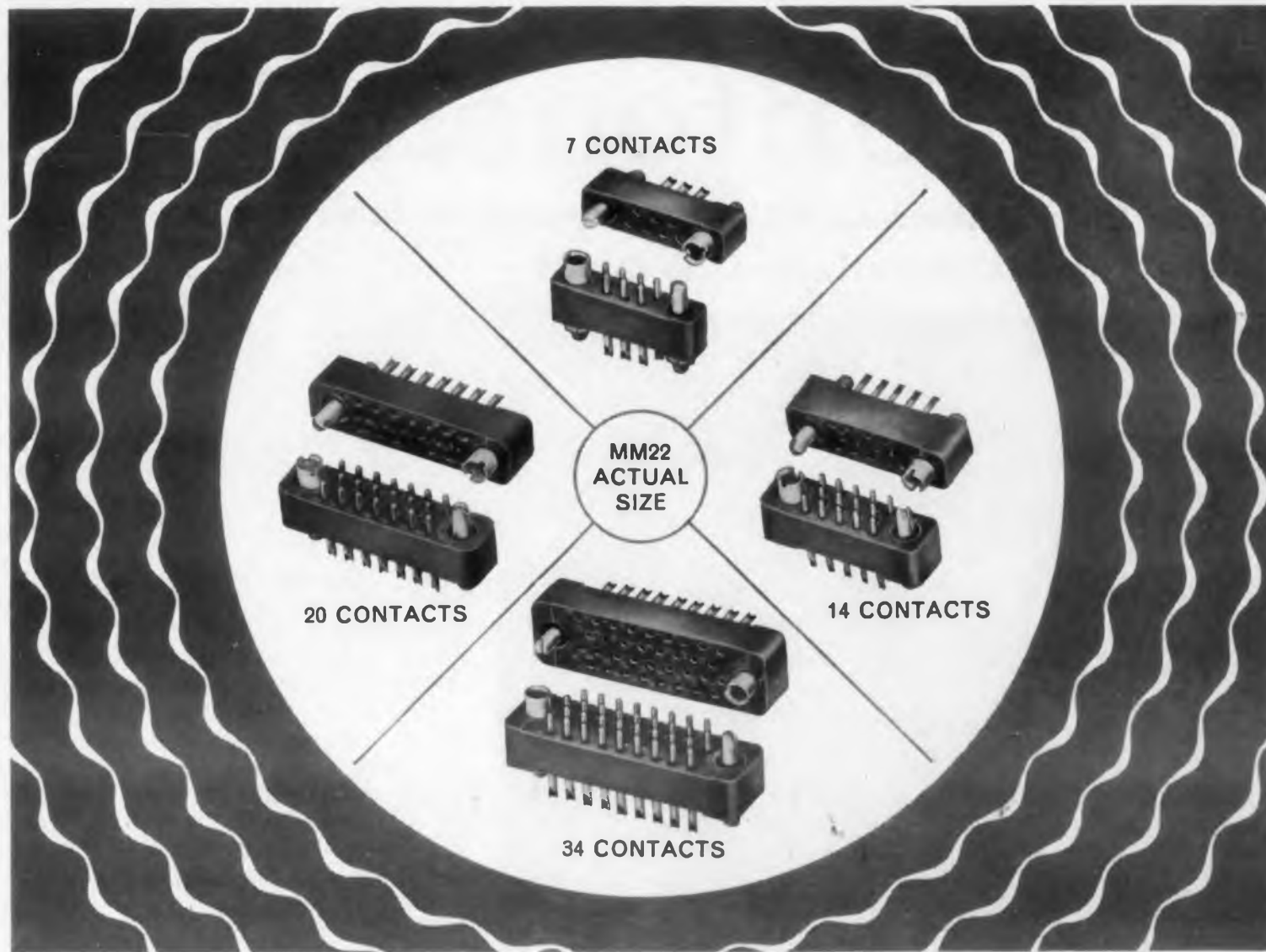
Preliminary tests showed Mr. Sweeney's machine can do the same jobs previously done by individual test panels, which took up to eight hours to build. The panel tests electronic parts such as regulators, sensors, controllers, amplifiers and other systems bought from outside vendors for the B-70.

The finished product is a 3-ft high cabinet with more than 1,500 wires and about 3,000 soldered points. It cost only \$165—a figure which does not take into account Mr. Sweeney's labor.

The machine is expected to be particularly useful in eliminating "one-shot" test panels which had to be built to inspect uncommon parts. Those panels often required up to 40 man-hours to build.



Plugging into a "homemade" electronics tester that he built on spare time out of spare parts, Ernest Sweeney of North American Aviation's Los Angeles Div. tests products to be used in tripersonic B-70 bomber program. The multi-purpose tester will save hundreds of man hours in development of 2,000-mph B-70, North American reports.



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Micro-Miniature Ruggedized Continental Connectors

- Smallest size without sacrificing performance
- Available with 5, 7, 9, 11, 20, 26, 29, 34 and 44 contacts
- Reversed guide pin and socket for positive polarization
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Continental Connector's Series MM22 precision micro-miniature connectors simplify interconnection of compact sub-assemblies where space limitations demand the smallest components and highest reliability.

ELECTRICAL AND MECHANICAL RATINGS

Voltage Ratings:	Breakdown	Recommended Test
At Sea Level	2400V. RMS	1600V. RMS
At 70,000 Ft.	650V. RMS	425V. RMS

Current Rating.....	3 Amps
Minimum Creepage Between Contacts.....	1/16"
Minimum Air Space Between Contacts.....	.040"
Contacts, Center-to-Center.....	3/32"
Pin Diameter.....	.030"
Solder Cup.....	#22 AWG Wire

Technical data sheets on micro-miniature and other Continental Connectors are available on request. Specify your requirements to Electronic Division, DeJUR-AMSCO Corporation, 45-01 Northern Boulevard, Long Island City 1, N. Y. (Exclusive Sales Agent.)



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CONTINENTAL CONNECTOR CORPORATION
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Purity pays off in quality — in uniformity of properties . . . in relatively flat resistivity and lifetime profiles for the entire length of single crystal silicon grown from Dow Corning polycrystalline rod and chunk . . . in maximum yield.

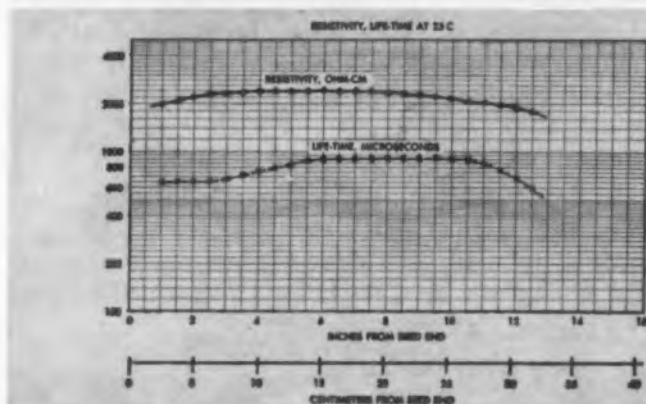
Specify polycrystalline rod if you use the zone refining process for conversion to single crystal — polycrystalline chunk if the Czochralski method is used. Both are of the same high quality.

Why is Dow Corning able to supply this untouchable quality?

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Typical properties of Dow Corning polycrystalline silicon, together with resistivity and life-time curves for an evaluation crystal, are shown below.



Typical Properties of Polycrystalline Silicon

Acceptor Impurity Content:	0.15 part/billion
Donor Impurity Content:	0.5 part/billion
Rod Diameter:	up to 26 mm (1.0 in.)
Rod Length:	up to 450 mm (17.7 in.)
Resistivity (vacuum zoned evaluation crystal):	>1000 ohm cm
Lifetime (vacuum zoned evaluation crystal):	>400 micro sec.

Free brochure — "Hyper-Pure Silicon for Semiconductor Devices." Write Dept. 3311a.

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NEWS

IDEP Data-Exchange Plan

Three Services Exchange Information To Improve Missiles, Space Vehicles

THE Interservice Data Exchange Program for ballistic missiles and space systems, that began approximately a year ago, is reported functioning smoothly. The purpose of IDEP is to stop duplicate controlled laboratory testing of piece parts and to improve the quality and reliability of missiles and space vehicles.

Data exchange among the services is not a new idea. There has been continuous exchange on an "as requested" basis. This however, is a long, slow process. IDEP is unique in that the exchange of test reports on piece parts is automatic.

Distribution Centers Set Up By Each of Three Services

The Army, Navy, and Air Force each have established a Data Distribution Center.

The Army DDC is at the Army Ballistic Missile Agency, Huntsville, Ala. The Navy DCC is at the Naval Ordnance Laboratory, Corona, Calif., and the Air Force DDC is located at the Air Force Ballistic Missile Div., Los Angeles.

Each service selects ballistic-missile and space-vehicle contractors who will participate in the data-exchange program. They are chosen on the basis of the importance of the laboratory test work they have under contract. The service is offered to the contractors at no cost. Individual contractors send test reports to the appropriate



Microfilmed report enlarged by a reader-printer is reviewed by J. H. Draughon, Army promoter of the Interservice Data Exchange Program idea. The machine is printing laboratory work copies for Army missile contractors at the same time.

Plan Minimizes Lab Duplication

Data Distribution Center. A common language has been worked out which will be understood by all services and their contractors, so the first step is to code the report. The report then goes on a summary card with the full text micro-filmed and attached to one side of the card. This film strip can contain the equivalent of 36 pages of typewritten material. Each DDC and contractor has a reader-printer which magnifies the microfilm to readable proportions. At the same time a built-in duplicator prints a copy for work use.

Microfilm Cards Are Sent To Other Centers Automatically

Each distribution center automatically sends a microfilm card to the other distribution centers and to all contractors participating in the program. Centers also send out monthly bibliographies to help engineers know what test reports are available.

Plans are being made at present to include National Aeronautics and Space Administration agencies in the IDEP. Long-range plans call further for working out a computer program. This would be an electronic brain. A designer could feed data into a computer and then question it as to whether or not a certain piece part had ever been laboratory tested, and by whom. ■ ■

Nuclear-Detection Device Program Begins at Texas Instruments

A part of the large-scale seismological R&D program, aimed at evolving techniques and equipment for distinguishing between natural earth-quakes and ground motion causes by nuclear blasts, is being undertaken by Texas Instruments.

The company has been awarded an Air Force contract for work on the program, called Project Vela, to help in developing methods for detecting and identifying nuclear explosions. The TI contract is for the first phase of the program which covers development of multiple arrays of seismic sensors and data-processing equipment to pick out distinguishing characteristics of seismic waves from distant explosions.

Work under the Air Force contract will be performed by Texas Instruments Geosciences and Instrumentation Div.

WHEN IT COMES TO SHIELDED WIRE



SLIDE
on the ferrule



SLIP
in the ground taps



CRIMP
the three together



SNAP
on the insulation

PRESTO!

the best insulated ferrule you can buy



How's that for speed! And the post-insulation of the Termashield Shielded Wire Ferrule is easily and quickly accomplished . . . you eliminate close tolerance cable stripping required by other techniques . . . you eliminate blind probing of taps into other type ferrules . . . you eliminate solder and burnt cable . . . you eliminate lost time . . . you eliminate doubt.

For positive attachment, top reliability, unbeatable speed and tangible economy, get A-MP Post-Insulated Termashield Shielded Wire Ferrules.

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With Link Digital Function Generator

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Standard signal levels for input and output circuits assure compatibility with standard analog equipment. Utilizing the greatest possible accuracy and stability combined with high speed computation, the DIGITAL FUNCTION GENERATOR delivers fast readouts of generated function in digital or analog form. This unique systems tool guarantees flexibility, ease of maintenance and remarkably low cost.

GENERAL SPECIFICATIONS

Computer type:	Special purpose serial digital
Number base:	Binary
Mode of operation:	Parallel
Memory type:	Magnetic Drum
Drum speed:	3,000 RPM
Memory capacity:	330,000 bits on 80 tracks
Word length:	32 bits
Interpolation rate:	800 per second simultaneous computation of division and multiplication
Function generation:	One variable: 0.02 sec/point Three variables: 0.1 sec/point
Accuracy:	0.1% dependent on programming accuracy

INPUT/OUTPUT CHARACTERISTICS

Input: (Continuous electrical analog signal)
 Number of inputs: 64 (expandable)
 Sequence: By computer command
 Level: 0 to +100 volt
 Conversion time: 936 microseconds

Output:
 Number of outputs: 80 (expandable)
 Selections: Fixed or by mode switch
 Level: 0 to +100 volt
 Drift: 24 millivolts in 16 hours

Output:
 Number of outputs: 128
 Signal: 12 binary bits at a frequency of 204.8 kilocycles per second
 Pulse level: 0 to -10 volt

Write to Dept. XX, Industrial Sales Department, for specific details on the many advantages and applications of the Digital Function Generator and information on Dialog Systems Building Blocks.

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NEWS

Heat Near That of Sun

Molecules Ionized, Dissociated By HF Electromagnetic Fields

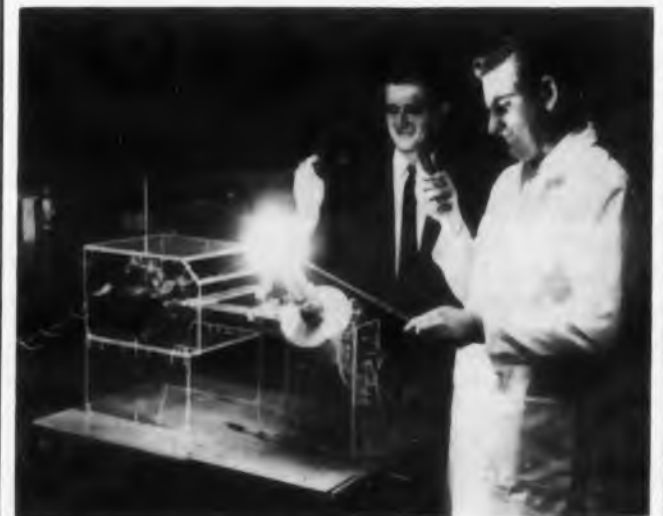
A "Plasma Torch" using an RF field to generate temperatures approaching those of the sun's surface has been built by the Amperex Electronic Corp., Hicksville, N.Y. High-frequency electromagnetic fields ionize and dissociate gas molecules passing through the torch. Recombination of this plasma as it exits from the torch liberates heat without combustion.

The principle is similar to that of the atomic hydrogen torch except that here the energy is supplied to the gas by an RF field rather than by an arc. Any gas, combustible or not, may be used.

The electromagnetic field is created by a coil or by a coaxial cable. The gas passes through the coil or within the cable, which must be specially constructed with perforated insulating discs. Torches of both types have been successfully tested by Amperex. The coil-type unit was powered by a standard transmitting triode, while the coax-type torch used a magnetron.

Frequency of Field Is Not Critical

Frequency of the field is not critical; the triode was operated at 27 mc and the magnetron at 2,450 mc. Both types operated cw with the triode delivering 250 w and the magnetron 1



"Plasma Torch" melts steel rod held by John Martin as Amperex President Frank Randall observes demonstration of the device. Heat is derived from high-frequency electromagnetic fields generated by triodes or magnetrons. Despite high heat, the torch itself remains cold. The process does not involve combustion and almost any gas can be used, according to Amperex engineers.

Sun With RF 'Plasma Torch'

In heavy-duty applications, however, it is likely that triodes would be preferable.

Test units have achieved temperatures of more than 3,000 C using compressed air, and experiments are under way to reach 5,700 C, the temperature of the sun's surface. Despite the high temperatures of the plasma, the torch itself remains cold.

Torch Was Developed

by West German Engineers

The torch was developed by a West German division of the Philips Co., of which Amperex is an affiliate. Amperex does not plan to manufacture the torch, but hopes to interest other companies in it so as to develop a new market for triodes and magnetrons. Prototype units were built for under \$1,000 and production models are expected to cost far less.

Suggested applications for the plasma torch include investigation of missile reentry, spraying high melting point metals and ceramics, and welding. Since heat is generated without oxidation, the torch could prove useful in processes where contamination must be avoided.

triode
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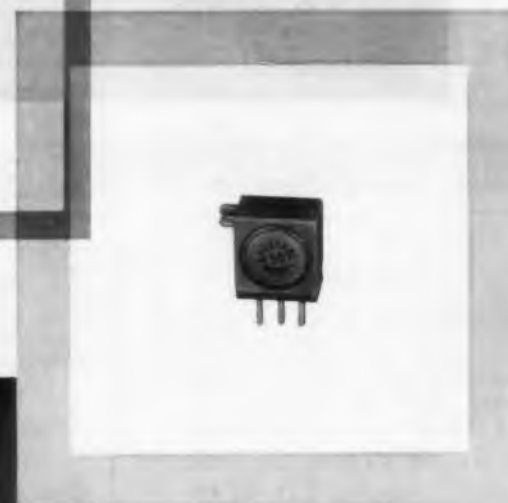
Lockheed TV Camera System to Present 'Space-tacular'

A device known as a Video Telemetering Camera System will enable missile designers on the ground to view what is happening inside a missile during flight. The system, developed by Lockheed Electronics Co. of Plainfield, N.J., functions like a TV set, but is reported many times more refined.

Both the Tiros and Midas satellites used cameras to photograph weather phenomena and the ground. The Lockheed camera, however, is designed to televise actual functioning of missiles during flight.

The strategically placed cameras will view happenings both inside and outside the missile as it soars through space. Once launched the functioning of the missile is viewed on a monitor by engineers and is photographed on motion-picture film.

These visual records will be a valuable aid to designers when making repairs or redesigning equipment, according to the company, and, in addition to speeding up missile development, the camera system could save millions of dollars.



Trimmers
shown actual size

with **NEW**

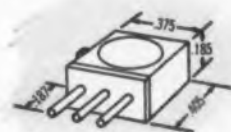
SPECTROL

Trimming
Potentiometers

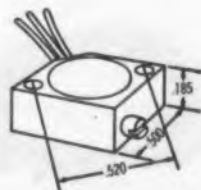
Go Ahead, TRIM SQUARE

- SIZE
- PERFORMANCE
- RELIABILITY
- ECONOMY

■ SIZE



THE MODEL 50
3/8" square, 3/16" high, and
weighing 1 gram, the Model 50
is available in standard resistances
of 50 ohms to 20K ohms.



THE MODEL 60
1/2" square, 3/16" high, and
weighing 2 grams, the Model 60
is available in standard resistances
of 50 ohms to 50K ohms.

■ PERFORMANCE

Stack 'em... up to 35 Model 50 trimmers in one cubic inch. Adjust 'em, 25 turns for full electrical travel... take your choice of side or top adjustment, slotted fillister head screw, Allen hex socket, or slotted headless screw flush mounted. Dissipates 1 watt—Model 50 and 2 watts—Model 60. Dual wiper provides double assurance of positive contact under all conditions. High resolution, typically 0.061% for the 50K ohms model. Resistance tolerance, $\pm 5\%$, temperature range, -55 to $+150^\circ\text{C}$.

■ RELIABILITY

At no extra cost, Spectrol trimmer potentiometers meet or exceed all applicable military specifications for altitude, fungus resistance, salt spray, sand and dust, humidity, temperature cycling, shock and vibration. Guaranteed load life, 1000 hours minimum.

■ ECONOMY

Prices in 1-9 quantities: Model 50—\$7.50 each, Model 60—\$6.50 each. Spectrol trimmers are ready now for immediate delivery from your local distributor. For complete technical information, call your Spectrol representative or write Dept. 36.

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CORPORATION

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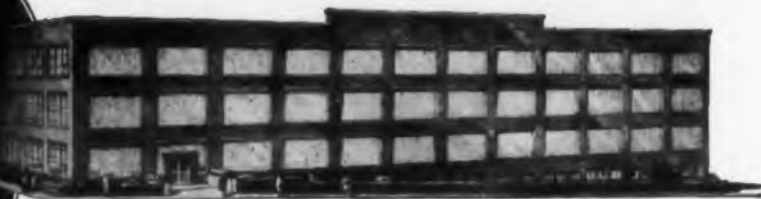
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PRECISION FORK OSCILLATOR UNITS

TYPE 2003



Size 1 1/2" dia. x 4 1/2" H. Wght. 8 oz.
Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 ($\pm .02\%$ at -65° to 85°C)
Type R2003 ($\pm .002\%$ at 15° to 35°C)
Type W2003 ($\pm .005\%$ at -65° to 85°C)
Double triode and 5 pigtail parts required.
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

TYPE 2007-6



TRANSISTORIZED, Silicon Type
Size 1 1/2" dia. x 3 1/2" H. Wght. 7 ozs.
Frequencies: 360 to 1000 cycles
Accuracies:
2007-6 ($\pm .02\%$ at -50° to $+ 85^{\circ}\text{C}$)
R2007-6 ($\pm .002\%$ at $+15^{\circ}$ to $+ 35^{\circ}\text{C}$)
W2007-6 ($\pm .005\%$ at -65° to $+ 85^{\circ}\text{C}$)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

TYPE 2001-2



Size 3 3/4" x 4 1/2" x 6" H., Wght. 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: $\pm .001\%$ at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3-12-28
B voltage, 100 to 300 V., at 5 to 10 ma.

ACCESSORY UNITS FOR 2001-2



- 1.—For low frequencies multi-vibrator type, 40-200 cy.
- D.—For low frequencies counter type, 40-200 cy.
- H.—For high freqs, up to 30 KC.
- M.—Power Amplifier, 2W output.
- P.—Power supply.

PRECISION FREQUENCY STANDARDS

TYPE 2005A

*Size 8" x 8" x 7 1/4" High
Weight, 14 lbs.*

Frequencies:
50 to 400 cycles (Specify)
Accuracy:
 $\pm .001\%$ from 20° to 30°C
Output, 10 Watts at 115V
Input, 115V. (50 to 400 cy.)



TYPE 2121A

*Size
8 3/4" x 19" panel
Weight, 25 lbs.*

Output: 115V
60 cycles, 10 Watt
Accuracy:
 $\pm .001\%$ 20° to 30°C
Input,
115V (50 to 400 cy.)



TYPE 2111C

*Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8 3/4" H.
Weight, 25 lbs.*

Frequencies: 50 to 1000 cy.
Accuracy:
($\pm .002\%$ at 15° to 35°C)
Output: 115V, 75W.
Input: 115V, 50 to 75 cy.



WHEN REQUESTING INFORMATION, PLEASE SPECIFY TYPE NUMBER

ATA
**American Time Products
Inc.**
61-20 Woodside Avenue
Woodside 77, N. Y.

NEWS

Transistorized Dc Motors

*May Be Generally Available in '67;
Have No Brushes, No Commutators*

TRANSISTORIZED dc motors designed to operate without commutators and brushes, reported to be in closely guarded development by a number of manufacturers, may be generally available early next year. "I expect to see perhaps 10 companies in the market by the middle of next year," a designer active in this field told ELECTRONIC DESIGN.

One manufacturer, Eastern Air Devices, Inc., Dover, N.H., has already announced its entry and reports having landed a \$250,000 initial contract with a "major eastern electronics company" to supply transistorized motors for use in military devices. Eastern claims that its motors offer a 20- to 100-fold increase in reliability compared to carbon-brush-equipped motors operating under severe conditions. Specific design information is being withheld, however, until patent applications are further along.

Meanwhile, the SER Co., Waltham, Mass., is marketing do-it-yourself kits of a transistorized dc motor for educational use and expects to patent and license the design for commercial use.

**One of Two General Approaches
May Involve Patent Difficulties**

This unusual state of affairs in what promises to be a significant design innovation is due to the fact that there are at least two separate design concepts involved—one of which may not be eligible for a patent.

In one approach, a transistorized dc-to-ac converter drives a conventional ac motor. Successful operation of this scheme generally requires a control feedback from the motor to synchronize the converter. This relatively straightforward method is said to be an old one whose practical implementation requires the high-power transistors only now available. Informed sources believe that many of the designs planned for introduction next year are variations of this scheme—including, perhaps, the Eastern Air Devices motor. It is also believed that obtaining a patent for a transistorized motor designed along these lines may prove difficult.

A second approach employs transistors to commutate the current to a specially designed dc motor. This is the principle of the SER kit motor. Its inventor, Dr. Harry Stockman, is a professor of electrical engineering at the Lowell Technological Institute, Lowell, Mass.

Motors Moving into Production

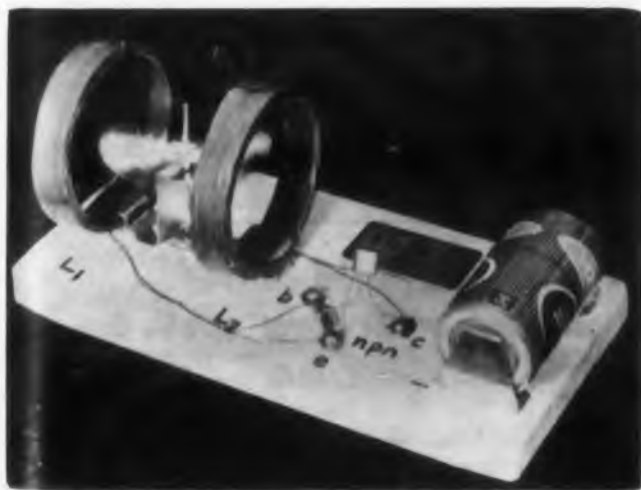
The SER motor consists of a permanent magnet rotor, two coils, and a 2N53 npn transistor. One coil is a sensing coil and the second a driving coil. As the magnetic rotor approaches the sensing coil, an emf is induced in the coil. This emf is applied to the transistor base in a common emitter circuit. The transistor fires, and current from the collector passes through the driving coil. This process occurs once during every rotation of the motor and provides a series of properly timed impulses to sustain rotation.

Self-Starting Is Difficult; Auxiliary Devices Are Needed

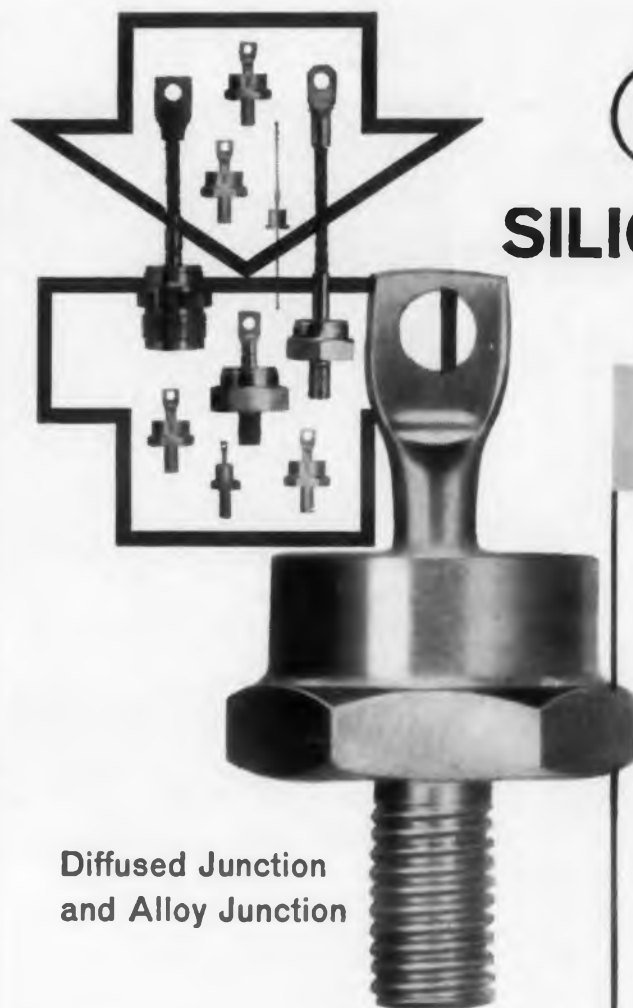
Both types of motors are inherently not self-starting and must include some provision to get them under way. This may consist of a starting winding, an electromagnet, a mechanical drive or other such means.

Dr. Stockman's claim of invention dates back to about 1950, at which time he reports having operated an analogous device using four 6L6's in parallel to commutate the motor. He obtained efficiencies on the order of 5 per cent and shelved the project. "With 1,500-w power transistors now available," Dr. Stockman said, "the idea now appears feasible."

Inherent advantages of a brushless dc motor include: absence of brush wear, which is particularly severe at high altitudes; greater safety in explosive environments; improved efficiency due to reduced friction; and generally improved reliability. Printed circuit motors could also employ the brushless principle to advantage. Still another application of these motors could be as integrating devices in electronic analog computers, where amplifier output is generally dc. ■ ■



Transistorized motor in kit form operates several months from a single flashlight battery. Operation in regenerative mode provides high efficiency with the rotor providing self-quenching action.



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250 ma to 100 amps

Type	Peak Reverse Voltage (Volts)	Average Forward Current	Maximum Reverse Current *	Max. Full Load Voltage Drop (Volts)	Surge Current† (Amps)
250-mA 150°C Ambient Temperature	1N538 1N540 1N547	200 400 600	750 mAdc @ 50°C 250 mAdc @ 150°C 750 mAdc @ 50°C 250 mAdc @ 150°C 750 mAdc @ 50°C 250 mAdc @ 150°C	250 μAdc 250 μAdc 250 μAdc	0.5 0.5 0.5
1 Amp 150°C Case Temperature	1N253 1N254 1N255 1N256	100 200 400 600	1.0 Adc 0.4 Adc 0.4 Adc 0.2 Adc	100 μAdc 100 μAdc 150 μAdc 250 μAdc	— — 1.0 ▲ —
20 Amp 140°C Case Temperature	1N1191 1N1192 1N1193 1N1194 1N1195 1N1196 1N1197 1N1198	50 100 150 200 300 400 500 600	20 Adc 20 Adc 20 Adc 20 Adc 20 Adc 20 Adc 20 Adc 20 Adc	5 mAdc 5 mAdc 5 mAdc 5 mAdc 5 mAdc 5 mAdc 5 mAdc 5 mAdc	.55 .55 .55 .55 .55 .55 .55 .55 Full cycle avg. 150°C case temp.
25 Amp 150°C Case Temperature	CS-120Z CS-120A CS-120B CS-120C CS-120D CS-120E CS-120F	50 100 200 300 400 500 600	25 Adc 25 Adc 25 Adc 25 Adc 25 Adc 25 Adc 25 Adc	5 mAdc 5 mAdc 5 mAdc 5 mAdc 5 mAdc 5 mAdc 5 mAdc	.55 .55 .55 .55 .55 .55 .55 Full cycle avg. @ 150°C case temp.
35 Amp 140°C Case Temperature	1N1183 1N1184 1N1185 1N1186 1N1187 1N1188 1N1189 1N1190	50 100 150 200 300 400 500 600	35 Adc 35 Adc 35 Adc 35 Adc 35 Adc 35 Adc 35 Adc 35 Adc	10 mAdc 10 mAdc 10 mAdc 10 mAdc 10 mAdc 10 mAdc 10 mAdc 10 mAdc	0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 full cycle avg. 140°C case temp.
50 Amp 150°C Case Temperature	CH116Z CH116A CH116B CH116D CH116F	50 100 200 400 600	50 Adc 50 Adc 50 Adc 50 Adc 50 Adc	20 mAdc 20 mAdc 20 mAdc 20 mAdc 20 mAdc	1.1 1.1 1.1 1.1 1.1
70 Amp 150°C Case Temperature	1N1396 1N1397 1N1398 1N1399 1N1400 1N1401 1N1402	50 100 150 200 300 400 500	70 Adc 70 Adc 70 Adc 70 Adc 70 Adc 70 Adc 70 Adc	15 mAdc 15 mAdc 15 mAdc 15 mAdc 15 mAdc 15 mAdc 15 mAdc	1.3 1.3 1.3 1.3 1.3 1.3 1.3
70 Amp 150°C Case Temperature	CH109Z CH109A CH109B CH109C CH109D CH109E	50 100 200 300 400 500	70 Adc 70 Adc 70 Adc 70 Adc 70 Adc 70 Adc	30 mAdc 30 mAdc 30 mAdc 30 mAdc 30 mAdc 30 mAdc	1.3 1.3 1.3 1.3 1.3 1.3
80 Amp 150°C Case Temperature	1N1291 1N1292 1N1293 1N1294	50 100 200 400	80 Adc 80 Adc 80 Adc 80 Adc	30 mAdc 30 mAdc 30 mAdc 30 mAdc	1.3 1.3 1.3 1.3

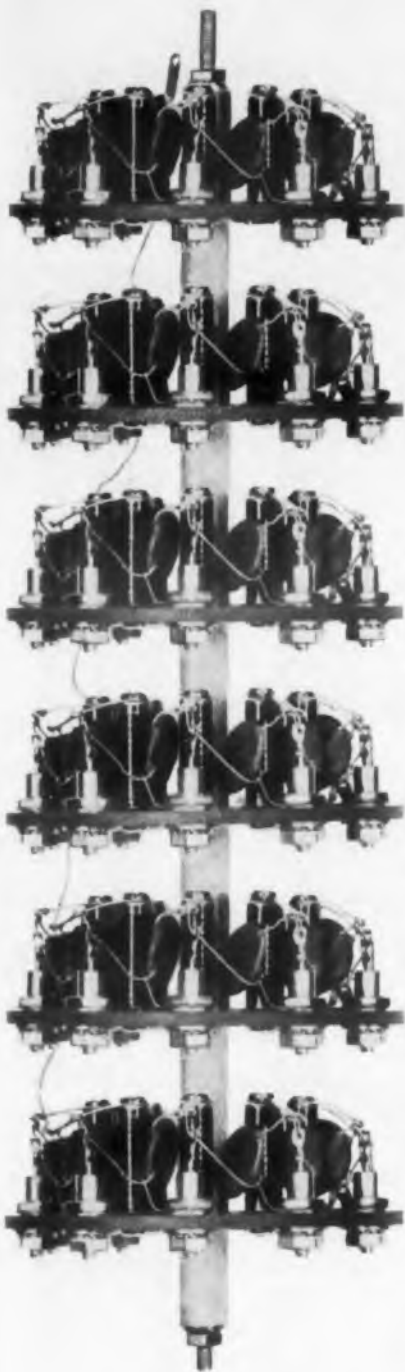
▲ Max. fwd. voltage drop @ 0.5 amp., 25°C case temperature
 * Full cycle average for rectifier operating into inductive or resistive load at rated current and voltage
 ** 50 amp units @ 100 amps D.C. and 25°C;
 † 70 and 80 amp units @ 150 amps D.C. and 25°C
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 Storage temperature range for all types . . . -65° to 200°C

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CIRCLE 35 ON READER-SERVICE CARD

NEWS



Germanium-mesa epitaxial transistors are thermo-compression bonded along production line at Sylvania's Semiconductor Div., Woburn, Mass.

Epitaxial Process to Take Leading Role

*Three Production Transistors On the Market
From New-Found Vapor-Deposition Process*

EPITAXIAL transistors, and even more complex devices made by this vapor-growth process, will take a prominent role in future designs, according to present indications.

Already three transistors have reached the production line, as shown in the table, and many more are expected to follow. Epitaxial devices are generally expected to make obsolete most amplifying and switching transistors now in use. Furthermore, control of the epitaxial process can result in more complex devices which should begin to reach the market within the coming year. Although component manufacturers are not discussing specific devices being planned, there is fairly general agreement that complex types should result in the near future from efforts now in progress.

Merck & Co., Rahway, N.J., has produced a crude sawtooth generator from a succession of epitaxial layers, demonstrating the feasibility of the concept for this application. Four-layer pnpn material is also being supplied by Merck to manufacturers for use in silicon controlled rectifier production. Other complex configurations are being produced by the company to meet specific requirements. Merck is also supplying two-layer n^+ on n material for use in making epitaxial transistors.

The potential of the process for producing the "universal transistor" is being exploited by Motorola with its 2N834 silicon-mesa. For switching applications lower storage time, lower saturation voltage and less collector capacitance have been achieved in comparison to present

Epitaxial Transistors in Production

Company	Device	Price
Motorola Semiconductor Products, Inc.	Type 2N834, silicon-mesa	\$18 ea for 100 or over
Rheem Semiconductor Corp.	Type RT409, silicon	\$170 ea for developmental units
Sylvania Electric Products, Inc.	Type SYL2300, germanium-mesa	\$27 ea to 100, \$18 ea for 100 or over
	Type SYL2301, germanium-mesa	\$18 ea to 100, \$12 ea for 100 or over

diffused mesas. In amplifier applications, higher power output with greater efficiency has been claimed because of the low series resistance to the devices.

Eventually, however, Motorola feels that optimization will again take over so that separate devices are made for switching and amplifying functions.

This can be done by varying junction area, junction configuration, and resistivity and thickness of the epitaxial layer, according to Motorola.

For switching devices low saturation voltage, low storage time, low r'_b , and careful control of current gain will be emphasized. In amplifier transistors moderately high breakdown voltage, low collector capacitance, low r'_b , and high gain-bandwidth product will be sought.

Manufacturing processes appear to be a key factor in the developing industry competition over epitaxial devices. A session devoted to the process at the recent Electron Devices Meeting in Washington, D.C., emphasized detailed manufacturing steps to be followed in producing devices. Questions from the floor concerned detailed portions of processes, such as per cents of impurities, cooling times, substrate preparation and similar points.

An exchange of ideas on epitaxial techniques was called for by Dr. N. T. Sandler of Pacific Semiconductors, Inc. Sharing of knowledge about the technique will benefit the entire industry, Dr. Sandler said.

Many of those at the session felt that the disclosures made by Bell Telephone Laboratories of details of the process developed there already have helped to push device development along much faster than would have been possible if each component manufacturer had to start from the beginning. The hesitation on the part of some speakers to answer specific pointed questions,

(continued on p 40)

The Epitaxial-Growth Process

In the epitaxial-growth process, semiconductor material in vaporized form is deposited on a semiconductor seed crystal. The deposited layer continues the single crystal structure of the seed. Compounds of semiconductors and halogens—iodine or chlorine—have commonly been used for the vapor process.

Control of this process adds several new benefits to device production. Extremely thin layers can be produced, doping levels can be carefully graded throughout a device, and sharp junctions can be made between layers of different resistivities anywhere in a device.

New Random Access Memory Package...

uses only 18.75" IN STANDARD 19" RACK



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GENERAL CERAMICS, continuing its leadership in the memory packaging field, has made available double and triple bay random access memories with up to 4096 characters x 32 bits per character at cycle times up to 6 micro-seconds. Now you can get design economy since the basic G-C package requires only 18.75" of standard rack space—a reduc-

tion of up to 80% over typical units requiring a full six feet.

General Ceramics offers space-saving random access memory designs with varying number of characters, word lengths and logic.

Optional design features include parity checking, test cycles, indicator lights and power supply locations.

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NOTABLE ACHIEVEMENTS AT JPL...

pioneering work in worldwide communication via satellites

PROJECT ECHO

On August 12th, 1960, JPL scientists at Goldstone, California, radioed the world's first transcontinental microwave message to be relayed by a passive, artificial earth satellite. This satellite was the 100 ft. plastic balloon Echo I orbiting around the Earth at an altitude of approximately 1,000 miles.

A pre-recorded statement by President Eisenhower was received 2,300 land miles away by scientists of the Bell Telephone Laboratories at Holmdel, New Jersey, as clearly as any conventional telephone call, in a fraction of a second.

Later in the course of the Echo experiment, the scientists at Goldstone and Holmdel conducted 2-way voice communication via the balloon satellite, Goldstone transmitting at 2,390 megacycles and Holmdel at 960 megacycles.

This successful experiment has demonstrated the feasibility of worldwide communication and is typical of many pioneering achievements of the Jet Propulsion Laboratory.



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CIRCLE 37 ON READER-SERVICE CARD

NEWS

(continued from p 39)

however, indicated that complete sharing of data can not be expected yet.

Prices of the epitaxials are expected to decline gradually as use rises. Motorola, for example, estimates that epitaxial mesa transistors will be priced lower than conventional mesas by mid-1961. As this trend goes on, however, the conventional manufacturing techniques will be displaced by epitaxial lines.

Philco to Improve Present Techniques, Add Epitaxial Silicon-Mesa Types

Comments about the epitaxial transistor making obsolete most other types have led to speculation about the Micro-Alloy Diffused Transistors made by Philco Corp. and licensees of Philco. These devices have proved highly competitive with mesa types up to now.

Philco feels that its MADT devices are competitive with the epitaxial mesas coming onto the market, however the company plans to improve its processes to compete with further refinements in the epitaxial art according to Dr. Clarence G. Thornton, director of research and development. Dr. Thornton feels that the epitaxial process will replace conventional diffusion, and that therefore the diffusion portion of the MADT process will be converted to an epitaxial step. This should allow further improvements in frequency response up to the 10-kmc region, Philco expects.

The company also plans to start production of epitaxial silicon mesa transistors, Dr. Thornton said, however because of the price differential between these and MADT types the epitaxials will probably be used only because of higher power requirements or high temperature needs.

More Devices Close to Marketing, Complex Epitaxials Next Big Step

Most other semiconductor manufacturers indicate plans for epitaxial devices and the three which are already in production have all announced plans for further devices. Motorola will follow up its silicon unit with a germanium-mesa designated type 2N828. Sylvania is working on silicon mesas to add to its present germaniums, and Rheem is planning to introduce epitaxial versions of its 2N699, 2N657 and RT5004 transistors.

Perhaps a more significant step will come with the marketing of more complex epitaxial devices. The high interest in the technique throughout the semiconductor industry portends keen competition in this field—competition that may bridge the gap to the molecular era. ■ ■

Trouble-Shooting by Telephone Cuts Computer Field Servicing

A unique technique designed to eliminate expensive field servicing of electronic computer-control and data-logging equipment by company engineers has been developed by Daystrom Inc.'s Control Systems Div. of La Jolla, Calif.

Key to the new systems service is that users of Daystrom equipment throughout the country, by means of a telephone call to a La Jolla-based console, can put their installations under the hand of a Daystrom expert and have him aid in programing or in trouble-shooting faults in the system's operation.

The La Jolla-console is identical in function to that used in connection with Daystrom installation. Once it is connected by means of a telephone wire to a console in the customer's plant, it can supervise and control the functioning of the customer's system exactly as though Daystrom personnel were in the customer's plant. In essence, this means that all of the skills that are available in the La Jolla laboratory are at the service of customers on a 24-hour-a-day basis.

If the operator in any one of the customer's plants found, for example, that the system wasn't executing a "branch command" as he thought it should, he would call La Jolla and explain his trouble. At the suggestion of La Jolla, the plant operator would cut his system into the telephone line and run his program off on the console. A programing expert would study that copy.

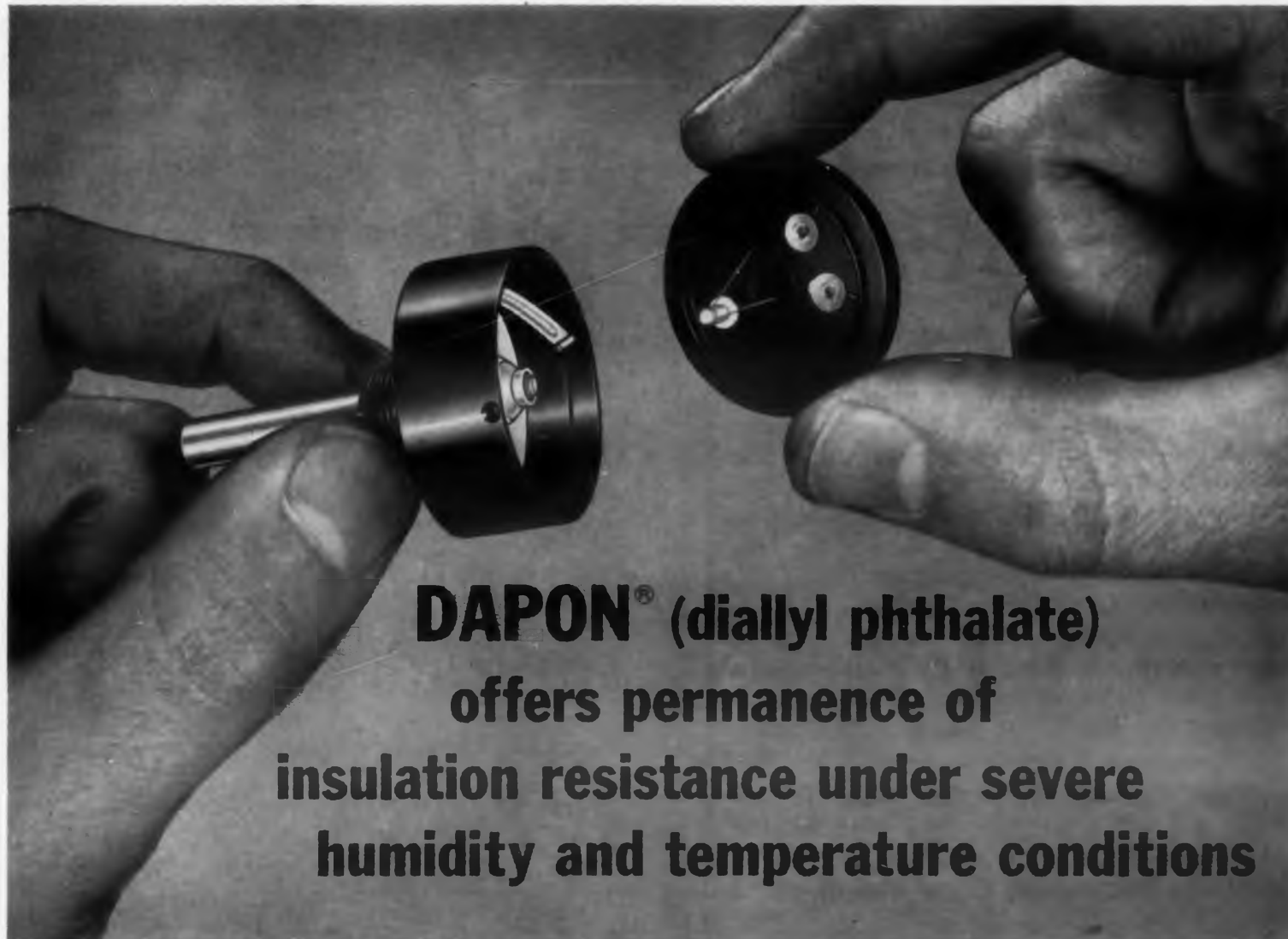
Once he had found the changes to be made, the programer would punch a paper tape to effect the change. He would then feed it into the tape recorder, which would automatically reprogram the customer's computer.

According to C. E. Jones, division general manager, the new service will be offered at a nominal fee.

Franklin Institute Gives Medal To Developer of X-Ray Image Amplifier

The development of an electronic device that brightens X-ray pictures as much as 500 times has won for Dr. J. W. Coltman, Westinghouse research scientist, an Edward Longstreth Medal of the Franklin Institute.

In citing Dr. Coltman for the development of the X-ray image amplifier, the Institute gives recognition to an invention which marked a milestone in the use of X-rays for the diagnosis of human disease. By means of an electronic tube, the image amplifier converts a low-intensity X-ray image into a pattern of electrons. These are accelerated and focused to form a brightened visible image on a phosphor screen.



DAPON® (diallyl phthalate)
offers permanence of
insulation resistance under severe
humidity and temperature conditions

This plastic is ideal for applications where changes in humidity can affect electrical values. DAPON can prevent costly "in service" failures in electrical and electronic components.

A new molded plastic potentiometer produced by New England Instrument Company features exceptional resistance to humidity, high reliability and low noise. A raised conductive plastic ring is used in place of resistance wire in these miniature units. The new potentiometers are ideal for servo and instrumentation applications where long life and extreme accuracy are important factors.

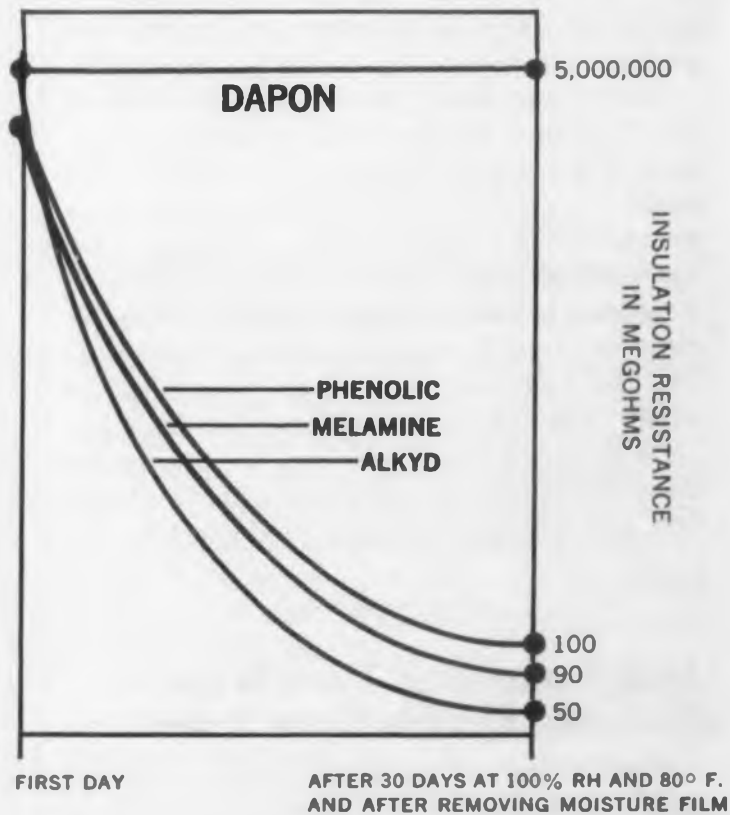
The solid resistance element, insulating base and silver terminal leads are molded in one operation with DAPON (diallyl phthalate) Resin. Result: a single, almost indestructible precision unit.

New England Instrument chose DAPON because of its superior electrical and physical properties, and its low moisture absorption. DAPON also molds easily around metal inserts without cracking, and withstands extremes of temperature, vibration and shock.

Specify DAPON (diallyl phthalate) Resin when you need:

- Low dielectric loss
- High dielectric strength
- Superior dimensional stability
- Excellent arc resistance
- High volume and surface resistance after high humidity-high temperature conditioning

Write for FMC's data sheet containing technical information about DAPON, suggested uses for this resin, and the names of DAPON compounders.



FOOD MACHINERY AND CHEMICAL CORPORATION
Dapon Department
161 East 42nd Street, New York 17, New York

CIRCLE 38 ON READER-SERVICE CARD

NEWS

Aerospace Recruiting Hot and Heavy, Most Prospects Come from STL

Intensive personnel recruiting is now being taken by the newly-formed Aerospace Corp. in Los Angeles. According to Ivan A. Getting, president, more than 100 engineers and scientists will be recruited during the next month.

Most of these will come from Space Technology Labs in Los Angeles, under the terms of an agreement established upon the formation of Aerospace Corp. "Our program is one of steady controlled transfer of personnel from STL to Aerospace," Dr. Getting said. "We must exercise the greatest care not to damage the Minuteman and other missile programs."

Aerospace Corp., whose formation was announced two months ago to serve as technical and systems consultants to the Air Force, now has about 100 scientists and a total of 600 to 700 personnel.

Closed-Circuit TV Used to Teach Polaris Submarine Crew Members

Polaris submarine crews are not going down to the sea until they take a course, via closed-circuit TV, on how to operate fire-control and guidance equipment.

The course is being given at the General Electric Ordnance Department's Pittsfield, Mass., plant. The company explained the need for televising the course. "Tight production schedules prevent taking components and subsystems from the production lines for classroom use. Conducting classes in the work areas is unsatisfactory because of the numerous surrounding distractions and the fact that all trainees cannot get an equally good view of what they must see.

"With closed-circuit television the trainees get close observation of hardware without distraction and without disrupting production."

Data Transmitted Three Ways With New Flexible Phone System

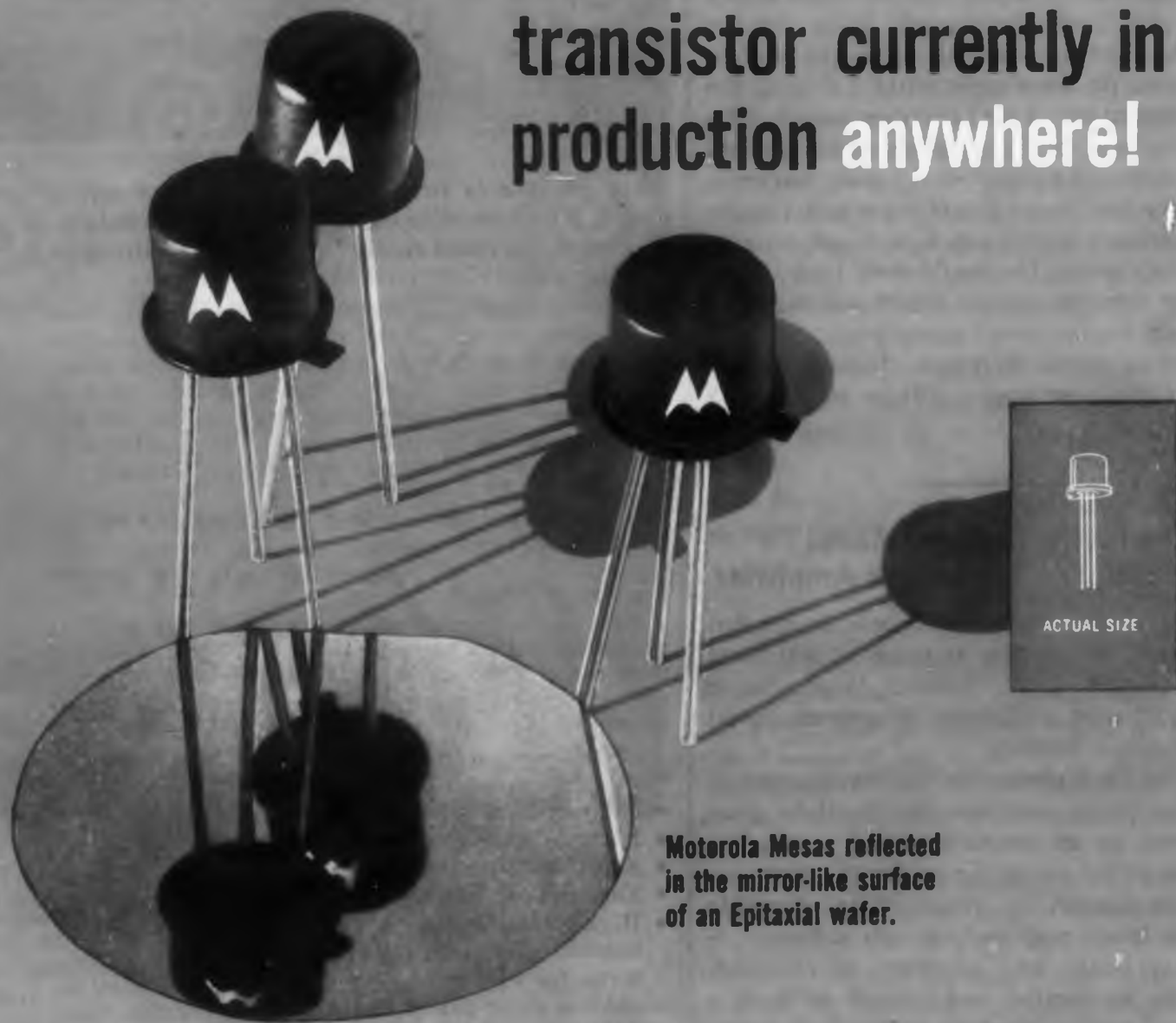
The flexibility of a new electronic system permits it to read or write data via punched-paper tape, punched cards or magnetic tape. The system, developed by the Digitronics Corp. of Albertson, N.Y., transmits data over the regular telephone network at a speed of 1,500 wpm.

The new development, called the Dial-o-verter

NOW IN PRODUCTION!

MOTOROLA EPITAXIAL MESA TRANSISTORS

the first "universal" transistor
for both switching and amplifier
applications... vastly superior to any
transistor currently in
production anywhere!

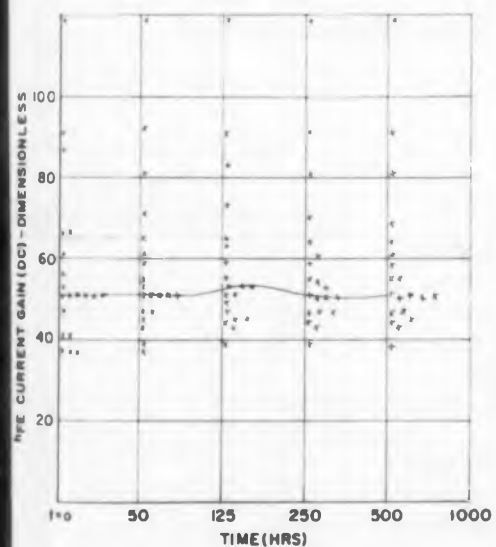
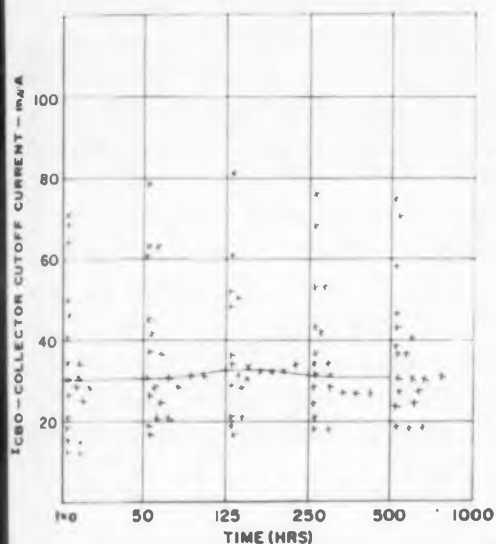


Motorola Mesas reflected
in the mirror-like surface
of an Epitaxial wafer.

NEW SILICON EPITAXIAL MESA MOTOROLA 2N834

...OFFERING SUPERIOR SWITCHING AND AMPLIFIER CHARACTERISTICS

RELIABILITY LIFE TEST DATA



SILICON EPITAXIAL MOTOROLA 2N834

CONDITIONS OF TEST:
300° Centigrade Storage

INITIAL LIMITS:
 $h_{FE} \geq 25$ at $V_{CE} = 1V, I_C = 10mA$
 $I_{CBO} < .5 \mu A$ dc at $V_{CB} = 30V$

NUMBER OF UNITS: 20

These new Motorola Epitaxial Mesa Transistors combine the *high reliability, high power dissipation and switching speed* of the Mesa structure with the *low saturation* of the high-frequency alloy types. This results in a superior switch and a superior amplifying device.

As a switching transistor, the 2N834's lower storage time, lower saturation resistance, and lower collector capacitance helps reduce propagation delay in computer circuits. The high collector-base voltage and the resultant high collector-emitter voltage assures elimination of "latch-ups."

In amplifier circuitry, the 2N834 is capable of delivering much higher power output at higher levels of efficiency. Since they represent practically no series resistance in the circuit, there is considerably less power loss in the collector.

- LOWER STORAGE TIME CONSTANT - 20 nsec
($I_C = I_B = I_{B2} = 10 \text{ mAdc}$)
- LOWER SATURATION VOLTAGE
($I_C = 10 \text{ mAdc}; I_B = 1 \text{ mAdc}$) - 0.14 volts dc
($I_C = 50 \text{ mAdc}; I_B = 5 \text{ mAdc}$) - 0.28 volts dc
- HIGHER POWER OUTPUT - 1/2 watt
($P_{TX} = 40 \text{ mW}; f = 70 \text{ mc}; G_v = 10 \text{ db gain}$)
- HIGHER BREAKDOWN VOLTAGE - $BV_{CEO} = 90$ volts dc
($I_E = 0; I_C = 100 \mu A$ dc)
- HIGHER CURRENT GAIN-BANDWIDTH PRODUCT - 500 mc
($V_{CE} = 20 \text{ Vdc}; I_C = 10 \text{ mA}$)
- LOWER COLLECTOR CAPACITANCE - 2.0 pf
($I_E = 0; V_{CB} = 20 \text{ Vdc}$)

WHY THE MOTOROLA EPITAXIAL PROCESS GIVES THESE OUTSTANDING DESIGN ADVANTAGES

Motorola's highly refined epitaxial processing technique results in an extremely thin high resistivity layer (about 0.1 mil) between the collector and base regions. Increased performance is thus gained in all device parameters with large reductions in both switching time and collector resistance.

The new process is ideal for Motorola's highly automated Mesa production facility. Only one additional step was necessary to achieve volume production of these devices.

FOR TECHNICAL DATA, prices and delivery information on Motorola Epitaxial Mesa Transistors and the address of your district office, write to Dept. EMT, 5005 E. McDowell Road, Phoenix, Arizona.



MOTOROLA
Semiconductor Products Inc.

A SUBSIDIARY OF MOTOROLA INC.

5005 EAST McDOWELL ROAD, PHOENIX, ARIZONA

CIRCLE 40 ON READER-SERVICE CARD

System, was created to function with the Bell System Data-Phone 200. It can transmit data in one medium at one point, and have it received in another medium at the other point. A plant can send paper tape, and have it produced either as cards or magnetic tape at the magnetic center, or vice versa.

Currently, data may be transmitted over private telephone or telegraph lines at a speed of six to 10 characters per second. According to the company, the Dial-o-verter operates via Data-Phone at a speed of 150 characters per sec.

OEMI-Sponsored Program Seeks Computer 'Common Language'

Two broad programs for the international standardization of data-processing machines and office machines are underway, reports the Office Equipment Manufacturers Institute.

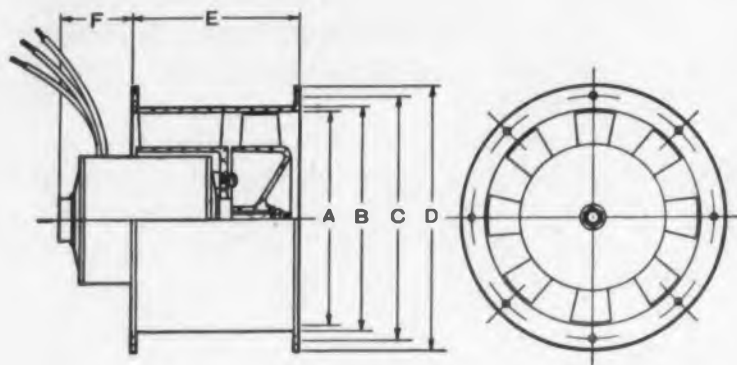
The efforts of the data-processing program will result in logical systems standards, including a common language, which will enable users of electronic data-processing equipment to interchange information and programs among computers. At present, data-processing programs are designed for the equipment of individual manufacturers and must be converted for use in any other manufacturer's product.

Both programs will be sponsored by the Institute and organized under the procedures of the American Standards Association.

\$1 Million NSF Grant Purchases High-Voltage Tandem Accelerator

A 12-million electron-volt tandem accelerator for use in low-energy nuclear physics research will be installed at the University of Pennsylvania. The National Science Foundation has awarded a grant of \$1 million to the university for the purchase of the equipment. The ion accelerator, commonly known as an "atom smasher," will also be available to research workers from neighboring institutions.

According to Dr. W. E. Stephens, professor of physics at the university, who will be in charge of the new facility, ion accelerators have proved to be exceptionally useful in investigating the properties of the atom's nucleus. Research work in this area, he pointed out, is concerned primarily with the investigation of the arrangement of nuclear particles within the nucleus and with the nature of the forces giving rise to this nuclear structure.



Model X702-402

A Complete New Line of Electronic Cooling Fans JOY Axivane Series 60

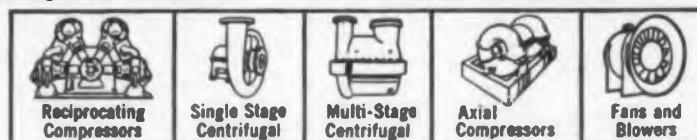
Developed by Joy specifically for 60 cycle commercial duty, the Series 60 vaneaxial fans operate at 3400 rpm, 115 volts, single phase, 50/60 cycles and produce from 50 to 500 cfm at static pressures of $\frac{1}{4}$ " through 1" wg. They are extremely compact and ruggedly built

of anodized aluminum. There are only three major parts; rotor, housing and motor. Production quantities are available on order and small quantities are immediately available off-the-shelf. Get complete information by writing for bulletin 2518-57

Model No.	Design CFM $\pm 3\%$	Max. CFM at Free Flow	Design PS $\pm 7\%$	Max. Pressure	Motor Data		Mechanical Dimensions (Inches)						Holes Per Flange	Total Weight Pounds
					BHP	CAP* MFD	A	B	C	D	E	F		
X702-401	50	70	0.35	0.45	.005	NONE	4.37	4.62	5.25	5.87	4.50	1.00	4	5.25
X702-402	100	145	0.35	0.60	.010	NONE	5.12	5.37	6.00	6.62	4.50	1.00	4	5.85
X702-403	150	205	0.35	0.80	.015	NONE	5.62	5.87	6.50	7.12	4.50	1.00	4	6.1
X702-404	200	265	0.50	0.79	.035	5	5.62	5.87	6.50	7.12	5.00	1.66	8	7.2
X702-405	250	330	0.50	0.82	.043	5	5.87	6.12	6.75	7.37	5.00	1.66	8	7.4
X702-406	300	410	0.50	0.93	.052	5	6.12	6.37	7.00	7.62	5.00	1.66	8	7.6
X702-407	350	490	0.50	0.95	.060	5	6.37	6.62	7.25	7.87	5.00	2.16	8	8.4
X702-408	400	590	0.50	1.07	.068	5	6.62	6.87	7.50	8.12	5.00	2.16	8	8.6
X702-409	450	650	0.50	1.05	.075	5	6.87	7.12	7.75	8.37	5.00	2.16	8	8.8
X702-410	500	735	0.50	1.15	.083	5	7.12	7.37	8.00	8.62	5.00	2.16	8	8.9

*Rated 236 WVAC—

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



CIRCLE 41 ON READER-SERVICE CARD

JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company
(Canada) Limited, Galt, Ontario

NEWS

Shipments of U.S. Components Reach Another All-Time High

Shipments of electronic components by U. S. manufacturers reached another all-time high during the first quarter of 1960, according to the Electronics Div., Business and Defense Services Administration, U. S. Dept. of Commerce.

Output of electron tubes, semiconductor devices, and other major electronic components during the first three months of 1960 increased 8 per cent over the preceding six-month rate and more than 20 per cent over the first-half 1959 rate. The increase was not general. Shipments of quartz crystals, transformers, and transistors were up sharply, whereas output of TV picture tubes, which is generally subject to seasonal declines during the first quarter, and power and special purpose tubes declined slightly during the first quarter 1960.

The following table, which gives details by component category, was derived from the quarterly Survey of Production Capabilities for Electronic Parts. The data presented, however, represent estimated total industry shipments rather than total shipments reported in the survey since adjustments were necessary where the coverage was not complete.

Estimated U.S. Shipments of Tubes And Semiconductors January-March 1960

Category	Value in million of dollars (1)		
	Total	Military	Nonmilitary
Power and special purpose tubes . . .	62.5	40.2	22.3
Receiving tubes	95.2	14.6	80.6
TV picture tubes	61.9	(2)	61.9
Semiconductor devices	136.6	66.4	70.2
Capacitors	65.5	20.3	45.2
Complex Components	5.2	2.7	2.5
Connectors	43.1	28.4	14.7
Quartz Crystals	4.8	1.4	3.4
Relays	48.8	22.5	26.3
Resistors	61.2	27.6	33.6

(1) Estimated total industry shipments including intra-plant and inter-plant transfers.

(2) An insignificant quantity and value of shipments of TV picture tubes for military applications are combined with non-military shipments to avoid disclosure of proprietary information.

Source: The quarterly Joint Survey of Production Capabilities for Electronic Parts conducted by the Electronics Production Resources Agency of the Dept. of Defense, and the Electronics Div., BDSA.

RCA Data-Processing Center Operates Round-the-Clock

The Radio Corp. of America formally opened its Electronic Data-Processing Center in the Morton Salt Building, Chicago, Ill. Its facilities will be made available on a round-the-clock basis.

The Chicago center is built around the RCA 501 electronic data-processing system. A feature of the opening ceremony was a demonstration of what the RCA 501 can do in a typical problem facing a business firm or government agency.

Some 400 transactions were run through the system against an inventory of some 5,000 items. In five and one-half minutes, the electronic "brain" had printed out:

- A list of the day's transactions.
- Purchase requisitions for items needing replenishment.
- A list of stocks inactive for three months.
- The number of units and dollar value of the previous day's inventory and the same data on following day's transactions.

This procedure, completely updating the company's inventory, probably would have taken three employees a full eight-hour day to duplicate, according to RCA.

Eventually, RCA plans to link its network of data-processing centers by a new communications system known as DaSpan (for data-spanning) so that companies with offices in various cities could channel their data back and forth with ease and speed. Such an arrangement could permit a number of Midwest cities to be linked with the Chicago center.

Other RCA Data-Processing Centers are in operation in Washington, New York's financial district, and at Cherry Hill, N.J., in the Philadelphia-Camden area.

High-Speed British Serial Printer Operates at 1,000 Words per Minute

A high-speed serial printer, designed to operate at 1,000 words per minute—10 times the speed of the fastest teleprinter—has been developed in Britain for use with electronic computers. It will be shown for the first time at the Business Efficiency Exhibition at London's Olympia by its designers, Creed & Co., Ltd.

The company will also exhibit what it claims is the world's fastest tape punch. The machine records 5-, 6-, or 8-track punched paper tape at a speed of 3,000 words per min. This is reportedly 10 times faster than output punches generally in service and 45 times faster than the standard teleprinter tape punches.

PRD *previews/reviews/design notes*

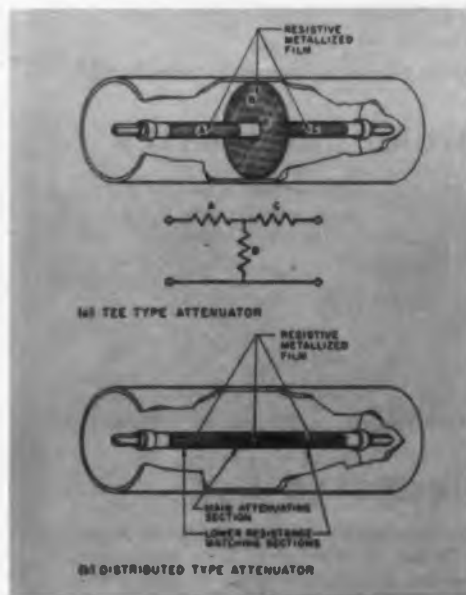
Design Considerations of Attenuators

The end use of an attenuator—whether as a standard in power or attenuation measurements, a power or signal level adjuster, an isolator or buffer pad—will, of course, bear on its design. But certain design and construction needs also remain constant. Here are some of the considerations that go into a PRD attenuator.

Attenuating Elements

We have found that metallized glass or ceramic generally make the best resistive elements. They are smooth, chemically inert, non-hygroscopic, and will not warp or change shape. We apply an extremely thin metal film to the element in two ways: by "paint" coating and baking, and by high vacuum deposition. The baked-on film method proves best for coaxial attenuators, and the vacuum deposition preferable for waveguide.

Fixed Coaxial Attenuators



PRD 1100

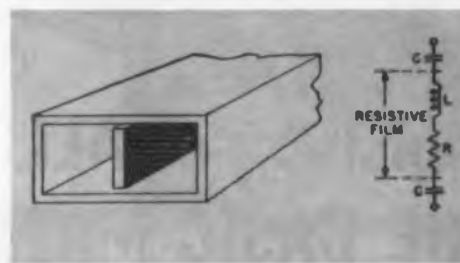


PRD 130

The two basic types of coaxial attenuators produced by PRD are shown above, in schematic drawing and photo-

graphs. The first, represented by the PRD 1100, uses one or more T sections with lumped resistive elements. The distributed type, illustrated by the PRD 130, uses an inner conductor of an electrically long resistive film. The T section PRD 1100 operates best at low frequencies, from dc to 4 KMC; the PRD 130 ranges from 2 to 10 KMC. Both dissipate one watt and are calibrated to ± 0.2 db accuracy. The PRD 130 can attenuate up to 20 db; PRD 1100 up to 10 db.

Waveguide Attenuators



The drawing above gives a schematic presentation, with equivalent circuit, of a resistive film parallel to the electric lines in a waveguide. Attenuation is varied by moving the metal-coated glass panel in two usual ways: (1) by lower-

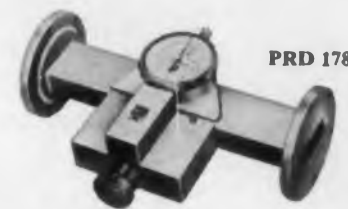


PRD 153-B

ing it into the waveguide through a slot, as in the PRD 153-B, known as a "flap" type (Freq. range 18.0 to 26.5 KMC; Attenuation to 35 db; Max. VSWR 1.10; Max. insertion loss 0.5 db; Calibration accuracy ± 0.2); or (2) by moving the lossy element from the side wall toward the center of the waveguide

CIRCLE 42 ON READER-SERVICE CARD

...known as the "vane" technique, and illustrated by PRD 178-B (Freq. range 5.4 to 7.2 KMC; Attenuation to 45 db; Max. VSWR 1.15; Max. insertion loss 0.5 db; Accuracy to ± 0.2).



PRD 178

Another version of the vane method of attenuation is exemplified by our level set attenuators, such as the PRD 171-B (Freq. range 2.6 to 3.95 KMC; Max. attenuation to 40 db; Max. VSWR 1.15).



PRD 171-B

These are only a few of more than one hundred attenuators produced by PRD and a brief review of the broad design principles involved. For more specifications on these and other units, write for the PRD Attenuator brochure. For design information, write our Applications Engineering Department.

We have many interesting openings for engineers...contact Mr. John R. Zabka

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ELECTRONICS, INC.
A Subsidiary of Harris-Intertype Corporation
Formerly, Polytechnic Research & Development Co., Inc.

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CORPORATION

LINDE 99.9% Pure ALUMINA ABRASIVES

'BULOVA' WATCH PINIONS (sample shown magnified 100x) now have important surfaces polished to a high precision finish with LINDE alumina abrasives. Actual size is at right →



Permit Critical Finishing of ALL Modern Metals with ONE BASIC MATERIAL

No longer need the minuteness of a metal part, or its shape, or its type of metal interfere with the quality of its finish.

All-new LINDE abrasive powders—of 99.9% pure alumina—now permit precision finishing and polishing, as well as sharpening and honing of many metal parts—with *one basic material*.

Depending upon usage, LINDE alumina powders can be used dry, mixed with water or other vehicles to make a thin slurry or heavy paste, or compounded with waxes in convenient stick form. They are uniform in size, thus eliminating levigation in finishing operations. And they are resistant to common acids.

Only two grades of these low-cost, fast-cutting, high-purity white powders are required: LINDE A (*alpha alumina*) for quicker cutting and an unsmear finish; LINDE B (*gamma alumina*) for somewhat slower cutting but an extremely fine finish.

For details on alumina abrasives as applied to your production problems, write Dept. ED-113, Linde Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, New York. In Canada: Union Carbide Canada Limited, Linde Gases Division, Toronto 12.

LINDE COMPANY

DIVISION OF UNION CARBIDE CORPORATION

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PHYSICAL PROPERTIES

	Type A-5175	Type B-5125
Chemical Formula	Al ₂ O ₃ (Alpha)	Al ₂ O ₃ (Gamma)
Crystal System	Hexagonal	Cubic
Hardness, Mohs'	9	8
Particle Size approximate (microns)	0.3*	<0.1
Apparent Density (g/c.c.)	0.3-0.6	0.2-0.5
Melting Point	2050° C.	Transforms to Alpha form at high temperatures

*Type C-5250 also available in 1.0 microns (approximate) particle size.

SUGGESTED USES

CHEMICAL: Catalyst Carrier • **ELECTRONICS:** Semiconductor Polishing • **JEWELRY:** Gem Stone and Crystal Polishing; Silver Polishing • **LIGHTING:** Phosphor Preparation • **CERAMICS:** Pure Oxide Ceramics • **METAL FABRICATION:** Finishing of Metal Parts; Knife Sharpening; Microtome Knife Sharpening; Razor Blade Sharpening • **METALLURGY:** Metallographic Polishing • **OPTICAL:** Glass Polishing

UNION CARBIDE

NEWS

"Project Dew Drop" Provides Troposcatter Communications Link

"Project Dew Drop," a communications system, will provide a new link between Thule Air Force Base in Greenland and the Distant Early Warning (DEW) Line rearward communications system at Cape Dyer on Baffin Island.

Signals originating either at Thule or Cape Dyer will leap the intervening 700 miles by means of tropospheric forward scatter. In this system, radio waves are beamed from an antenna to the troposphere, where they are reflected back to earth and picked up by a second precisely positioned antenna.

The Thule-Dyer link is believed to be the longest tropospheric scatter hop in the world. The Dew Drop antennas measure 150-ft high and 120-ft wide.

The Air Force contract for operation and maintenance of the Thule installation has been awarded to Federal Electric Corp., service organization of International Telephone and Telegraph Corp. of Clifton, N. J., by Rome Air Material Area, Griffis Air Force Base, Rome, N.Y.

NASA-DOD Coordinating Board Is Established for Space Programs

The National Aeronautics and Space Administration and Department of Defense have established a joint board for continuing coordination of the nation's aeronautics and space programs. Members of the board are top management personnel.

The agreement establishing the Aeronautics and Astronautics Coordinating Board provides that it will review planning to avoid duplication; coordinate activities of common interest; identify problems requiring solution by either NASA or DOD and insure a steady exchange of information.

The Director of Defense Research and Engineering and the Deputy Administrator of NASA will serve as co-chairmen. These positions are now held by Dr. H. F. York and Dr. H. L. Dryden, respectively.

Organization of the board includes a number of panels. These panels will identify and study problems related to space and aeronautics programs and make recommendations to the board for their solution. Panel chairmen are members of the board.

Accurate Data on Echo Satellite Provided by New Digital System

A highly accurate angle-measuring system is reported aiding scientists in pinpointing the position of Echo I, the nation's first communications satellite.

The system, developed by Datex Corp. of Monrovia, Calif., for NASA's Jet Propulsion Laboratory, is installed at the NASA-JPL facility in the Mojave Desert. The system automatically records and displays the satellite's coordinates in space as the 100-ft sphere speeds around the earth. The system also provides data for direct input into a high-speed digital computer.

According to the company, the high accuracy of the Datex data system is achieved by using a multipole computing resolver on each axis of the tracking antenna. A servo follow-up unit at the base of the antenna, utilizing a single-pole computing resolver, multiplies the antenna rotation by 90 to provide decimal data for recording and display. Multiplication by 128 is also performed to provide straight binary input to the digital computer.

The heart of the system consists of a pair of encoders for each axis of the tracking antenna. One of these is a decimal encoder that digitizes the antenna's angular position to one part in 180,000, or every 0.002 deg. The other is a binary encoder that digitizes the antenna position to one part in 262,144, or every 0.0014 deg. A time signal from a 100-kc digital clock is recorded together with the data.

Anechoic Chamber for Space Tests



This unusually shaped anechoic 40-ft chamber will help engineers at Republic Aviation investigate antenna performance in advanced aircraft and spacecraft without external interference from radio waves. Radio signals will be beamed at scale models of space vehicles and antennas while they are remotely rotated. An automatic antenna-pattern-measuring system, operating in the 200-50,000-mc range, will record results.

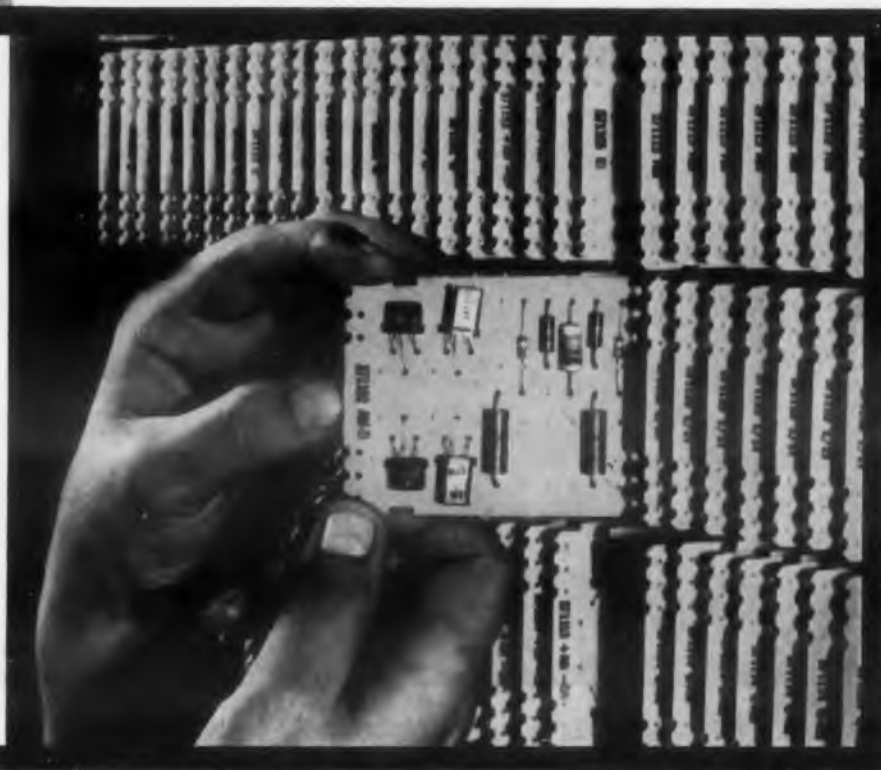


Textolite®/reliability

GE Textolite®

COPPER CLAD LAMINATES

Engineered cleanliness insures surface reliability for use in computer and military printed circuitry



G-E Textolite Copper-Clad Laminates are designed to meet or surpass stringent computer and military requirements. To do this, and assure superior performance with maximum circuit reliability and minimum rejects, *engineered cleanliness* is maintained in the entire production process.

All G-E Textolite Copper-Clad Laminates are produced in the sterile atmosphere of the room pictured at left. Washed, filtered, conditioned air eliminates dust and dirt. Special cleaning techniques for copper and press pans assure a smooth continuous surface. Pits, dents, pinholes and scratches are virtually eliminated. And the G-E engineered cleaning process just before inspection completes the job.

Try these outstanding General Electric Textolite grades:

- #11574—NEMA FR3—Self extinguishing epoxy paper
- #11571—NEMA XXXPC—Highest IR phenolic paper
- #11559—NEMA G-11—Self extinguishing epoxy glass
- #11558—NEMA G-10—Best machining epoxy glass

Write for samples to: Laminated Products Department, Section 60-4 General Electric Company, Coshoc-ton, Ohio. Dept. ED-110.



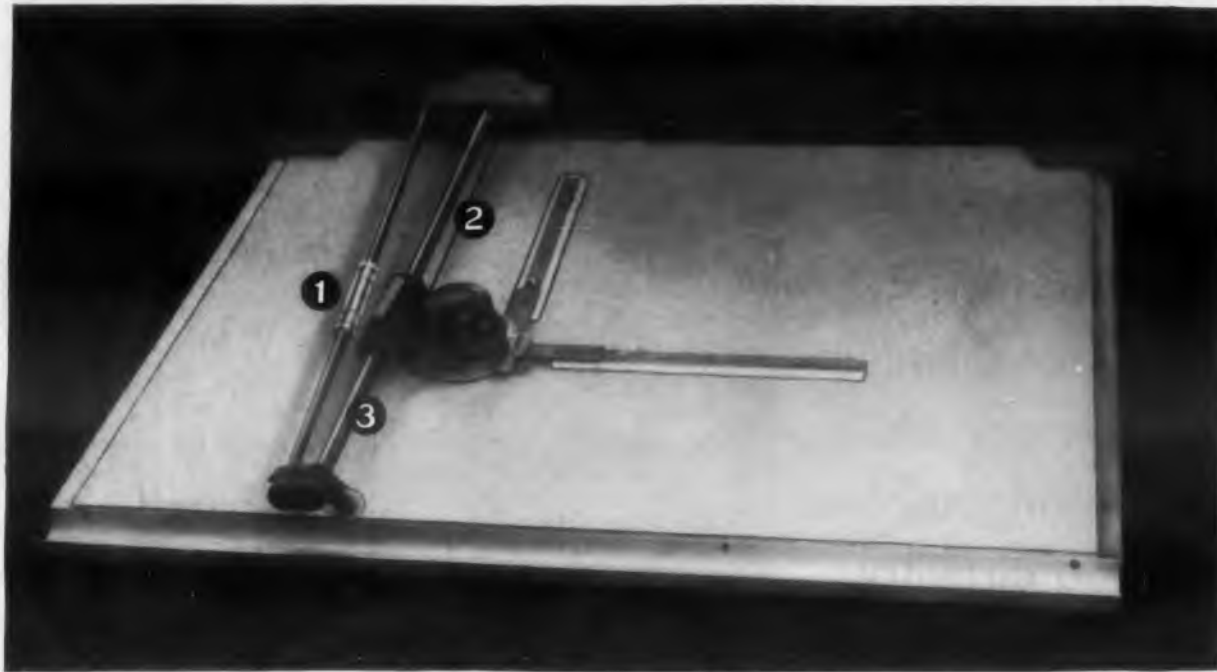
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GENERAL ELECTRIC
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Makes even the best draftsmen better

PARAGON

Auto-Flow[®]

DRAFTING MACHINE



3 Ways Better

- 1 Horizontal positioning lock now centrally located to permit locking or releasing while seated.
- 2 Improved cable attachment and increased cable strength provide maximum protection against breakdown, cable-snapping, and the wear and tear of constant use.
- 3 Larger diameter vertical rail and attendant structural improvements afford increased rigidity for sharper, surer work.



KEUFFEL & ESSER CO., Dept. ED 11, Hoboken, N. J.

- Please send information on the new K&E Paragon Auto-Flow[®] Drafting Machine.
 Please arrange a demonstration for me.

Name & Title _____

Company & Address _____

2048 R

CIRCLE 45 ON READER-SERVICE CARD

NEWS

Real-Time Tracking System To Be Studied by Radiation, Inc.

A new real-time missile tracking system to be known as SORTI (Star-Oriented Real-Time Tracking Instrument), will combine the high accuracy of the Ballistic Camera System with a Position Tracking System.

Subject of a Radiation, Inc. study contract for the Air Force Missile Test Center, this combination will provide immediate accurate information, during flight, about a missile's path. Instantaneous data on missile trajectories could enable immediate analysis and possible in-flight corrections.

The real-time position tracking system will use star positions for orientation reference. Incorporating electronic circuitry, SORTI will provide a method to overcome present handicaps in missile-trajectory tracking. Present real-time systems do not have the high accuracy of the Ballistic Camera System, whereas the camera system, which supplies information in photographic form, cannot present trajectory data as the flight is occurring.

Protective Relay by Coaxial Cable Said to Provide Many Advantages

Using coaxial cable for protective relaying "fills a gap in previous methods," according to a paper presented to the AIEE at its Fall General Meeting.

Coaxial cable can be used for other power-systems communications needs as well, including "interstation controlling, signalling, and dispatching functions," reported J. R. Linders, Cleveland Electric Illuminating Co., in a paper entitled, "Coaxial Cable For Protective Relaying Communications."

"With coaxial cable," he said, "the simple and straight-forward installation details eliminate the problem of elevated station ground potentials associated with conventional wire pilot circuits." Coaxial cable can be used "to piece out a microwave link, thus reducing limitations frequently associated with microwave terminal locations."

Mr. Linders warned, however, that "further experience is necessary to demonstrate that there are no unforeseen hazards when the coaxial cable is routed overhead, particularly when closely coupled to magnetic fields of the transmission circuit which it is protecting."

CIRCLE 46 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960

Japanese Electronic Exports To U. S. Continue To Rise

Japanese exports of electronic products to the United States in the first six months of 1960 totaled \$38.7 million compared with \$22.1 million during the same period last year, reports the Electronics Div. of the Business and Defense Services Administration, Dept. of Commerce.

In the April-June quarter this year, the export total—\$22.8 million—was \$1 million in excess of shipments to the U. S. for the entire year 1958. The 1959 exports were \$75.6 million.

During January-June, 1960, exports of radio receivers accounted for 77 per cent of all Japanese exports of electronic products to the U. S. and registered a gain over the corresponding period of 1959 of 69 per cent.

The following table shows Japanese exports of electronic products to the United States during the years 1958 and 1959 and during January-June 1960:

Japanese Exports of Electronic Products to the U. S.

January 1958-June 1960

Product	Value in thousands of dollars (1)		
	1958 Year	1959 Year	1960 Jan.-June
TOTAL	21,775	75,642	38,709
Radio receivers,			
total	17,904	62,373	29,796
Tube type	n.s.s.	2,552	1,938
With 3 or more			
transistors ...	n.s.s.	57,272	25,440
Other	n.s.s.	2,549	2,418
Radio-phonographs	59	547	286
Recorders, repro-			
ducers	449	1,617	1,429
Amplifiers	(2)	460	237
Microphones	177	321	204
Speakers	420	1,155	1,033
Condensers	288	533	480
Earphones	(2)	619	248
Tubes, total	314	2,088	1,839
Receiving	n.s.s.	2,034	1,833
Other	n.s.s.	54	6
Transistors	7	1,581	631
Other S. S. devices	(2)	92	9
Phonograph parts .	757	824	457
Other electronic			
products	1,400	3,432	2,060

(1) Converted to U.S. dollar equivalents at the rate of 360 yen=U. S. \$1.00.

(2) Not reported separately prior to 1959; value included in "Other electronic products."

n.s.s. Not shown separately.

Sources: Data obtained by the U.S. Embassy, Tokyo, from the Japanese Ministry of International Trade and Industry.

CIRCLE 46 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960

COMPUTERS 1961

SPECIAL JANUARY ISSUE

Proceedings of the IRE

Electronic computers are the "time machines" of today — they bring to man the precious gift of time. They think, relate, evaluate and solve fantastic problems in millionths of a second. Each operation they perform releases you, the radio-electronics engineer, the mathematician, the physicist, the chemist — for work that calls for the human mind and heart.

Obviously, you should know about computers. Computers, today, are more compact, more complex, and about 50,000 times faster than those made just a few years ago. Progress such as this means constant and dramatic changes. It would take precious hours each day to keep abreast of all developments.

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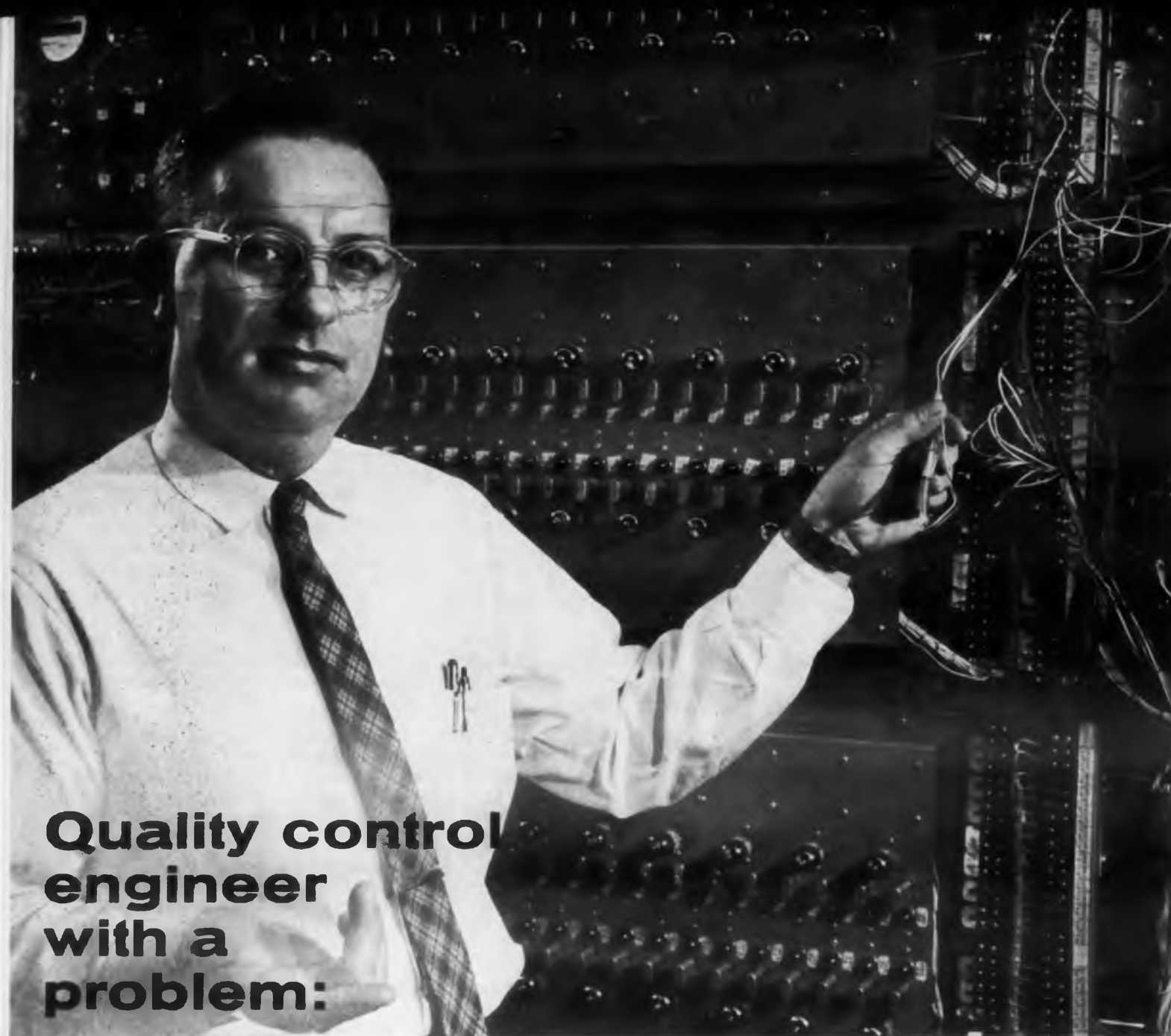
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**Quality control
engineer
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problem:**

"I can't test every relay!"

You shouldn't have to! Besides, quality can't be "tested into" relays—it has to be built in at every step of the production cycle. At General Electric it is.

Not simply individual tests for shock, vibration, etc., but *complete* quality control is what gives General Electric relays exceptional reliability.

Quality control begins with stringent material tolerances General Electric demands of its vendors, monitored by frequent appraisals on everything from tool calibration to their reporting procedures, and checked by G.E.'s careful processing of incoming materials. Result: less than 1% of incoming material must be rejected.

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- Of average relay manufacturing time, General Electric spends 30% in planned quality checks—much more for specials.
- More than 25% of total factory floor space is used to test relays.
- Advanced equipment and techniques are used, including the unitized testing console. This automatic, on-line testing center eliminates human error from production acceptance tests, eliminating another variable of relay reliability.

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For information on our special customer-requested testing program, or more on quality control, see your G-E Sales Engineer. General Electric Co., Specialty Control Dept., Waynesboro, Va.

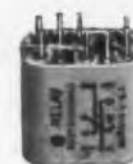
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General Electric sealed relays for the '60's



MICRO-MINIATURE

Small and light for military use, the General Electric Micro-miniature's dual-coil construction provides a highly efficient magnetic circuit, requiring minimum operating power. A balanced armature combined with extremely high tip forces gives the relay exceptional resistance to shock and vibration. It is available in current-calibrated and voltage-calibrated forms, SPDT or DPDT. Other specifications:

Operating Sensitivity: 200 milliwatts; 300 milliwatts.

Vibration: 20 G's, 55-2000 cps (except for certain mounting forms).

Shock: 50 G's per MIL-R-5757C.

Ambient Temperature: -65C to +125C.

Operating Time: (25C) 6 milliseconds maximum.

Release Time: 5 milliseconds maximum.

Contact Rating: 2 amps resistive at 28 VDC or 115 VAC.

Life: 100,000 operations minimum at rated load.

Dielectric Strength: 1000 V rms except 700 V across terminals.

Insulation Resistance: 1000 megohms minimum.

Contact Resistance: .05 ohms maximum at rated load.



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



4-POLE MICRO-MINIATURE: Welded construction, exceptionally long life. Rated 2 amps at 28 VDC, or 115 VAC resistive; requires only 10 milliwatts per pole.



GRID-SPACED MICRO-MINIATURE: Long-life crystal-can type, rated 3 amps at 28 VDC, operating sensitivity 300 mw; 16 mounting for ms; 30 G's vibration to 2000 cps.

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ELECTRONIC DESIGN • November 23, 1960

EDITORIAL

The Many Faces of Microwaves

No one can deny that microwaves have been enormously useful to the system and equipment designer in the fields of detection, reconnaissance, fire control, and communications. We suspect, however, that many designers working in other problem areas are handicapped by a failure to recognize the versatility of the microwave approach to problems.

ELECTRONIC DESIGN feels that the microwave technique is, in fact, a tool to be used in electronic devices that can solve problems for all areas of the economy.

For the meteorologist, the barometer and thermometer were obviously the closest things to a crystal ball. For the astronomer, what could surpass the telescope in studying the planets and the stars? The time has come when microwaves not only allow them to "see" farther in time and space, but is playing an important role in raising these sciences out of the "spectator-sport" class.

Similarly, it is understandably difficult for the microwave engineer, steeped in radar lore, to feel comfortable with the task of squeezing 100,000 telephone messages through a 5/8-in. pipe, or with the task of delivering a megawatt of sheer power with no conductor at all. And it taxes the vision of the communication-link veteran to see that microwaves not only can measure plasma at sun-temperature for the atomic scientist, but can actually generate these temperatures for the missile designer and the metallurgist.

It can be profitable for engineers on both sides of this system-technology interface to consider two questions:

- Is my current application really outside the area of competence for microwaves?
- Can I design a different microwave device to adapt this useful form of energy to the radically different problem?

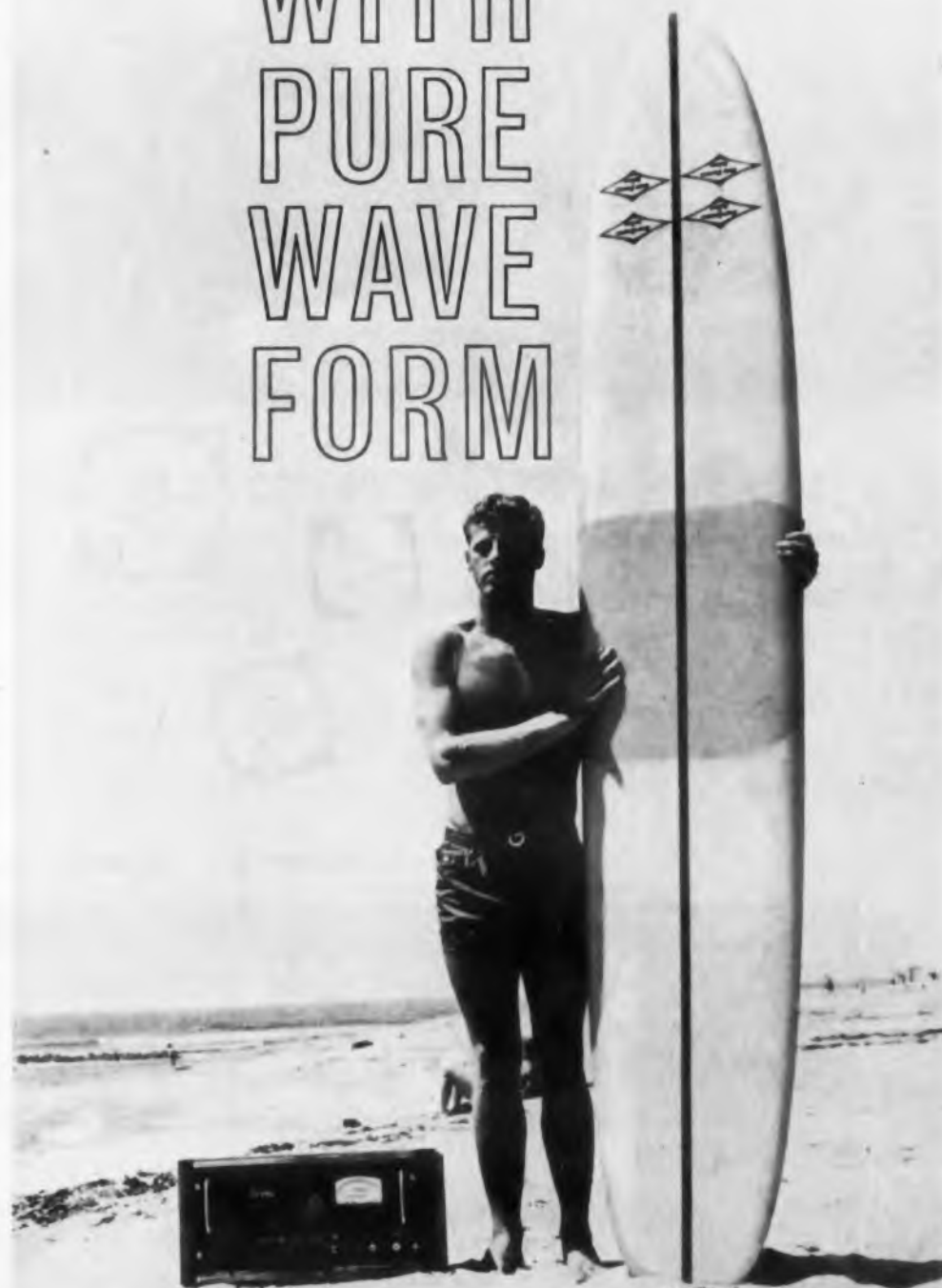
To answer such questions, a MICROWAVES section instituted with the Staff Report beginning on p 161 in this issue, henceforth will be a feature of every second issue of ELECTRONIC DESIGN.

To a large extent, the future for microwaves depends on the design engineer's ability to think of microwave energy and its properties independent of traditional applications. To meet radically new requirements, moreover, the microwave device designer must learn to shift emphasis to new parameters as needed.

As microwaves put on many faces, the microwave engineer must learn to wear many hats.

Robert N. DeFloria

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For those "at sea" about AC power sources, Behlman will send a free copy of its new guide, "AC Power Supplies."

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CIRCLE 94 ON READER-SERVICE CARD

Cascaded Transistors With Negative Feedback Make Ideal Amplifier Building-Blocks

There's nothing new about cascaded transistors, or about negative feedback. Using both, however, gives a configuration that is independent of both transistor parameters and load impedance. Delbert Johnson describes here how such configurations are reduced to four basic forms, and how to apply the forms.

Delbert L. Johnson*

Daystrom, Inc.
LaJolla, Calif.

A PAIR of cascaded transistors with negative feedback makes an ideal building-block for high-gain amplifiers. The feedback makes the gain virtually independent of transistor parameters, and can be chosen to make the gain also independent of the load.

The use of negative feedback makes a high-forward transmission gain necessary. This is the reason why more than one transistor are used. Three cascaded transistors also are useful, but a pair generally is sufficient for most design problems encountered.

For a circuit with high forward transmission gain and a feedback factor β ,

$$E_o/E_{in} = 1/\beta$$

or, the gain of the circuit is independent of the forward transmission path, in this case, the cascaded transistors.

Consider the amplifier building-block as an ideal source with an associated source impedance. If the load impedance were low, and the source impedance high, source output would be independent of the load.

If the load impedance were high and the source impedance low, the source output would again be independent of the load.

Feedback Changes Impedance Level

By properly choosing the feedback factor, one can adjust the output impedance of the cascaded

*Formerly with ITT Laboratories, Fort Wayne, Ind.

TABLE I—SUMMARY OF FEEDBACK-PAIR FORMS

DESIGNATION	DESCRIPTION	TRANSFER FUNCTION	TYPICAL CIRCUIT	FUNCTION
LIL	LOW IMPEDANCE INPUT LOW IMPEDANCE OUTPUT SIGNAL INVERSION	$\frac{E_o}{I_{in}} = -Z_m$		TRANSFER IMPEDANCE
LNH	LOW IMPEDANCE INPUT HIGH IMPEDANCE OUTPUT NO SIGNAL INVERSION	$\frac{I_o}{I_{in}} = \frac{Z_1}{Z_2}$		CURRENT AMPLIFIER
HNL	HIGH IMPEDANCE INPUT LOW IMPEDANCE OUTPUT NO SIGNAL INVERSION	$\frac{E_o}{E_{in}} = \frac{Z_1}{Z_2}$		VOLTAGE AMPLIFIER
HIH	HIGH IMPEDANCE INPUT HIGH IMPEDANCE OUTPUT SIGNAL INVERSION	$\frac{I_o}{E_{in}} = -Y_m$		TRANSFER ADMITTANCE

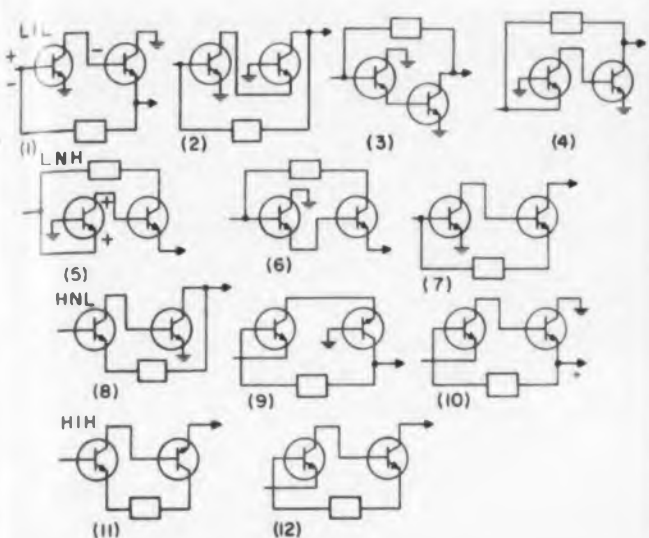


Fig. 1. Possible feedback-pair configurations. Configurations in each row are of the form designated at beginning of each row.

transistor pair so the signal output is independent of the load. This also applies to the input impedance, considered the load on a driver stage whose output impedance is known.

If only two impedance conditions (high and low) are allowed, only four amplifier configurations are possible: H to H, L to L, H to L, and L to H. That is, H to H denotes an amplifier having high input and output impedances and working between a low impedance source and a low impedance load. H to L works from a low impedance source into a high impedance load.

If one permits signals to enter only bases and emitters, and to leave only at emitters and collectors, specifying the input-output impedance lever also specifies whether the output is inverted with respect to the input.

Signal Inversion Determines Feedback Terminal

This knowledge is important if one is to use the building-block as a stage in a larger system. It also is important because it determines to what terminal of the first transistor the feedback voltage is to be brought.

To achieve negative feedback with a pair of cascaded transistors, the following design rules apply (keeping in mind conventions as to input and output terminals):

- If the feedback voltage is brought to the same terminal as the input signal, the feedback voltage must be inverted with respect to the input.

- If the feedback voltage is brought to a different terminal than the signal input, the feedback voltage must be in phase with the input.

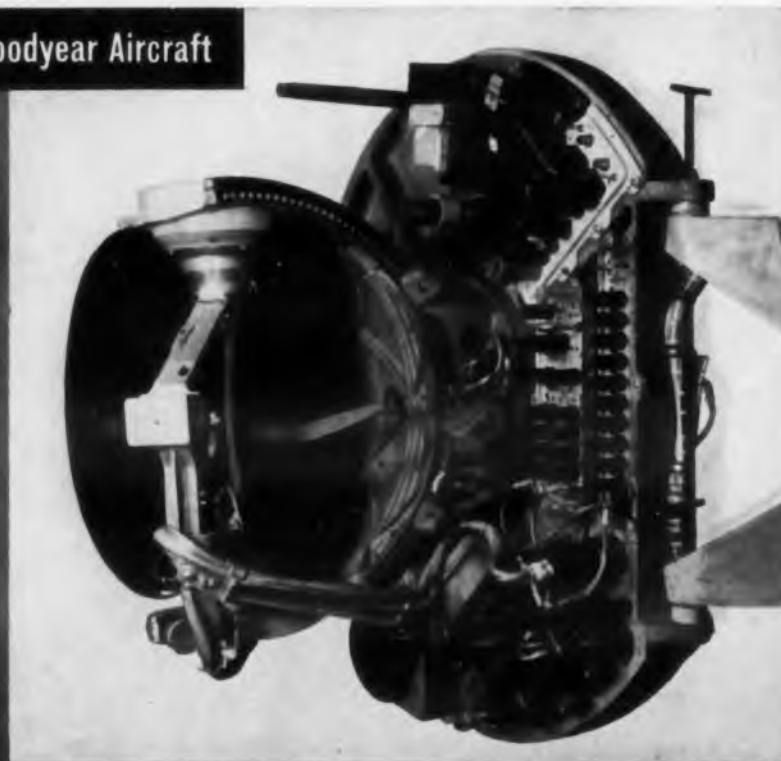
However, returning the feedback signal to the same terminal as the input signal lowers the effective input impedance of the amplifier; returning the feedback signal to a different terminal than the input signal, raises the effective input impedance.

(continued on p. 54)

AIRBORNE RADAR: another prime capability of Goodyear Aircraft



1. New surface-wave Luneberg lens concept for 1-inch-thick antenna provides 360° look in single sweep.



2. PINPOINT radar guidance system employs programmed data stored on film to guide missiles or aircraft to target.



3. Shaped beam reflector and line feed for high-altitude radar studies. System provides excellent pictures from 100,000 feet and higher.

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Feedback also alters the output impedance of the amplifier. Taking feedback from the same terminal as the output, lowers the output impedance. Taking feedback from a different terminal than output, raises output impedance.

Feedback, Signal Inversion Related

Thus, the level of input and output impedances determines whether the two-transistor amplifier with feedback inverts the input signal.

It has been found that amplifiers having high input and output impedances or low input and output impedances are inverting. Amplifiers having high input impedance and low output impedance (and vice versa) are noninverting.

The four amplifier designations (with respect to input and output impedances) are described in the accompanying table.

The possible configurations of cascaded transistors that meet these designations, are shown in Fig. 1.

For maximum gain stability, the amplifiers with low output impedance would work into high loads, and those with high output impedance into low loads. Also, the output impedance of the driver stage must be "opposite" that of the amplifier's input impedance.

Not All Realizable Circuits Useful

The circuits of Fig. 1 are all realizable, but not all equally useful. LHN-5 and LHN-6, for example, attempt to present a high output impedance at an emitter, and one would expect that reasonable feedback factors will not produce very high output impedance. Similarly, HNL-9 and HNL-10 attempt high input impedances at emitters.

The diagrams in Fig. 1 ignore all bias considerations. In general, bias resistors are chosen large enough so that virtually no signal current is shunted by them.

Bias resistors that incidentally provide dc feedback can be chosen to help stabilize operating points. The ac design of the feedback network often provides a dc path from output to input, and this can be used to advantage in stabilizing bias. The design provides a basis for selecting the impedance level for signal frequencies.

The circuits that exhibit a high input impedance often require a low-resistance bias path from the input terminal to ground. To realize the high input impedance, the bias path must be provided by the preceding stage, which should have a low-impedance output.

Cascading NPN to PNP Acceptable

In some instances, combining an npn and a pnp transistor results in a simplification of the bias design. The circuits of Fig. 1 are valid for any combination of npn and pnp transistors.

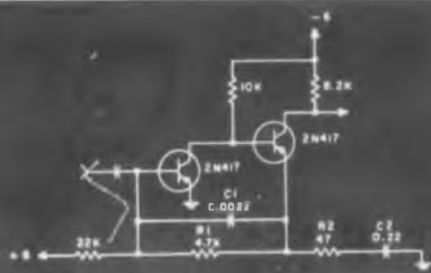


Fig. 2. An example of the feedback-pair configuration designated as LNH-7 in Fig. 1.

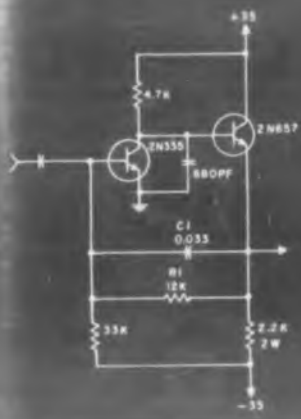


Fig. 3. An example of the feedback-pair configuration designated as LIL-1 in Fig. 1.

Fig. 2 is an example of circuit LNH-7. From the table,

$$\frac{I_o}{I_{in}} = \frac{R_1 \frac{1}{sC_1}}{R_1 + \frac{1}{sC_1}} = \frac{sR_1C_2}{(1 + sR_2C_2)(1 + sR_1C_1)}$$

If $R_2C_2 \geq 10 R_1C_1$, the midband gain would be,

$$\frac{I_o}{I_{in}} = \frac{sR_1C_2}{sR_2C_2} = \frac{R_1}{R_2}$$

In the case shown in Fig. 2, however, $R_1C_1 = R_2C_2$, so the maximum gain is down 6 db from the asymptote intersection at

$$f_1 = \frac{1}{2\pi R_1C_1}$$

The output impedance of the amplifier is paralleled by 8.2 K and is high enough so that the result is determined by the 8.2-K resistor alone. The input impedance is less than 300 ohms.

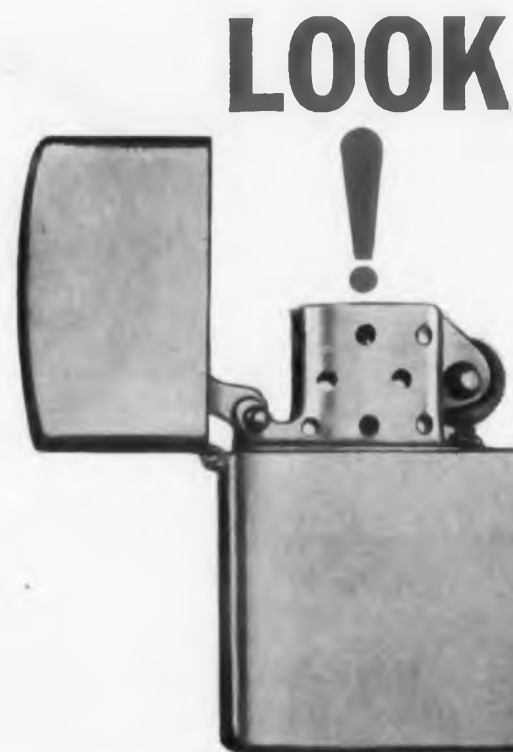
Fig. 3 shows a power amplifier using the LIL-1 configuration. From the table

$$\frac{E_o}{I_{in}} = -\frac{R_1 \frac{1}{sC_1}}{R_1 + \frac{1}{sC_1}} = -\frac{R_1}{1 + sR_1C_1}$$

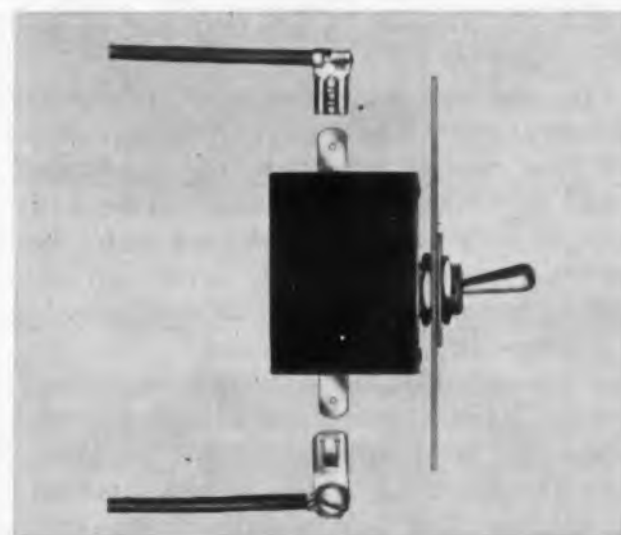
Feedback increases and gain decreases with frequency, and where the gain is flat, $sR_1C_1 \ll 1$, so

$$\frac{E_o}{I_{in}} = -R_1$$

(This circuit oscillates at high frequency if the 680-pf capacitor is removed. The capacity value was selected experimentally.) ■ ■



A NEW HYDRAULIC-MAGNETIC BREAKER NO BIGGER THAN A POCKET LIGHTER



Light . . . small . . . a snap to install! This 1½-ounce circuit breaker can help you out of a tight spot, if you're cramped for component space. Only 2½" x 5/8" x 2¼" overall, it can take the place of both a fuse and a switch—and save you installation time and trouble, in the bargain. A single half-inch hole is all you need for mounting, and there are only two connections to make, instead of four or more. (The breaker's "universal" terminals let you use the kind of connection best suited to the job, too—soldered, solderless, or screwed.) You can have this breaker in any integral or fractional current rating from 0.050 to 15 amps, at 110V, 60 or 400 cycles AC, or 50V DC. Whatever rating you spec will be decimal-point precise—and permanent (you don't have to de-rate the hydraulic-magnetic breaker for high ambient temperatures). Bulletin VP will give you more information. A word from you will put a copy in the mail.

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Test Equipment: Types and Characteristics

Part 3—Frequency Meters

In this third article of an ELECTRONIC DESIGN series, A. J. Reynolds, general manager of Technical Information Corp., describes frequency meters. His next article will deal with wattmeters.

A. J. Reynolds
Technical Information Corp.
New York, N. Y.

FREQUENCY shares with mass the distinction of being the quantity we are able to measure most accurately. Commercial equipment is available with claimed accuracy ranging from 5 per cent to 1 part in 10^9 .

More than for any other common measurement, it is necessary to select the right degree of accuracy for the job at hand. Generally, the greater the accuracy required in the answer, the greater the accuracy with which the "unknown" frequency must be known beforehand.

With many high-accuracy instruments it is possible, by reading them casually, to use them for work where full accuracy is not required. This certainly does not apply to frequency-measuring equipment.

A 1 per cent frequency meter is not necessarily a worse instrument than a 0.1 per cent frequency meter. One class of instrument, the absorption and grid dip meter, having accuracy in the 1 to 5 per cent range, is among the most useful instruments made. Long used by "hams" and engineers in the transmitter field, its great usefulness is achieving wider recognition.

The conventional high-accuracy frequency-measuring device—a master oscillator with multivibrators—has been replaced by the frequency counter for almost all but its primary function as a standard. This is due partly to the ease with which the counter type can be used by the non-technical person. Equally important is the ability of the counter, when associated with a

stable transfer oscillator, to function at frequencies up to the highest microwave region.

Some measurements, such as that of the carrier frequency of a pulsed transmission in the microwave region, can only be accomplished easily using the counter-transfer oscillator technique.

The frequency meters we have called Cross-over Counters, for want of a better name, are an interesting class of device. In their simplest form they consist of a transformer with a core having a so-called "square" hysteresis loop.

The input level is arranged so that the core is driven into saturation in both half cycles. The output is then a series of alternate-polarity, equal-amplitude, half-sine waves occurring at each polarity cross-over of the input sine wave.

Because the amplitude and shape of the output pulses depend on the transformer, while the number of pulses depend on the input frequency, rectifying the transformer output gives a current proportional to the number of either plus or minus pulses. The output meter is then simply calibrated in frequency.

Another technique is to amplify and clip the input sine wave, obtaining a rough square wave. This is then differentiated and the pulses so formed trigger a monostable multivibrator. The multivibrator ignores the negative going pulses, and provides one pulse of fixed amplitude and length for each positive going cross-over of the input wave (or per cycle).

The average dc current so produced may then be metered and calibrated in terms of frequency. This method, while essentially the same as the former, can be used at higher frequencies and is not limited by transformer characteristics. ■ ■

THE CHARACTERISTICS OF FREQUENCY METERS*

Bars indicating frequency range are divided into three sections. Solid lines indicate commercially available frequency range; broken lines indicate frequency coverage available on special order; dotted lines indicate that covering these frequencies would be too expensive and difficult for a practical instrument of the designated type.

Type	Frequency Range							Size Range	Price \$		Remarks
	100kc	1mc	10mc	100mc	1kmc	10kmc	100kmc		min	max	
Lumped Constant L & C ABSORPTION Sensitivity to 10's of μv .	Accuracy 0.1%—5% Commercial 1 part in 10^4 max							few in ³ to ft ³	Lo 10's	Lo 1000's	Most commercial instruments are low cost, low accuracy types.
Lumped Constant L & C GRID DRIP OSCILLATORS Normally used as source with passive circuits	Accuracy 0.1%—5% Commercial 1 part in 10^4 max							few in ³ to 1 ft ³	Lo 10's	Hi 100's	Many commercial instruments dual type — absorption & GDO.
Lumped Constant L & C HETERODYNE Sensitivity to μv .	Accuracy 0.01%—2 Commercial 1 part in 10^6 max							0.5 to 1 ft ³	Hi 10's	Hi 100's	Can be extremely accurate but the technique is expensive. The class is obsolescent in the higher accuracies.
CAVITY Sensitivity to μv .	Accuracy 0.1% Commercial 2 parts in 10^5 max							few in ³ to 0.5 ft ³	Hi 10's	Hi 100's	Lower frequency limit determined only by physical size and cost. Can be either absorption or transmission.
DIGITAL COUNTERS Sensitivity to mv.	Accuracy 0.1%—1 in 10^7 Commercial 1 part in 10^7 max							0.5 ft ³ to ft ³	Mid 100's	Mid 1000's	
TRANSFER OSCILLATORS (accessory to counter) Sensitivity to 10's of μv .	Accuracy 1 in 10^6 Commercial 1 part in 10^7 max							0.5 ft to 1 ft ³	Lo 100's	Lo 1000's	
MASTER OSCILLATOR plus interpolating system Sensitivity to μv .	Accuracy 3 in 10^4 —1 in 10^8 Commercial 2 in 10^{10} max 1 in 10^7 max							1 ft ³ to 3 Racks	Hi 100's	Mid 10,000's	Master Oscillator may be Crystal or Atomic Clock. Highest accuracy only to 10's of mc.
SYNTHESIZERS Provide output.	Accuracy 1 in 10^7 Commercial 1 part in 10^9 max							1 ft ³ to 3 Racks	Hi 100's	Mid 10,000's	High precision variable frequency generator.
FREQUENCY BRIDGE Sensitivity to mv.	Accuracy 0.1% Commercial 1 part in 10^4 max							0.5 to 1 ft ³	Mid 100's	Hi 100's	
CROSS-OVER COUNTERS Sensitivity to mv.	Accuracy 0.25%—2% Commercial 1 part in 10^4 ?							few in ³ to 0.5 ft ³	Mid 100's	Hi 100's	Higher accuracies to few kc only.
TUNED CIRCUIT Sensitivity to mv.	Accuracy 0.1cps Commercial 0.01cps max							few in ³ to 0.5	Hi 10's	Mid 100's	Tuned circuit may be L & C or mechanical, i.e., tuned reed. Used at power frequencies only.

*Technical Information Corp.

Encapsulating With Plastic Shells Simplifies Potting Process



Using plastic shells, instead of metal molds, for encapsulating electronic components can save time as well as money, according to author Milton Ross. Here, he points out where and how these savings can be realized.

Milton Ross
President,
The Milton Ross Co.
Haiboro, Pa.

ENCAPSULATING electronic components in plastic shells is easier, faster and less expensive than encapsulating in metal molds. Each time a new mold is needed it must be carefully designed and machined—an expensive investment. Plastic shells, however, can be purchased from a number of suppliers, ready for use, and in any quantity required. Further, their availability in a variety of shapes and sizes (Fig. 1), allows them to be used for a great many types of components requiring encapsulation.

Mold Encapsulation May Limit Production

The major disadvantage of encapsulating in a mold is the limitation it places on production. The number of molds available determines the number of units which can be encapsulated at any particular time. When a unit is encapsulated in a mold, it must be cured before it can be removed. Thus, to encapsulate 300 units in a four-hour period, it is necessary to have 300 molds. Before the molds are used again, they must be carefully cleaned and treated with a parting agent to assure removal of the casting from the cavity. The parting agents are applied to the mold by brushing, wiping, slushing, or spraying.

Molds also have a tendency to produce poor surface areas. Air trapped in the encapsulating material produces surface bubbles which deface the component. To correct this condition, molded components are often made oversize and machined or ground down after they are removed from the molds. Even when machining is not required, it is generally necessary to clean molded components before they can be used.

Storage of molds is also a problem. Because of the expense involved in machining, molds must be carefully stored and maintained for fu-

ture use. When a company encapsulates a variety of components, mold-storage considerations become major factors.

Plastic Shells Are Suited For High-Volume Production

For high-volume production, a faster, simpler technique is to encapsulate the components in plastic shells. With shells, no mold is required and as many components can be encapsulated at one time as desired. Since a mold is not used, the capital investment is less because the machining and maintenance costs are eliminated.

Plastic shells do not require any cleaning before or after encapsulation. As soon as the encapsulant cures, the components are ready to be used. The smooth outside plastic shell makes a neat, attractive package. Even if some small air bubbles do appear on the surface of the encapsulant, the shell covers them and the component is completely protected. In addition to having high moisture and chemical resistance, the plastic shells can withstand continuous operating temperatures as high as 450 F.

Encapsulated in plastic shells, components or circuit modules are mounted on plastic-to-metal seal (PMS) headers before they are encapsulated. A header is simply a plastic seal with metal pins permanently molded to it. Many of the different types of standard and special PMS headers are shown in Fig. 2. They are designed for printed-circuit sockets and direct mounting on printed-circuit boards. Mounted on PMS headers, components can be easily inserted into test sockets for a final check before the encapsulating material is added.

Shells are available in almost any color—a desirable feature for color-coding components. They can be molded with code numbers and trade names and made with riser feet to keep the shell off the printed-circuit board during soldering. The riser feet also permit air to circulate around the components and provide a longer

lead length for the soldering heat to travel before reaching them.

There are many techniques for filling the shell with encapsulant. The most convenient, especially for small manufacturers, is to use a precision pellet. Encapsulating material, which has been very carefully compounded, is purchased in the form of these small pellets.

The component to be encapsulated is placed inside a properly sized shell and a pellet is placed on top of the component. A matched quad diode package encapsulated with a pellet is shown in Fig. 3.

A tray full of units is prepared in this manner and then placed in an oven. Under heat, the pellet melts and completely encapsulates the component. In a period of two or three hours, depending on the type of pellet, the epoxy has flowed, encapsulated, and cured. The pellets are exactly the right size to encapsulate the component and fill the shell.

Most companies are not expert in mixing encapsulants and pellets provide them with material characteristics they can depend on. However, pellets can be made with a variety of electrical and adhesion properties.

The same material is also available in powdered form. Using the powder, a component can be either partially or completely encapsulated, depending on the amount of powder used.

In one application of powder, a company wanted to prevent a small toroidal-wound ferrite core from vibrating within the shell, but did not want to encapsulate the entire core. With the right amount of powder, engineers were able to encapsulate the core partially, protect the leads, and keep the core from vibrating.

For those who prefer to mix their own encapsulant, pressure guns can be used to fill the shells. The mixed epoxy is put into a polyethylene container in the gun and shot into the encapsulating shell.

For void-free encapsulation, the mixed epoxy

(continued on p. 60)

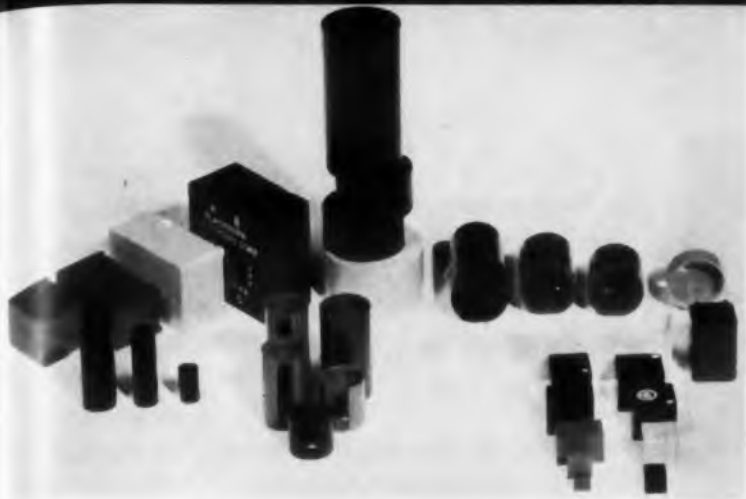


Fig. 1. A large variety of standard plastic shells are available for encapsulating electronic components.

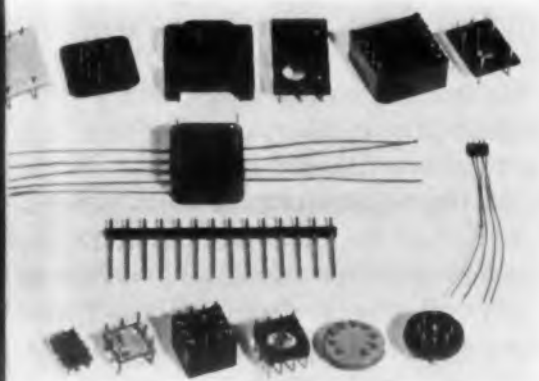


Fig. 2. There is also a large variety of headers available for mounting electronic components before encapsulation in the shells.

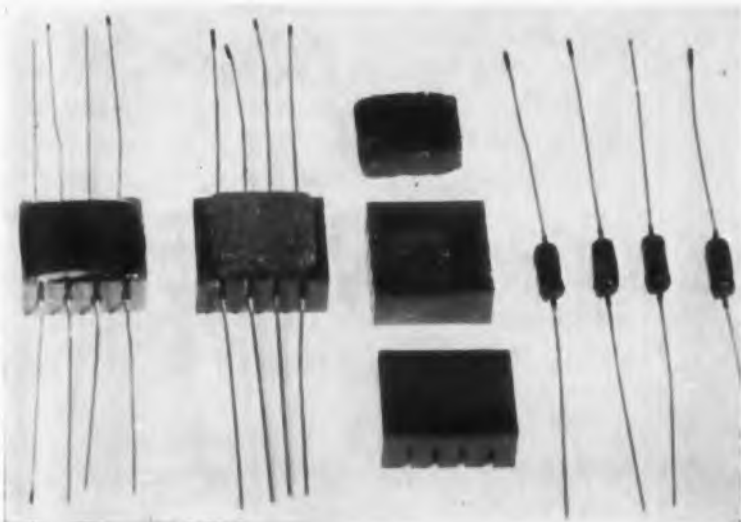


Fig. 3. Four matched diodes placed in a plastic shell have an encapsulating pellet set on top of them. Photo at right shows the diode package after curing at 85 C.



Fig. 4. Component leads can be left to extend straight out of the shell after encapsulation.



Fig. 5. Component can be soldered permanently to a PMS header before encapsulation. This particular shell has a chimney which holds extra encapsulant to provide for any shrinkage.

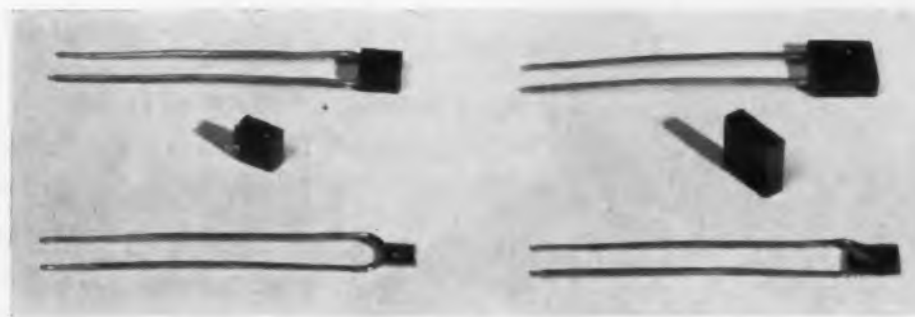
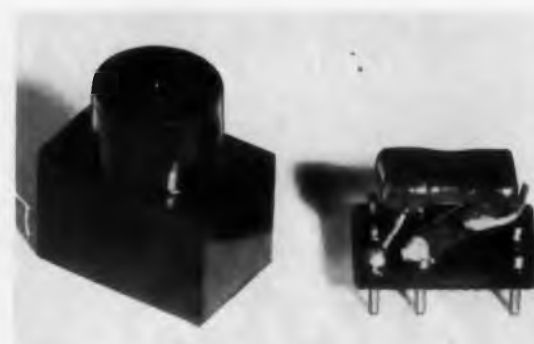


Fig. 6. Plastic shells give mechanical stability and environmental immunity to "VK" micro-miniature ceramic capacitors manufactured by Vitramon, Inc.

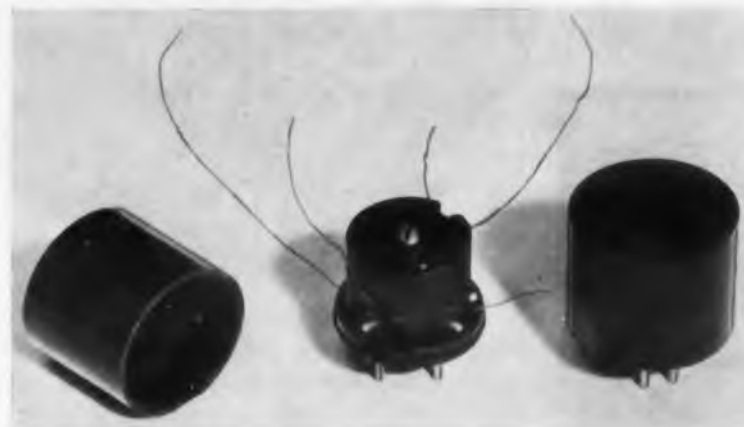


Fig. 7. Pulse transformer attached to a PMS header ready for soldering and encapsulation.

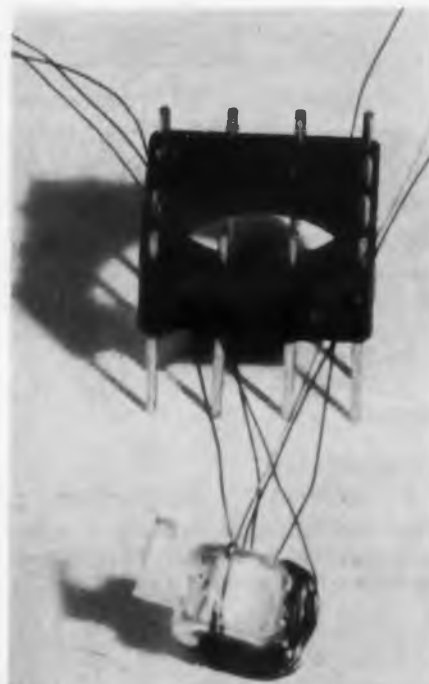


Fig. 8. Hook-like arm holds tape-wound core while leads are being soldered to PMS header.

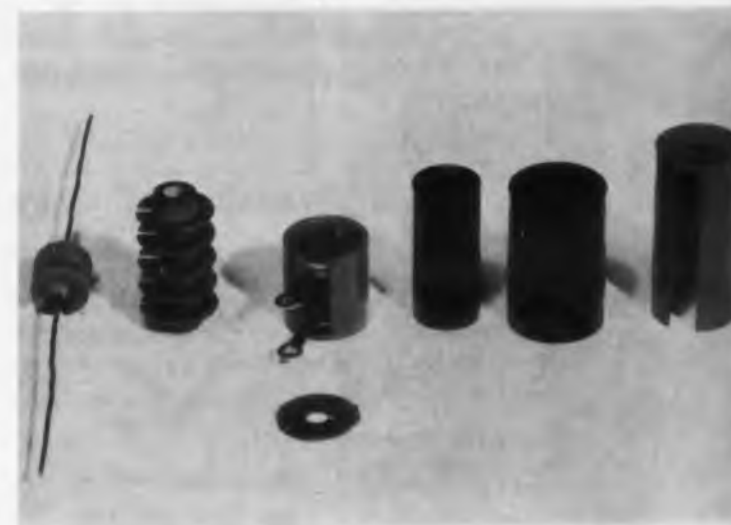


Fig. 9. Shown here are two of the variety of plastic forms and shells available for coils and wire-wound resistors.

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TEMPERATURE COEFFICIENT	.0001 to .1 mfd. $+40 \pm 15$ ppm/°C; 0.2 to 0.5 mfd. -120 ± 15 ppm/°C.
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is put into a vacuum chamber to remove the air. Sometimes heat is used in the chamber and other times only the exotherm of the epoxy is needed.

Encapsulating Materials Used in the Process

The particular application of the component to be encapsulated determines the encapsulating material. There are many materials available: diallyl phthalate, alkyd, phenolic materials, epoxies, and thermoplastics such as polyethylene, nylon, styrene, and polycarbonate.

Epoxies are generally made up of three components: the resin, a curing agent, and a filler. Pot life, jelling time, exotherm, curing time, and heat resistance are directly dependent on the curing agent. Important factors to consider when selecting an epoxy: electrical-dielectric strength, arc resistance, volume resistivity and surface resistivity, physical-impact strength, heat distortion, temperature susceptibility, water absorption, flammability and shrinkage. Physical and electrical properties of epoxies can be varied through the use of appropriate curing agents, fillers and thickening agents.

The bond between a thermosetting resin and the shell is generally superior to the bond of a thermoplastic. With a properly molded encapsulating shell, the bond of the epoxy to the shell is as strong as the bond of the epoxy to itself. Thermoplastics are less expensive and have a higher flexural and impact strength than thermosetting resins, but most engineers prefer thermosetting resins because of the strong bond they make with the shell.

Sealing and Header Combination Can Be Varied

When a component is encapsulated in a shell the leads can be handled in three different ways. They can be simply left extending out of the shell, Fig. 4; they can be inserted through a lid with drilled or molded holes placed over the protruding leads; or they can be soldered to metal pins permanently molded in a plastic seal, Fig. 5.

If the encapsulated component must also be hermetically sealed, a glass-to-metal seal should be used. For many applications, however, hermetic sealing is not necessary and a plastic-to-metal seal will actually do a better job because the encapsulating material adheres better to plastic than it does to the smooth glass surface.

Plastic-to-metal seals are available in various shapes and pin sizes, from soft copper lead wires to rigid pins 0.080-in. in diameter. They are also made in 7-pin, 9-pin, 13-pin and 15-pin sizes to fit standard miniature sockets. It is always ad-

visible to pick a standard-size header and shell with a standard pin spacing of 0.1, 0.15, or 0.2 in. because it eliminates tooling cost. Pin spacing tolerances of plus or minus 0.002-in. non-accumulative can be held on PMS headers in sizes to fit all available printed-circuit connectors.

Header pins are available in various metals. Brass, copper, nickel, and cobar are common, and many varieties of plating, including gold and silver, can be done on request.

Because of the mass-production techniques used by manufacturers of plastic-to-metal seal headers, it is usually more expensive to push pins into a punched board or molded lid than it is to buy a PMS with the pins permanently molded in place. The quality and tolerances of a standard PMS will also be higher than a punched or molded board with pin inserts.

Examples of Plastic Shell Encapsulation Run a Wide Gamut

Practically any electronic component can be easily encapsulated in a plastic shell. Two Vitramon "VK" ceramic capacitors are shown in Fig. 6. The plastic shell offers several important advantages for capacitor manufacturers. Varying wall thickness and cracking of the meniscus at the junction of the leads and body—faults commonly associated with dipped capacitors—are totally eliminated. Plastic shells permit internal as well as external visual and mechanical inspection. Shells with thin spots, bubbles, or pin holes can be culled out before the capacitor is potted in its case. Uniform size of the shells permits them to be cartridge-fed for automatic insertion of the capacitors.

Standard plastic shells are also made for various transformer sizes. The leads are soldered to pins molded in the plastic shells. A pulse transformer is attached to a PMS header in Fig. 7.

An unusual header used for mounting a tape-wound core is shown in Fig. 8. The core is held in position for soldering the leads by a hook-like arm which fits in a slot in the PMS header.

A variety of shells are available for wire-wound resistors and coils. Two different types are illustrated in Fig. 9. One type uses a slotted shell with the leads protruding through a hole in the end cup.

Plastic shells and headers offer a convenient, reliable and economical method for encapsulating electronic components. They eliminate many of the problems associated with encapsulating in metal molds and the extra facilities needed for machining, cleaning and storing molds. When properly used, they can provide engineers with a simple solution to many of their encapsulating problems. ■ ■



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CIRCLE 68 ON READER-SERVICE CARD

Design Tape Recorders For Minimum Size, Weight, and Power



Dr. John G. Frayne (holding the "Astronaut" recorder which he helped develop), has won repeated acclaim for his many achievements in engineering. For developing a 6-track stereo system for Todd-AO, he received the Samuel L. Warner Memorial Award of the Society of Motion Picture and Television Engineers. For his standardization of the stereo-disc system which has been adopted by the phonograph-recording industry throughout the world, he received the Emile Berliner Award of the Audio Engineering Society. For developing techniques of measuring intermodulation distortion he received an Academy Award from the Academy of Motion Picture Arts and Sciences.

He has been president of SMPTE and was awarded its Progress Medal and Its Journal Award. Formerly engineering manager of Westrex Corp., where he spent 30 years, he is now manager of development engineering of CEC's Datalab Div.

Co-author, Dr. Robert L. Sink, with 21 years of experience in various phases of electronics engineering, is associate director of Datalab. He has 20 patents issued or pending. Dr. Sink is a member of the Technical Advisory Group for the Air Force Armament Center at Elgin Air Force Base, Fla.; he is a fellow and former national director of the IRE, a past chairman of its Professional Group on Instrumentation, and a member of ISA.

Dr. Robert L. Sink, Dr. John G. Frayne
Datalab Div.
Consolidated Electroynamics Corp.
Pasadena, Calif.

AN UNDERSTANDING of the power requirements of any tape recorder is essential to the design of recorders for minimum weight, size and power consumption.

Drive Motors Consume Most Power

Exclusive of electronic circuitry, such as amplifiers and bias oscillators, a tape transport dissipates from 80 per cent to 95 per cent of the power supplied to it in the drive motors. The remainder of the power is used to overcome head and bearing friction.

The power required to operate a tape transport can readily be estimated if the tape width and tape speed are known. The estimate would be based on the following assumptions:

1. A 1-in. wide tape is conventionally wound with 16 oz tension. Other tape widths are wound at a tension proportional to the width. Either the reel-drive motor or the capstan motor must expend power to overcome tape tension.

2. The normal force of tape passing a head is roughly equal to the tape tension. The dynamic coefficient of friction for tape passing over a head is about 0.2.

3. The coefficient of friction of ball bearings is about 0.001, about two orders of magnitude less than head friction.

Therefore, it can be neglected in estimating power consumption.

4. The efficiency of gear and pulley drives is high—about 96 per cent per stage of reduction.

5. The most extravagant power dissipation is in electric motors. Small motors have efficiencies, practically speaking, of about 5 to 20 per cent. If voltage regulators or inverters are used to

power the motor or motors, it would be reasonable to assume an efficiency of 10 per cent for the regulator or inverter-motor.

Equation Gives Close Estimate Of Transport Power Requirements

Based on these factors and the tape speed, the power consumption can be estimated from the following equation:

$$P = \frac{0.118 S}{\eta} w(1 + n\mu)$$

where $\left(w \times \frac{1 \text{ lb}}{\text{in.}} = \text{tension}\right)$

P = power consumption, w

S = tape speed, in./sec

w = tape width, in.

μ = coefficient of friction of oxide on head, dimensionless

n = number of record or playback heads in contact with the tape, dimensionless

η = efficiency of motor drive, per cent $\times 10^{-2}$

0.118 = conversion factor for normalizing the units

For example, the recorder illustrated in Fig. 1 consumes according to the equation, 3.10 w. The actual power consumption is between 3 and 4 w so the equation gave a reasonable answer. Note that a recorder with 100 per cent efficiency would require only 0.15 w.

Techniques Available For Cutting Power Needs

Power consumption can obviously be reduced by doing the following:

(a) Increasing efficiency of electrical-to-mechanical power conversion in the drive motors.

(b) Decreasing tape speed.

A not-so-obvious means of reducing power consumption is to practically eliminate the tension that normally must be overcome by the reel

drive or capstan motor. The recorder illustrated in Figs. 2 and 3 does this by means of a constant torque applied between the take-up and supply reels.

A small amount of power is required to overcome friction in the springs used to maintain this torque between the reels. A modified equa-

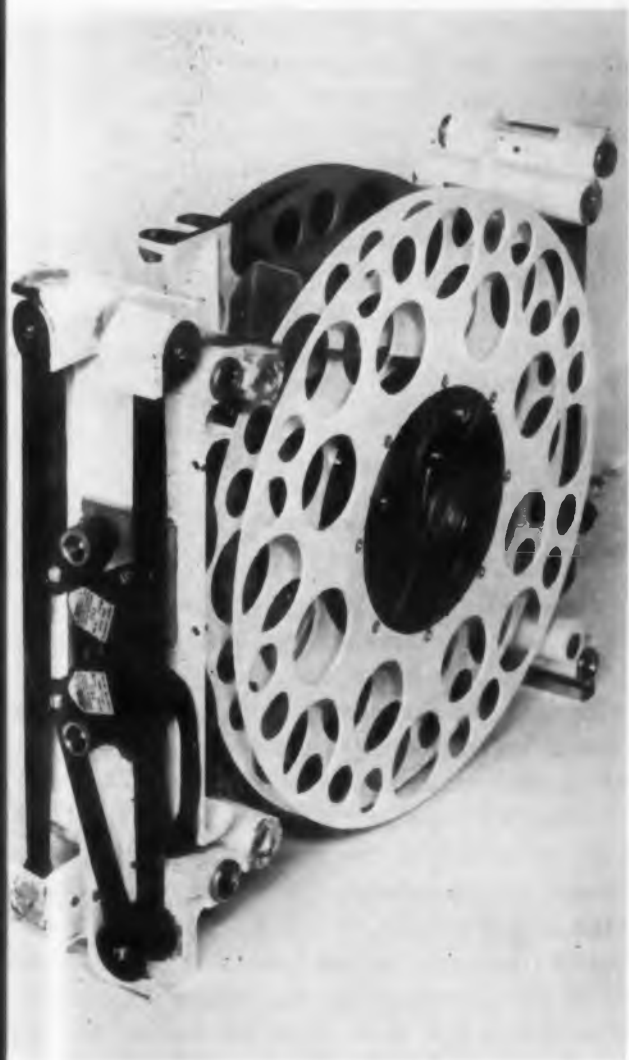


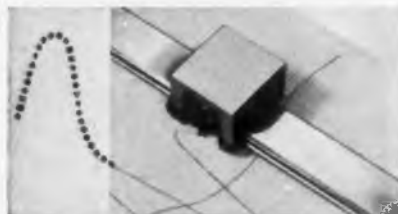
Fig. 1. Compact "Astronaut" tape recorder for Project Mercury consumes less than 8 w.



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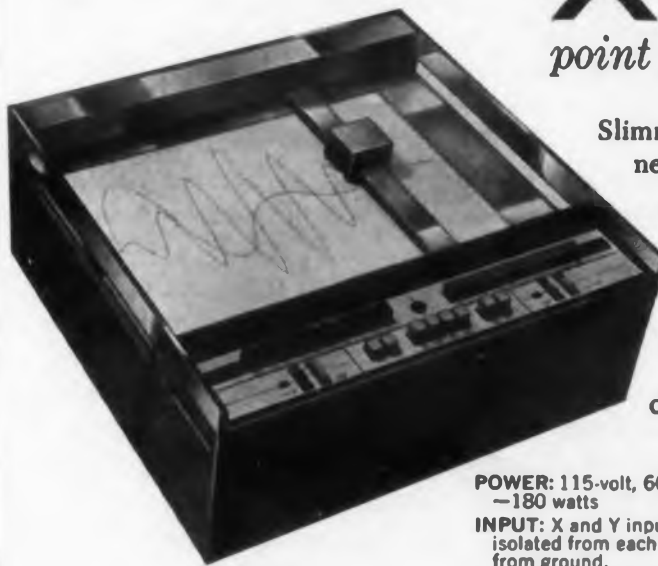


PRINTING FEATURES: Multiple symbol printing head—12 symbols... self contained ink supply.

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POWER: 115-volt, 60 cycle
—180 watts
INPUT: X and Y inputs
isolated from each other and
from ground.
INPUT RESISTANCE:
2 megohms nominal on
most scales. 1 megohm per
volt on .5 millivolts per inch
to .1 volts per inch scales.

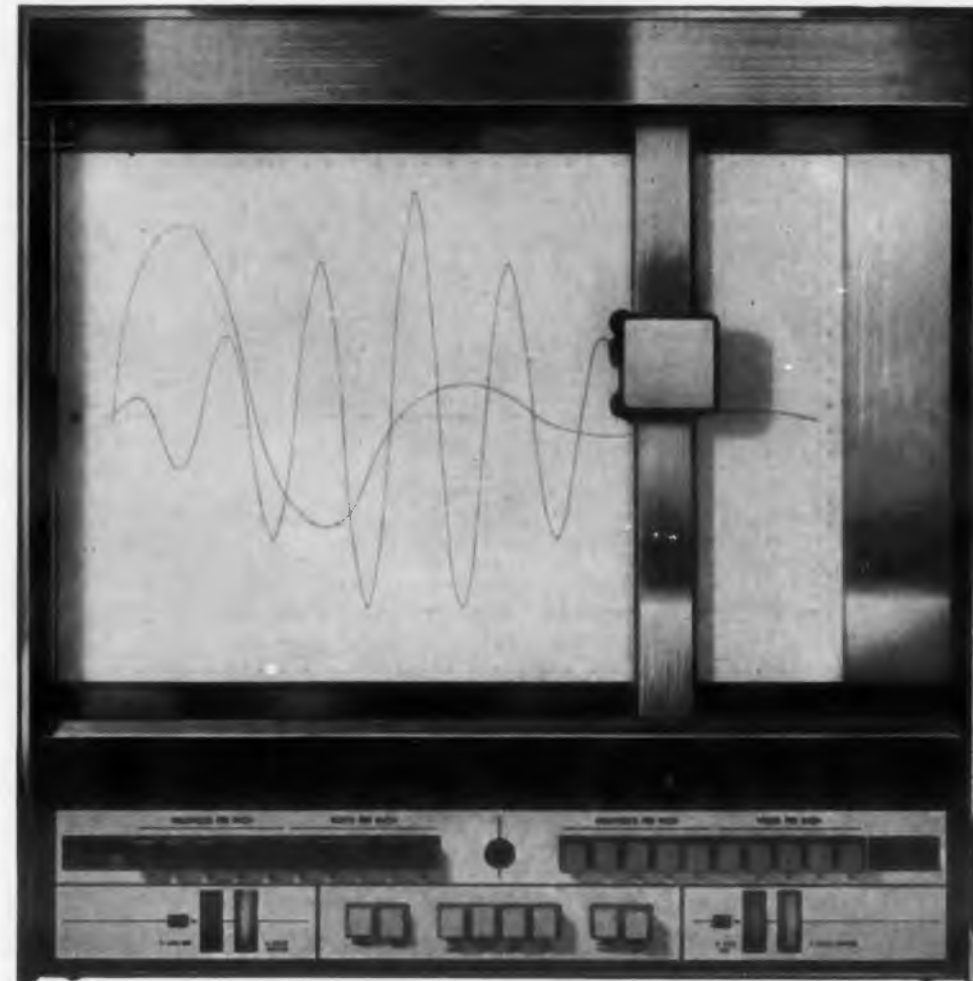
OPERATING INFORMATION

INPUT SENSITIVITY: .5 millivolts per inch
to 50 volts per inch with calibrated push
button scales at .5, .1, 5, 10 and 50 milli-
volts per inch and .1, .5, 1, 5 and 10 volts per
inch. Vernier controls permit continuous sen-
sitivity adjustment between fixed scales, per-
mitting full scale plotting for any sensitivity.
ACCURACY: Static .1%, dynamic .2% at 10°
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PLOTTER CALIBRATION ACCURACY:
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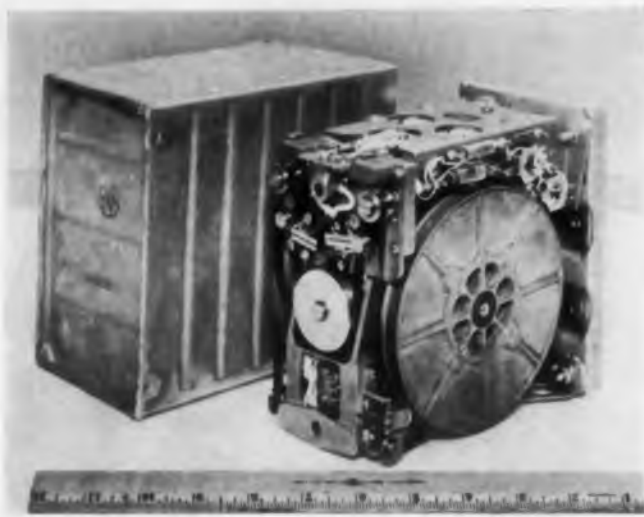


Fig. 2. In 5 min, this Project Courier recorder can record the speeded-up, 13-hr output of a teletype machine. On command, it plays back the signal in 5 min and telemeters it back to earth. The recorder weighs only 5 lb.

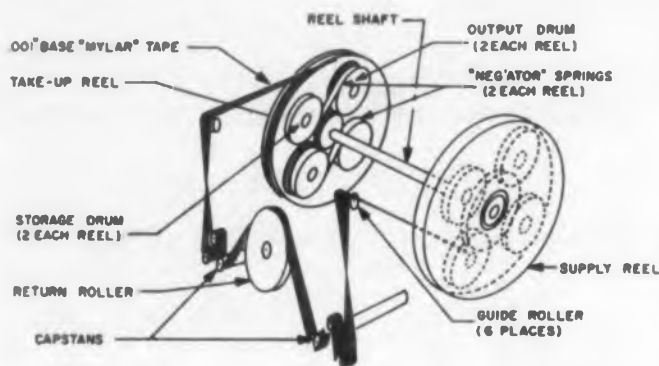


Fig. 3. Spring-driven reeling system in Courier recorder, (Fig. 2), cuts power requirements, eliminates take-up motors, brakes, clutches, and switches. Hunter Spring Co.'s "Neg'ator" springs apply reverse torque through a common shaft to the reels.

tion for power consumed by this type of recorder is:

$$P = \frac{0.118 S}{\eta} = [w ((1 - \eta') + n\mu)]$$

η' is the efficiency of the spring assembly.

Reduced Tape Tension Can Lower Power Required

There is a limit to how far tape tension can be reduced before the tape winding is unsatisfactory. Although it is conventional to use a tension of 16 oz per in. of tape width, the tension can be reduced to 3 oz before the tape becomes too loosely wound. Reduced tension frequently is accompanied by lower high-frequency response or increased drop-out rates.

The dual-capstan drive should allow a great reduction in supply and take-up tension because the relatively high tension required for good tape-to-head contact is developed by the slight difference in speeds of the two capstans.

Eliminating pinch rolls does not necessarily reduce power consumption since they can be spring-loaded or operated in toggle fashion so they require little power. But it is worth while to eliminate them as they are a potential source of flutter.

Most Tape Transports Use Huskier Motor Than Needed

Most tape transports use motors with a greater power-output capability than is theoretically necessary. This is so an increase in bearing friction will not impair transport operation.

Bearing friction normally is negligible compared to head friction. However, differential shrinkage of a bearing and its housing because of temperature changes will greatly increase friction.

Temperatures below about 0 F usually result in significant increases in bearing friction because of increased lubricant viscosity. When a recorder is intended to be operated at sub-zero temperatures, bearing friction should be carefully estimated—it has a great effect on motor requirements and power consumption.

Differential contraction or expansion of bearing housings because of dissimilar temperature coefficients can affect power consumption and recorder performance.

The power consumption of the tape transport may not be of paramount importance in airborne systems, where the transport may use only a fraction of the power supplied to the recorder package and its circuitry.

Non-mechanical energy may be absorbed or dissipated as follows:

1. Energy is absorbed in the recording media.
2. Energy is absorbed and lost in the head.
3. Energy is required in electronic circuits.

In the recording media, the hysteresis energy loss is expressed by Steinmetz's equation:

$$W = \eta B^{1.6} \quad (1)$$

where B = maximum induction in maxwells, and η = the coefficient of hysteresis for the media involved. Energy will be given in ergs per cycle per cc.

This hysteresis power loss may also be calculated with the formula:

$$P = \frac{Vf}{4\pi} \times (\text{the area of the hysteresis loop})$$

Any consistent system of units may be used in this equation where V = volume of magnetic material, and f = frequency.

Head Geometry and Bias Frequency Play Role in Power Determination

In calculating the energy absorbed in the recording medium one must also consider the geometry of the associated record head, especially gap lengths and track widths.

The energy absorbed in the recording medium is directly proportional to the bias frequency. From Steinmetz's equation it is also apparent that the energy absorbed in the medium is proportional, not to remanent induction, but to the 1.6th power of B .

Consider the energy absorbed in a medium when the bias frequency is 100 kc, the recording head has a gap of 0.0005 in. and the recording track is 0.05 in. on a tape with a coating thickness of 0.00035 in. and a retentivity of approximately 700 gauss.

AC Bias Improves Recording But No Bias Cuts Power

From Eq. 2, the energy absorbed in the medium will be about 25 μ w. By halving the bias frequency, we halve the energy. If a medium with half the retentivity were used, the energy would be reduced by a factor of about 3, from Steinmetz's equation.

Consider recording without ac bias. The energy absorbed in the recording medium is reduced by nine-tenths. The energy is further reduced by the ratio of bias frequency to average signal frequency, which means a total reduction of 98 per cent in energy absorbed in the medium. The energy lost in the medium due to the signal is a function of $B_{RS}^{1.6}$. The flux available for playback is a direct function of B_{RS} . From this equation we may deduce relative efficiencies of media

such as metal tapes and oxide-coated plastic tapes.

A comparison of the B_{RS}^{1-6}/B_{RS} ratio for different tapes indicates that oxide-coated, plastic-based tapes are four to five times more efficient than metal tapes.

Record Head Has Three Major Sources of Loss

In a given record head, there are three major sources of energy loss: heat, eddy current losses, and hysteresis losses.

Heat losses are given by the equation:

$$P = I^2R$$

where R = dc resistance of the windings.

Eddy current losses are given by:

$$P = V \frac{\pi^2 f^2 r^2 B_{peak}^2}{6e}$$

where f = frequency, r = lamination thickness, B = flux density, e = resistivity, V = volume.

A practical value for heat loss in a recording head may be 500 μ w; average eddy-current energy loss may be about 2.5 mw when the bias frequency is 100 kc.

In his book, "Ferromagnetism," Boxworth gives the bias-hysteresis loss for 65 Permalloy with 100-kc bias as 250 μ w. The signal-current hysteresis loss will be about 25 μ w. In both cases, gap losses are ignored.

In examining the eddy-current loss formula, eddy-current losses are a function of the square of the frequency involved and the square of the lamination thickness as well as the square of the induction. Thus, a high value of head inductance is desirable but it is also possible to conserve these losses by reducing lamination thickness and bias frequency.

Transistor amplifiers in a recorder will dissipate perhaps 25 mw per channel. Vacuum tubes use more than 1 w per tube. It is apparent that solid-state devices should be more efficient.

The table shows typical power requirements per recording channel with and without the use of bias techniques. ■ ■

Typical Recording Power Per Channel (Mw)

	With Bias	Without Bias
Signal Circuitry	25	25
Bias Circuitry	250	None
Eddy Current (Head)	2.5	0.025
Dc Losses (Head)	0.25	0.002
Tape (With 100-kc bias)	0.025	<0.001
Hysteresis Loss	0.25	—
Total	278.025 mw	25.027+ mw



Arnold Pulse Transformer Cores are individually tested under actual pulse conditions

Here's technical data on

ARNOLD SILECTRON CORES

Bulletin SC-107 A

... this newly-reprinted 52-page bulletin contains design information on Arnold Tape Cores wound from Silectron (grain-oriented silicon steel). It includes data on cut C and E cores, and uncut toroids and rectangular shapes. Sizes range from a fraction of an ounce to more than a hundred pounds, in standard tape thicknesses of 1, 2, 4 and 12 mils.

Cores are listed in the order of their power-handling capacity, to permit easier selection to fit your requirements, and curves showing the effect of impregnation on core material properties are included. A valuable addition to your engineering files—write for your copy today.

ADDRESS DEPT. ED-11

The inset photograph above illustrates a special Arnold advantage: a 10-megawatt pulse-testing installation which enables us to test-prove pulse cores to an extent unequalled elsewhere in the industry.

For example, Arnold 1 mil Silectron "C" cores—supplied with a guaranteed minimum pulse permeability of 300—are tested at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gauss. The 2 mil cores, with a guaranteed minimum pulse permeability of 600, receive standard tests at 2 microseconds, 400 pulses per second, at a peak flux

density of 10,000 gauss.

The test equipment has a variable range which may enable us to make special tests duplicating the actual operating conditions of the transformer. The pulser permits tests at .05, .25, 2.0 and 10.0 microsecond pulse duration, at repetition rates varying anywhere from 50 to 1000 pulses per second.

This is just another of Arnold's facilities for better service on magnetic materials of all description.

● Let us supply your requirements.
*The Arnold Engineering Company,
Main Office & Plant, Marengo, Ill.*



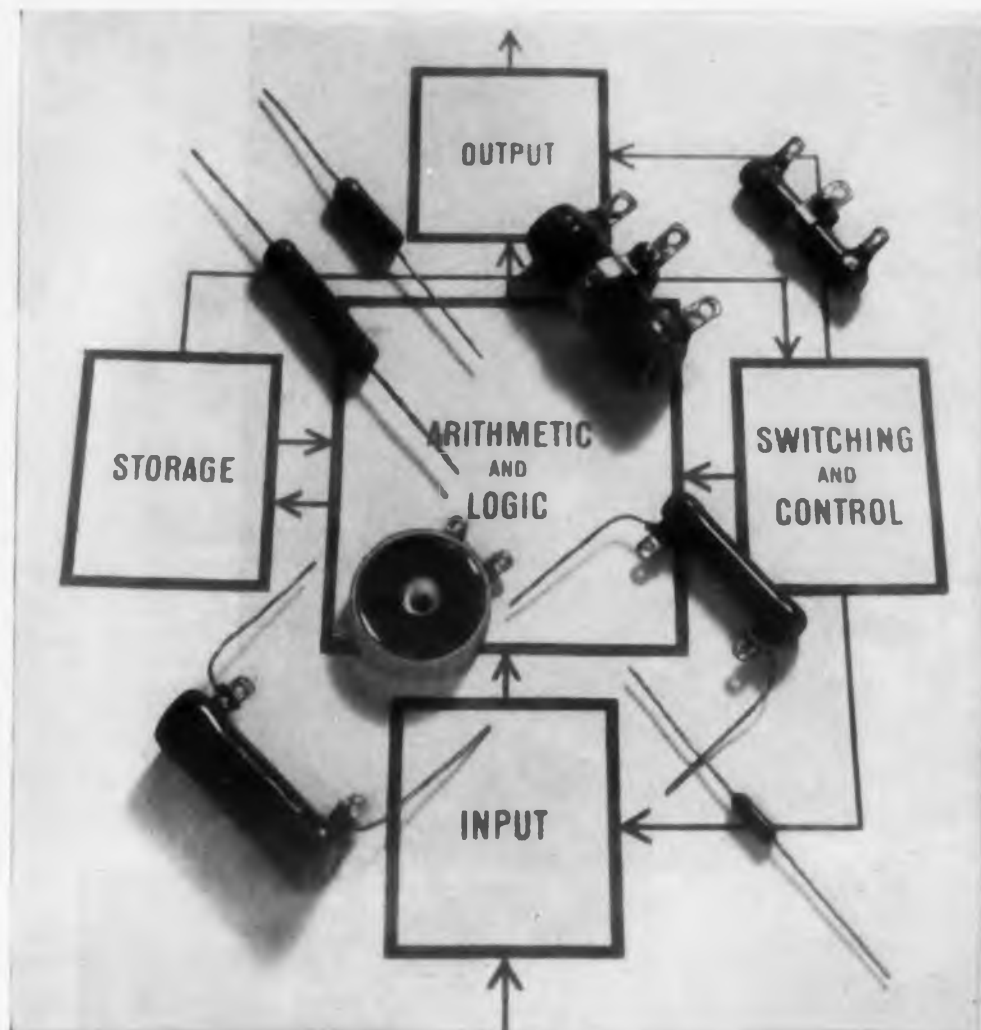
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CIRCLE 58 ON READER-SERVICE CARD



In modern digital computers

PERFORMANCE IS THE PAY-OFF

A big, modern digital computer may cost as much as \$10-million to buy outright. Even rental may run as high as \$50,000 a month.

With money like that involved, computer-makers can't take a chance on sub-standard components. They want, and get, the best components . . . the best resistors. Where wire-wound power resistors are required, they frequently specify Ward Leonard VITROHMS.

There's another reason, too, why computer manufacturers want only the best: They're shooting for 99.99 . . . % statistical reliability of *components*, and the more "9's" the better. Computer components—say, resistors—are numbered in the tens of thousands, and they have to have this kind of performance to get 99.8% reliability in their final product. For this reason, computer makers insist on, and get, *performance*—as continuous and reliable as the state of the art permits. And again, where wire-wounds are required, they are likely to specify Ward Leonard VITROHMS.

If you want maximum quality and maximum reliability in your product, follow the lead of outstanding digital computer manufacturers—like IBM, Remington Rand, and Burroughs—and specify W/L VITROHMS. You'll find full information in catalog D130. Write for your copy, and the name of your nearest VITROHM distributor, today. Ward Leonard Electric Co., 77 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada, Ltd., Toronto.) o.e



RESULT-ENGINEERED CONTROLS SINCE 1892

WARD LEONARD
ELECTRIC CO. MOUNT VERNON
NEW YORK

RESISTORS • RHEOSTATS • RELAYS • CONTROLS • DIMMERS
CIRCLE 50 ON READER-SERVICE CARD



Solid-State Microwave Signal Source

A RESPECTABLE level of microwave power can now be obtained from a commercially available, all-solid-state signal source. With outputs from 4.0 w at 75 mc to 30 mw at 6 Gc, these low-power-consumption units will have many applications, primarily those now served by such devices as the reflex klystron. They can be applied as pump sources for parametric amplifiers or for any application requiring a fixed-tuned, microwave signal generator.

Beyond the theory stage, these new signal sources are now being offered by the Apparatus Division of Texas Instrument, Inc., Dallas, for custom-engineered applications.

Impedance-Matching Networks Provide Maximum Energy Transfer

The harmonic generator circuit model shown in Fig. 1 is typical of the type that has been used in the theoretical study of reactance-diode frequency multipliers. Terms Z_1 and Z_2 represent impedance-matching networks which provide maximum transfer of energy from source to diode, and diode to load, respectively. They are adjusted for minimum insertion loss. The input and output filters are parallel resonant at the fundamental and output harmonic frequencies, respectively. Thus they present ideal zero impedance to all other frequencies.

If the impedances Z_1 and Z_2 present a perfect match between source and load, and if the input and output filters are ideal, the only loss in the circuit will be that produced by the diode. This theoretical perfection is not attained, hence the losses must be considered to

provide accurate circuit analysis results.

Expansion of this circuit model into an actual tripler harmonic generator is shown in Fig. 2. The abrupt junction diode used has a capacitance of 47 pf and a Q of 30 at 70 mc (the circuit multiplies from 70 to 210 mc). It exhibits a capacitance variation which is the inverse square root of the voltage variation.

Major Harmonics Are Tuned Out

With a power-source output impedance of 50 ohms, and the series-resonant traps tuned to the proper frequency, conversion efficiencies in excess of 50 per cent are possible with the circuit shown. Practical considerations make it impossible to provide resonant traps for all the unwanted harmonic frequencies, so only the major harmonics are tuned out. This circuit is capable of producing the specified efficiencies for all power levels from 400 mw to 3.5 w.

The high-pass filter at the output provides attenuation in excess of 20 db for all frequencies below the third harmonic. Only negligible amounts of higher harmonic power appear at the output, so the total power output is essentially equal to the power of the third harmonic.

Fig. 3 gives the schematic of a quintupler multiplier of very similar configuration. Frequencies are multiplied from 220 mc to 1,100 mc. Efficiencies as high as 28 per cent have been achieved in practice with this circuit.

Prototype Shows Modular Construction

Shown is an engineering prototype of a family of solid-state sources and har-

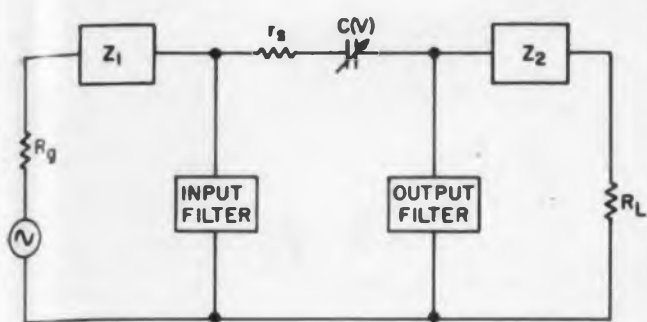


Fig. 1. Harmonic generator circuit model

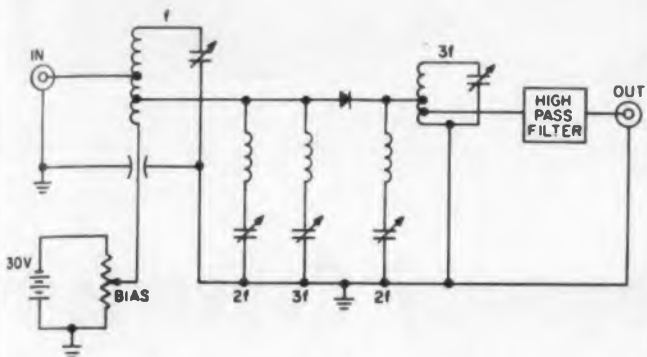


Fig. 2. Typical circuit for frequency tripler

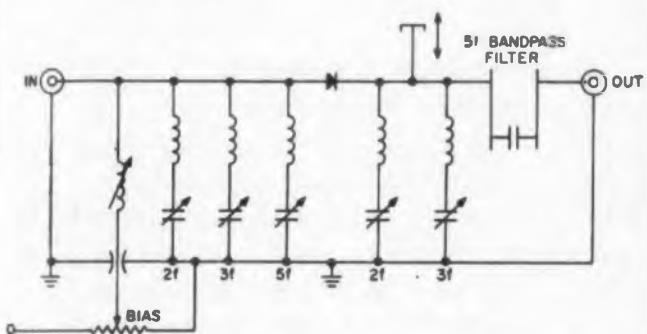


Fig. 3. Typical circuit for frequency quintupler

monic generators available for custom-engineered applications from 75 mc through 6 Gc. Modular construction breaks down as follows: base module is a 73.3-mc oscillator driver; upper-right module is a harmonic frequency tripler, multiplying 73.3 to 220 mc; upper-left module is a quintupler multiplying 220 to 1.100 mc; front module is a strip-transmission line quintupler multiplying the signal from 1.1 to 5.5 Gc. The unit measures 2-1/4 x 3-5/8 x 5 in. with no attempt at miniaturization.

The availability of these solid-state signal sources for custom-engineered applications is from 60 to 90 days.

Currently, prices for this family of devices range from \$500 to \$5000, depending on frequency, quantity and customer's environmental and other specifications.

For more information on these new devices turn to the Reader-Service Card and circle 251.

NEW DEPARTURES IN MINIATURE



ULTRA-CLEAN INCUBATORS FOR M/I* BALL BEARINGS N/D'S NEW WHITE ROOM PROVIDES ULTRA-CLEAN ENVIRONMENT FOR M/I BALL BEARING ASSEMBLY

N/D announces a new White Room at Sandusky, Ohio incorporating the latest technological advances available today. This new room provides a virtually dust-free atmosphere so necessary for the production of Miniature and Instrument Ball Bearings of high reliability.

Environmental controls within the room hold temperature to plus or minus 1°... with maximum humidity only 40%. Final air filtration into room removes particles smaller than 3/10 micron. A complete air change is made every three minutes. Engineers and technicians entering the room are thoroughly bathed by air showers in two successive deduster chambers.

You can benefit from New Departure's 25 years of experience in M/I ball bearing production by calling your nearby N/D Sales Engineer. Or write Department L.S., New Departure, Division of General Motors Corporation, Bristol, Conn.

*Miniature and Instrument Ball Bearings.



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M/I BALL BEARING CATALOG,
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NEW DEPARTURE

MINIATURE AND INSTRUMENT BALL BEARINGS

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FEATURES

- * DC to 500 kc frequency range, 6 cm undistorted deflection at 1 mc.
- * Identical, calibrated high-gain amplifiers.
- * 10 mv/cm to 100 v/cm sensitivity range.
- * New "tailor-made" CRT operating at 5 kv.
- * Sweep speeds: 1 usec/cm to 10 sec. full-scale.
- * Single sweep with rearming provisions.
- * Selection of auto or driven sweep.

HIGH-FREQUENCY FEATURES — IN A NEW LOW-FREQUENCY OSCILLOSCOPE

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401-B

□ A comprehensive performer — simplifying many procedures previously requiring specialized oscilloscopes. The 401-B provides high-frequency type concepts with low-frequency operation. The 401-B features identical amplifiers — enabling equal-ordinate, calibrated plots for accurate measuring on both axes. Its wide range of sweep speeds, provisions for single sweeps with rearming facilities, selection of auto or driven sweep, an "electronic shutter" and other unique features — all helping to create versatile displays on a new high brilliance 5 kv cathode-ray tube — establish the 401-B as a true general purpose, high performance oscilloscope. Write for complete details.

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CIRCLE 55 ON READER-SERVICE CARD



By combining a standard electronic counter with this new voltage-to-frequency converter, the engineer has an average-reading voltmeter, fairly immune to noise and hum at the input.

Voltage to Frequency Converter

USING a voltage-to-frequency converter with a standard electronic counter provides the user with an average-reading digital voltmeter, largely immune to noise or hum at the input. With the new v-to-f converter, a record of total input can also be obtained. In applications like the measurement of rocket thrust, where data is desired both on total thrust and the manner in which thrust varies, the system eliminates tedious manual integration from a series of digital readings or recorded curves.

H-P Dymec Units Integrate Inputs

Designed by engineers at Dymec Div. of Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif., the models 2210 and 2211 convert an input voltage to a proportional frequency, which is then applied to an electronic counter to complete the process of conversion from analog to digital form. Unlike most analog-to-digital converters, which use either ramp or comparison techniques to measure the instantaneous value of an applied voltage, the Dymec units integrate the input and measure the average value over a selected time interval.

The applied voltage is measured continuously rather than sampled as with other techniques. But, because it is integrated over a discrete time interval, an average reading is obtained instead of an instantaneous one. This reading is digitally indicated by counting the number

of output pulses generated during the time interval.

High-Gain Amplifier Achieves Integration

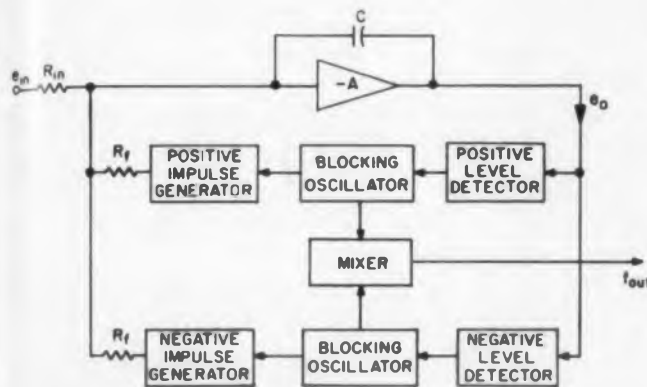
To achieve the integration a high gain operational amplifier is used, as in the block diagram. Chopper-stabilized, the amplifier is the same type as used in analog computers. Normally three inputs are applied to the amplifier—one, the unknown voltage; second and third, the two polarities of feedback pulses. In some cases, the company says, an additional input is used for application of a dc bias to provide an output frequency offset.

When an unknown voltage is applied to the converter, the output rises according to:

$$e_o = -\frac{1}{R_{in}C} \int e_{in} dt.$$

When e_o reaches a predetermined trigger level, a single pulse is generated and fed back to the input of the amplifier. Polarity of the pulse is opposite to that of the unknown; when the pulse is integrated, e_o immediately falls below the trigger level. As e_{in} continues, e_o rises again to the trigger level and another pulse is generated.

This mechanism of generating pulses prevents a net change in e_o beyond that corresponding to the integral of a single pulse. And since the pulses fed back to the amplifier input have a constant area.



Block diagram of the v-to-f converter shows how positive or negative (depending on input polarity) constant-area feedback pulses are generated. Pulse rate is proportional to level of e_{in} .

it follows that over any definite period of time the number of pulses generated is proportional (± 1 pulse) to the integral of the input voltage. Average, being the time integral divided by the period of integration, is read directly on standard counters with gate times such as 0.1 sec and 1 sec. Direct reading is a result of the integral power of 10 gate times and v-to-f conversion ratio of 10 kc per v and 100 kc per v.

These constant-area pulses are derived from an output winding on a magnetic core which is switched from one saturation limit to the other. Area of the output pulse is governed by the saturation flux of the core and by the number of turns on the output winding. Temperature and line voltage variation and pulse frequency can affect the saturation flux.

Accuracy of the v-to-f converter is mainly determined by the ability of the pulse generator to deliver constant-area pulses to the input of the operational amplifier, by the stability of the amplifier, and by the linearity of conversion. In practice, the company asserts, stability is the controlling factor. Accuracy for the model 2210 is 0.1 per cent of full scale, for the 2211A 0.03 per cent and for the 2211B 0.04 per cent.

Input ranges for the Model 2210 can be stepped from 0-1 to 0-1.000 vdc in four clicks of the dial. Output is from zero to 10 kc. Both standard 2211 models have rated inputs of 0-1 vdc; output of the 2211A ranges from zero to 10 kc, of the 2211B zero to 100 kc.

For more information on this voltage-to-frequency converter turn to the Reader-Service Card and circle 252.

Another *NARDA* exclusive!

DIGITAL

1-8-6-50

Direct- Reading Frequency Meters

No interpolations needed!

New — and only from Narda! Microwave frequency meters you can read at a glance! The digital counter permits even the least-experienced to get rapid, precise readings without interpolations, charts or curves. And, because the tuning rate is linear with frequency, the new meters are readily adaptable for remote indication. May be panel-mounted, too, if you have a system application.

Best of all, you get these features with no sacrifice of quality or accuracy (0.1% or better): The high-Q cavities are precision-bored; the cast housing is extremely rugged; the mechanism is carefully and accurately constructed. Electrically, the unit is equivalent to a straight section of waveguide when detuned. Dip at resonance is at least 10%. Complete specifications are shown at right.

This is just one of many precision Narda microwave products. For a free copy of our complete catalog, write to: Dept. ED-12.



SPECIFICATIONS

Band	X	KU	K
Frequency (KMC)	8.20-12.4	12.4-18.0	18.0-26.5
Waveguide (in.)	1 x 1/2	.702 x .391	1/2 x 1/4
Accuracy	0.08%	0.1%	0.1%
Loaded Q	7000	5000	4000
Length (in.)	4	4	4
NARDA Model Number	840	839	838
Price	\$195.	\$250.	\$275.



the **narda** microwave corporation

118-160 HERRICKS ROAD, MINEOLA, L. I., N. Y. • PIONEER 6-4650

CIRCLE 57 ON READER-SERVICE CARD

NEW PRODUCTS

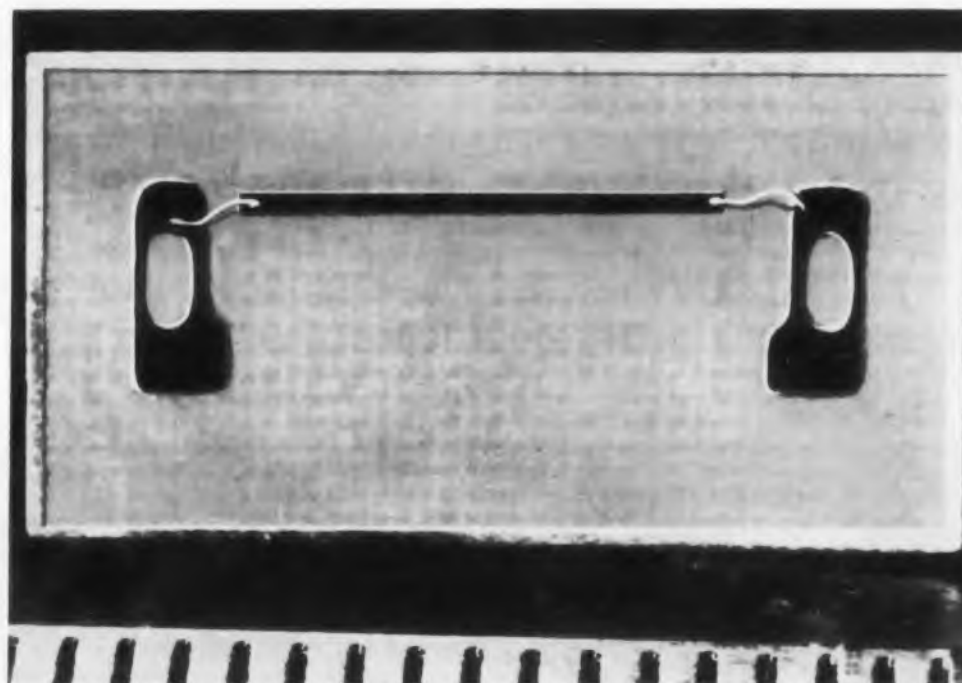
Covering all new products generally specified by engineers designing electronic original equipment. Use the Reader-Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.



Microwave Receiver-Transmitter Operates At 12,000 Mc 401

Model MR-40 receiver-transmitter, able to operate at 12,000 mc, provides broad-band communications particularly suited for high-speed data transfer as well as transmission of telephone and teletypewriter messages. The basic components are two reflex klystron tubes, one in the receiver and one in the transmitter. Each tube is rated for a life of 20,000 hr of continuous operation. Besides data transmission, the system handles voice and control and monitor functions. It can carry data at 62,000 characters per sec when used with the firm's transmission multiplex system.

Motorola Inc., Communications Div., Dept. ED, 4501 W. Augusta Blvd., Chicago 51, Ill.

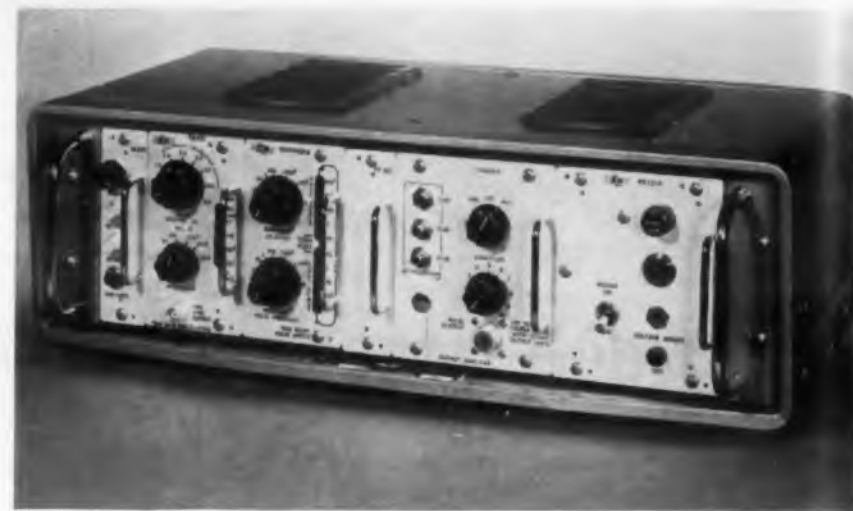


Strain Gage Sensitivity Is 50 To 60 Times That of Its Metallic Counterparts 400

The Micro-Sensor MS 105-350 semiconductor strain gage is claimed to have a sensitivity of 50 to 60 times that of its metallic counterparts. Nominal gage factor at 77 F is $130 \pm 10\%$ and spread per package is within $\pm 2\%$. Nominal resistance is 350 ohms $\pm 10\%$ and spread per package is $\pm 1\%$. Maximum operating strain is over 3,000 microstrain, recommended bridge current is 30 ma max and minimum usable radius of curvature in 1 in. Operating temperature range is -65 to $+180$ F; dimensions are $0.625 \times 0.02 \times 0.0005$ in. Four gages are housed in one package.

Micro Systems, Electro-Optical Systems, Inc., Dept. ED, 2925 E. Foothill Blvd., Pasadena, Calif.

Price: \$98 per package.
Availability: From stock.



Pulse Generator Provides Up To 2,000,000 Pulses Per Sec 399

Four-watt pulses at the rate of 2,000,000 pulses per sec drain only 20 w of input power in series 3500 transistorized pulse generators. These wide-range instruments are modularized to enable continuous variation of repetition rates from 200 cps to 2 mc. Rise times are 0.02 μ sec with a 12-v amplitude from an output impedance of 50 ohms. With type TB431A time-base module, instruments in this series have continuously variable repetition rates from 1 pulse per 5 sec to 2,000 pulses per sec. Continuously variable pulse delays from 0.25 to 1,000 μ sec are available with the standard instrument.

Electro Pulse, Inc., Dept. ED, 6711 S. Sepulveda Blvd., Los Angeles 45, Calif.

Price: \$960 for single-pulse unit; \$1,880 for double-pulse type.

Diode Tester Indexes 403
3,600 Units Per Hour

Type T-501A diode tester automatically indexes, tests and sorts diodes at the rate of 3,600 units per hour. Ten tests are performed in this sequence: orientation check, inverse tests and forward tests. Any one test can be programmed for forward or reverse tests in any sequence. Shorted or open units can be rejected at the rate of 7,200 per hour. The unit idles with open contacts at 2,400 steps per hour. Applications are in production testing, engineering analysis, quality control and incoming inspection.

Atlantis Electronics Corp., Dept. ED, 322-26 Broadway St., Garland, Tex.

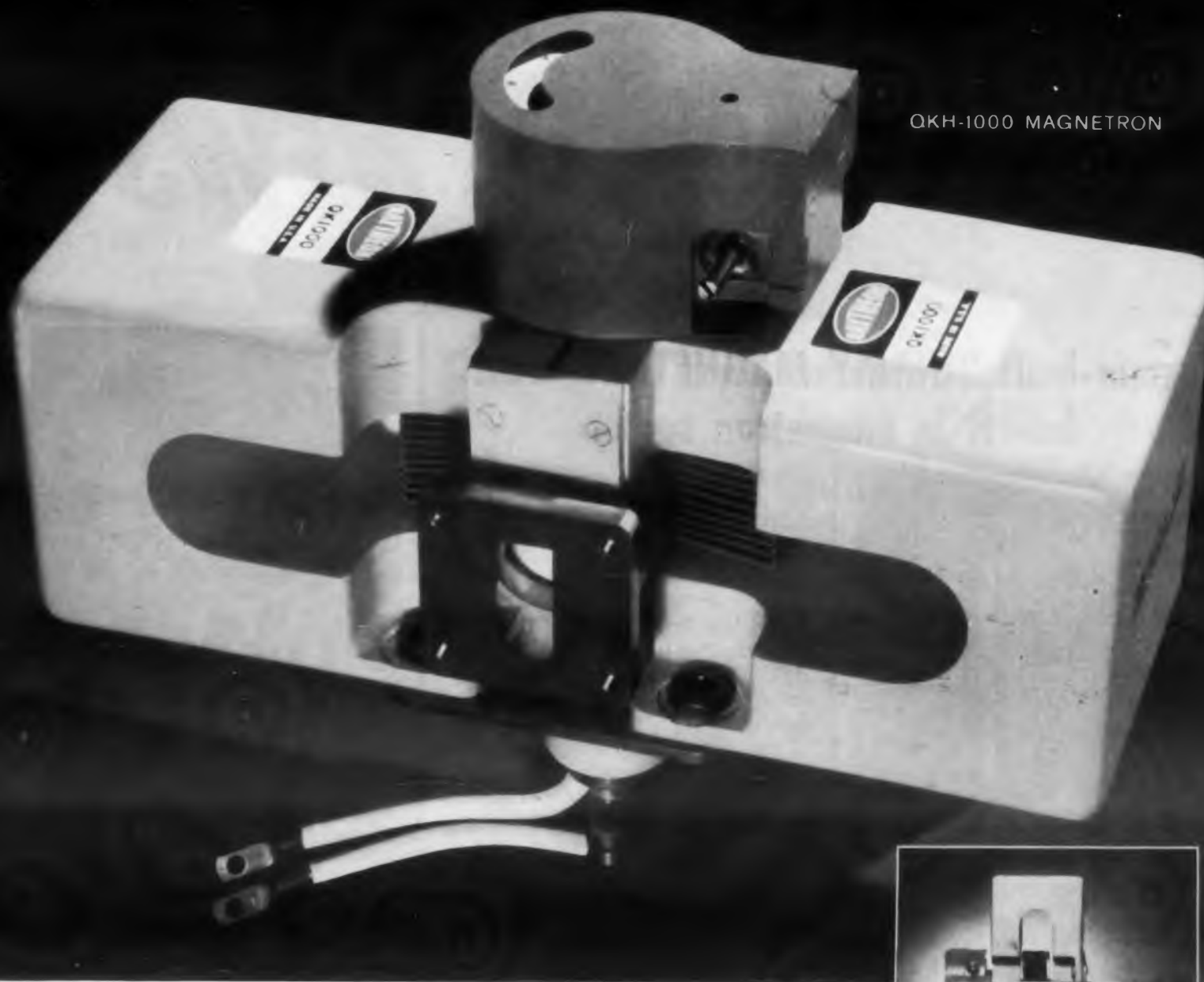


Traveling-Wave Tube 402
Has Less Than 4-Db Noise

Intended for operation in the front-end of communications receivers in the frequency range of 2,500 to 3,700 mc, this traveling-wave tube has a broadband noise figure of less than 3.5 db. Minimum tube noise figures are as low as 2.5 db. The tube is operated in a two-field jump solenoid weighing less than 30 lb. The solenoid dissipates less than 200 w in providing a magnetic field of about 800 gauss for focusing the electron beam. Relatively flat small-signal gains of about 30 to 35 db and saturated power outputs of about 3 to 4 mw can be obtained with tube noise figures below 4 db.

Radio Corp. of America, Dept. ED, 30 Rockefeller Plaza, New York 20, N.Y.

CIRCLE 59 ON READER-SERVICE CARD >



QKH-1000 MAGNETRON

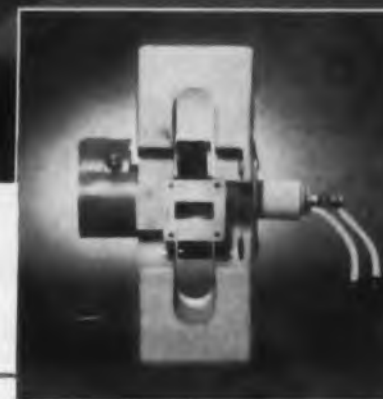
New Raytheon tunable magnetron improves airborne radar performance

250 kW QKH-1000—all ceramic and metal tube—improves performance of existing systems, provides increased capability for new systems.

This new X-band pulsed magnetron—specially designed for airborne applications—results from Raytheon's long experience in quantity production of magnetrons for use under severe environmental conditions.

The tube is rapidly tunable from 8,500 to 9,600 Mc, with a typical tuning rate of 100,000 Mc/sec in the hydraulically tuned version. Ceramic construction and newly-designed cooling fins provide high ambient temperature tolerance. Study programs are underway to permit operation to 350°C.

The tube's heliarc welded output assembly and magnet shape enhance its physical rigidity. Unique anode construction achieves better voltage and frequency stability. Designed for economical volume production, the QKH-1000 directly replaces the RK-6249 magnetron in existing systems.



QKH-1000—GENERAL CHARACTERISTICS

Power Output	250 kW (nominal)
Frequency Range	8500-9600 Mc
Anode Voltage	27.5 kV
Anode Current	25 amps (peak)
Stability	0.2% missing pulses
Bandwidth $\frac{1.65}{t_p}$ Mc; $i_b = 25 \pm 15\%$ amps (peak)	
Pulse Widths	Up to 3.3 μ sec

Write for detailed application information to Raytheon Company, Microwave and Power Tube Division, Waltham 54, Massachusetts. In Canada: Waterloo, Ontario. In Europe: Zurich, Switzerland.

RAYTHEON COMPANY

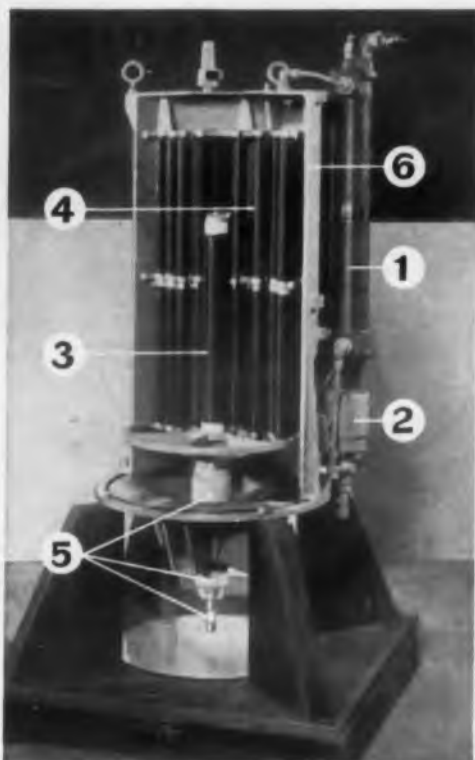
MICROWAVE AND POWER TUBE DIVISION

RAYTHEON

Electronic Products **NEWS**

by **CARBORUNDUM®**

Custom-built DUMMY MAGNETRON LOAD inserts in magnetron socket



(1) Heat exchanger (2) Pump — water and ethylene glycol (3) GLOBAR 500 watt resistor to simulate magnetron filament characteristics (4) Varistor load bank to simulate anode characteristics (5) Ceramic-to-metal assembly duplicating magnetron termination (6) "O" ring sealed aluminum cast housing.

CIRCLE 804 ON READER-SERVICE CARD

The dummy magnetron load at left, cut open to show construction, was designed by Hazeltine Corporation engineers and produced by Carborundum's Global Plant. It is used as a stable termination of known characteristics for evaluating the pulse performance of the Hazeltine AN/APS-95 transmitter modulator, newest Air Force early warning radar development.

The dummy load dissipates 10 kw average power. Peak pulse amplitude is 50/70 kv. Unique features include provision for direct insertion of the load in magnetron socket, use of liquid heat exchanger and inclusion of a proportional viewing resistor.

This load is typical of custom-built devices by Carborundum, utilizing the non-linear characteristics of GLOBAR® resistors and varistors. Ceramic-to-metal assemblies and ceramic parts were produced at Carborundum's Latrobe Plant. For information on high power packaged loads to suit your requirements, write Global Plant, Refractories Div., Dept. EDL-110, Carborundum Co., Niagara Falls, N. Y.

CIRCLE 805 ON READER-SERVICE CARD



Crushable Ceramic Preforms —Swaging tubes for thermocouples

These preforms are used for stringing on thermocouple leads, insertion in seamless stainless steel sheaths and subsequent crushing during swaging to produce densely packed ceramic powder insulation. They are now available in a choice of materials:

Low Boron Content Magnesium Oxide
High Purity Aluminum Oxide (Fused and Calcined)

Stabilized Zirconium Oxide
Low Hafnium Stabilized
Zirconium Oxide

Preforms are offered for one, two and four hole applications, with other multiple four up to six hole tubing available on request. Sizes range from .022" O.D. with holes from .005" diam. as standard sizes. Special diameters made to specifications. For complete technical data, write Latrobe Plant, Refractories Div., Dept. EDP-110, Carborundum Company, Latrobe, Pa.

CIRCLE 806 ON READER-SERVICE CARD

CUSTOM-BUILT SEALS AND METAL-BONDED CERAMICS



CIRCLE 804, 805, 806, 807 ON READER-SERVICE CARD

offer advantages for your product

The samples shown at left are typical of the many types produced by Carborundum's Latrobe plant.

#1 is a metal-bonded ceramic-to-metal assembly with an operating range up to 500 C in air and 1080 C in controlled atmosphere. It's highly resistant to thermal and physical shock and can be readily brazed. Used for thermopile lead-throughs, pressure vessels, space capsules, canned nuclear pumps and reactors, heating elements, rectifier housings.

#2 is another example of metal-bonded ceramic with similar properties.

#3 is a silver metallized ceramic part for less severe requirements. Operating range up to 150 C.

#4 Vacuum-tight lightweight glass-to-metal assembly produced with KOVAR® matched expansion type glass seals. The glass and metal oxide interfuse to make a true chemical bond. For information, write Latrobe Plant, Refractories Div., Dept. EDS-110, Latrobe, Pa.

CIRCLE 807 ON READER-SERVICE CARD

NEW PRODUCTS

Rotating Coil Fluxmeter

636

Has accuracy of 0.01%

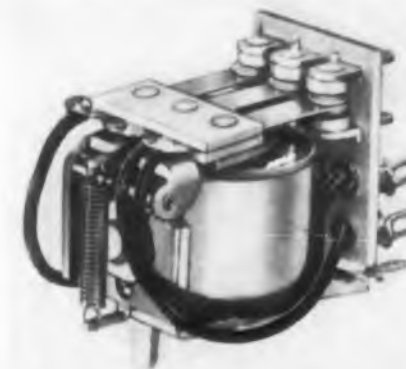


Rotating coil fluxmeter, model 601, is capable of measuring or controlling non-uniform fields to an accuracy of 0.01%. Fields do not have to be homogeneous to be measured. Measurements are made by means of a null-indicating meter with readings taken from a high accuracy, calibrated attenuator. Dimensions are 30 x 6 x 6 in., weight is 42 lb. Power required is 117 v ac, 60 cps, 10,530 w.

J. C. Carter Co., Electronics Div., Dept. ED, 671 W. 17th St., Costa Mesa, Calif.

General-Purpose AC-DC Relay 739

Hermetically-sealed unit



This general-purpose ac-dc relay is a hermetically-sealed unit. Model 88 relay is available with spdt, dpdt and 3pdt contacts. It has 5- and 10-amp ratings. The unit is for dc operation to 220 v, ac operation to 440 v. It measures 1-3/16 x 1-1/4 x 1-13/16 in.

Magnecraft Electric Co., Dept. ED, 3350D W. Grand Ave., Chicago 51, Ill.

Price: \$2.50 to \$4.50 ea, 1 to 1,000.

Availability: 14 days.

Pulse Transformers

601

Have pre-molded epoxy-resin cases

Pre-molded epoxy-resin cases house type 32Z miniature pulse transformers. Style 1 units are for pulse voltages up to 60 v at an average power rating of 0.3 w max; Style 3 units are for volt-

ages up to 200 v at an average power rating of 1 w max.

Sprague Electric Co., Special Products Div., Dept. ED, North Adams, Mass.

Miniature Low-Frequency Oscillator 732

Measures 1 x 1 x 2-1/2 in.



Model FS-1001 F miniature low-frequency oscillator measures 1 x 1 x 2-1/2 in. The unit meets requirements for missile-power-supply-frequency and computer-master-time reference. Specifications are: frequency, as low as 8 kc; stability, $\pm 0.004\%$ to $+60^\circ\text{C}$; $\pm 0.019\%$ from -55 to $+70^\circ\text{C}$; $\pm 0.025\%$ from -55 to $+100^\circ\text{C}$; rise and fall time, 10 μsec max; output voltage, 0 ± 0.5 v to 6 ± 3 , -0.5 v swing; vibration, 30 g from 20 to 2,000 cps; shock, 70 g for 11 msec; temperature range, -55 to $+100^\circ\text{C}$.

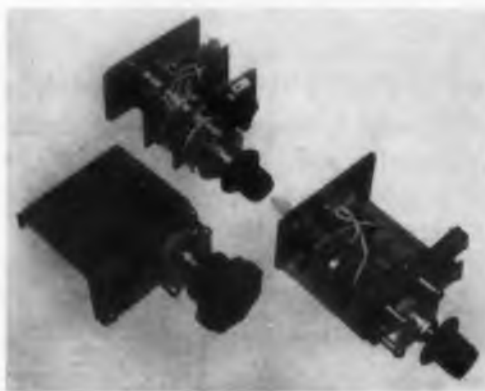
Monitor Products Co., Dept. ED, 815 Fremont, South Pasadena, Calif.

Price: \$200 to \$300 ea, prototype units.

Availability: 30 days.

Rotary Switches 386

Packaged switching assemblies are furnished



The Dot Switch-Pak packaged switching assemblies were originally designed for use with an electronic attenuator. The design differs from that of conventional rotary switches in that an eccentric or cardiac cam actuates a movable printed circuit board that is in contact with a stationary circuit board. Variations in cam shape and circuit layout can be designed for extremely complex switching sequences.

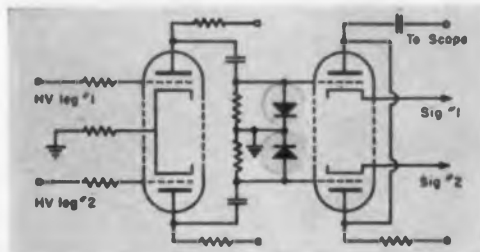
The Ucinite Co., Dept. ED, 459 Watertown St., Newtonville, Mass.

Availability: Made to suit customer specs.



GENERAL INSTRUMENT SEMICONDUCTOR REPORT

Design Notes...



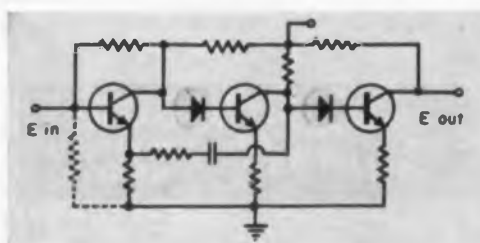
DIODE CLAMPS PREVENT DRIFT IN HIGH SPEED ELECTRONIC SWITCHES

The problem of drift in high speed electronic switches has been solved through the use of clamp diodes. This application is especially useful for stabilizing the operation of go, no-go oscilloscopic testing of dynamic parameters in a variety of electronic components.

In the circuit, General Instrument MP-300 silicon diode/rectifiers may be used because of their superior stability and low reverse leakage (only $.05 \mu\text{a}$ @ 25°C).

Changing from vacuum tube to silicon clamp diodes minimizes problems associated with varying contact potentials. Equipment reliability is improved since total thermal dissipation is reduced. Further, equipment does not have to be reset in case of power line failure.

The small physical size of General Instrument diode/rectifiers is important where a large number of switches are to be used in a single piece of equipment.



NOVEL CIRCUIT USES DIODES FOR AUDIO COUPLING There are many benefits to be gained through diode coupling of audio amplifiers. The simplified three-stage transistorized audio amplifier shown above uses General Instrument IN645 subminiature silicon diodes.

Since the diodes are forward biased, ac is virtually direct coupled—resulting in a flat frequency response limited only by transistor parameters. Need for large coupling capacitors is eliminated. Virtually lossless ac coupling is obtained. And, temperature stability is improved because of low external base resistance.

Complete schematics of above circuits are available upon request.

Proved Reliability: ZERO FAILURES after 11,000 hours operation at 150°C !

IN645-1N649 DIODE/RECTIFIERS AVAILABLE IN PRODUCTION QUANTITIES... EXCEED USAF STANDARDS

General Instrument 1N645 through 1N649 subminiature rectifiers are ideally suited for applications requiring small size and very high reliability. These hermetically sealed glass units are designed to operate over an ambient range from -65° to 150°C ... pass MIL-E-1/1143 specifications for breakdown voltage... offer superior life test performance. This series covers the range of 225 to 600 PIV, with maximum average rectified current of 400 ma @ 25°C . Maximum reverse current @ PIV is only $0.2 \mu\text{a}$.

These diode/rectifiers are subjected to 100% environmental testing and dynamic oscilloscopic tests to assure high electrical and mechanical uniformity, surpassing the most stringent military specifications.

LIFE TESTS indicate outstanding stability of the General Instrument 1N645 series subminiature rectifiers under load. Graph shows results of a 1,000-hour test of 231 units from a normal production run. (Conditions: V_{RMS} 160 V ac; I_o 400 ma dc.)



NEW MP SERIES DESIGNED FOR 200°C OPERATION!

General Instrument has achieved an outstanding power-to-size relationship in the high quality MP silicon diode/rectifier series. Parameters for these subminiature glass units are suitable for a wide range of applications under high-temperature conditions:

TYPE	PIV	DC OUTPUT CURRENT (Ma)		REVERSE LEAKAGE (μa) @ PIV		FORWARD DROP @ 400 Ma @ 25°C
		25°C	200°C	25°C	200°C	
MP 100	100	400	50	.05	75	1.0
MP 225	225	400	50	.05	75	1.0
MP 300	300	400	40	.05	75	1.0
MP 400	400	400	35	.05	75	1.0
MP 500	500	400	25	.05	75	1.0
MP 600	600	400	20	.05	75	1.0

CALL ON GENERAL INSTRUMENT for technical data and applications assistance on the complete line of General Instrument high reliability silicon diodes.



SEMICONDUCTOR DIVISION GENERAL INSTRUMENT CORPORATION

65 Gouverneur Street, Newark 4, New Jersey

4448

IN CANADA: General Instrument—F. W. Sickles of Canada Ltd., P.O. Box 408, 151 S. Weber Street, Waterloo, Ontario, Canada. Sherwood 4-8101.

CIRCLE 60 ON READER-SERVICE CARD

NEW CR* POWER SUPPLY



**NJE Offers Greatest
Power Per Panel Inch!**

- *Controlled Rectifiers
- Low Cost
- Remote Sensing
- Remote Programming

- *Fully Transistorized
- Series Operation
- Parallel Operation
- Constant Current#

- Convection Cooled, No Blowers

0-36 V	0-6 A	3 1/2" High
0-36 V	0-20 A	7" High
0-18 V	0-30 A	7" High

Output		Model No.	Input Power		Max. Ripple mv	Static Regulation		Dimensions H x W x D	Approx. Weight Pounds	Price
Volts	Amps		Volts	Freq. ††		Load †	Line †			
0-36	0-6	CR-36-6	105-125	55-65	3 P-P	±0.005% or ±0.5 mv	±0.02% or ±0.5 mv	3 1/2 x 19 x 16 5/8	45	\$595
0-36*	0-20	CR-36-20	105-125	55-65	3 P-P	±0.01 % or ± 1 mv	±0.02% or ± 1 mv	7 x 19 x 16 5/8	70	845
0-18**	0-30	CR-18-30	105-125	55-65	3 P-P	±0.01 % or ± 1 mv	±0.02% or ± 1 mv	7 x 19 x 16 5/8	70	845

†Whichever is greater
††Available for 400 cycle operation

*Preload of 1 ampere required for operation of 0-6 VDC
**Preload of 1.5 ampere required for operation of 0-3 VDC
#Contact factory or local representative



WRITE TODAY FOR COMPLETE TECHNICAL DATA

NJE CORPORATION
20 Boright Avenue • Kenilworth, New Jersey
BR. 2-6000 • TWX Cranford, NJ 51 • FAX-FFP

NEW PRODUCTS

Miniature Gear Heads

373

Occupy less than 1 cu in.



Developed for applications of airborne and missile equipment, these miniature gear heads, occupying less than 1 cu in., are available with reduction ratios as high as 2,000,000,000:1. Input starting torque can be as low as 0.002 oz-in. Miniature motors, including synchro and servo types, have been designed for use in conjunction with the gear heads.

Elgin National Watch Co., Elgin Micronics Div., Dept. ED, 366 Bluff City Blvd., Elgin, Ill.

Tachometers

675

Weigh less than 1.5 oz



Model SS-779E-1 dc tachometers weigh less than 1.5 oz and have an armature inertia of 3.5 g-cm². Linearity is 0.1%. Output is 3 v per 1,000 rpm and ripple does not exceed 3% of the dc output. An aluminum housing is used.

Servo-Tek Products Co., Dept. ED, 1086 Goffle Road, Hawthorne, N.J.

Price & Availability: \$32.50; from stock.

Silicon Transistors

582

For switching applications

Type 2N726 is the pnp complement to the 2N702 npn silicon mesa transistor. It has 1-w dissipation at 25 C. The BV_{CEO} is 20 v. The dc-beta is 15 to 45 at 25 C. At 100 mc, the unit has 1.4 min h_{fe} . Temperature range is -65 to +175 C.

Texas Instruments Inc., Dept. ED, P. O. Box 312, Dallas 21, Tex.

Availability: Immediate.

Plugs and Contacts

392

For aircraft and portable use



The Tuchel series of microminiature and miniature plugs are for use in aircraft, portable instrumentation, and other electronic applications. They can have 10, 16, 28, 34, and 50 contacts. Having a polyester insulation material, the plugs stand temperatures up to 356 F. Other specifications are: contact current rating, 3 amp; contact voltage rating, 60 v; and cable clamp opening, 0.197 in. in ID. Contacts are made of silver-copper alloy and accommodate 26-gage wire.

Cannon Electric Co., Dept. ED, 3208 Humbolt St., Los Angeles 31, Calif.

Availability: From stock.

Coaxial Line Duplexer

417

For 406 to 450 mc

This 3-1/8-in. duplexer uses two cell-type tubes and a single cell-type receiver protector tube. For the transmitter, peak power is 3 megawatt and average power is 5 kw. Units for other frequencies can also be furnished.

Bomac Laboratories, Inc., Dept. ED, Salem Road, Beverly, Mass.

Silicon Diodes

708

Stand severe environments



These high-conductance diodes are for applications requiring a small, lightweight device capable of standing severe environmental conditions. Designated types 1N482 through 1N488, the units are encased in a 400-mw package. Reverse working voltage is 36 to 380 v and reverse breakdown voltage is 40 to 420 v. Forward voltage, at 100 ma and 25 C, is 1.1 v for the 10% tolerance units and 1 v for the 5% types.

Hoffman Electronics Corp., Dept. ED, 3761 S. Hill St., Los Angeles, Calif.

Price: Type 1N482, \$1.19; type 1N488, \$4.50.

Availability: Immediate.



Probing new dimensions in Electronics through Stackpole Research . . .

A MAJOR NEW FERRITE

FOR TELE-COMMUNICATIONS

Permeability: 1800

Temperature Constant: 1.8×10^{-6} per °C (—20° to 120° C)

Avg. Temperature Coefficient (un-gapped cores):

0.29% per °C (—20° to 85° C)

μQ (merit factor): Greater than 200,000 at 100 kc

. . . these in brief are the salient electrical characteristics of Stackpole Ceramag 501—a remarkable new low-loss ferrite grade for the 10 kc to 250 kc range. Already revolutionizing the design of carrier-current communications filters, the material shows considerable promise for electronic switching circuits and others as well.

Cup cores of Ceramag 501 no larger than a quarter enable the design of filters with such narrow pass bands that message-handling capacities of communications systems can be increased from 2 to over 90 messages per channel. The extraordinary high gain of filters using Ceramag 501 combine with other inherent advantages—smaller size, no aging or life problems—for a significant contribution to system reliability.

But equally significant is the extremely close tolerances to which these cores are made. To achieve the exact air gap required, Ceramag 501 cups are supplied in matched pairs. Special Stackpole-designed mounting hardware and tuning slugs can also be supplied to assure easy assembly and maximum electrical performance with your own coil designs.

Almost four years in development, Ceramag 501 represents another basic contribution based on magnetic ceramic research and engineering by the oldest commercial ferrite producer in the United States.

Complete details on Ceramag 501 and the remarkable research facilities that made it possible are available upon request to the *Electronic Components Division*, Stackpole Carbon Company, St. Marys, Pa.



STACKPOLE Ceramag® FERRITE CORES

CERAMAG® FERRITE CORES • VARIABLE COMPOSITION RESISTORS • SLIDE & SNAP SWITCHES • CERAMAGNET® CERAMIC MAGNETS • FIXED COMPOSITION CAPACITORS • BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT • ELECTRICAL CONTACTS • GRAPHITE BEARINGS, SEAL RINGS, ANODES • HUNDREDS OF RELATED CARBON & GRAPHITE PRODUCTS.

CIRCLE 62 ON READER-SERVICE CARD

NEW PRODUCTS

Ultrasonic Cleaner 397

For heavy-duty use

These cleaners require no operator attention or tuning. The basic generator for model 10001 heavy-duty system provides an output of 1 kw avg and 4 kw peak. Units can be combined in modular installations to give up to 10-kw operation. Tanks have 8- and 32-gal capacities.

Powertron Ultrasonic Corp., Dept. ED, Patterson Place, Roosevelt Field, Garden City, N.Y.

Price: Starts at \$2,790.

Availability: From stock.

Teflon Stock 404

Comes in all basic shapes

This Teflon stock comes in tape, sheets, rods, and tubes. The sheets can be furnished in sizes up to 48 sq in. The tubes can be up to 36 in. in diameter and the rods, up to 20 in.

Fluoro-Plastics, Inc., Dept. ED, 2417-X62 Federal St., Philadelphia 46, Pa.

Price: \$9 to \$12 per lb.

Availability: Immediate.

Phase-Lock Telemetry 432 Receivers

Operates with dynamic range of 100 db

These phase-lock telemetry receivers operate with a range of 100 db at a sensitivity of -185 dbw. The units integrate phase-lock detection with a series of complementary modules. The five modules are the detector, converter, converter control, remote acquisition control and power supply. The detector unit has a 30-mc input. Units are available in models to cover the 108, 135, 378 and 960-mc bands. They can be used for propagation studies, satellite tracking and special-purpose telemetry.

Siegler Corp., Hallamore Electronics Div., Dept. ED, 714 N. Brookhurst St., Anaheim, Calif.

NEW! CONTROLLED

4 TRANSITRON TYPES AUGMENT

Silicon Controlled Rectifiers / Switches



NEW! CONTROLLED SWITCHES

TSW31S · TSW201S PNP bistable switching devices in TO-18 packages, with maximum holding current of 1 ma.

- High gate sensitivity 20 μ A to fire
- Covers current range from 1 ma to 200 ma @ 75°C ambient
- Voltage ratings up to 200 volts available
- Temperature range: -65°C to +150°C

CIRCLE 831 ON READER-SERVICE CARD



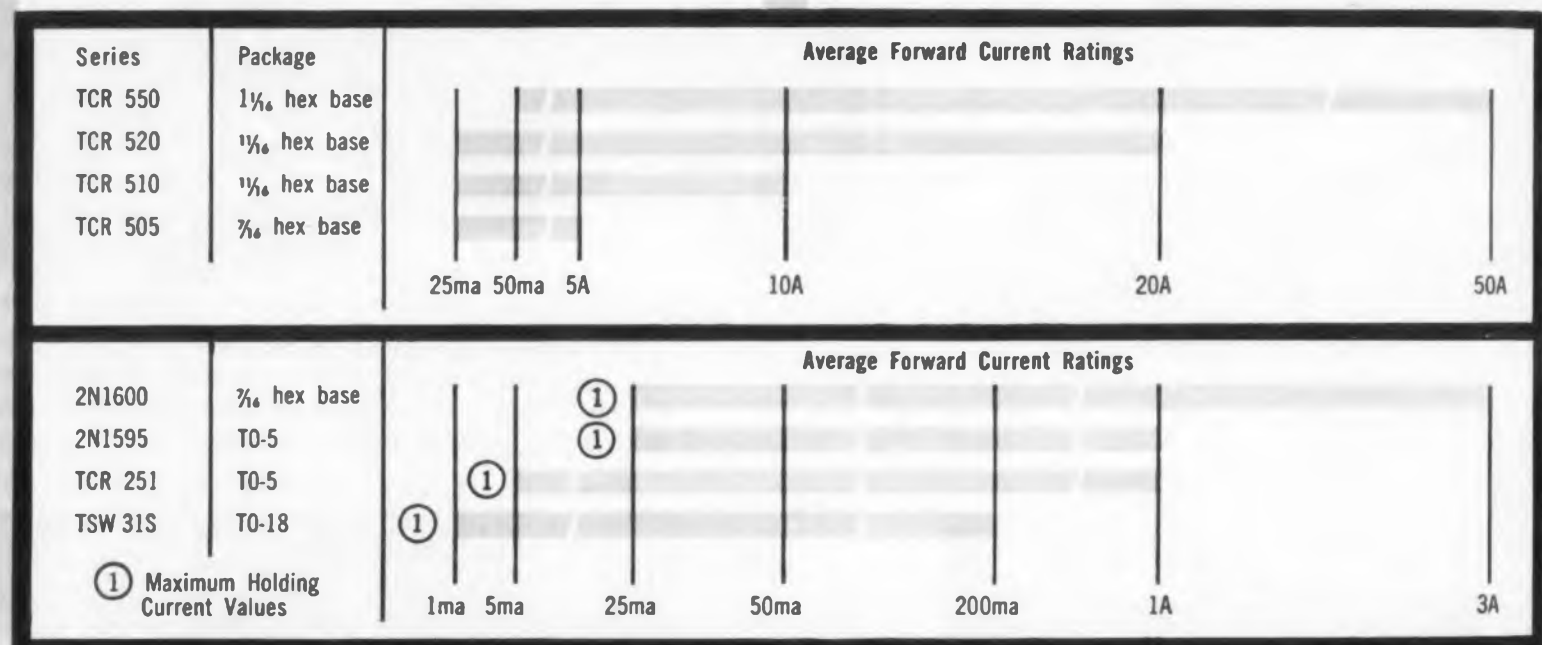
NEW! TO-5 PACKAGE CONTROLLED RECTIFIERS

Two series of diffused silicon PNP bistable switching devices with very low triggering requirements and micro-second switching.

TCR251-TCR4001 series featuring:

- Low leakage: 100 μ A @ 125°C case
 - High gate sensitivity: 200 μ A @ 25°C
 - Low Holding Current: 5 mA maximum @ 25°C
 - Current rating: 1 amp at 80°C case or 600 ma at 25°C ambient
 - Voltage ratings: Up to 400 volts
- Plus 2N1595-2N1599 series with same current and voltage ratings

CIRCLE 832 ON READER-SERVICE CARD



The complete Transistron line of Controlled Rectifiers and Controlled Switches includes the following higher current types:



NEW! 2N1600-2N1604 and TCR505-TCR4005 series diffused Silicon Controlled Rectifiers

- Current ratings: 3 amps at 80°C case; 1 amp @ 125°C case
- Voltage ratings: Up to 400 volts
- Package: 3/8" hex base



10 Amp Series

- Current ratings: 10 amps @ 25°C case; 5 amps at 100°C case
- Voltage ratings: Up to 400 volts
- Package: 1/2" hex base

20 Amp Series

- Current ratings: 20 amps @ 25°C case; 10 amps at 100°C case
- Voltage ratings: Up to 400 volts
- Package: 1/2" hex base



NEW!

50 Amp Series

- Current ratings: 50 amps at 100°C case
- Voltage ratings: Up to 400 volts
- Package: 1 1/4" hex base

ED RECTIFIERS & SWITCHES

EN INDUSTRY'S BROADEST LINE!

Binistors / Transwitches



THE BINISTOR (by-nis-tor)

Transitron's new silicon NPN Tetrode offers simpler, more reliable, more economical switching and storage circuitry. The key parameters of this bistable, negative resistance device are determined by external circuitry, providing remarkable stability and uniformity over wide temperature ranges. The signal and output swings are compatible with present transistor and diode circuits. Two series are available: The wide temperature range or military types and the commercial and industrial computer types. The stability and uniformity of each unit in the military series is absolutely guaranteed by the method of specification at critical temperatures (-65°C and +150°C).

CIRCLE 833 ON READER-SERVICE CARD
ABSOLUTE MAXIMUM RATINGS

	3N56	3N57
Collector to Emitter Voltage (V_{CE})	15 Volts	15 Volts
Collector Current @ 25°C (I_C)	30 mA	30 mA
Storage & Operating Ambient Temp. Range	-65°C to +150°C	-55°C to +100°C

3N56 MILITARY TYPE

SPECIFICATIONS & TYPICAL CHARACTERISTICS (At Noted Ambient Temp.)

TURN-ON	AMBIENT TEMP	MIN.	TYPICAL	MAX.	TEST CONDITIONS
D.C. Collector Saturation Voltage (V_{CE})	-65°C	—	0.46	1.0 V	$I_C = 10\text{mA}, I_b = +.5\text{mA}^*$ $V_J = 4\text{V}, R_J = 3\text{K}$ supply
	+25°C	—	0.7	1.0 V	
	+150°C	—	1.2	1.5 V	
Critical Injector Current (I_{crit})	-65°C	0	.38	.5 mA	$I_C = 10\text{mA}, I_b = -50\mu\text{a}$
	+25°C	0	.28	.5 mA	
	+150°C	0	.21	.5 mA	
TURN-OFF Base Cutoff Current (I_{bo})	-65°C	—	—	—	$V_{CE} = 15\text{volts}, V_{JE} = +13\text{volts}$ $V_{BE} = -.6\text{volts}$
	+25°C	—	.020	0.2 μA	
	+150°C	—	2.0	10.0 μA	

3N57 COMPUTER TYPE

SPECIFICATIONS & TYPICAL CHARACTERISTICS @ 25°C

TURN-ON	MIN.	TYPICAL	MAX.	TEST CONDITIONS
D.C. Collector Saturation Voltage (V_{CE})	—	0.7	1.0 V	$I_C = 10\text{mA}, I_b = +.5\text{mA}^*$ $V_J = 4\text{V}, R_J = 3\text{K}$ supply
Critical Injector Current (I_{crit})	0	.28	0.5 mA	$I_C = 10\text{mA}, I_b = -50\mu\text{a}$ $I_C = 0.25\text{mA}, I_b = -50\mu\text{a}$
TURN-OFF Base Cutoff Current (I_{bo})	—	.020	.2 μA	$V_{CE} = 15\text{volts}, V_{JE} = +13\text{volts}$ $V_{BE} = -.6\text{volts}$

*Unit must switch on under the above conditions; however, actual V_{CE} measurement is made with $I_b = -50\mu\text{a}$



THE TRANSWITCH

A PNPN bistable silicon computer element that can be turned on and off with gate current. The device is available in the T0-18 package, and is designed for miniaturized memory circuits, ring counters, shift registers, controlled rectifier drivers, and flip flop equivalents. A 100 ma series (TSW-31A-TSW-201A) has been added to the Transwitch series. Both series (50mA and 100mA) are available in voltage ratings up to 200 volts. For commercial and industrial applications, the SW-30 type is now available. This unit, especially designed for lower temperature applications, features maximum collector current rating of 30mA and maximum voltage rating 30 volts.

CIRCLE 834 ON READER-SERVICE CARD
ABSOLUTE MAXIMUM RATINGS

	SW-30	TSW-31 thru TSW-201	TSW-31A thru TSW-201A
Forward current I_f	30 mA	50 mA	100 mA
Operating temp. range	-55°C to +85°C	-55°C to +125°C	-55°C to +125°C

SPECIFICATIONS (AT 25°C)

	SW-30	TSW-31 thru TSW-201	TSW-31A thru TSW-201A
Max. Saturation Voltage (V_s)	1.5 V @ 30 mA	1.5 V @ 50 mA	2 V @ 100 mA
Max. Forward "OFF" Current (I_{CEO})	10 μA	10 μA	10 μA
Max. Reverse Current (I_R)	10 μA	10 μA	10 μA
Max. Forward "OFF" Current (I_{CEO})	50 μA @ 85°C	50 μA @ 125°C	50 μA @ 125°C
Max. Reverse Current (I_R)	50 μA @ 85°C	50 μA @ 125°C	50 μA @ 125°C
Max. Gate Voltage to Switch "ON" ($V_{G ON}$)	1.0 V	1.0 V	1.0 V
Max. Gate Current to Switch "ON" ($I_{G ON}$)	1.5 mA	1.0 mA	1.0 mA
Max. Gate Voltage to Switch "OFF" ($V_{G OFF}$)	-5.0 V	-4.0 V	-6 V
Max. Gate Current to Switch "OFF" ($I_{G OFF}$)	-8.0 mA	-10 mA	-20 mA
Max. Holding Current (I_H)	10.0 mA	5.0 mA	7.0 mA

In writing for further information on all these devices, refer to the following bulletin numbers:

Controlled Rectifiers & Switches	Binistor & Transwitch
TSW-31S series Bulletin # TE-1356E	TSW-31A Bulletin # TE-1357B-1
TCR-251 series Bulletin # TE-1356D	TSW-31 Bulletin # TE-1357B
2N1595 series Bulletin # TE-1356C	SW-30 Bulletin # TE-1357E
2N1600 series Bulletin # TE-1356B-1	3N56 Bulletin # TE-1360A
TCR-505 series Bulletin # TE-1356B	3N57 Bulletin # TE-1360B
10 amp series Bulletin # TE-1356A-1	
20 amp series Bulletin # TE-1356A	
50 amp series Bulletin # TE-1356AA	



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CHICAGO, Illinois
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Oak Park, Ill. Village 8-5556

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DAYTON, Ohio
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Hollywood 28, Calif. Hollywood 2-2381

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ORLANDO, Florida
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205 E. Jackson St. Cherry 1-4526

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cable address: Troica

CIRCLE 835 ON READER-SERVICE CARD

◀ CIRCLE 831-834 ON READER-SERVICE CARD

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electronic corporation
wakefield, melrose, boston, mass.



"Leadership in Semiconductors"

SEE YOUR AUTHORIZED DISTRIBUTOR FOR QUANTITIES FROM 1-999



United Eyelets and Eyeleting Machines Keep this Princess on Constant Call



US 0-04

The new Princess telephone — a product of the Western Electric Company — is an achievement in communication design INSIDE as well as out, thanks in part to a United Eyeleting Machine that automatically feeds and sets six twin United Eyelets in a plastic insulating terminal board no bigger than a cigarette lighter.

United achieved automation of terminal board production. Accurate alignment of the setting bar and an especially rigid frame — unique with the Model F United Eyeleting Machine — brings uniform pressure to bear on all six twin United Eyelets scattered over a broad pattern range. Reliability for the lifetime of the Princess was thus assured.

If you want faster production using greatly simplified setups of multiple mechanisms plus absolute reliability in multiple eyelet patterns, call on United . . . where over sixty years' experience in the design, development and production of eyelets and eyeleting machines, is at your service.

Your nearest United sales office has full information on the complete line of United Eyelets and Eyeleting Machines. Call or write today.

United

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140 FEDERAL STREET, BOSTON 7, MASSACHUSETTS

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CIRCLE 65 ON READER-SERVICE CARD

NEW PRODUCTS

Circuit Breaker

646

For low current circuit protection



Circuit breaker model MP-1660 is designed to protect low current circuits and components of electronic equipment. It is trip-free, manually operated and is available in 1/4- to 10-amp ratings. Minimum capacity is 2,000 per cent of rated load. The manufacturer claims ambient temperature has almost no effect on calibration. Terminals are quick disconnect type.

Mechanical Products, Inc., Dept. ED, Jackson, Mich.

Delay Lines

418

Delay time is accurate to ± 1 nsec

These delay lines consist of 285 ft of 1/2-in., 50-ohm cable. Terminating ends are bent on a 2-in. radius. Each unit is 16 in. in diameter and 6-in. high. Applications include missile checkout equipment.

American Tube Bending Co., Electronics Div., Dept. ED, New Haven, Conn.

DC Amplifier

621

Weights 110 lb



Model 759-5 dc amplifier weighs 110 lb. It accepts inputs of ± 1 , 10, 100 and 1,000 μv full scale. Input impedance is 1 to 5 meg. Model 759-6 low-level amplifier has the same specifications but includes a built-in panel-meter.

Magnetic Instruments Co., Inc., Dept. ED, 546 Commerce St., Thornwood, N.Y.

Price: \$199.50 ea.

Availability: From stock.

Isolation Transformer

718

Ultrashielded, hermetically-sealed units



Types HIT-1, 2 and 3 isolation transformers simulate battery operation. These ultrashielded, hermetically-sealed units are for critical circuits requiring great isolation for power line equipment. The effective capacity coupling between primary and secondary windings is less than 0.1 pf. Input is 115 v, 50 to 60 cps; output is 115 v. The units meet MIL-T-27A specs.

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N.Y.

Price: HIT-1, \$33 ea; HIT-2, \$48 ea; HIT-3, \$69 ea.

Availability: From stock.

Push-Pull Switch

609

For variable resistors

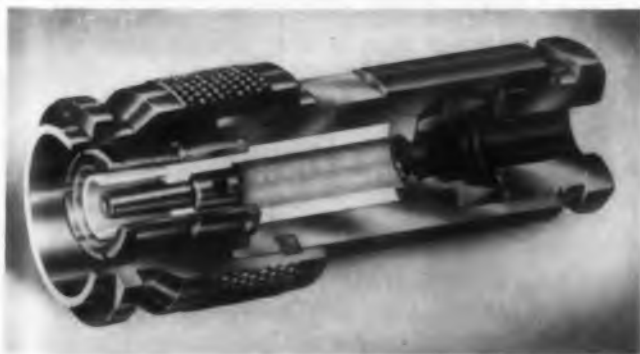
Type G-16 switch is rated at 5 amp at 125 v ac and has spst contacts. It can be furnished on many of the firm's variable resistors to control volume, tone, contrast and other variable-resistor functions.

Stackpole Carbon Co., Electronic Components Div., Dept. ED, St. Marys, Pa.

RF Connectors

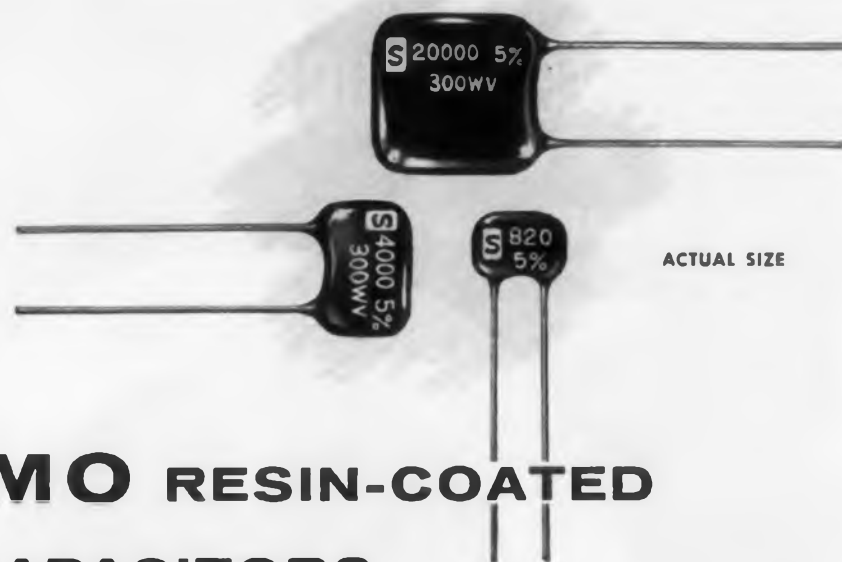
672

For use with small coaxial cables



Designed for use with coaxial cables such as the RG59 B/U, these connectors are offered in impedances of 50 and 75 ohms. Maximum voltage ratings is 2,500 v. All body parts are brass; irradiated polyolefin and polypropylene are used.

National Connector Corp., Dept. ED, 311 Fifth Ave., N., Minneapolis 1, Minn.



NEW SANGAMO RESIN-COATED SILVERED-MICA CAPACITORS...

are significantly smaller... operate to +150° C... exceed proposed dipped-mica capacitor military specifications



Sangamo experience with mica capacitors and years of engineering know-how and quality development underline two new Type D Resin-Coated Silvered-Mica Capacitors. Designed for operation at temperatures of +125° C and +150° C, both offer the advantages of radial leads, small size, full rated working voltage without derating, and a clean, moisture-sealed protective resin coating. Physical and electrical features of the Type D capacitor are ideal for etched circuits, high component-density equipments, missiles, computers, and instrumentation devices. Type D capacitors are available with characteristics C, D, E, or F, in nearly all capacitance values.

Test these new Sangamo Type D Resin-Coated Silvered-Mica Capacitors — they more than meet proposed military specifications. Try them in your own circuits — they will fulfill all expectations of today's most critical applications. Those who know capacitors choose Sangamo for outstanding performance and long life.

... Type D Resin-Coated Silvered-Mica Capacitors are an important part of the transistorized circuitry of this Sangamo Type 460 Tape Transport System. Their small size, high-temperature performance, and reliability contribute materially to the transport's recording uniformity and play-back accuracy —

SC60-7

SANGAMO ELECTRIC COMPANY, Springfield, Illinois
— designing toward the promise of tomorrow

CIRCLE 66 ON READER-SERVICE CARD

CERTIFIED PROOF *in writing*

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UNNECESSARY

FOR

FANSTEEL
TANTALUM
CAPACITORS

Gold Cap *



Hundreds of manufacturers are now saving time and money by specifying Gold-Caps exclusively because they no longer need to inspect or test on their own to verify reliability.

Each and every Fansteel Gold-Cap shipped conforms to the most complete and rigid specifications ever prescribed for any production component. Users get certified written proof that each has successfully passed a series of the most uncompromising tests ever devised for checking reliability in a tantalum capacitor.

Only Fansteel dares take the responsibility of *pre-testing* for you —and certifying the results!

Gold-Cap Tantalum Capacitors in some ratings now available from stock. Complete Gold-Cap Specifications available on request. Fansteel Metallurgical Corporation, North Chicago, Illinois, U.S.A.

*Trademark

FANSTEEL

WHERE RELIABILITY DICTATES STANDARDS

CIRCLE 70 ON READER-SERVICE CARD

C609A

NEW PRODUCTS

Space Acceleration Computer 431

Gives true rms indication

The absolute space acceleration computer computes and indicates the true rms value of the space acceleration vector. The Dial-A-Gain in each channel normalizes each sensitivity separately. The unit has a 10-db range. Power requirement is 105 to 125 v, 60 cps, 100 w. Frequency response is $\pm 2\%$ from 5 to 5,000 cps. Accelerometer sensitivity is 1 to 100 mv rms per g rms and measurement is 0.3 to 100 g rms in five ranges. Accuracy is $\pm 3\%$ on logarithmic scale, 15 to 5,000 cps; $\pm 5\%$ from 5 to 15 cps. Input impedance is at least 200 meg shunted by less than 100 pf.

Unholtz-Dickie Corp., Dept. ED, 2994 Whitney Ave., Hamden, Conn.

Relay Socket 405

Measures 1-11/32 in. long

Series 145-8 precision-molded, 8-contact relay socket measures 1-11/32 in. long. It can be furnished with solder cup for direct wiring or dip-solder pin termination for printed-circuit assembly. Body material is glass-filled Diallyl Phthalate or asbestos-filled Melamine.

Continental Connector Corp., Dept. ED, Woodside 77, L.I., N.Y.
Availability: Four to six weeks.

Servo Repeater 527

For shaft-position indication

Suitable for use with a synchro transmitter, this device indicates in digital form the angular position of a remote shaft. The coded output, in various binary codes, is suitable for entry to printers, tape punches, card punches and light banks. Designated type SR-114, the unit is accurate to ± 1.5 counts, has a resolution of 0.36 deg of the input shaft, and measures 8 x 6 x 4 in.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

Trigger Tubes 485

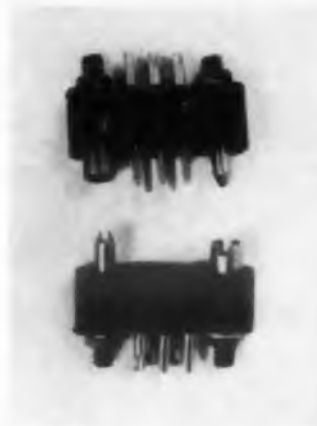
For high- and low-current applications

These trigger tubes are offered in four models. Types LTG-27-2 and LTG-27-2A are rated at 6 ma; types 120TG-27-2 and 160TG-27-2 are rated at 0.5 ma. They are claimed to be the smallest tubes of this type.

Signalite, Inc., Dept. ED, 37-41 Neptune Highway, Neptune, N.J.

Miniature Connectors 486

Variety of types offered



Series 300 microminiature connectors are available with 5, 7, 9, 11, 14, 20, 26, 34, 44, and 55 contacts. They can be supplied with guide pin and guide socket or jacking screwlock with or without hoods. Contacts are made of phosphor bronze or beryllium copper. Body material is glass reinforced with diallyl phthalate, glass-filled Plaskon Alkyd or other materials.

Atlan Connectors Corp., Dept. ED, 27 E. 21st St., New York 10, N.Y.

Price & Availability: From stock to three weeks.

Hydraulic Motor 529

Controls missile antennas

Type CMF-02 controls missile antennas as they track moving targets. The unit develops 1/3 hp at 6,000 rpm, continuous speed. Displacement is 0.02 cu in. per revolution. The motor maintains a smooth motion even at low speeds.

The Bendix Corp., Bendix Hamilton Div., Dept. ED, Hamilton, Ohio.

Digital Servo Indicator 487

Has synchronized chart drive

Having a 3-in. synchronized chart drive, model 243 digital servo indicator provides permanent recording of transducer outputs. Digital readout accuracy is 0.1%; chart accuracy is $\pm 1\%$. Dimensions are 6 x 11-1/8 x 12 in.

Gilmore Industries, Inc., Dept. ED, 13015 Woodland Ave., Cleveland 20, Ohio.

Piezoelectric Accelerometer

488

For in-flight transducer measurements



Model 606 piezoelectric accelerometer is for special shock and vibration test applications. It is 1/4 in. long and weighs 1 g. Sensitivity is 2.5 mv per g, frequency response is 5 cps to 10 kc and resonant frequency is 135 kc. Maximum acceleration is 40,000 g. Amplitude linearity is $\pm 2\%$.

Columbia Research Laboratories, Dept. ED, Macdade Blvd. and Bullens Lane, Woodlyne, Pa.

Price & Availability: \$225 in quantities of 1 to 5, \$202.50 in quantities of 6 to 10, and \$191.25 in quantities of 11 to 50. Delivery time is two weeks.

Terminal Strip

526

Quick-disconnect type

This terminal strip speeds up the maintenance of electronic systems by making it possible to rapidly disconnect a malfunctioning unit. It is a combination of a barrier-terminal strip and a blade-type inter-connecting strip. Made of a special alloy of bronze, the device is corrosion resistant.

Infrared Industries, Inc., Dept. ED, P. O. Box 42, Waltham 54, Mass.

Transistorized Gaussmeter

521

Reads from 1- to 30,000-gauss full scale

Model 110 portable, direct-reading gaussmeter measures direction and magnitude of magnetic-flux density. It reads from 1- to 30,000-gauss, full scale, in these 10 ranges: 1, 3, 10, 30, 100, 300, 1,000, 3,000, 10,000 and 30,000 gauss. Applications include readout of magnetic ink and magnetic tape, meters, vibration pickups, dc motors and magnets.

F. W. Bell, Inc., Dept. ED, Columbus, Ohio.

Price: \$350 ea.

Availability: November 15, 1960.

Test Console

489

For inertial gyros

This console contains all necessary electronics for testing inertial gyros. Features include: a torque-to-balance feedback loop, magnetic-suspension panel, compensation, dual-photocell amplifiers, gyro-wheel supplies, frequency source, dual demodulator and servo amplifier.

Northeastern Engineering, Inc., Dept. ED, Manchester, N.H.

Availability: 120 days.

DC-DC Converters

490

For mobile transceiver equipment

Models 701 and 702 dc-dc converters for mobile transceiver equipment provide dual outputs in various combinations from 250 v dc at 300 ma to 500 v dc at 150 ma, for a total of 100 w. Input is 12.8 v. The units, transistorized, have an efficiency better than 90% at 100 w. Ripple is less than 1% rms. The model 701 measures 5-11/16 x 2-13/16 x 3-1/2 in.; model 702 measures 4-9/16 x 2-13/16 x 4-1/16 in. Both units weigh about 2 lb.

Universal Transistor Products Corp., Dept. ED, 36 Sylvester St., Westbury, L.I., N.Y.

Price: Unit price for model 701 is \$100, for model 702 is \$108.

2 MORE NEW FANSTEEL IN SERIES SILICON POWER RECTIFIERS

**TOUGH...
RUGGED...
RELIABLE**

Newest addition to Fansteel's expanding line of 1N Series Silicon Power Rectifiers

Full 160 amp. load in half-wave circuits, up to 450 amps. in 3-phase bridge circuits

Designed for rugged duty on the toughest applications

Full 240 amp. load in half-wave circuits, up to 675 amps. in 3-phase bridge circuits

Assembled and sealed in Fansteel's surgically-clean "white room" for maximum reliability

Operating temperatures up to 150°C Case temperature. Peak reverse voltages 50 to 400 volts.

Write for Complete Technical Data

FANSTEEL METALLURGICAL CORPORATION • North Chicago, Illinois • U.S.A.



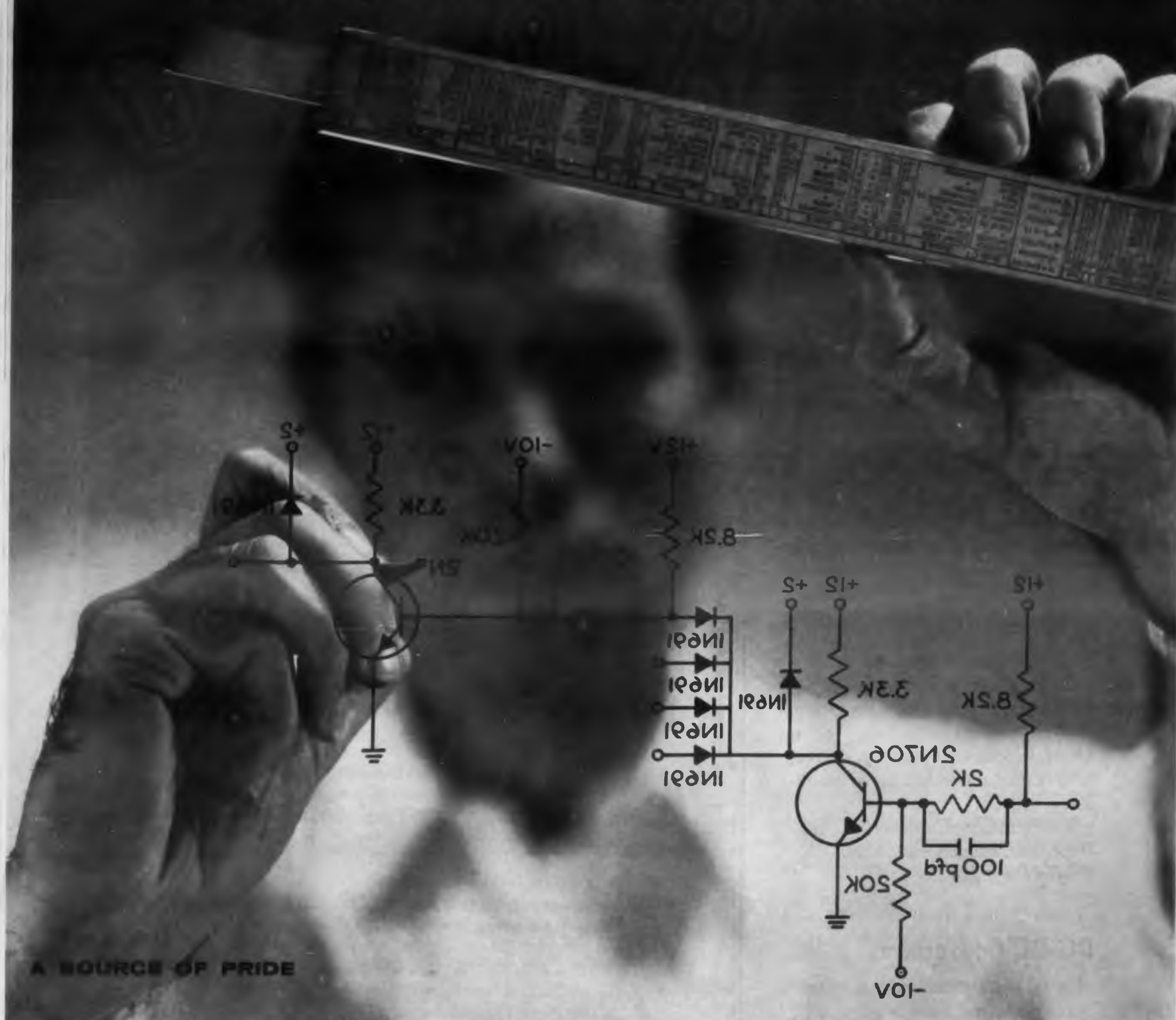
WHERE RELIABILITY DICTATES STANDARDS

CIRCLE 71 ON READER-SERVICE CARD

E608A

81

POINT OF NO RETURNS



A SOURCE OF PRIDE

Desk-eye view of a computer logic circuit utilizing Sperry 2N706 Silicon Mesa Transistors.

SPERRY

SPERRY SEMICONDUCTOR
DIVISION

OF

SPERRY RAND CORPORATION
NORWALK, CONNECTICUT

Here's where you put your experience on the line.

Will the vendor you select confirm the confidence of your decision . . . or will the transistors he delivers return to haunt him — and you?

63 QC checks before and during mechanized manufacture. Our way of trying to make your confidence our **only** return!

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*Trade Mark, Sperry Rand Corporation

NEW PRODUCTS

Precision Ratio Transformers 491

Provide voltage division from 1 to 0.001

This set of three precision ratio transformers can provide any voltage division from 1 to 0.001 in steps of 0.001 with an accuracy of one part in 10,000. Input is 0 to 6.3 v, 60 cps, or 0 to 40 v, 400 cps. Type A transformer has taps providing ratios from 0.1 to 1; type B transformer provides 0.01 to 0.1 ratios; type C transformer provides 0.001 to 0.01 ratios. Devices measure 1-1/2 in. diameter and 1-3/8 in. high. Units are hermetically sealed.

Magneto, Inc., Dept. ED, 6 Richter Court, East Northport, L.I., N.Y.

Price: Kit, \$180; individual units, \$75.

Power Relay 523

Contact rating is 10 amp at 115 v ac

Having coil voltages up to 230 v ac or 115 v dc, type-P2 relay has a contact rating of 10 amp at 115 v ac. It has 3/16-in. quick-connect or solder terminals on the front panel, and, if necessary, on the coil. Contact arrangements are up to 3pdt.

Warco Industries, Dept. ED, 6625 Delmar Blvd., St. Louis 30, Mo.

Ferrite Isolators 492

Are temperature compensated

These temperature-compensated ferrite isolators are offered in both waveguide and coaxial types. Designed for military applications, they withstand environmental extremes. Typical specs are: operating frequency, several bands within the 1,120 to 12,400 mc range; isolation up to 40 db; and insertion loss, 0.5 to 1 db.

Caswell Electronics Corp., Dept. ED, 414 Queens Lane, San Jose, Calif.

Availability: From stock.

← CIRCLE 72 ON READER-SERVICE CARD

Code Translator 493

Converts binary to binary-coded-decimal

Model 3-101 code transistor provides inline digital data translation of straight binary-coded data into a binary coded decimal form. It has applications in instrumentation, data processing and computing systems. The unit accepts straight binary inputs of pulse or level configuration. It is completely integrated with an associated power supply, an internal programming and control circuits. It operates at 5,000 conversions per second for maximum word length.

Applied Development Corp., Dept. ED, 12838 Weber Way, Hawthorne, Calif.

Price & Availability: \$3,950 ea; delivery 30 days after order received.

Power-Supply Controller 737

Maintains an accuracy of 1 part in 10^5

This nuclear magnetic resonance controller is for current-regulated dc power supplies. In operation, minute variations in the electrical current supplied to a load are detected, amplified and fed to the controller. The device can maintain control with accuracies to 1 part in 10^5 .

Automation Industries, Inc., Dept. ED, 3613 Aviation Blvd., Manhattan Beach, Calif.

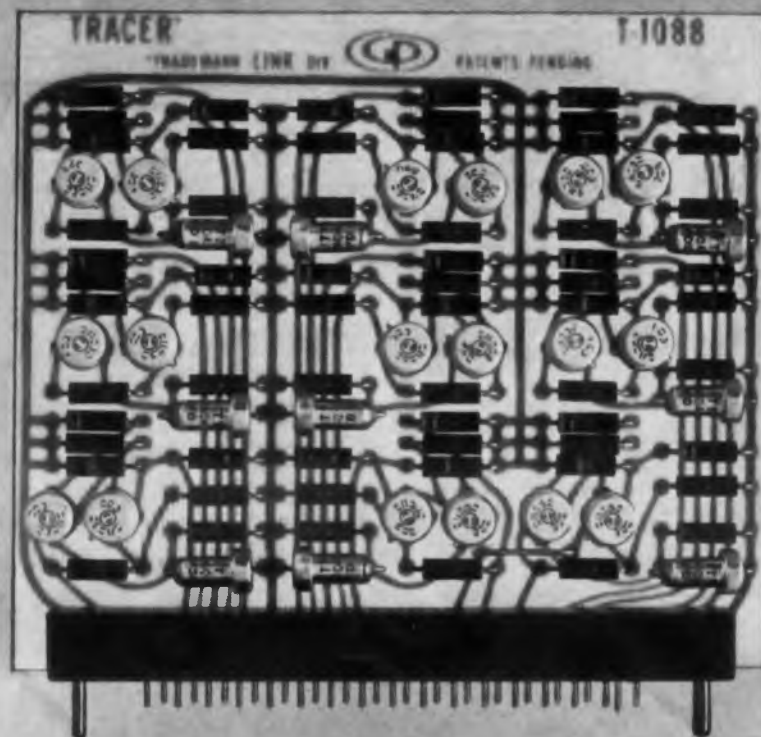
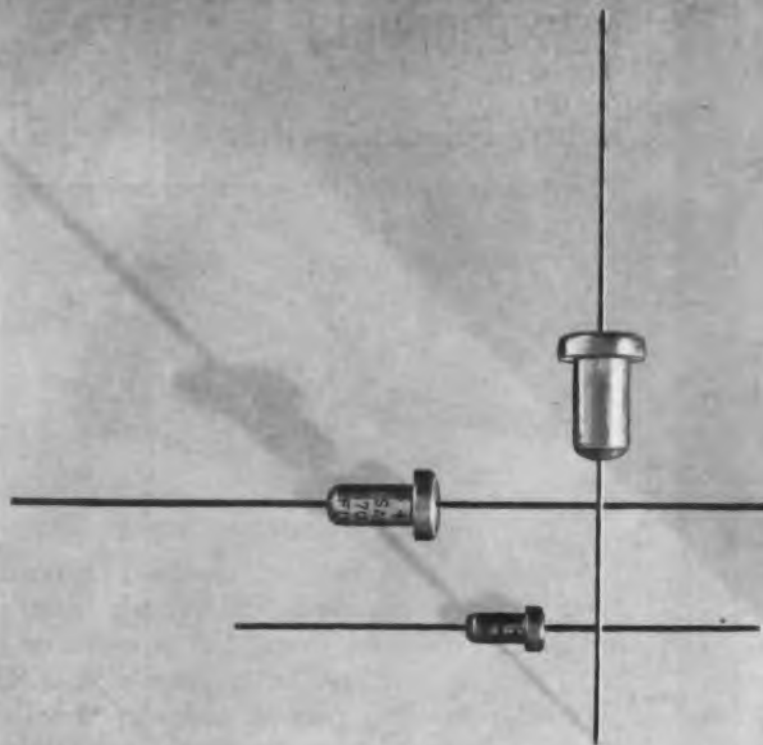
TV Deflection Yokes 494

For transistorized TV

These deflection yokes, used to control the beam of TV picture tubes, are designed for battery-powered, transistorized TV sets. The yokes have a form of toroidal vertical winding and a saddle-shaped horizontal winding. Vertical sensitivity is claimed to be 30% better than that of current model yokes.

General Instrument Corp., F. W. Sickles Div., Dept. ED, 165 Front St., Chicopee, Mass.

CIRCLE 73 ON READER-SERVICE CARD ➤



Link Division of General Precision, Inc. specified ITT capacitors for this vital portion of its Tracer Identification and Control System, which demands utmost reliability and long life expectancy from every component.

TOTAL PROCESS CONTROL AND DISCIPLINED PRODUCTION DELIVER

HIGH-RELIABILITY WET-ANODE TANTALUM CAPACITORS FROM ITT

ITT wet-anode tantalum capacitors meet MIL-C-3965B—a fact proved by independent laboratory qualifications tests on ITT capacitors. The reliability and long life expectancy of these competitively-priced capacitors are direct results of ITT's total process control and disciplined production procedures, above and beyond testing standards more stringent than normal industry practice—and backed by ITT's world-wide facilities and experience.



Phone these ITT-CD Capacitor Sales Offices:

Albuquerque	AX 9-8013	Los Angeles	HI 6-6325
Boston	CA 7-2980	Miami	MI 4-3311
Chicago	SP 7-2250	Minneapolis	WE 9-0457
Cleveland	GR 5-3080	New York	LO 5-1820
Dallas	EM 1-1765	Philadelphia	TR 8-3737
Dayton	BA 8-5493	Phoenix	WH 5-2471
Denver	KE 4-5091	Rochester	FI 2-1413
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IN STOCK AT ITT DISTRIBUTORS:

- TWO TYPES—M-Type and P-Type, for applications from -55 to 85 and 125 C. respectively
- 29 VALUES—from 1.75 to 330 mfd's over a working voltage range to 125 VDC and maximum surge voltages to 140 VDC
- COMPACT AND RUGGED—sintered tantalum slug in fine-silver cases for 2000-hour life at maximum temperature and working voltage
- GUARANTEED—to 80,000 ft. and accelerations of 20 G's with a 0.1 in. excursion in 50-2000 cps range
- LONG STORAGE LIFE—tantalum-oxide dielectric is completely stable; assures trouble-free operation

COMPLETE SPECIFICATIONS ON ITT wet- and solid-anode tantalum capacitors are available on request. Write on your letterhead, please, to the address below.

ENGINEERS: Your ITT representative has a complete set of qualifications and quality control tests for your inspection.

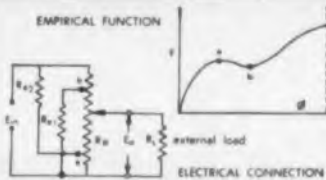
Total accuracy
Inherent reliability
Extremized construction

NON-LINEAR FUNCTION POTENTIOMETERS

$$R = f(\theta)$$

Non-linear potentiometers are used in many applications where the output of a linear potentiometer is not desired. The maximum accuracy is obtained by the use of a non-linear potentiometer. The maximum accuracy is obtained by the use of a non-linear potentiometer. The maximum accuracy is obtained by the use of a non-linear potentiometer.

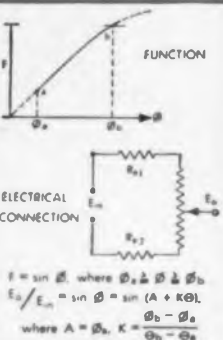
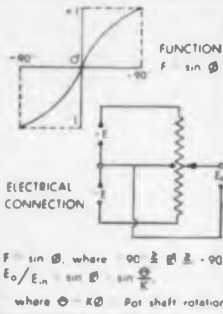
Among the uses of TIC non-linear pots are as gain potentiometers, as zero potentiometers in feedback control systems, as a gain potentiometer in a wide variety of systems. The use of the maximum accuracy of TIC non-linear pots can be included as a step in a gain potentiometer, as a step in a gain potentiometer, as a step in a gain potentiometer.



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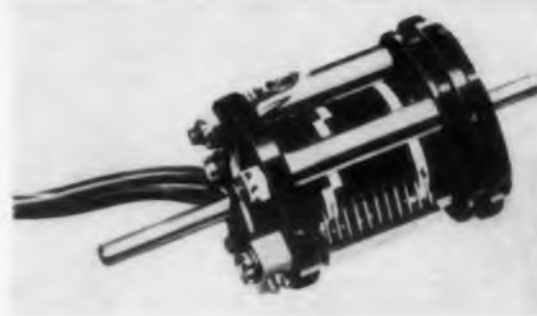


NEW PRODUCTS

Rotary Selector Switch

712

For telemetry, sampling, scanning, and pulsing



A rotary selector switch is designed for telemetry, sampling, scanning, and pulsing, particularly in missiles and aircraft. It is available in 8, 10 and 12 positions. It is enclosed in a size 10 synchro housing. Angular accuracy is within 15 min of arc. Gold-epoxy drum commutators and mating broom type precious metal brushes render low contact resistance and noise. Life expectancy is over 20 million cycles.

Airflyte Electronics Co., Dept. ED, 535 Avenue A, Bayonne, N.J.

Availability: From stock.

Magnetic-Amplifier Relay

679

Components are immersed in potting gel



In this 400-cps magnetic-amplifier relay, all components are immersed in the potting gel within the hermetically sealed enclosure. The unit has a 100-g shock rating and 10 g to 55 cps vibration immunity. Push-pull circuitry affords stable operation over $\pm 10\%$ variations in line voltage and frequency. Sensitivity is $0.2 \mu w$ dc. The unit can be used for comparison of circuits, voltages and resistances in order to monitor temperature, light intensity, radiation level and other variables.

Sigma Instruments, Inc., Dept. ED, 197 Pearl St., South Braintree 85, Mass.

Price: List, from \$120 to \$140.

Availability: Sample quantities, three to four weeks.

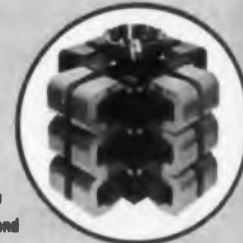
Think Clean

When you think of high vacuums, you have to think clean... and if you think of exceptionally clean vacuums, without fluids or other contaminants, you have to think of UlteVac electronic vacuum pumps — made by Ultek, the only manufacturer devoted exclusively to the technology of fluidless vacuum pumping. UlteVac pumps, using no moving parts, hot filaments, or refrigeration, produce vacuums to 10^{-9} mm Hg and below; operate unattended for months, invulnerable to power failure. System vacuum automatically measured.



ELECTRONIC HIGH-VACUUM PUMPS

1 to 1000 Liters/Second



Series 327 Pump
270 Liters/Second

Also from Ultek, an exclusive line of high vacuum accessories, including:

- SORPTION ROUGHING PUMPS
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Literature available (state application) from Ultek or its exclusive sales representative, Kinney Mfg. Div. of the New York Air Brake Co. Sales Offices in major U. S. cities.

ULTEK
CORP.

920-D Commercial St. • Palo Alto, Calif. • DA 1-4117

CIRCLE 74 ON READER-SERVICE CARD

Germanium Transistors

677

For communications applications



The 2N1405 germanium mesa transistors are for use as rf amplifiers, oscillators or if amplifiers in transceivers and communications equipment. Noise figure is low at frequencies in excess of 1,000 mc. Conversion gain approximates the amplifier gain in the range of 200 to 500 mc. Typical bandwidth product is 300 mc.

Texas Instruments, Dept. ED, P. O. Box 312, Dallas 21, Tex.

Variable-Inductance Tuner

613

Covers from 20 to 300 mc

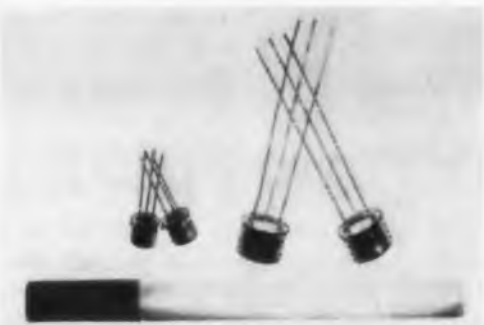
The 300 series, having one to seven ganged sections each about 1.5-in. sq and 1-in. long, are for use in military and commercial communications systems. They offer a frequency-rotation ratio of 4:1. A linearity of ± 150 kc can be furnished.

P. R. Mallory & Co., Inc., Dept. ED, Indianapolis 6, Ind.

Silicon Transistors

676

Small-signal type



This line of silicon mesa transistors is designed for applications such as audio and servo amplifiers, power supplies and medium-speed switches. They are designated the 2N734, 2N738, 2N1564 and 2N1572. Both TO-18 and TO-5 cases are offered. Betas are 20 to 50, 40 to 100 and 80 to 100.

Texas Instruments Inc., Dept. ED, P. O. Box 312, Dallas 21, Tex.



*ESC's new miniature
Transponder Delay Line fits
into just 6 cubic inches!*

For modern airborne equipment, where space and weight are critical, ESC has created a new **Miniature Transponder Delay Line**—Model 52-44...which embodies the most advanced techniques of weight and space reduction. It measures just 6 cubic inches total!

Specifications—Model 52-44, Lumped Constant Delay Line:

Impedance—470 ohms	Attenuation—4 db
Delay Time—20.3 \pm .1	Size—1" x 2" x 3"
Rise Time—.6 (max.)	Weight—6 ounces
Temperature Coefficient—	Tapped as required
65 ppm or better over a temperature range of -55°C to +125°C	



Custom variations available to your exacting specifications.



ESC

WRITE TODAY FOR COMPLETE TECHNICAL DATA.

*exceptional employment opportunities for engineers experienced
in computer components...excellent profit-sharing plan.*

ELECTRONICS CORP. 534 Bergen Boulevard, Palisades Park, New Jersey

Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Step variable delay lines • Shift registers • Video transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

CIRCLE 76 ON READER-SERVICE CARD

EL84 6BQ5

high slope output pentode

Output pentode rated for 12W anode dissipation, primarily intended for use in a.c. mains operated equipment.

characteristics

V_a	250	V
V_{g2}	250	V
I_a	48	mA
I_{g2}	5.5	mA
V_{g1}	-7.3	V
g_m	11.3	mA/V
r_a	38	k Ω
μ_{g1-g2}	19	

SUPPLIES AVAILABLE FROM:

IN THE U.S.A.
International Electronics Corporation
81 Spring Street, New York 12, N.Y.
Worth 8-0790

IN CANADA
Rogers Electronic Tubes & Components
116 Vanderhoof Avenue, Toronto 17, Ontario.
Hudson 5-8621



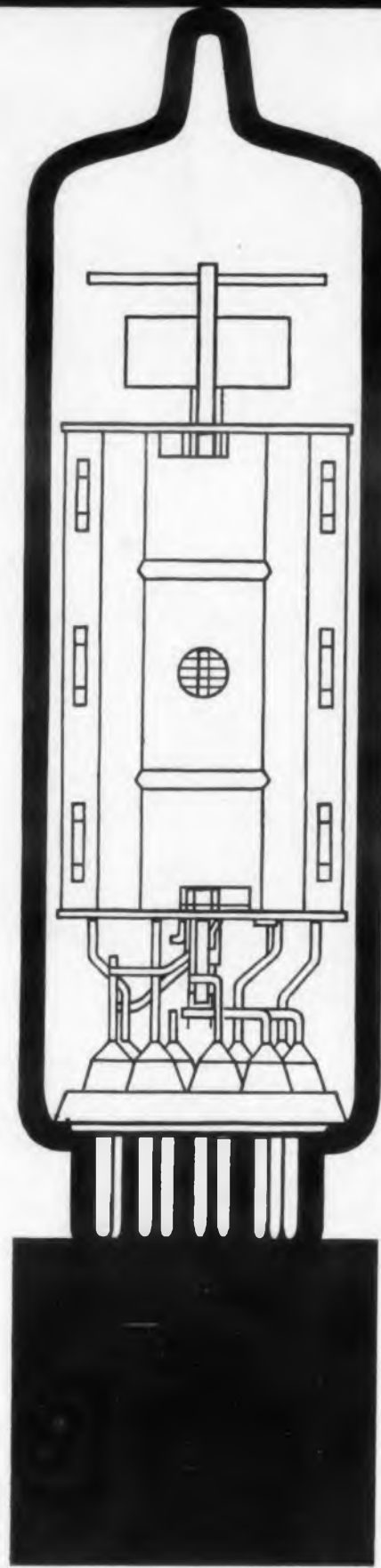
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ELECTRONIC TUBES

BRITAIN'S FIRST CHOICE
FOR FIRST EQUIPMENTS

MULLARD OVERSEAS LTD, MULLARD HOUSE,
TORRINGTON PLACE, LONDON, ENGLAND



MEV 106

NEW PRODUCTS

Frequency Converter

663

Delivers 100 va



Delivering 100 va, model 4010A frequency converter has a wide selection of frequency ranges from 50 to 4,000 cps with fixed frequency accuracies up to 0.001%. Resistive or reactive loads can be handled. Harmonic distortion is nominally 1%. The unit mounts in a standard relay-rack panel. It is for use in missile checkout systems, mag-amp testing, servo systems, aircraft instrumentation and other applications.

Tel-Instrument Electronics Corp., Dept. ED,
728 Garden St., Carlstadt, N.J.

Sweep Generators

678

For checking if circuits



The LD series of sweep generators includes four models; LD-3, 4, 5 and 6, covering the ranges 3.5 to 17 mc, 9 to 40 mc, 15 to 90 mc, and 46 to 140 mc. They are suited for testing and aligning if amplifiers and if stages. Flatness is 5% over the maximum sweep width and linearity is better than 1.2:1. A dual-triode, push-pull oscillator produces an output signal that can be attenuated by a series of 10 toggle switches and a vernier of 0 to 10 db. Output is 1 μ v to 1 v rms into 50 ohms.

Telonic Industries Inc., Dept. ED, Beech Grove, Ind.

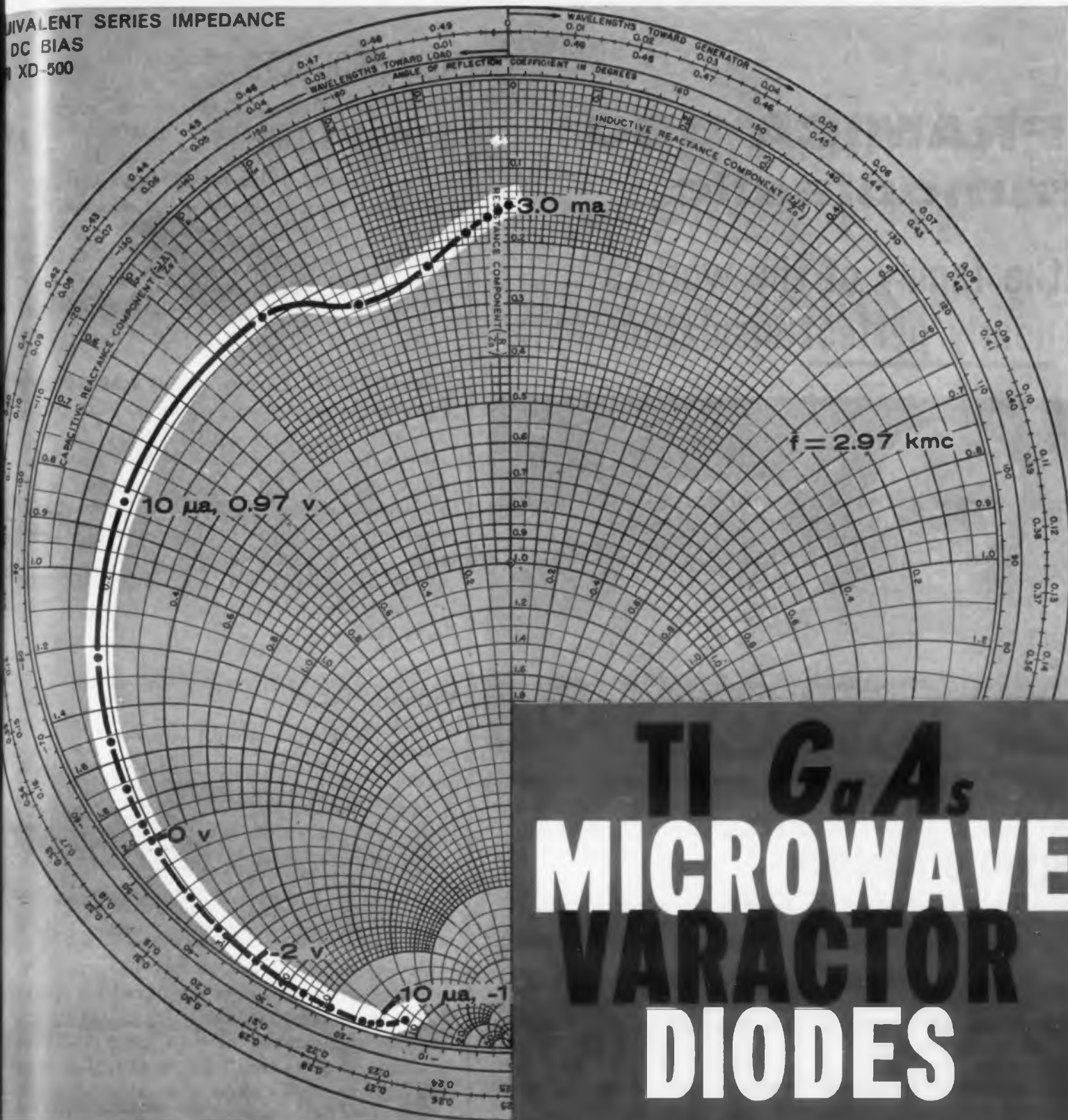
Price: \$695.

Availability: 30 days.

DIVALENT SERIES IMPEDANCE

DC BIAS

XD-500



TI GaAs MICROWAVE VARACTOR DIODES

Minimum cutoff frequency of 144 kmc at -2 v

ELECTRICAL CHARACTERISTICS AT 25°C AMBIENT											
SYMBOL	PARAMETER	TEST CONDITIONS	XD-500		XD-501		XD-502		XD-503		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
BV_R	Reverse Breakdown Voltage	$I_R = 10\mu a$	6	6	6	6	6	6	6	6	v
C	Total Capacitance	$f = 1 mc, V_R = 0v$	0.5	1.4	0.5	1.4	0.5	1.4	0.5	1.4	μmf
Q	Quality Factor	$f = 3 kmc, V_R = -2v$	20	27	36	48					-
f_{CO}	Cutoff Frequency	$V_R = -2v$	60	81	108	144					kmc
f_{CO}	Typ Cutoff Frequency	Typ $BV_R = -10v$	130	175	215	310					kmc

SEMICONDUCTOR-COMPONENTS DIVISION

TEXAS  **INSTRUMENTS**
LIMITED INCORPORATED
DALLAS ROAD - BEDFORD, ENGLAND 13800 NORTH CENTRAL EXPRESSWAY - DALLAS, TEXAS

CIRCLE 78 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960

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CIRCLE 79 ON READER-SERVICE CARD

87

SUPRAMICA® 560 ceramoplastic

from the family of the world's
most nearly perfect insulation



helps to maintain peak gyro efficiency

Leading gyro producers design parts made of precision-molded SUPRAMICA 560 ceramoplastic, an *exclusive formulation of MYCALEX CORPORATION OF AMERICA* capable of retaining absolute dimensional stability at a maximum temperature endurance up to +932°F (unstressed) . . . in complex but lightweight designs. These small parts function as vital components of miniature gyros . . . critical applications where the highest standards for precision accuracy must be met.

SUPRAMICA 560 ceramoplastic having the same thermal expansion coefficient of many insert metals, can tightly bond and permanently anchor gold leads, stainless steel contacts and stainless steel threaded inserts . . . in parts with wall thicknesses of only .010".

SUPRAMICA 560 ceramoplastic offers premium insulating properties with excellent economy in production scale runs. SUPRAMICA 560 ceramoplastic is but one of a family of versatile electrical and electronic insulating materials produced by MYCALEX CORPORATION OF AMERICA . . .

- MYCALEX® glass-bonded mica,
maximum temperature endurance (unstressed)—up to +700°F
heat distortion temperature * —up to +850°F
- SUPRAMICA® ceramoplastic,
maximum temperature endurance (unstressed)—up to +1550°F
heat distortion temperature * —up to +1360°F
- SYNTHAMICA® synthetic mica,
maximum temperature endurance (unstressed)—up to +2000°F
* ASTM test method D 648 (modified) at stress of 264 psi.

Write for technical information today.

General Offices and Plant: 121 Clifton Blvd., Clifton, N. J.
Executive Offices: 30 Rockefeller Plaza, New York 20, N. Y.

World's largest manufacturer of glass-bonded mica, ceramoplastic and synthetic mica products

CIRCLE 83 ON READER-SERVICE CARD



MYCALEX
CORPORATION OF AMERICA

NEW PRODUCTS

DC Power Supply

331

Has 0.01% regulation



Model SR-200EP power supply features 0.01% regulation for load changes from no-load to full-load, and 0.01% regulation for line voltage fluctuations from 95 to 135 v. DC output is variable from 0 to 15 v, maximum output current is 200 ma. Isolation from the power line results in noise, measured with a grounded 350 ohm bridge, of only 1 μ v peak-to-peak.

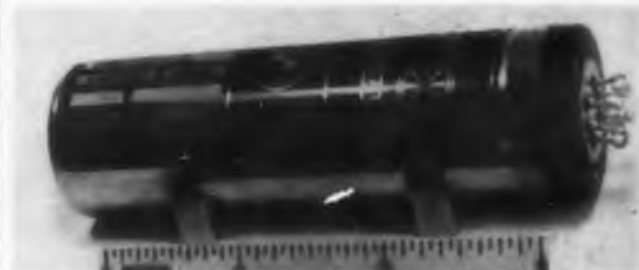
Video Instruments Co., Inc., Dept. ED, 3002 Pennsylvania Ave., Santa Monica, Calif.

Price: \$145.

Vidicon Tube

382

Peak response is 0.4 μ a per mw



Model ML-S522B vidicon tube has a peak response of about 0.4 μ a per mw of radiant energy at 4050 A. Designed primarily for industrial and scientific applications, the tube has a resolution capability of 600 lines. It measures 6.25 in.-long and 1.125 in. in diameter. It is interchangeable with standard vidicon tubes.

Raytheon Co., Machlett Laboratories, Inc., Dept. ED, 1063 Hope St., Springdale, Conn.

Price: \$415.

Availability: 45 days.

Ultra-Miniature Indicator Lights 744

Lens cap has colored cylindrical lens



Series No. 250 indicator lights have a lens cap with a colored cylindrical lens and a clear lamp cartridge without a legend. The lens is 0.425 in.

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in diam and accommodates up to three hot-stamped digits, symbols or letters. The lamp cartridges have voltages ranging from 1.35 to 28 v. The Data Cap lights measure approximately 1-5/8 in. in over-all length. They are for use in data-processing equipment, computers, instrumentation, control equipment and automation.

Dialight Corp., Dept. ED, 60 Stewart Ave., Brooklyn 37, N.Y.

Price: Quoted on application.

Availability: 7 to 12 days.

Vulcanized Fibre

358

Flame resistant



Pyronil E, flame-resistant vulcanized fibre is available in rolls, coils and sheets in thicknesses of 0.01 to 1/16 in. In 1/32-in. thickness it has a dielectric strength of 215 v per mil, and arc resistance of 50 sec under ASTM test method D-495.

National Vulcanized Fibre Co., Dept. ED, 1060 Beech St., Wilmington 99, Del.

Price: \$3.30 per 48 x 80 in. sheet, 1/32 in. thick. Availability: Two weeks.

Inductance Decades

378

With high Q-factor



These inductance decades are specially aged and temperature cycled for long-term stability. Accuracy is better than 1.5%. Types DI-1A, DI-1B, DI-1C and DI-1D have inductance ranges extending to 10, 1, 0.1 and 0.01 h. They can handle maximum currents of 50 to 200 ma.

Magnetico, Inc., Dept. ED, 6 Richter Court, E. Northport, L.I., N.Y.

Availability: From stock.

BERYLCO INSPIRES NEW DESIGN THINKING



3 1/2 times actual size



Electrical connector of beryllium copper rod: By selecting a Berylco alloy, the designer met requirements for high conductivity, corrosion resistance, high contact force, and excellent resistance to creep. The connector also has enough yield strength to permit mis-alignment of the mating connector without loss of electrical contact. It is usable up to 300°F. Lead-in wires can be soft-soldered to the connector.

New advances in critical parts performance now possible The ever-widening and increasingly successful use of Berylco beryllium copper alloys is opening a whole new area of design thinking on parts. The list of attributes in this amazing alloy reads like a Who's Who of famous performance characteristics: good conductivity, high fatigue strength, non-magnetic, high strength, unusual wear resistance, resistance to anelastic behavior, good corrosion resistance, excellent hardness, wide operating temperature range. Find out what these characteristics can mean to the parts you are now working on. Write for our latest BERYLLIUM COPPER BULLETIN. To assist you further, an experienced, knowledgeable staff of field and mill technicians stand ready to translate design possibilities into performance realities.



THE BERYLLIUM CORPORATION

Reading, Pennsylvania

CIRCLE 85 ON READER-SERVICE CARD



Bearing race cast from beryllium copper ingot: The choice of Berylco alloy on this investment casting was easily made because its high fluidity provides good surface, close tolerances, excellent detail and the ability to cast thin sections. When added to the advantages of the alloy itself, like high strength and good wear resistance, it becomes easy to see why beryllium copper is being used more and more in several casting methods.



Bellows of beryllium copper strip: The design engineer on this part knows a Berylco alloy is a fine choice because its low modulus of elasticity (approx. 18.5×10^6) gives greater deflection for a given pressure change than other high strength alloys. And it has good fatigue strength with a yield strength that gives excellent usable movement range.

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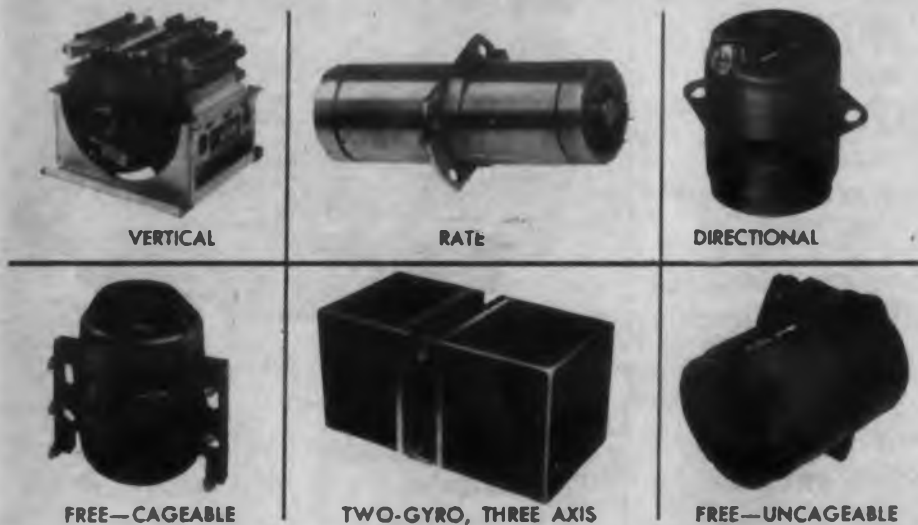
ENGINEERING
REPORT
ON BENDIX COMPONENTS



Bendix vertical and directional gyros contribute to accuracy and dependability of guidance system on United States Air Force (Green) Quail air-launched decoy missile manufactured by McDonnell Aircraft.

LIGHTWEIGHT, RELIABLE GYROS TO MEET TODAY'S RUGGED NEEDS

THE BENDIX LINE FEATURES SIX GYRO TYPES



- Electrolytic switches for precise erection and long service life.
- Operating life of 1000 hours.
- The Two-Gyro Three Axis Control erection rate is 1.3°/min. Other gyros shown have normal erection rate of 2°/min. with fast erection up to 120°/min.
- Either flexible or hard mounting.

For full details on Bendix Gyros for specific applications, write ...

Eclipse-Pioneer Division

Teterboro, N. J.



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 86 ON READER-SERVICE CARD

NEW PRODUCTS

VHF Receiving Multicoupler 357

Frequency range is 30 to 260 mc



Model VHM-2 wideband multicoupler has a frequency range of 30 to 260 mc. Noise figure is 8-db max when operated in a 52-ohm system. Nominal gain is 15 db between the unit's input and any output. Isolation between outputs is 40 db min; between outputs and input, it is 70-db min. Power requirements are 200 va at 115 or 230 v, 50 to 60 cps. The unit is for wideband spectrum monitoring, telemetry and air-to-ground communications.

Applied Technology, Inc., Dept. ED, 930 Industrial Ave., Palo Alto, Calif.

Price: \$2,500 ea.

Availability: 60 days.

Differential Amplifier 571

Dissipation is less than 330 mw

Type P2 dc amplifier is designed for applications such as high-reliability process control, electrometer applications and instrumentation. Gain is 30,000 at design center and 20,000 at Q. C. pass limit. The unit operates for 90 hr using two pairs of mercury batteries. It measures 4 x 1-1/4 x 1-11/16 in.

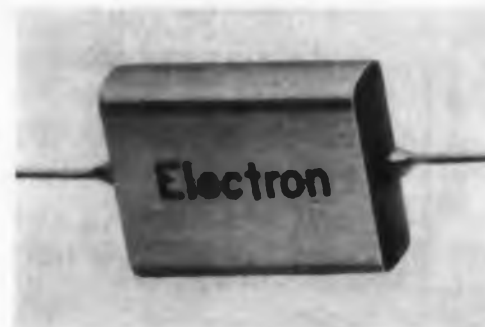
George A. Philbrick Researches, Inc., Dept. ED, 285 Columbus Ave., Boston 16, Mass.

Price: \$210 in quantities of one to nine units.

Availability: Four to eight weeks delivery.

Metallized Capacitors 379

Over 100 models offered



Offered in over 100 standard models, these capacitors come in two basic stylings: the rectangular tube DG and the round tube DL. The

REPORT

CAM COMPENSATOR

Efficient compensating device for servo system error.



The type CP-20-A1 is a simple, entirely mechanical means of correcting an output data shaft in relation to either servo loop errors, sensing errors, or known environmental factors affecting the system. Eliminates need for adjusting remotely placed or inaccessible units. Ask for full details.

CONTROL TRANSFORMER

Changes mechanical differential inputs to electrical outputs.



Here is a corrosion-resistant unit that features a rotatable housing construction along with a standard synchro mounting. Because housing, as well as shaft, can be rotated, an additional output can be introduced into control system circuitry. Stator housing assembly is driven by a gear accessible through a slot in the housing, thus translating mechanical differential inputs into electrical outputs.

Manufacturers of

GYROS • ROTATING COMPONENTS
RADAR DEVICES • INSTRUMENTATION
PACKAGED COMPONENTS

Eclipse-Pioneer Division



Teterboro, N. J.

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units are hermetically sealed and operate from -55. to +85 C. Insulation resistances are 10,000 meg times minimum capacitance at 25 C. Dissipation factor is less than 1% at 25 C; test voltage is 1.5 times rated voltage.

Marshall Industries, Electron Products Div., Dept. ED, 430 N. Halstead St., Pasadena, Calif.
Price: \$0.69 to \$2.52 in quantities of 1,000.
Availability: From stock to four weeks.

Cryogenic Cooler

623

For infrared detectors



Model FW-22 cryogenic cooler cools dewar-type infrared detector cells with liquid nitrogen, liquid oxygen or liquid air. It operates continuously for 22 hr from filling, 16 hr after 24-hr standby, up to 82 hr total. The unit is constructed of a storage container and a transfer line which permits custom designing for any application.

ITT Laboratories, Components & Instrumentation Lab., Dept. ED, Fort Wayne, Ind.

Price: Storage unit: sample, \$500; 10 units, \$400 ea. Transfer line: sample, \$400; 10 units, \$300 ea.

Availability: 60 days.

Vibration Exciter

620

Frequency range from 20 cps to 27 kcps

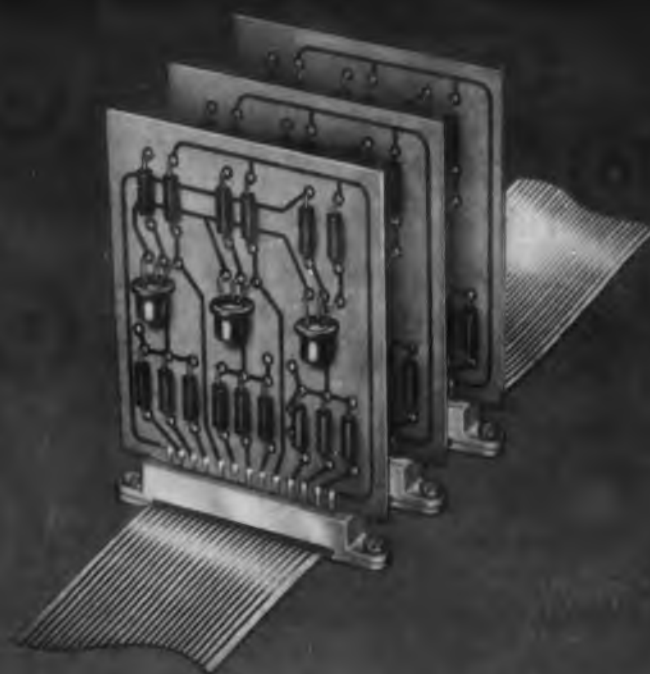
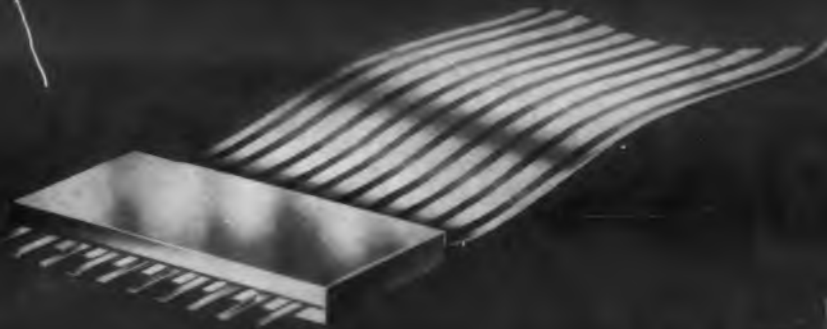
The frequency range of this vibration exciter is from 20 cps to 27 kcps. It is designed for 75 w continuous duty without air cooling. When using 200 w for intermittent duty an air supply of 10 psi is required. Excitation voltage can be random noise, white noise or complex wave. The maximum specimen weight is 1/4 lb. A high frequency accelerometer can be built into the vibration platform on special order. When used with a feedback controlling system, this will give a constant ± 1 db frequency response from 20 cps to in excess of 20 kcps.

Vibrasonics, Inc., Dept. ED, 10 High St., Boston, Mass.

Availability: 30 to 45 days.

POS-E-KON™

the only connectors designed expressly for FLAT CONDUCTOR CABLE



For military and space applications with various basic equipment is custom adapted for any installation. Laboratory test as required flat multi-conductor cable as flexible printed circuitry with these completely dependable, easily installed fittings. Designed to your requirements, the Pos-E-Kon Line is as versatile and extensive as your needs. Many standard items to choose from.

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CIRCLE 88 ON READER-SERVICE CARD

NEW PRODUCTS

Wide-Band Amplifier 389

Gain is up to 25

Model 8-12 amplifier has an adjustable gain of up to 25 and a loop gain of over 800. Input voltages can be sinusoidal or complex. Frequency response is flat within 0.25 db from 200 cps to 200 kc. Input voltage amplitude is 5 mv to 0.15 v for a gain setting of 10. Input impedance is 50 K and output impedance is 200 ohms.

Acton Laboratories, Inc., Space Instrumentation Div., Dept. ED, 533 Main St., Acton, Mass.

Carbon Film Resistors 564

Tolerances 0.5% are offered

The Gold Seal carbon film resistors have been tested at 25 times rated wattage for 1 sec. Calibrated at 25 C, the units are offered in tolerances of 0.5%, 1%, 2%, and 5%. Maximum voltage coefficient is less than 0.002% per v; average coefficient is 0.0002%.

Technology Instrument Corp., Dept. ED, 531 Main St., Acton, Mass.

Amplifier Tubes 391

Stand high shock and vibration

These tubes are for military and industrial applications where freedom from microphonics is essential. Type 7737 broadband amplifier pentode is similar to type 6688 and is for airborne applications, coaxial-cable amplifiers, and video and broadband if amplifiers in communications links and TV equipment. Type 7308, high-gain twin triode, similar to the 6922, is for use in radar, oscilloscopes, computers, broadband amplifiers and critical airborne applications.

Amperex Electronic Corp., Semiconductor and Special Purpose Tube Dept., Dept. ED, 230 Duffy Ave., Hicksville, L.I., N.Y.

Price: 7308, \$5.20; 7737, \$7.80 in lots of 1 to 49.

Availability: Immediate.



NO MULTIPLE BREAKS OR DISCONTINUITIES



NO HYSTERESIS



NO ROUND KNEES



ALL PSI
ZENER
DIODES
ARE
100%
SCOPE-
CHECKED

IMMEDIATE DELIVERY!
MILITARY TYPE
IN746A thru IN759A



THE PSI POLICY OF 100% OSCILLOSCOPE TESTING OF ALL ZENER diodes and assemblies is your protection against circuit instability due to double peak, soft knee, hysteresis and the many other "ailments" commonly found in less carefully screened zener diodes. Reliability and electrical performance plus *substantially higher power dissipation of 500 mW* make this broad line of zener diodes well worth your early investigation. Tight leakage at 75% or 90% of zener voltage may be specified when ordering.

NEW! LOW VOLTAGE REGULATING DIODES...1.5 TO 3.0 VOLTS. These new types are characterized by extremely low dynamic impedance and extended operating temperature range. Available in $\pm 5\%$ and $\pm 2\%$ types. Rugged and compact, the units measure 3/8" diameter by .53" long and are furnished with wire leads for easy mounting on printed circuit boards.

LOW VOLTAGE REGULATORS—PSI offers the highest surge, power and current rating of any subminiature regulator available.

VOLTAGE REFERENCE DIODES—These six types, with nominal voltage ranging from 6.8 to 40.8 volts, provide a temperature coefficient of less than $0.025\%/^{\circ}\text{C}$ and by specifying version "A" can be supplied at less than $.0025\%/^{\circ}\text{C}$.

All types available now in production quantities

Pacific Semiconductors, Inc.

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Authorized distributors coast-to-coast

500mW POWER DISSIPATION

PSI Type Number	Elect. Equiv.	Zener Voltage @ 5mA @ 25°C		Maximum Dynamic Resistance (ohms) ¹	Maximum Inverse Current		At Inverse Voltage (v)
		E _Z Min. (v)	E _Z Max. (v)		I _b @ 25°C (μA)	I _b @ 100°C (μA)	
PS6465	1N465	2.0	3.2	60	75	100	1
PS6466	1N466	3.0	3.9	55	50	100	1
PS6467	1N467	3.7	4.5	45	5	100	1
PS6468	1N468	4.3	5.4	35	5	100	1.5
PS6469	1N469	5.2	6.4	20	5	100	1.5
PS6470	1N470	6.2	8.0	10	5	50	3.5

1. Measured at 10mA DC Zener current with 1mA RMS signal superposed.
Also available PS6313-6318 covering 7.5v to 27v Zener Voltages.

EIA Type	Zener (Breakdown) Voltage @ 5mA		Maximum Inverse Current		At Inverse Voltage (v)	Maximum Dynamic Resistance (ohms) ¹
	E _Z Min. (v)	E _Z Max. (v)	I _b @ 25°C (μA)	I _b @ 100°C (μA)		
1N702	2.0	3.2	75	100	-1	60
1N703	3.0	3.9	50	100	-1	55
1N704	3.7	4.5	5	100	-1	45
1N705	4.3	5.4	5	100	-1.5	35
1N706	5.2	6.4	5	100	-1.5	20
1N707	6.2	8.0	5	50	-3.5	10

1. Measured at 10mA DC Zener current with 1mA RMS signal superposed.
Also available 1N708-1N723 covering 5.5v to 27v Zener Voltages.

PSI Type Number	Elect. Equiv.	Zener Voltage @ 200 μA @ 25°C		Maximum Inverse Current		At Inverse Voltage (v)
		E _Z Min. (v)	E _Z Max. (v)	I _b @ 25°C (μA)	I _b @ 100°C (μA)	
PS6313	1N1313	7.5	10	.5	5	6.8
PS6314	1N1314	9	12	.5	5	8.2
PS6315	1N1315	11	14.5	.5	5	10.0
PS6316	1N1316	13.5	18	.5	5	12.0
PS6317	1N1317	17	21	.5	5	15.0
PS6318	1N1318	20	27	.1	10	18.0

EIA Type ¹	Zener Voltage E _Z (Volts) ²	Max. Inverse Current E _a = -1V μA		Max. Dynamic Resistance I _Z = 20mA I _{ac} = 1mA Ohms (Max.)
		25°C	150°C	
1N746	3.3	10	30	26
1N747	3.8	10	30	24
1N748	3.9	10	30	23
1N749	4.3	2	30	22
1N750	4.7	2	30	19
1N751	5.1	1	20	17
1N752	5.6	1	20	11
1N753	6.2	0.1	20	7
1N754	6.8	0.1	20	5
1N755	7.5	0.1	20	6
1N756	8.2	0.1	20	8
1N757	9.1	0.1	20	10
1N758	10.0	0.1	20	17
1N759	12.0	0.1	20	30

1. $\pm 10\%$ Zener Voltage Tolerance. 2. E_Z measured at Test Current I_Z = 20mA. All of the above types can be supplied in $\pm 5\%$ Tolerance. Add "A" suffix to indicate units with $\pm 5\%$ Tolerance of center Zener Voltage Value.

LOW VOLTAGE REGULATORS

PSI Type	E _r + 1mA (volts)	I + 1 min. (mA)	Max. Dyn. Res. @ 1mA (ohm)	I _b @ 25°C (μA) Max.
1N912	0.62 \pm 10%	100	80	1.0 @ -5v
1N913	0.62 \pm 10%	250	80	5.0 @ -5v

VOLTAGE REFERENCE DIODES

EIA Type Number	REFERENCE VOLTAGE @ 7.5mA @ 25°C (volts)			Max. Voltage change from 25°C Reference Voltage (volts) -55°C to +100°C	Max. Dynamic Resistance (ohms)
	Min.	Avg.	Max.		
1N2765	6.46	6.80	7.14	± 0.050	20
1N2766	12.92	13.60	14.28	± 0.100	40
1N2767	19.38	20.40	21.42	± 0.150	60
1N2768	25.84	27.40	28.56	± 0.200	80
1N2769	32.30	34.00	35.70	± 0.250	100
1N2770	38.76	40.80	42.84	± 0.300	120

1. Measured with 1mA AC superimposed on 7.5mA DC.
Max. Operating Temp. @ I_Z = 7.5mA: -65°C to +175°C.
Also available in "A" version - $.0025\%/^{\circ}\text{C}$.

Sequence Timer 355

Has adjustable cams

Model 4-23 miniature sequence timer has adjustable cams that can be set within 0.1% of the total period. Designed for rocket and missile applications, the unit surpasses requirements of MIL-E-5272C for vibration, shock and acceleration. Adjustable time span is 1 sec to 45 min. Accuracy is better than 3%. Current drain is less than 70 ma.

Acton Laboratories Inc., Dept. ED, Acton, Mass.

Single-Crystal Silicon 390

Comes in diameters to 26 mm

This single-crystal, high-purity silicon comes in diameters to 26 mm and lengths to 250 mm. Undoped P type crystals have less than 0.15 parts per billion of boron, greater than 1,000 ohms resistivity per cm and a minority carrier lifetime exceeding 400 μsec.

Dow Corning Corp., Dept. ED, Midland, Mich.

Price: \$2.96 per gr.

Availability: In production quantities.

RTV and Epoxy-Silicone Rubbers 537

Operate from 450 to 600 F

The Eccosil series of RTV silicone-rubbers and epoxy-rubber combinations are suitable for electrical applications up to 450 F (for epoxy-silicones) and up to 600 F (for silicone rubbers). Type 4850 RTV silicone rubber is intended for general-purpose potting, caulking and mold-making. Type 4640 RTV silicone rubber, for airborne applications, weighs less than 40 lb per cu ft. Type 4712 epoxy-silicone, for potting applications, retains its flexibility after heat aging. Type 4520 epoxy-silicone is a low-viscosity impregnant and potting compound suitable for transformers and coils.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

CIRCLE 90 ON READER-SERVICE CARD

◀ CIRCLE 90 ON READER-SERVICE CARD

here's why Amperex[®]

VHF P·A·D·T High-Gain Transistors ARE BETTER... for AM/FM, mobile communications, car radio, and instrumentation!

1 Maximum Uniformity and Interchangeability

By combining the best qualities of both the alloy and the diffusion approaches to transistor construction — and by means of special "self-jigging" techniques — the Amperex Post Alloy Diffusion Process achieves maximum yield and uniformity, virtually eliminating the need for "selection". From drawing-board to final quality control checkpoint, the PADT process rigidly maintains the specifications of each transistor you require, not only to provide hitherto unattainable uniformity, but also maximum interchangeability with competitive types — plus...

2 High Beta The revolutionary PADT process provides a guaranteed *minimum* beta of 40... an average of 150... with resultant high power gain! Therefore, PADT transistors can now guarantee...

3 Maximum Design Freedom for Engineers The unprecedented characteristics of PADT transistors provide easier temperature stabilization, lower bias circuit loss, higher dissipation reserve, superior K factor, high alpha cut-off frequencies and safe, extremely conservative collector voltage ratings.

7 NEW P·A·D·T PNP TYPES specifically designed for specific applications — and now in mass production at the new Amperex semiconductor plant in Slatersville, Rhode Island

APPLICATION	TYPE NO.	FUNCTION	FEATURES
CAR RADIO	PADT-23	RF amplifier in 6 or 12 volt car radio applications from .5 to 1.5 mc, or in portable broadcast receivers.	Low leakage and high current gain minimizes AGC current requirements. Improved noise figure. High base-to-emitter voltage rating minimizes danger of breakdown.
	PADT-24	IF amplifier (455 or 262.5 kc), or in mobile communication receivers; at 6 or 12 volts.	Low collector-to-base capacitance; plus extremely small collector cut-off current. Minimum Beta of 40 to facilitate the design of AGC circuits.
	PADT-27	Mixer, oscillator or converter, 455 or 262.5 kc; at 6 or 12 volts.	Low mixer noise averaging only 3 db at 1 mc. Low leakage, less than 50 μ a at 60°C.
MOBILE COMMUNICATIONS	PADT-25	High frequency IF amplifier in mobile communication and airborne receivers.	Unusually high output resistance for improved receiver selectivity. Less than 50 μ a leakage at 60°C improves AGC operation.
	PADT-26	RF or IF amplifier, or mixer, in receivers operating up to 100 mc.	Typical power gain greater than 14 db at 100 mc, with a noise figure less than 9 db. High base-to-emitter breakdown voltage for extreme safety.
	PADT-28	RF amplifier for service in the 175 mc region.	Typical gain of 14 db at 200 mc. Noise figure, 5.8 db. Maximum frequency of oscillation, 700 mc. Extremely low base resistance.
	PADT-31	Mixer, oscillator, or frequency multiplier at frequencies up to 60 mc.	High output resistance (30,000 ohms typical at 10.7 mc). Power gain — more than 14 db at 60 mc. Conversion gain 20 db min. at 27 mc.

In stock at the following Amperex distributors:

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ADLETA COMPANY FORT WORTH, TEXAS	RADIO SHACK CORP. BOSTON, MASS.
BRILL SEMICONDUCTOR CORP. OAKLAND 6, CALIF.	RADIO SHACK CORP. STAMFORD, CONN.
ELMAR ELECTRONICS INC. OAKLAND 7, CALIF.	RADIO SHACK CORP. W. HARTFORD, CONN.
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MILQ ELECTRONICS NEW YORK, N. Y.	R. V. WEATHERFORD COMPANY GLENDALE 1, CALIF.

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P·A·D·T TRANSISTORS 'COMPARISON-TESTED' WITH COMPETITIVE CAR RADIO BRANDS

Stage	Parameter	Amperex PADT Transistor	Brand X	Brand Y
ALL	$f_{co}(mc)$	70 typ	42 typ	Approx 12.6 min ⁽¹⁾
	$h_{fe}(f=1 kc)$	40 min 150 typ	60 typ	RF 20-80 CONV 20-200 IF 20-100
	$f_{max}(mc)$ $P_c(mw \text{ at } 45^\circ C)$ $I_{CBO}(25^\circ C)$	262 ⁽²⁾ typ 67 8 μ a max 1.5 μ a typ	60 ⁽²⁾ 7 typ	50 min 30 10 max
RF	Maximum Available Power Gain 1.5 mc	47.5 db ⁽³⁾	47.5	—
IF	Maximum Available Power Gain 455 kc	60.6 db ⁽⁴⁾	54.5 db	55

(1) Calculated on the basis of $f_{max}=50 mc$ and $r_b \cdot C_c=200 \mu s$ substituted in the following equation: $f_{co} \approx \frac{1}{2\pi} \sqrt{\frac{1}{r_b \cdot C_c}}$

(2) Calculated value based on a maximum available power gain of 28 db at 10.7 mc and a power fall of 6 db per octave.

(3) Based on P_c at 25°C of 80 mw. P_c at 55°C of 50 mw and a linear derating factor which is 1 mw/°C.

(4) Calculated by the following equation: $PG_{max \text{ avail}} = \frac{|Y_{fe}|^2}{4g_{ie} R_{oe}}$

Coming soon! New P·A·D·T Switching, UHF and Power types!

NEW PRODUCTS

Silicon Diode 550

Temperature range is -100 to $+250$ C

This glass diode operates in ambient temperatures of -100 to $+250$ C and withstands power overloads of 10 times normal rating. It also stands piv up to 10,000 v. The silicon wafer is bonded directly to the terminal pins, eliminating the whisker spring. The unit is compact in size.

Unitrode Transistor Products, Inc., Dept. ED, 214 Calvary St., Waltham 54, Mass.

Diffused-Base Transistors 549

Have cadmium junctions

These MADT transistors have cadmium junctions, permitting high-junction operating temperatures. Six types are offered: 2N501, 2N501A (meeting Mil specs), 2N504, 2N588, 2N1411, and 2N1427. The first two are fast-switching, multi-purpose types; the others are for oscillating, amplifying, pulse shaping and switching.

General Transistor Corp., Dept. ED, 91-27 138th Place, Jamaica 35, N. Y.

Availability: Units are in mass-production.

Solenoid 542

For missile applications

Designed for missile use, the solenoid meets MIL-E-5272 requirements. It has a built-in spst normally-open switch rated for 2 amp at 115 v ac. The device operates on a cycle of one stroke of 1-min duration at 5-min intervals. Coil ratings are from 28 to 135 v dc at 270 ma max. Temperature range is -65 to $+160$ F. Minimum stroke is 0.078 in. Unit measures 0.91 in. in diameter and 1.2 in. long, and weighs about 2.5 oz.

Elgin National Watch Co., Microelectronics Div., Dept. ED, 21001 Nordhoff St., Chatsworth, Calif.

◀ CIRCLE 91 ON READER-SERVICE CARD

Dual-Channel Sampling Oscilloscope 534

Rise time is 0.4 nsec

The model 112 dual-channel sampling oscilloscope displays two separate waveforms or a single waveform at two different sweep speeds. Rise time is 0.4 nsec; sweep speeds to 0.05 sec per cm are available. Dual-channel controls permit horizontal and vertical adjustment of each channel, either separately or together.

Lumatron Electronics, Inc., Dept. ED, 116 County Courthouse Road, New Hyde Park, L.I., N.Y.

Extended-Scale Indicator 543

Has a moving-tape readout

The model S1-60T extended-scale indicator has a moving-tape readout. The instrument, a closed-loop servo device, drives a 50-in. tape scale marked from 0 to 1,000 in graduations every 0.05 in. Five inches of scale are exposed. The indicator is suitable for applications such as stress and strain measurements, displacements and measuring systems, electronic balances, pressure readouts, automatic-process control, and missile and engine analysis test-stand indications.

Schaevitz Engineering, Dept. ED, P.O. Box 505, Camden, N. J.

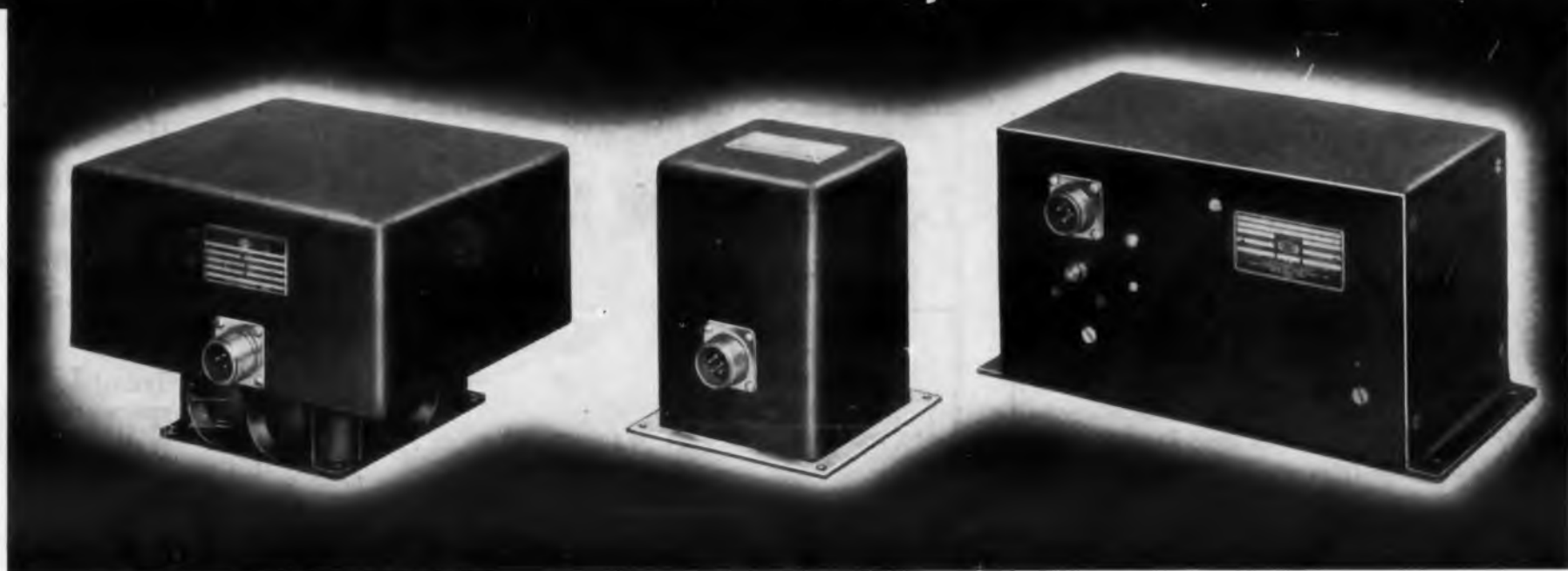
Subminiature Insulating Discs 540

Diameters are 0.02 to 0.5 in.

Subminiature insulating discs are available with diameters from 0.02 to 0.5 in. in any graduations, and with thicknesses from 0.008 to 0.05 in. The discs are 96% alumina oxide, metallized on either or both sides with molybdenum manganese and plated with nickel, copper or gold. The parts are applicable to diode assemblies, rectifier insulation, and similar high-temperature applications.

Mitronics, Inc., Dept. ED, 1290 Central Ave., Hillside, N.J.

CIRCLE 92 ON READER-SERVICE CARD ▶



Where can you use solid-state inverters with performance like this?

- **Wide operating temperature ranges**—Models now available and in development, designed for ambients ranging from a low of -55°C to $+125^{\circ}\text{C}$.
- **Closer frequency regulation**—As close as ± 0.02 cps under full load at ambients from $+60^{\circ}\text{F}$ to 175°F in some models.
- **Voltage regulation to $\pm 0.87\%$** under full load at ambients ranging from -20°F to $+175^{\circ}\text{F}$.
- **High-power-conversion efficiencies** under full load 28v dc input.
- **Protection against output overloads**—100 va models will withstand 100 va overloading, for 10 minute periods once an hour.
- **Transient voltage suppression**—Transient suppressor removes or attenuates voltage spikes—safeguards semi-conductor elements.

Features like these, in addition to small size and high power output-to-weight ratios, make Hamilton Standard static inverters ideal for such military and commercial applications as:

- aircraft emergency power supplies
- missiles, satellites
- gyro and instrument power supplies
- stand-by power for remote stations
- mobile equipment power supplies
- industrial computer power supplies

Hamilton Standard static inverters have already been chosen by the three principal military services. A variety of 100 and 500 va models, single- and three- phase, are now under development.

CHARACTERISTICS OF 100-VA STATIC INVERTERS

CATALOG NO.	ECB-1.1-AA	ECB-1.1.7-AA	ECB-1.1.13-AA
Output Voltage	115v $\pm 1v$	115v $\pm 5\%$	115v $\pm 5v$
Frequency	400 $\pm \frac{1}{4}$ cps	400 cps $\pm 1\%$	400 $\pm 1\%$
Phases	Three	Three	Single
Transient protection	Yes	Yes	Yes
Input Voltage			
Nominal	28v dc	28v dc	28v dc
Range	18-29v dc	20-29v dc	18-29v dc
Dimensions	5"x6"x8 $\frac{1}{4}$ "	5"x6"x7 $\frac{1}{4}$ "	5 $\frac{1}{2}$ "x5 $\frac{1}{2}$ "x8 $\frac{1}{8}$ "

Complete specifications and data are available on these and other Hamilton Standard static inverters from 100 to 500 va, single and polyphase.

STATIC INVERTER GUIDE—New Engineering data booklet available for the asking. Just clip coupon and mail today to:



HAMILTON STANDARD • Electronics Department
71 Main Street, Broad Brook, Conn.

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Position _____
Company _____
Address _____

HAMILTON STANDARD

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UNITED AIRCRAFT CORPORATION
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BROAD BROOK, CONNECTICUT

ENVIRONMENTAL CONDITIONING SYSTEMS • ENGINE & FLIGHT CONTROLS
ELECTRONICS • GROUND SUPPORT EQUIPMENT
HYDRAULICS • STARTERS • PROPELLERS

NEW PRODUCTS

Miniature Relays 395

Measure 1-3/4 x 15/32 x 2/3 oz

The series 124 relay requires only 85-mw coil power to activate the 2-amp contacts. Switching can be done at 100 cps, drop-out can be as high as 75% of pull-in, and sensitivity is as low as 25 mw. It is available with one normally-open, or one normally-closed or one normally-open and one normally-closed contact arrangement. A military version is also available.

Wheelock Signals Inc., Dept. ED, Long Branch, N. J.

Price: \$21.50.

Availability: Some units in stock.

Switching-Time Meters 558

Read times to 0.5 nsec

The models 400 and 420 switching-time meters provide direct meter readings, printed-readout or automated go, no-go testing of switching times to 0.5 nsec. Rise, fall, storage and delay times of transistors, tunnel diodes, computer elements and circuits can be measured with an accuracy of $\pm 3\%$ or 0.2 nsec.

Lumatron Electronics, Dept. ED, 116 County Courthouse Road, New Hyde Park, L.I., N.Y.

Power Transistors 398

Diffused-alloy type

Types 2N1651, 2N1652 and 2N1653 transistors are designed for high-frequency switching at an I_c of up to 25 amp dc. A diffused-base region provides low input resistance and typical cut-off frequencies of 2 mc while maintaining breakdown voltage at 120 v dc. Having flat beta parameters, the units are suitable for use as amplifiers as well as switches.

The Bendix Corp., Semiconductor Products, Dept. ED, Holmdel, N.J.

Price: \$9 to \$29.50.

Availability: Four weeks.

Self-adhering

E-Z-CODE WIRE MARKERS

SAVE TIME SAVE MONEY



With E-Z-CODES you grab the Tab... not the adhesive

All give sure fool-proof lasting identification to any size wires. Thousands of stock items, letters, numbers, sequence, combinations, NEMA colors, etc. Stock materials: Vari-Temp Cloth, Flame-proof Aluminum Foil, oil resistant Vinyl-Plastic, super-thin Polyester all in 1 1/2" and 3/4" length markers. Miniature and Sub-miniature sizes too.

Free Samples, Literature and Name of Your Local Stocking Distributor.

WESTLINE PRODUCTS

A Division of Western Lithograph Company
601 EAST 2nd STREET, LOS ANGELES 54, CALIF.

CIRCLE 219 ON READER-SERVICE CARD

If Dielectric or Corrosion Problems are Causing Coil Trouble...



PRECISION can help eliminate them

Precision specializes in square, rectangular, round or special shaped coil forms... kraft, fish paper, acetate, DuPont Mylar, Johns-Manville Quinterra, Resinite impregnated, other high dielectric materials or combinations... to help you solve any dielectric or corrosion problem. Forms can be made to your exact specifications in all sizes from 1/16" square to 8" square with wall thicknesses of from .010 to .125.

Precision Paper Tubes are available in standard or exclusive patented DI-FORMED construction for greater crush resistance, high tensile strength and extreme dimensional stability.

Write, wire or phone for full information



PRECISION PAPER TUBE CO.

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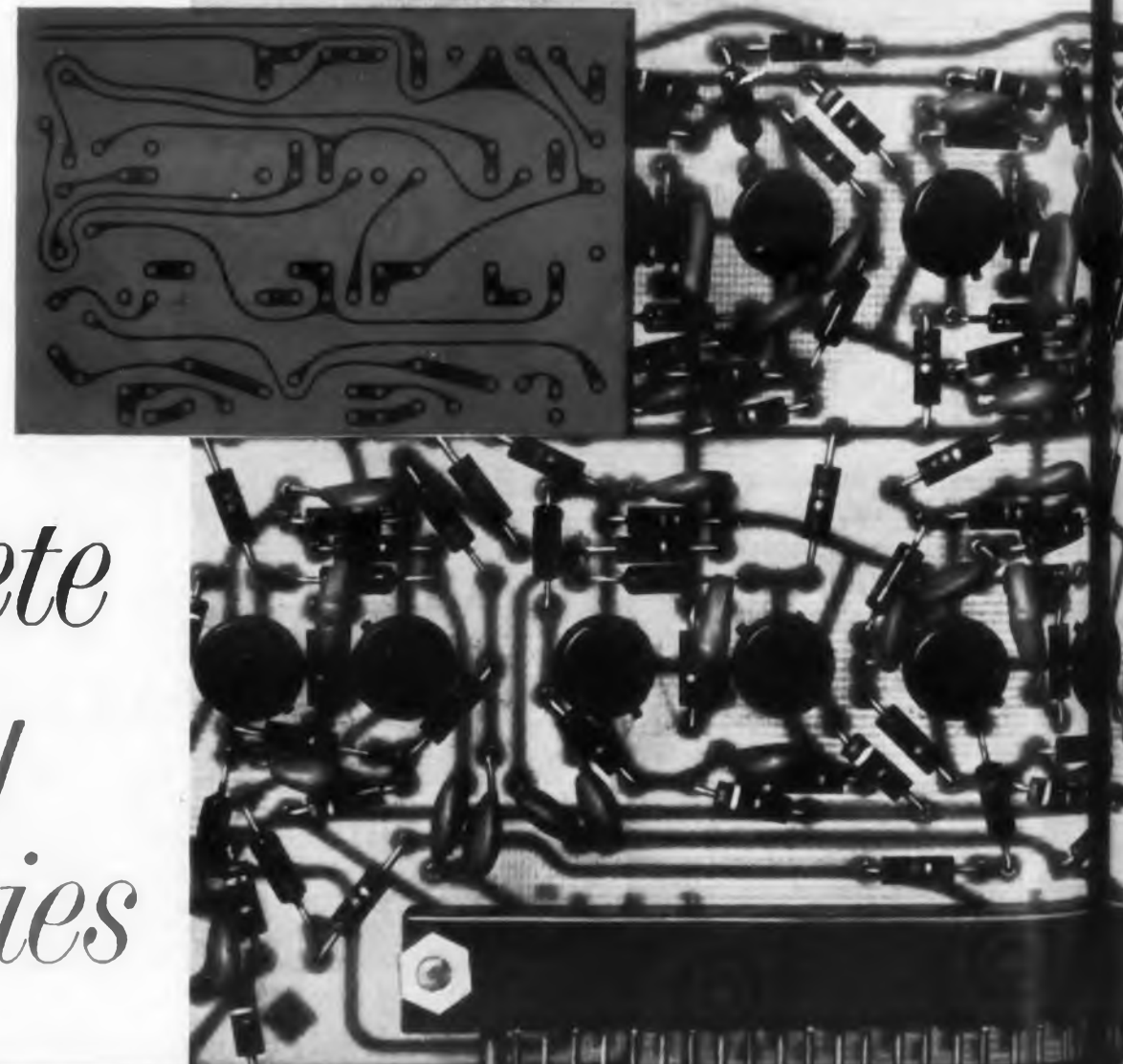
CHICAGO 47, ILL.

Plant No. 2: 1 Flower Street, Hartford, Conn.

CIRCLE 220 ON READER-SERVICE CARD

Lockheed
Electronics
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Circuitry
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Let **LOCKWELL**® solve your quick release pin problem...the quality way.

Large diameter release button allows arctic glove operation.
Red release button: suggests caution — locates button.

Grip-well handles with optimum operational clearances.

Handle independent of steel shoulder—does not contribute to holding power of pin.

Steel shoulder for maximum wear qualities and greater tension capability.

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LOCKWELL PINS are the quality answer for a quick release fitting where safety, speed of removal and dependability are of paramount importance.



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CIRCLE 221 ON READER-SERVICE CARD

tunable RF AMPLIFIER

300-1000 MCS



- Low Noise Figure
- Tuning Range to 150 mcs
- 10 mcs Bandwidth
- Single Control Tunability
- High Gain
- High Reliability

This versatile and dependable UHF RF amplifier permits the user to vary the frequency of the amplifier up to $\pm 10\%$ of nominal center frequency (not to exceed 150 mcs range) in the frequency range of 300 - 1000 mcs. Tuning is done by means of a slotted shaft accessible through the front panel.

The amplifier is supplied complete with power supply, mounted on a 3½" high panel to fit a standard rack.

GENERAL SPECIFICATIONS — MODEL UH-2 (AT)

Center Frequency	300 mcs to 1000 mcs
Freq. Range (tunable)	Up to $\pm 10\%$ of nominal F° (not to exceed 150 mcs range)
Bandwidth	10 mcs nominal
Noise Figure	5.5 db at 400 mcs; 9.0 db at 1000 mcs
Gain	18 db nominal (representative values)
Source and Output Impedance	50 ohms

Write for further information.

Applied Research inc.

76 South Bayles Avenue

Port Washington, N. Y.

CIRCLE 222 ON READER-SERVICE CARD

Decade Counter 560

Counts 100,000 events per sec

Model PDC-1000 modular decade counter counts up to 100,000 events per sec. It provides digits 0 through 9 that are readable at 30 ft and at angles of 120 deg. Numerals are 1-1/2-in. high and 1-in. wide. Units weigh less than 1 lb and measure 2-3/8 x 1-1/2 x 8-1/2 in.

Telemetry, Inc., Dept. ED, 12927 S. Budlong Ave., Gardena, Calif.

Data Logging System 561

With 80 points

This data logging system sequentially scans, measures and records 80 variables. Speed is 1 variable per sec. Data is printed on an adding-machine type printer with a tape punch. The tape-punch code is suitable for input to the firm's Dataron computer.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

Photoelectric Relay 562

Operate under adverse conditions

These heavy-duty, highly sensitive relays are for use in atmospheres dense with foreign matter and where an extraneous light source could cause false operation. They can be used, for example, to detect the position of parts in ovens and furnaces. Type PL operates at distances to 2,000 ft and type PLJ, at distances under 100 ft.

The Clark Controller Co., Dept. ED, 1146 E. 152nd St., Cleveland 10, Ohio.

Test Jack 563

Has stamped lug on reverse side

Type SKT-36 is designed to receive a probe measuring 0.05 in. in diameter and 0.025-in. long. Beryllium copper contacts are used. The lug on the reverse side of the chassis is 0.287-in. long and provides a soldering hole 0.052 x 0.156 in.

Sealectro Corp., Dept. ED, 139 Hoyt St., Mamaroneck, N. Y.

◀ CIRCLE 223 ON READER-SERVICE CARD

COMPLETE CIRCUITRY FACILITIES from artwork to finished boards... on both inexpensive commercial etched-copper circuitry through the most sophisticated "plated through hole" (mil. spec.) type boards.

ENGINEERING AND DESIGN assistance in the development of printed circuit artwork.

ASSEMBLY OF COMPONENTS of all types — commercial, miniature and sub-miniature, using either hand soldering, automatic flow soldering, or welding techniques.

MAXIMUM QUALITY CONTROL is maintained in every phase of operation with individual inspectors specializing in artwork, photography, plating and etching, fabrication and assembly.

For further information regarding your printed circuitry requirements write Marketing Department, Lockheed Electronics Company, Avionics and Industrial Products Division, 6201 E. Randolph Street, Los Angeles, California.

LOCKHEED ELECTRONICS

COMPANY



NEW PRODUCTS

Magnetic-Reed Switch 533

Rated at 15 v-a max

The type DRG-1 magnetic-reed switch is rated at 15 v-a max resistive, up to 1 amp and 250 v. Contact reeds are gold-plated; normally-open, normally-closed with bias magnet or latching arrangements are available. Tube OD is 0.2 in., and length is 3-1/4 in. Life is over 150,000,000 cycles.

Hamlin, Inc., Dept. ED, Lake Mills, Wis.

Time-Delay Relay 532

Three types offered

The MTRH time-delay relay has operate or release times from 10 msec to 1 sec in the type MTRH-1, 1 to 90 sec in the type MTRH-4, and 15 sec to 5 min in the type MTRH-8. The units are miniature, hermetically sealed, and operate from -55 to +125 C. Contacts to 7pdt can be furnished.

Bronson Corp., Dept. ED, 41 S. Jefferson Road, Whippany, N.J.

Insulation Sleeving 517

Shrinks to permanent fit

Thermofit is an irradiated-insulation sleeving that shrinks to a permanent specified size when exposed to heat. Supplied with an expanded diameter to slip over components, the material shrinks tightly over component contours when exposed to 235 F for 3 to 5 sec. The material, self-extinguishing and thermally stabilized, withstands -100 F without brittling, is inert to fungus, resists acids and fuels, and has high-abrasion resistance and dielectric strength. The sleeving is available in 4-ft lengths in standard, after-shrinking ID's from 0.027 to 2.07 in.

Raychem Corp., Dept. ED, Oakside at Northside, Redwood City, Calif.

Price: Dependent upon size and quantity.

Availability: From stock.



GL-2C40A



GL-2C43



Z-5033



GL-6442

LIGHTHOUSE - GLASS

Typical output is 75 mw as a CW oscillator at 3370 mc. Greater output obtainable at lower frequencies. Features include low interelectrode capacitances, low lead inductance and low loss. Performance-proved and economy-priced. Height is 2 9/16".

Typical applications are as a Class A RF amplifier, a Class C CW oscillator and a plate-pulsed oscillator.

Typical output is 1.75 kw as a pulsed oscillator at 3370 mc. Greater output obtainable at lower frequencies. This single-ended tube features low impedance and is 2 11/16" high. Like the GL-2C40A, this tube is economy-priced.

Typical applications are as a Class C RF amplifier, a Class C CW oscillator, and a plate-pulsed oscillator.

A long-life version of type GL-2C43. The objective for this tube is 15,000 hours at 1000 mc. While designated developmental until this objective is proved, the tube is available from production. Like the GL-2C43, it is single-ended, features low impedance, and is 2 11/16" high.

It is designed to serve as a Class C CW oscillator.

A general purpose, medium-mu triode, this tube is especially adapted to pulsed operation up to approximately 5000 mc. It gives 2 kw of pulsed power output at 500 mc, and approximately 500 mw at 5000 mc. Height is 2 3/8".

Typical applications include Class C amplifier, oscillator, mixer amplifier in both CW and pulsed service.

TO MEET ALL APPLICATION REQUIREMENTS . . .

General Electric Now Offers You Industry's Most

LIGHTHOUSE - MINIATURE CERAMIC



GL-6299



GL-7391



GL-7644



Z-5435

Ultra-reliable for high-gain, low-noise applications to 3000 mc. Noise figure of 4.3 db and gain of 18.5 db at 450 mc. Operational warranty is 1000 hours. This UHF-SHF tube has high shock and vibration resistance and is conduction-cooled. This tube and its derivatives are only 1" high.

Its application is as a Class A₁ RF amplifier.

This is a Class C version of tube type GL-6299. It operates up to 6000 mc. Its power output is 65 mw at 5400 mc. Moreover, its power output is greater than 0.5 watts at 500 mc. This new, metal-ceramic UHF-SHF low-power triode features conduction cooling and has a grounded grid.

Principal application is as a Class C CW oscillator.

This derivative of type GL-6299 operates up to 3000 mc, and is notable for its high spike resistance capabilities. The tube is unilaterally interchangeable with type GL-6299. Only recently announced, this sturdy, UHF, low-noise and low-power triode features a grounded grid and conduction cooling.

It is especially suitable for application as a Class A₁ RF amplifier.

The frequency range for this tube is up to approximately 3000 mc. It is a low-noise, high-gain triode, similar in all respects to GL-6299 except that it is designed with an isolated heater. It features a grounded grid and is conduction-cooled.

It is recommended for application as a Class A₁ RF amplifier.



GL-6771



GL-6897



Z-5387



Z-5079A

ROUCERAMIC

High-gain, high- μ , closed-spaced tube with useful output in excess of 500 mw at 4000 mc, CW and under pulsed conditions. Several hundred mw obtainable at 6000 mc. Features low interelectrode capacitances and rugged planar construction. Height is 2 39/64". Recommended for low and intermediate level amplifier and multiplier applications because of its exceptional gain.

This version of the 2C39 family is especially suited to high-frequency operation. Has 100 watt anode dissipation. Gives 30% efficiency and 10 db gain at 1860 mc and 600 volts. Height is 2 11/16". Efficient pulse performance to 3000 mc. Notable for consistent high-gain performance, resulting from closely controlled manufacturing and processing tolerances and thorough characteristic testing in accordance with MIL-E-1/1037B.

This tube is a finless version of type GL-6897 for applications where there are space limitations, and the full plate dissipation of the GL-6897 is not required. Height is 2 3/4".

Possible applications include pulsed airborne navigational equipment and airborne communications. The tube is operable as a Class C pulsed or CW amplifier, oscillator, and frequency multiplier.

A conduction-cooled version of type GL-6897, for grounded-grid Class C power amplifiers, oscillators, or frequency-multiplier circuits up to 2500 mc. 35 watts plate dissipation readily obtainable. Features same rugged disc-seal construction as type GL-6897. Gives consistent high performance. Height is 2 3/4".

Designed specifically for missile and other non-air-cooled applications.

Industry's Most Complete Line of Microwave Triodes

Illustrated on these two pages are just twelve of the more than twenty microwave triode types General Electric now offers . . . industry's most complete line. Rugged, versatile G-E "lighthouse" triodes are now available for all types of microwave communication, navigation, identification and radar equipment . . . for all ground, sea and airborne applications.

For more information on General Electric's complete line of microwave triodes, and for competent application engineering assistance, contact your General Electric Power Tube Sales Office.

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701 Washington Street
Newtonville, Massachusetts
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Telephone: HARRISON 2-1030

SCHENECTADY
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Schenectady 5, New York
Telephone: FRANKLIN 4-2211
Ext: 5-3433

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200 Main Avenue
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Chicago 41, Illinois
Telephone: SPRING 7-1600

DAYTON
118 West First Street
Dayton 2, Ohio
Telephone: BALDWIN 3-7151

WESTERN
11840 West Olympic Boulevard
Los Angeles 64, California
Telephone: GRANITE 9-7765

WASHINGTON
Wyatt Building—Room 1313
777—14th Street, N. W.
Washington, D. C.
Telephone: EXECUTIVE 3-3600

POWER TUBE DEPARTMENT

GENERAL ELECTRIC

265-01-8481-28

Solenoid-Released Brake 525

For 40-frame motors

This spring-set, solenoid-released brake unit is for size-40 frame motors. Torque rating is 3 ft-lb. Called the style H 44, the brake is available for ac or dc and with drip-proof enclosure.

Stearns Electric Corp., Dept. ED, 120 N. Broadway, Milwaukee 2, Wis.

Metallized Paper Capacitors 539

Wax and epoxy impregnated

These metallized paper capacitors are available in 100, 200, 400, and 600-wvdc ratings, 20% tolerance. Series ME capacitors, designed for dc circuitry, are vacuum epoxy-impregnated and sealed in epoxy cases. Operating temperature range is -55 to +125; capacitance values are from 0.001 to 2 μ f. Series WE capacitors, for use in ac or dc circuits, are vacuum wax-impregnated. They have operating temperatures from -55 to +85 C and capacitance values from 0.001 to 1.5 μ f. Most military environmental specifications are met.

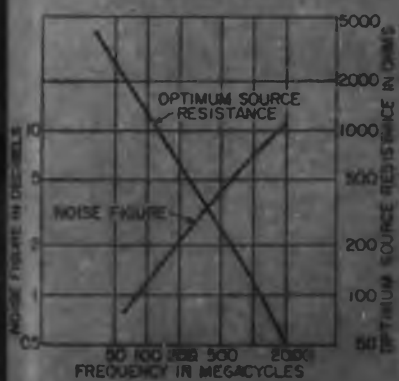
Marshall Industries, Electron Products Div., Dept. ED, 430 N. Halstead St., Pasadena, Calif.

Digital Subtractors 541

Will drive lamp banks or mercury relays

The type SU-100 transistorized-digital subtractor determines the arithmetical difference between two inputs and provides voltage-level outputs suitable for driving lamp banks or mercury relays. The subtraction process is parallel except for carries. Maximum propagation time is 50 μ sec per decimal digit. The unit consists of circuit modules mounted in a relay-rack chassis. It measures 7 x 19 x 11 in. and weighs about 20 lb.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.



Calculated Noise Performance for Noise-matched, Grid-return Circuit Operation, Input Circuit Losses Neglected.

GL-6299 • GL-7644 • Z-5435

Operating Conditions

$E_c = 6.3$ volts

$E_b = 0$ volts

$E_c / I_b = 10$ milliamperes

◀ CIRCLE 96 ON READER-SERVICE CARD

Bryant Memory Drums For Every Storage Application

Whatever your immediate or long-range computer requirements, Bryant is equipped to provide "right now" response to your needs for prompt delivery of custom-designed memory drums, standard storage units, read/record heads, and other precision memory system components.

Remember—Bryant Magnetic Memory Drums offer these special features:

- Time-proven reliability
- Super-precise ball bearing suspension
- Dynamic runout less than .0001"
- Dynamically balanced at operating speed
- Precision integral-drive induction motors
- Exclusive tapered drum design



GENERAL MEMORY

Capacity—20,000 to 2,500,000 bits @ 130 bits per inch . . . **Tracks**—40 to 420 . . . **Speed**—600 to 24,000 rpm . . . **Size**—5" dia. x 2" long to 10" dia. x 19" long . . . **Access time**—As low as 2.5 ms (one head per track).

MASS MEMORY
Capacity—Up to 6,210,500 bits on a single drum . . . **Tracks**—Up to 825 . . . **Speed**—900, 1800 or 3600 rpm . . . **Size**—18.5" dia. x up to 34" long . . . **Access time**—As low as 16.6 ms (one head per track).

BUFFER APPLICATIONS

Capacity—Up to 225,000 bits . . . **Tracks**—Up to 150 . . . **Speed**—Up to 60,000 rpm . . . **Size**—3" to 5" dia. x 1" to 8" long . . . **Access time**—As low as 0.25 ms (4 heads per track @ 60,000 rpm).

AIRBORNE SYSTEMS
Capacity—60,000 to 180,000 bits . . . **Tracks**—50 to 150 . . . **Speed**—Up to 18,000 rpm . . . **Size**—As small as 6" dia. x 6" long . . . **Weight**—As light as 7 lbs. . . . **Access time**—As low as 3.3 ms (one head per track).

SPECIAL PURPOSE MEMORIES

Analog recording . . . **Multispeed operation** . . . **Speed**—As low as 2.5 rpm . . . **Aerodynamic heads** for high density, high frequency recording . . . **Flux-sensitive heads** for low-speed playback . . . **Air bearing drums** . . . **Magnetic Disc Files** for mass storage up to 150,000,000 bits.

For more detailed information, or if you'd like to discuss your particular storage drum application problems, contact your Bryant Representative, or write direct.

60-C-1

BRYANT COMPUTER PRODUCTS

852 LADD ROAD • WALLED LAKE, MICHIGAN
Market 4-4571

A DIVISION OF EX-CELL-O CORPORATION

EX-CELL-O PRECISION

XLO

CIRCLE 97 ON READER-SERVICE CARD

NEW PRODUCTS

Slip Ring Assembly

359

With 13 rings



Each of the 13 rings in this assembly is comprised of 32 segments with each segment carrying an individual circuit. The segmented ring assembly, which carries 25 amp and 440 v, is 25 in. in diameter and 26-in. high.

Breeze Corp., Inc., Dept. ED, 700 Liberty Ave., Union, N.J.

Coaxial Connectors

698

Have Collett clamp construction

The TM and TNC series Coaxitube semi-rigid connectors have Collett clamp construction. Specifications include: matched impedance, 50 ohms; operating temperature, -65 to +260 F; voltage, 1,500 v rms, 60 cps (TNC) and 500 v rms, 60 cps (TM).

General RF Fittings, Inc., Dept. ED, 702 Beacon St., Boston 15, Mass.

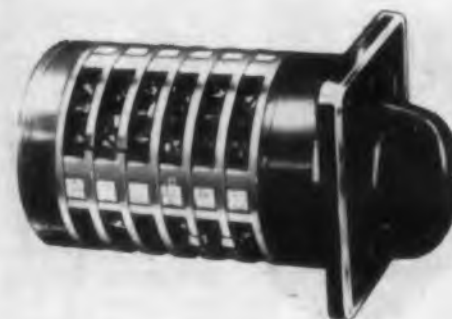
Price: On request.

Availability: From stock.

Rotary Switch

360

Is rated at 20 amp at 600 v ac



Type A-16 modular switch has four isolated, double-break silver-alloy contacts in each stage. Up to 48 contacts can be employed in a minimum switch length of 12 stages. The switch-latching



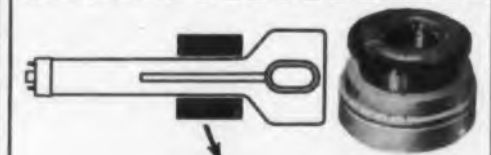
a spot is a spot
is a high
resolution spot
with

CELCO YOKES

• Celco YOKES
keep spots smallest

• Celco YOKES
keep spots roundest

• Celco YOKES
keep spots sharpest



Use a CELCO DEFLECTION YOKE for your high resolution applications.

In a DISPLAY SPOT? call Celco!

Celco

Constantine Engineering
Laboratories Co.

Main Plant: MAHWAN, N. J. DAVIS 7-1123

• Pacific Division - Cucamonga, Calif. - YUKON 2-2688

CIRCLE 98 ON READER-SERVICE CARD

mechanism can be furnished for 90, 60, 45, 30, 20 and 15 deg throw. All components, except the current-carrying parts, are made of insulating materials.

American Solenoid Co., Inc., Dept. ED, U. S. highway 22, Union, N.J.

Availability: Five to ten days.

Removable-Contact Connectors 351

Available in single- and double-insert types



These removable-contact connectors, called Repicon, are available in single- and double-insert types. The components have die-cast aluminum shells, removable crimp-style or solder-type contacts, interchangeable male and female inserts and backing plates to hold inserts in housing. The units are available in 34, 42, 50, 81 and 162 contact configurations.

General Products Corp., Dept. ED, Union Springs, N.Y.

Price: On request.

Availability: 15 days.

Semi-Automatic Telecode Transmitter 353

For use in the 433L system



The AN/TMT-1 telecode transmitter is for use in the 433L system which transmits weather and flight-plan information. It has 72-movable character switches. Code speeds range from 75 to 2,400 cps. The unit's prime application is in air-traffic control, but it can be used in a nationwide weather net for rapid transmission of information to major weather centers. Output can be altered by a quick-change plug-in circuit card.

Wang Laboratories, Inc., Dept. ED, 12 Huron Drive, Natick, Mass.

Price: \$7,000 ea.

Availability: 12 to 16 weeks; made on order.

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COST
UP TO
40%
LESS
THAN PAPERS OR
ELECTROLYTICS



.290"

These are Ultra-Kaps*—ultra-miniature ceramic capacitors for any low voltage use requiring extremely high capacities, low power factor and small size.

Ultra-Kaps have excellent stability from -55°C to $+85^{\circ}\text{C}$... and there has never been a case of electrical failure among the millions of them now in the field.

SPECIFICATIONS

10 VDCW Ultra-Kaps

Capacitance Range05 to .47 mfd.
Sizes290" to .840" diam.
Thickness156"
Power Factor at 1 KC 10%

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Capacitance Range02 to 2.2 mfd.
Sizes125" to .840" diam.
Thickness156"
Power Factor at 1 KC 3%

For complete technical data and price, write us or see your CENTRALAB Sales representative. Ultra-Kaps* are also available in industrial quantities for immediate delivery at factory prices through your local CENTRALAB distributor.

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In Canada: P. O. Box 400, Ajax, Ontario

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D-6015

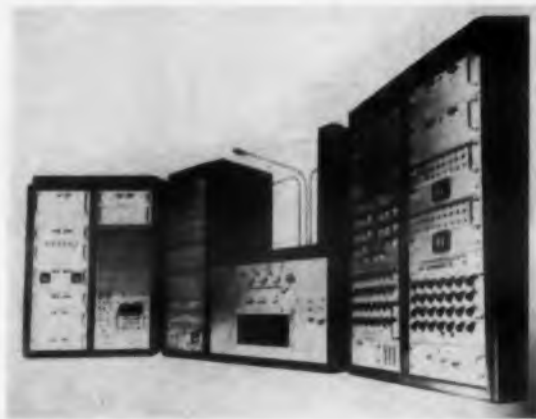
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NEW PRODUCTS

Magnetic Record Analyzer

352

Has three drums with 28-traces per drum



Model MRA-2 magnetic record analyzer has three drums with 28 traces per drum, 4-kc carrier frequency, deviation of 1 to 7 kc, and a check trace of 100 cps from recorded tape. Record presentation is 6-in. photographic film, 5.7 sec in length. Tape speed is 7.5 ips; tape width is 4 in. Power requirement is 115 v, 50 to 60 cps, single-phase.

Mandrel Industries, Inc., Electro-Tech Labs Div., Dept. ED, P.O. Box 13243, Houston 19, Tex.

Price: \$135,000 ea.

Availability: 90 to 120 days.

Resistance Decades

370

Accuracy is $\pm 0.1\%$



These eight models provide an accuracy of $\pm 0.1\%$ and 2 w of power per step. They have from one to four decades. Model 340, shown, has a resistance range of up to 110 meg in steps of 1 meg. Model 341 has a resistance range of up to 111.1 meg in steps of 10,000 ohms. Average temperature coefficient is less than 8 ppm per deg C.

The Winslow Co., Dept. ED, 701 Lehigh Ave., Union, N.J.

FREQUENCY STANDARDS



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Units for right angle drive for panel mounting available at \$10.00 additional each. Order these by adding the letters PM to the model number.

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.07% ACCURACY
10% ABSORPTION
TYPE N CONNECTORS
LOADED Q 1000

MODEL 12-1 DR



2 - 4 KMC
.07% ACCURACY
10% ABSORPTION
TYPE N CONNECTORS
LOADED Q 1000

MODEL 24-1 DR



4 - 8 KMC
.07% ACCURACY
10% ABSORPTION
TYPE N CONNECTORS
LOADED Q 1000

MODEL 48-1 DR



7 - 10 KMC
.07% ACCURACY
10% ABSORPTION
UG - 51/U FLANGES
LOADED Q 50001

MODEL 710-1 DR



8.2 - 12.4 KMC
.07% ACCURACY
10% ABSORPTION
UG - 39/U FLANGES
LOADED Q 5000

MODEL 812-1 DR



12 - 18 KMC
0.1% ACCURACY
10% ABSORPTION
UG - 419/U FLANGES
LOADED Q 3000

MODEL 1218-1 DR



FREQUENCY STANDARDS P.O. BOX 504 ASBURY PARK, N. J.

PRospect 4-0500

CIRCLE 100 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960

FREQUENCY STANDARDS



IMMEDIATE DELIVERY FROM STOCK

HIGH PERFORMANCE LOW-PASS FILTERS

FREQUENCY STANDARDS OFFERS A LINE OF IMPROVED PERFORMANCE LOW-PASS FILTERS UTILIZING DESIGNS BASED UPON MODERN NETWORK THEORY. THE UNITS TERMINATED BY TYPE N CONNECTORS EXHIBIT A MAXIMUM VSWR OF 1.35 IN THE PASSBAND AND REJECT FREQUENCIES LOCATED AT $1.25 F_c$ BY A MINIMUM OF 30 DB. ABSOLUTE ACCURACY OF THE CUTOFF FREQUENCIES IS $\pm 5\%$. THESE UNITS HAVE A MAXIMUM PEAK POWER RATING OF 5KW AND ARE AVAILABLE WITH ALL POPULAR TYPES OF RF CONNECTORS.

PRICE: \$32.00 EACH*

* QUANTITY DISCOUNTS AVAILABLE.

- IMPROVED PERFORMANCE
- COMPLETE FREQUENCY COVERAGE-L TO X-BAND
- LOW COST
- IMMEDIATE DELIVERY

F_c (mcs)	TYPE N CONNECTORS	TYPE TNC CONNECTORS	TYPE C CONNECTORS	TYPE BNC CONNECTORS	TYPE HN CONNECTORS
1000	FS10LN	FS10LT	FS10LC	FS10LB	FS10LH
1500	FS15LN	FS15LT	FS15LC	FS15LB	FS15LH
2000	FS20LN	FS20LT	FS20LC	FS20LB	FS20LH
2500	FS25LN	FS25LT	FS25LC	FS25LB	FS25LH
3000	FS30LN	FS30LT	FS30LC	FS30LB	FS30LH
3500	FS35LN	FS35LT	FS35LC	FS35LB	FS35LH
4000	FS40LN	FS40LT	FS40LC	FS40LB	FS40LH
4500	FS45LN	FS45LT	FS45LC	FS45LB	FS45LH
5000	FS50LN	FS50LT	FS50LC	FS50LB	FS50LH
5500	FS55LN	FS55LT	FS55LC	FS55LB	FS55LH
6000	FS60LN	FS60LT	FS60LC	FS60LB	FS60LH
6500	FS65LN	FS65LT	FS65LC	FS65LB	FS65LH
7000	FS70LN	FS70LT	FS70LC	FS70LB	FS70LH
7500	FS75LN	FS75LT	FS75LC	FS75LB	FS75LH
8000	FS80LN	FS80LT	FS80LC	FS80LB	FS80LH

FREQUENCY STANDARDS P. O. BOX 504 ASBURY PARK, N. J.

PRospect 4-0500

CIRCLE 101 ON READER-SERVICE CARD

Telemetry Transmitter

365

For fm-fm and PCM systems



Type TR-10 telemetry transmitter, for use with the firm's fm-fm and PCM systems, has been used in several missile projects. Specifications include: 2.5 w output with true fm modulation over the band of 2.5 to 265 mc; 99.9% reliability for 500 hr; modulation frequency response of ± 2 db from 3 cps to 300 kc; vibration-induced noise of less than 1.5-kc deviation at 20 g from 20 to 2,000 cps; modulation linearity of less than 1% from straight line at 125 kc.

United ElectroDynamics, Inc., Dept. ED, 200 Allendale Road, Pasadena, Calif.

Price: \$825.

Availability: 60 to 90 days.

General-Purpose Oscilloscope

369

Has 5-mc bandwidth



Type 440 oscilloscope has 17 sweep speed calibrated from 1 μ sec per cm to 200 msec per cm. A sweep expander extends the range to 0.1 μ sec per cm. Accelerating potential is 5 kv. A sweep vernier permits continuous adjustment and extends the sweep range to 10 sec full scale. A 10-step attenuator permits observation of any signal between 50 mv per cm to 500 v full scale a rise times of 0.08 μ sec or less. The unit has bandwidth of dc to 5 mc in the vertical amplifier and dc to 500 kc in the horizontal amplifier.

Fairchild Camera & Instrument Corp., Alle B. Du Mont Labs. Div., Dept. ED, 750 Bloorfield Ave., Clifton, N.J.

Availability: Late fall, 1960.

NEW LIGHT is shed daily on microwave tube state-of-the-art by the engineers and scientists at Sperry's Gainesville, Florida plant. If existing hardware doesn't readily solve your tube application problem, call Gainesville, FRanklin 2-0411 collect, for full information about Sperry capabilities.



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 CIRCLE 103 ON READER-SERVICE CARD



NEW PRODUCTS

Crystal-Controlled Marker Generators 736

Use harmonic and side-band techniques



Models CM-6 and CM-10 crystal-controlled marker generators use harmonic and side-band techniques to attain more marking indications. The CM-6 is a 6-crystal, portable unit; the CM-10 is a 10-crystal unit for rack mounting. Use of one center-frequency oscillator permits a choice of two side-band oscillator frequencies providing a total of five marks: one at the center frequency, two at the band edges and two at the 3-db down points.

Jerold Electronics Corp., Dept. ED, 15th and Lehigh Ave., Philadelphia 32, Pa.
Price: \$285, CM-6; \$425, CM-10.

Frequency-to-DC Converter 366

Plug-in type



The PI-400 converter is designed for use with flowmeters, tachometers and other frequency-measuring applications. It can be used in ground-support test equipment, engine test stands, control applications and other instrumentation where precise analog forms of frequencies and pulse rates are required. The unit furnishes a low-impedance dc output voltage and current proportional to the frequency or pulse rate of the input. It also provides visual indication of input frequency and a pulse output for operating counters and recorders. The output of up to 5 v is accurate to 0.1%.

Anadex Instruments, Inc., Dept. ED, 14734 Arminta St., Van Nuys, Calif.

Price: \$375.

Availability: 30 days.

NEW BORG LOW-INERTIA MOTORS

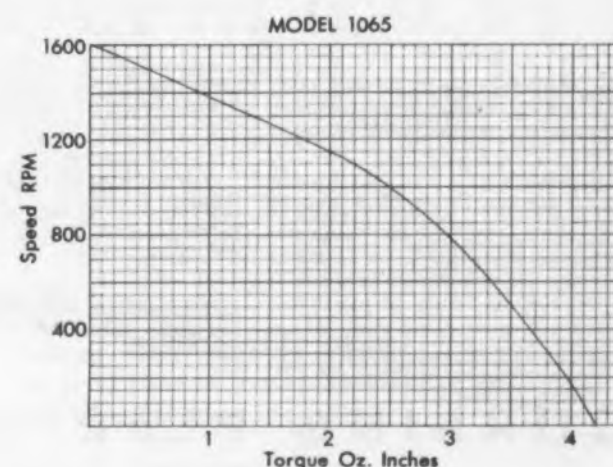
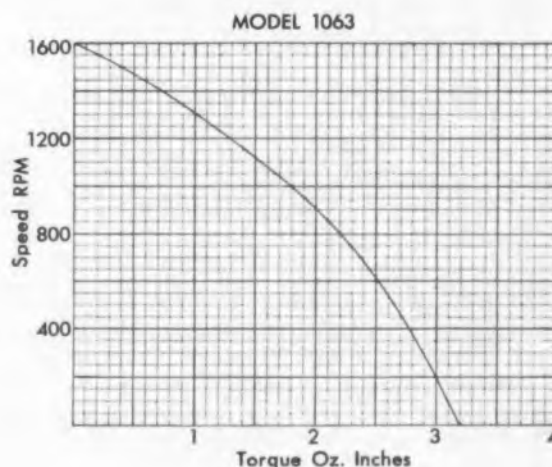


Model 1063 actual size

Borg's new 1060 Series Low-Inertia, Sub-Fractional Horsepower Instrument Motors are specifically designed for applications where *exceptionally rugged and reliable* control motors are demanded! They can be operated two-phase, or split-capacitor connected for single-phase operation, from a 115 volt, 60 cycle source. Extended rotor-bearing preload-adjustments are provided for minimum starting voltages. Ample electrical and mechanical safety margins are included for critical instrument applications such as medical equipment. Gear train models are also available in twenty gear ratios from 6 : 1 to 1800 : 1. Upgrade your precision equipment now . . . investigate new Borg 1060 Series Low-Inertia Motors!

CONTACT YOUR BORG DISTRIBUTOR OR TECHNICAL REPRESENTATIVE FOR CATALOG SHEET BED-A165

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CIRCLE 104 ON READER-SERVICE CARD



MOISTURE ABSORPTION IS NAUGHT, NIL, ZERO IN CORNING NF RESISTORS

Glass-enclosed, fusion-sealed Corning NF resistors have boiled merrily in salt water for days without showing a jot of change in their electrical characteristics.

These are resistors that are rugged, completely moisture resistant, highly vibration resistant... in short, resistors that exceed the requirements of MIL-R-10509C, Char. B, better than any we've seen or heard of.

The key to such fortitude is our NF structure. We start with glass rods with metal oxide applied under heat. This in it-

self makes a moisture-resistant, almost abnormally stable resistor, as you well know if you have ever used our regular N-style resistors.

We encapsulate this basic unit in a glass envelope and apply glass-to-metal seals at the leads... comparable to those in a vacuum tube.

IMMEDIATE DELIVERY • There are two models of this gem in production, ready for *quick shipment*: the 1/8-watt NF-60

and the 1/4-watt NF-65. Resistance ranges from 100 ohms to 360K ohms. Voltage ratings are 250v and 300v. Full rating at 70°C. with derating to 150°C. More data:

Load life 0.3%
Voltage coefficient 0.001%/v
Temp. coefficient 0.03%/°C.
Insulation resist. . 100,000 megohms

To get this and other data for your file, just write and ask for Data Sheet CE-2.02. Address: Corning Glass Works, 540 High Street, Bradford, Pennsylvania.



CORNING ELECTRONIC COMPONENTS

CORNING GLASS WORKS, BRADFORD, PA.



1/8-WATT NF-60

ACTUAL SIZE

1/4-WATT NF-65

CIRCLE 105 ON READER-SERVICE CARD

NEW PRODUCTS

Voltage-Controlled Subcarrier Oscillator 385

For fm-telemetry applications



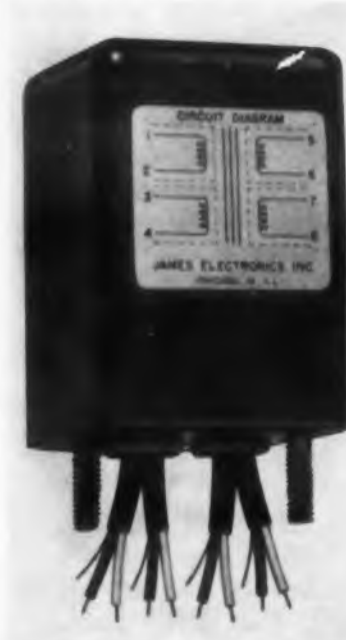
Model 0-20 subcarrier oscillator has good data stability telemetering applications ranging from -55 to +125 C. The unit measures 2.25 x 1.875 x 0.875 in. It meets a wide range of missile, satellite and aircraft applications. The unit is available in all standard IRIG channels with inputs of 0 to 5 v and -2.5 to +2.5 v.

Dorsett Electronics Labs., Inc., Dept. ED, 119 W. Boyd, Norman, Okla.

Price: \$300.

Availability: 30 to 60 days.

Chopper Differential Transformers 372



Inductance is 1,200 h

These instrument transformers have windings balanced to within $\pm 0.05\%$ to the turn. Other specs include: inductance, 1,200 h; common mode rejection, 120 db; hum bucking and magnetic shielding, 135 db; frequency response, 30 cps to 8 kc.

James Electronics Inc., Dept. ED, 4050 N. Rockwell St., Chicago 18, Ill.

Availability: Two weeks.

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Twin meters read pulse repetition frequency and pulse duration simultaneously. Rise time is 0.02 microseconds; decay time, 0.03 microseconds. Pulse duration, continuously variable from 0.1 to 1000 microseconds. Jitter, less than 0.005 microseconds. Pulse repetition rate, continuously variable from 10 to 100,000 pps in four ranges. Price **\$625**



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*A Self-Powered Calibrator for Electrical Instrument
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Two terminal connections cover all 49 ranges for unusually fast operation. DC accuracy is $\pm 0.5\%$ F.S.; AC, $\pm 0.75\%$ F.S. (at 77°F, 25°C). Separate meters (self shielded movements) for DC and AC readings. Price **\$1620**

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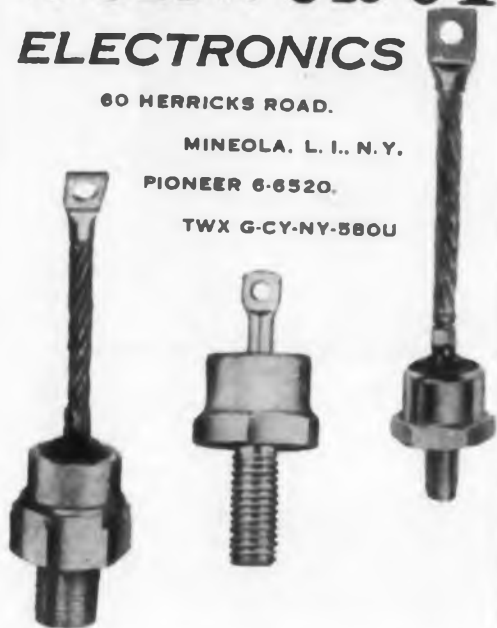
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MINEOLA, L. I., N. Y.

PIONEER 6-6520.

TWX G-CY-NY-580U



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Westinghouse 30-amp silicon "rock-top" power transistors

New 30-amp ratings, the industry's highest! These latest Westinghouse Silicon Power Transistors are especially designed for those applications where you need more transistor power, extra long-life and extra stability under all operating conditions. Your choice of nine devices in this new family—each rated at 30 amps.—for greater flexibility of circuit design in high-power applications. Other Westinghouse high-performance features include: • Exclusive "rocktop" ceramic construction for greater reliability • Voltage ratings to 200 volts • Double-ended case design • Low saturation resistance • 250 watts power dissipation.

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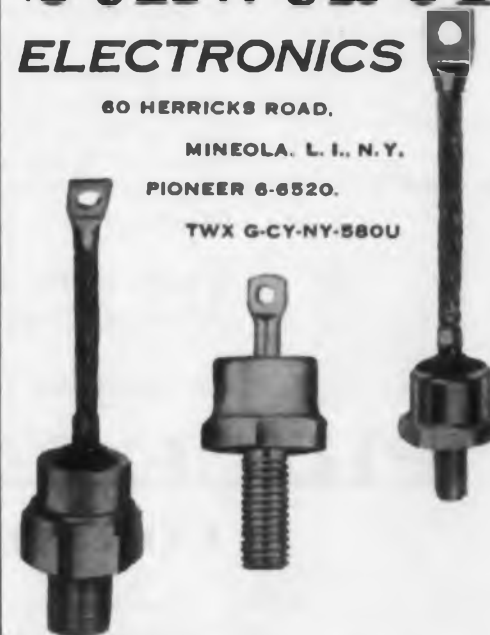
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60 HERRICKS ROAD,

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PIONEER 6-6520.

TWX G-CY-NY-580U



CIRCLE 109 ON READER-SERVICE CARD

← CIRCLE 110 ON READER-SERVICE CARD

Now...
A telephone type relay
you can plug in
and depend on!



Style 5400A

Style 5400A relays are designed for reliable switching in commercial and military printed circuit applications. They are available with contact combinations up to 4 form C and with a wide variety of contact materials for dependable switching of contact loads up to 5 amps.

An insulating board is provided to maintain printed circuit terminal alignment and to protect the relay from mechanical damage. Four tapped holes can be provided in the relay frame for additional mounting support if desired. All relays meet applicable portions of specification MIL-R-5757C.

General Characteristics:

Maximum Coil Resistance: 11,000 ohms
 Sensitivity:

Style 5409A (DPDT) 0.5 watts at pull-in.

Style 5424A (4PDT) 0.8 watts at pull-in.

Contact Combinations: To 4PDT

Military Specifications: MIL-R-5757C

Dielectric Strength:

1000 VRMS coil and contacts

Operate Time: 15 Milliseconds Maximum

Release Time: 10 Milliseconds Maximum

Temperature Range: Standard construction to 85°C.;
 special to 125°C.

Weight: Approximately 1.7 oz.

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NEW PRODUCTS

Commutator Simulator

377

Provides flexible pulse train



A combination of magnetic logic elements and thyristors enables this unit to generate repetitive frames of pulses accurately simulating the output of a commutator. It provides pulse trains for PAM or PDM. Any pulse or group of pulses can be varied in width or amplitude or both; any number of pulses can be set up in a frame to operate at any repetition rate.

Portronics, Inc., Dept. ED, Box 697, Tarzana, Calif.

Price: \$645 for 28-channel unit.

Availability: Made on order for 30-day delivery.

DC-DC Converter

371

Weights 1.5 lb



Model 100PS dc-dc converter converts battery power to primary power for aircraft, missile and industrial applications. Completely transistorized, the unit weighs about 1.5 lb and measures 4-1/4 x 3-3/4 x 2-3/4 in. The output is 250 v dc, 75 w, and the input is 12 v dc.

Johnson Electronics, Inc., Dept. ED, P.O. Box 1675, Casselberry, Fla.

Price: \$100.

Availability: 30 days.

MORE BOUNCE
TO THE MILLIGRAM



PHOSPHOR
BRONZE

From .000125" thin to .010", Somers Thinstrip phosphor bronze is produced by a unique high-speed annealing process which provides a uniform fine grain structure. Thus, spring temper metal is produced with elongation up to five times that of coarse grain methods, making possible the forming of much more intricate parts for many instrument and electro-mechanical applications. And Somers' close control of grain size guarantees prolonged fatigue resistance unattainable through ordinary methods.

Whatever your Thinstrip problems, in copper, copper alloys and stainless steel from .010" down and nickel and nickel alloys from .020" down, write for the Somers confidential data blank. No obligation, of course.

FOR EXACTING STANDARDS ONLY



Somers Brass Company, Inc.
 116 BALDWIN AVE., WATERBURY, CONN.
 CIRCLE 112 ON READER-SERVICE CARD



TRANSFORMER

***Constant Voltage Output**
for low voltage applications

SPECIFICATIONS

Input Voltage 90-130 Volts
Output Voltage 12 Volts
Output Capacity 50 Watts

This unique, compact unit has a short-circuit overload protection and an output voltage variation, with rated input voltage of 90-130V, which is less than $\pm 1.5\%$. The output voltage variation, with change of load current from $\frac{1}{4}$ L to full L, is equal to $\pm 3.0\%$. Hermetically sealed for high reliability and long life.

C	Output V	Full Load I	Input V
CVO-10	10V	5 amp.	90-130
CVO-12	12V	4 amp.	90-130
CVO-14	14V	3.5 amp.	90-130
CVO-16	16V	3 amp.	90-130
CVO-18	18V	2.75 amp.	90-130

WRITE TODAY

Free Descriptive
Literature Available



NYTRONICS, INC.
553 Springfield Ave., Berkeley Heights, N. J.
CRestview 3-9300

ESSEX ELECTRONICS DIVISION, BERKELEY HEIGHTS, N. J.
AUTOMATION PRODUCTS DIVISION, LEXINGTON, KY.
ESSEX ELECTRONICS OF CANADA LTD., TRENTON, ONT.

CIRCLE 113 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960

Servomotor Tachometer

383



For navigation and
control systems

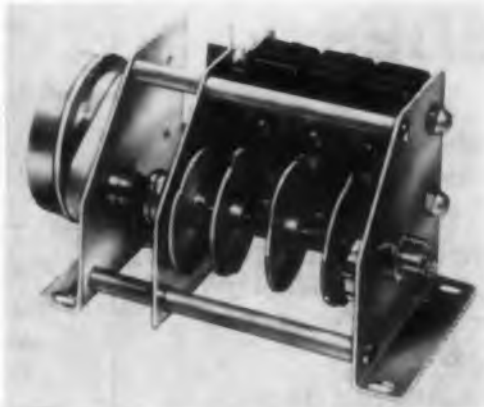
For use in navigation and control systems, where fast response is needed, this unit has a torque of 0.25 oz-in. with a rotor moment of inertia of 0.18 gm-cm². Mechanical time constant is 0.01305 sec; no-load speed is 10,250 rpm. A 400-cps, two-phase unit, the tachometer is available with control phase windings of 26 v, 36 v (center-tapped) or 115 v. It weighs 2.72 oz and has a diameter of 0.75 in.

Sperry Rand Corp., Wright Machinery Co., Dept. ED, Calvin & Holloway Sts., Durham, N.C.

Program Cam Timers

367

External clutch permits automatic reset



Series 650 multi-switch program cam timers have external clutches which permit instant automatic reset. Any time cycle from 1 sec to 60 hr and from 2 to 5 load switches can be specified. The units are available in 115 or 220 v, 60 cps models.

Industrial Timer Corp., Dept. ED, 1407 McCarter Highway, Newark 4, N.J.

Price: \$25.50 to \$43.50, 115-v units; \$27.50 to \$45.50, 220-v units.

Availability: 6 to 8 weeks.

- Adjustable
- Subminiature
- Weighs only 1.3 oz.
- Ni-Span C pressure capsule
- Stainless steel housing



NEW BRISTOL PRESSURE SWITCH

Here's a subminiature pressure switch that incorporates the superb reliability characteristics of larger Bristol pressure switches. Yet, it's both miniature in size and it's adjustable.

It's the Bristol Type C2060... with six models covering ranges from 2-15 psi, absolute, to 20-200 psi gauge.

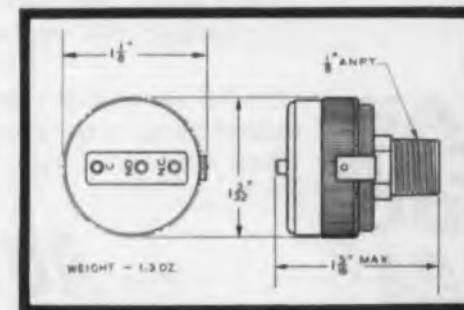
Easy pressure adjustment. You can change pressure settings easily and simply, without tools. Just turn the top portion of the switch. A strong ball detent holds settings positively even under severe vibration and shock.

Withstands shock, vibration, and acceleration in excess of MIL-E-005272B requirements. SPDT snap-action contacts are rated at 5 amps, 125vac, 60

cps; 2.5 amps d-c resistive load.

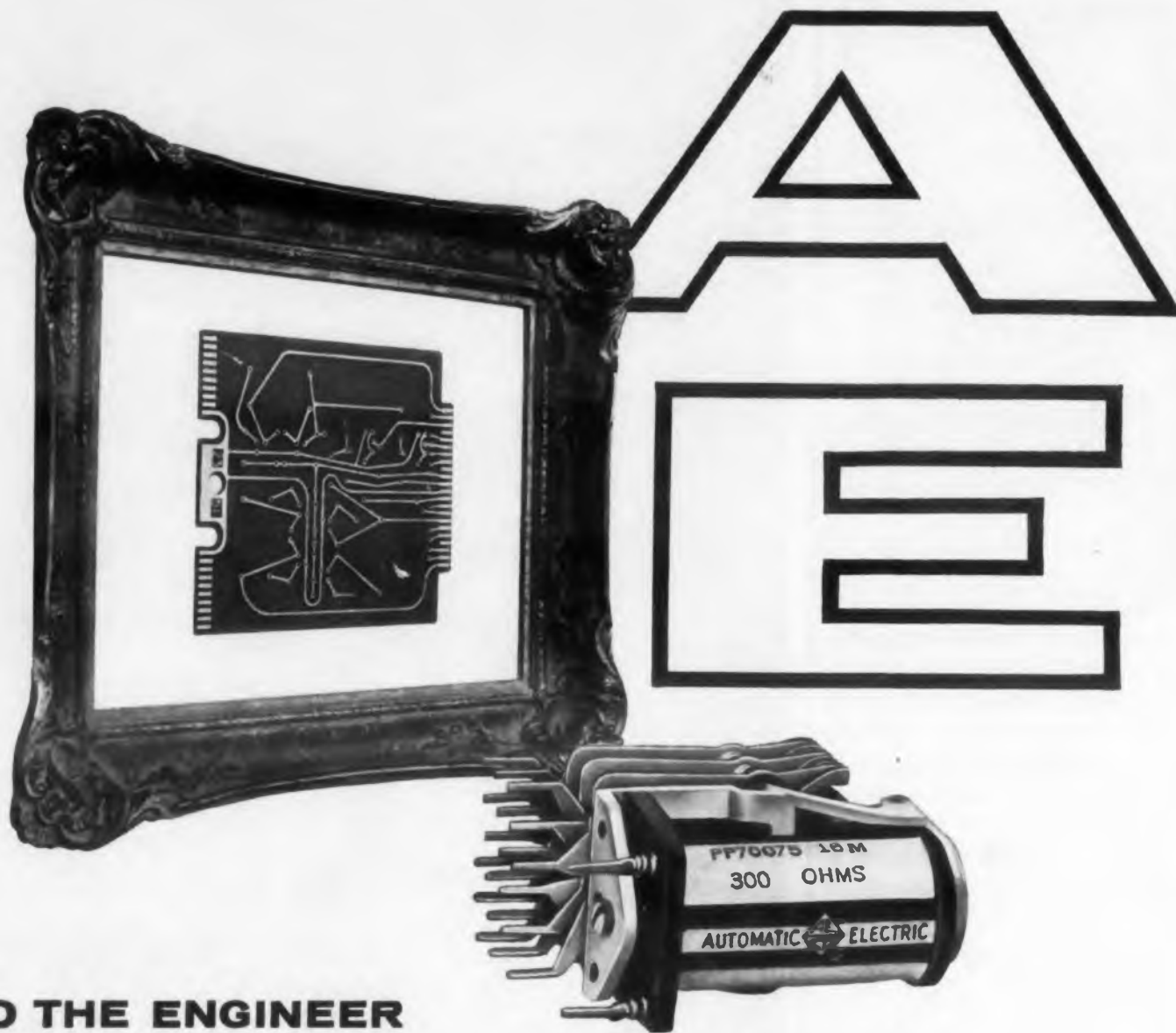
Get complete specifications on the new Bristol adjustable pressure switch today. Simply write for Bulletin AV 2015. The Bristol Company, Aircraft Equipment Division, 151 Bristol Road, Waterbury 20, Conn.

O.14



Dimensions

BRISTOL FINE PRECISION INSTRUMENTS
FOR OVER SEVENTY YEARS
CIRCLE 114 ON READER-SERVICE CARD



TO THE ENGINEER

who wants to make the most of his etchings

If your printed circuit board designs involve switching, you can count on getting the best results by using AE Class E relays with direct-connect terminals.

Series EQPC relays, with end-mounted printed circuit lugs, occupy a minimum of board space, and furnish dramatic savings in assembly and wiring time.

The AE Series EQPC printed circuit relay is a miniaturized version of the premium-quality Class B telephone-type relay, with many of its

best features. Contact reliability exceeding 200 million operations can be expected.

Automatic Electric also supplies Class E relays with Taper-Tab terminals, and prewired for plug-in, with 8- to 20-prong octal plugs, with or without hermetically sealed containers or dust-tight housings.

Want details? Just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois. Also ask for Circular 1702-E on *Relays for Industry*, and the new *Conversion Factors* booklet.

**AE
CAN
DO**



AUTOMATIC ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS



NEW PRODUCTS

DC Power Supply

354

Has 0.1% regulation



Model 101-D solid-state dc power supply has 0.1% regulation. This modular unit measures 2-1/4 x 2-3/4 x 6-7/8 in. Ripple is less than 1 mv rms. Input is 100 to 130 v, 50 to 2,000 cps. Temperature stabilization insures a drift of $\pm 0.01\%$ per deg C max. An output of 12 v dc at 1 amp over a -25 to $+45$ C range can operate up to $+71$ C at reduced output current.

Viking Industries, Inc., Dept. ED, 21343 Roscoe Blvd., Canoga Park, Calif.

Price: \$255 ea.

Availability: 21 days.

Chart Recorder

721

Portable clamp-on, permanent pick-up types



The Rustrak chart recorder has been adapted for use with transducers in ac current ranges from 5 to 600 amp. Portable clamp-on and permanent pick-up type transducers are available. The ammeter reads and records the current directly onto a moving chart for a permanent record. The current recorder has variable chart speeds from 1 to 240 in. per hr. The unit indicates specific power loads at various times of the day, the location of a troubled area, and precise on-and-off time for power equipment. It can be located up to 2,000 ft away from the current pick-up transducer. Accuracy is 5%.

Rust Industrial Co., Dept. ED, 130 Silver St., Manchester, N.H.

Price: \$124.50 with permanent transducer; \$132.50 with clamp-on transducer.

CIRCLE 116 ON READER-SERVICE CARD >

ELECTRONIC DESIGN • November 23, 1960

Mercury Battery

585

Is multi-voltage reference source

This low impedance, multi-voltage, mercury battery provides a laboratory reference source for instrument calibration, bias circuits and supplying stable dc output for measuring and control systems. Eight outputs from 0 to 10.8 v in 1.35 v increments are provided with an accuracy of $\pm 1/2\%$ of stated open circuit voltage. The unit shock. It is temperature stable within 1% from -20 to +160 F at drains up to 100 μ amp. The is not damaged by brief short circuits, sustained drain within rated capacity, severe vibration or manufacturer claims an accuracy of one part per million for short periods and less than $\pm 1/2\%$ for 3 yr or more at normal temperature.

P. R. Mallory and Co. Inc., The Mallory Battery Co. Div., Dept. ED, Indianapolis 6, Ind.
Price: \$39.50.

Tunnel Diodes

608

For computer applications

These tunnel diodes can be furnished with switching speeds up to 0.1 nsec and peak-to-valley ratios of up to 15:1. Other specs include: operation at clock frequencies up to 1,000 mc; peak currents of 5, 20 and 50 mc controlled to $\pm 5\%$; and low inductance of 0.4 m μ h. Temperature range is -65 to +150 C. The units can be dip soldered. They are designated types 1N3128, 1N3129, 1N3130 (germanium types) and 1N3138 (gallium-arsenide).

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, Somerville, N.J.

Germanium Alloy-Junction Transistors

696

For use in computers

These germanium alloy-junction transistors are for use in computers. Types 2N1302, 2N1304, 2N1306 and 2N1308 are npn units; types 2N1303, 2N1305, 2N1307 and 2N1309 are pnp units. All units use the standard JEDEC TO-5 package. Maximum ratings for all units are: collector-to-base voltage, 25 v; emitter-to-base voltage, 25 v; collector current, 300 ma; power dissipation in free air, 150 mw; temperature range, -65 to +100 C.

Sylvania Electric Products Inc., Semiconductor Div., Dept. ED, 730 Third Ave., New York 17, N.Y.

Price: \$1.60 to \$4.80, 1 to 99 units; \$1.10 to \$3.30, 100 to 999 units.

Availability: From stock.

for the service
you need...
for the sizes you want...

SPEER RESISTORS

You're sure to find the sizes and types you want in Speer's complete line of 1/2-, 1- and 2-watt fixed composition resistors, which meet or exceed the requirements of specifications MIL R11 and RS 172. The fast, efficient service for which Speer has gained a wide reputation can also help you eliminate costly production delays. So next time, specify Speer! Speer now offers these new sizes:

Speer Type	MIL Style	Rating in watts	Body		Lead	
			Nominal Diameter	Nominal Length	Wire Size	Nominal Length
SR 1/2	RC 20	1/2	.138	.390	A.W.G. # 20	1 1/2
SR 1	RC 32	1	.225	.562	# 18	1 1/2
SR 2	RC 42	2	.312	.688	# 17	1 1/2

Other Electronics Divisions of Speer Carbon Company
Jeffers Electronics, Du Bois, Pa.
Onondaga Electronics, Syracuse, N. Y.



Speer Resistor Division

Speer Carbon Company, Bradford, Pennsylvania

CIRCLE 117 ON READER-SERVICE CARD

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ELECTRONIC DESIGN • November 23, 1960



The Martin Company, Orlando—8,229 people working in 21 new (1958) buildings on a 6,777-acre site. Here over 2,400 of the nation's best engineers pursue vital and stimulating projects like Lacrosse, Bullpup, GAM-83 and Pershing missiles, Missile Master and other electronic systems.

CAREER OPPORTUNITIES IN FLORIDA for engineers in these areas: design, development, fundamental and applied research, reliability, quality, systems test, manufacturing and associated engineering areas. . . . Write C. H. Lang, Director of Employment, The Martin Company, Orlando 3, Florida. See facing page.

WORK IN THE CLIMATE OF ACHIEVEMENT

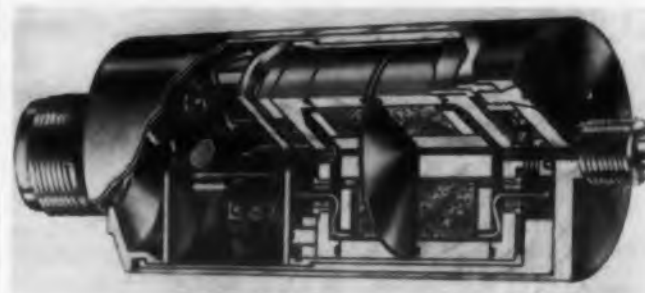
MARTIN
ORLANDO

NEW PRODUCTS

Pressure Transducer

436

Contains one moving part



Type A-6 pressure transducer, designed for systems applications, is suitable for use in severe environments. The only moving part is the magnetic diaphragm. It measures slightly over 1.5 in. in diameter and less than 4-in. long. The input and output circuitry are integrally contained within the unit.

Mitchell Camera Corp., Astromics Div., Dept. ED, 611 W. Harvard St., Glendale, Calif.

Price: \$245.

Availability: 45 days.

Adjustable Speed Drive

587

Standard speed range is 8:1

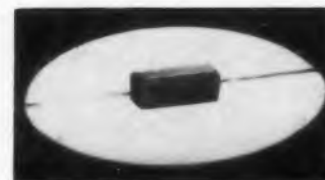
This device, called Statotrol drive, is available in standard ratings from 1/20 to 3/4 hp. It operates at 115 v, 50 to 60 cps. The solid-state silicon-controlled rectifier converts ac to controlled dc.

General Electric Co., Specialty Control Dept., Dept. ED, Schenectady, N.Y.

Axial-Lead Resistor

443

Has three w rating



The PW-3 axial-lead, power, wire-wound resistor has fire-proof inorganic construction. Resistance elements are wound on glass-fibre cores, tinned-copper leads are secured to the element and the assembly is sealed in a rectangular ceramic case. Resistance range is from 0.24 to 6,200 ohms with standard tolerances of $\pm 5\%$ and $\pm 10\%$. The unit has heavy-duty crimp termination and can stand a 5-lb pull.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

Price: Less than \$50 per thousand.

Availability: Three week delivery.

first
choice
FOR
critical
applications



ADJUSTABLE PRECISION POLYSTYRENE CAPACITORS



.01% accuracy
hermetically sealed

SOUTHERN ELECTRONICS hermetically sealed precision adjustable capacitors are finding many applications in analog computers, network tuning circuits, differential analyzers and similar electronic circuitry that requires the utmost in accuracy and reliability.

SEC has pioneered in the design and manufacture of hermetically sealed adjustable capacitors, and this experience has resulted in a .01% accuracy standard, and a degree of in-circuit-reliability not previously available at any price. SEC adjustable capacitors incorporate features proven to be years ahead of any comparable product now available.

GENERAL SPECIFICATIONS

Available from .01 mfd. to 10 mfd.

Accuracy: .01%

Long Term Stability: 0.03%

Temperature Coefficient: -100 PPM per °C

Temperature Range: -40°F to +140°F

Write today for complete specifications and general catalog.



Pioneers in custom precision
capacitor engineering

**SOUTHERN
ELECTRONICS**
Corporation

150 WEST CYPRESS AVENUE
BURBANK, CALIFORNIA

CIRCLE 118 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960



PAUL B. PICKAR, PH.D., RESEARCH PHYSICIST

Why did I move to Martin-Orlando? Freedom. Freedom to do the work I like . . . and the time and equipment to do it. I'm a physicist . . . working in solid state physics. That's what I know—what I want to do. Nobody asked me to work in, say, spectrometry—which is not my field. I was given a lab and facilities to work with, and, above all, a lot of freedom to carry out my work. Right now, we're applying modern theories to semi-conductors which haven't been investigated before . . . I also like the chance to talk with other scientists who understand my field and to work with some of the younger fellows who are coming along. Martin is one big company where you don't get lost in the crowd. My wife, the kids, love Florida . . . the climate, the ocean, country living. We have everything we need.

Write C. H. Lang, Director of Employment, The Martin Company, Orlando 4, Fla. (For Career Opportunities, see facing page.)

WORK IN THE CLIMATE OF ACHIEVEMENT

MARTIN
ORLANDO

Panel-Mounted Dial Assemblies 458

Mount on any test panel



Models DA and DR dial assemblies mount on any test panel and accept the synchro without further fixturing. The synchro or potentiometer is inserted into a spring-loaded collet. The dial is graduated in 1 deg intervals, a scale vernier allows readings to 0.1 deg. Model DR is recommended where a high degree of set-ability is required, one rotation of the vernier knob rotates the synchro or resolver only 16 min-of-arc.

Theta Instrument Corp., Dept. ED, 520 Victor St., Saddle Brook, N.J.

Price: Model DA, \$85; model DR, \$170; job Saddle Brook.

Availability: From stock.

Binary-Decade Counter 459

For general purpose applications



Model 11G, transistorized binary-decade counter, is designed for general purpose applications in data acquisition, data processing and digital control. The counter supply voltage may be varied by over a two to one margin from 0 to 100 kc. This permits application to existing power sources in the range from ± 7.5 v to ± 17 v. The unit is converted to a four-bit register by deletion of the flip-flop coupling component.

Electronic Counters, Inc., Dept. ED, 155 Eileen Way, Syosset, L.I., N.Y.

Price: \$82.

Availability: From stock.

Draft-Field Transistor 584

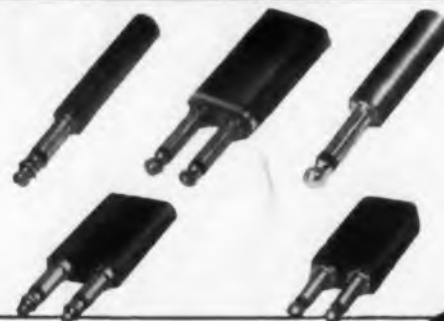
With two emitters

Type 3746 drift-field transistor with two emitters is a germanium pnp alloy-type unit. It can be used in mixer-oscillator circuits in super-heterodyne receivers, two-signal mixer circuits and switching circuits. Specs include: V_{cb} , -34 v max; I_{cb} , -16 μ a max; and I_{eb} , -16 μ a.

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, Somerville, N.J.

ADC *the Quality line of*

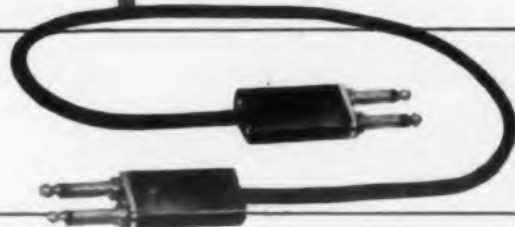
PLUGS



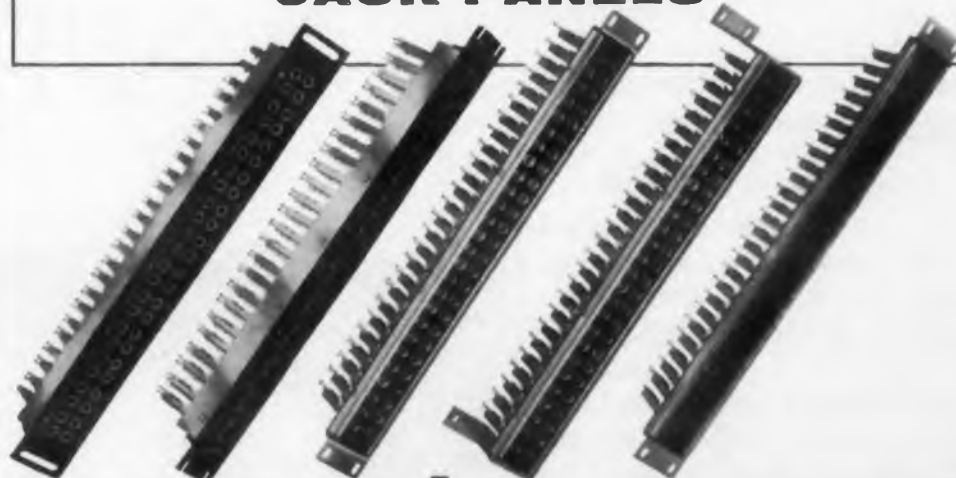
JACKS



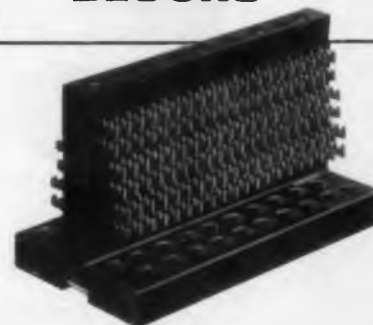
PATCH CORDS



JACK PANELS



TERMINAL BLOCKS



SWITCHBOARD TYPE

Lamp Jacks Lamp Strips Jack Strips



For completeness of line, for quality and dependability, for availability from stock you'll like . . . ADC JACKS—First choice of the country's foremost manufacturers of communication equipment, unique one piece frame provides maximum strength . . . ADC JACK PANELS—One of the most complete assortments of jack panels available for use wherever audio signals are switched and distributed . . . ADC PLUGS AND PATCH CORDS—Standard in the communication industry! . . . ADC TERMINAL BLOCKS molded to your specifications; six popular sizes in stock.



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CIRCLE 120 ON READER-SERVICE CARD

NEW PRODUCTS

Ignitron Tube 388

Is rated at 600 v rms

Type 7681 ignitron is claimed to permit a 50% boost in the power output of size C welders without increasing equipment dimensions. In ac control service, two of these tubes, in inverse parallel, control 1,800 kva with an anode current of 113.5 amp. With a maximum anode current of 210 amp, the corresponding maximum demand is 600 kva. It can also be used in frequency-changer welding.

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

Price: (OEM) \$125.16.

Availability: From inventory.

Transponder Function 565 Tester

Performs go/no-go testing

Model 860A is for use in ground checkout of installed transponders. It provides a check for receiver sensitivity and transmitter output in addition to a partial check of decoder-encoder performance. The unit is portable, weighs less than 4 lb, and operates from four 1.5-v D batteries.

The Wilcox Electric Co., Inc., Dept. ED, Kansas City, Mo.

Digital Module 567

Operates from 0 to 200 kc

Type 201 Logibloc flip-flop operates from 0 to 200 kc. It can be converted to set-reset type bistable flip-flops, triggering-type binary counters, or shift registers. The output from each flip-flop can drive a maximum load of four flip-flops, four Nor circuits, eight gate resistors, or four gate capacitors. Rise time is 0.5 μ sec at 6 v.

Wang Laboratories, Inc., Dept. ED, 12 Huron Dr., Natick, Mass.

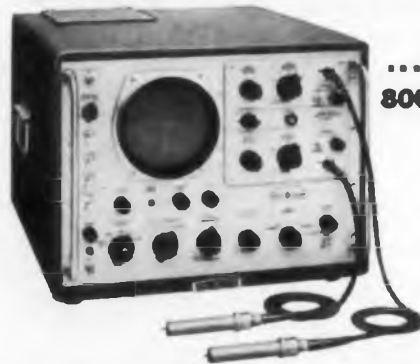
Price: \$31 ea, 1 to 100; \$29.45 ea, 100 to 300; \$28.67 ea, over 300.

Availability: From stock.

In RELIABILITY, test in the equipment tested. For G-E Five-Star Tubes application needs best.



TUBE LIFE REQUIREMENTS: LOW GRID CURRENT, HIGH G_m



...in **hp** Model 185A
800-mc Oscilloscope

Advanced pulse-sampling circuitry of the 185A calls for an amplifier tube with (1) grid current so low that current is not withdrawn from a grid-to-ground storage capacitor, and (2) high G_m for maximum amplification. These characteristics must be maintained. General Electric's 5-Star 5654 was chosen by Hewlett-Packard after extensive tests; helps in producing a dependable high-speed instrument to measure transistor response time and diode switching speeds, and test fast computer circuits and surveillance radars.

TUBE NOISE MUST REMAIN AT MINIMUM LEVEL



...in **hp** Model 425A
Micro Volt-Ammeter

So sensitive it will measure down to 10 microvolts and 10 micro-microamperes—stable, with extremely low drift—Hewlett-Packard's 425A calls for sustained tube performance at minimum noise level. In the key amplifier socket for modulator output, General Electric 5-Star 5751-WA's have cut line rejects from noise sharply, and help preserve usefulness of the equipment after it is placed in service. Before, another tube in the same socket caused a 30% reject rate!

st instruments must surpass

d. Hewlett-Packard  uses

because they satisfy

st....here is your proof!

TUBES MUST STAY FREE OF INTERFACE EFFECTS

...in  Model 460B
Wide Band Amplifier



In order that high pulse power or voltage may be applied to a load, Hewlett-Packard's 460B uses 13 5-Star 5654 tubes in a distributed-amplifier circuit. Tube requirements are severe. The high-voltage, low-duty cycle pulses entail operation at max ratings for brief intervals, between long periods of tube cut-off. Interface effects would handicap reliability. General Electric's 5654's score both in minimum interface and high over-all performance...help Model 460B meet consistently, often exceed, its operating specifications.

TELEPHONE TODAY! New York, WI 7-4065...Boston, DE 2-7122...Washington, EX 3-3600
Chicago, SP 7-1600...Dallas, RI 7-4296...Los Angeles, GR 9-7765, BR 2-8566...San Francisco, DI 2-7201

Progress Is Our Most Important Product

GENERAL  ELECTRIC

431-101

Oscilloscope

387

Supplied in kit form

Model IO-10 oscilloscope can be used as a readout for computers, for wave-form observation, and for voltage, frequency and phase-shift measurement. Specifications include: vertical and horizontal channels, bandwidth, dc to 200 kc; sensitivity, 0.1 v peak-to-peak per 1/4 in. Input impedance is 3.6 meg shunted by 35 pf. Dimensions are 7-5/8 x 4-5/8 x 11 in.

Daystrom, Inc., Heath Co., Dept. ED, Benton Harbor, Mich.

Price: \$79.95.

Semiconductor Tester 394

Output can be recorded

Called Smart, this automatic test system measures up to 16 different dc parameters of a transistor or other component. The data can be recorded within 12 sec on an IBM 526 summary punch or other recording device. Using all 16 parameters, 300 transistors may be tested per hour. Using fewer parameters, up to 500 semiconductors per hour can be handled.

Texas Instruments, Inc., Dept. ED, 3609 Buffalo Speedway, Houston 6, Tex.

Price: \$70,000 to \$78,500 without card punch.

Availability: Made to order; 90- to 120-day delivery.

Binary Encoding Switch

396

Permits stacking up to 16 switches

This switch links push-buttons mechanically to a common contact array, one for each bit of information at one end of the switch assembly. It requires only five connections. Over-all dimensions are 10-1/16 x 1-11/16 x 15/16 in. Depth behind the panel is 1-3/32 in. Contact rating is 3 amp at 120 v ac or 1 amp at 120 v dc.

Telex, Inc., Special Products Div., Dept. ED, 1633 Eustis St., St. Paul, Minn.

Availability: 30-day delivery.

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NOW!
A WHOLE FAMILY OF



Powertron

ELECTRONIC GENERATORS



Single Phase
With Output
Powers From
3VA-750VA



Two-Phase
With Output
Powers From
6VA-1500VA



Three-Phase
With Output
Powers From
9VA-2250VA

TYPICAL SPECIFICATIONS (Model 250 Illustrated Above)

Fixed Frequency	400 C.P.S.
Accuracy	25%
Distortion	Less than 1%
Regulation	Less than 1%
Output Power	250VA
Variable Frequency	350-450 CPS
External Freq. Range	50-4000 CPS
Output Voltage	0-125V RMS
Mounting	Desk Top or 8 3/4" x 19" Rack Panel.

- HIGHER POWER UNITS TO ORDER
- FREQUENCY ACCURACIES AVAILABLE TO .001%

OFF THE SHELF DELIVERY ON MANY OF THE MODELS LISTED BELOW:

Model 1040 (1Ø, 3VA)	Model 1040-2 (2Ø, 6VA)	Model 1040-3 (3Ø, 9VA)
Model 1040A (1Ø, 8VA)	Model 1040A-2 (2Ø, 8VA)	Model 1040A-3 (3Ø, 24VA)
Model 1500 (1Ø, 20VA)	Model 1500-2 (2Ø, 40VA)	Model 1500-3 (3Ø, 60VA)
Model 150 (1Ø, 160VA)	Model 150-2 (2Ø, 320VA)	Model 150-3 (3Ø, 480VA)
Model 250 (1Ø, 250VA)	Model 250-2 (2Ø, 500VA)	Model 250-3 (3Ø, 750VA)
Model 750 (1Ø, 750VA)	Model 750-2 (2Ø, 1500VA)	Model 750-3 (3Ø, 2250VA)

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INDUSTRIAL TEST EQUIPMENT CO.

55 E. 11th ST. • NEW YORK 3 • GR. 3-4684

CIRCLE 124 ON READER-SERVICE CARD

NEW PRODUCTS

Analog Computer Kit 455

For basic analog principles



This unit demonstrates basic-analog computing principles and can be used for multiplications, divisions, powers and roots, log operations and trig problems. It is assembled with a screwdriver and pliers, and operates on two flashlight batteries. The computer is 20-in. long, 9-in. wide, and 2-in. deep.

Edmund Scientific Co., Dept. ED, Barrington, N.J.

Price: \$14.95 postpaid.

Availability: From stock.

Transistorized DC Power Supplies 457

Line regulation is 0.01%



Model SR-1000EP provides 0 to 30 v dc at 1 amp max. Line regulation from 95 to 135 v is better than 0.01%. Noise to ground is less than 10 µv peak-to-peak; leakage resistance is greater than 10,000 meg; output impedance is less than 0.1 ohm; line-voltage transients do not cause overshoot or ringing. Model SR-1000E is similar, except that line-and load-regulation are 0.1%.

Video Instruments Co., Inc., Dept. ED, 3002 Pennsylvania Ave., Santa Monica, Calif.

Price: SR-1000EP, \$340; SR-1000E, \$295.

Single-Turn Potentiometers 583

Are rated at 1.2 w at 60 C

The 1200 series units measure 7/8 in. in diameter and are rated at 1.2 w at 60 C. Resistance values are from 1 to 100 K, values up to 500 K can be furnished on special order. Units have glass-filled diallyl phthalate body, gold-plated solid-brass terminals, electrically-welded taps and stainless-steel housing clamps. Units are available for flange or bushing mounting for servo or panel use.

Duncan Electronics, Dept. ED, 1305 Wakeham Ave., Santa Ana, Calif.

Availability: Immediate.



Specifying filters to meet the more sophisticated performance requirements has its frustrations. Greater sophistication breeds more complexity, especially when compounded by miniaturization within even more critical limits. Put these all together and you have filter design problems tailor-made for our engineering department. Try us.

E. G.—We produce a Low Pass Filter with less than 2% overshoot on square waves and more than 30 DB/Octave attenuation.

Write today for your portfolio of performance characteristics.

COMPONENTS CORPORATION

2855-57 N. HALSTED ST.
CHICAGO 14, ILLINOIS
EASTGATE 7-6566



CIRCLE 125 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960

Transistorized Power Supply

727

Portable unit



Model MP 12-2.5 miniature dc power supply can be used as a component of automatic systems for remote programming and bench use. It is rated at 0 to 12 v dc, 0 to 25 amp, continuously variable over the entire range. Output voltage is programmable over the full range at 500 ohm per v. The unit can be used as a constant current source over the entire current and voltage range. Some specifications are: line regulation, 0.05%; load regulation, will not exceed 0.05%; ripple, 250 uv max; continuous operation at full load, up to 50 C. The unit measures 6 x 8 x 10 in.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

Price: F.O.B. Springfield \$295.

Availability: 3 weeks.

Frequency-To-DC Converter

444

Converts frequency to dc voltage



This converter, known as the "Freqmeter" is a completely solid-state unit which will linearly convert frequency or repetition rate of signals to a proportional dc voltage. It will function properly when driven with sine, square and triangular waves, pulses, etc. The unit will also indicate the average frequency of random signals. The output may be used to drive meters, galvanometers, oscilloscopes or other indicating devices. No warmup time is required.

Solid State Electronics Co., Dept. ED, 15321 Fayen St., Sepulveda, Calif.



NEW "SCOTCHCAST" RESIN POWDER PROTECTS PARTS IN SECONDS!

New, from 3M, a 100% epoxy resin powder you can spray on! Protects, insulates, and moisture-proofs electrical-electronic parts and related hardware such as transformer cans, computer racks, etc., in just seconds. Overspray is recoverable—there's no waste.

"SCOTCHCAST" BRAND Resin No. XR-5026 is a one-part epoxy powder that applies quickly and easily by spray gun, dusting, or aerated-bed process. Applied to pre-heated parts, it liquefies on contact, flows into a smooth even coat, and in most cases cures by residual heat alone in a

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on
epoxy
resin**

matter of seconds into a strong, impact-resistant finish.

"SCOTCHCAST" Resin No. XR-5026 provides excellent edge coverage, high cut-through resistance, fine electrical properties, and continuous class F operation. Resists attack by fuel oil, gasoline, kerosene, and most chemicals.

Discover how "SCOTCHCAST" Resin No. XR-5026 can do a better job of improving your components and cutting your insulating costs. Write for complete information: 3M Co., Dept. EBA-110 900 Bush Ave., St. Paul 6, Minnesota.



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Electrical Products Division

"SCOTCHCAST" IS A REGISTERED TRADEMARK OF 3M CO., ST. PAUL 6, MINN.

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RCA

ELECTRONIC INSTRUMENTS

...bring RCA reputation, reliability and precision measurements to industry

Specify the V-O-M with the Extras!



Only \$43.95*

WV-38A VOLT-OHM-MILLIAMMETER

Compare this superlative RCA V-O-M against the model you may have been thinking of buying. See if it doesn't check out better in these extra features:

- EXTRA! 1.0 volt and 0.25 volt DC ranges!
- EXTRA! Big easy-to-read 5 1/4" meter!
- EXTRA! Non-breakable plastic case; no glass to crack or shatter!
- EXTRA! Red test lead has probe and slip-on alligator clip for added versatility!
- EXTRA! Convenient location of jacks permits switching without interference from leads!
- EXTRA! Spring clips on the handle to hold test leads!
- EXTRA! DB scales clearly marked: no squinting!

Complete with batteries, instruction book and all probes, clips and cables. (RCA V-O-M Kit, WV-38A(K), only \$29.95*). Rugged, scuff-proof, stain-resistant laminated vinyl carrying case, only \$4.95* extra!



NEW!

WA-44C

AUDIO GENERATOR

Generates sine and square wave signals for testing audio systems. Frequency range: 20 cps to 200 Kc. Total Harmonic Distortion 0.25% from 30 cps to 15 Kc. Used in measurement of intermodulation distortion, frequency response, db and dbm, input and output impedances, speaker resonance, transient response and phase shift. Also used to check tone controls, phonograph equalizers, resonant frequency of AC circuits, locate speaker and cabinet rattles, and to determine unknown frequencies.

Only \$98.50* (With cable and instructions.)

NEW PRODUCTS

High Potential Circuit Tester 447

For multiple circuit testing



Model T-660 high-potential circuit tester is a semi-automatic device for detecting high-resistance leakage breakdown, arcing or shorting on electronic-control circuits of all types. It is capable of testing 167 related circuits simultaneously against all others, or one non-related circuit at a time, and can be expanded for programming to customer requirements in multiples of 56. The unit has variable-peak time adjustment from one to 60 sec, and can automatically advance from one circuit to another.

Trans-America Dynamics Corp., Dept. ED, 149-A Babylon Turnpike, Roosevelt, L.I., N.Y.

Temperature Switches 448

Meet MIL-S-5272-A



Light-duty temperature switch SX336 is designed for use where a highly sensitive control is desired. It is engineered to meet MIL-S-5272-A and industrial specifications where small size and light weight are necessary. Model SX337 has a low-standard setting tolerance of ± 5 , depending on the balance of the electrical circuit involved. Model SX336 possesses a contact rating of 1 amp, 115 v ac, and can be hermetically sealed.

Sciaco Controls Inc., Dept. ED, 210 Taylor St., Riverside, N.J.

Transistor Test Equipment 598

Comes in modular form

Designed for manual, semi-automatic and automatic component testing, this line of test equipment is furnished in modular form. Each module contains basic test circuits. Various read-out panels, including those with special indications, can be supplied. The unit is claimed to be compatible with present testing needs and future expansion programs.

Herbert Industries, Dept. ED, Washington and Noble Street, Norristown, Pa.



WT-100A ELECTRON-TUBE MICROMHOMETER

Precision laboratory instrument for measuring: true transconductance (accuracy better than $\pm 3\%$) — control-grid-to-plate (gm) and suppressor-grid-to-plate; electrode currents — plate, suppressor-grid, screen-grid, and control-grid; heater-cathode leakage current; voltage drop across low-voltage rectifier types; forward and reverse currents in small dry-disc rectifiers, and crystal diodes. For production-line testing, equipment design and development, quality control programs, preventive maintenance. Accommodates variety of bases and envelopes. Test tubes at published ratings or at ratings under which the tube is expected to operate. \$1,075.00*



WO-91A 5-INCH OSCILLOSCOPE

A high-performance, wide-band oscilloscope ideally suited for servicing broadcast or closed-circuit TV (color or black and white), industrial and commercial signaling and communications systems, and general electronics applications. 5" graph screen provides good resolution. Dual bandwidth (4.5 Mc at 0.053 volts rms/in. sensitivity and 1.5 Mc at 0.018 volts rms/in. sensitivity). Internal calibrating voltage and calibrated graph screen. Includes special direct/low cap shielded probe and cable.

\$239.50* (Complete with ground cable, insulated clip, instruction book.)

ALSO AVAILABLE . . . WO-33A—3-INCH SUPER-PORTABLE OSCILLOSCOPE Only \$129.95* complete with low-cap direct input probe, cable, power cord, cord-carrying brackets, instructions. (RCA Super-Portable Oscilloscope Kit, (WO-33A(K), only \$79.95*.)



WV-77E VOLTOHMYST®

To measure AC and DC voltages, 0 to 1,500 volts; resistances from 0.2 to 1,000 ohms. Famous RCA VoltOhmyst quality at a low price! Separate scales, 1 1/2 volts rms and 4 volts peak-to-peak, for accuracy in low-voltage ac measurements. Fuse-protected ohms-divider network. Complete with ultra-slim probes, long flexible leads.

Only \$43.95* (Easy-to-assemble kit, WV-77E(K), only \$29.95*)



NEW! WV-98B SENIOR VOLTOHMYST®

For making accurate AC and DC voltage measurements as well as measuring resistances from 0 to 1,000 megohms. Measures peak-to-peak values of complex wave forms. Rugged, die-cast aluminum case. Easy-to-read 6 1/2-inch meter! A fine VTVM for electronic engineers and technicians! Includes special dc/ac-ohms shielded probe and cable.

\$79.50* (Complete with ground lead, alligator clip, instruction booklet.)

WV-84C ULTRA-SENSITIVE DC MICROAMMETER



Battery-operated vacuum-tube microammeter measures down to 0.0002 microampere. Designed for general industrial, chemical, and critical laboratory applications. Especially useful in measuring "dark currents" in vidicons and phototubes, as well as minute currents in image orthicons. \$110.00*

See them at your Authorized RCA Test Equipment Distributor.



The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

*User Price (Optional)

47

**THERE ARE MORE
DAYSTROM SQUARETRIM'S
IN THE FIELD TODAY
THAN ALL OTHER SQUARE
TRIMMING POTS COMBINED**

Here's why...

Because engineers want to be sure of the basic design, more of them look to the originator of the square-shaped trimmers. They look to Daystrom when specifying this kind of potentiometer.

Because they want to be sure of performance and reliability, more designers look to Daystrom for their SQUARETRIM'S. They know they can trust Daystrom specs. They appreciate the conservative ratings, and they have full confidence in the greater safety margin that such ratings afford. And they can be sure that Daystrom SQUARETRIM'S will go on meeting application requirements with the same high reliability that has been proven by the 2,000,000 units that have seen field service over the past five years.

Because engineers want to be sure of availability, they like the convenience of doing business with two complete factory sales and stocking offices—one on each coast. They know that from these two factory offices and Daystrom's 23 representatives and many stocking distributors from coast to coast, they can expect to obtain the exact SQUARETRIM'S to meet their needs. They know they are selecting from the broadest line of square-shaped trimming potentiometers available today when they specify the Daystrom SQUARETRIM line.

That is why more knowledgeable designers looking for trimming potentiometers specify Daystrom SQUARETRIM—they want the best...and the best is easiest to get.

For more information or a complete file listing the entire SQUARETRIM line, contact your nearest Daystrom Representative or Distributor, or write the factory direct. Ask for Data File ED-1179-1.

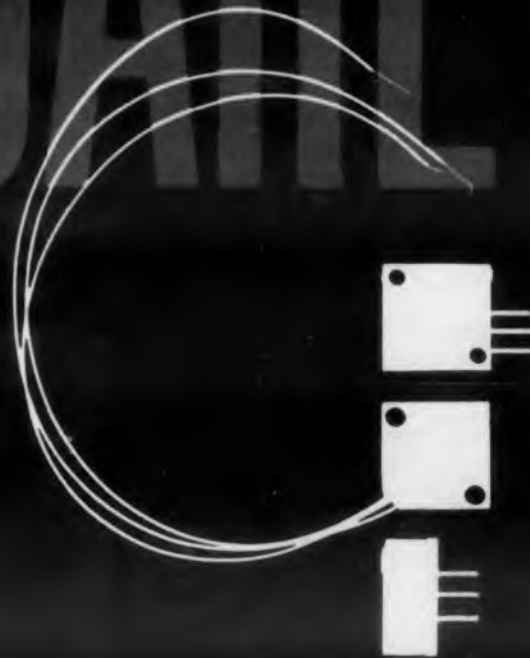


DAYSTROM

POTENTIOMETER DIVISION
ARCHBALD, PENNSYLVANIA
CIRCLE 128 ON READER-SERVICE CARD

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SQUARETRIM



48

FIVE YEARS OF PROVEN TRIMMER PERFORMANCE



THE ONLY SQUARE TRIMMING POTS WITH OVER 2,000,000 UNITS DELIVERED

Daystrom SQUARETRIM potentiometers may look like the many square configuration copies which have been flooding the industry in recent weeks, but they are different. This difference is in their outstanding performance, reliability and broad-line availability. Daystrom has had five years to develop, produce and field-prove the features of the SQUARETRIM potentiometers, so whatever features are important to your application, you can be sure that there is a Daystrom SQUARETRIM to meet your most exacting requirements.

The proof that Daystrom delivers what it promises can be found in over 2,000,000 Daystrom SQUARETRIM'S which have

been placed into customer operation since 1955. It costs no more to be sure, so when you are ready to order trimming potentiometers, contact your nearest Daystrom Representative or Distributor for immediate delivery. Or you may write the factory direct for Data File ED-1350-1.

DAYSTROM, INCORPORATED
POTENTIOMETER DIVISION
Archbald, Pennsylvania • CANal 6-3300 (New York, N.Y.)

THIS "BABY"
CAN REALLY
TAKE IT!



AMPEX

specifies Hill signal generators for use in the AR-200 magnetic tape recorder because of their high reliability under extreme environmental conditions. The compact Hill units generate a precision 60-cycle frequency which is power amplified to operate the recorder's capstan drive motor. While paralleling the qualities of advanced laboratory recorders, the sturdy Ampex AR-200 will withstand shock up to 15 G's, operate at altitudes of 100,000 feet, function under excessive temperature changes and in up to 100% humidity. It displaces only 1.6 cubic feet.

BULLETIN FS 17900 fully describes Hill's Signal Generator used in this application. Write for your copy.

Hill Electronics manufactures precision, crystal controlled frequency sources, filters and other crystal devices for operation under all types and combinations of conditions.

HILL ELECTRONICS, INC.

MECHANICSBURG, PENNSYLVANIA

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SHOCK



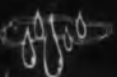
VIBRATION



HEAT



COLD



HUMIDITY



ALTITUDE

NEW PRODUCTS

Bistable Amplifier

439

For use as a static relay



Responding to input signals of $0.05 \mu\text{w}$, this amplifier produces a 24-v dc output at up to 1 amp. Response time is 22 msec. The unit is a combination magnetic amplifier-controlled rectifier using all silicon solid-state components. It operates over the temperature range of -55 to $+85$ C.

Norbatrol Electronics Corp., Dept. ED, 356 Collins Ave., Pittsburgh 6, Pa.

Price: \$92.50.

Availability: Two weeks.

Time Analyzer

454

Features 10 μsec resolution



The system 1500 can be used with any pulsed-neutron source for making decay studies. It will make a time analysis of events which occur during a total interval of 200 μsec to 2 sec. Events occurring during the total interval will be counted in one of the 20 channels which are opened in sequence for equal periods of time. Each channel has 10- μsec resolution, channel width is adjustable 10 μsec to 0.1 sec. Simple ganged control resets 10 scalers with one operation.

Eldorado Electronics, Dept. ED, 2821 Tenth St., Berkeley, Calif.

Price: \$7,850.

Availability: Approximately 60 days.

THE CASE OF THE FRUGAL DIODE BUYER



You might call him frugal. Tight is a better word. But you really couldn't blame him for wanting to pay as little as possible for diodes to go in the computers he manufactured. He made good products, sure. But his computers didn't have to go to Mars and back. They were just terrestrial units designed to give the right answers to earth-type people.

He checked every important diode manufacturer in the country, but every one gave him a terrible sinking feeling in his pocketbook. So you can imagine his delight when he discovered Xytan. Xytan, you know, is the company that sells top-grade diodes for a fraction of their original cost. The Xytan products are semiconductors that were made to meet very exacting MIL specs, but perhaps missed a parameter or two by just a sliver, and could not be shipped.

Our friend found exactly what he needed at Xytan. They were rugged glass-packaged diodes that were plainly marked and classified. He found that by making a quantity purchase he could buy them at only 17 1/2¢ each. They were perfect for his computers—which he sold at sizable profit.

If you're looking for top-grade semiconductors at tremendous bargains, write:

XYTAN

1755 Placentia Ave.
Costa Mesa, California Midway 6-5097

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GCA Display

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A YOKE FOR ANY SCAN to your Specifications

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COMPLETE LINE of deflection yokes for every military and special purpose—in production quantities or custom designed to your exact requirement.

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Phone: GRanite 4-2071

Indianapolis: Joe Murphy
Phone: VICTOR 6-0359

Los Angeles: Ash M. Wood Co.
Phone: CUmberland 3-1201

syntronic

INSTRUMENTS, INC.

100 Industrial Road, Addison, Illinois
Phone: Kingswood 3-6444

CIRCLE 132 ON READER-SERVICE CARD

Flexible Printed-Circuit Materials 477

Copper-clad unsupported Teflon, known as DI-CLAD ST-1 is available in sizes up to 18 x 42 in., with base thicknesses from 0.003 to 0.060 in. Copper-clad glass-fabric Teflon grades are available in sizes up to 36 x 42 in., with a thickness of 0.005 in. for DI-CLAD 116T and a thickness of 0.010 for DI-CLAD 128T. These materials have been developed for flexible printed-circuit applications.

Continental-Diamond Fibre Corp., Dept. ED, Newark, Delaware.

Two Component Adhesive 481

This two-component adhesive offers a peel strength of 63.3 in-lb on aluminum-to-aluminum. It has a tensile-shear strength of 3,300 psi, a pot life of 3 to 4 days and 45% elongation. It is recommended by the manufacturer for bonding honeycomb-aluminum panels, ferrous metals, ceramics and glass.

Hysol Corp., Adhesives and Sealants Dept., Dept. ED, Olean, N.Y.

Price: \$6.27 for a 1 qt trial sample.

Electrical Contact Lubricant 482

This lubricant and conditioner is intended for use on all electrical contacts. It is a high-molecular weight, branch-chain, saturated ester which may be used on arcing as well as non-arcing contacts. It has a wide temperature range, it pours at -50 F and flashes at +457 F. It increases contact surface life by reducing layers of tarnish.

Electralab Printed Electronics Corp., Dept. ED, Needham Heights 94, Mass.

Sub-Miniature Crystal Sockets 483

These sub-miniature, low-loss crystal sockets are designed to conserve space in wired- or printed-circuit applications. The Teflon body reduces the danger of breakage. They are intended for use wherever low loss, frequency stability and mechanical shock and vibration are a problem. The contacts are made of silver-plated beryllium copper.

Garlock Inc., Dept. ED, Camden 1, N.J.

Cathode-Ray Tubes 476

This line of cathode-ray monitor tubes meets the specifications of broadcast- and high-resolution closed circuit monitoring. Tubes have an integral-safety plate laminated directly to the tube face. They are available in all sizes and types from 8-in. to 27-in.

Continental Electronics Corp. of California, Dept. ED, Los Angeles, Calif.

Printed-Circuit Test Points 484

These printed-circuit test points have a flashover of 3,000 vrms and a capacitance of 0.25 μ fd. The brackets are made of silver-plated and gold-flashed brass; the contact material is beryllium-copper, silver-plated and gold-flashed. They are available in the 10 standard RMA colors.

Garlock Inc., Dept. ED, Camden 1, N.J.

BIRD

"Termaline" 50 ohm Coaxial Line LOAD RESISTORS



MODEL 888

1200
Watts
Continuous
Duty

1500 Watts
Intermittent Duty

2 to 3 KW
Continuous Duty with
forced air cooling

Input connections are
available to terminate
most coaxial lines.

BIRD "Termaline" Load Resistors are designed to provide a constant impedance of 50 ohm from DC through the useful coaxial frequency range. Each Resistor is intended to simulate an infinite length of 50-ohm line, thus providing an almost reflectionless termination. Low VSWR and freedom from radiation makes the Bird Loads extremely useful during adjustment and testing. Measurements of power are also possible when these Resistors are used as terminations for the appropriate Bird "ThruLine" Directional Wattmeters. Accuracy in RF resistance, rugged ability to absorb power and absence of any need for adjustments has long characterized the Bird "Termaline" Load Resistors. For specifications on standard models see chart below. For other requirements please phone or write. Our long experience in this field may assist you in the solution of your problem.

Model	Max. Power	Freq. Range	Max. VSWR*	Input Connector
80-M	5 W	0-4 KMC	1.2	Type "N" male
80-F	5 W	0-4 KMC	1.2	Type "N" female
80-CM	5 W	0-4 KMC	1.2	Type "C" male
80-CF	5 W	0-4 KMC	1.2	Type "C" female
80-BNCM	5 W	0-4 KMC	1.2	Type BNC male
80-BNCF	5 W	0-4 KMC	1.2	Type BNC female
80-A	20 W	0-1000 MC	1.1	Type "N" female
81	50 W	0-4 KMC	1.2	Type "N" female
81-B	80 W	0-4 KMC	1.2	Type "N" female
82-A	500 W	0-3.3 KMC	1.2	Coplanar. Adapter to UG-218/U supplied
82-AU	500 W	0-3.3 KMC	1.2	"LC" Jack mates with UG-154/U plug on RG-17/U cable
82-C	2500 W**	0-3.3 KMC	1.2	Coplanar. Fittings and cable assemblies for flexible and rigid coax lines available

*VSWR on all models is 1.1 max. from DC to 1000 MC.
**Water cooled

Other Bird Instruments



"ThruLine"
Directional
RF Wattmeters



"Termaline"
RF Absorption
Wattmeters



Coaxial
RF Filters



Coaxial
RF Switches



BIRD

ELECTRONIC CORP.

Churchill 8-1200

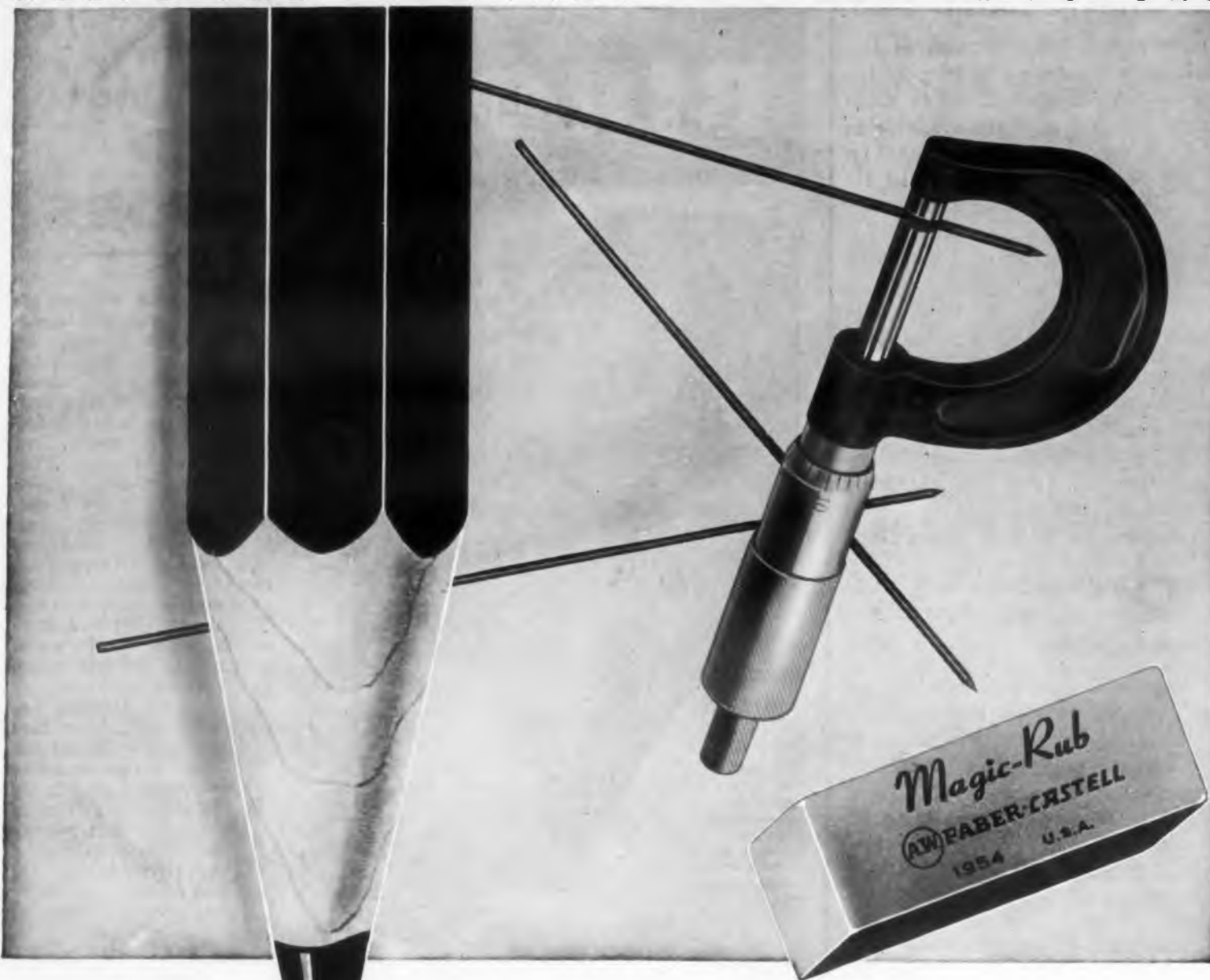
30303 Aurora Road, Cleveland 39, Ohio

Western Representative:

VAN GROOS COMPANY, Woodland Hills, Calif.

CIRCLE 133 ON READER-SERVICE CARD

HELPS THE HAND THAT SHAPES THE FUTURE



CASTELL

LIGHTS UP THE PATHS OF PRECISION

Man's creative ability and the tools that help him express it! Fortunate are those who toil in the vineyard of architecture, engineering, designing and drafting. For a few cents they can buy CASTELL, the world's finest drawing pencil, partner in progress the world over. This needs restating only for the benefit of the young now coming up in the profession. Old seasoned hands have known it for generations. CASTELL is an unquestioned fact in a creative man's life.

#9000 CASTELL Pencil with world's finest natural graphite that tests out at more than 99% pure carbon. Exclusive microlette mills process this superb graphite into a drawing lead that lays down graphite-saturated non-feathering lines of intense opacity for cleaner, more durable originals and clearer, sharper prints. Extra strong lead takes needlepoint sharpness without breaking or splintering. Smooth, 100% grit-free consistently uniform pencil after pencil, in full range, 8B to 10H.

#9007 CASTELL Pencil with Eraser.

CASTELL Pencils and Leads draw perfectly on all surfaces, including Cronar and Mylar base films. Give graphite-saturated lines, easy to erase, no ghosting — excellent reproduction.

CASTELL Rubberless MAGIC-RUB ERASER soaks up graphite without abrading drawing surfaces, and residue rolls off. Leaves no "oil" stain or "ghost." Tests highest in ease of use, line removal and non-smudging. Tests first on Cronar and Mylar base films. For all papers and vellums.

#9800SG CASTELL LOCKTITE TEL-A-GRADE Holder, perfectly balanced, lightweight, with new no-slip functional grip that lightens finger pressure without slipping, and relieves finger fatigue. Unique degree lead indicating device.

#9030 CASTELL Refill Lead, matching exactly #9000 pencil in quality and grading, degrees 7B to 10H, packed in reusable plastic tube with gold cap. Many other styles and colors of CASTELL Pencils, Holders and Refill Leads.

A.W.FABER-CASTELL 41-47 Dickerson Street, Newark 3, N. J.



CIRCLE 134 ON READER-SERVICE CARD

NEW PRODUCTS

Subminiature Relay Adjustment 449

For use in extreme environments



This 100-mw adjustment of the manufacturer's Series 33 relay is designated "VG" and is for applications where relay compactness and reliability under extremes of vibration and temperature are required. It has the following specifications: vibration, 30 g to 5,000 cps; operating-temperature range, -65 to +125 C; contact rating, 2 amp at 28 v dc or 120 v ac, resistive load. Shock of 70 g and constant acceleration will not open contacts with relay energized or de-energized.

Sigma Instruments, Inc., Dept. ED, 192 Pearl St., South Braintree 85, Mass.

Elastomeric Mounting System 603

Protects small equipment on jet aircraft

Type BL-1705 mounting system, weighing 0.38 lb, supports a 1.2-lb pressure transducer. The system is for shock and vibration protection from -65 to +300 F. Natural frequency is 45 cps. It accommodates many different shapes and all instruments meeting ARINC 408.

Lord Manufacturing Co., Dept. ED, Erie, Pa. Availability: Made on order.

Sinusoidal Oscillator 451

Frequency range is 25 cps to 100 kc



Model S-100 silicon-transistor sinusoidal oscillator is an epoxy-encapsulated unit designed to produce a sine-wave signal. Output characteristics are: waveform, sinusoidal; frequency, from 25 cps to 100 kc; amplitude, greater than 2 v rms for load impedance greater than 680 K; output impedance, 20 K; distortion, less than 5% total. Operating characteristics: supply requirement, +28 v, 1 ma; temperature stability, less than 0.03% frequency drift per degree C from -25 to +85 C.

Solid State Electronics Co., Dept. ED, 15321 Rayen St., Sepulveda, Calif.

Data Equipment

Complete line offered

437



The Digipac line of equipment includes logic blocks, chassis, and power supplies. A complete control system can be assembled from these standard units. No soldering is required. Three sizes of standard chassis hold 50, 100 and 200 blocks and mount on a panel measuring 3.5 x 19 in.

Dynamic Controls Co., Dept. ED, 2225 Massachusetts Ave., Cambridge 40, Mass.

Price: \$20 to \$39 per block; \$280 to \$625 per chassis.

Availability: Immediate.

Time-Code Generator

Supplies a BCD time code

453



The ZA-803 time-code generator supplies a BCD time code which is read out once per second at a rate of 25 pps. It has a frequency stability of three parts in 10^8 which is equivalent to one second per month. Provisions are made for even greater accuracy when required. A one-pps positive-pulse synchronizing signal is available on the unit for comparison with WWV time signals.

Electronic Engineering Co. of California, Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

Price: \$7,925.

Availability: From stock.

Varactor Diodes

In frequencies to 310 kmc

599

Types XD-501, 502 and 503 are diffused-gallium, arsenide mesa units. Type XD-503 is rated for a minimum cut-off frequency at breakdown of 310 kmc. Capacitance range is 0.5 to 1.4 pf. Series inductance is 0.7 μ h at 9.4 kmc. Units can be used in parametric amplifiers, communications networks, missile-space vehicles, telemetry systems and other microwave equipment.

Texas Instruments Inc., Dept. ED, P. O. Box 312 Dallas 21, Tex.

Large • small • any size between—



ALITE is geared to meet
your requirements for
CERAMIC-TO-METAL SEALS



Alite offers completely integrated facilities and expert engineering assistance for producing high quality, vacuum-tight, ceramic-metal components for all your mechanical and electrical requirements.

Hermetic seals and bushings embodying Alite—the high-alumina ceramic developed by U. S. Stoneware—have the ability to withstand severe physical and thermal shock without leaks or cracking. Produced to precision tolerances, Alite units have high impact and tensile strengths for grueling environmental conditions. They maintain excellent electrical and mechanical characteristics over a wide range of frequency and temperature. The extra-smooth, hard, high-fired glaze gives superior surface resistivity.

Every manufacturing step is closely supervised in our own plant. Positive quality control assures strict adherence to specifications, absolute uniformity and reliability of completed components.

At no obligation to you, send us your drawings for recommendations or quotation.

FREE Technical Data



For complete technical data on Alite and Alite Ceramic-to-Metal Seals, write for Bulletins A-7R and A-40.

ALITE DIVISION

U. S. STONWARE

BOX 119 ORRVILLE, OHIO

New York Office
60 East 42nd St.

118F-1

CIRCLE 135 ON READER-SERVICE CARD



COUCH ROTARY RELAYS

Start with a unique and simple design — manufacture within a narrow range of tolerances — specify performance on the *conservative* side — this is how Couch solves the problem of supplying relays that meet the present and future needs of our aircraft and missile programs.

The record shows that this technique is successful: many thousands of Couch CVE type rotary relays are providing consistent flight insurance in complex systems under the most severe environmental conditions.

IMPORTANT SPECIFICATIONS

Contacts: 4PDT (dry circuit to 10 amps)

Size: 1 3/2" D x 1 1/2" H

Weight: 3.2 oz. max.

Pull-in power: 1/2 watt

Ambient temperature: -65° to +125°C

Vibration resistance: 20G's, 5 to 2000 cps

Shock resistance: 75G's operating, 200G's non-operating

Write for complete specifications.



COUCH ORDNANCE, INC.

A Subsidiary of S. H. Couch Company, Inc.

3 Arlington St., North Quincy 71, Mass. Tel.: (Boston) Bluehills 8-4147

CIRCLE 136 ON READER-SERVICE CARD

NEW PRODUCTS

Instrument Choppers

368

For 60 and 400-cps operation



These low-thermal-noise instrument choppers are for 60- and 400-cps operations. Thermal electromotive force is less than 0.5 μ v to +55 C. Models for dpdt and spdt circuitry are available.

James Electronics Inc., Dept. ED, 4050 N. Rockwell St., Chicago 18, Ill.

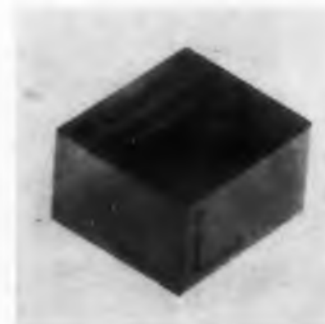
Price: \$25 to \$40 ea.

Availability: From stock.

Accelerometer

384

Tri-axial type



Model 510-TX accelerometer makes simultaneous measurements of acceleration due to shock and vibration in three mutually perpendicular planes. An aluminum block, steel unit, it weighs 37 g and measures 1-1/8 x 1 x 5/8 in. Sensitivity is 20 mv per g along each axis; frequency response is 2 cps to 5 kc. Resonant frequency is 100 kc, maximum acceleration is 1,000 g and amplitude linearity is $\pm 1\%$.

Columbia Research Laboratories, Dept. ED, MacDade Blvd. and Bullens Lane, Woodlyne, Pa.

Price: \$465 ea for up to five units.

Availability: Two weeks.

DC Amplifier

592

Has built-in power supply

This amplifier, model 1100, combines in one package a differential-input, wideband dc amplifier, a bridge balance circuit and a regulated strain-gage power supply. A second dc amplifier can replace the power supply. Eight units can be mounted on a single 19-in. rack.

Cubic Corp., Dept. ED, San Diego, Calif.

Resistance up to 100 Million (1 x 10¹¹) MEGOHMS!



High Voltage Resistors

From a miniature 1/4 watt resistor, rated at 250 volts, to the 100 watt resistor, rated up to 125 KV. Tapped resistors and matched pairs also available. Low temperature and voltage coefficients.

Few can match—and none can exceed—the stability and performance of rpc HIGH VOLTAGE RESISTORS! Ask anybody who uses them.

Tolerance—15% standard. 10%, 5% and 3% available. 2% in matched pairs.

Further information or engineering assistance gladly supplied.

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PRODUCTS
COMPANY

914 S. 13th St., Harrisburg, Pa.

CIRCLE 137 ON READER-SERVICE CARD



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MODULAR CONSOLE
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**SLOPED FRONT
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- Tops of front and rear are rounded.
- Designed for multiple installations.
- Made of No. 14 gauge steel and welded throughout.
- Sloped front is 19° from vertical.
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- Ball cornered end panels.

- Frame finished in gray hammertone. End panels in brown hammertone.

Cat. No. FS-1001

Contact your local distributor or
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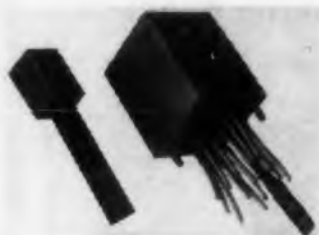
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NEW YORK 59, N. Y.

WESTERN
SALES OFFICE:
1667 Laurel Street, San Carlos, California
EXPORT DEPARTMENT: EMEC, 127 Grace St.,
Plainville, New York
IN CANADA: PREMIER METAL HOUSINGS, Ltd.,
3810 Smart Ave., Montreal

CIRCLE 138 ON READER-SERVICE CARD
ELECTRONIC DESIGN • November 23, 1960

Solid-State Telemetry Switch 362

Switching time is less than 20 μ sec



This solid-state telemetry switch has been designed for use with crystal vibration transducers and in high impedance telemetry circuits. Switching time is less than 20 μ sec. It is available in switching circuit arrangements ranging from one to six poles, single or double throw. There are four methods of actuating the switch: closing contacts; applying a dc supply voltage shift; applying voltage to control leads; applying pulses to control leads. The size varies with the complexity of the switching circuit, approximately 0.7 cu in. per pole in single throw and 1.0 cu in. in double throw models.

Amelco, Inc., Dept. ED, 12964 Panama St., Los Angeles 66, Calif.

Printed-Circuit Plug 376

Measures 0.045 in. in diameter



Type 2850, a 0.045-in. diameter plug, is primarily designed for edge mounting on 1/16- and 1/32-in. printed-circuit boards. It may also be used for conventional circuits. Measuring about 13/64-in. long, the plug mates with jacks 2378 and 2650. Material is brass per QQ-B-626a, Comp. 22, 1/2 hard with 0.0002-in. silver plate plus 0.00002-in. gold flash or 0.0002-in. bright alloy plate.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

Motor Tachometers 596

Sizes 11, 15 and 18 are offered

This line is available in frame sizes 11, 15 and 18 with standard or high torque ratings. A constant output ratio of $\pm 0.04\%$ per deg C is provided. Phase shift is 0.06 deg per deg C over the temperature range of -55 to $+125$ C.

Daystrom, Inc., Dept. ED, Murray Hill, N.J.

WIDE-RANGE TRANSISTORIZED POWER SUPPLIES:

available for immediate
off-the-shelf delivery



Here is a complete line of transistorized power supplies. Exacting performance of the unique differential DC amplifier assures extremely tight static and dynamic regulation; ultrafast response . . . less than 20 μ sec; very low output impedance and a high degree of drift stability with temperature — plus complete protection from short circuits and overload.

CHECK THE FOLLOWING CHART FOR YOUR REQUIREMENTS:

	Output Voltage	Output Amps	Static Regulation		Output Impedance	Ripple	Panel Height
	DC	DC	Load	Line	Ohms	Millivolts Peak-to-peak	
T-200-C	0 - 10	0 - 3	.03%	.03%	.040	2.0	3½
T-205-C	0 - 10	0 - 10	.03%	.03%	.012	2.0	3½
T-210-C	0 - 10	0 - 30	.03%	.03%	.004	2.0	5¼
T-215-C	0 - 32	0 - 1	.02%	.02%	.240	2.0	3½
T-220-C	0 - 32	0 - 3	.02%	.02%	.080	2.0	3½
T-225-C	0 - 32	0 - 10	.02%	.02%	.024	2.0	5¼
T-221-C	0 - 50	0 - 2	.02%	.03%	.200	4.5	3½
T-230-C	0 - 150	0 - 0.75	.02%	.05%	1.000	6.0	3½
T-235-C	0 - 150	0 - 2	.02%	.05%	.500	6.0	5¼

These transistorized supplies, contained in compact light-weight consoles, have front and rear terminals, permitting either rack or cabinet installation for such applications as laboratory, computer power (digital or analog), production testing, and ground support equipment.

Write for the Armour Stablvolt catalog describing the complete line of transistorized and magnetically regulated power supplies for your application.



as

ARMOUR/STABLVOLT

division of Magnetic Research Corp.

3160 W. EL SEGUNDO BLVD., HAWTHORNE, CALIF.

CIRCLE 139 ON READER-SERVICE CARD

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**COUPLED MODE
AND PARAMETRIC ELECTRONICS**

By WILLIAM H. LOUISELL, Bell Telephone Laboratories. 1960. 268 pages. \$11.50

**DIGITAL APPLICATIONS
OF MAGNETIC DEVICES**

Edited by ALBERT J. MEYERHOFF, Burroughs Corporation Research Center. 1960. Approx. 656 pages. Prob. \$14.00

**INTRODUCTION TO
MODERN NETWORK SYNTHESIS**

By M. E. VAN VALKENBURG, University of Illinois. 1960. 498 pages. \$11.75

PHOTOCONDUCTIVITY OF SOLIDS

By RICHARD H. BUBE, RCA Laboratories. 1960. 461 pages. \$14.75

**DIRECT CONVERSION
OF HEAT TO ELECTRICITY**

Edited by JOSEPH KAYE and JOHN A. WELSH, both of M.I.T. 1960. 388 pages. \$8.75

**FOUNDATIONS FOR A CONTROL THEORY
OF MULTIVARIABLE SYSTEMS**

By MIHAJLO D. MESAROVIC, Case Institute of Technology. A Technology Press Research Monograph. M.I.T. 1960. Approx. 128 pages. \$3.50

FREQUENCY-POWER FORMULAS

By PAUL PENFIELD, JR., M.I.T. A Technology Press Research Monograph, M.I.T. 1960. Approx. 256 pages. \$4.00

**THE THEORY AND DESIGN
OF INDUCTANCE COILS, 2nd Edn.**

By V. G. WELSBY, University of Birmingham, England. 1960. In Press.

ELECTRONIC EQUIPMENT RELIABILITY

By G. W. A. DUMMER and NORMAN B. GRIFFIN, Royal Radar Establishment, England. 1960. In Press

**SELECTED SEMICONDUCTOR
CIRCUITS HANDBOOK**

Edited by SEYMOUR SCHWARTZ, Transistor Applications, Inc. 1960. 506 pages. \$12.00

THE ANTENNA

By L. THOUREL, French School of Civil Aviation. 1960. In Press

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JOHN WILEY & SONS, Inc.

440 Park Avenue South, New York 16, N.Y.

CIRCLE 140 ON READER-SERVICE CARD

NEW PRODUCTS

Alpha-Numeric Readout Modules 361

For data display systems



Two basic types of alpha-numeric readout modules are offered as standard models. Momentary operation is provided by type 203, while type 204 has been designed for pulse-controlled latching or memory operation. Measuring 3-9/16-in. high x 2-11/16-in. wide x 2-13/32-in. deep, the modules can be energized as required to display any letter in the English alphabet and any numeral from 0 through 9. Operation can be from any dc voltage from 1 to 30 v, with response time less than 0.1 sec.

Allard Instrument Corp., Dept. ED, 146 E. 2nd St., Mineola, L.I., N.Y.

High Resistance Potentiometers 374

Resistance range is 1 to 10 meg



This series of small, megohm potentiometers is designed for use where high resistance is required to match tube characteristics. Specifications are: resistance range, 1 to 10 meg $\pm 5\%$; mechanical angle, continuous; electrical angle, $320 \pm \text{deg}$; linearity, 1% standard, 0.5% special; taps can be provided on the resistance elements. The manufacturer claims the potentiometers will meet or exceed all existing military specifications.

Accuracy, Inc., Dept. ED, 4 Gordon St., Waltham 54, Mass.

Impulse Relay 580

Is rated at 1,500 w, non-inductive

Series 670 impulse relay has contact arrangements up to dpdt with ratings of 1,500 w, non-inductive, or up to 20 amp, locked motor current. Applications include control of motors and speakers.

Guardian Electric Manufacturing Co., Dept. ED, 1550 W. Carroll Ave., Chicago 7, Ill.

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EXCLUSIVE EXPERIENCE and unique combination of Facilities offer big savings in time and money. For example, Rototest offers 6000 amp. of regulated 28 Volt D.C. . . . poly-environmental facilities . . . equipment to perform valid random vibration tests. Fast service on any combination of over 160 Mil Spec qualifications - 32 with ASES A recognition for QPL testing.

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GET YOUR ROTOTEST FACILITIES BROCHURE NOW Write or phone J. K. Davidson. Please indicate areas of interest or specific problem.

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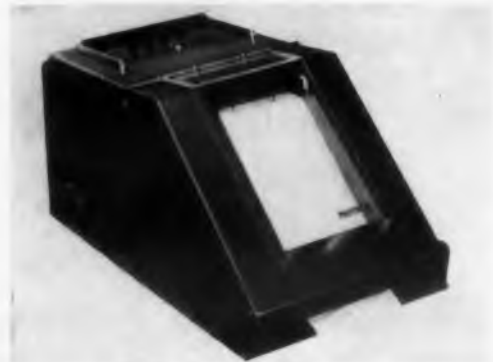
CIRCLE 141 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960

Oscillographs

438

With chart speeds to 100 mm per sec



These direct-writing oscillographs provide chart speeds of 1, 5, 25 and 100 mm per sec or 1, 2, 5, 10, 25, 50 and 100 mm per sec. They provide up to eight channels of curvilinear or rectilinear recording. A choice of galvanometers provides ranges of coil resistances up to 3,000 ohms. Chart-speed accuracy is maintained by means of a synchronous motor.

Photron Instrument Co., Dept. ED, 6516 Detroit Ave., Cleveland 2, Ohio.

Availability: Stock to 30 days.

Mini-Module Crystal Oscillator 700

Temperature is -55 to $+90$ C

The M-3 Mini-Module crystal oscillator has a temperature range of -55 to $+90$ C. The oscillator module measures $1 \times 1/2 \times 3/8$ in.; the output module measures $7/8 \times 1/2 \times 3/8$ in. Each module weighs less than 1 oz. Vibration is 20 g, 50 msec. The oscillator module provides 1 v rms into 2-k load; the output module provides desired sine-wave, square-wave or pulse.

Monitor Products Co., Dept. ED, 815 Fremont Ave., South Pasadena, Calif.

Price: \$60 to \$80, to 100 items.

Availability: 60 days.

Miniature Feed-Through Capacitor 742

Has 50,000 meg IR at room temperature

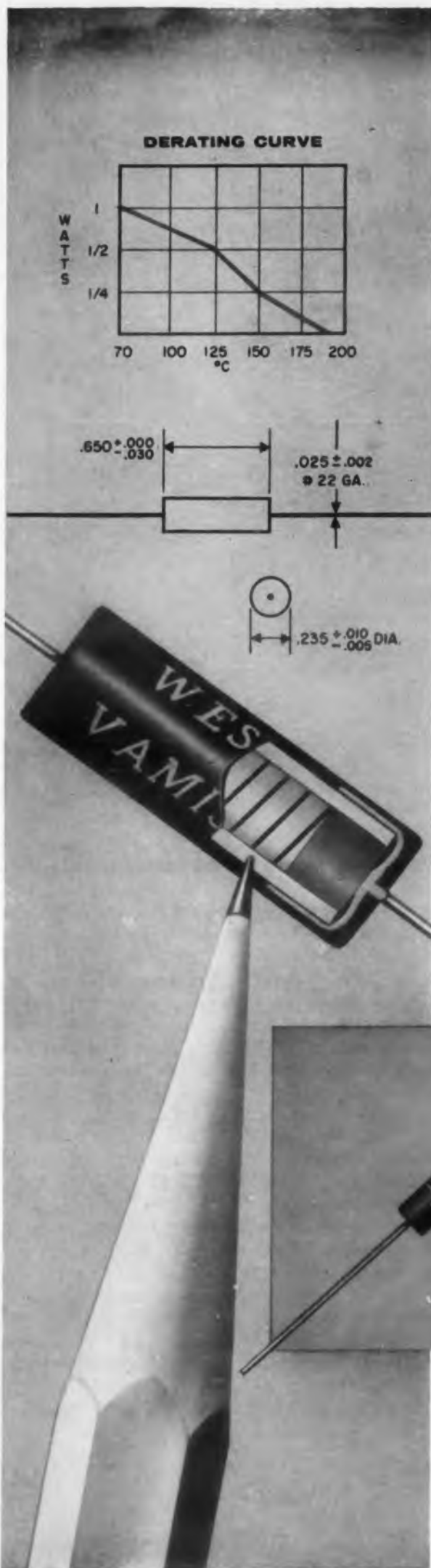


This miniature, feed-through capacitor has 50,000 meg IR at room temperature. The unit is hi-potted at 800 wvdc and can be used at full, 200 wvdc from -55 to $+150$ C. Available in plain- or screw-thread types, it is standard in $-.820$, 1,000 and 1,200-pf values.

King Electronics, Inc., Dept. ED, 915 S. Meridian Ave., South Pasadena, Calif.

Price: 81¢ to \$1.17, 10 to 1,000.

Availability: From stock.



IDEAL FOR MINIATURIZATION... WESTON 1/2-WATT VAMISTOR® IN 1/4-WATT SIZE

Metal film resistor is supplied in tolerances of $\pm 1\%$, $\pm 0.5\%$, $\pm 0.25\%$, $\pm 0.1\%$

Exclusive Weston VAMISTORS are especially suited to applications requiring resistors of small size, close tolerances and high reliability. The 1/2-watt "Missile Line" VAMISTOR is no larger than a conventional 1/4-watt, yet has a half-watt rating at 125°C. "Missile Line" VAMISTORS, employing internal inert gas, therefore offer double ratings with the same physical size.

Unique Weston design utilizes a special alloy metal film, thermally fused inside a steatite tube. The epoxy-encapsulated unit has higher abrasion resistance, and greater resistance to thermal shock and voltage surges than ordinary film-type resistors.

Many other advantages are provided by the VAMISTOR: Selected units are available with a maximum temperature coefficient of 25 parts per million/°C. Maximum voltage coefficient is only -1 part per million/volt. These resistors offer unusually long shelf life, produce no corona, and are practically non-inductive. Weston VAMISTORS are produced under the most rigid control standards, and meet or surpass all applicable MIL specifications.

Call your Weston representative for more information on the VAMISTOR line, or write for Catalog 04-101.

Daystrom, Incorporated, Weston Instruments Division, Newark 12, New Jersey. International Sales Division, 100 Empire St., Newark 12, N. J.

In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ontario.

Model 9855-4 1/2-watt VAMISTOR is supplied in resistances from 100 ohms to 1.5 megohms. Voltage: up to 350. Tolerances: 1%, 0.5%, 0.25% and 0.1%. Overload: withstands 5 times rating for 10 seconds with only 0.012% average deviation from indicated value. Other sizes and ratings also available.

DAYSTROM, INCORPORATED
WESTON INSTRUMENTS DIVISION
Reliability by Design

CIRCLE 142 ON READER-SERVICE CARD

NOVAR



A STATEMENT TO THE INDUSTRY

In recent months, several leading tube manufacturers have issued statements and product notices regarding new large receiving-type tubes having an all-glass base instead of the conventional plastic base.

With great pride, RCA announces its new line of NOVAR receiving tubes. These types, which are now being sampled developmentally to the industry, reflect the careful effort made by our engineers to design a product that has low initial cost and low replacement cost; top quality; and simplicity of installation and conversion.

The new NOVAR tube has a 9-pin base with a pin-circle diameter of .687" and a pin length of .350". Most important, the inner leads used in NOVAR tubes have a diameter of 30 mils. Thus, the NOVAR tube types have a strong cage support and feature high heat-dissipation capability. Relatively cooler operation can therefore be expected from NOVAR types with consequent improvements in tube reliability and life.

Of equal importance is the wide distance between pins in the NOVAR tubes: .212". As a result the new RCA types

can withstand high voltage gradients between pins. In other tubes using relatively close spacings, voltage breakdown between pins will occur at much lower values when all pins are used. It is evident, therefore, that certain families of tubes would be very difficult to design using a base with close pin spacings.

There is another factor. NOVAR tubes offer outstanding versatility. There is no function presently served by "octal" tubes that cannot be duplicated by the new RCA NOVAR line. In addition, these tubes will be priced lower than their present "octal" counterparts.

RCA believes that the introduction of NOVAR tubes represents a logical and realistic approach to the design of large glass-based receiving tubes. During 1961, as the new tubes are installed in a variety of home entertainment equipment, we are sure that our approach will be commended: that the development of the NOVAR line will have outstanding significance in the manufacture of finer, more reliable electronics components.

RCA Electron Tube Division, Harrison, N. J.



The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

NEW PRODUCTS

Subcarrier Discriminator

364

Dynamic input range is 60 db



Model TDA-300 uses the phase-lock concept of coherent detection and has solid-state circuitry throughout. The dynamic input range provides for effective use of signals under severe conditions. Operating frequency is up to 300 kc and frequency deviation is $\pm 40\%$. Input impedance is greater than 500 K and less than 30 pf. The unit is suited for rack mounting.

The Bendix Corp., Bendix-Pacific Div., Dept. ED, 11600 Sherman Way, North Hollywood, Calif.

Chart Drive

579

Can be field mounted

This chart drive is for use with the firm's Speedomax G strip-chart recorder. Easily field mounted in place of standard change gears, the unit provides dial selection of eight chart speeds while the chart is running.

Barry Controls Inc., Inesco Co., Dept. ED, Hollis St., Groton, Mass.

Germanium Power Transistors

748

Units rated for 100-C continuous-junction operation



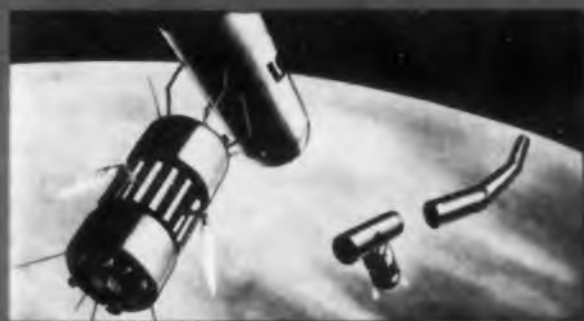
These 15-amp, germanium power transistors are rated for 100-C continuous-junction operation. The units come in a TO-36 package and have a 150-w rating. They dissipate 150 w at 25 C case temperature. Thermal resistance is 0.5 C per w max. The units are designated types 2N173, 2N174, 2N277, 2N278, 2N441 through 2N443, 2N1099, 2N1100 and 2N1358.

Motorola Semiconductor Products Inc., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.

Price: \$2.25 to \$15 ea.

Availability: From stock.

THE ASTROTUG



Tugboat for Space: Spaceborne scientific laboratories and platforms for further exploration into space are an accepted concept based on established engineering techniques. Components would be fired as individual units into space, on precalculated orbits, and there assembled. To solve the major problems of how men are to live and work in space during the assembly process, Lockheed has prepared a detailed engineering design of an astrotug—a manned vehicle housing a crew of two or three. Missile-launched, the astrotug will be capable of supporting its crew for a number of days in an environment of suitable atmosphere and with provisions for exercise, relaxation, bathing facilities, medical care, illumination and adequate food and water.

The Lockheed astrotug is a completely independent working vehicle. Personnel need not leave it in space suits in order to work on the project of assembling the space station components. As shown in the diagram, the tug consists of two double-walled pressure vessels approximately 20 feet long overall and 9 feet in inside diameter. Swivelling rocket nozzles are arranged for maneuvering. On the forward end, extending out are four mechanical manipulator arms with interchangeable "hands" for such specialized functions as gripping, welding, hammering, cutting, running screws, etc. "Hands" can be changed by remote control from inside. Viewing ports provide uninterrupted observation. Radar antennas, searchlights, and other equipment necessary to the tug's work are mounted externally. Main controls and instruments including radar, radio, infrared, computers and navigation consoles are duplicated in each of the two major compartments as a safety measure.

Men working in single units afloat in space suits would have little applicable force and could work for very limited periods of time. With the Lockheed astrotug, personnel could carry on the work in relative safety and comfort with maximum efficiency. A special reentry vehicle, separate from the astrotug, has been conceived for ferrying to and from earth. Tugs themselves would remain floating in orbit indefinitely, being reprovisioned and refurbished as fresh crews arrive in relief.

Space vehicle development is typical of Lockheed Missiles and Space Division's broad diversification. The Division possesses complete capability in more than 40 areas of science and technology—from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists. They include: celestial mechanics; computer research and development; electromagnetic wave propagation and radiation; electronics; the flight sciences; human engineering; magnetohydrodynamics; man in space; materials and processes; applied mathematics; oceanography; operations research and analysis; ionic, nuclear and plasma propulsion and exotic fuels; sonics; space communications; space medicine; space navigation; and space physics.

Engineers and Scientists: Such programs reach far into the future and deal with unknown and stimulating environments. It is a rewarding future with a company that has an outstanding record of progress and achievement. If you are experienced in any of the above areas, or in related work, we invite your inquiry. Please write: Research and Development Staff, Dept. K-21, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM; the Air Force AGENA Satellite in the DISCOVERER Program and the MIDAS and SAMOS Satellites

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AVAILABLE**



**NOW . . . REGULATE 1KV WITH THIS HERMETIC SEAL
Miniaturized AC REGULATOR**

NOW . . . nearly a kilowatt of AC power can be regulated by this special Hermetic Seal Unit weighing less than 10 pounds. Built to Mil-E-5400 and Mil-E-5272 specifications, it is primarily magnetic assuring high reliability for critical aircraft and missile power regulation requirements. For regulating three-phase power, a package of three units performs efficiently. Write for literature describing electrical and mechanical characteristics of this entire family of AC Regulators.

SPECIFICATIONS: MODEL NO. VRAC-104

ELECTRICAL CHARACTERISTICS: ENVIRONMENT CONDITIONS:

INPUT: 108 to 122 volts
 FREQUENCY: 380 to 420 cycles
 OUTPUT: 115V \pm 1V from 2 to 8 amperes
 RESPONSE: < 100 ms / 9V_{IN} increments
 DISTORTION: 5% max over input voltage and frequency range (exclusive of source)
 OPERATING TEMPERATURE RANGE:
 -55°C to +71°C
 DUTY CYCLE: Continuous

Altitude: to 50,000 ft.
 Humidity: 95% 50°C 360 hours
 Shock: 15 g's
 Vibration: 10 g's 5 to 500 cycles

MECHANICAL CHARACTERISTICS:

Size: 5" x 5" x 12"
 Weight: Less than 10 lbs.

WRITE FOR BULLETIN NPB-106

HST Special Products Division designs and produces customized regulators, power supplies, servo amplifiers, and other special packaged electronic components for industrial and military uses. Write us your requirements; we will gladly submit recommendations and quotations without obligation.

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SPECIAL PRODUCTS DIVISION
 2925 Merrell Road Dallas 29, Texas Phone Fleetwood 7-9481
 CIRCLE 145 ON READER-SERVICE CARD

NEW PRODUCTS

DC Amplifier 570

Has 10-v output

This chopper-stabilized dc amplifier is said to step up low-level signals from a variety of transducers to 10 v with a high degree of accuracy. The device, designated AccuData III, has both single-ended and differential input connections. Maximum gain is 34,000; input impedance is 20 meg single-ended or 2 meg differential; output current is 65 ma at 5 v or 25 ma at 10 v. Output impedance is less than 0.1 ohm. The instrument is described as useful in high-frequency data handling systems.

Minneapolis-Honeywell, Boston Div., Dept. ED, 40 Life St., Boston 35, Mass.

DC Power Supply 729

For tunnel-diode powering applications



Model TD1 transistorized, regulated dc power supply is for tunnel-diode powering applications. Specifications include: output voltage, 0-1.5 v at 0-250 ma currents; regulation, 1 mv per 10% line change at any rated load; load regulation, 1 mv from no-load to full-load; ripple, less than 600 μ v rms; transient response, less than 50 μ sec; line input, from 105 to 125 v ac, single phase, 60 cps. The unit has multiple zener diode reference. Remote error sensing terminals are provided to obtain low output impedance at the load.

Universal Electronics Co., Dept. ED, 1720 22nd St., Santa Monica, Calif.

Price: \$495 ea, F.O.B. Factory.

Availability: From stock.

Power Supply 600

Provides 30 amp at 0 to 36 v

Model P-30-36 power supply, using silicon rectifiers and an all-transistorized regulator, has a regulation of 0.5% and less than 25 mv ripple. It is equipped with a four-range output voltage switch; operation can be at 50 to 400 cps. Rack height is 12.25 in.

Foto-Video Electronics, Inc., Dept. ED, 36 Commerce Road, Cedar Grove, N.J.

Price: \$995.

Availability: From stock.

Environmental conditioning for detection systems



AiResearch cooling of airborne detection systems is accomplished by an extremely reliable, compact unit which is both an air-cooled cold plate and mounting structure for the detection system's transistorized power supply.

This lightweight package weighs 7.2 lb., and has a heat rejection of 500 watts. It consists of four AiResearch Minifans and an all-aluminum structure with 44 separate modules. Each module is electrically isolated and may be removed individually for quick, easy replacement.

AiResearch is the leading designer and manufacturer of such advanced electronic conditioning equipment and systems. This production unit is one example of the broad production-proven capability of AiResearch in providing extremely reliable, lightweight, compact cooling packages for aircraft, missile, space and ground support applications.

Environmental conditioning equipment has been produced for the following electronic systems:

Detection • Communication • Control • Ground Support • Guidance

Write for literature today.



AiResearch Manufacturing Division

Los Angeles 45, California

CIRCLE 146 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960



How to double performance of your magnetic tape recorders

Now you can record 125-kc data at 30 ips instead of 60 on most existing data recorders. How? By using the new Ampex FR-600 for playback. New record/playback capability in the FR-600 saves previous equipment from obsolescence with some added benefits of its own—for example, recording 500 kc at 120 ips.

Your curiosity whetted? See our full page on the FR-600 in November 9 ELECTRONIC DESIGN, or write for descriptive literature, and we'll send the ad along too.

AMPEX

AMPEX DATA PRODUCTS COMPANY
Box 5000 Redwood City, California

Interval Timer 586

Time delay is from 2 to 300 sec

Model 50-203 flip-flop device has a time delay of 2 to 300 sec. It operates from a -20 v power input, two signal inputs (start and stop), and two outputs. One output must be connected to an external emitter-follower to drive the timing circuit. The signal inputs consist of a positive pulse approximately 20 μ sec wide, 10 v in amplitude, and having a maximum source impedance of 5,000 ohms. Retriggering time is 50 msec, temperature range is -67 to $+160$ F, and vibration is up to 15 g. Timing is accurate to within $\pm 10\%$.

Hydro-Aire Co., Dept. ED, 3000 Winona Ave., Burbank, Calif.

Transistorized Telemetry Unit 730



For telemetry stress, strain, torque and temp

Model WT-75-1 transistorized telemetry unit is for telemetry stress, strain, torque and temperature from a moving object to a remote indicator. Specifications include: linearity, $\pm 1\%$ full scale; range, 50 ft unobstructed. Shock is 30 g; vibration is 30 g, 10 to 2,000 cps; rotation is 22,000 rpm. Operating temperature is 0 to 100 C.

Wiley Electronics Co., Dept. ED, 2045 W. Cheryl Drive, Phoenix, Ariz.

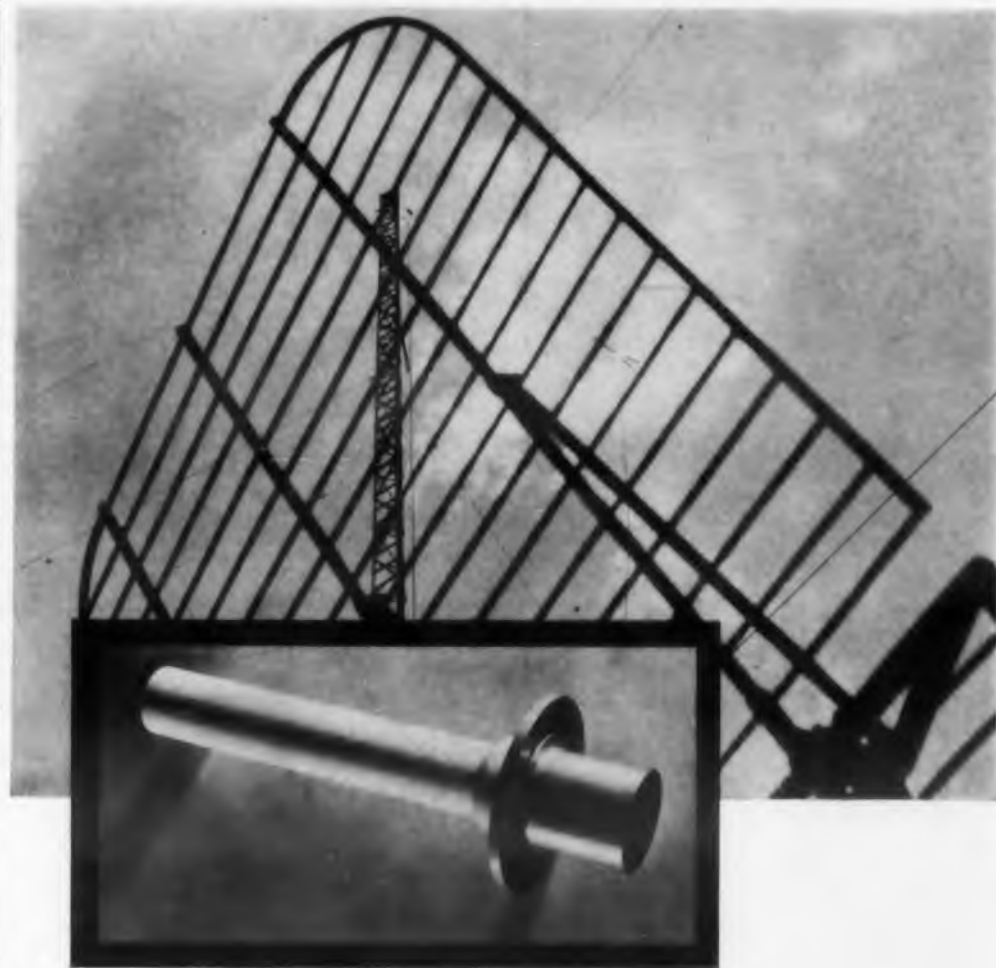
Availability: 30 to 60 days.

Three-Pole Switch 617

Slide-switch type

Type SW-369 3pdt slide switch can be used in audio systems, electronic measuring devices and industrial controls. It is rated at 3 amp, 125 v ac-dc; models with other ratings can also be furnished. All terminals and contacts are silver plated. Distance from mounting surface to tip of terminal is 0.575 in.

Continental-Wirt Electronics Corp., Dept. ED, 26 W. Queen Lane, Philadelphia 44, Pa.



High Efficiency Stub Antenna... another design problem solved by HRB-SINGER

Among HRB's most recent developments in the area of antenna design is the unusual and outstanding tunable stub antenna. This extra-sturdy antenna is truly omni-directional in the horizontal plane. Used in conjunction with UHF transmitter receivers, its prime application is in aircraft and missile telemetry. Its capacity to remain unaffected by extremely high altitudes and its wide range tunability make it ideal for application in missile tracking.

The tunable stub antenna represents only one of the many major developments brought about through the designing of antennas to meet specific customer requirements and applications. Years of experience in the development of these highly complex and versatile antenna designs provide a diversified capability to solve your specific antenna problem. Investigate by writing Dept. E-10. Informative literature describing the HRB-Singer antenna capability is yours for the asking.

ELECTRONIC RESEARCH AND DEVELOPMENT in the areas of:

Communications • Countermeasures • Reconnaissance • Operations Research • Human Factors • Intelligence • Weapons Systems Studies and Analysis • Nuclear Physics • Astrophysics • Antenna Systems

HRB

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A SUBSIDIARY OF THE SINGER MANUFACTURING COMPANY
Science Park, State College, Pa.



CIRCLE 148 ON READER-SERVICE CARD

Highly Reliable

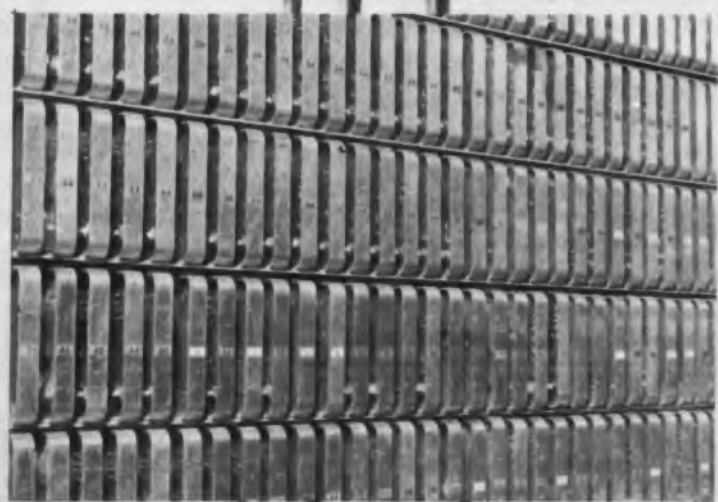
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1S79
1S84



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 **Hitachi, Ltd.**

Tokyo Japan

Cable Address: "HITACHY" TOKYO

NEW PRODUCTS

High-Precision Bridge Console 724

For comprehensive audio-frequency measurements



The BC-101 bridge console measures impedance from 20 μ ohms to thousands of megohms; accuracy is 0.01%. Comparisons of impedances can be made to an accuracy of 0.001%. The console incorporates these six units: Type S-121 audio-signal generator; B-821 high-precision, low-impedance comparator; B-921 high-precision, high-impedance comparator; B-221 universal bridge; B-321 low-inductance bridge; and A-321 waveform analyzer.

Wayne Kerr Corp., Dept. ED, 1633 Race St., Philadelphia 3, Pa.

Price: \$10,800.

Availability: Custom-made.

Direct-Reading Oscillograph 612

For laboratory use

The 1406 Visicorder produces instantly readable records of up to six channels. It can be furnished with a choice of galvanometers and record-drive speeds and is available with grid line and timing systems. It records variables from 0 to 200 cps, has paper speeds up to 25 in. per sec and uses an internal three-speed timer.

Minneapolis-Honeywell, Heiland Div., Dept. ED, 5200 E. Evans Ave., Denver 22, Colo.

Price: \$1,845 with galvanometers, grid line and timer.

Miniature Fixed-Delay Timer 591

Range is 25 msec to 1 min

This fixed-delay timer is a solid-state device with a range of 25 msec to 1 min. It weighs 1.4 oz and occupies less than 1 cu in. The timer is temperature-compensated within 5% from -55 to $+80$ C. Input voltage is 18 to 30 v dc. The device withstands 20-g acceleration for 1 min and has a 100,000-cycle life. Adjustable units are available on request.

Elgin National Watch Co., Micronics Div., Dept. ED, 21001 Nordoff St., Chatsworth, Calif.

Variable Resistors

581

Slide-switch type

These slide-switch control units are based on the firm's model 2 composition variable resistor. It is a 1/2-w unit, measuring 15/16 in. in diameter, with resistances from 200 ohms to 10 meg. Switches are available in positive or spring-return types, spst to 4pdt. Ratings of up to 6 amp can be furnished.

Centralab, Div. of Globe-Union Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

Price: \$0.60 to \$0.70 ea.

Portable Volt-Ohmmeter

725

Has an accuracy of $\pm 0.1\%$



Model 61 battery-powered volt-ohmmeter is for precision measurement of dc voltage and resistance. A pot circuit is used for voltage measurements. The unknown voltage is compared to an accurate 0 to 1.000 v (or 0 to 0.1000 v) reference voltage. Voltages above 1 v are divided with a precision 10-K ohm per volt divider to 0 to 1 v.

F. W. Bell, Inc., Dept. ED, Columbus, Ohio.

Price: \$425 ea.

Availability: November 15, 1960.

Push-Pull Servo

740

Unit supplies 113 v $\pm 10\%$



Model 1057 push-pull servo supplies 113 v $\pm 10\%$. It operates on 400 cps ± 4 cps. Input impedance is 500 ohms; output is 26 v at 400 cps. Temperature range is -65 to $+165$ F. The unit stands 0.4 v per cps from 0 to 300 cps. It meets MIL-E-5272A specifications.

Lumen, Inc., Dept. ED, Moen Ave., P.O. Box 005, Joliet, Ill.

Price: Sample, \$275; 2 to 4 units, \$220 ea.

Availability: Made on order.

UHF Planar Tubes from Machlett



for Communications - Navigation - Telemetry - Radar & Missile Application

General purpose glass or ceramic planar triodes to 5000 mc/sec

• • •

Special purpose glass or ceramic planar triodes — examples of special characteristics now available:

- Quick warm-up (12 sec. cathode heating)
- High current cathode (150 ma plate current)
- Plate pulsed power
(2 - 3kw to 3000 mc/sec)
(2kw to 5000 mc/sec)
- Grid pulsed power
(1½ to 2kw to 3000 mc/sec)

Machlett design capability in UHF planar tubes includes—

Mesh grid since 1945 (gold-plated tungsten mesh grid retains tight tolerance stability over broad thermal range. Detuning effects of sagging grid largely eliminated.)

NEW thermally stable anode (eliminates detuning effects of varying plate dissipation.)

Write now for the Machlett UHF Planar Tube Brochure — describing the industry's strongest line of planar tubes.

THE MACHLETT LABORATORIES INCORPORATED

Springdale

Connecticut

Subsidiary of Raytheon Company

CIRCLE 151 ON READER-SERVICE CARD

BALLANTINE'S MODEL 305A VOLTMETER

measures peak, or peak to peak

PULSES

0.5 μ s

as short as

AT PULSE RATES AS LOW AS 5 pps
... VOLTAGES OF 1 mv TO 1000 v

Also measures

Complex Waveforms

having fundamental of
5 cps to 500 kc with
harmonics to 2 mc.

Accuracy

is 2% to 5% OF
INDICATED
VOLTAGE, depending
upon waveform and
frequency.

Scale

is the usual Ballantine
log-voltage and linear db,
individually hand-
calibrated for optimum
precision.

Input Impedance

is 2 meg, shunted by
10 pf to 25 pf.



Price: \$395.

THIS "A" MODEL is the result of improvements and new features AFTER 11 YEARS OF MANUFACTURING THE VERY SUCCESSFUL MODEL 305

Write for brochure giving many more details



— Since 1932 —

BALLANTINE LABORATORIES INC.

Boonton, New Jersey

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

CIRCLE 155 ON READER-SERVICE CARD

NEW PRODUCTS

Digit-Matic Data Punch

720

For remote-control adding machine operation



The Digit-Matic data punch is for remote-control adding machine operation through the use of solenoids. The results are a printed-detail tape and a punched-data processing tape. The unit can be activated through digital converters, control instruments, digital counters, digital test equipment, flowmeters, pulse-height analyzers and time-interval meters. The punched tape contains coded information in 5, 6, 7 or 8 channels. The output can be used to plot curves. The complete line includes the 10-key serial entry model and the parallel entry full keyboard machine.

Victor Adding Machine Co., Dept. ED, 3900 N. Rockwell St., Chicago 18, Ill.

Price: Approx. \$2,000.

Availability: 90 to 120 days.

Thermocouple Wire

594

Measures -200 to +1,300 C

Thermocoax thermocouple wire, for measuring temperatures from -200 to +1,300 C, is available in lengths to 650 ft. It consists of two conductors, a chrome-nickel alloy and an aluminum-nickel alloy, within a stainless steel or Inconel sheath. Diameters are as small as 0.013 in. Average sensitivity is 41 μ v per deg C; accuracy is ± 2.8 C from 0 to 350 C and $\pm 0.75\%$ from 350 to 1,300 C.

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

Trimmer Capacitor

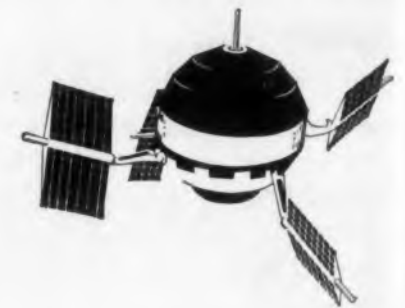
614

Range is 2 to 10 pf

This quartz Sealcap unit is designed for operation over the temperature range of -55 to +200 C. Other specifications are: wvdc, 3,000 v; dielectric strength, 5,000 v; insulation resistance, 2×10^8 meg; and temperature coefficient, ± 50 ppm per deg C. Q-factor is 1,500 at 1 mc.

JFD Electronics Corp., Dept. ED, Brooklyn, N.Y.

SOLID STATE FRONTIERS



TRACKING DOWN A WHISPER AT 20,000,000 MILES

Keeping in touch with satellites in their solar orbits calls for detection of the last faint whisper of available signal strength. At ranges approaching 20,000,000 miles, the conservation of only 0.1 db in signal may add another 200,000 miles of closed contact.

At these extraterrestrial boundaries, optimum stabilization of parametric amplifier gain with antenna mismatches takes on critical importance, and utilization of the non-reciprocal properties of ferrite isolators to achieve this stability — without introducing excessive loss — appears indispensable.

For the Pioneer V, currently breaking all long-distance communications records, compact UHF isolators, developed by Motorola, provide this important assistance. At primary receiving stations in the satellite tracking network, these tiny ferrite devices help to improve receiver performance by stabilizing the gain of parametric amplifiers from changes in antenna impedance.

Motorola Type LI01 UHF Isolator, illustrated, provides more than 10 db isolation with less than 1 db insertion loss over a 30 mc bandwidth.

Originally designed for this satellite tracking application, Type LI01 is now a standard item ideally suited for all wide band, low power applications where minimum size and weight are essential without sacrifice to performance.



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ISOLATORS • CIRCULATORS • PARAMETRIC
AMPLIFIERS • SWITCHING CIRCULATORS
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MOTOROLA INC.
Solid State Electronics
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8201 East McDowell Rd.
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CIRCLE 156 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960

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capacitors

IN QUANTITIES UP TO
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ARIZONA: Radio Specialties & Appl. Corp., 917 N. 7th St., Phoenix.

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COLORADO: Denver Electronics Supply Co., 1254 Arapahoe St., Denver 4.

DISTRICT OF COLUMBIA: Capitol Radio Wholesalers Inc., 2120 14 St., N.W., Wash., D. C.

FLORIDA: Elect. Supply, 1301 Hibiscus Blvd., Melbourne; Elect. Supply, 61 N. E. 9th St., Miami.

ILLINOIS: Newark Electronics Corp., 223 W. Madison St., Chicago 6.

MARYLAND: D & H Distributing Company, Inc., 2025 Worcester St., Baltimore 30; Kann-Ellert Electronics, Inc., 2050 Rock Rose Avenue, Baltimore; Wholesale Radio Parts Co. Inc., 308 W. Redwood St., Baltimore 1.

MASSACHUSETTS: Cramer Electronics Inc., 811 Boylston St., Boston 16; Radio Shack Corp., 730 Commonwealth Ave., Boston 17.

NEW JERSEY: Federated Purchaser Inc., 1021 U.S. Rte. 22, Mountainside; General Radio Supply Co., 600 Penn St., Camden 2; Radio Elec. Service Co., Inc., 513 Cooper St., Camden 2.

NEW MEXICO: Electronics Parts Co., Inc., 222 Truman St., N. E., Albuquerque; Midland Specialty Co., 1712 Lomas Bl. N.E., Albuquerque; Radio Specialties Co., Inc., 209 Penn Ave., Alamogordo.

NEW YORK: Arrow Elect. Inc., 525 Jericho Turnpike, Mineola, L. I.; Elect. Center Inc., 211 W. 19th St., N. Y. 11; Harvey Radio Co., Inc., 103 W. 43rd St., N. Y. 36; Lafayette Radio, 100 Sixth Ave., N. Y. 13; Stack Industrial Electronics, Inc., 45 Washington Street, Binghamton; Terminal Elect. Inc., 236 W. 17 St., N. Y. 17.

NORTH CAROLINA: Dalton-Hoge Radio Supply Co., Inc., 938 Burke St., Winston-Salem.

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TENNESSEE: Electra Distributing Co., 1914 West End Ave., Nashville 4.

TEXAS: All-State Dist. Co., 2411 Ross Ave., Dallas 1; Busacker Elect. Equip. Co. Inc., 1216 W. Clay, Houston 19; Engineering Supply Co., 6000 Denton Dr., Dallas 35; Midland Specialty Co., 500 W. Paisano Dr., El Paso; The Perry Shankle Co., 1801 S. Flores St., San Antonio.

UTAH: Carter Supply Co., 3214 Washington Blvd., Ogden.

WASHINGTON: C & G Radio Supply Co., 2221 Third Ave., Seattle.

CANADA: Electro Sonic Supply Co., Ltd., 543 Yonge Street, Toronto 5, Ont.

ARCO ELECTRONICS, INC.
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Exclusive Supplier of ELMENCO Capacitors to
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Another New Achievement from El-Menco

A New Smaller Size

Dipped Silvered

Mica Capacitor

El-Menco's
SUB-MINIATURE
DM-10

Mica Capacitor...

Sets New Standard in Miniature Reliability!

■ This sub-miniature DM-10 Mica Capacitor retains the same superior electrical characteristics of silvered mica capacitors as found in much larger sizes. It assures a high order of performance in extreme miniaturization applications — missiles, printed circuits and all compact electronic equipment. Parallel leads provide greater versatility. Tough phenolic casings protect against physical damage and penetration of moisture.

Capacity and Voltage Ranges

Working Voltage	Capacity Range
100 WVDC	1 MMF thru 360 MMF
300 WVDC	1 MMF thru 300 MMF
500 WVDC	1 MMF thru 250 MMF

Operating Temperature: up to 150° C.

Characteristics: C, D, E and F, depending on capacitance value

Leads: #26 AWG (.0159") Copperweld wire

EL-MENCO'S SUB-MIDGET DM-10 . . . THE NEW SMALLER MINIATURE MICA CAPACITOR

El-Menco
Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors
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- molded mica • dipped mica • mica trimmer • dipped paper
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Arco Electronics, Inc., 64 White St., New York 13, N. Y.
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

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EL-MENCO'S DM-10 MEETS ALL THE ELECTRICAL REQUIREMENTS OF MILITARY SPEC. #MIL-C-5B AND EIA SPECIFICATION RS-153

Other sizes also ideal for miniaturization applications —

DM-15... up to 820 mmf at 300 VDCW, up to 400 mmf at 500 VDCW.

DM-19... up to 5400 mmf at 300 VDCW, up to 4000 mmf at 500 VDCW.

WRITE FOR SAMPLES OF EL-MENCO DM-10 CAPACITORS and brochures describing El-Menco's complete line of capacitors.



ACTUAL SIZE

CIRCLE 153 ON READER-SERVICE CARD



NWL AIR CORE REACTOR

range: 40 H at 12 Amp. rms

NWL's latest unit is especially designed and engineered for air-blast operation at a temperature rise not exceeding 10°C. Radial ducts permit free flow of air along both sides of the pie-wound coils. Rigid mechanical support assures permanent alignment of coils.

The reactor illustrated, is only one of many special units manufactured by NWL, such as: Iron core reactors, large power, electronic and pulse transformers, chokes, etc.

Each NWL unit is thoroughly tested and must meet all customer requirements before shipment. We shall be pleased to quote you up to 300 KV and up to 500 KVA, depending on your individual requirements.



Notthelfer

SAY: NO-TEL-FER

NOTHELFER WINDING LABORATORIES, INC., P.O. Box 455, Dept. ED11, Trenton, N.J.
(Specialists in custom-building)

CIRCLE 158 ON READER-SERVICE CARD

NEW PRODUCTS

Thyratron

746



For control applications

Type NL-6989/C6J/KL 6.4-amp thyratron is a 1,000-v peak-forward and 1,250-v peak-inverse tube. The tube is for control applications involving inductive loads. Commutation factor is 130 v per μsec x amp per μsec . Specifications include: filament volts, 2.5 v; filament current, 21 amp; peak-anode current, 80 amp; ambient temperature, -55 to $+75$ C. The NL-C6J/K is a pin-base model and the NL-C6J/KP is a bracket-base model.

National Electronics, Inc., Dept. ED, Geneva, Ill.

Price: NL-6989/C6J/KL, \$29.45; NL-C6J/KL, \$28.30; NL-C6J/KP, \$29.45.

Availability: From stock.

Electrolytic Capacitors

605

In four different styles

Type MLE subminiature electrolytic capacitors are designed for operation in critical circuits. They are said to give ten years of service; temperature range is -40 to $+85$ C. Type CQM capacitors, suited for computers, have long life, low leakage current, are designed to operate from -20 to $+65$ C, and are hermetically sealed in aluminum containers. Type TAK-H capacitor is a wet electrolyte tantalum type, seep- and vibration-proof, meeting MIL-C-3965 specs. The type TAD capacitor is a solid tantalum device of high reliability. It is hermetically sealed, has a long shelf and operating life, has a temperature rating of -40 to $+85$ C, to $+125$ C with derating, and is available in a wide variety of sizes and shapes.

Pyramid Electric Co., Dept. ED, Darlington, S.C.

SOLID STATE FRONTIERS



Motorola Solid State Devices Laboratory Manager Cacheris and Developer Sakiotis with XS01 Switch.

NEW FERRITE SWITCH OFFERS FIRST BROADBAND MICROSECOND SWITCHING

Microwave systems engineers looking for a fast-acting, highly reliable duplexing device will do well to investigate the advantages of the Model XS01 Ferrite Switch.

Operating at X-band, the 3-port device provides an 18% bandwidth and can be switched in less than one-millionth of a second. Moreover, it has high average power handling capability and, to our knowledge, is the only one of its kind.

Supplementing a circulator with a switch of this kind eliminates the need for T-R tubes in the majority of applications and, thus, shortens switching time, prolongs operating life and improves reliability. The XS01 has a wider bandwidth than differential phase shift circulators and has the added advantage of much smaller magnetic field requirements, and, consequently, smaller driver units.

The switch is also available in a 4-port version for receiver-transmitter switching between two antennas.

TYPICAL SPECIFICATIONS

Frequency range	8.75-10.5 kmc
Insertion loss	1.25 max.
Isolation	23 db min.
Input VSWR	1.4 max.
Power handling capability	80 watts avg.
Minimum switching time	0.75 usec.

REPRESENTATIVE MOTOROLA SOLID STATE DEVICES

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CIRCLE 159 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960

Component Sockets 393

Miniature and microminiature

These sockets accommodate diodes, transistors, miniature-vacuum tubes, capacitors and resistors. Standard types accept 0.01 to 0.06-in. diameters; types made on special order accept a 0.004-in. diam. Called Tran-Grip, the sockets use a closed-entry, multiple-spring, contact-gripping device.

Omega Precision, Inc., Dept. ED, 757 N. Coney Ave., Azusa, Calif.

Price: \$0.06 ea in lots of 100,000.

Availability: From stock.

Electronic Pre-determining Counters 553

For high-output machines and processes

No. 1601 counters have speeds up to 1,000 counts per min. Control contacts operate and hold from a minimum of 0.3 sec. The unit can be modified for automatic sequential predetermining, using two or more preset numbers. No. 1604 has up to six decade-counters, with one, two, or more sets of preset numbers. The unit has momentary or indefinite holding time and instantaneous recycling. It operates up to 5,000 counts per sec and recycles at 1,000 cps.

Veeder-Root Inc., Electronic Control Div., Dept. ED, 83 Elm St., Danvers, Mass.

Silicon Varactor Diodes 555

Have pigtail leads

These nine high-voltage silicon varactor diodes, MA-4380X through MA-4388X, are housed in standard subminiature glass cases with pigtail leads. The series cover a capacitance range of 0.2 pf min to 15 pf max at -6 v; piv rating is 30-v min. Typical Q is 200 to 300 at 100 mc.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

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RAYTHEON
"PROGRAM 2020"
MEETS YOUR
VOLTAGE
REGULATOR
SPECIFICATIONS
FAST AND AT
LOW COST FROM
STANDARD DESIGNS



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LOW-COST RAYTHEON REGULATED DC POWER PACKAGES



SPECIFY A RAYTHEON
"RD" POWER SUPPLY AND ELIMINATE
POWER SUPPLY DESIGN HEADACHES

132 different ready-to-operate models for standard 19-inch rack installation, 3 to 1,000 volts, 50 to 3,000 watts

These compact Raytheon "RD" units are the complete low-cost solution to your power supply problems without any sacrifice of the heavy-duty industrial performance your specifications demand.

The new power packages utilize ferroresonant (magnetic) voltage regulation coupled with full-wave silicon diode rectification and

capacitive input filtering. Ripple is reduced to within 0.5 to 1.0% depending on model.

Raytheon assures prompt delivery of your selection from 132 different models in 20 voltage steps and 7 power ratings, 3 to 1,000 volts, 50 to 3,000 watts, all for 19-inch rack mounting.

CHECK THESE BENEFITS OF "RD" POWER SUPPLIES

- Lowest cost consistent with heavy-duty industrial ratings
- 132 models: 3 to 1,000 volts, 50 to 3,000 watts
- Self-protecting; extremely dependable
- DC output filtered and isolated
- Improved load regulation
- 19" rack mounting; 6 sizes, panel heights from 3½" to 28"
- Regulation $\pm 1\%$ for line variation of $\pm 15\%$



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Selection Guide and
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Please send me

- Raytheon "RD" Product Selection Data #4-290
 Raytheon 2020 Regulator Selection Guide and Catalog #4-265

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Title _____
Company _____
City _____ State _____



SINGLE TRANSIENT PEAK READING VOLTMETERS



Model PRV-2 Single Transient Peak Reading Voltmeter.
Approximate size, 10½" x 20" x 15¼". Weight, 55 pounds.

Read single transient pulses with 1% accuracy

The Curtiss-Wright Model PRV-2 Single Transient Peak Reading Voltmeter reads out the peak amplitude of rectangular pulses of 25 microseconds or greater rise time to an accuracy of 1%. Rate of fall required to initiate cycle is 0.2 volts per microsecond on the 1200-volt scale and 0.02 volts per microsecond on the 120-volt scale. Read-out is provided, directly in volts, as a 4-digit decimal value. The first peak voltage detected blocks further input values until reset.

You can use Model PRV-2 for peak pulse measurement wherever an oscilloscope would be too inconvenient—or too inaccurate. It is perfect for blast studies, shock studies, spherics measurements, to measure any transient phenomena which can be characterized by a voltage pulse. Input range: 3-120 volts @ 200 Kohm, 20 uuf input impedance; 30-1200 volts @ 2 megohm, 20 uuf input impedance. And, of course, the PRV-2 can be modified to accommodate a variety of input requirements.

Write us about your needs.



SOLID STATE RELAYS for micro-second switching applications. Extremely resistant to high shock and vibration environments.

Inter Mountain Instrument Branch—Electronics Division

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SOLID STATE RELAYS • SINGLE TRANSIENT PEAK READING VOLTMETERS • TRANSISTOR TEST INSTRUMENTS AND SYSTEMS • DIGITAL DATA ACQUISITION AND PROCESSING SYSTEMS

CIRCLE 161 ON READER-SERVICE CARD

NEW PRODUCTS

Load Cells

734

High-temperature measurement devices



These load cells are high-temperature measurement devices that perform tension and compression measurements up to 750 F. The cells are available in 5,000, 10,000, 20,000 and 50,000-lb ranges having 0.25% of full scale accuracy. Outputs are 120 or 350 ohm.

Micro-Test, Inc., Dept. ED, 1718 21st St., Santa Monica, Calif.

Price: \$500 to \$1,200 ea, according to capacity.
Availability: 30 days.

Magnetic-Tape Heads

593

For Hall-effect recording

These Hall-effect magnetic-tape heads, types SBV-535 and SBV-536, eliminate reading errors resulting from varying tape speed and unscheduled standstill. Signal pickup heads have a gap length of 0.5 mm and have gap parallel to tape motion. Sound reproduce heads have the gap perpendicular to tape motion and a gap length of 8 to 15 micron. Static magnetic signaling is possible.

GRH Halltest Co., Dept. ED, 155 S. Morgan Blvd., Valparaiso, Ind.

Temperature Sensor

703

For use up to 750 F

This temperature sensor is for use up to 750 F. The unit is insensitive to strain. It can be welded to any ferrous or non-ferrous metal in one min or less. Units are available in 60- and 120-ohm resistances.

Micro-Test, Inc., Dept. ED, 1718 21st St., Santa Monica, Calif.

Price: \$30 ea.
Availability: 15 days.

TO HIGH GAIN, LOW NOISE BENEFITS OF MOTOROLA PARAMETRIC AMPLIFIERS NOW ADD SMALLEST SIZE- WEIGHT CHARACTERISTICS AND LOWEST PUMP POWER REQUIREMENTS AVAILABLE

Take for example Motorola's range of exploration: Working amplifiers have been developed or are under development for operation from 10 mc to more than 10,000 mc.

Or consider size and weight: Negative resistance amplifier Type LPA01, tunable from 180 mc to 270 mc, is the smallest and lightest VHF parametric amplifier commercially available. It achieves 16 db gain over a 1.5 mc bandwidth with noise figure of 1.5 db.

In the UHF range, Type LPA02 is tunable from 400 mc to 460 mc. This is a negative resistance type with a noise figure of approximately 2 db yielding 13 db gain and a 3 mc minimum bandwidth. Only 1.5 mw (maximum) of pump power is required.

Motorola designed laboratory units have been operated at S-band and X-band with high performance.

Motorola Type LPA01 parametric amplifier is a variable reactance amplifier of the negative resistance type. Two resonant coaxial lines are interconnected at the high impedance end by a varactor diode. One cavity is resonant at both the signal and pump frequencies, while the second cavity is resonant at the difference of these two frequencies. This use of dual resonance, which permits impedance matching at the pump frequency, is a significant factor in keeping pump power requirements to a minimum.



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ISOLATORS • CIRCULATORS • PARAMETRIC AMPLIFIERS • SWITCHING CIRCULATORS • HIGH-SPEED, BROAD-BAND SWITCHES • PHASE SHIFTERS •

For detailed information, write:

MOTOROLA INC.
Solid State Electronics
Department



8201 East McDowell Rd.,
Scottsdale, Arizona WHitney 5-6311

CIRCLE 162 ON READER-SERVICE CARD

Transmission Test Equipment 551

Units are transistorized

Model TTS-11 level-measuring set measures levels from +8 dbm to -30 dbm on 600 or 900-ohm circuits. Two 9-v batteries powering the unit last approximately 100 hr for intermittent operations and 0.1-db change in calibration. Frequency response is within 0.1 db from 200 to 7,000 cps. Model TTS-14 level-meter measures levels from 0 to -20 dbm. It operates from a 9-v battery that has a life of over 200 hr of intermittent operation and 140 hr continuous. Model TTS-15 transmission test set measures levels from +8 to -30 dbm and supplies output levels up to 0 dbm at six frequencies. Signals are supplied and measurements made on 600 or 900-ohm circuits. Frequency accuracy is 2% from 50 to 100 deg F. Batteries for all units are transistorized.

Northeast Electronics Corp., Dept. ED, Concord, N.H.
Price: TTS-11, \$140; TTS-14, \$72; TTS-15, \$225.

Availability: From stock.

Electrolytic Capacitors 552

Stand life test of 2,000 hr

Type STP tantalum units stand a life test of 2,000 hr when tested per MIL-C-26655A. Temperature range is -55 to +125 C. The units have a positive hermetic seal and polar construction.

Efcon, Inc., Dept. ED, Patterson, Pl., Garden City, L.I., N.Y.

Digital Clock 556

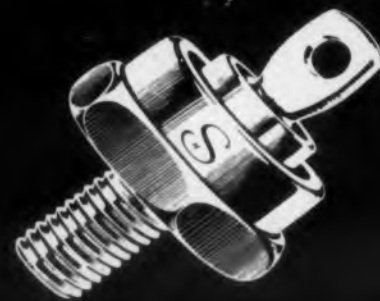
In 12-hour and 24-hour styles

This digital clock has 5/8-in. digits on the 12-hr model and 5/16-in. digits on the 24-hr clock. A calibrated seconds indicator is provided. Digits can be reset from front panel. Instrument resists shock of 1,000 lb per in. Unit measures 4-1/2 x 6 x 3-1/4 in. and weighs 3.5 lb.

Pennwood Numechron Co., Dept. ED, 7249 Frankstown Ave., Pittsburgh 8, Pa.

CIRCLE 160 ON READER-SERVICE CARD ►

In Answer to the Ad that Started it all...



If safety factors are a
MUST in your application...

Specify SRC!

An outstanding illustration of SRC quality, reliability and safety is found in its 35 ampere silicon power rectifiers. For example, these hermetically sealed diodes are so conservatively rated that they will withstand 1200 ampere surges!

These silicon rectifiers are nominally rated at 35 amperes and are available in a range of 50 to 600 volts. Readily interchangeable with standard existing 35 ampere units, this entire premium rectifier series is now available for immediate delivery at no premium in price!

For further detailed information and technical data send today for your free copy of the new SRC Silicon Rectifier Handbook and Catalog covering the full line up through 400 ampere units.

As substantiated by United Testing Laboratories



STANDARD OF QUALITY
STANDARD RECTIFIER CORP.

620 East Dyer Road, Santa Ana, California - Kimberly 5-8241

In August, the Standard Rectifier Corporation launched its national advertising campaign. The original ad of this new series is shown reproduced above. The response it has enjoyed, since initially appearing in the electronic trade journals, has been tremendous! It has resulted in literally hundreds of requests for further information.

The Standard Rectifier Corporation is fully aware of the need... indeed the demand of industry for electronic components that embody greater factors of safety and reliability. To further substantiate these claims made in reference to the quality of our products, we have listed below a few of the more important reasons why an ever-increasing number of engineers are specifying SRC!

1 SRC uses an aluminum-silicon junction substantially larger in area than industry standards. SRC's "planar" type construction extends the area of contact across the entire silicon chip.
BENEFIT: Nearly twice the surge rating of competitive products! More efficient heat dissipation... longer life.

2 Every SRC rectifier product is completely production tested and inspected by the use of sophisticated sweeping techniques at 100 volts above, or two times rated PV, whichever is lower.
BENEFIT: For greater transient protection.

3 Another plus feature of SRC's unique type of bond is its newly developed method of utilizing water-soluble molibdenum based in their "fluxing" compound design... this results in a nearly perfect bonding of materials.
BENEFIT: Less thermal fatigue stress.

4 SRC extensively tests its rectifiers for various surge ratings. Example: The 35 amp series is tested at 150 amps for two seconds. Independent lab tests show it will safely handle eight times normal rating up to 1,000 amperes!
BENEFIT: Better protection and surge protection, thus resulting in more effective surge protection.

In the coming months our ads will serve to introduce many new and exciting products... the results of Standard's research and development. We hope you will watch for them, and we invite your inquiries.

As substantiated by the United Testing Laboratories



STANDARD OF QUALITY

STANDARD RECTIFIER CORP.

620 East Dyer Road, Santa Ana, California
Kimberly 5-8241 - TWX: 8 ANA 8103

NEW PRODUCTS

Solid-State Pulse Generator 738

Unit is 50% to 70% smaller than tube-types



This 9-kw solid-state pulse generator is 50% to 70% smaller than tube-types. It is for use in low-power radar altimeters, surveillance and target-scoring. Standard models operate from a 200-v dc source and can be used with magnetrons or microwave triodes. Pulse width is 0.25 μ sec; rise time is 30 to 40 nsec. Standard pulse frequencies are 10, 5 or 2 prf kc.

Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

Price: On request.

Availability: 30 days.

Data Converter 728

Speed is 3,000 words per min



Type D300 data converter converts information between punched paper and magnetic tape in either direction. In addition to tape-to-tape conversion, the unit can have card input and output. The basic unit contains the circuitry for accepting data from the input, storing data, and feeding data to the output tapes. The user specifies whatever additional features may be required.

Digitronics Corp., Dykor Div., Dept. ED, Albertson Ave., Albertson, L.I., N.Y.

Price: \$42,000 for the basic unit.

New Circulator

- < 0.5 db insertion loss
- 20 db isolation
- 30% bandwidth at C-band

Motorola's new broadband Y-circulator Model CC04 fills a threefold purpose. As a stripline circulator it provides exceptional performance wherever small size and light weight are essential. It also serves as a high-speed electronic switch, acting as a shutter, for example, to protect against receiver burnout resulting from a mismatched antenna. Finally, because of its compact construction, it can be readily cascaded into an integral switching matrix capable of connecting one or more inputs to any one of a number of outputs.

The 3-port circulator, with coaxial connectors, offers 20 db isolation with less than 0.5 db insertion loss over an approximate 30% bandwidth at C-band, a 50% greater bandwidth than has been generally available heretofore.

The microwave characteristics of the switch are identical to those of the circulator. With a compact, transistorized driver, switching times of 10 μ s have been achieved. Faster switching times are possible with vacuum tube drivers. Utilizing this design, a single-pole, 32-throw switching matrix, complete with drivers, occupies a volume of only 5 x 13 x 19 inches.

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CIRCLE 165 ON READER-SERVICE CARD



EXCELLENT form-factor and operating versatility make these rugged magnetrons ideal for many small-package applications including CW or pulsed radar beacons, test equipment oscillators, airborne navigation, proximity detection, surveillance, and transponder type operations.

Light, dependable, and with proven capabilities, these tubes operate at 500 to 600 peak volts and 150 ma peak pulsed current, permitting low-cost modulator components for all applications. They give a nominal power output of 1 watt CW and 15 watts peak.

Engineering programs in progress at Microwave Associates are directed towards development of this tube as a voltage-tunable magnetron within the same form-factor. These inquiries are welcomed on these and other magnetrons.

A copy of our new 72 page Magnetron Catalog is available upon written request on your company letterhead.



MICROWAVE ASSOCIATES, INC.
BURLINGTON, MASSACHUSETTS

Western Union FAX • TWX: Burlington, Mass., 942 • BRowning 2-3000

CIRCLE 164 ON READER-SERVICE CARD

Feedthrough Terminals

375

Shank diameter is 0.125 in.



These terminals are offered in two types, both have shank diameters of 0.125 in. Type 1035 has double turrets at each end. Height, when mounted, is 0.241 in. at one end and 0.134 in. at the other. Type 1036 has double turrets at one end and a single-turret at the other. Height of the double turret mounted is 0.241 in., and of the single turret, 0.082 in.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

Voltage-Current Calibrator

575

Sensitivity is 1 mv

Model 1082 calibrator samples and measures ac, pulse and dc signals from 1 mv to 10 v; this range extends to 200 v with the firm's signal attenuator. Other specs include: input signal bandwidth, over 100 mc; output accuracy, 0.1% of full scale. Operating as a signal comparator, the unit provides a positive or negative reference voltage signal. It is particularly suited for use in digital computer laboratories.

Rese Engineering, Inc., Dept. ED, 731 Arch St., Philadelphia 6, Pa.

Power Supply

615

Delivers 10,000 v dc

This high-voltage supply weighs 5.75 lb and provides a fixed output of 10,000 v dc at 2 ma. It is an unregulated transformer-rectifier unit operating from an input of 115 v at 400 cps. Ripple is less than 20 v peak-to-peak. Operating life is 2,000 hr min; temperature range is -54 to +71 C. Designated model P755A, the unit provides the gun potential to a high-persistence display tube and may be used in other applications where space and weight must be considered.

ITT, Industrial Products Div., Dept. ED, 15191 Bledsoe St., San Fernando, Calif.



WHO MAKES FINE MOTORS THIS SMALL?

Globe Industries makes motors this small to make your design more compact, reliable and salable. If you make miniature instrument packages for space exploration — if you build airborne and ground support equipment — if you want to design smaller typewriters, computers, recorders or other products, look at these 3 motors:

TYPE VS—The smallest, most powerful precision miniature d.c. motor for its size. Only $\frac{1}{16}$ " flat, four VS motors fit in a regular cigarette pack with room to spare. It has the power to lift its own weight to the top of the Empire State Building in 1 minute! Typical continuous torque—.25 oz. in.; typical intermittent torque—.5 oz. ins. We can design gear units, governors and brakes to meet MIL specs also.

TYPE SS — Only $\frac{1}{8}$ " in diameter, Type SS d.c. motors typically produce continuous duty torques of .3 oz. in.; intermittent torques to .6 oz. ins. With the basic Type SS motor you can specify any of 21 planetary gear speed reducers or 28 spur gear speed reducers. Governors and brakes are available also. Designed to meet MIL specs.

TYPE MM — The most widely used precision $1\frac{1}{4}$ " d.c. motor in the world, MM motors typically produce .5 oz. in. in continuous duty applications — 1.0 oz. in. intermittent duty. Choose from 101 ratios of planetary gear speed reductions. Brakes, governors and clutches can be included. MIL specs are invited.

For details about these motors request Bulletin VSM. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

GLOBE INDUSTRIES, INC.

PRECISION MINIATURE A.C. & D.C. MOTORS, ACTUATORS,
TIMERS, GYROS, STEPPERS, BLOWERS, MOTORIZED DEVICES

GLOBE

CIRCLE 163 ON READER-SERVICE CARD

SOMETHING REALLY NEW IN PANEL METERS!



THIS SLIM-LINE, TRIM-LINE STYLIST

Have a look at the most distinctively different meter design in years. Start with styling (as your customers do): note the thoroughbred leanness, the crisply drawn detail, the overall look of precision. Consider function: see how the picture-window dial is recessed and angled back for easier reading. Ponder practicality: observe that the self-trimming case is installed with just a single panel cutout. Sample the specifications: choose from two sizes—Model 561, 5" x 2 $\frac{7}{8}$ ", and Model 361, 3 $\frac{1}{2}$ " x 2"; both in satin-finish Bakelite; both available in standard microampere, ampere, millivolt and volt ranges, AC or DC. Prices and other data? Ask for Bulletin 107.



ASSEMBLY PRODUCTS, INC.
Chesterland 17, Ohio

CIRCLE 167 ON READER-SERVICE CARD

NEW PRODUCTS

Pressure-Transducer Calibration 750 System

Range of 0-3500 psi in 1-psi increments



This pressure-transducer calibration system has a 0-3500 psi range covered by 1-psi increments. The automatic unit does eight hr of manual work in 20 min. A ratio of weight-to-psi output from 8 to 80 is obtainable. The system consists of a Frieden tape reader, relay and control console, pneumatic switching cabinet, and the weight handler and balance. The instrument zeros, calibrates, and standardizes pressure recorders associated with the pre-programmed range.

Gilmore Industries, Inc., Dept. ED, 13015 Woodland Ave., Cleveland 20, Ohio.

Television Relay Equipment 589

Has 1-w klystron carrier generator

The type MV-30 television relay microwave equipment utilizes a 1-w klystron tube to generate the microwave carrier. The receiver is said to have a long-life if strip with built-in phase equalization. The equipment can transmit monochrome or color video signals. It provides a 15-kc audio channel. The equipment operates in the 5,925- to 7,125-mc bands. The separate transmitter and receiver units mount in 19-in., 7-ft racks.

Motorola, Inc., Communications and Industrial Electronics Div., Dept. ED, 4501 W. Augusta Blvd., Chicago 51, Ill.

Reset Timer 597

Combines delay and interval timers

The Acrotime external-clutch reset timer combines the functions of delay and interval timers. Series BR is for mounting in the rear of control panels, in control cabinets and in other applications where timing interval is changed infrequently. Series BP is for panel-mounting and has a bezel and dome assembly, a dial assembly and a pre-wired 12-position terminal board. The unit can be supplied with a single 15-amp spdt load switch or two 10-amp spdt load switches. Design is modular.

General Time Corp., Haydon Div., Dept. ED, 245 E. Elm St., Torrington, Conn.

SOLID STATE FRONTIERS



C-BAND CIRCULATOR

Lightweight, compact and with high performance over a broad range of temperature, Motorola C-Band Circulators were designed for — and are providing — high levels of efficiency and reliability in today's most advanced military electronic equipment.

Equally applicable to nonmilitary systems, these Motorola ferrite circulators operate from 5400 to 5900 mc with insertion loss of less than 1.2 db. Isolation, in both the transmit and receive modes, is more than 12 db over the entire frequency band and over a temperature range of 0° to 85°C, or 0° to 105°C, depending on model.

Experience-proven in critical applications — in missile-borne radar transponders, for example — these highly efficient ferrite devices when used in conjunction with a preselector provide isolation from antenna mismatches, eliminate need for switching gas tubes, and perform duplexing functions, even for CW systems.

Whether your specifications demand smaller size and lighter weight, better isolation, or elimination of separate transmitting and receiving antennas, we suggest that you investigate all the advantages that this Motorola solid state device offers to modern microwave systems planning. Full specifications and details upon request.

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Solid State Electronics Department



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Scottsdale, Arizona WHitney 5-6311

CIRCLE 168 ON READER-SERVICE CARD

Interval Timer 559

Repeat accuracy is 0.0025

Available for ac or dc operation, model 309 push-button timer has a repeat accuracy of 0.0025. It provides automatic shut-off and reset. It has one spdt snap-action load contact; an additional spdt snap-action independent load contact is optional. The unit can be furnished in 16 dial ranges from 6 sec to 60 hr.

Automatic Timing & Controls, Inc., Dept. ED, King of Prussia, Pa.

Pushbutton Control Units 566

Have single-circuit contact blocks

The type R-series control units and selector switches, have convertible terminals that can be changed from normally open to normally closed, and vice versa, without use of additional parts or special tools. They are keyed to insure staggering of terminals when mounted in more than one tier; up to eight units may be combined for use on a single operator. They are built to JIC and NEMA standards.

Mackworth Rees, Inc., Dept. ED, 1573 E. Forest Ave., Detroit 7, Mich.

Price: \$7 to \$35 ea.

Availability: From stock.

Time Delay Relay 434

For automatic and semi-automatic applications

Model 591 time-delay relay is suitable for many automatic and semi-automatic applications. It is available in single-pole and dpdt models. Some specifications are: operating voltage, 105 to 125 v, 60 to 1,200 cps; power required, 2 w; time intervals, 0.003 to 300 sec; output-relay rating, 3 pdt relay with 5-amp contacts. The unit measures 2 x 2-1/4 x 3-1/8 in. and weighs approximately 9 oz.

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

Price: \$19.75

Availability: 2 to 3 weeks.

CIRCLE 166 ON READER-SERVICE CARD ▶

THIS IS WHY

THE *Beam-X** SWITCH

OUTPERFORMS ALL OTHER ELECTRONIC SWITCHES

• LOWEST COST

• SIZE —
1.1" x 3"

• RUGGED SHOCK
AND VIBRATION

• WEIGHT —
1.8 OUNCES

• ELIMINATES
90 TRANSISTORS,
DIODES AND
RESISTORS



BX1000
ACTUAL SIZE

- 10 CONSTANT CURRENT OUTPUTS
- MEMORY AND AUTOMATIC LOCKING
- TOTAL POWER — 1.2 WATTS
- HIGH TEMPERATURE
- LONG LIFE — HIGH VACUUM
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- ANY NUMBER OF POSITIONS
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MICROWAVE PRODUCTS



Four-Channel Microwave Filter 463

Has built-in video detectors

Model 1201 etched-circuit four-channel microwave filter has built-in video detectors designed to cover a very wide input dynamic range. Each channel has a band-pass of 2,600 to 3,200 mc at a maximum input vswr of 2:1. The video detectors have tangential sensitivities of -40 dbm min. Filter dimensions are 6.15-in. in diameter and 0.7-in. thick, excluding connectors.

R S Electronic Corp., Dept. ED, 435 Portage Ave., Palo Alto, Calif.
Availability: 30 days.



Four Types of Reflex Klystrons 464

Provide 4-to-1 tuning range

These reflex klystrons are offered in four frequency bands. Suitable for local oscillator operation in receivers with audio frequency control, type ZV 1011 has a range of 4 to 11 kmc at temperatures to 250 C. Master oscillator and driver tubes, types ZV1010X, ZV1021X and ZV1009X operate from 950 to 2,800 mc, 1,000 to 4,000 mc and 1,700 to 5,000 mc, respectively. They require no cooling, resist shock and vibration and are of all-ceramic construction.

Polarad Electronics Corp., Dept. ED, 43-20 34th St., Long Island City 1, N.Y.

All-Electronic Pulse Generator 465

Has rise time of 0.5 nsec

Model 750 pulse generator can deliver positive and negative nanosecond pulses simultaneously. Specifications are: rise time, 0.5 nsec; repetition rate range, 10 to 100,000 pulses per sec; dimensions, 10 x 10 x 13 in.; weight, 15 lb. It has single-shot capability. Pulse amplitudes are fixed at approximately 8 v into 50 ohms. Pulse outputs are preceded by a trigger pulse available on the front panel. Time difference between trigger pulse and main pulses is selectable over a 100-nsec range. Pulses may be varied from 2 to 100 nsec by means of an external charge cable.

Edgerton, Germeshausen And Grier, Inc., Dept. ED, 160 Brookline Ave., Boston, Mass.





Coaxial Monoplexers 462

For systems using two antennas

Those coaxial-line monoplexers are for use in radar systems using separate transmitting and receiving antennas. The unit shown protects the receiver from the transmitted signal and from other signals that may be accidentally directed at the receiving antenna. Terminated directional couplers are provided for power-monitoring purposes. The unit shown is for the frequency range of 406 to 450 mc. Transmitter power peak is 30 kw and transmitter power average, 50 w.

Bomac Laboratories, Inc., Dept. ED, Salem Road, Beverly, Mass.

Traveling Wave Tube 461

Designed for X-band radar

The Z-3090 traveling wave tube is designed for use in X-band radar applications. It can be used as a driver tube in a pulsed high-power chain or as a final amplifier in a medium power application. Focusing of the beam is accomplished with a periodic permanent magnet. Specifications are: frequency, 8,500 to 9,700 mc; peak power output, nominal, 10 kw; pulse-beam voltage, 16 kv approximate; pulse-beam current, 4.0 amp approximate; efficiency, 15%; power gain, nominal, 35 db; duty cycle, max, 0.005.

General Electric Co., Power Tube Dept., Dept. ED, Schenectady, N.Y.
Availability: 90 days.

YOUR GUARANTEE OF PRODUCT RELIABILITY

ACKNOWLEDGMENT
CORNISH WIRE COMPANY
INCORPORATED
50 CHURCH ST. - NEW YORK 7

DATE: SEPTEMBER 15, 1960 OUR ORDER # 90-534

SOLD TO: SHIP TO:

A B C ELECTRONICS MANUFACTURING COMPANY
1913 GLENWOOD AVENUE
FORKY HILLS, N. J.

QUANTITY DESCRIPTION SHIPPED DATE QUANTITY PRICE

20,000 FT.	12/2 CABLE IN ACCORDANCE WITH MIL-C-5766B			
20,000 FT.	CO-93 MEY (3/16) S30 0375 IN ACCORDANCE WITH MIL-C-3432A			
100,000	COS-2 (18) IN ACCORDANCE WITH MIL-C-3884			

MATERIAL TO BE SOURCE INSPECTED IN ACCORDANCE WITH APPLICABLE SPECIFICATIONS

CONTRACT #16135-PP-00-01-C5

WE WILL SHIP FROM WILLIAMSTOWN, MASSACHUSETTS

ITEM 1 AND 2 - OCTOBER 15, 1960

ITEM 3 - NOVEMBER 1, 1960

41 years of design, engineering and manufacturing experience goes into every Cornish cord set, wire and cable assembly. Manufactured to rigid military specifications, Cornish products have proven their high standard of reliability in a wide variety of electronic applications. Design problems, requiring custom components, are a specialty with Cornish engineers. We welcome the opportunity to discuss the requirements of your specific problems with you.

Cornish produces a wide range of products to meet military specifications some of which are: MIL-C-5756B / MIL-C-7974 / MIL-C-12064A(CE) / J-C-90A / MIL-C-3432A / MIL-C-3884 /
CORNISH WIRE COMPANY, 50 CHURCH STREET, NEW YORK 7, NEW YORK



CIRCLE 181 ON READER-SERVICE CARD

**ONE
MANUFACTURING
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RG/U COAXIAL CABLES**



RG-209/U



TIMES produces more RG/U type coaxial cables than any other manufacturer in the world—including many types *unobtainable* from other sources.

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Choose from the industry's most complete line of approved coaxial cable—or let TIMES' Engineering Service assist you in developing coaxial cables to meet your specific applications.

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Please rush FREE literature on:

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- Data Transmission Cables
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- For Info. Only Have Rep. Call



CIRCLE 182 ON READER-SERVICE CARD

MICROWAVE PRODUCTS

Waveguide Rotary Joints

467

Range is 8.5 to 9.6 kmc



Two I-style waveguide rotary joints, having an 8.5- to 9.6-kmc range, are available in WR90 and WR112 waveguide sizes. The units can be non-pressurized or 30-psig pressurized and can be aluminum or copper alloy types.

Microwave Development Laboratories, Inc., Dept. ED, 92 Broad St., Babson Park 57, Wellesley, Mass.

Price: \$400 to \$500.

Availability: Some units, from stock.

High Power Microwave Triode

468

Gain is 18 db at 4 Gc



Used as a narrow band cw amplifier at 4 Gc, microwave triode type DX145A/EC157 has a gain of 18 to 19 db with a power output of 0.5 w. As a broadband amplifier at 4 Gc, it has a gain of 12 db with a power output of 0.5 w. Saturation cw power output can be as high as 2.5 w. The tube is guaranteed for 6,000 hr and has an expected life of 10,000 hr. It can be used as an oscillator, a doubler or tripler. As an oscillator it will operate in the 5-Gc range, as a

doubler it provides useful output at 6 Gc. Operating voltage is 180 v.

Amperex Electronic Corp., Microwave Dept., Dept. ED, 230 Duffy Ave., Hicksville, Long Island, N.Y.

Price: \$135 ea.

Availability: From stock.

Voltage Tunable Magnetron

469

Has range of 400 to 1,200 mc

The X-747 voltage-tunable magnetron can be tuned over the range of 400 to 1,200 mc with a nominal output power of 100 mw. No complicated regulation of heater voltage is needed. Back heating is eliminated through an indirectly heated matrix cathode and through advanced electron injection design. Heater power supply can be ac or dc. The linear tuning characteristics simplify circuit design.

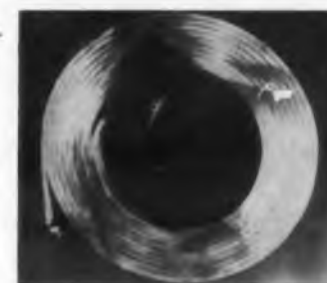
Eitel-McCullough, Inc., Microwave Tube Div., Dept ED, San Carlos, Calif.

Availability: Immediate.

X-Band Delay Line

470

Reduced 50% in size



This X-band delay line, reduced 50% in physical size over conventional lines, meets the demand for compact and lightweight test equipment packaging. The delay line can be supplied as an individual unit or as a packaged assembly in fixed or variable lengths. Bends, interconnections and adapters are available as separate items.

Turbo Machine Co., Dept. ED, Lansdale, Pa.

Price: From \$125 ea.

Availability: 45 to 60 days.

Amplifier Klystron Delivers

20 Kw

471

Of X-band cw power

Series VA849 amplifier klystrons are rated at 20 kw cw. They cover a frequency range of 7.125 to 8.5 Gc and are tunable over a 60-mc range. Powergain is 37-db; bandwidth is 30 mc min.

The synchronously-tuned power gain and bandwidth are 53 db and 15 mc, respectively. The electromagnetically focused tubes were designed for applications requiring low am and fm residual noise. Applications include repeater satellites, moon-bounce signalling, radio astronomy and reflections from clouds of tiny orbiting needles, plus cw radar and illuminator service.

Varian Associates, Tube Div., Dept ED, 611 Hansen Way, Palo Alto, Calif.

Price: On request.

Availability: 120 days.

Mixer-Preamplifier

472

For microwave and guidance systems



Designed for use at 9.6 to 10.7 kmc, model 90MB-361F1 mixer-preamplifier serves as a low-noise, wide-band down-converter for maser and parametric rf amplifiers. Noise figure is less than 9.5 db and minimum gain is 25 db. The unit is fixed-tuned with a stabilizing circuit that eliminates the need for realignment after replacement of tubes or crystals. The preamp output is matched to 50 ohms.

Microwave Development Laboratories, Inc., Dept. ED, 92 Broad St., Babson Park 57, Wellesley, Mass.

Coaxial Transmission Sections

473

Peak pulse is 3 megawatt



These 3-1/8-in. coaxial sections are capable of 3-megawatt peak pulse power. They are flexible sections able to meet the vibration requirements of MIL-E-5422. Special flanges to reduce rf leakage are used.

Telerad Manufacturing Corp., Dept. ED, 1440 Broadway, New York 18, N.Y.

POWER WIRE WOUND RESISTORS

if it's news, expect it first from IRC

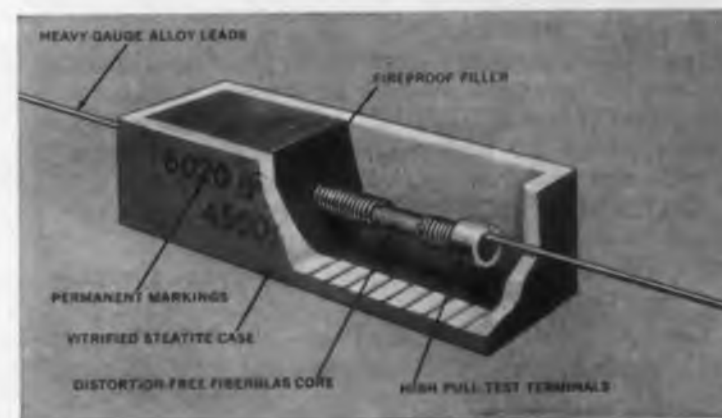


Transistor circuits and low power applications need this safety feature!

IRC PW Resistors are available with special resistance windings, designed to act as a standard resistor at normal operating wattages and fuse at some specific overload condition. Thus they provide an ideal solution—resistor and fuse in one unit—a great advantage in circuits which tend to short or where overloading of a component creates a fire hazard.

These double-duty resistors come in six sizes—3, 5, 7, 10, 15 and 20 watts. And, no derating is required even at high ranges.

For additional information on IRC Power Wire Wound Resistors, write for Bulletin P-2, International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.



Leading supplier to manufacturers of electronic equipment

CIRCLE 169 ON READER-SERVICE CARD

OTHER FUSE POSTS
MAY LOOK LIKE THESE...
BUT ONLY LITTELFUSE HAS **PIQ***

A Fuse Post to meet every application—every requirement



EXTRACTING FUSE POST! Fuse is held in end of removable knob for quick, safe and easy replacement of blown fuse. Safe "dead front" fuse mountings assured. U/L Approved.

A—3AG Fuse Post (finger operated knob)—No. 342001

A—8AG Fuse Post (finger operated knob)—No. 372001

B—3AG Fuse Post (Screwdriver Slot)—No. 341001

B—8AG Fuse Post (Screwdriver Slot)—No. 371001

C—4AG Fuse Post (Finger Operated Knob)—No. 442001

D—3AG Miniature Fuse Post (Finger Operated)—No. 342012

E—NEW INDICATING 3AG FUSE POSTS! (344,000 series) It Glows When The Fuse Blows. Long life incandescent bulb for low voltage ranges—2½-7V; 7-16V; 16-32V. New high degree vacuum neon lamp for high voltage ranges for greater brilliance and visibility—90-125V; 200-250V.

WATERTIGHT FUSE POSTS Specially designed for use where excessive moisture is a problem.

F—5AG Watertight Fuse Post. Has flange mounting.—No. 571004.

G—3AG Watertight Fuse Post—No. 342006

G—4AG Watertight Fuse Post—No. 442006

For complete details on these items and quotations on special application requirements, write to:

Precision Engineering
Design Know-how
Quality Craftmanship

LITTELFUSE
DES PLAINES, ILLINOIS

CIRCLE 171 ON READER-SERVICE CARD

MICROWAVE PRODUCTS

Coaxial Switches 363

Are spdt type



Designed for insertion into a miniature circuit, these switches measure 1.3 x 0.6 x 0.65 in. Weight is 1.25 oz. At 2 kmc, vswr is 1.25, insertion loss is 0.8 db, and crosstalk is down to 60 db. Contact rating is 1 amp at 150 v resistive. Characteristic impedance is 50 ohms and minimum operating life is 50,000 operations.

Microdot, Inc., Dept. ED, 220 Pasadena Ave., South Pasadena, Calif.

Rotation Circulators 673

Have a vswr of 1.3 max



These four-port rotation circulators have a vswr of 1.3 max on all ports and produce 15-db isolation. Insertion loss is 0.4 db max. These models are offered: CK 100, for 22.5 to 25 kmc; CKU 100, for 13 to 14.5 kmc; CX 100, for 8.5 to 9.8 kmc; CXL 140, for 7.4 to 8.4 kmc; and CXB 140, for 5.4 to 5.9 kmc.

Rantec Corp., Dept. ED, Calabasas, Calif.

Low-Pass Filters 380

Coaxial type



These filters are compact in design and stand shock and vibration. They are bi-directional and furnish broad stop-band response. Specifications are: insertion loss, 0.5 db max; vswr, 1.5 max;

rejection slope, 12 db min at 1-1/4 times center frequency; spurious responses, 30 db min; and power handling capacity, 15 to 50 w, cw. Cutoff frequencies are 125 to 4,000 mc.

Maury & Associates, Dept. ED, 10373 Mills Ave., Pomona, Calif.

Price: \$35 to \$52.50 in quantities of 10.

Availability: Two to five weeks delivery.

K-Band Microwave-Mixer Assembly 735

Minimum frequency range is 34 to 36 kmc



Model MMK-2 microwave-mixer amplifier has a minimum frequency range of 34 to 36 kmc. The unit combines a K-band waveguide mixer and a matched preamplifier. Specifications include: over-all gain, 25 db; if bandwidth, 8 mc; noise figure, 10 db max; power requirements, 150 v dc at 45 ma and 6.3 v at 0.6 amp.

LEL, Inc., Dept. ED, Akron St., Copiague, N.Y.

Price: \$1,695 ea.

Availability: 30 to 60 days.

Coaxial Isolators 435

For L- and S-bands



These coaxial isolators both have a maximum vswr of 1.25. Model IcLM3 operates from 1,250 to 1,600 mc. Designed to handle a peak power of 5 kw or 25 w avg, it has a minimum isolation of 20 db and an insertion loss of 1 db max. Model IcSM2, covering 2,000 to 4,000 mc, handles 5 kw peak and 5 w avg. Isolation is 30-db max and 20-db min. Insertion loss is 2 db with 1 db possible over a narrow band.

Raytheon Co., Special Microwave Devices Operations, Dept. ED, 130 Second Ave., Waltham 54, Mass.

Price: IcSM2, \$350; IcLM3, \$450.

Availability: Five weeks.

Field Intensity Meter And Receiver

657

Operates in 1,000 to 10,000 mc range



Operating in the frequency range between 1,000 and 10,000 mc, model FIM microwave calibrated field intensity meter and receiver is a combination triple conversion microwave superheterodyne receiver and calibrated signal generator. It indicates the absolute power level of a radiated or conducted input signal by comparing it against a signal generated internally by the signal calibrator. The signal indication is in microvolts, db above 1 μ v and db above 1 μ v per mc. All input signals can be attenuated up to 80 db in 1 db steps.

Polarad Electronics Corp., Dept. ED, 43-20 34th St., Long Island City 1, N.Y.

Coaxial Wavemeters

634

Frequency range is from 2,300 to 8,200 mc



These coaxial wavemeters cover the frequency range of 2,300 to 8,200 mc. The transmission-type units come in eight models: model 951, 951CR, 952, 952CR, 953, 953CR, 954 and 954CR. They have 2-in. micrometers, directly readable to 0.0001 in., calibrated every 50 mc. The crystal-output models, suffixed with CR, are adjusted to give a 20- μ amp min dc output with 1 mw input power. Accuracy is 0.02%; loaded Q is 1,000 to 4,000. Model 950 crystal current-indicator is a 50- μ amp, 3-in.-sq meter for use with the wavemeters.

Waveline, Inc., Dept. ED, Caldwell, N.J.

Price: On request.

Availability: Made on order.

MORE MORE MORE MILITARY TYPES

...and still more* are coming!

Whatever your requirements for military types of semiconductors, you'll find a big selection at Raytheon. Silicon transistors... germanium transistors... gold bonded or point contact diodes... diffused junction silicon rectifiers - Raytheon gives you a choice of types to give you utmost latitude in circuit design and component procurement. To bring your files up to date on this growing Raytheon group, ask for Data-Pak #11.

Consult your local authorized Raytheon Distributors for up to date information on all Raytheon semiconductor products.

FOR YOUR CRITICAL APPLICATIONS CHECK THIS GROWING FAMILY OF MILITARY TYPES:

Service	Type	Specification	Service	Type	Specification	Service	Type	Specification
PNP Silicon Transistors			Germanium Point Contact Diodes			Silicon Diffused Junction Rectifiers		
SIGC	2N328A	MIL-S-19500/110 Amend. 1	NAVY	2N422	MIL-T-19500/66A	JAN	1N253	MIL-E-1/1024A
SIGC	2N329A	MIL-S-19500/111 Amend. 1	SIGC	2N425	MIL-T-19500/41A	JAN	1N254	MIL-E-1/989B
Germanium Gold Bonded Diodes			SIGC	2N426	MIL-T-19500/42A	JAN	1N255	MIL-E-1/990B
JAN	1N270	MIL-E-1/992A	SIGC	2N427	MIL-T-19500/43A	JAN	1N256	MIL-E-1/991B
JAN	1N276	MIL-E-1/1025	SIGC	2N428	MIL-T-19500/44A	JAN	1N538	MIL-E-1/1084A
JAN	1N277	MIL-E-1/993A	SIGC	2N464	MIL-T-19500/49B	JAN	1N540	MIL-E-1/1085A
JAN	1N281	MIL-E-1/961	SIGC	2N465	MIL-T-19500/50A	JAN	1N547	MIL-E-1/1083A
PNP Germanium Transistors			SIGC	2N466	MIL-T-19500/51A	Silicon Diffused Junction Diodes		
USAF	2N404	MIL-T-19500/20	SIGC	2N467	MIL-T-19500/52B	USAF	1N645	MIL-E-1/1143
SIGC	2N416	MIL-T-19500/56A	Germanium Point Contact Diodes			USAF	1N646	MIL-E-1/1143
SIGC	2N417	MIL-T-19500/57A	JAN	1N26A	MIL-E-1/156C	USAF	1N647	MIL-E-1/1143
			JAN	1N127A	MIL-E-1/157C	USAF	1N648	MIL-E-1/1143
			JAN	1N128	MIL-E-1/158B	USAF	1N649	MIL-E-1/1143
			JAN	1N198	MIL-E-1/700			

* LATEST ADDITIONS

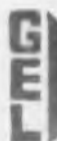
Service	Type	Specification
Silicon Diffused Junction Rectifiers		
NAVY	1N1124A	MIL-S-19500/104
NAVY	1N1126A	MIL-S-19500/104
NAVY	1N1128A	MIL-S-19500/104
PNP Germanium Transistor		
JAN	1N2466	MIL-S-19500/51B

RAYTHEON COMPANY SEMICONDUCTOR DIVISION

RAYTHEON

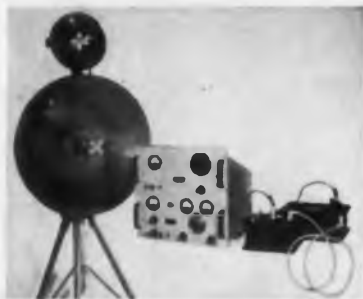
SILICON AND GERMANIUM DIODES AND TRANSISTORS • SILICON RECTIFIERS • CIRCUIT-PAKS
 ENGLEWOOD CLIFFS, N. J., Lowell 7-4911 (Manhattan, Wisconsin 7-6400) • BOSTON, MASS., Hillcrest 4-6700 • CHICAGO, ILL., National 5-4000 • LOS ANGELES, CAL., Plymouth 7-9181
 ORLANDO, FLA., Garden 3-0618 • SYRACUSE, N. Y., Howard 3-9141 • PHILADELPHIA, PA., (Haddonfield, N. J.), Hazel 8-1272 • BALTIMORE, MD., Southfield 1-0480
 CLEVELAND, OHIO, Winton 1-7716 • DAYTON, OHIO, Baldwin 3-8128 • DETROIT, MICH., Trinity 3-8830 • SAN FRANCISCO, CAL., (Redwood City), Emerson 9-5066
 CANADA: Waterloo, Ont., Sherwood 5-8831 • GOVERNMENT RELATIONS: Washington, D. C., Metropolitan 8-5206

CIRCLE 172 ON READER-SERVICE CARD



COMPLETE MICROWAVE TELEMETRY SYSTEMS

TRANSMITTERS, RECEIVERS, DISPLAYS, ANTENNAS



MICROWAVE TRANSMITTER GROUP, 2150-2350 mc

The GEL Telemetry Transmitter Group 19A1 features improved frequency stability ($\pm 0.005\%$ under all environmental conditions); true frequency modulation which can operate with FM-FM or PCM data input in accordance with IRIG specifications in addition to voice modulation where required; and operation under severe environmental conditions.

The Transmitter Group consists of 3 components: Basic 4-Watt Transmitter, Power Supply, and 15-Watt Power Amplifier. Installation in airborne vehicles where space is limited mounts these conduction-cooled units on an aluminum plate which in turn is mounted with good thermal contact to the airframe which acts as a heat sink.

FEATURES

- **Frequency Stability:** $\pm 0.005\%$ (all environmental conditions)
- **Modulation:** Operates with FM-FM, FM/PDM FM, PCM
- **Max. Deviation:** ± 0.5 mc
- **Distortion:** Total output distortion not to exceed 1.0%
- **Primary Power:** Either 28 VDC or 110 V, 400 cycles
- **Environmental:** Pressurized for operation up to 80,000 ft.

Operating temperature: -54°C to $+85^{\circ}\text{C}$
 Operation through shock of 100g for 11 milliseconds
 Vibration: 10-500 cps, 10g
 500-2000 cps, 15g

FREQUENCY DISPLAY UNIT, SERIES 24

Companion units to GEL Receivers, Types 20A1, 22A1, and 25A1, Series 24 Frequency Display Units feature good resolution.



equalization for IF non-linearity ± 3 db, low spurious radiation, edge-lighted scale, and 60 db image rejection. A signal as low as 8 microvolts at the input of the receiver gives full-scale deflection.

Sweep width, center frequency, and gain controls are located below the 3" Cathode Ray Tube. All normally used CRT Controls are front-of-panel screwdriver adjustments protected by an easily removed cover.

FEATURES

- 20 kc Resolution
- Equalization to ± 3 db
- Low Spurious Radiation
- Edge-lighted Scale
- High Sensitivity
- 60 db Image Rejection

GEL Also Designs and Manufactures a Complete Line of Telemetry Equipment in the VHF Band.



MICROWAVE RECEIVERS, 2150 - 2350 mc

GEL Telemetry Receiver Type 20A1 can be used for reception of FM-FM, PDM-FM, and PCM transmissions at ground installations or in airborne applications.

Operation has been simplified as far as possible; number of operating controls is minimum, compatible with optimum performance. The unit is of the double superheterodyne type with both local oscillators crystal-controlled. Design includes FM capture characteristics, high frequency stability, and variable IF bandwidths. Sub-assembly construction is used for simplicity of servicing in the field. AGC extends dynamic range to 100,000 microvolts or 0.1v of RF signal.

This Receiver provides simultaneous AM and FM video, pre-detection 10 mc IF frequency, signal level recorder, and 60 mc IF for operation of a GEL Type 24A1 Frequency Display Unit.

FEATURES

- **Frequency Stability:** $\pm 0.005\%$ of received frequency using standard MIL CR-33/U crystal without oven
- **Image Rejection:** Greater than 65 db
- **IF Bandwidth:** Plug-in second IF strips with bandwidths of 0.75, 1.5, and 2.0 mc
- **Selectivity:** Response has 60 to 6 db bandwidth of approx. 2.5
- **Interference Immunity:** Highly selective pre-selector for attenuation of interfering signals

MICROWAVE ANTENNAS

The unique GEL Antenna, Model 610-20, is a dual-beamwidth, circularly-polarized receiving antenna with an operating frequency range of 1000 to 2600 mc. This manually operated Antenna consists of two center-fed parabolic reflectors tripod-mounted facing the same direction on a vertical line, with the wide beam reflector above. Both reflectors may be directed simultaneously to any azimuth angle. Tilt adjustment allows elevation angles up to 45 degrees above the horizon. Each reflector is fed by broadband circularly-polarized crossed dipoles. Output of each feed is brought out separately to a 50-ohm Type C female conductor so that either can be connected to an appropriate receiver.



Write for Technical Data Sheets on Compatible GEL Microwave Telemetry Equipment.

MICROWAVE PRODUCTS

Microwave Relay Link

726

Range is 10,500 to 13,200 mc



Model 420A portable link and model 420AR rack-mounted version have a baseband width of 5 mc, a power output of 0.1 w and operate in the 10,500 to 13,200 mc range. They can transmit computer data, remote control functions and telemetering information. The transmitter and receiver are self-contained in individual units weighing 31 and 32 lb, respectively. Power consumption of the transmitter is 70 w; for the receiver it is 160 w. The 5-mc bandwidth is flat within 0.5 db.

Mechanical Products, Inc., Electronic Systems Div., Dept. ED, 1438 River St., Jackson, Mich.
 Price: \$4,490.

Thin-Film Resistors

641

For microwave applications



These thin-film carbon resistors are designed for use in microwave attenuators, coaxial terminations and other special applications. Specifications are: frequency, dc to 10,000 mc; disc-type resistance, 0.001 ohms to 1,500 ohms; temperature, -55 to $+150$ C; tolerance, $+1\%$ standard. The manufacturer claims these resistors give superior performance under pulse applications.

Film Resistors, Inc., Dept. ED, 242 Ridgedale Ave., Morristown, N.J.

Broadband Terminations

610

For the range of 8.2 to 12.4 kmc

Designed for a waveguide measuring 0.9 x 0.2 in., this absorbing load has a vswr of less than 1.03:1 from 8.2 to 12.4 kmc. Maximum power dis-

ADDRESS ALL INQUIRIES TO:
 General Electronic Labs, Inc.
 8521 Second Avenue
 Silver Spring, Maryland



GENERAL ELECTRONIC
LABORATORIES, INC.
 CAMBRIDGE 42, MASS. SILVER SPRING, MD.

CIRCLE 170 ON READER-SERVICE CARD

726 sipation is 1 w avg, making the unit suitable for most low-power design measurements and production testing. It measures 6-in. long and is of aluminum construction. Flanging consists of a centered UG-68/U configuration.

Turbo Machine Co., Dept. ED, Lansdale, Pa.
Price: \$60.

Availability: From stock.

UHF Noise Source

445

Has noise output of 18.0 db at 190 v



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Coaxial-type uhf noise source, model T44U4C, covers a frequency range of 0.55 to 0.65 kmc and has a noise output of 18.0 db at an operating voltage of 190 v. It has a striking voltage of 1500 v. The circuit length of the tube is 10-5/16 in. overall. It is capable of operation under typical military environment conditions.

Tucor, Inc., Dept. ED, 18 Marshall St., S. Norwalk, Conn.

Precision Waveguide Gages

694

For checking outer dimensions of waveguides

641 Series O.D. precision waveguide gages are for checking the outer dimensions of waveguides to MIL-W-85C and EIA standards. The range of waveguides covered is from WR-975 (0.75 to 1.12 kmc) to WR-15 (75 to 110 kmc). The gages are precision-ground to a tolerance of 0.0002 in. All 22 units have go, no-go configuration.

Somerset Radiation Laboratory, Inc., Dept. ED, 192 Central Ave., Stirling, N.J.

Price: \$95 to \$280 ea.

Availability: From stock, F.O.B. Stirling.

S-Band Parametric Amplifier

704

Has 100-mc tuning range

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Model S1000 S-band parametric amplifier has a 100-mc tuning range. Other specifications include: operating gain, 17 db; bandwidth, 20 mc at 3-db points; system noise figure, 2.5 to 3 db operating into a mixer with a 10-db noise figure. The assembly consists of a three-port ferrite circulator, a reflection-type diode amplifier, a pump klystron, a variable attenuator and a directional-coupler monitor.

Micromega Corp., Dept. ED, Venice, Calif.

Price: \$4,950 ea, engineering prototype.

Availability: 90 days.

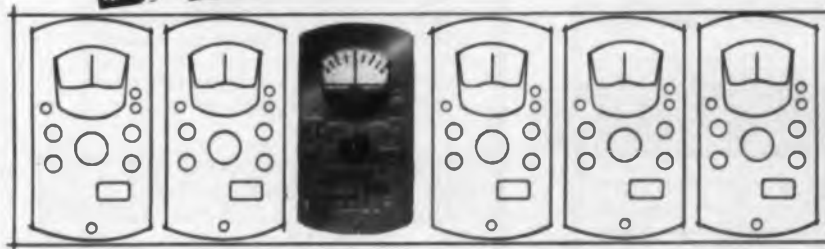
TRANSISTORIZED PHASE-LOCK FM-FM GROUND STATION:

1/6TH

THE SIZE, AND

OFF THE SHELF
IMMEDIATE DELIVERY
\$1490.

INCLUDES ALL FREQUENCY DETERMINING ELEMENTS



Low power consumption, less heat dissipation, increased reliability, low threshold. Six discriminators in 5¼" x 19" standard rack. For information write Dept. F, Vector Mfg. Co., Southampton, Pa.



CIRCLE 173 ON READER-SERVICE CARD

FXR's
FERRITE ISOLATORS



Series 157

- OPERATION: Full waveguide band-width
- RANGE: Waveguide 3.95 to 26.50 KMc Coax 2.0 to 4.0 KMc
- ISOLATION: 15 to 30 db depending upon range
- VSWR: Waveguide 1.15 max Coax 1.2 max
- INSERTION LOSS: 1db max

No. 1 of a series of FXR's new precision microwave components designed to meet the ever-growing needs of the microwave industry.

FXR's Ferrite Isolators are broadband, high performance waveguide and coaxial microwave components which provide maximum isolation and minimum insertion loss. In general these isolators are used in any application where it is desired to attenuate either the forward or reverse power flow without corresponding attenuation in the opposite direction. They are used to reduce the VSWR presented by a load and to isolate the oscillator for more stable operation.

Model No.	Frequency Range KMc	Minimum Isolation db	Peak Power	Price
M157A	3.95- 5.85	18	*2KW	\$270.00
C157A	5.85- 8.20	20	*2KW	245.00
W157A	7.05-10	24	*2KW	245.00
X157A	8.20-12.4	30	*2KW	220.00
Y157A	12.40-18	24	**1KW	245.00
K157A	18.00-26.50	24	**1KW	270.00
K157AF†				270.00
N157A	2.00- 4.00	15	**2KW	450.00

*Load VSWR 5 **Load VSWR 2
†K157AF has the same specifications as K157A, except for the flange.

Write for Catalog Sheet No. 157

FXR, Inc.

Design-Development-Manufacture
25-26 50th Street/ RA. 1-9000
Woodside, N. Y./TWX: NY 43745

CIRCLE 175 ON READER-SERVICE CARD

156

FXR's
WAVEGUIDE SWITCHES



Series 641

- OPERATION: Full waveguide band-width
- RANGE: 3.95 KMc to 40.00 KMc (in 7 sizes)
- CROSSTALK: 60 db min
- VSWR: 1.10 max
- Choice of manual or electrical drive
- High-power capacity

No. 2 of a series of FXR's new precision microwave components designed to meet the ever-growing needs of the microwave industry.

FXR's Waveguide Switches find applications on the test bench and in microwave systems. Operating over the full waveguide frequency ranges, these switches provide trouble-free operation with high isolation and high-power capacity. The milled aluminum waveguide rotor assures low VSWR. For long life it is mounted on ball bearings and is electrically connected to the stator through non-contacting choke sections.

MODEL NO.	FREQUENCY RANGE KMc	WAVEGUIDE TYPE Wg-()/U	*PRICE (MANUAL)
H641A	3.95- 5.85	49	\$350.00
C641A	5.85- 8.20	50	300.00
W641A	7.05-10.00	51	265.00
X641A	8.20-12.40	52	225.00
Y641A	12.40-18.00	91	250.00
K641A, AF	18.00-26.50	53	275.00
U641A, AF	26.50-40.00	96	300.00

*Slightly higher for electrically driven units.

Write for Catalog Sheet No. 641

FXR, Inc.

Design-Development-Manufacture
25-26 50th Street/ RA. 1-9000
Woodside, N. Y./TWX: NY 43745

CIRCLE 176 ON READER-SERVICE CARD

MICROWAVE PRODUCTS

L-Band Antennas

446

Flush-mounted and blade-types



Two L-band antennas, the AT-740/A flush-mounted and the AT-741/A blade, cover the 960- to 1220-mc frequency for IFF-TACAN. They have a vswr less than 1.5 to 1 from 1,000 to 1,100 mc. Each has a nominal impedance of 50 ohms and is vertically polarized. The BNC probe of each is approximately 18 db down. The blade type weighs 6.4 oz while the flush-mounted type weighs 12 oz. Both have HN connectors.

Transco Products, Inc., Dept. ED, 11210 Nebraska Ave., Los Angeles, Calif.

Waveguide Terminations

450

For rf power measurements



These waveguide terminations cover frequency ranges of 5.8 to 8.2 kmc (model 187B-C) and 7.0 to 10.0 kmc (model 1878-XB). Unpressurized, model 187B-C can be operated at average powers to 5 kw or peak powers to 500 kw. Model 187-XB is rated at 3 kw average power or 300 kw peak power. Both models can be pressurized to 45 psig to permit operation at higher power levels. The loads utilize a rigid, plastic-water tube mounted in a waveguide section and diagonally oriented for impedance matching.

Philco Corp., Sierra Electronic Corp. Div., Dept. ED, Menlo Park, Calif.

C-Band Triode Oscillator

749

Weights 4-1/2 oz



Model 151C C-band triode oscillator weighs 4-1/2 oz. The miniature unit covers the fre-

FXR's **BROADBAND FIXED COAXIAL ATTENUATORS**



Series 180

- FREQUENCY RANGE: 0.6 KMc to 12.4 KMc
- ATTENUATION VALUES: 3, 6, 10, 20 db
- CONNECTORS: Type N - male one end, female the opposite end

No. 3 of a series of FXR's new precision microwave components designed to meet the ever-growing needs of the microwave industry.

FXR's Broadband Fixed Coaxial Attenuators are extremely useful and completely dependable in applications requiring isolation between RF components and extending power meter ranges. They may also be used for the calibration of directional couplers, in obtaining antenna characteristics and for similar applications. These attenuators have exceptional stability and are capable of withstanding appreciable overloads and peak power with no change in characteristics. They have high shock and vibration resistance and exhibit a negligible change of attenuation under humidity and temperature cycling.

Model No.	Frequency KMc	Max. VSWR	Frequency Sensitivity db	Price
N180A	.6-11.0	1.3	(- .3) (+ .5)	\$42.00
N180B	1.0-11.0	1.3	(- .6) (+ .7)	42.00
N180C	1.0- 2.0 2.0-11.0	1.35 1.30	(-1.2) (+1.3)	42.00
N180D	2.0- 3.0 3.0-11.0 11.0-12.4	1.35 1.30 1.40	(-1.3) (+1.9)	42.00

Write for Catalog Sheet No. 180

FXR, Inc.

Design-Development-Manufacture
25-26 50th Street/ RA. 1-9000
Woodside, N. Y./TWX: NY 43745

CIRCLE 177 ON READER-SERVICE CARD

FXR's COAXIAL BROADBAND BI-DIRECTIONAL COUPLERS



Model No. N616D

- OPERATION: Full two octave frequency range
- FREQUENCY RANGE: Model 616 — 0.25 KMc to 1.0 KMc
Model 617 — 1.0 KMc to 4.0 KMc
- COUPLING: 20 ± 2 db including frequency sensitivity
- DIRECTIVITY: 20 db min
- Individual calibration curves attached

No. 4 of a series of FXR's new precision microwave components designed to meet the ever-growing needs of the microwave industry.

FXR's Coaxial Broadband Bi-Directional Couplers are versatile components with high directivity and uniform coupling over a range of two octaves. These couplers can be employed in reflectometer setups, to monitor power and frequency or as a standard of attenuation. The built-in loads on the line can absorb 1 watt of CW power which makes the couplers ideal for the injection of large values of local oscillator power into a mixer circuit.

The main line VSWR is less than 1.2 and the auxiliary arm VSWR is less than 1.25 including the termination.

MODEL NO.	FREQUENCY RANGE KMc	CONNECTOR TYPE	PRICE
N616D	0.250-1	N Jack	\$160.00
N617D	1-4.0	UG-23C/U equivalent	150.00

Calibration curves for the incident and reflected couplers are attached to each instrument.

Write for Catalog Sheet No. 616

FXR, Inc.

Design-Development-Manufacture
25-26 50th Street RA. 1-9000
Woodside, N. Y./TWX: NY 43745

quency range from 4,200 to 6,000 mc in 50-mc min. steps. Temperature stability is ±10 kc per deg C. The unit requires a plate voltage of 200-v nominal and 6.3 v for filaments. It is for use as a local oscillator, cw signal source and driver for crystal harmonic generators.

John Gombos Co., Inc., Dept. ED, Webro Road, Clifton, N.J.

Price: On request.

Availability: 30 days.

Tee Circulator Switch

674

For the band of 10 to 10.5 kmc



These tee circulator switches are for use in the frequency range of 10 to 10.5 kmc. An isolation of 20 db between channels is obtained and insertion loss is less than 0.4 db. Special tuning can be used to peak the isolation at any frequency in the bank. Switching is accomplished in 300 μsec when 2 v is applied to the actuating coil.

Rantec Corp., Dept. ED, Calabasas, Calif.

Microwave Reflex Oscillator

356

Eliminates RF grids



The SRX-265 oscillator eliminates rf grids. Efficiencies of 3% to 4% have been obtained at the X-band. Electrons must pass through one ungridded aperture in this unit. Output at X-band is 1 w.

Sperry Rand Corp., Electronic Tube Div., Dept. ED, Gainesville, Fla.

Price: On request.

Availability: On request.

FXR, Inc.

Design-Development-Manufacture
25-26 50th Street RA. 1-9000
Woodside, N. Y./TWX: NY 43745

FXR's STANDARD STEP ATTENUATORS



Series 176

- OPERATION: Full waveguide bandwidth
- FREQUENCY RANGE:
7.05 KMc to 10 KMc
8.2 KMc to 12.4 KMc
- STEP LOSS: 40 db
- CALIBRATION & FREQUENCY SENSITIVITY: ±0.4 db max
- VSWR: 1.1 max
- INSERTION LOSS: 0.5 db max

No. 5 of a series of FXR's new precision microwave components designed to meet the ever-growing needs of the microwave industry.

FXR's Standard Step Attenuator differs uniquely from other standard step attenuators in that the attenuation in a waveguide line can be changed without removing any component in the line. This convenient feature adds significantly to measurement accuracy. The attenuation is determined by the size of coupling holes and not by the resistivity of a loss-producing element. The attenuation value is, therefore, independent of time and ambient conditions and is relatively constant with frequency.

MODEL NO.	FREQUENCY RANGE KMc	WAVEGUIDE TYPE RG-()/U	PRICE
W176A	7.05-10.0	51	\$185.00
X176A	8.2-12.4	52	165.00

Write for Catalog Sheet No. 176

FXR, Inc.

Design-Development-Manufacture
25-26 50th Street RA. 1-9000
Woodside, N. Y./TWX: NY 43745

CIRCLE 179 ON READER-SERVICE CARD

FXR's FIXED PRECISION ATTENUATORS



Series 175

- OPERATION: Full waveguide bandwidth
- WAVEGUIDE RANGE: 2.6 KMc to 90.00 KMc
- Values factory set between 0.3 and 30.00 db
- Absolute accuracy (including frequency sensitivity)
±0.3 db for values to 20 db
±0.5 db for values 20 to 30 db
- VSWR: 1.15 max

No. 6 of a series of FXR's new precision microwave components designed to meet the ever-growing needs of the microwave industry.

FXR's Fixed Precision Attenuators find use in standardizing the testing of attenuators, directional couplers and similar instruments in the laboratory or on the production line. Attenuation values are almost completely determined by the angular position of an attenuation film in a cylindrical waveguide and are insensitive to frequency or the characteristics of this absorbing film.

MODEL NO.	FREQUENCY RANGE KMc	WAVEGUIDE TYPE RG-()/U	PRICE
S175A	2.60-3.95	48	\$365.00
H175A	3.95-5.85	49	240.00
C175A	5.85-8.20	50	135.00
W175A	7.05-10.00	51	115.00
X175A	8.20-12.40	52	95.00
V175A	12.40-18.00	91	115.00
K175A, AF	18.00-26.50	53	240.00
U175A, AF	26.50-40.00	98	250.00
Q175A	33.00-50.00	97	475.00
M175A	50.00-75.00	98	425.00
E175A	60.00-90.00	99	675.00

Write for Catalog Sheet No. 175

FXR, Inc.

Design-Development-Manufacture
25-26 50th Street RA. 1-9000
Woodside, N. Y./TWX: NY 43745

CIRCLE 180 ON READER-SERVICE CARD



MANUFACTURERS OF:
Microwave Products, Educational,
Medical, Laboratory Instruments

For precise quantitative analysis of:

- Dielectric properties of solids and liquids
- Ferromagnetic effects
- Paramagnetic relaxation and resonance effects
- Absorption spectra of gases
- Molecular beam resonance
- Superconductivity phenomena
- Microwave accelerated particles
- Radiometry
- Velocity and phase by interferometry
- Transmission and absorption spectrometry
- Plasma diagnostics



CIRCLE 821 ON
READER-SERVICE CARD

NEW FERRITE-LOADED CRYSTAL MULTIPLIER

You have long wanted more power at Ultra-microwave[®] frequencies. These ferrite-loaded harmonic generators deliver 10 db more power at the second harmonic.

Units are available with outputs to 200 KMC/sec.

UNIQUE FERRITE ISOLATORS



We use a special ferromagnetic compound in these units. Result: improved unidirectivity.

Typical Specifications

Frequency range: full waveguide bandwidth
Insertion loss: 1.0 db max.
Isolation: 30 db min.
VSWR: 1.15 max.
Overall length: 5 7/8"

CIRCLE 822 ON READER-SERVICE CARD

CLICHE' DEPT.

We not only claim "the most complete line"—we have it!

DE MORNAY

STUB TUNERS

—the finest money can buy, offering precise resettability . . . micrometer depth control . . . VSWR as high as 20/1, as low as 1.02 . . . micrometer readout to .0001".

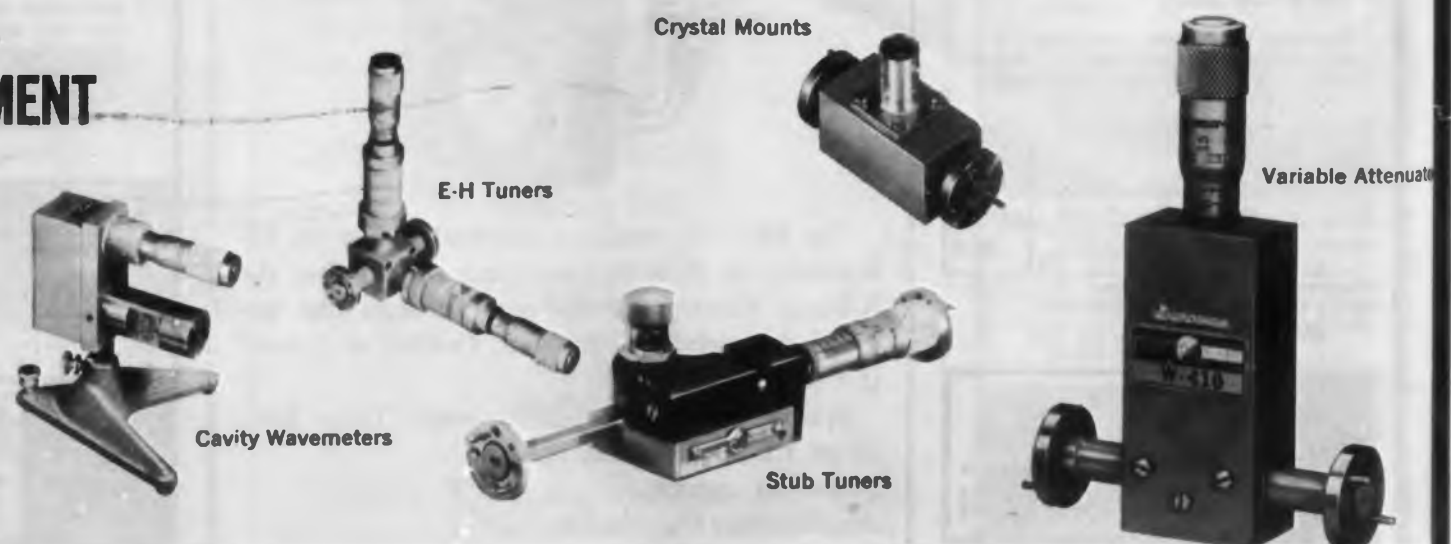


CIRCLE 823 ON READER-SERVICE CARD

ULTRAMICROWAVE[®] EQUIPMENT

This line—the most widely used in America today—has opened new horizons in microwave applications. If you are interested in higher and higher frequencies, get in touch with us—we're now working with frequencies up to 300 KMC/sec.

CIRCLE 824 ON READER-SERVICE CARD



WHAT IS THE FREQUENCY STANDARD FOR THE U.S.A.?

ANSWER: By act of congress, the U.S. Bureau of Standards determines the primary standard, based on the revolution of the earth. Our unique design, methods, and environmentally controlled calibration procedures enable us to deliver production cavity wavemeters calibrated to an accuracy of 1×10^4 . Transfer of frequency calibration from U.S. Bureau of Standards data is accomplished well within the limits defined.

Exclusive features:

- Hermetically sealed
- Temp. comp. 10^{-5} fMc/°C, -30 to +70°C
- Covers full waveguide bandwidth
- High Q values
- .0001 micrometer resolution

CIRCLE 825 ON READER-SERVICE CARD

A CHALLENGE TO YOU!

Buy any one of our 1500 stock items. Try it. If it doesn't meet our specifications, the person who verifies this and notifies us will receive a reward of \$50.00.

This offer holds good for orders placed until the end of the month following publication of this issue.

BONARDI

OLD! OLD! OLD!

—yes, we're proud to have the oldest name in the business.

AWARD of MERIT

THIS ANNUAL AWARD IS MADE IN RECOGNITION OF OUTSTANDING ACHIEVEMENT IN INDUSTRIAL DESIGN

To DeMORNAY-BONARDI
For PRECISION STANDING WAVE DETECTOR

Credits to Individuals
RICHARD DeMORNAY, Director of Engineering



Chairman, Board of Directors

Walter Peterson

Senior Director

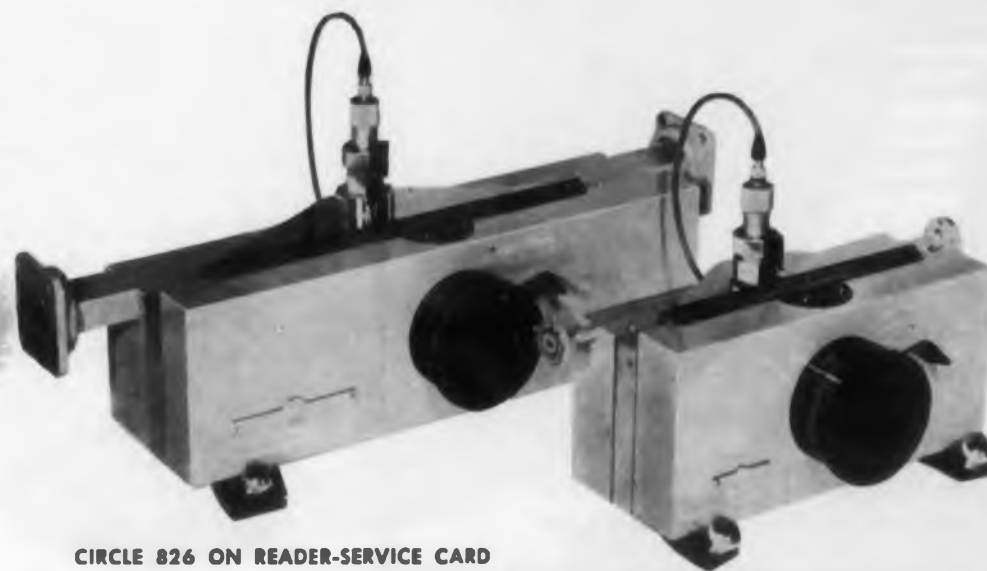
James G. Miller

Presented at Los Angeles, August, 1960

STANDING WAVE DETECTORS

Exceptionally accurate . . . patented, gearless, infinitely variable speed drive . . . linear displacement readout to .01 mm . . . direct phase readout . . . only 30 seconds to change to any of 10 other waveguide sections, with perfect alignment.

Available from 5.8 KMC to 300 KMC.



CIRCLE 826 ON READER-SERVICE CARD

CIRCLE 821-826 ON READER-SERVICE CARD

X-BAND ISOLATORS FOR BROADBAND APPLICATIONS



**HIGH-POWER X-BAND ISOLATOR IXH7
AVAILABLE FROM STOCK**

PRICE: \$175.00

TYPICAL SPECIFICATIONS X-BAND ISOLATOR MODEL IXH7

Frequency range (mc)	8,200-12,400
Isolation	
Minimum	23 db
Maximum	30 db
Insertion loss	
Minimum	0.5 db
Maximum	0.8 db
Power	
Peak	25 kw
Average	150 watts
VSWR	
Minimum	1.04
Maximum	1.17
Weight (max.)	2.5 lbs.
Max. dimension	3.75 in.
Flanges	UG 391U
Waveguide	RG 521U

COMPACT, HIGH-POWER ISOLATOR PROVIDES 20 DB OF ISOLATION OVER ENTIRE BAND FROM 8,200 TO 12,400 MC

The operating characteristics of the Model IXH7 isolator are maintained at peak power levels up to 25 kw over a 4.2 kmc bandwidth. Isolation is 20 db, minimum and insertion loss is 0.8 db, maximum.

High-power broadband capabilities coupled with unusually compact design make this isolator ideally suited for microwave test equipment applications and microwave system needs to appreciably reduce load mismatch.

To learn more about this significant development or other important Raytheon advances in microwave ferrite devices, please write, stating your particular area of interest, to the address below.



THE MOST MODERN FACILITY devoted exclusively to microwave ferrite device and materials development, testing and production.

RAYTHEON COMPANY
SPECIAL MICROWAVE DEVICE OPERATIONS
WALTHAM INDUSTRIAL PARK
WALTHAM 54, MASSACHUSETTS

*In Canada, contact Raytheon Canada, Ltd.
P. O. Box 152, Waterloo, Ontario*



EXCELLENCE IN ELECTRONICS

CIRCLE 183 ON READER-SERVICE CARD

MICROWAVE PRODUCTS

Coaxial Noise Source

731

Frequency range is 1 to 2 kmc



Model T44L1D coaxial noise source covers a frequency range of 1 to 2 kmc and has an 18.5-db noise output. This double-ended unit, 10-1/4 in. long, is for noise measurement and testing of microwave components. Nominal operating voltage is 180 v, operating current is 50 ma and striking voltage is 1,200 v.

Tucor, Inc., Dept. ED, 18 Marshall St., South Norwalk, Conn.

Price: \$250 to \$450 ea, 1 to 100.

Availability: 30 days.

High-Voltage Triode

602

Can switch 150,000 v

Type ML-7668 triode can switch 150,000 v in pulse modulators for radars and other electronic switching applications. This oil-cooled tube has dc plate and inverse voltages of 150,000 v and a peak cathode current of 6.5 amp. Dissipation of grid and plate are 50 and 750 w, respectively. At 150,000 v, the cut-off grid voltage is approximately -900 v. The tube measures 11-5/8-in. high and has a 5-1/8-in. diameter. Filament voltage is 12.6 v; filament current is about 29 amp.

The Machlett Labs., Inc., Dept. ED, 1063 Hope St., Springdale, Conn.

Price: \$1,090 OEM.

Availability: 90 to 120 days.

Bandpass Filters

606

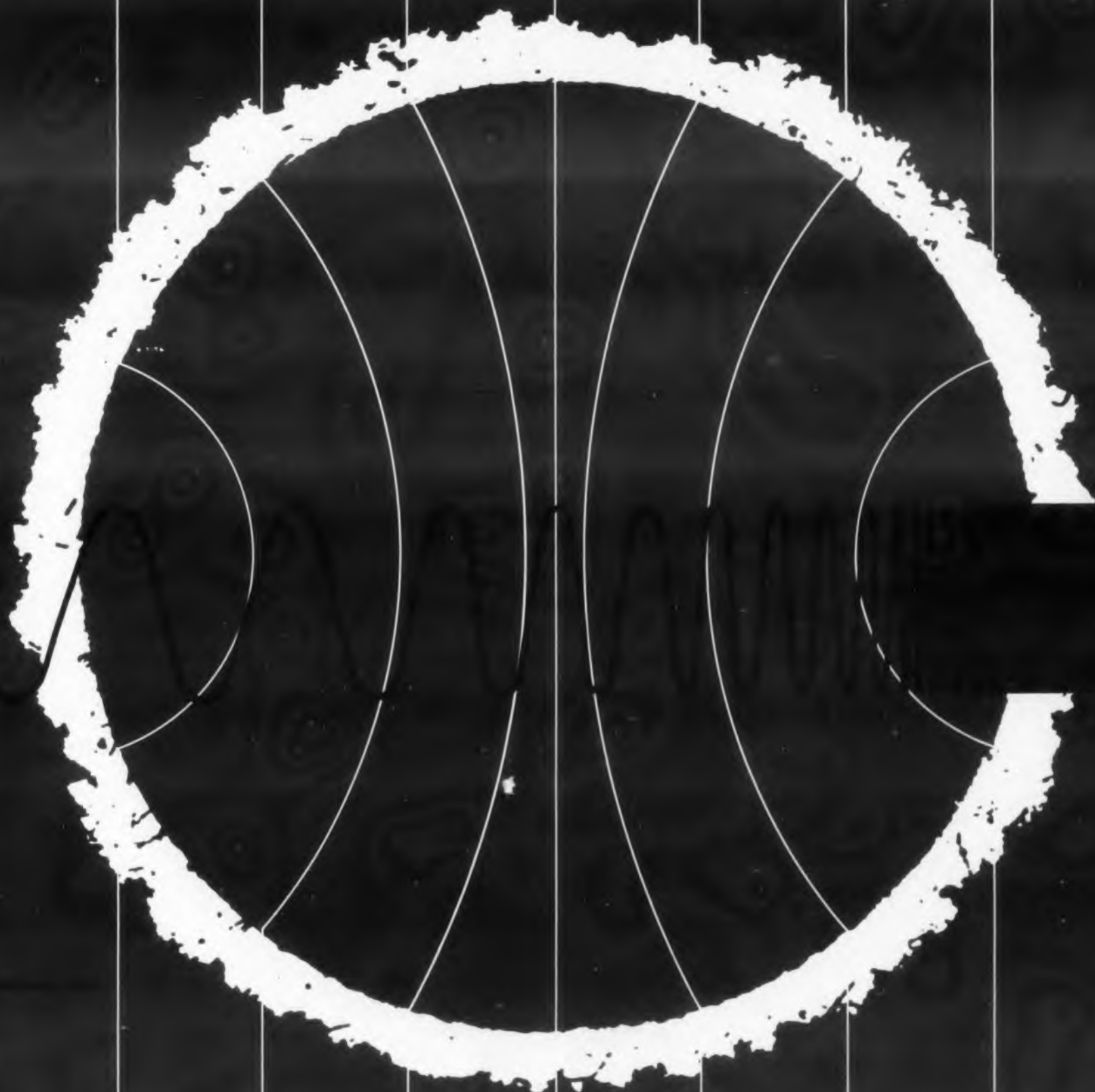
Nominal insertion loss is 2 db

The Serco BPF filters have a nominal insertion loss of 2 db in passband with peaks of 3-db max. Insertion loss is greater than 60 db from dc to center frequency. The units stand severe environmental conditions. Eight models, covering 200 to 4,000 mc, can be furnished. Type N, BNC or TNC female connectors are used.

Sigma Electronics Research Corp., Dept. ED, 15735 Ambaum Blvd., Seattle 66, Wash.

Availability: 45 days.

M I C R O W A V E S



Get the complete story on microwave tubes and components in these two new booklets from **BOMAC**



MICROWAVES

Trends In Microwaves

The potential for microwaves is rooted squarely in the basic function of technology — solving problems in the physical world by applying physical science. Microwaves have been found eminently suited to this task, partly because of the versatility of the microwave form of energy, and partly because of the ingenuity and adaptability of the engineers working on it.

This increased utilization of microwaves is reflected in industry projections. The microwave segment of the industry is expected to expand at an annual growth rate of 20 to 25 per cent over the next five years.

In this report, **ELECTRONIC DESIGN** shows how current developments are confirming the optimism of the microwave picture. To accomplish this end, the editors have chosen five articles:

A sampling of the new commercial jobs that can be accomplished by microwaves is contained in:

Microwaves Invade New Commercial Fields p 161

A survey of advanced microwave antenna designs is the subject of the second article, titled

Breakout in Microwave Antenna Design p 166

A selection of interesting and widely differing new tube designs is presented in

New Tubes for Agile, Reliable, Powerful Microwave Systems . . p 172

The variety of approaches taken by component designers in solving three pressing problems is treated in

Advanced Components Spotlighted By Microwave Spectrum Squeeze p 176

A roundup of new test equipment that speeds up the laboratory phase of microwave development is presented in

Test Equipment Developments Speed Microwave Progress p 182



What's new in microwave? You'll find full information in these 2 new BOMAC booklets. One is a complete product catalog in a new, more convenient format (tubes are listed first by band, then by type) to make it easier and quicker for you to find the tube you want. The second booklet gives you facts and figures on any of BOMAC's new components and test equipment. Put together, they give you a complete, concise picture of what's new in microwave for 1960. Be sure to send for your copies today.



BOMAC laboratories, inc.

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Offices in major cities — A subsidiary of Varian Associates.

Leaders in the design, development and manufacture of TR, ATR, Pre-TR tubes; shutters; tolerance cavities; crystal protectors; silicon diodes; magnetrons; klystrons; duplexers; pressurizing windows; noise source tubes; high frequency triode oscillators; surge protectors.

CIRCLE 184 ON READER-SERVICE CARD

Microwaves Invade New Commercial Fields

A new generation of commercial microwave systems is taking on roles unthinkable just a few years ago. In totally new fields, microwaves play an important part in taming the atom, running our industries, mapping our world, cooking our food and making the sea and sky safe for private and commercial navigators. ELECTRONIC DESIGN samples the evidence of expansion in commercial applications for this versatile form of energy.

Robert N. DeFloria
Associate Editor

THERE is no question about it—the microwave systems picture is changing radically.

It is no longer merely a matter of upgrading radar systems that handle faster aircraft and new missiles. Nor is it just a process of extending mileage for microwave telephone and television links. These advances are important, to be sure, but something more is happening, especially in commercial microwaves.

What is taking place is an invasion of problem areas never before thought susceptible to microwave solutions. More than that, we are witnessing the creation of new industrial fields and product lines impossible without microwaves. The lesson to be gained from sampling these new developments is one of design and marketing orientation.

The designer of systems, who is alive to the broadening versatility of microwaves, may experience the pleasure of finding his product in a new commercial field, temporarily free of competition. In the same way, the device designer who keeps abreast of developing new applications at the systems level, will more often than not assure an expanding market for his devices. In this sense, important parts of successful microwave design on any level are keeping abreast of developing applications, and using the imagination to create new ones.

Just what can microwaves accomplish? Here are a few recently established end-uses of considerable variety, most of them independent of military appropriations.

Duplicate The Sun's Inferno With A Cold, Fuel-Less Torch

A plasma torch (Fig. 1), just announced by Amperex Electronics, has achieved temperatures of over 3,000 C, with the sun's surface temperature (5,700 C) in prospect. One model of this new heat system uses 1 kw of S-band energy to disassociate the molecules of nitrogen and form the plasma. When the plasma recombines, the



Fig. 1. A plasma-microwave torch, capable of melting a steel rod without itself becoming warm, was recently announced by Amperex.



MICROWAVES



Fig. 2. Energy converter turns μ into thermal energy aboard Raytheon's microwave-powered helicopter.

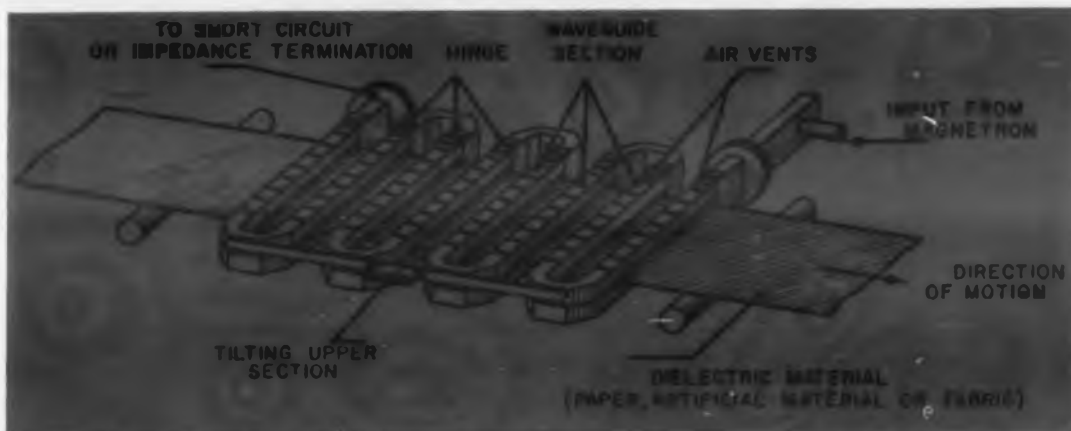


Fig. 3. Hazard-free drying of inks and dyes is accomplished by this German continuous-feed microwave industrial unit. Any dielectric material can be handled.



Fig. 4. One of the smallest and most inexpensive microwave systems, this Sperry Radar 5 is a safety boon to small-boat operators.

absorbed energy is released producing the enormous temperatures.

Since this occurs beyond the torch's nozzle, the torch remains cold to the touch and exhibits no nozzle wear. Since the nitrogen is recycled, no fuel is consumed, no oxidation occurs.

The small size, long wear, and low price (well under \$1,000 in production) opens many new fields for this microwave heat system. These in-



Fig. 5. Microwaves has moved into the vending-machine by way of this Rudd-Melikian Kwik Kooker.

clude spraying high melting-point metals and ceramics, missile reentry research, petroleum and chemical processing, welding, etching, machining and many others.

Transmit Power for Miles Without Wires

An ancient dream of wireless power transmission came a step closer to reality with the just-

announced construction of heat exchanger prototype elements by Raytheon. These units are the airborne end of the amplatron power transmission system.

Representing a thoroughly new field of application, the system is designed to power a 9-ton helicopter at 12 to 13 miles altitudes (present helicopter altitude record is about 8 miles). The system, result of studies partly WADD-funded and partly company-funded, will allow a 2,000-lb payload to remain at altitude for 3 to 6 weeks.

The present system specifications are enormous: 250 6-Gc amplitrons, rated at 300-500 hp, drive a 400-ft linear array that illuminates an elliptical cylinder. This array beams the energy to the 40 or so airborne horns with a total aperture of 50 ft. The received energy drives the 2,100 hp (approximately 1.5 megawatts) gas turbine.

The converter, shown in Fig. 2, admits microwave energy and closed-cycle air at the feet of the "A". Electromagnetic and aerothermodynamic circuits are mixed in the "A" legs. Air exits at the top of the "A" at 1620 F, to drive the gas turbine.

Efficiency is improved by heat exchange between turbine-exhaust gas (air) and unheated gas in the closed cycle, and by heating ambient open-cycle air used in rotor-tip jets. All this occurs at an altitude where atmospheric pressure is down to about 1 lb.

Over-all efficiency, from basic fuel on the ground to mechanical output in the air is about 6 per cent. When the vehicle and personnel savings are included, this is a satisfactory system efficiency.

Applications? Here are just two possibilities. A string of these platforms, mounting I-R sensors, could detect the plume of Polaris-like missiles approaching our coasts. A chain of four fixed-wing (more efficient) platforms could provide a microwave link across the Atlantic. More broadly, almost any situation in which energy is needed and cables are impractical can constitute a proper application for this system.

Dry Newsprint Rapidly Without Fire Hazard

From Germany comes a report of a microwave system that solves a stubborn problem. The problem is how to dry ink rapidly without the usual fire-hazard in case the continuous-flow feed stops. When heat is used, a fire in such a case has a high probability.

The system employs a meandering waveguide feed (Fig. 3) slotted to receive the paper (or fabric) to be dried. Microwave energy (at 2.4 Gc) couples efficiently to the dielectric ink when it is wet, but very poorly when it becomes dry. Since the wet material enters near the termination end of the run, and exits at the stronger-field source section, constant coupling is effected. Should the

MICROWAVES

work stop, the coupling drops to near zero as the ink dries.

Applications include not only the great number of high-speed printing presses, but also the many printed fabric mills.

Give A Sunday Sailor An All-Weather Eye

To design a successful system for the small-boat field, three things are prime: ease of installation, simple operation, and low cost. This Sperry Radar 5 (Fig. 4) seems to have connected on all three.

A 40-lb antenna, an indicator no larger and no more complicated than a portable TV set and a \$1,495 price tag make it an attractive system. Two scales allow the skipper to scan the area for a radius of 0.5 or 5 miles, regardless of weather. Other small-boat radars, priced under \$3,000, are manufactured by RCA, Raytheon, and LaVoie.

Is the field worth entering? So far, 4,000 stations have been licensed. A station could be one boat or a fishing fleet. This represents just a surface scratch on the vast and growing fleet in the pleasure boat field.

Run A 50-Mile Surveyor's Line In The Space of Five Min

Microwave is creating a sizable revolution in surveying. A system like Cubics Electrotape can measure a 50-mile linear distance to an accuracy of ± 1 in. ± 3 ppm. The 1 in. represents instrument error, while the 3 ppm is a fairly irreducible propagation anomaly error. High accuracy is achieved by using multiple CW modulation and phase-comparison techniques.

The actual shot takes about 5 min, but to get the highest accuracy from the system, geological corrections must be made to the readings. This requires measurement of temperature, pressure, and humidity at each of the pair of units.

The units are in the 25-35 lb range, mounted on tripods. The two are interchangeable, permitting double-running the measurements for error checks.

Applications are many and growing: Surveying county lines, building highways, laying pipe lines, establishing control points for photogrammetry are but a few of the fields of application. When used to install microwave link repeater stations, an assured clear microwave sight from station to station is an added bonus.

In the Future: Cook A Meal In A Vending Machine

The microwave vending machine is now a reality, with the recent introduction of the Kwik Kooker (Fig. 5) by Rudd-Melikian Inc. of Hat-



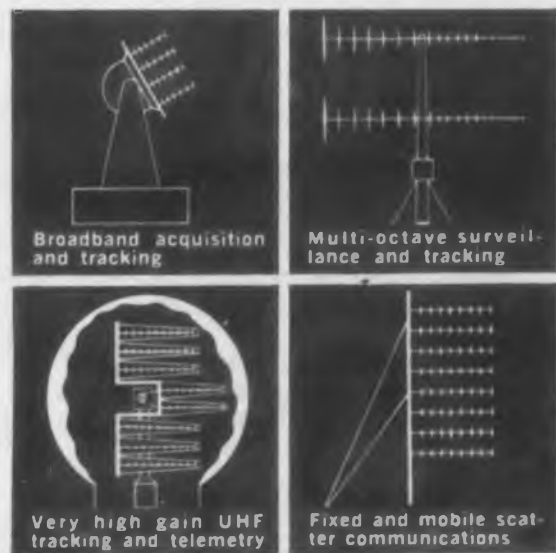
AVIEN-BOGNER ANTENNAS

A dramatic breakaway from the limitations of conventional antenna types, Avien-Bogner Antennas offer unparalleled capability for precise integration into advanced telemetry, tracking, surveillance, scatter communications and radar systems.

Designed around the patented Bogner bipolarized endfire element modules, they can be quickly supplied in configurations to meet a wide variety of complex requirements in the VHF, UHF and SHF bands. Characteristics include high gain, multi-octave frequency coverage, excellent side lobe control, rapid variation of beamwidth, and accurate self tracking.

And — Avien-Bogner antennas afford real savings in cost, size and weight over large steerable or fixed paraboloids with comparable performance. For the complete story, call or write today.

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AERO-SPACE AND GROUND SUPPORT SYSTEMS ENGINEERING IN: ANTENNA SYSTEMS • FUEL AND PROPELLANT MANAGEMENT • TEMPERATURE MEASUREMENT AND CONTROL • LIQUID FLOW INSTRUMENTATION • CHECKOUT



CIRCLE 185 ON READER-SERVICE CARD



DIODES Designed as rectifiers, EG&G's high-power, high-voltage diodes can be used as hold-off diodes, inverse clippers and backswing clippers. Compact, lightweight and rugged, they are built to withstand severe shock, vibration and high temperatures.

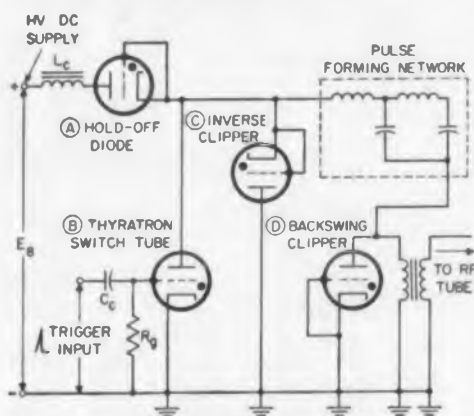
THIS IS THE FIRST COMPLETE LINE OF CERAMIC-METAL, HYDROGEN-FILLED TUBES ever made available to the industry

Now, for the first time, design engineers have at their disposal a *complete* line of miniaturized, hydrogen-filled tubes, which will meet most radar circuit requirements and permit the design of truly compact modulator packages.

TYPE	CLIPPER DIODE RATINGS				RECTIFIER RATINGS			HEATER				CATHODE & RESERVOIR WARM-UP TIME minutes	DIMENSIONS		WT. lbs.
	epx kv	lb a	lb Adc	Ip Aac	epx kv	lb a	lb Adc	Ef Vac	If lac max.	Eres Vac	Ires lac max.		Max. Height-inches	Max. Dia.-inches	
HR-2	8.0	9.0	.100	2.0	8.0	1.5	0.25	6.3	3.2	*	*	0.5	2-1/2	1-1/5	0.13
HR-1	25.0	250	.125	4.0	20.0	9.0	1.5	5.0	9.5	5.0	3.5	5	4-5/8	2-5/16	0.95
HR-3	25.0	500	.500	16.0	25.0	30.0	5.0	6.3	13.0	6.3	4.0	10	5-3/4	3-3/8	2.07

NOTES: *Reservoir connected internally across cathode-heater. Temperature range -55°C to +125°C ambient; 400°C envelope max.

TYPICAL MODULATOR APPLICATION



Model 7322/1802 functionally replaces 5949, 5948 and most 1257 glass tubes.

Model 7620/HY-1 functionally replaces 4C35, 5C22 and most 5949 glass tubes.

Model 7621/HY-2 functionally replaces 1258, 3C45 and most 4C35 glass tubes

Model 7620/HY-1 plus A4-18 base electrically & mechanically replaces 5C22/HT-415 and 4587 glass tubes.



THYRATONS EG&G's rugged, lightweight, durable thyratrons have all passed vigorous vibration and shock tests. They are designed to operate at high power levels, high repetition rates and high temperatures and can be mounted in any position.

	Model 7322/1802	Model 7620/HY-1	Model 7621/HY-2
● compact modular circuitry (length).....	5-3/4"	4-5/8"	2-1/2"
(dia.).....	3-3/8"	2-5/16"	1-1/5"
● light weight (lbs.).....	2.07	0.82	0.13
● max. peak anode voltage.....	25,000	20,000	8,000
● max. peak anode current (amps).....	1,500	500	90
● max. average current (amps).....	1.5	0.5	0.1
● wide temperature capability.....	-55°C to +125°C ambient; 400°C envelope max.		
● long life.....	unique hydrogen reservoir in all models.		
● rugged dependability	all models pass vigorous shock and vibration tests.		
● cathode & reservoir warm-up time.....	10 min.	5 min.	30 sec.
● high plate dissipation factor.....	20 x 10 ⁹	10 x 10 ⁹	1 x 10 ⁹

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CIRCLE 186 ON READER-SERVICE CARD



MICROWAVES

boro, Pa. This forward-looking vending-machine company has made it possible to store food frozen in a vending machine, and, with the aid of a small microwave oven, sell heated pastries, sandwiches, vegetables, or complete dinners.

The microwave section is supplied by Raytheon, pioneer of microwave cooking. In the present model, cooking time from 15-60 sec. makes it necessary to remove the food from a delivery chute and heat separately. In the planning stage is a vending machine that can deliver a cooked meal within the 10-sec allowable vending cycle.

Another closely related device is the continuous-belt microwave oven recently demonstrated in Europe by Philips Lamp. Called the Philips Holland Magnetron, the unit can deliver 150 cooked meals per hour, with a 1,000 meal-per-hour unit in the planning. Amperex, Philips' U. S.



Fig. 6. One of the largest non-military systems, this W. L. Maxson height-finder antenna array, developed for the FAA, when complete, will use 30 miles of waveguide in developing 333 beams.

affiliate, is marketing the unit for institutional feeding and industrial heating applications. The system now uses five 2-kw magnetrons feeding energy to the passing material through five parabolas. Plans call for the conversion to the 5-kw type 55125 magnetron, with corresponding lift in the heating capacity of the oven.

The potential market for these devices and their logical design descendants is enormous. When the cost, reliability and safety factors can be substantially improved, 50 million homes will become end-users.

Separate The Aircraft 'Stacks' In Airport-Traffic Jams

As if to indicate that non-military microwave systems need not be small, the W. L. Maxson height-surveillance radar (AHSR-1) involves a 160-ft tower and three 100-ton antenna arrays. One of these million-dollar arrays is shown going up (Fig. 6) at the National Aviation Facilities Experimental Center in Atlantic City recently.

The antenna is representative of a new class of phased arrays that will make a considerable difference to microwave components manufacturers in this system, and in other systems, tube manufacturers. This passive antenna receives return pulses from a separate ASR radar and determines elevation very rapidly. The "plumber's delight" has 3,168 antenna elements and 30 miles of waveguide in its three sides. Each of the three antennas generates 111 beams in which to receive energy. Electronic-signal processing replaces the mechanical scanning of a slower "conventional" parabola.

With the increasing traffic snarls at the nation's airports, equipment in this general class are designed into an expanding market.

New Applications, New Design Criteria

The wide range of system requirements represented by this sampling of commercial microwave systems is translatable directly into widely differing component-design criteria. As microwaves expand into strange new fields of application, the parts designers must work to optimize new sets of parameters.

In many cases, cost, size and reliability of components have gained an importance quite beyond anything called for previously. Yet, these are valid and necessary conditions for successful penetration into these newer fields of microwave applications. The following four articles indicate some steps that have been taken by antenna, source, component and test equipment designers to meet the challenge of rapidly changing system requirements. ■ ■

now 100 times greater average power

Now you can obtain traveling-wave tubes capable of 10 to 100 times the average power of conventional helix tubes. These X-band tubes are representative of a wide variety of the first commercially available all metal filter-type structures yielding both high gain and wide bandwidth. Their attractively small size and weight are made possible through application of the latest periodic focusing techniques.

Typical of these recent advances is the pictured 308H. For the first time a power traveling-wave tube is offered with a high- μ grid-controlled gun. This advantage, coupled with 53 db of saturation gain, provides exciting possibilities for the systems designer.

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307H



308H

Control grid $\mu = 55$. 15 kw peak power output (150 watt average), 8.6—9.9 kmc frequency range, 53 db saturation gain, 1% maximum duty cycle, beam voltage = 24 kv, 14 lbs. total weight of tube and magnet.



319H

20 kw peak power output (200 watt average), 8.4—9.6 kmc frequency range, 54 db saturation gain, 1% maximum duty cycle, beam voltage = 24 kv, 17 lbs. total weight of tube and magnet.

For full details on these and other equally outstanding tubes write or wire Hughes Microwave Tube Division, 11105 Anza Avenue, Los Angeles 45, California.

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Breakout in Microwave Antenna Design



In a dramatic break with traditional optical design, antenna arrays have been risen from the realm of the theoretical, and are now a reality. The cause—pressing new operational requirements. The means—development of the necessary components. In a graphic, yet comprehensive overview, authors Gustafson, Shestak and Stark show how this coincidence of need and means has changed the current status of these exotic radiators.

L. A. Gustafson, L. N. Shestak, L. Stark

Hughes Aircraft Co.
Culver City, Calif.

SINCE the speed and number of planes and missiles is constantly increasing, there is an urgent need for search and tracking radars with greater range, resolution, and information rates. Such performance requires antennas that radiate more energy, and beams that scan more rapidly and carry more information than ever before.

Because the amount of power carried by a single radiator is limited by electrical breakdown, the trend toward antenna arrays is now well established. Lack of suitable components, however, hindered the growth of array application until recently. Fortunately, methods and hardware for array scanning are now rapidly becoming available to the antenna designer, and array research has advanced understanding of mutual coupling effects in electronically scanned arrays. Thus, both the need and the means have now developed for the high-speed scanning of large arrays from a fixed mechanical position—on the ground, on ship board, or in the air.

Electronic Scanning Theory Now Paying Off In Hardware

Much of the theoretical background for the design of electronically scanned antennas has



Fig. 1. Line source and parabolic cylinder allow electronic scanning to be effected by change in frequency.

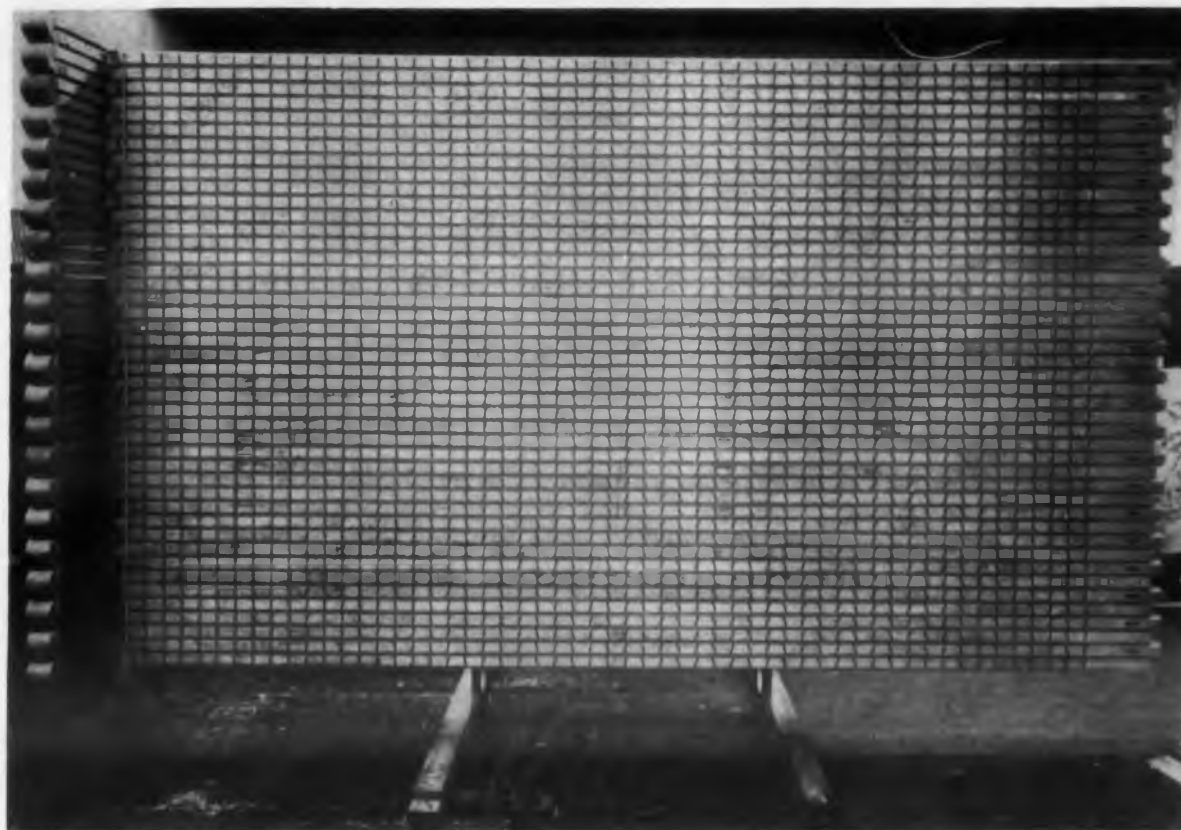


Fig. 2. Closer control aperture amplitude distribution is effected in this advanced design in which the parabolic cylinder is replaced by waveguide slot arrays.

been available for several years. Efficient aperture distribution for arrays of discrete elements can be calculated by the methods of T. T. Taylor.¹ The effects of errors due to the construction tolerances have been investigated by Bailin and Ehrlich² and by Elliott.³ The errors in the antenna pattern caused by scanning the array can be predicted using results obtained by Elliott and Kurtz,^{4,5} Odum⁶ and Spradley.⁷ Design information for various types of slot arrays has been published by Cullen,⁸ Ashmead,⁹ Kaminow and Stegen,¹⁰ Gruenberg,¹¹ and many others.

Major advances in component technology have recently made possible the development of hardware from this wealth of theoretical antenna-design information. Compact ferrite phase-shifters, which have low losses and require only nominal control power, are now available for electronic scanning. Wide-bandwidth high-power transmitters extend the usefulness and versatility of frequency-scanning techniques. Low-loss, lightweight dielectrics offer the antenna designer the chance to reduce the size of complex feed systems. All these hardware advances bring nearer an era of truly versatile, electronically scanned antennas: flush-mounted antennas for aerospace vehicles and high-speed planes, high-resolution reconnaissance antennas, and powerful long-range ship- or ground-based search and track antennas. (A description of some of the newer com-

ponent developments that are contributing to this breakthrough is presented in the advanced components article, p 176).

Linear Antenna Arrays Steered In One Plane by Phasing

Electronic-beam scanning of antenna-array systems is based on the phasing principle in antenna theory. The theory of optimum radiation patterns for line sources has been studied extensively,^{1,12,13} and the antenna designer can compute the optimum amplitude distribution (along the line source) that will produce the narrowest beam-width and lowest side-lobe intensities for a given array length.

As the beam is scanned from the broadside direction in a linear array, the beam broadens and the gain of the array decreases. If the amplitude distribution is maintained throughout scan, then the side-lobe levels remain the same. Except in the end-fire region, gain and beam-width can be predicted quite accurately from the extent of the aperture projected in the direction of radiation.¹⁴ The projected aperture rule indicates a gain decrease of 0.707 for a scan angle of 45 deg. Thus a 90-deg sector can be scanned with a gain-drop of 1.5 db at the sector edges.

Antenna applications requiring a pencil beam often employ a phased-line source feed and a

focusing element to collimate the beam along the coordinate perpendicular to the line source. This configuration offers a pencil beam which can be electrically scanned in the plane of the line source. A simple arrangement of this type consists of a line source and a parabolic cylinder reflector. Alternatively the phased line source can feed a set of linear arrays to achieve beam collimation.

Line Source and Parabolic Cylinder Offer Electronic Stabilization

Fig. 1 shows a line source and parabolic cylinder frequency-scanning antenna developed at Hughes Aircraft Co. The frequency-scanning feed, contained inside the metal fin is a serpentine waveguide. The radiators are slots milled in the narrow wall of the guide. Antenna performance is remarkably good throughout the electronic scan. The beam can be stabilized by electronic means, hence, heavy mechanical stabilizing motors are not required.

An advanced version of this antenna concept is shown in Fig. 2. The parabolic cylinder is replaced by a family of waveguide slot arrays. This antenna offers greater opportunity for improved performance because the aperture amplitude distribution can be controlled more closely, and the theoretical results of optimum aperture design can be exploited. The antenna is more

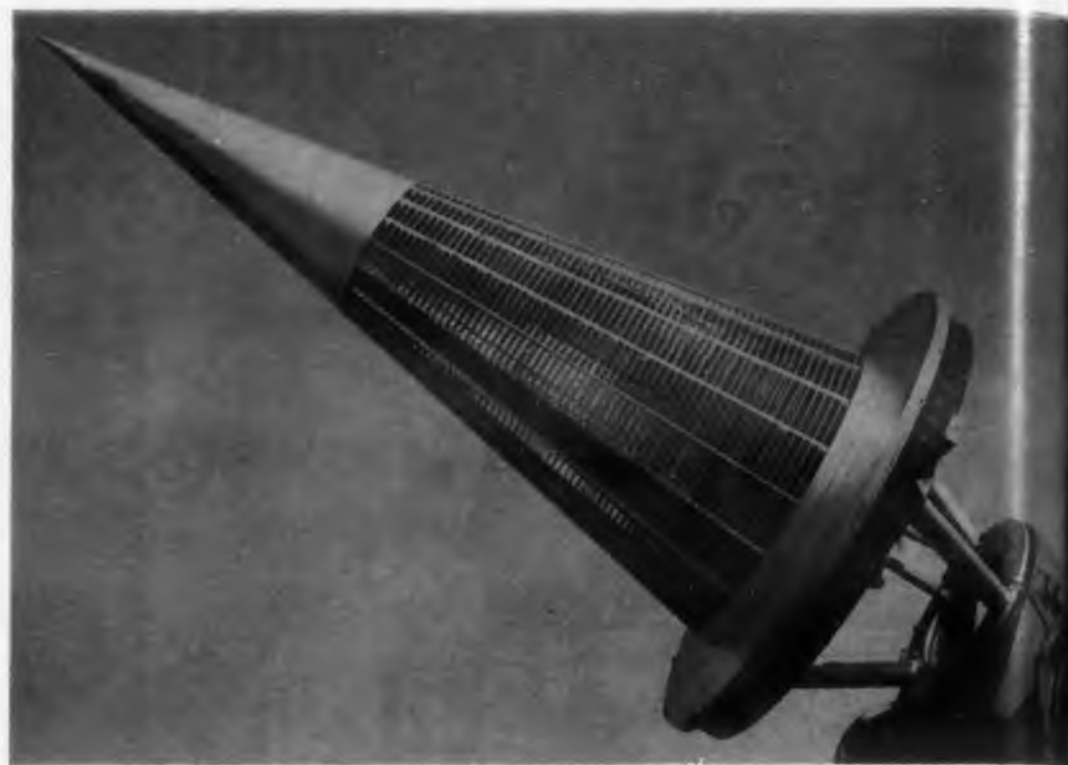
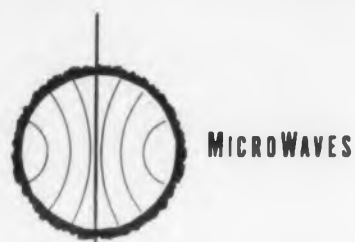


Fig. 3. Nose-cone antenna can be scanned over most of the forward hemisphere by combination of frequency change and mechanical motion of feed.

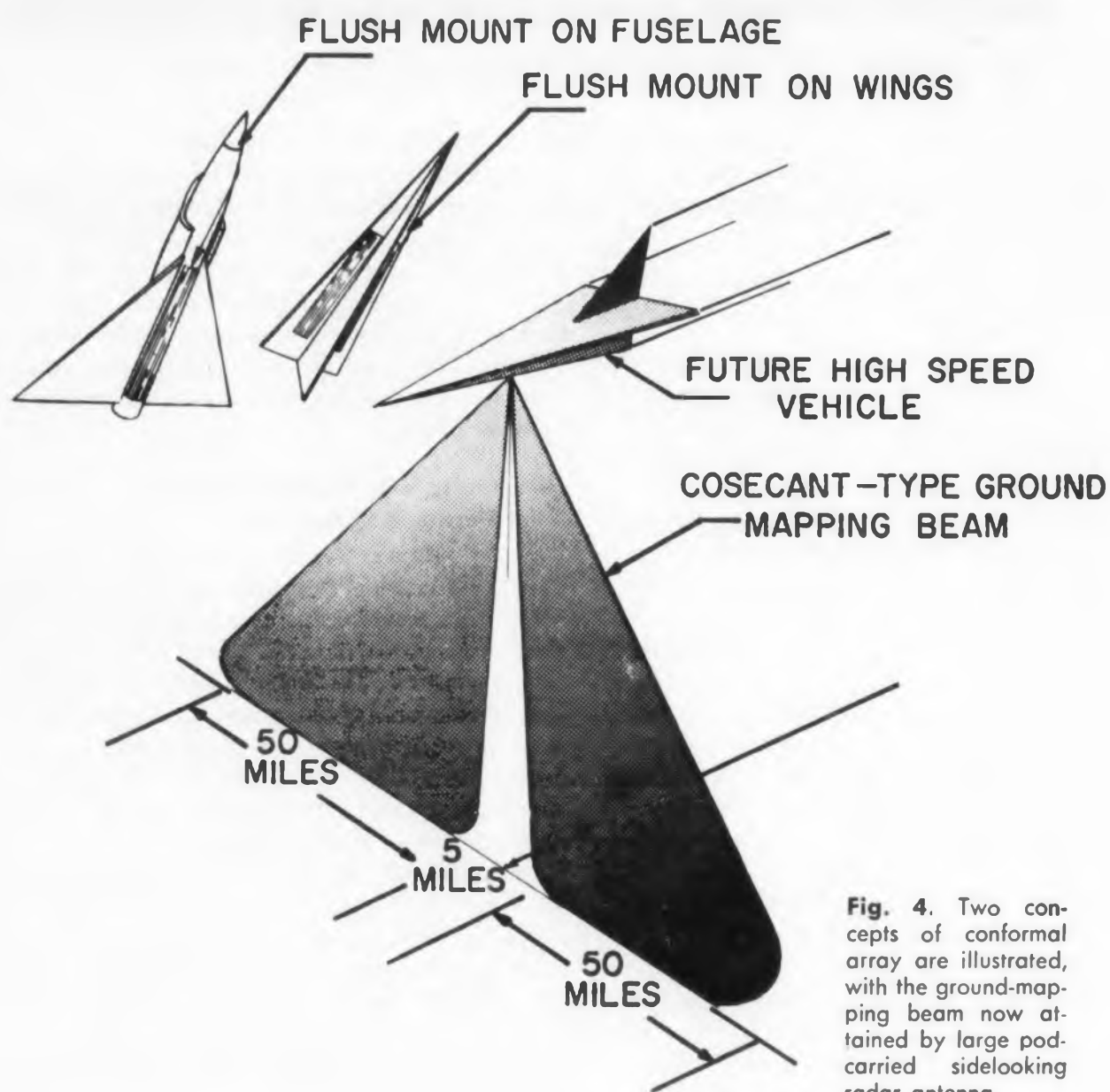


Fig. 4. Two concepts of conformal array are illustrated, with the ground-mapping beam now attained by large pod-carried sidelooking radar antenna.

complex, but it is smaller than the cylindrical counterpart for the same performance.

More Complex Two-Dimensional Arrays Are Steerable in Two Coordinates

Electronic beam-scanning with a two-dimensional array is more complex than the linear array, but offers more operational flexibility. If all elements of the array are excited in phase, a pencil beam is formed at broad-side to the array. If phase grading is applied along both coordinates of the array, the radiated wave-front is tilted at some angle with respect to the array, and the beam points away from the broad-side. The direction of radiation is determined in a manner analogous to Snell's Law, by matching phase constants along the boundary. In general, as the interelement phase-shift is varied along one coordinate of the array, the beam scans along a cone whose axis is the other coordinate.

The design of two-dimensional planar arrays for optimum-radiation patterns makes use of separable aperture distributions and applies the results of analysis of linear arrays.¹⁵ As opposed to optical-type antennas it is possible in principle to design an optimum radiating aperture for an array antenna since finely divided segments of the aperture can be controlled.

Phase Scanning Can Be Accomplished By Ferrites, Klystrons or TWT's

Ferrite phase shifters can be made reciprocal and thus can be used on transmit and receive. The ferrite has long life and a high reliability

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factor, as opposed to electron-tube phase shifters. Ferrite phase shifters require temperature stabilization or closed-loop phase control. They are suitable as phase shifters in branch lines since in this case they do not create serious problems with regard to loss and power breakdown. The Reggia-Spencer phase shifter¹⁶ is well suited to electronic scanning systems because the magnetizing field is low. Step switching of the control field thus requires only a small amount of drive power.

Microwave amplifier tubes, having a large drift angle, can change phase by variation of the beam voltage. A large variation in phase is possible in klystrons and traveling-wave tubes. The advantage of this method is that the functions of amplification and phase shifting can be combined. Closed-loop phase control is usually required because the phase change is usually a sensitive function of voltage and beam current, and because aging affects emission.

Frequency Scanning, Suited For Linear Arrays, Is Also Adaptable for 2-D Scanning

Frequency scanning is achieved by variation of the signal frequency in an antenna feed, designed so that the beam position is sensitive to frequency. The feed is so designed that the delay between the tap points is much greater than the delay in free space. Feeds of this type have been most commonly designed as serpentine feeds of waveguide or coax, but helices have also been studied.

Near broad-side, the beam position is a linear function of frequency. A wide angle can be scanned by the use of a large frequency variation. Alternatively, the frequency variation may be kept small if the distance between tap-off points is made large relative to element spacing, or if there is a large ratio of guide wavelength to free-space wavelength. Use of the second alternative increases feed loss and thus a major design consideration is frequency bandwidth versus feed loss. Ten per cent bandwidth has been employed in designs to date and a feed loss of 1.0 db is common.

At higher or lower frequencies corresponding to addition or subtraction of an integral number of guide wavelengths between tap-off points in the feed, the beam is returned to broad-side. These frequencies correspond to the centers of additional bands throughout which the beam can be scanned.

Frequency-scanning systems are reciprocal, and scanning is achieved primarily by an inactive device. Frequency scanning has proved very successful in linear-array applications, and combined with other electronic scan methods

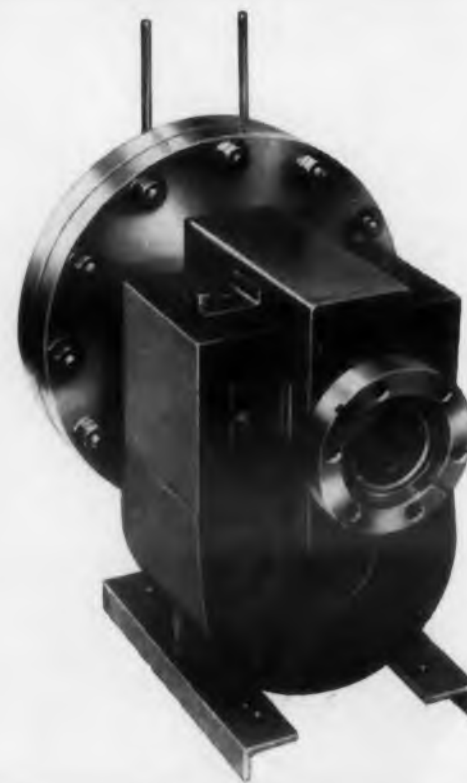
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Announcing...

wide range voltage-tunable magnetron from Eimac

Take a look at the world's most advanced voltage-tunable magnetron: Eimac's new X-747, shown here with its magnet and cavity. This new tube can be tuned over the exceptional range of 400-1200 megacycles—a range approached by no other electronically tunable device. And it's extremely linear! Nominal output power of the X-747 is 100 milliwatts.

And too, the X-747 is easier to use than any similar device. No complicated heater voltage regulation is needed. Back heating is eliminated through its exclusive indirectly-heated matrix cathode plus advanced electron injection design. And heater power supply can be *either* AC or DC.

These advances make possible the most reliable voltage-tunable magnetron available today. Eimac can readily develop and produce other VTM types to meet *your* specific needs. For full information, write: Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

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in a two-dimensional array can give electronic scanning in two coordinates. In the simplest type of two-dimensional electronic scanning system, the number of active phase shifters is equal to the number of columns in the array rather than the total number of radiating elements.

Phase Shift Can Be Derived From Frequency Shift By Mixing

Phase shift can be obtained by a change of frequency through a delay-line followed by a mixing operation in which the frequency variation is removed and the phase change retained. An amplifier chain must follow the mixers in order to radiate high power. The amplifiers must be extremely stable or closed-loop phase control must be employed. Such systems are being employed for electronic-scanning radar applications. These systems are not reciprocal and must be switched into a receiving state.

This method may also be combined with frequency scanning in a two-dimensional array. The frequency variation in the mixing operation is partially retained for frequency scanning along the other array coordinate.

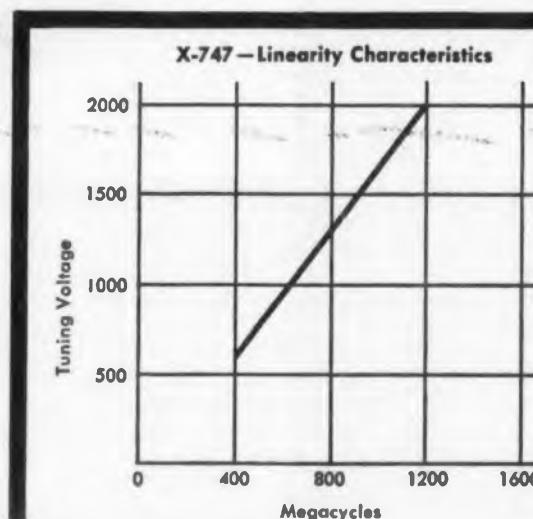
Flush Nose-Cone Antennas A Reality Through Scanning

For airborne radar, the best combination of paraboloid reflector and radome still leaves much to be desired. The next step is an antenna that can be flush-mounted on the nose of an aircraft, thus eliminating the radome completely. Studies on such an antenna have been going forward at Hughes for several years. Fig. 3 illustrates the latest antenna developed in these studies.

Extension of Electronic Scanning Theory Provides Large-Area Conformal Arrays

Another application of the flush-antenna technique that promises early operational capability is the airborne high-resolution reconnaissance system. Current practice is to mount the antenna in an auxiliary pod. Fig. 4 is an artist's sketch of two types of conformal array on a high-speed air vehicle. Here the array is visualized as a small segment of the cylindrical fuselage, or as a flat rectangular slab lying on the underside of the wing.

High-resolution reconnaissance systems generally require a rather large rectangular aperture in order to form a narrow beam in azimuth, and



a shaped beam in elevation. Control of the elevation beam is desirable both to correct for vehicle roll and to permit operation at many altitudes. An experimental array which can accomplish these goals utilizes ferrite devices for control of the phase of each radiating array. Iris coupled slots¹⁷ are employed so that the amplitude of energy to each radiating array can be independently controlled. A variety of the problems associated with flush reconnaissance antennas can very easily be simulated with this array and the solutions experimentally verified. ■■

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Microwave Component News

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K-4160, shown approx. 1/3 actual size.
Fins facilitate forced-air cooling.



K-4186, shown approx. 1/2 actual size.
Flange connects to heat sink.

Forced air cooled	Conduction cooled	Frequency
K-4035	K-4189	5925-6225 mc
K-4162	K-4188	6125-6425 mc
K-4202	K-4187	6425-6575 mc
K-4161	K-4186	6575-6875 mc
K-4034	K-4185	6875-7125 mc
K-4160	K-4184	7125-7425 mc
K-4033	K-4183	7425-7750 mc
K-4036	K-4182	7750-8100 mc



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Fig. 1. 100 mw of electronically swept output over 400- to 1,200-mc range available from new EIMAC X-747 VTM. Tests so far indicate linearity better than 1 part in 1,000.

New Tubes For Agile, Reliable, Powerful Microwave Systems



In low power applications, microwave system and test equipment designers have been looking for wider, more linear electronic tuning. They are also forever seeking a better solution to the problem of reducing down-time caused by tube failure. In high power X-band equipment, the search is for more power, lower weight and greater frequency agility. Author Terry Bibbins reports on successful approaches to these problems, backs up the descriptions by concrete examples in newly developed microwave tubes and indicates their areas of application.

Terry Bibbins

Applications Engineer
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San Carlos, Calif.

THE CURRENT pace of progress in microwave-tube design makes it a major problem simply to keep up with new product developments and, what is more, there are as many ways of measuring this progress as there are design objectives.

For the radar designer, power is most important. For most other applications some other parameter is prime: for the data-transmission system, linearity is overriding; for telemetry, weight is important; for communications, reliability; for the ECM designer, frequency agility and broad band. Here are examples of some of the significant advances in these parameters to come along recently.

Near-Perfect Linearity Achieved Over 3-to-1 Frequency Range in VTM

An example of a tube in the low-range category is the long-life, broadband, voltage-tunable magnetron recently announced by Eitel-McCullough, Inc. This tube, the X747, (Fig. 1) is the first of a series of VTM's to be produced by the company. It can be electronically swept over the frequency range of 400 to 1,200 mc and will provide a nominal output power of 100 mw over this band.

In addition to its unique 3-to-1 bandwidth, this



Fig. 2. Complete interchangeability of active element in the Sperry STC-236 TWT enables unskilled maintenance man to put communication repeater back on the air if tube fails.

tube has two other characteristics differentiating it from other devices in this general frequency range. It is designed for long-life service, and it is an extremely linear swept-oscillator.

The most prevalent complaint concerning magnetron oscillators is the short life experienced as a result of back-bombardment of the cathode. This effect may be minimized by two methods: providing a more rugged cathode, and removing the active cathode material from the rf section of the tube. Eimac chose to employ both methods.

In the X-747, the electron-injection system is used, removing the indirectly heated cathode from the rf field. This design has the added advantage of minimizing output power variations over the frequency range as a result of the limiting effect of the control anode. This element, to a first approximation, controls the amount of cathode current, regardless of the vane (frequency-determining) voltage.

The cathode material used in the X-747 is the EM-A structure developed at Eimac. This material is a pressed matrix of pure metals and their oxides, resulting in an emitting surface possessing the best characteristics of both constituents. The oxides permit efficient operation. The pure metals present a rugged surface, unharmed by electron or ion bombardment. This cathode material has been field-proven in high-power klystrons, with life of more than 15,000 hr experienced. This design and the improved cathode material, together with metal and ceramic construction, result in a tube capable of life on the order of 3,000 to 10,000 hr.

The extreme linearity of this tube is a typical characteristic of magnetrons. In these devices, the relation between frequency, anode-voltage, and cross-magnetic field is theoretically linear. Thus, ideally, a linear change in voltage produces a linear-frequency deviation. In practice, this tube is at least 99.9 per cent linear over a 20-mc bandwidth (the limit of the test equipment available at the time of testing). That is, the fre-

quency voltage curve deviates from a straight line by less than 1 part on 1,000. Further tests are now being initiated to determine its linearity over the complete 3-to-1 bandwidth.

The wide bandwidth, extreme linearity, and rugged construction make this tube well suited for missile fuse systems and ECM drivers or transmitters. When used in such systems, it may be possible to trade bandwidth for power output and efficiency. In a narrow-band circuit this tube has produced output powers of over 10 w and efficiencies of 35 to 40 per cent.

Active Element Can Be Quick-Changed Without Returning in TWT

A somewhat different approach to the life and replacement problem is taken by Sperry Electronic Tube Division in the development of the STC-236 traveling-wave tube. Intended for use in microwave repeater stations, this tube covers the 5.9 to 8.2 Gc (kmc) communication band with a nominal output power of 10 w and a small signal gain of 35 db. Because it is designed for commercial communication service, the design goal was the development of a reliable long-life tube, requiring a minimum of adjustments by the operator.

Realizing that replacements would be inevitable, an extremely simple replacement procedure was developed which can be performed by non-technical operators. The tube-and-magnet/waveguide assembly are constructed as separate units, (Fig. 2), so that replacement would involve removal of the tube only, without dismantling the waveguide assembly.

The periodic-permanent-magnet stack is an integral part of the waveguide assembly, and adequate shielding is provided by this construction so that the tube is unaffected by stray magnetic fields. Therefore, placement of transformers and chokes is not critical, simplifying circuit layout. A single matching tuner is provided on the input and output waveguide sec-

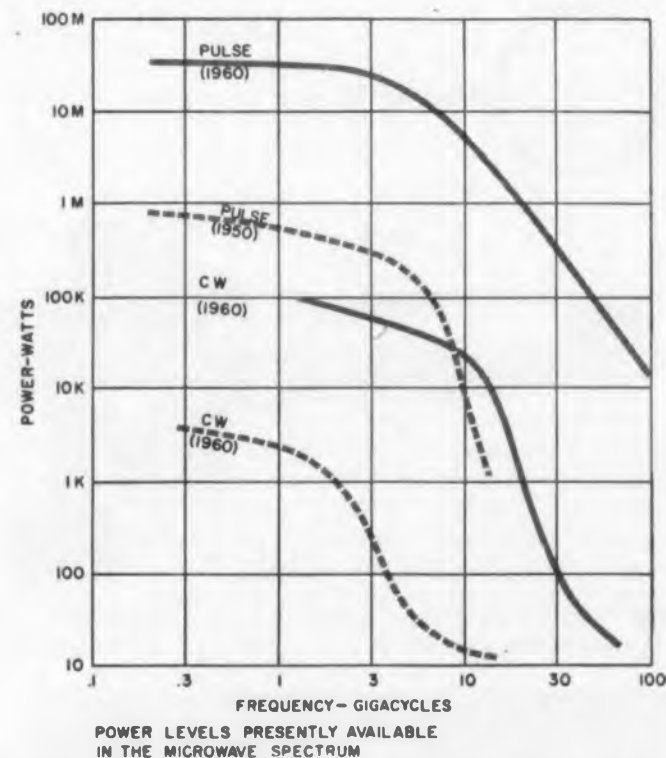


Fig. 3. Quantum jump in microwave power over the past decade points the way to further power increases in the near future.

tions to provide simplified matching of the tube to the circuit. By means of these tuners it is possible to maintain the input and output "hot" VSWR's below 1.1 to 1 over a 100-mc bandwidth.

Once the system is properly matched, it is not necessary to repeat this procedure. By maintaining extremely close manufacturing tolerances, Sperry is able to obtain a sufficiently high degree of uniformity to permit complete interchangeability. In the event of tube failure, the operator merely loosens the simple tube-holding device, removes the tube, and inserts the replacement. Upon tightening the tube holder, the replacement procedure is complete.

By this design, system down-time in the event of tube failure has been greatly lessened. In addition, high reliability and long life are guaranteed as a result of the tube construction. The oxide cathode is conservatively designed for expectant life of 10,000 hours or more. The materials and techniques employed in the manufacture of this tube result in a simple, clean structure at a relatively low cost. The result is an inexpensive, reliable product well suited for commercial communication service.

High Power Cw Upped Tenfold At X-Band In Three Years

The oft-quoted available power level, while far from the only parameter, is nevertheless one good indicator of tube progress. The current level of power available across the microwave spectrum is graphically represented in Fig. 3. The advance over the tubes of a decade ago



Fig. 4. In just three years, Varian's 20-kw VA-849 klystron has increased available power an order of magnitude in the 7.125 to 8.5 Gc range.



Fig. 5. From a 21-lb package, Hughes' 307H TWT can deliver 100-kw peak power at X band. This tube is one of a family using half a dozen recent developments to minimize PPM size and weight.

can be gathered from a comparison with the dotted line on the chart.

This rapid advance in the high-power cw field is well illustrated in the development history of Varian Associates' VA-849 klystron (Fig. 4). This tube will deliver a cw-output power of more than 20 kw over the frequency range of 7.125 to 8.5 Gc (kmc). Until this tube was developed, the 2-kw VA-806 series, announced in 1957, was the most powerful tube available in this frequency range. Available X-band power, in other words, has jumped one order of magnitude in just three years' time, and in a single new-tube announcement. But this impressive rate of development cannot be tossed off simply as the result of a single "major breakthrough." It is actually the culmination of industry-wide engineering effort across the board over the past years.

A considerable amount of design effort on the VA-849 was directed toward higher reliability. The klystron's metal and ceramic structure are rugged and capable of long service. The output window is ceramic to withstand the dielectric heating effect at this power level. The convergent beam type gun uses an impregnated-tungsten cathode, which assists materially in the achievement of very long life.

In spite of the extremely high output power, the operation is not at all critical. The tube's

position in the hardware requires no adjusting. Matching the input and output to the transmission line is factory-preset at the optimum condition for most applications. Adjustment of the magnetic field strength is not critical. Even the tuning adjustment is non-critical. Therefore it is relatively difficult for the operator to inadvertently cause the catastrophic failure of this tube.

Lightweight (200 lb including magnet) and high efficiency (33 per cent) make the VA-849 an excellent choice for portable radar service. The klystron is a four-gap, internal-cavity design. In narrow-band service, a power gain of over 50 db may be obtained. When broadbanded by stagger-tuning the cavities, a bandwidth of more than 30 mc may be achieved.

100 Kw Pulsed X-Band Power Generated By 21-lb TWT

In the pulse field, the rate of development of new products has equaled and in some cases exceeded that in the cw field. It is now possible to obtain a pulsed output power of over 100 kw from a device with a total weight less than 21 lb. This tube is the 307H (Fig. 5) produced by the Microwave Tube Div. of Hughes Aircraft Co. It is one of a series of pulse traveling-wave tubes produced by Hughes which cover the 8.5 to 9.5 Gc range at different output levels.

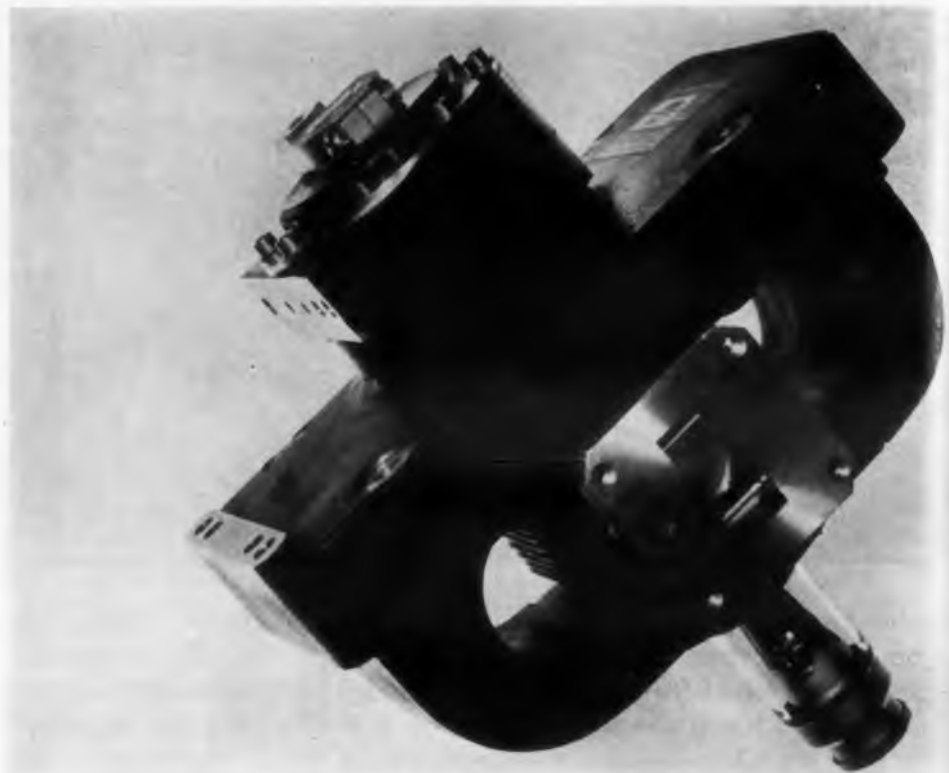


Fig. 6. A tuning rate of 100 Gc per sec per sec is provided by the 70-kw, hydraulically tuned type L-3305 magnetron developed by Litton.

The 307H will deliver 100 kw peak power at a duty cycle of 0.01, or an average output of 1000 w. It has a saturation gain of over 54 db and an efficiency of at least 20 per cent. It is a ruggedized ceramic and metal TWT suitable for airborne applications. The tube uses a standard convergent gun, with a dispenser type cathode. This results in an efficient rugged cathode capable of long life operation.

The design and construction techniques employed in this tube result in almost complete freedom from microphonics and undesirable phase-shift variations. Therefore it is suitable for the most stringent requirements of MTI radars and multi-element phased array systems. The slow-wave structure of this tube is composed of a series of separate cavities. This yields an extremely high degree of separation between input and output. In fact, the cold insertion loss of this tube is over 300 db.

The Brillouin focusing technique is used in this periodic permanent magnet tube, permitting the use of the smallest possible magnets. In addition, the magnet material is a new class of Ferreramic, possessing an extremely high coercive force for a given size and weight. Finally, by using the cavity end-plates as magnetic pole pieces, the magnetic field requirements are reduced to a minimum. For these reasons, an over-

MICROWAVES

all diameter of less than 3 in. and a length of 24 in. are achieved.

The other tubes in this family are the 319H covering 8.4 to 9.5 Gc with a 20-kw peak, 200-w average capability, and the 308H covering 8.6 to 9.8 Gc with a peak output of 15 kw and an average output of 150 w. The 308H is the only tube of this series that employs a gridded gun for pulsing, since the others are designed for beam pulsing.

100 Gc-per-Sec² Tuning Rate Achieved in 70-Kw X-Band Magnetron

Another type of pulse tube which has long enjoyed the favor of radar designers is the magnetron. If a rapid-tuning mechanism is added to this device it becomes even more useful. The L-3305 (Fig. 6) hydraulically tuned magnetron developed by the Electron Tube Div. of Litton Industries is just such a device. Addition of the tuner mechanism to the fixed-tune 6543 magnetron, resulted in the 70-kw pulse tube, tunable over the range of 8.5 to 9.6 Gc. A duty cycle of up to 0.001 and pulse lengths from 0.4 to 4.5 sec are within the capabilities of this tube.

The hydraulic-tuner system may be programmed with either sinusoidal or random signals and may be set to traverse the entire frequency range or some smaller portion if desired. Maximum tuning-rate capability is 100 Gc per sec per sec. An average rate of 50 Gc per sec per sec is recommended for maximum mechanical life.

The hydraulic actuator is an integral part of the tube design while the hydraulic valve mounts directly to the actuator. These features provide positive tuning action, nearly zero error, and optimize reliability and ease of maintenance. The hydraulic power supply may be remotely located to permit flexible system design. A linearsyn mounting is also provided so that frequency can be preset or monitored providing coarse automatic frequency control.

The tube is designed to be operated in any position and there is no requirement for scavenging oil. Long-life seals on the magnetron actuator assure both long shelf-life and in-use life. The L-3305 is well suited for duty in ECM and ECCM applications requiring frequency agility and reliability. ■ ■

For further information on any of these microwave tubes, turn to the Reader-Service Card and circle the number indicated:

Eimac Type X747 VTM	253
Sperry Type STC-236 TWT	254
Varian Type VA-849 Klystron	255
Hughes Type 307H TWT	256
Litton Type L-3305 Tunable Magnetron	257

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SPECIFICATIONS STANDARD RADOMES

Dia. Feet	Type No.	Attenuation @ 6 kmc. db	VSWR Contribution @ 6 kmc	Thrust at* 30 psf (Flats), lbs.
10	R10	0.4	0.02	1,990
8	R8	0.4	0.02	1,270
6	R6	0.4	0.02	714
4	R4	0.4	0.02	320
2	R2	0.4	0.02	75

*Including antenna

HEATED RADOMES

Dia. Feet	Type No.	Attenuation @ 6 kmc. db	VSWR Contribution @ 6 kmc.	Thrust at* 30 psf. (Flats), lbs.	Power** Reqmts.
10	HR10	0.7	0.02	1,990	3,400 watts
8	HR8	0.7	0.02	1,270	2,400 watts
6	HR6	0.7	0.02	714	1,200 watts
4	HR4	0.7	0.02	320	550 watts
2	HR2	0.7	0.02	75	150 watts

*Including antenna

**Power requirements for HR10 and HR8 are 3 wire single phase 60 cycle 220 volts.

Power requirements for HR6, HR4 and HR2 are single phase 60 cycle 115 v.

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"We have had up to four inches of ice on the radome with practically no reduction of antenna effectiveness." *KLIX-AM-TV, The KLIX Corporation, Twin Falls, Idaho*

"Our field forces report that the radomes produce a signal loss of less than 1 db per antenna. Several radomes were removed and antennas inspected following a heavy snow storm and no snow or ice was found in the antennas." *Natural Gas Pipeline Company of America*

CIRCLE 191 ON READER-SERVICE CARD



MICROWAVES

Advanced Components Spotlighted By Microwave Spectrum Squeeze



With the arrival of the high-power, multi-beam arrays and the use of microwave energy to accomplish an increasing variety of functions, the microways are becoming as crowded as the highways. This drops a set of urgent problems into the lap of the component designer: high-speed rf switching, rf filtering and power sensitive limiters. Authors Bob Terry (left) and Bob Allen describe the most recent approaches to these problems, and some devices that exemplify them.

Robert Terry, Robert Allen

Microwave Associates
Burlington, Mass.

TODAY'S radars are becoming more exotic and are required, in many instances, to perform multiple operations. The tracking of and recording of many targets simultaneously is one example. In other systems, multiple antennas are used with perhaps several power tubes per system. In radars to come we see the combination of multiple antenna feeds, transmission lines, and large numbers of power sources so arranged as to produce high-speed scanning at resultant high-power output.

In all these fast-acting, vast-quantity data-producing systems, high-speed switching (10 μ sec or less) at both high and low power, are now very necessary devices. Similarly, if a system is to function in the presence of interference from many other radiating microwave systems, rf filters are a must. Finally, for sensitive receivers to survive in this environment, power-sensitive limiters are a matter of life or death.

High-Speed, High-Power Switches Favor Ferrite Devices

In the high-power area there have been two approaches to high-speed switching, namely, ferrite and gaseous devices, both requiring driving or switching power. The use of semiconductors, though at present limited to low power, holds

some promise for medium-power switching in the watt region.

The use of ferrites is most extensive and holds the best promise of success down to the S-band region. In these devices the design objectives are: low switching power, maximum peak power capacity, broader bandwidth, a high degree of isolation, and temperature stability.

To achieve low switch power, the effect of hysteresis losses and shorted turn effect of the rf transmission must be reduced to a minimum consistent with no addition to rf insertion loss or loss of peak power capacity. The most often used approach along these lines has been the Faraday-type rotator, a four-port circulator utilizing two right-angle polarization transducers and a section of orthogonal transmission line supporting a ferrite rod, tube, or multiple ferrite strips. To eliminate the shorted turns of the rotational section, various techniques are being used such as thin high-resistivity metal walls or orthogonal double-rigid circular or square waveguide (cruciform) wherein the outer walls are removed. Whatever techniques are used, the problem is one of preventing arcing in areas of field intensification along with preservation of constant field rotation with frequency, to produce broadband operation in either switch position.

Another problem is the selection of the means of holding the switch in its quiescent condition. If a double coil is used, one for pulsing and one for switching, then additional power must be



Fig. 1. New order of high-power switching is represented by Ferrotec's R-107HS that can switch 100 kw of Ku-band power in 10 μ sec.



Fig. 2. A line of coaxial microwave switches, providing 20-db isolation and low level loss of less than 0.5 db is represented by Microwave Associates' MA-3452.



Fig. 3. Representative of a line of spdt switches for frequencies up to 18 Gc, this American Electronic Labs SNB 203 A switches 25 mc \pm 5 mc, with an insertion loss under 2 db and isolation over 50 db.

supplied. If permanent magnets are used, then they cannot deteriorate in the presence of an opposing pulsed magnetic field. Sometimes this requires the use of ceramic magnets which unfortunately are particularly temperature-sensitive.

The pulse fields generated in these devices are appreciable and leakage flux is large since the flux path reluctance is large. For this reason, consideration must be given to the switched field effect on other apparatus and vice versa. Magnetic shielding may be considered. However, such shielding must not appreciably shunt quiescent or driving flux.

Several Novel Switch Designs Improve Bandwidth, Speed, Isolation, Power

Notable among the many laboratories working on this type of non-reciprocal switch is Motorola, Inc., who announced their XS01 rotator circulator switch this past summer. The component boasts and 18 per cent bandwidth, 80-w power capacity, 0.75- μ sec switch time and 23-db isolation. It operates in X_u waveguide size systems.

Also responsible in advancing the rotator ferrite switch design is Ferrotec Corp. This company has announced a 22 per cent bandwidth four-port switched circulator model R-165LS in X_u , which operates up to 100 kw peak power. Of note is the Ku Ferrotec rotator switch R-107HS (Fig. 1) which lacks bandwidth (any 2 per cent section of the 15.7 to 16.9 Gc range) but has a 125-kw peak power capacity. Switching time is

given as 10 μ sec, which is claimed to be quite conservative. The switching time is measured to the 90 per cent switched condition since the 3-db condition used is not considered practical from a functional point of view. This device permits two microwave antennas to be time-shared by a common transmitter and receiver.

A novel ferrite switch has recently been demonstrated at Bell Laboratories employing a configuration called the "tetrahedral junction" which consists of two cross-polarized rectangular waveguides with a ferrite rod along their common axis. Principal advantage of this type of switch is a very low insertion loss of less than 0.1 db (lower in principle than is possible with any similar waveguide device). It also provides high switching speed of 1 μ sec, large bandwidth—approximately 10 per cent and very high isolation of approximately 60 db in the reflecting state. Information is not yet available on power capacity of such devices.

There are other well-known laboratories, notably Bell Telephone Laboratories, the pioneer in the field, Hughes Aircraft Co., Rantex, Raytheon, and Kearfott, all endeavoring to improve today's performance.

Certainly risky, and one hopes a challenge to be proved wrong, is the following specification of a general nature which is probably the "edge-of-the-art" now and for at least next year in regards to rotator ferrite non-reciprocal switches. Power levels may be scaled to other bands:

Frequency range.....	15 per cent
Isolation	25 db
Insertion loss	0.5 db
Peak power	200 kw (X_u)
Switch time	2 μ sec max (fall or rise)
Temp. Environment	40 to 85 C
Drive power	2 w max

Differential Phase-Shift Switch Boasts High Capacity But Needs Breakthrough

For high-power capacity and 12 to 14 per cent bandwidths the differential phase shift type has been unsurpassed. The most difficult problem with this switch is the waveguide shorted-turn effect of the rectangular TE_{10} mode waveguide combined with the substantially higher field required by this type of circulator. There has been no announced break-through for this problem. Plated plastic and thin-wall stainless-steel waveguides have been used, but the microsecond switch-time performance is still far away. Peak-power capacity of this type of switched circulator is well into the megawatt region in X_L waveguide.

Airtron is doing work in this type of switch, particularly on a reciprocal model in X_L using a switched phase shift section between two side-wall 3-db hybrids. Though not competitive in speed with the low field strength rotator (milliseconds vs microseconds), this reciprocal switch demonstrates the high power capacity and broadband reciprocal switching performance made



Fig. 4. Solid state "tinkertoy" duplexer includes balanced limiters, enabling it to handle 10-kw peaks while recovering in 10 nsec.

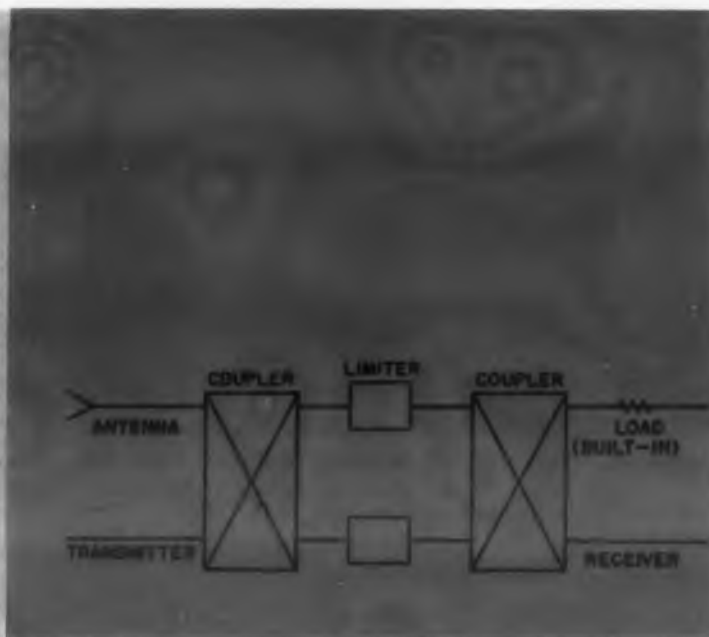


Fig. 5. Diagram shows placement of limiters in the duplexing circuitry.

possible through the unique combination of fixed and switched ferrite phase shifters.

The switching time of this type of circulator may be decreased by substantially increasing the driving voltage. Switch speeds on the order of 750 to 800 μ sec have been obtained at Microwave Associates with a Ka-band phase shift circulator type MA-125E driving the unit with 500-v peak.

We suggest the following specifications as the targets for the near future for the switched differential phase circulators considering all frequencies from K through S band:

Bandwidth	14 per cent
Isolation	25 db
Insertion loss	0.5 db
Peak Power—Waveguide rating	
Switch time	20 μ sec to 90 per cent point
Temperature range	50 to 100 C

Electronically Scanned Antennas Spur Fast, Low-Power Switch Developments

Increasing use of multiple-channel systems which incorporate electronically scanned antenna systems (see "Breakout In Antenna Design," p 166), requires devices capable of switching at speeds in the lower nanosecond region. Since gas and ferrite switches operate at microsecond speeds, the semiconductor diode type of switches

provide the best solution to design problems in which speed is a dominant factor.

Also of prime consideration is the driving power requirement. While circulator-type switches for high power may require up to 10 w of driving power and rotational units for handling medium power may require 1 or 2 w broadband semiconductor switches which handle up to 10 w cw power use only 70- to 100-mw switching power. Narrowband devices (coaxial) for switching at frequencies between 200 mc and 2,800 mc require only 10 mw of switching power.

The limitation of these switches is certainly not speed, since there is no known limit on the speed of switching by either nonlinear resistors or nonlinear capacitors. Though this may seem a strong statement (for example with present limitations of ferrite switches) its truth becomes clear when a switch using either a p-i-n or p-n diode is considered as merely a kind of frequency converter.

In addition to high speed and low-driving power, other design considerations of particular importance to military systems are light weight, ruggedness, and high percentage reliability.

Within the past year, a substantial variety of coaxial and waveguide switches (single-pole-double-throw and single-pole-multiple-throw)

has been introduced by Microwave Associates, Inc., (Fig. 2), and by American Electronic Laboratories, Inc., (Fig. 3). Minimum isolation provided by available units is generally about 20 db with maximum insertion loss ranging from 0.5 db to 2.0 db for units which handle up to 10 w cw power.

Discussion of the relative merits of circulator, rotational, and semiconductor switches is pointless since the initial decision as to what power will be used for the system determines the type of switch needed. Development work by both firms mentioned above is being done to increase power-handling level and to reduce insertion losses. Devices operable up to 40 Gc are anticipated for incorporation into 1961 designs.

Limiters Can Mean System Survival In Strong Radiation Environment

Many radars operating at different frequencies within a relatively limited area, in addition to creating the interference problem mentioned earlier, also create a problem in receiver protection. Aircraft on the ground, taxiing down the runway with radars off, are susceptible to receiver burnout from stray radar signals originating either from nearby aircraft or from ground-based radars (direct or reflected signals).

Semiconductor power-sensitive limiters which have been made commercially available during the past year provide good protection in such instances. They eliminate from design mechanical shutters or switches and insure extremely long life and high reliability.

Devices of this type are being used in retrofit and new systems to replace present crystal protectors. They provide constant protection since they are completely passive and are not dependent upon any external bias.

Where continuous system operation is required, the diode limiters with present capacities up to 5 kw (uhf frequencies) provide significant increases in system reliability. At higher frequencies, units are available with capacities up to 500-w peak.

An all solid-state duplexer which incorporates a balanced limiter configuration was announced by Microwave Associates in October 1960. (Fig. 4). Using the limiters as shown in sketch (Fig. 5), these devices handle up to 10-kw peak power. The recovery time of these units is less than 10 nsec and the transmitter-receiver isolation at rated power and regardless of antenna mismatch is a minimum of 40 db.

Where solid-state duplexers can be incorporated into new designs they eliminate external power sources needed for "keep alive" and provide continuous receiver protection. Advances expected by the manufacturer during 1961 are

availability of higher power handling units and extension to frequencies through K-band.

High Power Filters Can Mean System Operation in RFI Environment

System interference is an acute problem even where actual system burnout is not. Naval ships carry dozens of radar systems from millimeter to centimeter range. High-density coverage, ground-based systems operate in close proximity to each other, feeding common computer centers. Even at airports, one is aware of megawatt S-band surveillance radars, L-band long distance search systems, K-band short range taxi systems, X-band precision approach systems, and all within a few miles of each other. Adding to this radiation jumble are high-power military acquisition radars and airborne C- and X-band commercial radars. Near the airport one can expect an X_b band communication system to be unable to operate across its full allocated band because of pulse radar interference. Like the highways of today, the "microways" are jammed and will get even more packed in future years.

Several basic approaches have been taken to provide efficient filtering of high-power microwave systems. They depend largely on the degree of suppression required and the proximity of the undesired radiation band relative to the signal band.

One approach to the problem is to shunt the spurious radiation into a resistive termination (drop-band filtering). The second is to reflect the undesired signal back to the power source or into an external load by means of one or several hybrids. In all cases the filter must handle high power levels in the passband.

High-Q Filters Based On Hybrids And Reactive Shunts

For large amounts of attenuation at frequencies very near the passband of the radar, high-Q components or circuits are required. Of the high-Q filters several types have been notable. The first of these uses a high-Q bandpass type of filter in conjunction with either top wall or sidewall three db hybrids. The unit in effect becomes a high-powered diplexer. The critical problem with this type of filter is the extremely high electric fields which occur in the resonant sections of the filters at the passband frequencies. One approach along these lines which has been noted in the past is the unique filter design of Wheeler Laboratories in S-band waveguide.

Of the two means of increasing this filter-power capacity (high-pressure or high-vacuum), the Wheeler filter is presently being used with high vacuum. The San Carlos division of Litton

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AV Series—
The smallest, lightest variable step attenuators available, they consist of six or more coaxial attenuators mounted within a single housing. Characterized by low VSWR and zero insertion loss, they are used from DC to 2000 mc.



AW Series—
Waterproof, environmental-resistant, variable step attenuators for use from DC to 4500 mc with low VSWR and zero insertion loss. Their low cost and rugged design make their use practical where other models are prohibitively expensive and delicate.

For in-line mounting.



AX Series—
Waterproof, environmental-resistant, variable step attenuators for use from DC to 4500 mc with low VSWR and zero insertion loss. Similar to AW Series attenuators but designed for front-panel mounting.

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FREQUENCY RANGE (kmc)	4-10	0-5	0-5	0-5	0-2	0-4.5	0-4.5
ATTENUATION VALUES (db)	0-20	0-60	0-30	0-60	0-20 ⁽¹⁾	0-30	0-30
MAXIMUM VSWR	1.40	1.30	1.40	1.40	1.25	1.30	1.30
ACCURACY (db) ⁽¹⁾	±0.5	±0.5	±0.5	±1.0	±0.7	±0.5	±0.5
POWER, AVERAGE (watts)	2	2	5	15	2	2	2
POWER, PEAK (kw)	2	2	3	3	1	2	2
OVERALL LENGTH (in.) ⁽²⁾	8.4	6.9	8.1	10.5	2.8	3.3	4.7
WEIGHT (oz.) ⁽²⁾	33	27	31	40	6.1	9.7	13.3
METHOD OF ADJUSTMENT	knob	knob	knob	knob	(4)	(4)	knob
PUSH-PULL MOTION REQ'D	yes	yes	yes	yes	no	no	no
PANEL MOUNTING	yes	yes	yes	yes	no	no	yes
CHASSIS MOUNTING	yes	yes	yes	yes	no	no	no
WATERPROOF	no	no	no	no	no	yes	yes
PRICE ^{(1) (2)}	280.00	250.00	340.00	430.00	150.00	220.00	240.00

NOTES: (1) 10 db nominal (2) Type N connectors (3) Per turret (4) Knurled finger grip on rotating tumbler

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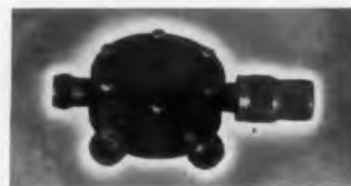
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MICROWAVE COMPONENTS

L-Band Blade and Flush Antennas



Identical in RF characteristics, the new Transco AT-721/A, blade and AT-740/A, flush antennas cover 960 to 1220 MC for IFF-TACAN. Both antennas are built to MIL specifications and can form a part of the complete TRANSOCO multiplex system. Transco Products, Inc., Los Angeles, Calif.



Hybrid

Light weight Hybrids with low VSWR's over a broad bandwidth are available from Transco, in the L, S, and C bands. Hybrid shown is C-Band and has a small 50 ohm load also available from Transco Products, Inc., Los Angeles, Calif.



Precision Attenuator

Motor actuator takes only 50 seconds to actuate from 0 to 100db, direct reading accuracy to .1 db. Can be supplied with 6 preset stops any place between 0 and 100 db. Unit shown is C-Band. Transco Products, Inc., Los Angeles, Calif.



Delay Line

K-Band non-loaded waveguide delay line for ground checkout of a missile radar system. Two delays may be remotely selected and a variable attenuation bleed line (from input to output) is provided with a directional coupler and monitor crystal. Transco Products, Inc., Los Angeles, Calif.



Power Divider

One shown is "3-way even" for operation from 2700 to 3500 MC, typical of complete line of 2 and 3 way dividers for L, S, C, and X-Bands available from Transco. Write Transco Products for full information on all Microwave Components shown on this page.



MICROWAVES

Industries is presently developing techniques, designed to secure a vacuum sufficiently low to enable the transmission of better than a megawatt through the Wheeler filter. The difficult problems encountered in achieving reliable vacuums in the field for this or similar devices is apparent.

Another approach to high-Q filtering is the use of multiple reactive shunt elements. An example of this type of filter was developed by Sage Laboratories. The technique makes use of shunt waveguide stubs whose cut-off frequency (TE_{10}) is just above the system passband. In the stop band, the stubs propagate and thereby present a highly reactive mismatch for these frequencies. Proper location of the stubs preserves match in the passband and optimizes stagger-tuned mismatch in the reject band. It provides moderate attenuation of 30 to 45 db in the stopband and has sufficiently high Q to enable location of the stopband within 2 per cent of the upper limit of the passband. The filter is highly reactive and rejects all power back toward the power source. This particular type of filter could then be used with a resonant absorption isolator or used with three db hybrids to shunt the filtered power off into a resistive load. Band rejection filters of this type have been manufactured by Airtron in the C-band waveguide and exhibit A 0.2-db insertion loss as against a 30-db reduction in the stopband. Power handling capacity is rated at 0.5 megawatt at atmospheric pressure.

Many Approaches Are Taken In Low-Q Filtering

Lower-Q filtering suffices in systems wherein either frequency or twice guide-wavelength harmonics are prevalent or deleterious to other systems. These lower low-Q shunt methods are being developed in a variety of forms. One type of high-power filter designed for attenuating harmonics or frequencies substantially removed from the radar passband incorporates high power sidewall hybrids terminated in resistive waveguides whose TE_{10} mode cut-off is below that of the operating systems. The hybrid is therefore shorted in the system passband. It is, however, resistively terminated in higher unwanted frequencies. The resistive terminations must be effective for the higher order modes that may be encountered at the higher frequencies.

Other types of moderately low-Q shunt filtering take the form of section of waveguide with

multiple branch arms coupling to the stopband frequencies or higher order modes existing in the waveguide but not coupling to the system pass-band TE_{10} mode. Along these lines, Sierra Laboratories announced this year their L-band high-power harmonic filter which uses this coupling technique. Similar in approach is the absorbing filter designed by General Electric for use in high-power S-band systems. This particular GE filter utilizes a large number of resistive-shunt waveguides coupling to higher order modes or frequencies substantially out of the system pass-band. This type of filter is of the low-Q type, but offers particularly good suppression at high powers. Another type of high-power filter which lacks bandwidth but which has interesting possibilities is the bridge-type or constant resistive filter. This filter consists of several hybrids connected in the form of an rf bridge with symmetrical arm lengths. It is designed to pass power in the system passband, yet shunting power in a particularly unwanted band into a resistive load. This technique has been used in the past with very low powers for diplexing in communication systems (Bell systems). This constant resistance type of diplexing system is also applicable to extremely high powers with suitable design of the hybrids involved.

Magnetic Bias Sensitivity Used As Design Basis For Unique Ferrite Filters

A unique application of ferrites in high-power harmonic filtering makes use of the magnetic-bias sensitivity of the resonant-absorption region of ferrite material. With suitable magnetic bias (transverse direction), ferrite strips or sheets, located on the waveguide broad wall may be made absorptive at one or more harmonics. Since resonance in the passband, is well below the magnetic bias used, low loss is encountered in transmission of pass band power. First, apparently, to produce operating units in this area is Sperry Gyroscope's Long Island Microwave Div. Work here was done in the L-band region.

The disadvantage of the technique is chiefly the high field and extended area of flux required which necessitates very large and therefore heavy magnetic structures. The suppressed frequency region must also be appreciably removed from the pass band in order to avoid large pass-band loss. ■ ■

Significant advances in other areas of Microwave Components will be the subject of a future ELECTRONIC DESIGN article by authors Robert Terry and Robert Allen.

LITTON INDUSTRIES MICROWAVE TUBES P, L, S, C, X, K BANDS

KLYSTRONS

Type Number	Frequency Range Megacycles	Peak Power (Minimum) Megawatts	Cathode Pulse Length Microseconds	RF Duty Ratio	Remarks
L-3270	1250 to 1350	2	8	0.0025	Broadband (100 megacycles between 2 megawatt points)
LT-7504 (L-3035)	1240 to 1360	2.2	8	0.0025	Long range search radar
L-3257	1280 to 1330	4	30	0.0003	For linear accelerator
L-3227	1280 to 1330	5	8	0.002	For linear accelerator
L-3250	1250 to 1350	10	7.2	0.0015	Long range search radar and linear accelerator
L-3387	1250 to 1350	30	7.2	0.0033	Long range search radar
L-3302	2855	10	7.2	0.0015	For linear accelerator and radar
L-3355	1250 to 1350	20	7.2	0.0015	Long range search radar

TRAVELING WAVE TUBES

Type Number	Frequency Range Megacycles	Power Output	Focusing	Duty Factor
L-3266	7000 to 11,000	20 mw	PPM	CW
L-3236	7000 to 11,000	2 W	PPM	CW
L-3470	4000 to 8000	20 mw	PPM	CW
L-3471	4000 to 8000	2 W	PPM	CW
L-3472*	8500 to 9600	10 W	PPM	CW
	7000 to 11,000	5 W		
L-3264*	100 to 300	100 W	Solenoid	CW

* In development

M-TYPE BACKWARD WAVE OSCILLATORS

Type Number	Frequency Range Megacycles	Power Output	Focusing	Factor	Remarks
L-3148	8500 to 11,000	150 watts minimum	Permanent magnet	CW	No holes in a 1.5/1VSWR

A complete line of M-BWO's is available but classified

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PULSE MAGNETRONS

Type Number	Frequency Range Megacycles	Peak Power (Min.) KW	Duty Ratio	Remarks
L-3204	8800±25	0.04	0.25	Extremely high duty
L-3105	9300±40	0.10	0.027	Highly ruggedized; frequency stable
L-3028	9280 to 9320	0.12	0.027	Frequency stable; pulse train capability
L-3379	8800 to 9500*	1.0	0.003	Highly ruggedized; frequency stable
L-3058	9330 to 9350*	1.0	0.003	Frequency stable
L-3358	16,000 to 16,500*	1.0	0.001	Highly ruggedized; frequency stable
L-3380	8800 to 9500*	2.0	0.002	Highly ruggedized; frequency stable
L-3359	16,000 to 16,500*	2.0	0.001	Highly ruggedized; frequency stable
L-3381	8800 to 9500*	3.0	0.001	Highly ruggedized; frequency stable
L-3382	8800 to 9500*	4.0	0.001	Highly ruggedized; frequency stable
LT-6233	9280 to 9345	7.0	0.003	High duty beacon magnetron
L-3103	8500 to 9600*	30.0	0.002	High duty version of LT-6543
L-3168	9375±30	30.0	0.002	High duty version of LT-4J52A
L-3306	16,000 to 17,000*	30.0	0.002	High duty version of L-3083A
L-3083A	16,000 to 17,000*	60.0	0.001	Recommended for new systems
LT-6543A	8500 to 9600*	65.0	0.001	Recommended for MTI systems
L-3305	8600 to 9500*	65.0	0.001	Recommended for frequency diversity
LT-6510	9375±30	65.0	0.001	Recommended for MTI systems
LT-4J52A	9375±30	70.0	0.001	Recommended for new systems
L-3312	8500 to 9600*	200.0	0.001	In development
L-3313	8600 to 9500*	200.0	0.001	Hydraulically tunable for frequency diversity
LT-4J50A	9375±30	225.0	0.001	Recommended for new systems

*Fixed frequency versions available generally throughout tunable range.

CW MAGNETRONS

Type Number	Frequency Range Megacycles	Minimum Power Watts	Remarks
L-3456	350-590	500	These CW Magnetrons may be pulsed to approximately 2 kilowatts peak power and are recommended for component testing.
L-3459	590-975	500	
L-3465	975-1500	400	
L-3464	1500-2350	400	
L-3460	2350-3575	500	
L-3461	3575-4975	400	
L-3467	4975-6175	400	
L-3468	6175-7275	300	
L-3462	7275-8775	300	
L-3463	8775-10,475	250	

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Test Equipment Developments Speed Microwave Progress



Four problem areas impeding microwave development were recently eased by advances in test equipment. The spectrum squeeze has made exploitation of the millimetric band a necessity. The international and, eventually, interplanetary scope of microwave experiments has made reliable standards a critical requirement. Power measurements have suffered from drift and from slow read-out. Finally point-by-point frequency tests have taken hours in production testing. Authors Poulter (left) and Minck describe the techniques used to break these bottlenecks and sample some of the instruments that embody the techniques.

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Development Manager

John Minck
Applications Engineer
Microwave Div., Hewlett-Packard Co.
Palo Alto, Calif.

MICROWAVE test equipment design is responding to the needs generated by an accelerated pace of microwave-system developments. It is, at the same time, taking advantage of the rapid developments in components, materials, and fabricating techniques to fill these needs. Typical of recent progress in microwave test instrumentation are new developments in (1) millimeter waveguide, (2) measurement standards, (3) power measuring instruments and (4) swept-frequency testing.

Millimeter Waveguide Expands Spectrum Many Times

Until the past few years millimeter-waveguide development was seriously hampered by a lack of adequate microwave-signal sources. Recently, however, some significant tube advances have been made in the millimeter regions. Using these tubes and other devices such as crystal harmonic generators, considerable effort is now being expended in the region up to and above 100 Gc (kmc)^{1,2}.

Making research in this region practical are the *F* and *G* band waveguide-equipment lines developed by FXR, Inc., Woodside, N.Y. Because

millimeter waveguide cannot be produced merely by scaling down from lower frequency waveguide, a high degree of design ingenuity was needed to arrive at a workable product line.

For instance, the FXR slotted line shown in Fig. 1 departs from the conventional practice of using a moving probe. In this case the probe is stationary, and the standing-wave pattern is moved past it by means of an integral phase shifter. Normal SWR measurement techniques are further modified because of high losses in the guide between the line and the device under test. A nomogram is furnished to help determine the appropriate compensation for these line losses.

Much of the millimeter waveguide development has already been useful in spectroscopy and plasma studies of various types. The new techniques, however, are expected to have increasing value to other applications, both commercial and military. One area of special interest is the booming space-communications business where small components and antennas, and narrow beam-widths are particularly desirable.

Measurement Standards Tie Together World-Wide Experiments

An outstanding characteristic of our present "aerospace" era is that microwave experiments are no longer confined within a single laboratory, or even a given locality. Instead, many applications of microwaves are worldwide in scope—and they may easily be expected to become uni-

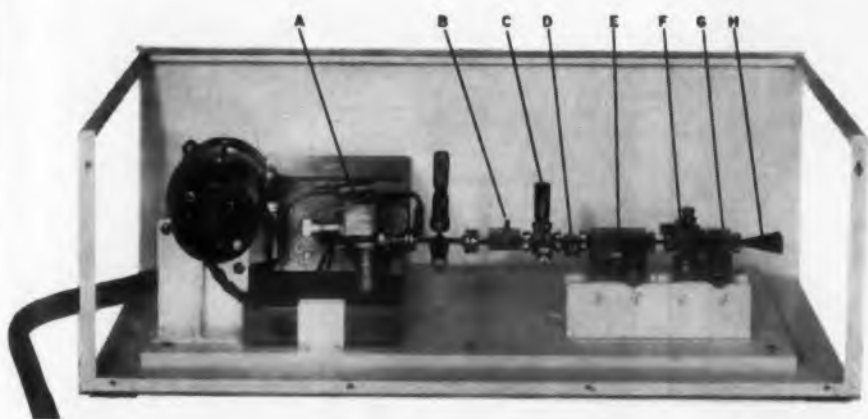


Fig. 1. Waveguide test bench for work in the 140 to 220 Gc range by FXR, Inc. The set-up includes (A) Raytheon's QK369 klystron, (B) Harmonic Generator, (C) E/H tuner, (D) Frequency meter, (E) Precision variable attenuator, (F) Detector mount and crystal cartridge, (G) Slotted section, and (H) Horn.

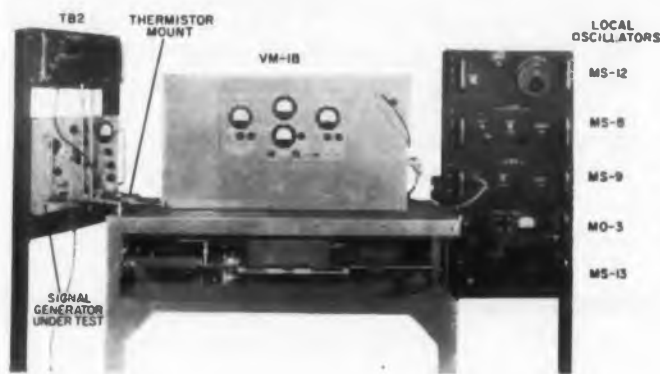


Fig. 2. Signal generator attenuators may be calibrated to high accuracy down to low level of -107 dbm using this Weinschel VM-1B attenuator comparator set-up which compares the unknown attenuation against a precise cut-off attenuator.

verse wide in the future. This extension of the area covered by a single experiment, or by a single operating system, has created an urgent need for standardization of measurements and techniques. Problems of standardization encompass the entire microwave field including the common measurements of power, attenuation, frequency and impedance.

The Boulder Laboratories of the National Bureau of Standards have spearheaded the work in standardization. This surge of activity in the standards field has also extended into all areas of microwave test equipment, design, production, and application. One noticeable result has been that most companies supplying equipment to the government are being asked to furnish calibrations "traceable to the National Bureau of Standards" as assurance of reliability and proper specification control. This government requirement has led, in turn, to special attention in standards techniques, and to a renewed interest in processes and execution of these techniques.

One example of an instrument recently introduced to make standard power measurements more conveniently is the Weinschel Model PB-1 Precision Dc Power Bridge. This instrument accurately sets and controls substituted power in

bolometer mounts to help make more accurate power measurements. Coupled with a precision potentiometer, standard cell, a well-regulated power supply, and a galvanometer, all commonly found in standards labs, this bridge determines substituted power to accuracies of better than 0.3 per cent.

Maximum convenience is obtained by placing the bolometer mount on the secondary arm of a 3-db directional coupler. This permanent combination may then be certified for a calibration factor by the NBS Calibration Center at three frequencies in X-band. The "calibration factor" is defined as the ratio of dc substituted power to incident rf power leaving the main arm. This arrangement thus provides a very reliable transfer standard from the precise micro-calorimeter type of measurements made at NBS, and offers a reasonable means for achieving accurate power measurements in other standards laboratories.

Another commercial instrument that provides excellent measurement accuracy is the Weinschel Model VM-1B Standard Attenuator Calibrator. (Fig. 2.) It is used to make attenuation measurements of microwave attenuators, by comparison with an extremely precise 30-mc piston attenuator³. A 30-mc heterodyne signal is obtained



Fig. 3. This Narda Model 440A power bridge is fully transistorized allowing it to operate from a rechargeable nicad battery. This eliminates drift caused by changes in bolometer bias current and provides for a fully portable rf power measurement.

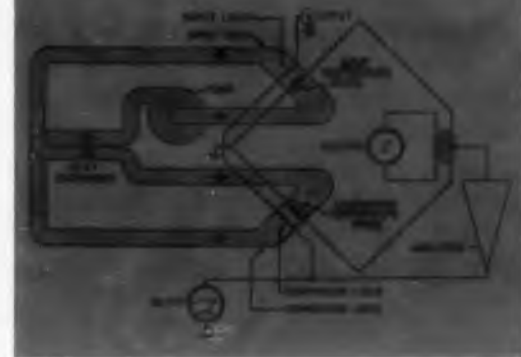


Fig. 4. Functional diagram of the Hewlett-Packard Model 434A colorimeter. Response time is less than 5 sec since an oil stream carries heat from the microwave load to detection gauges. Coaxial input accepts power from dc to 12.4 Gc.

by mixing a local oscillator with the microwave output of the attenuator under test. This 30-mc signal is compared at a 1,000-cps rate with the 30-mc precision signal from the standard attenuator, by use of an if amplifier and detector. Thus, the if amplifier and detector elements are balancing elements only, and for this reason their stability does not affect accuracy. This bridging scheme permits measurements of signal generator attenuators in the region of -97 dbm to accuracies of 0.1 db/10 db.

Power Measurements Are Made Faster, More Stable

One of the major achievements in instruments for microwave-power measurements has been reduction of drift caused by ambient changes in the bolometer operating points. Several approaches have been used successfully. The new Narda Model 440A Microwave Power Meter (Fig. 3) minimizes a serious drift problem caused by sensitivity of the zero point to dc bias variations. This is done by designing a transistorized instrument in which an internal battery provides a stable dc source.

Another new power meter, the FXR Model N831A uses a dual thermistor arrangement to

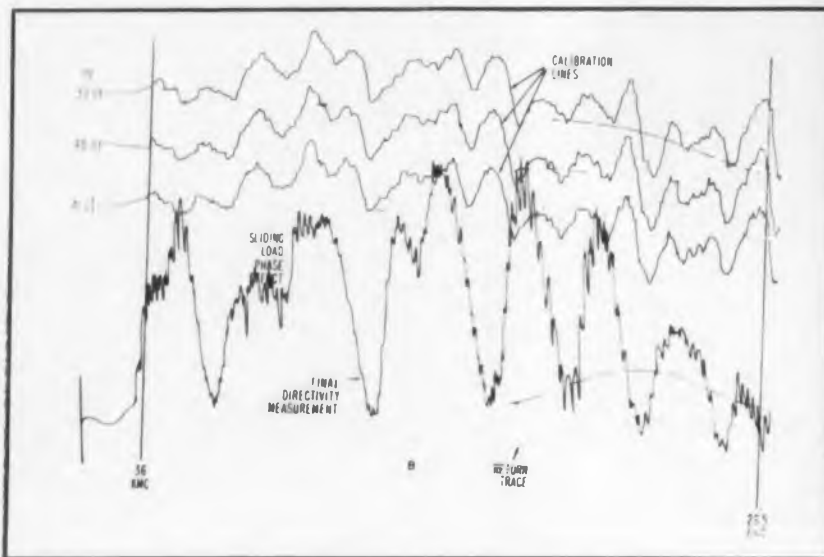


Fig. 5. (a) Block diagram for swept-frequency directivity test on broadband directional couplers from 26.5 to 36 Gc. X-Y calibration records are shown in (b). Calibration lines are plotted by replacing sliding load with a short and making three sweeps with 39, 40, and 41 db set on the Model 382A attenuator. Attenuator is then set to 0 db and sliding load replaced on main line. As sweeper slowly covers the band, the operator manually phases the sliding load in and out, producing fine structure on the final curve, and thus eliminates the effect of load reflection vector on the measurement.

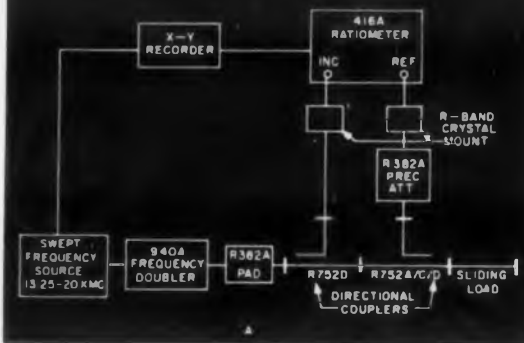


Fig. 6. Hewlett-Packard Model 185A sampling oscilloscope faithfully displays sub-nanosecond pulses with its DC-1000 megacycle bandwidth. High sensitivity of 3 mv per cm permits even small reflections from vhf elements to be analyzed with ease using pulse reflection techniques.

eliminate another basic cause of zero drift. One thermistor is exposed to the rf power, and the other is used as a temperature-balancing element. Through this method, the over-all drift has been reduced sufficiently to achieve an additional 10 db of sensitivity. This provides an over-all power sensitivity of 10 μ w.

Ultimate accuracy in microwave-power measurements continues to be achieved with calorimetric techniques. Thermal time constants, however, have generally limited usefulness by requiring long stabilizing and reading times.

Reduction in the reading time of calorimeters is provided by the Hewlett-Packard Model 434A (Fig. 4) Calorimetric Power Meter. In this instrument the full scale response time is less than 5 sec by transferring the heat from input microwave power to comparison gauges by means of a flowing oil. The oil stream moves past both a microwave and a dc load, in two thermally identical terminations. Feedback and comparison circuitry set the dc power equal to the microwave power, and the dc is metered for power indication. Even after allowing for substitution errors, the Model 434A has an over-all accuracy of 5 per cent. Considerably greater accuracy can be achieved by careful calibration for the power and frequency range being used since the 5 per

cent figure applied to power values from 10 mws to 10 w at frequencies from dc to 12.4 Gc.

Swept-Frequency Techniques Cut Production Testing Time by 10

Production testing of microwave test equipment has often required a disproportionate amount of time as compared to other microwave components. Testing has been more time-consuming because most microwave test equipment is specifically designed to be broadband, and because tight specifications are normally established for the entire rated bandwidth. As waveguide coverage of the frequency spectrum has increased, point by point testing techniques have rapidly become not only laborious but extremely expensive.

For many years the measurement of swr on a swept frequency basis through reflectometer techniques has provided a reliable fast means of test for most microwave instruments⁴. Until recently, however, swept-frequency tests have generally been restricted to ranges at which active swept frequency microwave sources have been available. The practical limit has been about 18 Gc.

A recent Hewlett-Packard development, Models 938A and 940A Frequency Doubler Sets, extend the usable range of swept-frequency

measurement techniques up to 40 Gc. The doubler sets utilize broadband crystal harmonic generators with relatively low conversion loss to yield in the order of 1/2 to 1 mw from 18 to 40 Gc in two bands when driven with typical commercially available backward wave oscillators.

Point-by-point production testing techniques used on a Hewlett-Packard Model R752C required measurement of directivity at 26 points across the 26.5 to 40 Gc band, and took several hours. Now, by using the Model 940A frequency doubler, as shown in Fig. 5, directivity tests are made on a swept-frequency basis, with total measurement time-out to the order of 20 min.

Future Trends—Drawing On Component Advances

Looking ahead we can expect to see new tubes which will provide microwave power for signal generators in higher and higher frequency bands. Pulse powers are now being used in the millimeter region, and commercial spectrum analyzers will soon be available for more accurate and detailed pulse analysis up to 90 Gc.

More types of microwave test equipment will soon be transistorized, bringing both added reliability and more convenient size. New measuring conveniences, greater accuracy, and better

MICROWAVES

stability are among the features which will be advertised during the coming year by microwave test equipment manufacturers.

Testing techniques will also be reviewed to take advantage of new equipment developments such as sampling oscilloscopes. Notable are Lumatron's model 12 and Hewlett-Packard's model 185A (Fig. 6). Devices of this type can give 3-db bandwidths of as much as 1,000 mc with extremely high effective sweep speeds to yield a unique display of reflections out of vhf and uhf devices. Testing methods have already been devised⁵ which use the radar technique of inserting a nanosecond pulse into the piece of equipment under test. The reflected pulse is then viewed on the sampling oscilloscope, and all of the reflections are analyzed on a time-separation basis.

One example of this is a test used to compensate the four resistive "pi" network pads of a vhf attenuator. The four reflections were observed time-separated on the scope face and adjustments were made individually. The test permitted speedy adjustment and resulted in increased bandwidths as well.

As sampling oscillography moves up the frequency range, and sub-nanosecond pulses become available, additional techniques will be worked out to take advantage of the faster and more accurate measurements possible. Instruments designers are now working out design and fabrication techniques which will utilize the more recent advances in semiconductors, tubes and ferrites produced by the components industry. The never-ending process of design innovation shows no signs of slowing down. ■ ■

Acknowledgement

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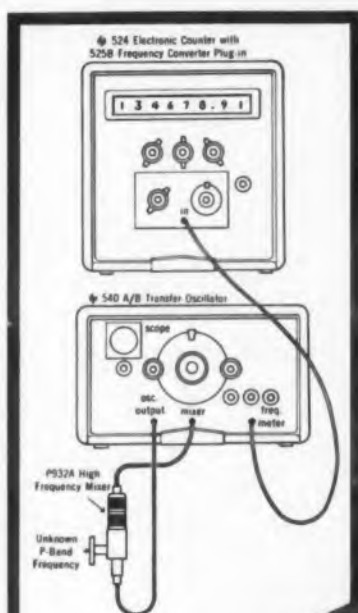
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hp P932A maximum input power is 100 mw, minimum video output is 0.1 mv rms with 0 dbm input, output impedance 1000 ohms with 35 $\mu\mu\text{f}$ shunt, sensitivity approximately -10 dbm. \$250.00.

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	524C/D + 525B + 540B + P932A (0-10 MC) (100-220 MC) (220 MC - 12.4 KMC) (12.4 - 18 KMC)	\$3,400.00

*Based on 524D Frequency Counter \$2,150.00. 524C price \$2,300.00. Counter and Transfer Oscillator prices are for cabinet mounts; rack mounts are slightly lower.
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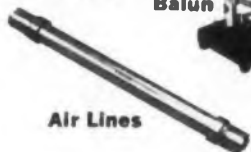


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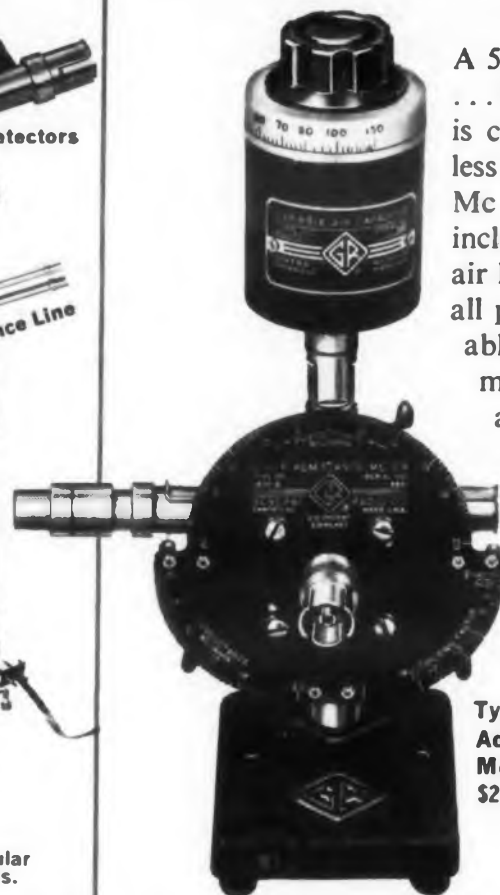


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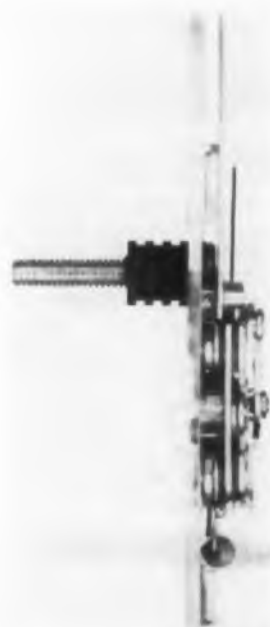
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A printed circuit rotor, no more than 8-mils thick, is at the heart of an unusually thin panel meter. Base material for the printed rotor, in a 5-ma movement, is 4-mil-thick, anodized aluminum. The anodizing serves as the insulation between the pure aluminum and the laminated copper which is bonded to both sides of the base and etched. The aluminum base provides much of the necessary meter damping.

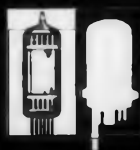
(continued on p 186)



Paper-thin meter rotor consists of printed coils on anodized aluminum base.



Surface-mounting panel meter in side view (shown without case).



Bendix Craftsmanship at work for you

TYPICAL SPECIFICATIONS			
	Phase Shifter	Y Circulator	Attenuator
Frequency Range	5700 to 5800 mc	4700 to 5700 mc	4900 to 5800 mc
Insertion Loss	1 db max	0.4 db max	1 db max
Impedance	50 ohms	50 ohms	50 ohms
VSWR	1.30 max	1.20 max	1.75 max
Power Handling Capacity			
Average	5 watts	10 watts	5 watts
Peak	5 kilowatts	10 kilowatts	5 kilowatts
Temperature Range	-55 C to +85 C	-55 C to +85 C	-55 C to +85 C
Diameter	1.12"	2.375"	1.12"
Weight	6 oz	11 oz	6 oz

NEW BENDIX® MICROWAVE FERRITE DEVICES.* 1 The Electrically Variable Phase Shifter, TFP-1, can produce phase shifts in excess of 90° over a minimum bandwidth of 10%. Chief uses are as phase modulator, fast shift, and in a wide variety of r-f direction finding devices. 2 The Y-Circulator, TFC-1, offers at least 20 db isolation with less than 0.4 db insertion over bandwidth exceeding 20%. Ideal for use with masers, and parametric amplifiers. 3 The Electrically Variable Attenuator, TFA-1, has a range exceeding 25 db over a minimum bandwidth of 15%. Useful in fast AGC circuits and remote level control applications. Write today.

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Red Bank Division

EATONTOWN, NEW JERSEY



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size . . .



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PYROFILM CARBON FILM microwave resistors

are
100% greater
in rated
power

Now . . . from Pyrofilm, a complete range of microwave resistors that supply twice as much power dissipation per unit area at higher voltages than other dissipative types.

Meeting your requirements for greater power, Pyrofilm's rod and disc microwave resistors are available in 1/2 to 6 watt power ratings.

Configurations are matched to your specifications. Varnish that withstands 200°C for prolonged periods of time renders these resistors virtually insensitive to environmental and atmospheric conditions.

Whenever your designs include microwave resistors, Pyrofilm's technical staff will gladly assist you.



FEATURES

- RESISTANCE RANGE: 1 ohm to 800 ohms
- STANDARD TOLERANCE: 1%
- RATED POWER: Full power at 70°C derated to zero at 150°C
- EXTREMELY LOW NOISE LEVEL
- INHERENTLY NON-INDUCTIVE
- TEMPERATURE COEFFICIENT: -.020 to .023%/°C
- TEMPERATURE RANGE: -55°C to 150°C

For additional information write for catalog C-60

PYROFILM RESISTOR COMPANY, INC.

U. S. Highway #46 • Parsippany, New Jersey
DEarfield 4-8282

CIRCLE 199 ON READER-SERVICE CARD

DESIGN DECISIONS

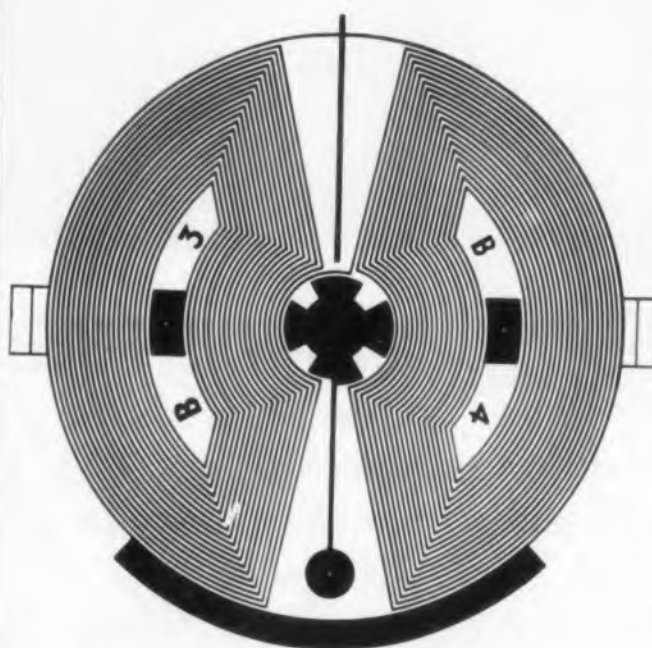
The rotor, with its nylon pointer, weighs less than half a gram. It is pivoted between a 0.1-in. ceramic ring magnet and a steel front plate which completes the magnetic circuit. (The magnet is twice as thick for 1-ma movements.)

The ring magnet provides immunity to the effects of stray magnetic fields so the meter can be mounted on any surface, even in the presence of a field.

Since the pointer is made of nylon, it can be pinned without damage. The printed wiring is also highly immune to overload damage. Since every turn of the printed coils is exposed to air, the movement can tolerate a long exposure to 1000 per cent overload (5000 per cent for the 1-ma movement).

The complete movement, weighing about an ounce, has about 1/9 the weight of conventional meter movements. Not counting terminals, the 1/2-in. thickness of the meter is about 1/5 the thickness of conventional units.

Manufactured by Parker Electrical Instrument Corp. of 375 Fairfield Ave., Stamford, Conn., the meter provides another advantage which cannot be overlooked—convenience. In mounting it, there is no need to flycut a hole for the meter body. It's merely necessary to drill two 3/8-in. holes, 1-1/2-in. apart.



From the front, if the case were on, this panel meter would look like many others.

Initial Condition Circuit Allows An Analog Computer to 'Remember'

A standard operational-amplifier integrator can be given a "memory" by feeding a signal to



360° of versatility

Gamewell SG-270 Precision Rotary Switch.

A precious metal ring is the heart of a Gamewell Style SG-270 Precision Rotary Switch.

This perfect circle of metal may be cut into as many angular segments or positions as desired . . . providing the precise basis for a highly versatile switching component . . . can be assembled with potentiometer sections if desired.

Custom designed, the SG-270 switch is ideal for circuit sampling, sequencing, programming, digital generators, etc. Connections to the segments are made through terminals adjacent to the segments on the periphery of the housing. Precious metal rings and brushes provide smooth, trouble-free action with either Make Before Break (MBB) or Break Before Make (BBM) contacts. Multiple gangs can be assembled to provide multi-pole switches. Cased in special plastic, the SG-270 switch is inherently fungus resistant . . . stable at high temperatures . . . sizes 3/8" — 1 1/4" — 1 1/2" — 2" — 3" — 5" diameter in various mounting styles. It can be used with confidence over a wide range of environmental requirements. Write, stating requirements, to THE GAMEWELL COMPANY, 1396 Chestnut Street, Newton Upper Falls 64, Massachusetts. A Subsidiary of E. W. Bliss Co.

BLISS

Gamewell

Precision Potentiometers
"Integrals of High Performance"

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CIRCLE 911 ON CAREER INQUIRY FORM, PAGE 219
ELECTRONIC DESIGN • November 23, 1960

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EXTREME . . .

NEW
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ENVIRONMENTAL
CONNECTORS

Series ME-2000
and FE-2000

This Hi-Reli-Acon Environmental Type Connector is designed to fulfill the rugged environmental requirements of MIL-C-26500.

Outstanding features include resilient rubber inserts which provide sealing throughout extremes of temperature and pressure. Contacts are of crimp style and are basically designed about the requirements of MIL-C-26636. The connectors are available with 55 contacts or less. Strain relief clamp hardware, is optional.

Complete information & technical data are available . . . write today!



Methode manufacturing corp.
7447 W. Wilson Ave. • Chicago 31, Ill.

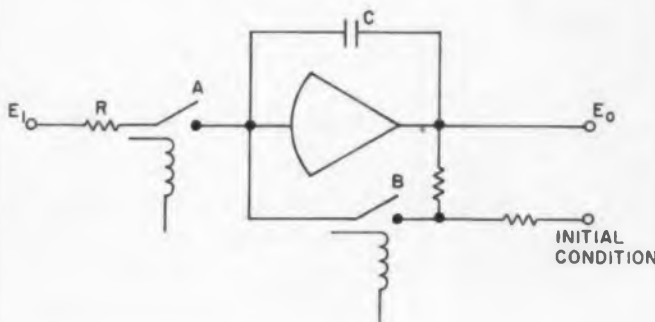
CIRCLE 202 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960

the initial-condition input instead of the normal input.

The theory is to use the integrator's feedback capacitor to "track" the voltage at the initial-condition input, and, when desired, have the capacitor "sit" at one voltage by opening a relay in the initial condition circuit.

To set an initial condition in the typical integrator circuit shown, relay A must be open and relay B closed. The output voltage—the voltage across the capacitor—will be the negative of the initial-condition voltage.



Standard operational integrator, can "store" voltages introduced at "initial-condition" terminal. For this application, device does not work as integrator and normal input is not used—relay A is opened.

If relay A then is closed and relay B is opened, the circuit will integrate the voltage at the normal input, E_i . The integrated voltage waveform, E_o , will begin with the previously-set initial condition. After a time duration, the output may be reset to the initial condition by opening A and closing B. Thus, the output can be made cyclic.

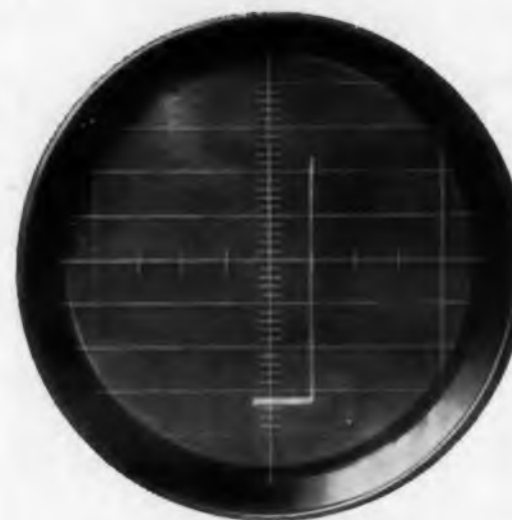
The "memory" function is achieved by coupling the output of a standard integrator to the initial-condition input of another integrator. In this second integrator, relay A always is open and relay B always closed.

Thus, the output of the first is reproduced across the capacitor of the second—or, the second integrator "tracks" the first. If relay B in the second integrator is opened, the integrator's output becomes a constant—the output value existing at the moment of opening.

Thus, the second integrator either "tracks" or "stores" a voltage, but does not integrate it.

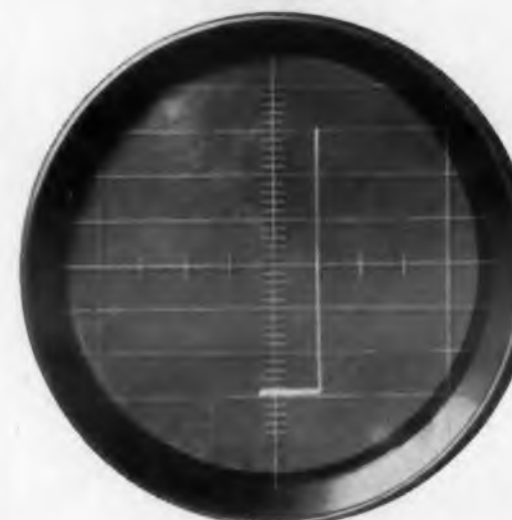
This technique was incorporated in operational-integrator modules produced by Computer Systems, Inc., New Brunswick, N. J. In practice, the switching is done electronically rather than with relays. The comparatively long switching time of relays would limit the system to handling waveforms with long time constants.

Depending on the polarity of the switching signal and its amplitude with respect to a reference, the memory can be made to hold during either the reset or operating part of the cycle.



(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 "torque 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.



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Food Machinery and Chemical Corporation
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A REVOLUTIONARY PRESSURE TRANSDUCER WITH 5V. D-C OUTPUT

3S-G

TRIPLE

SOLID-STATE STRAIN GAUGE TRANSDUCER

OTHERS MAY HAVE PROMISED IT... STILL OTHERS MIGHT HAVE HINTED THEY'RE ON THE VERGE OF GETTING IT... BUT ONLY FAIRCHILD HAS IT!... THE INDUSTRY'S FIRST 3S-G

The Fairchild 3S-G combines the best overall characteristics of both strain gauge and pot-type transducers, has none of their inadequacies. It has a semiconductor strain-gauge sensor. It possesses extraordinary accuracy and environmental capabilities. It produces a 5-volt d-c output signal that eliminates the need for impedance-matching or signal amplification. In its utter simplicity (only two mechanically-functioning parts) it is extremely reliable. It also incorporates a resistive calibration device.

The Fairchild 3S-G is responsive to both static and high-frequency dynamic pressures. It is fully compatible with existing military ground telemetry and industrial systems. It is competitively priced, measures all media and is insensitive to case distortions.

The Fairchild 3S-G is only 3" long, 1 1/8" diam., and weighs only 5 ounces. It meets and exceeds MIL-E-5272B. Pressure ranges from 0-100 to 0-10,000 psig full scale now available, below 100 psig will be available soon. Better than $\pm 0.1\%$ linearity and 0.1% hysteresis over temperature range of -65 to $+250^\circ\text{F}$. Both zero and full range sensitivity change less than 0.5% over any 100°F excursion within the rated temp. range. It has infinite resolution.

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TRANSducers
RATE GYROS
POTENTIOMETERS
ACCELEROMETERS

CIRCLE 205 ON READER-SERVICE CARD

NEW LITERATURE

Batteries

261

This two-page data sheet, No. P102, describes the firm's Silvercel P-1517 (silver-zinc) battery having a typical discharge of 135 amp for 12 min. Electrical characteristics and typical applications, such as underwater propulsion and aircraft electronics, are described. Discharge curves, environmental and physical characteristics are included. Yardney Electric Corp., 40-50 Leonard St., New York 13, N. Y.

Magnet-Wire Varnish

262

Isonel 31 varnish designed for use with Poly-Thermalized and similar magnet wires, is described in this four-page bulletin, No.S-123. Applications of the varnish are listed. Curves of thermal capabilities and bonding strength are given. Schenectady Varnish Co., Inc., Schenectady 1, N.Y.

Computer Logic Systems

263

A series of 17 modular, plug-in logic circuits for 500 kc operation in digital computers is described in this six-page bulletin. Designated the series 4000 system building blocks, the devices include flip-flops, inverters, pulse generators and amplifiers, delays, clocks, decoders and amplifiers. Diagrams and specifications accompany the descriptions of each module. Digital Equipment Corp., Maynard, Mass.

Fibre Control Tape

264

Bulletin No. 1313, two pages, describes Peerless fibre control tape for machine-tool control and data-processing applications. Durability of the fibre tape is compared with that of paper tape. Illustrations and tabulated physical properties and prices are given. National Vulcanized Fibre Co., 1060 Beech St., Wilmington 99, Del.

Random-Noise Generator

265

This four-page illustrated brochure describes the firm's type 1390-B random-noise generator. A basic schematic of the instrument, curves comparing the amplitude distribution of random noise with that encountered in active communications systems and amplitude-frequency characteristics of the noise generator are included. Typical applications are given. General Radio Co., West Concord, Mass.

NATIONAL'S



Self-locking, wear-resistant, machined, stainless steel threaded inserts for use in aluminum and brass. Easily applied, their dependable grip in the parent metal as well as their permanent self-locking ability make them ideal for a diversity of critical uses. The complete line includes one basic type in four sizes. Each of the four sizes are available for insertion into any of five metal thicknesses. All National Radio Company self-locking captive nuts are made to conform with the following specifications:

Material Stainless steel Class 303 per FED QQ-S-763b.

Finish Passivated per MIL-P-12011.

Threads Size 4, 6, and 8 NC-2B.
Size 10 NF-2B

National Radio Company also manufactures other captive nuts and studs including the line of exclusive "Flush Mount" types. Available in five sizes for use in metal thickness from 1/16" up, this type of captive nut fits flush on both sides of aluminum or brass sheet to provide strong permanent tapped holes.

National Radio Company's engineering staff will be glad to discuss your applications and possible variations to best meet your requirements.

NATIONAL RADIO COMPANY, INC.

MELROSE 76, MASSACHUSETTS

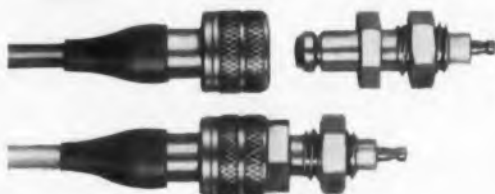
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Push the plug straight into the receptacle and it locks into place ... only a direct pull on the spring-loaded plug collar will release the connection ... no twist, no tools, no noise.



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vibration	up to 10G's at 10-3000 cps
shock	up to 100G's, any axis
temperature range	-70° to +550°F
voltage breakdown	1500v rms minimum at 1 atmosphere
frequency range	0 to 12 KMC
impedance	50, 75, 95 ohms
VSWR	1:1.2 maximum
typical weight, plug	0.10 ounces
receptacle	0.10 ounces

Immediate delivery of a host of standard plugs and receptacles ... fast factory modification to your specifications.

Send for EPL Connector Catalog ... complete specs, outline drawings, construction details, prices ... Snap-Lock and friction-held connectors.

Electro-Physics Laboratories

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division of Marshall Industries

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CIRCLE 207 ON READER-SERVICE CARD

Crystal-Can Relays

266

This three-page bulletin describes the firm's series MV crystal can relays including those meeting Mil specifications. Dimensional drawings, specifications and ordering information are included. Elgin National Watch Co., Electronics Div., 2435 N. Naomi St., Burbank, Calif.

Format Control Buffer

267

This four-page data sheet describes the firm's type ZA-751 format control buffer for data processing systems. The instrument makes digital magnetic tapes in the IBM 727/729 format suitable for entry into IBM 650, 704, 705, and 709 electronic data processing machines. Input can be from analog-to-digital converters, time-code generators, punched-card readers, electric typewriters, punched paper tape and digital magnetic tape. Principles of operation of the instrument and technical specifications are given. Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif.

Blowers and Fans

268

Applications, specifications and descriptions of blowers and fans are given in this 16-page catalog. Housing, duct-panel, control and filter-grille assembly information is included. McLean Engineering Laboratories, Inc., Box 228, Princeton, N. J.

Semiconductors

This 12-page catalog presents specifications and dimensional diagrams for vhf transistors manufactured under the post-alloy-diffusion process for convertor, mixer and oscillator applications. This process is described in the catalog. Also included are specifications and diagrams for germanium pnp and npn audio, computer and switching transistors, germanium and silicon reference and power rectifier types, and photodiodes. Write on company letterhead to Amperex Electronic Corp., Dept. ED, 230 Duffy Ave., Hicksville, N.Y.

Batteries

270

This two-page data sheet, No. P104, describes the firm's type P/N 5522 Silvercel battery developed for guidance systems, telemetering, servo and hydraulic controls, and radio beacons and strobe lights in missile nose cones. Typical applications, discharge curves, electrical, environmental and physical characteristics are given. Yardney Electric Corp., 40-50 Leonard St., New York 13, N. Y.



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These extensive facilities for engineering, test and production are described in a comprehensive brochure. It is yours for the asking.



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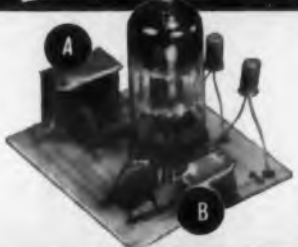
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Permit positioning foil-wrapped components A & B closely, minimizing interaction due to magnetic fields . . . making possible compact and less costly systems.

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Shielding cables reduces magnetic radiation or pickup.



Wrapping tubes prevents outside magnetic interference.

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Composite photo demonstrating that magnetic shielding qualities of Rigid Netic Alloy Material are not significantly affected by vibration, shock (including dropping or bumping) etc. Netic is non-retentive, requires no periodic annealing.

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NEW LITERATURE

Toroidal Inductors

A 24 x 36 in., metal-edged wall chart describes toroidal and variable inductors. Twenty graphs provide Q-vs-frequency curves for several ranges of voltage and inductance. A table supplies electrical and physical data for 25 typical toroidal inductors, and provides diagrams and sizes of several commonly-used hermetic and epoxy-potted metal cases. Similar information is given for variable inductors. Write on company letterhead to Burnell & Co., Inc., Dept. ED, 10 Pelham Parkway, Pelham Manor, N.Y.

Capacitors

272

Metallized, epoxy-cased capacitors are described in one-page data sheet No. DE. Specifications and temperature-characteristics curves covering insulation resistance, dissipation factor and voltage derating are shown. Physical dimensions and part numbers for 200, 400 and 600 v dc models are tabulated. Marshall Industries, Electron Products Div., 430 N. Halstead St., Pasadena, Calif.

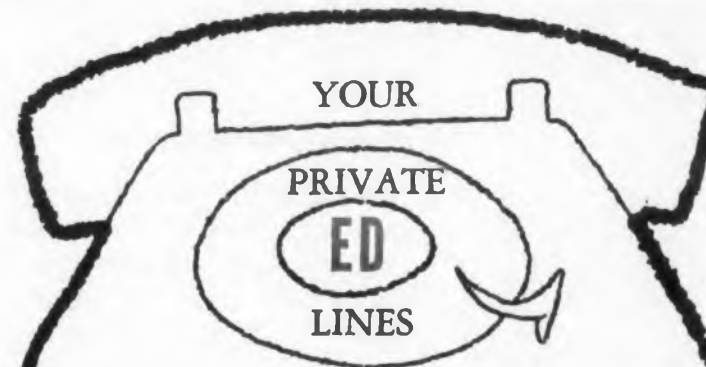
Radar Noise Measurement 273

This 11-page application note, No. 43, describes techniques for continuous monitoring of radar noise figures. It reviews the theory of automatic noise figure measurements and outlines radar system requirements for integral noise-figure meters. It also describes the firm's model 344A noise-figure meter and its applications in operating radar sets. Several illustrations and a block diagram of a typical radar system with an integral noise-figure meter are provided. Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif.

Timers

274

Illustrated Catalog No. D-31 covers timing components and linear measuring systems for industrial and military applications. Listed in its 30 pages are specifications and characteristics of the units. Special sections discuss electronic timers, special timers and their applications, package control systems, military components and systems, differential transformers, motion transmitters and related devices. Automatic Timing & Controls, Inc., King of Prussia, Pa.



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Vibration Isolators 275

The firm's series L21 and L22 miniature isolators are described in two-page bulletin No. 60-07. The devices are illustrated. Physical specifications are listed and performance curves included. Application information is given. Barry Controls, Inc., 700 Pleasant St., Watertown 72, Mass.

Copper-Oxide Rectifiers 276

Data on copper-oxide rectifiers is given in this four-page data sheet. Physical and electrical specifications are tabulated for six different series; illustrations and construction and application information are included. Edal Industries, Inc., 4 Short Beach Road, East Haven, Conn.

DC Power Supplies 277

Seven regulated, dc power supplies rated from 0 to 125 v at up to 20 amp are described in this two-page data sheet, No. 204-A. Illustrations and electrical and physical specifications are given. Opad Electric Co., 43 Walker St., New York 13, N.Y.

Electronic Components

An electronics supply house has issued this 576-page catalog covering the firm's stock of parts and components. Included are semiconductors and tubes, test instruments, transformers, resistors, capacitors, printed-circuit components, relays, switches, connectors, communications equipment, power supplies, and a variety of other types of electronic equipment and components. Write on company letterhead to Allied Radio Corp., Dept. ED, 100 N. Western Ave., Chicago 80, Ill.

Timing Modules 279

Sixteen-page bulletin, No. 5906, describes the circuit design, manufacturing and assembly process, and standard and special-type specifications for the firm's controlled solid-state timing modules. Data on sizes, available mounting arrangements, weights and terminal styles are included. Block diagrams illustrate information on circuit and system applications of the modules. Tempo Instrument Inc., Commercial St., P.O. Box 338, Hicksville, N.Y.

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 GaAs **FOR** HgTe GeSb
SOLID STATE MATERIALS

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CIRCLE 912 ON CAREER INQUIRY FORM, PAGE 219



NEW LITERATURE

Tantalum Slug Capacitors 280

A line of military-type tantalum slug capacitors, insulated and uninsulated, is covered in this four-page bulletin, No. 159E. Construction and application information is given. Electrical and physical specifications are listed. A table gives characteristics for over 50 types. Testing information is included. Ohmite Manufacturing Co., 3601 Howard St., Skokie, Ill.

Closed-Circuit TV Camera 281

Information on the reliability and performance capabilities of the firm's type TE-9-A self-contained, transistorized, closed-circuit TV camera appears in Bulletin No. ECL 85. Electrical, mechanical and environmental specifications are listed for this cylindrical, 9-lb camera. General Electric Co., P.O. Box 4197, Lynchburg, Va.

Telephone-Type Relays 282

This four-page folder gives information on a line of telephone-type relays. Coil

data, operating and release times, contact ratings and physical specifications for seven models are tabulated. A relay selection nomograph and various operating curves are given. Potter & Brumfield, Princeton, Ind.

High Voltage Cable 283

Two four-page bulletins, "LSHV High Voltage" and "High Performance Cables" describe high-voltage cable with laminated-tape, dielectric-oil and extruded-Teflon constructions. These lightweight, miniature wires and cables are said to have high-corona thresholds. Engineering data given covers voltage and temperature ranges, performance, tabular specifications and applications. Boston Insulated Wire & Cable Co., Bay St., Dorchester 25, Mass.

Permanent Magnets 284

This catalog on permanent magnets lists multiple casts, blocks, bars, cylinders, salient pole, curved path and Genox types. General Magnetic Corp., 10001 Erwin Ave., Detroit 34, Mich.

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SETKO Set Screw & Mfg. Co. 265 Main St. Bartlett, Ill. 574

CIRCLE 213 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960

Silicone Rubber Insulation Tape 285

Two four-page bulletins, Nos. 205-A and 312, describe a line of silicone rubber insulating tape for form-wound coils. Bulletin No. 205-A describes the tape, giving electrical insulation data and a physical specifications chart. Bulletin No. 312 tabulates physical specifications and information for winding the tape. Moxness Products, Inc., 1914 Indiana St., Racine, Wis.

Waveguide Pressure Windows 286

Waveguide pressure windows are described in this 12-page brochure. Operation, application and installation data for the devices which operate from 2.4 to 40 kmc is given. Dimensional drawings data is given for flange and solder-mounted mica and kovar-glass types. Microwave Associates, Inc., Burlington, Mass.

Toroidal Components 287

Toroids, toroidal coils, and special toroidal components are described and illustrated in this eight-page bulletin. Electrical specifications, outline drawings, and

characteristics curves are included. Also described are a 50-v regulated dual power supply and a 10 μ sec, 1 msec marker generator. Johnson Electronics, Inc., Electro-Magnetic Div., P.O. Box 1675, Casselberry, Fla.

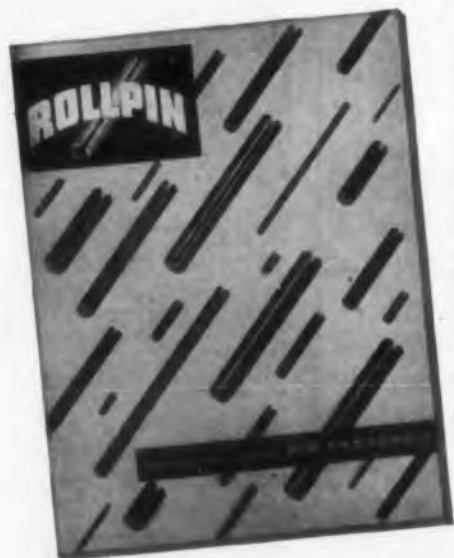
Trimmer Capacitors

The firm's Mini-Trimmer line of miniature trimmer capacitors is described in this two-page data sheet. Physical and electrical specifications and dimensional drawings for panel-mount and printed-circuit-mount styles are given. Write on company letterhead to Corning Electronic Components, Corning Glass Works, Dept. ED, Bradford, Pa.

Fluorocarbon Resins 289

Polypenco and Fluorosint TFE fluorocarbon resins are described in this eight-page brochure, No. BR-4. Electrical, thermal, mechanical, and chemical properties are tabulated. Electronic and thermal applications are described and illustrated. Available sizes and shapes of the materials are listed. The Polymer Corp. of Pennsylvania, 2140 Fairmount Ave., Reading, Pa.

New ROLLPIN APPLICATION DATA!



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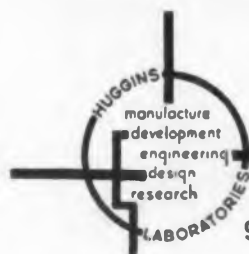
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CIRCLE 218 ON READER-SERVICE CARD

NEW LITERATURE

Test Equipment 290

Catalog No. 60 covers a line of high-voltage test sets, Hipot testers, dc overpotential testers, corona test sets and continuous-production type insulation testers. Also described are wire sparkers, cable-fault locating sets, a pinhole detector/counter, an abrasion-scrape tester for military wire, automatic test sets for cable testing and high-voltage rectifier units. Peschel Electronics, Inc., Patterson, N.Y.

Environmental Chambers 291

The subject of this 32-page illustrated brochure, No. 600, is environmental testing and other applications for controlled atmospheric conditions. A line of environmental chambers is cataloged, with general descriptions, illustrations, and specifications. The brochure includes data on temperature performance and specific heat of various substances, on metal shrinkage, low temperature refrigerants, convection fluids, temperature conversion, and on temperature controls. Schematic diagrams and engineering data on cascade equipment are also given. Webber Manufacturing Co., Inc., P. O. Box 217, Indianapolis 6, Ind.

Data Translator 292

This two-page data sheet describes the operation of the firm's type ZA-26965 paper-to-magnetic tape data translator. The instrument converts coded input data recorded on punched paper tape into an alpha-numeric code with a format directly acceptable to an IBM 704/705 electronic data processing machine. Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif.

UHF, VHF Equipment 293

A series of uhf-vhf equipment is described and illustrated in this six-page bulletin. Amplifiers, converters, signal generators, doppler equipment and transmitters are included. Electrical specifications are given. Resdel Engineering Corp., 330 S. Fair Oaks Ave., Pasadena, Calif.

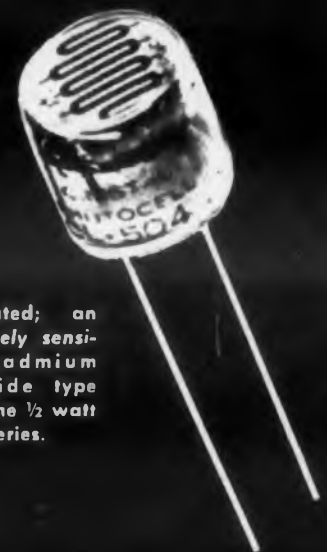
Selenium Rectifiers 294

High-voltage selenium rectifiers, selenium diodes, arc suppressors and miniature multiple circuits are described and illustrated in this eight-page brochure. Current-rating curves are included. Physical and electrical data is tabulated. Edal Industries, Inc., 64 Franklin St., New Haven, Conn.



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ELECTRONIC DESIGN • November 23, 1960

Selenium Rectifiers 295

This eight-page catalog, No. EL-316, covers selenium diodes and rectifiers. Technical data, circuit diagrams, rectifier stack designs, coding systems and photos are included. Also described are special mounting styles and rectifiers for printed circuits. Radio Receptor Co., Inc., 240 Wythe Ave., Brooklyn 11, N. Y.

Controlled Atmosphere Systems 296

This four-page brochure, No. 2-360-5M, describes controlled-atmosphere systems for the manufacture of semiconductors. These special enclosures are available as plain glove boxes or as complete systems including vacuum ovens and pumps, bake-out ovens, gages and controls. The assembly is discussed and illustrated. Kewaunee Scientific Equipment, 4009 Logan St., Adrian, Mich.

Washable Tracing Film 297

This four-page bulletin describes Herculene drafting film and Duralar pencils, a combination intended to produce washable tracings. Samples of each are included. The development of the film and pencil is covered, and instructions for washing with soap and water are given. Keuffel & Esser Co., Third and Adams Sts., Hoboken, N.J.

Toggle-Switch Assemblies 298

Toggle-switch assemblies with paddle-shaped tab indicators are described in this two-page data sheet, No. 174. Information on operation and contact arrangements of the devices, and tabulated electrical ratings are given. Illustrations and dimensional drawings are included. Micro Switch, Freeport, Ill.

Bobbin and Coil Winder 299

This two-page, two-color data sheet illustrates and describes the firm's models 315-AM and 39-AM miniature bobbin and coil winders. Photographs and mechanical specifications are included. Geo. Stevens Manufacturing Co., Inc., Pulaski Road at Peterson, Chicago 46, Ill.

Magnifying Comparator 300

This illustrated folder describes and gives application data for the firm's magnifying comparator. The tool checks gages, templates, layouts, forms, and sizes of punches and dies, and shows amount of wear to be corrected on edges of cutting tools. Finescale Co., 218 S. Western Ave., Los Angeles 4, Calif.



NEW KEARFOTT DIGISTROBE* DISPLAY

Kearfott's new, highly compact Digistrobe digital display utilizes the stroboscopic principle to produce an exceptionally high-definition readout in the actual size shown here. Through the use of a unique shutter arrangement, a single diode-encoding matrix is shared by all columns (5 in the standard model), resulting in substantial savings in electronic components and circuitry. The fast response time of the Digistrobe (56 milliseconds transition from one five-digit quantity to a totally different one) permits a single unit to sample several different inputs on command through an input selector switch. Up to 15 individual displays of existing types can thus be replaced by a single Kearfott Digistrobe!

Incorporating only two moving parts and exclusively solid-state switching circuitry, the Digistrobe has extremely long life expectancy and requires minimum maintenance and service. Operation is directly from the output register of a computer, counter or allied equipment, eliminating the cost of intervening circuitry. Two years of extensive laboratory tests assure compliance with Kearfott's rigid standards of quality. For complete data and specifications, write for Digistrobe bulletin.

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MORE CAPACITANCE, LESS WEIGHT — Combined volume of 40 TES Capacitors equals that of large paper capacitor which far outweighs them. But combined capacitance of TES capacitors is 24,000 microfarads to only 4 for paper capacitor.

FOR FULL DETAILS on TES plug-in or other types of tantalum capacitors, write Tansitor Electronics, Inc., Dept. 12 West Road, Bennington, Vermont.

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Both leads of these new TANSITOR TES-type capacitors emerge from one end. So, only one seal is required, with consequent savings in length.

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- Polar or non-polar
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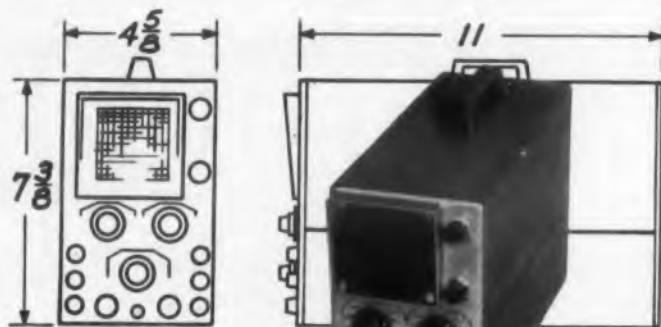


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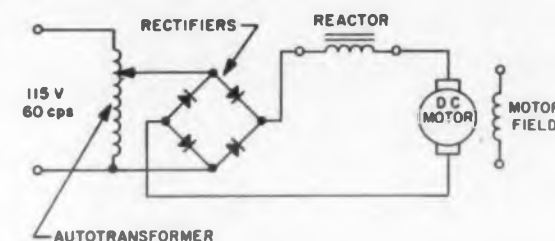
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Quite often it is desired to drive a dc motor from a rectified 60-cps supply.

By varying the voltage to the supply, the speed may be selected at a desired level. The major drawback of this mode of operation is the poor regulation obtained. This is mainly due to the motor's behaving as a capacitor when it is not loaded, and as a resistor when it is loaded.



Choke in series with dc motor armature improves speed regulation.

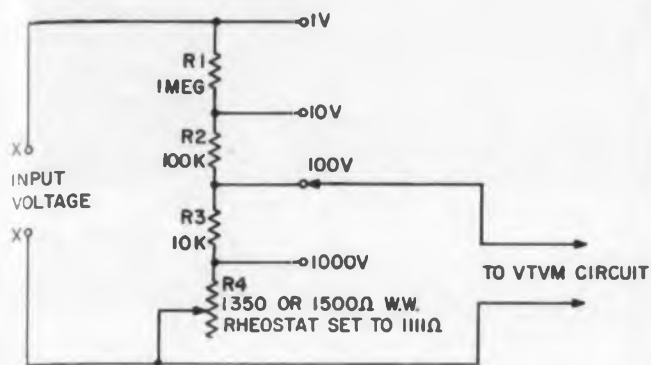
Appreciable improvement may be had by inserting an inexpensive dc choke in series with the motor armature. The choke smoothes out the changes in the waveform and reduces the speed variation to within ± 5 per cent.

Baruch Berman, Chief Engineer, ACE Electronics Div., Paramus, N.J.

Simplified VTVM Range Divider

When designing the input voltage divider (range switching network) for a dc vacuum tube voltmeter, it is convenient to select 10 meg as the total resistance. But this causes each resistance (except the lowest) in the string to have an odd value, obtainable only by connecting several resistors in series.

The divider can be simplified by selecting 1,111,111 ohms for the total resistance. (There is nothing sacred about the customary even 10 meg.) When this is done, all except the lower resistor (R_1 in the accompanying illustration) can have even values obtained with single resistors. The 1,111-ohm unit (the only odd-valued one) may consist of one each 1000-, 100-, 10-, and 1-ohm resistors in series. Or, for further simplification, may be a miniature 1,350- or 1,500-ohm



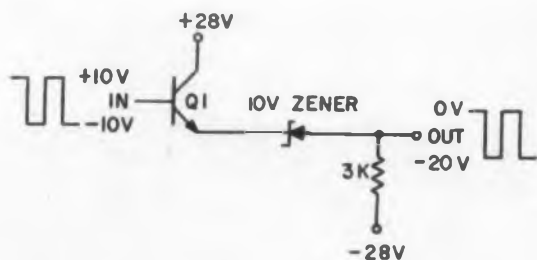
Voltage divider can be simplified by selecting the total resistance to be 1,111,111 ohms.

wirewound rheostat, as shown, set to 1,111 ohms with a standard input voltage applied to terminals X-X.

Rufus P. Turner, Consulting Engineer, Los Angeles, Calif.

Zener Diode Helps Shift Pulse Levels

We had to shift a train of random input, uniform amplitude pulses, of either plus or minus 10 v levels, to lie between zero and -20 v. Because of the random nature of the input, an RC type of dc restorer could not be used. Our solution to the problem is shown in the figure.



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Emitter follower Q_1 isolates the level shifting Zener diode from the input signal source. When the input is at +10 v, (assuming a negligible V_{BE}), the Zener diode looks into an open circuit voltage of 38 v. This voltage is great enough to break the Zener down. Thus, with +10 v input and 10 v dropped across the Zener, the output will sit at zero volt. Similarly with -10 v input, the output will be at -20 v. The slight shift in Zener voltage due to diode current variations was not critical in this application.

P. Cutler, Universal Electronic Controls, Garden Grove, Calif.

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The display, essentially a notch-watt-meter, is free from parallax. This equipment provides laboratory performance with simplicity adaptable to the production line.

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IDEAS FOR DESIGN

Two Relay Contacts Clear Integrator For Rapid Operation

In repetitive tests conducted with an integrator of high linearity, it was necessary to clear the integrator for the next run as quickly as possible without interfering with its linearity. Relay contacts connected directly across the capacitor will rapidly discharge the integrator. However, the leakage across the opened contacts affects the linearity during integration.

A scheme commonly used in analog computers for discharging an integrator is shown in Fig. 1. During integration, the relay contacts are closed, effectively placing R' and R'' across the amplifier input and output respectively. In this way, R' and R'' do not interfere with the operation, if their values are appropriately chosen. Thus, the problem of relay leakage is avoided.

Using this circuit arrangement, the time taken to discharge the integrator was several seconds with the values of circuit components required in the application: time constant = 1 sec, $R = 1$ meg, $C = 1$ μ f.

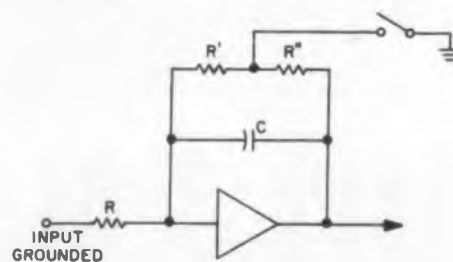


Fig. 1. During integration relay is closed; R' and R'' appear across input and output respectively. However, discharge time constant (with relay open) is long.

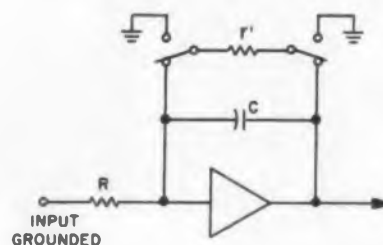
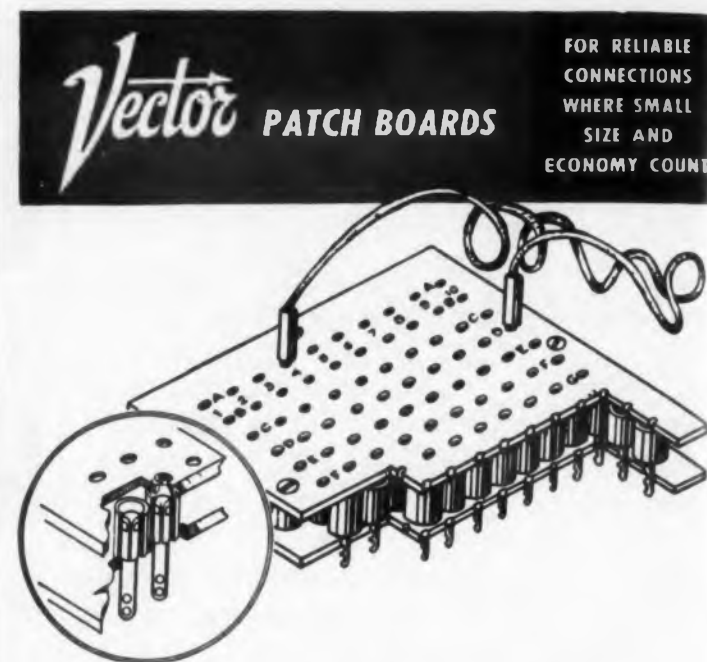


Fig. 2. Fast (100 μ sec) clearing can be obtained with two relays. Contacts are open during integration, with relay leakage appeared across input and output.

With a second relay as shown in Fig. 2, a discharge time of about 100 μ sec was obtained without degrading the integrator linearity. During integration, any leakage across the relays is placed across the input and output of the amplifier and not across the capacitor. To keep the discharge current within the relay contact rating, a small resistor r' was included in the shorting link.

Bernard F. Wadsworth, Research Engineer, Australian National University, Canberra, Australia.



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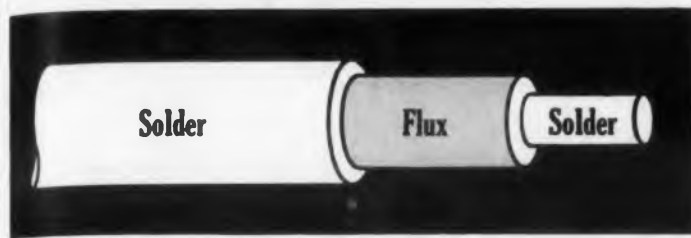
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Transistor Electronics Corporation

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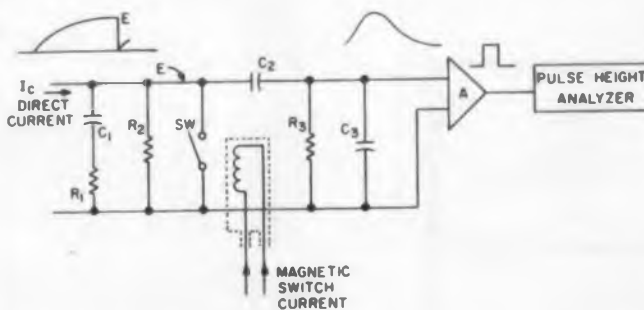
Check and mail for literature desired / 525 FULTON ST.
W. & L. E. GURLEY / TROY, NEW YORK

Sensitive Pulsing Circuit Measures 10^{-15} Amp

Extremely small direct currents can be easily measured by a circuit, shown in the figure, which senses pulses whose heights are proportional to the current. The pulse height analyzer can be calibrated to read out currents approaching 10^{-15} amp.

Current I entering R_1C_1 is integrated until the equilibrium voltage $E=IR_1$ is reached. Periodically, a switch Sw shorts out C_1 , discharging it to zero and transmitting a pulse of amplitude E through C_2 to pulse amplifier A . The amplifier input time constant R_3C_3 divides down the sharp rise E at its input to $EC_2/(C_3+C_2)$. Measurement is only made of the rise voltage, requiring a high-speed, constant-gain, pulse amplifier. A fast scope and camera have been able to measure currents as low as the 10^{-15} amp mentioned previously.

In selecting components, if R_1 is typically a Victoreen High-Meg resistor of thousands or even millions of megohms, the open switch resistance should be 100 times greater. Such a switch requirement is easily met by using a reed switch, manufactured by such companies as Revere and Clare. The switching is accomplished by an electrostatically shielded coil wound on a Teflon bobbin surrounding the glass. Capacitors C_1 and C_2 , of approximately 10 pf can be either air or Teflon insulated.



Extremely small (10^{-15} amp) direct currents are measured by sensing a pulse of proportional height.

If I represents the desired minimum detectable current, amplifier sensitivity must reach $IR_1C_2/(C_3+C_2)$. Hence, if C_1 is 100 times greater than the switch capacity of about 0.1 pf, and is 10 times greater than C_2 and C_3 , R_1 is determined. Actually deeper considerations of noise and bandwidth govern the parameters. However, the approximations given here are sufficient. It will be observed that several current inputs can be commutated sequentially, merely by switching the respective R_1C_1 .

Patrick F. Howden, Systems Engineer, Consolidated Systems Corp., Monrovia, Calif.

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DIAL ASSEMBLIES for computer display applications

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Both models supplied with dial engravings shown. Available on special order: etched dials and anti-backlash gearing which provide readout accuracies to 1 minute of arc.

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Dial assemblies are only one product in the COMPLETE Reeves Series of high-precision Servo-Mechanical Parts, recognized by engineers as an industry standard for highest accuracy and reliability.

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2RV60

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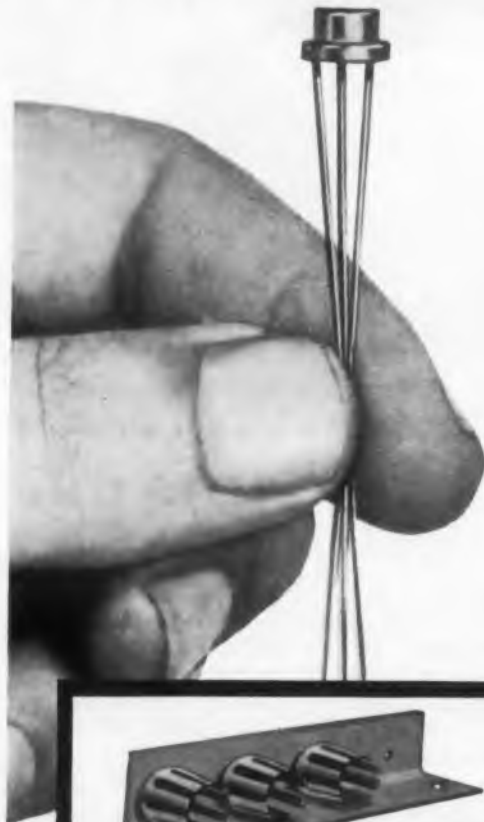
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IERC TRANSISTOR HEAT DISSIPATOR



actual size

accepts .305 to .335 variations in TO-5 cases!



IERC Transistor Heat-dissipating Retainers readily accommodate diameter variations up to .030" found in TO-5, TO-9, TO-11, TO-39 transistor cases. This single IERC part saves you time and costs in specifying, stocking and application.

IERC's exclusive design features maximum thermal contact with transistor case for efficient transfer of heat to the dissipator and heat sink. Attaching methods suitable for printed circuit boards, chassis and heat sinks provide thermal benefits and retention in extreme shock and vibration environments.

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2. MULTIPLE MOUNTING



3. BACK-TO-BACK MOUNTING

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CIRCLE 765 ON READER-SERVICE CARD

PATENTS

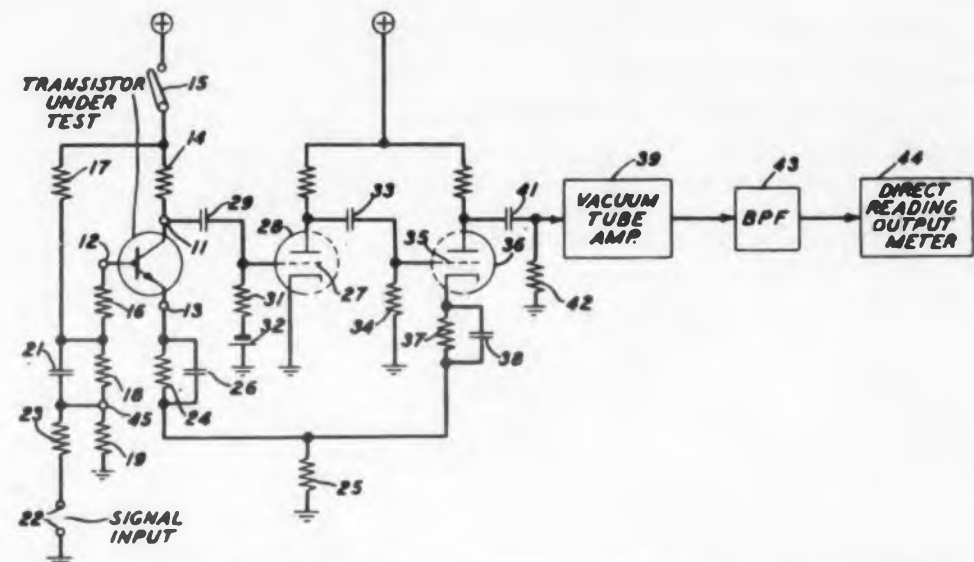
Benjamin Bernste

Noise Figure Measuring Instrument

Patent No. 2,935,684. H. E. Lanning. (Assigned to Bell Telephone Labs.)

The noise figure of either a transistor or a vacuum tube is made direct reading by means of a negative feedback amplifier having a predetermined noise resistance. A table of typical components used in the circuit is provided.

In schematic, a transistor under test is connected to an amplifier wired for at least 40-db feedback. The meter is compensated by measuring the thermal noise power of the input resistance, resistors 16 and 19. Noise figure of the transistor is read directly on the meter, independently of the gain of the transistor under test.



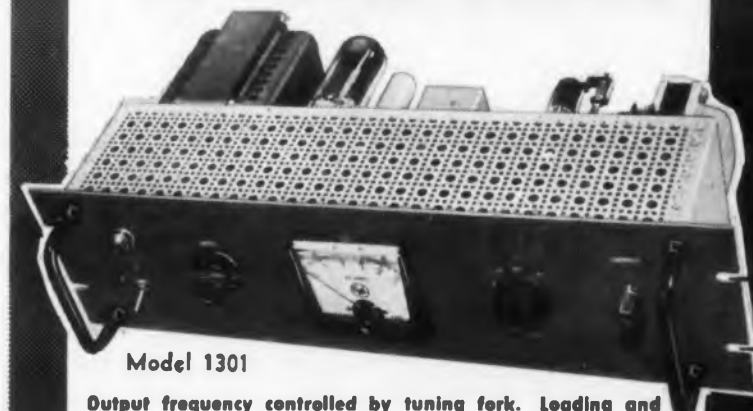
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Output frequency controlled by tuning fork. Loading and line voltage changes have negligible effect on output frequency, less than 1 PPM over the ambient temperature range of 0° to 50°C.

Harmonic content is 0.1% into a load unity power factor at rated output level. The noise and hum level is better than 60 db down.

Three output voltages available. Each adjustable from zero to maximum.

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CIRCLE 766 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1964

Digital-to-Analog Servo System

Patent No. 2,943,248. O. W. Ritchey.
(Assigned to Boeing Airplane Co.)

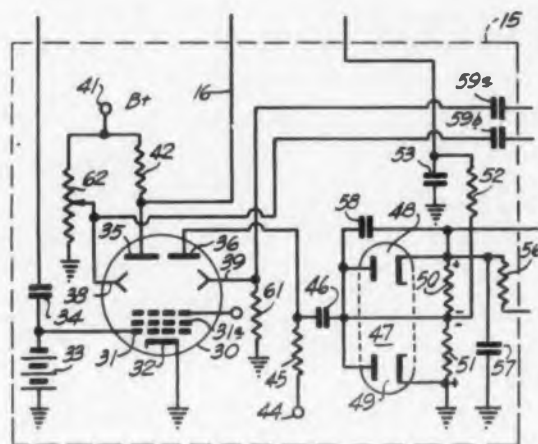
The angular position of a servomotor rotor is varied in accordance with digital information applied to a binary counter. The motor has two stator and two rotor windings. The motor responds to the difference in phase angle between a reference voltage and a voltage produced in the circuit by the digital information.

Television Receiver

Patent No. 2,925,466. G. E. Lowitz. (Assigned to Sylvania Electric Products.)

Video and synch pulses are separated, in a television receiver, by means of a beam deflection tube gated at the horizontal scanning rate.

The composite signal is coupled to control grid 31 of beam deflection tube 30. This tube is driven by a sweep voltage applied to deflection plates 38 and 39. During the trace interval, the electron beam is directed to collector 35 which connects the video information to the display tube.



Selective Detection of Radar Targets in The Presence of Noise Signals

Patent No. 2,943,316. F. D. Covely. (Assigned to Radio Corp. of America.)

Repetitive signal groups are separated from random signals, some of which may be larger in amplitude than the repetitive ones. A threshold circuit eliminates all signals of less than a predetermined amplitude. The signals passing the threshold circuit trigger gated pulses that drive a circuit whose output depends only on the coincidence of a gated pulse.

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Model illustrates a wide-spaced, 12 element circular polarized optimum-tuned skewed dipole "SPIRALRAY" antenna. Provides unusually high gain, even response, in all polarization planes, vertical, horizontal or oblique with unusually high signal-to-noise ratio.

NO OTHER CIRCULAR POLARIZED ARRAY known to the art today can provide the linear high gain and signal-to-noise ratio in all radiation planes.

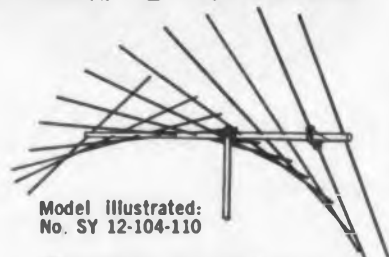
The ideal antenna for missile tracking, telemetering and no-fade response to mobile (or moving) stations.

Models available to extend the practical range of 2-Way Communication Systems.

Model SY-12-104-11
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Model MSY-104-110
\$390.00

(f.o.b. Asbury
Park, N. J.)



Model Illustrated:
No. SY 12-104-110

Electrical Specifications—Model No. SY-12-104-110: Polarization, circular, linear within 1/2 db. Gain 13 db. F/B-Ratio 30 db. V/S/W/R (50 ohm cable) 1.1/1. Beamwidth at half power points 33 degrees. Max. power input 300 w, with "Balun" supplied.

Mechanical Specifications: Boom diameter 2" O.D. x 25 ft. All aluminum boom and elements. Weight approx 25 lbs. Rated wind-load 90 mph. No ice load. Available for 120 mph wind load. (Model No. MSY-104-110).

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CIRCLE 767 ON READER-SERVICE CARD

"I owe my success to
my trusty Sigma Type 22
RJC200G SIL relay"

— PORTHOS P. GIZZARD



With a sizable amount of our business due to saber-rattling on a national scale, it's heartening to discover some relay prospects among those who practice skewering each other just for fun. One of our reps recently wrote in, calling our attention to a device in which a buzzer sounds when a proper forward-moving fencing "hit" is scored. The buzzer circuit is closed by the contacts of a Sigma "22" relay, which in turn is wired to a battery and a plunger switch at the tip of the foil or epee. The inventor's name is L. A. Wortman, and he holds no lesser rank than chairman of the Electrical Weapons Committee of the Amateur Fencers League of America, as well as American Delegate to the Electrical Signaling Comm., Federation International D'Esgrime.

We sincerely hope, however, that Mr. Wortman shows more mercy in a *salle d'armes* than he does to the hermetically sealed enclosure of his Sigma sensitive relay. In describing his ingenious boon to practice fencers (fencing practicers?), he calmly states "The relay is a Sigma Type 22J200 or equivalent... (These dual series) coils must be separated and reconnected ... The case of the relay is easily removed with a pair of diagonal wire cutters.

Starting at the bottom edge and peeling, the cover comes off as though it were a sardine-can cover." Really, Mr. Wortman. If Series 22 relay enclosures were meant to be removable, we would have made them that way. (On second thought, maybe supplying a little key with each hermetically sealed Sigma relay might not be such a bad idea at that. Remember that Air Force captain and his little drill?)

At all events, this clearly points out one fact: clever people are still successfully applying Sigma relays in ways which turn our application engineers green (92 parts horror, 8 parts envy). We can only hope that future builders of electrical fencing instruments and kindred souls will first ask us if we have what they want, before picking up the side-cutting pliers. It might pleasantly surprise some to see the assortment of open and sealed, single- or dual-coil, magnetic latching, big and little relays we can offer. We might even have one for Mr. Wortman's august body which would signal a hit not by a buzz on a buzzer, but simply by saying "ouch."

"22" Bulletin on request; application engineering by letter and over the phone.

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5 megacycle stepping rates

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2 ampere pulse amplitudes

PULSE

10 millimicrosecond rise time

GENERATOR

Model 1200 Programmed Millimicrosecond Current Pulse Generator for research and development of very high speed magnetic materials, solid state devices and computer circuits. Write for Bulletin 60-B.



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your own accurate
test chamber for \$735



Econ-O-Line, a temperature test chamber within your budget, the first of its kind. It brings you a temperature range of -100°F . to $+350^{\circ}\text{F}$., with pulldown to -100°F . from ambient in less than five minutes if desired. Heat up to $+350^{\circ}\text{F}$. from ambient may be had in thirty minutes. Liquefied CO_2 refrigeration (dry ice cooling also available) provides an accuracy of $\pm 2^{\circ}\text{F}$. The circulation motor is externally mounted. The Econ-O-Line has internal working dimensions of 14" x 14" x 14". Interior is of series 304 stainless steel, heliarc welded; the exterior is heavy gauge steel, with a green speckled enamel finish. The window illustrated is optional at extra cost.

ASSOCIATED TESTING LABORATORIES, Inc.

Manufacturing Division

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WAYNE, NEW JERSEY

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Testing Laboratories at Wayne, New Jersey and Winter Park (Orlando) Florida

CIRCLE 770 ON READER-SERVICE CARD

PATENTS

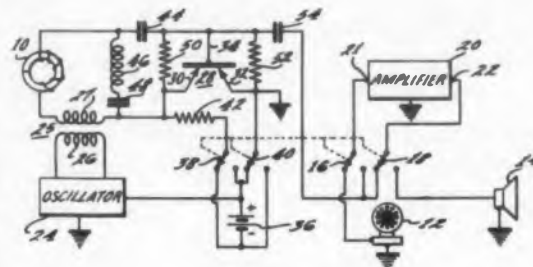
Signal Amplifier Circuits

Patent No. 2,938,963. F. D. Waldhauer. (Assigned to RCA.)

A symmetrical transistor, conveniently biased to interchange the emitter and collector electrodes, provides stable and low noise amplification in a tape recording system.

With the switch in the indicated position, electrode 32 of transistor 28 is the emitter, and electrode 30, the collector. The microphone signals pass through amplifier 20 to transistor 28, which drives the recording head 10.

With the switch in the second position, electrode 30 becomes the emitter and electrode 32 is the collector. The re-



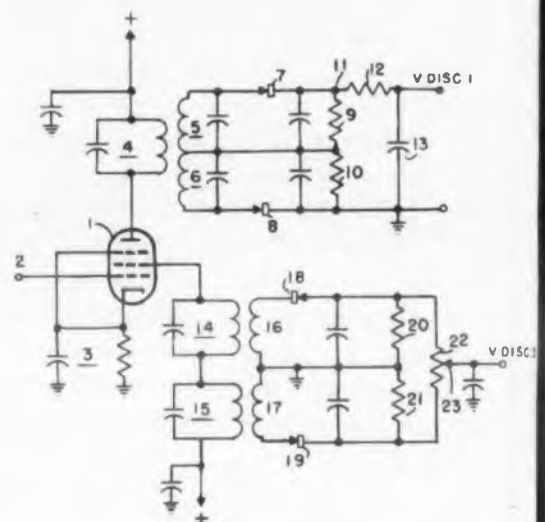
corded information is picked up by head 10 and coupled through transistor 28 which is now the preamplifier.

FM-Discriminator

Patent No. 2,941,075. E. Christian. (Assigned to U. S. Army.)

A narrow-band and a wide-band fm discriminator, having high sensitivity, are designed around a single pentode tube.

As shown in schematic, the plate con-



PROTECT & CONTROL

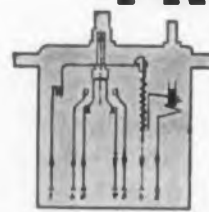
YOUR PRODUCT WITH

E-T-A

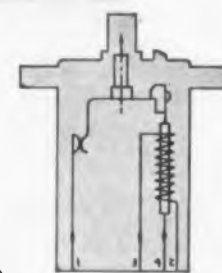
CIRCUIT BREAKERS

Evaluate how E-T-A can economically simplify your design—

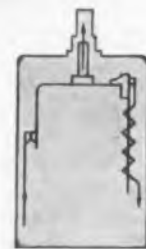
- Control of several component functions with one breaker
- Starting as low as 50 milliamp
- Also performs as On-Off Switch
- Miniature size
- Low cost per unit



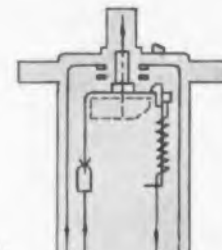
Two auxiliary circuits N.C., N.O., Shunt-Thermal Magnetic Circuit Breaker



Control of two circuits — Overcurrent Circuit Breaker



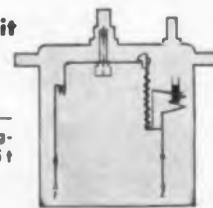
Series trip — Overcurrent Circuit Breaker



Auxiliary Circuits N.O.—Overcurrent Circuit Breaker



Series trip — Thermal Magnetic Circuit Breaker



Series trip — Overload Relay

For engineering assistance call or write to—

E-T-A PRODUCTS COMPANY of AMERICA

6284 N. Cicero Ave.

Phone: Kildare 5-1554

Chicago 46, Ill.

CIRCLE 771 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 23, 1960

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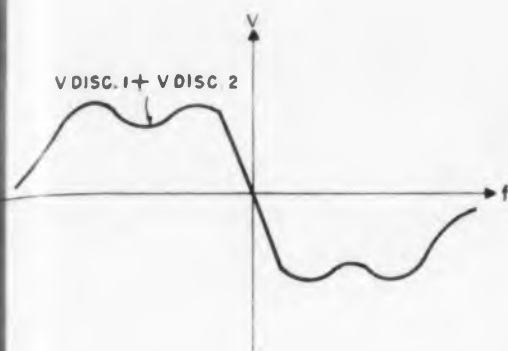
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ains a high sensitivity, narrow-band
discriminator network. In addition, a
similar circuit is coupled to the screen
grid. The two outputs can be combined
to produce the over-all wide-band high
gain response.

Balanced Phase Sensing Circuitry

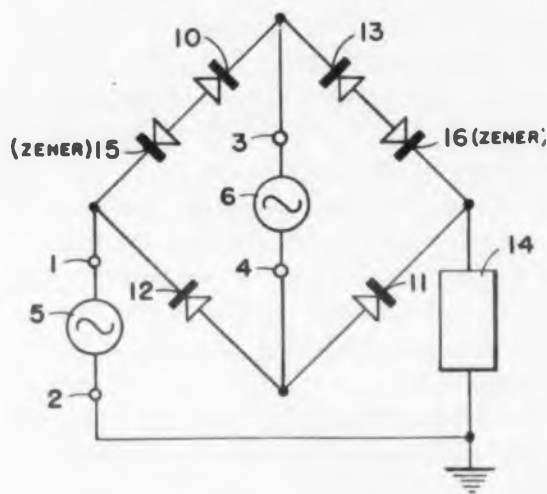
Patent No. 2,945,950. R. L. Midkiff. (As-
signed to Avco Manufacturing Corp.)

High impedance and passive amplifi-
cation is obtained by using two Zener
diodes in addition to the four diodes of
the conventional diode-type phase sensi-
tive detector.

In operation, a drive signal in the

forward direction produces the same
current as in the known circuit. How-
ever, in the reverse direction the imped-
ance of the Zener diode is high and a
very small current flows. When the Zener
breakdown voltage is exceeded, a very
large current flows in the load to give
increased gain.

The patent also discloses phase detec-
tor applications of the Zener diodes, 15
and 16, as well as several improved
modulator circuits.



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350 — 1000 MC	—90 to —100 dbm	10.88 — 18.0 KMC	—70 to — 90 dbm
910 — 2200 MC	—90 to —100 dbm	18.0 — 26.4 KMC	—60 to — 85 dbm
1980 — 4500 MC	—80 to — 90 dbm	26.4 — 44.0 KMC	—55 to — 85 dbm

*measured when signal and noise equal 2X noise

Using one tuning head which contains one triode and two Klystron oscillators, Model SPA-4 offers more exclusive advantages for applications demanding extreme sensitivity, stability, versatility, accuracy.

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He was going to Texas and his guidance system went haywire!"

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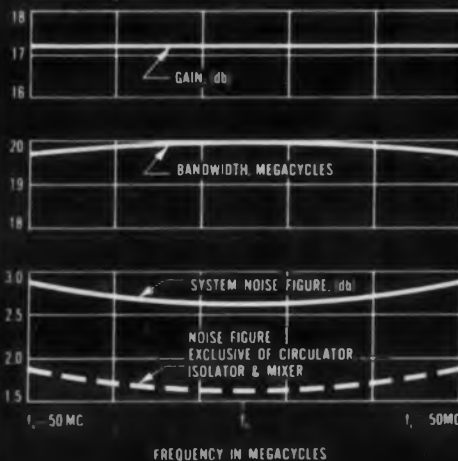
WRITE FOR BULLETINS S-1159 AND TCO/300-OC.



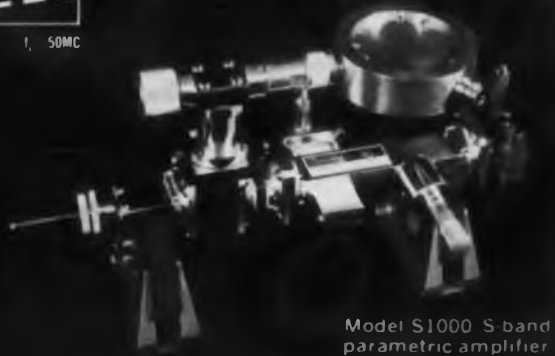
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Model S1000 S-band parametric amplifier

Micromega Corporation

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BOOKS

Analog Computation

Albert S. Jackson, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 652 pp, \$13.50.

This study of analog computers can be understood by those who do not have an electronics background. The book is written as a college text, but may be of value to the engineer who has specialized in other areas.

Topics covered include: basic concepts of analog computation, basic analog-computer elements, magnitude and time scaling, the solution of mathematical models, statistical problems, design concepts and operating characteristics of available analog-computer components, and analog-digital methods of computation.

Introduction to Modern Network Synthesis

M. E. Van Valkenburg, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 498 pp, \$11.75.

Basic methods of modern network synthesis are presented, including applications in communications and automatic control systems. Beginning chapters cover Brune's positive real functions and the procedures for synthesizing LC, RC, RL and RLC one terminal-pair networks. Two chapters on approximation and one on the relationship of parts of network functions are included. The remainder of the book deals with methods for the synthesis of two terminal-pair networks, including the Cauer ladder development, the Guillemin and



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Philadelphia 7, Pa.

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ELECTRONIC DESIGN • November 23, 1960

Darlington methods and the synthesis of networks by the image-parameter method.

Self-Saturating Magnetic Amplifiers

Lynn, Pula, Ringelman, and Timmel, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 217 pp, \$8.

The purpose of this book is to show how to design complex magnetic-amplifier circuits. Among the topics discussed are: techniques for dealing with the transient behavior of self-saturating magnetic amplifiers, testing methods applicable to magnetic amplifier core material, and commonly encountered design problems. Graphs, charts and diagrams are used.

Nuclear Electronics, Vol. II

International Atomic Energy Agency, Karntner Ring II, Vienna I, Austria. International Publications, Inc., 801 Third Ave., New York 22, N. Y., 378 pp, \$4.

A reference for the specialist, this book is the second volume of the proceedings of the International Symposium on Nuclear Electronics organized by the

French Society of Radio-Electricians. Many of the articles are written in French. Some of the topics covered in English are: non-linear kinetics and stability studies on analog computers, a two-dimensional kicksorter with magnetic-drum storage, and the use of transistors in nuclear instruments.

Traveling-Wave Engineering

Richard K. Moore, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 360 pp, \$11.

Intended as a textbook, this book may also be used by the practicing engineer as a source of analogies between different kinds of waves. Most new ideas are presented in terms of transmission lines, but examples are given to show their application to other types of waves. Methods widely used for transmission lines are applied to electromagnetic waves, vibrating strings and membranes, acoustic waves, longitudinal and transverse waves in solids, the wave function of wave mechanics and the various types of diffusion. Only linear systems are discussed.

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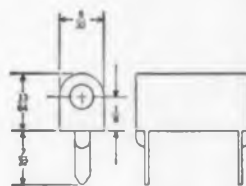
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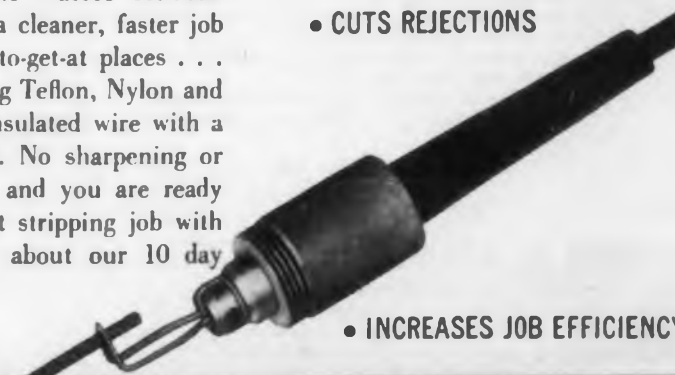
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RUSSIAN TRANSLATIONS

J. George Adashko

**Surface-Wave Antenna Radiates
From Waveguide Bends**

THIS IS a preliminary report on a type of surface-wave antenna, in which radiation is produced by transverse bends in waveguides carrying surface waves. It differs from currently used antennas, which produce radiation either at the edge of a slow-wave structure, by irregularities along the slow-wave structure, or by bends in the longitudinal direction of the waveguide. Unlike the surface-wave antenna of the third type, the new type of antenna can have a planar guiding surface.

Examples of the transverse cross sections of several of the simplest surface-waveguides using dielectric strips of various sections of indentations in the metal, are shown in Fig. 1. Analogous waveguides, made in the form of longitudinally-periodic structures (ribs, etc.) are also possible.

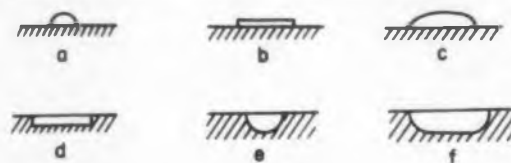


Fig. 1. Surface-waveguides can be made using dielectric strips of various cross-sections indented in the metal.

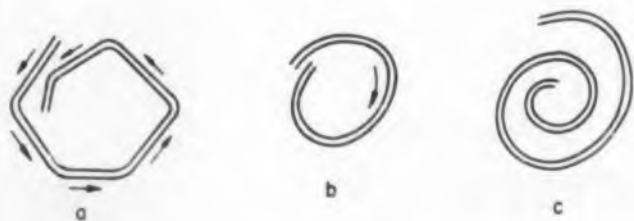


Fig. 3. These waveguide shapes may be used to obtain uniform radiation in the antenna plane.

Let us consider several examples of antennas, made up of such waveguides, bent in a transverse direction.

Fig. 2 shows very simple antennas in the form of straight waveguides, carrying traveling surface waves in one direction, bent transversely in one or two regions. These regions radiate, and there are reasons to expect relatively broad directivity patterns. The pattern's maxima lie within the angles bounded by the direction of the traveling waves in two segments of the waveguides adjacent to the bend. To reduce reflection in the bend area, it is advisable to use a relatively small retardation of the phase velocity, and to use bend radii that are not too small.

Fig. 3 shows antenna modifications in which attempts are made to obtain uniform radiation in the antenna plane. The forms resemble a poly-



Fig. 2. Straight waveguides, bent in one or two places, radiate in the sections near the bends.



Fig. 4. Slightly curved shapes produce a co-secant-shaped directivity pattern.

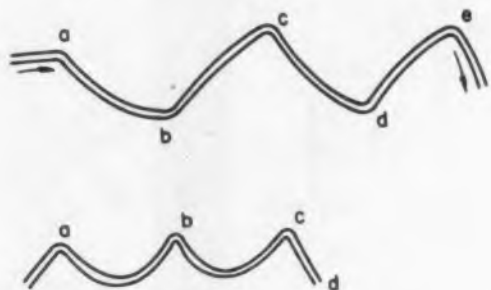


Fig. 5. The major part of the radiation is confined here to the points labeled.

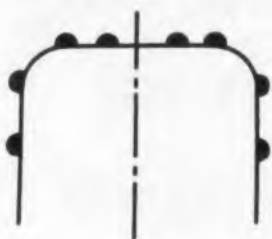


Fig. 6. Antenna versions shown in Figs. 3 and 4 are combined to form an antenna shown here in cross-section.

gon, a circle, and a spiral. In the case of the spiral, an additional degree of uniformity of radiation is expected. This is because in each succeeding loop the transverse curvature is increased, while the surface-wave energy carried by the waveguide is reduced by the radiation in the preceding loop.

Interesting variants are shown, Fig. 4, where it is desired to have the directivity pattern approach a co-secant shape. Radiation from each succeeding section is reduced here by the decreased curvature.

Two other antenna versions, Fig. 5, confine the major part of the radiation to the regions of large (and increasing) curvature (points *a*, *b*, *c*, *d*, *e*). In the remaining regions, the radiation is weaker because of the much smaller bending of the waveguide.

It is possible, in principle, to launch surface waves from combinations of the different classes of antennas illustrated above. A possible antenna structure, which combines the third and fourth versions listed, is shown in section in Fig. 6. The guide surface is in the form of a cylinder, gradually transformed into a flat cap. The waveguide carrying the surface wave is a cylindrical helix which becomes a flat converging spiral. Some parts of the helix radiate because of the longitudinal curvature of the guiding surface, while other parts radiate because of the transverse waveguide curvature.

Quantitative values of parameters will be treated in a later, more extensive paper.

Translated from "New Type of Surface-Wave Antenna" by M. S. Neyman, *News of the Colleges—Radio Engineering*, No. 2, 1960, Mar-Apr, pp 281-282.

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GERMAN ABSTRACTS

E. Brenner

Impedance of Carbon Film Resistors

FOR CARBON film resistors, the impedance variation with frequency depends not only on the intrinsic resistor but also on the mounting conditions. For resistance values above about 300 ohms, the carbon layer is deposited in helical form on a ceramic body so that an equivalent circuit, Fig. 1, includes the dc resistance R_0 , the helix inductance L_h , the end-to-end capacitance C_k , the series $R_q C_q$ branch representing axial resistances and capacitance between helix elements, the lead inductance L_z and the distributed capacitance to ground C_E .

To measure a meaningful driving point impedance, an objective method for simulating mounting conditions must be used. One such method consists of placing the resistor in a cylindrical metal container whose dimensions bear a fixed relationship to the resistor length a , as shown in Fig. 2. As voltage, V_1 , is applied to the resistor under test, x , the resistor is above a metal plate M and in series with a standard resistor R_N . The voltage across R_N is measured. If the impedance of the test sample, Z_x , is much larger than R_N then

$$Z_x = R_N \frac{V_1}{V_2}$$

For low-ohm resistors (below 100 ohms), the impedance is inductive, and the resistor is represented by the series combination of R_0 and L . For high-ohm resistors (above 1,000 ohms), a parallel combination of R_0 and a capacitance C represents the element adequately. In the intermediate range, a series branch $R_0 L$ in parallel with C is used.

Once L (or C) has been determined from the logarithmic impedance-frequency graph, a cut-

(continued on p 210)

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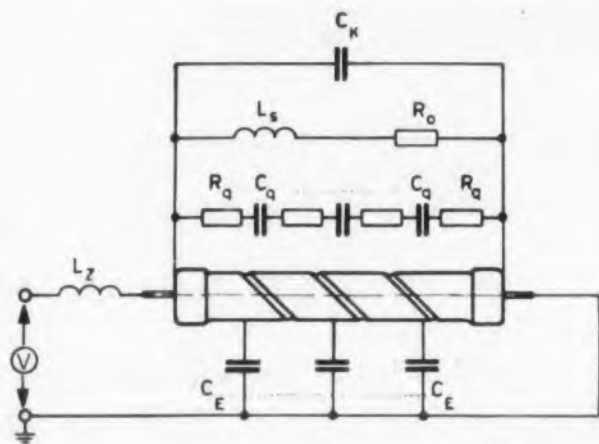


Fig. 1. Equivalent circuit for deposited-carbon resistor.

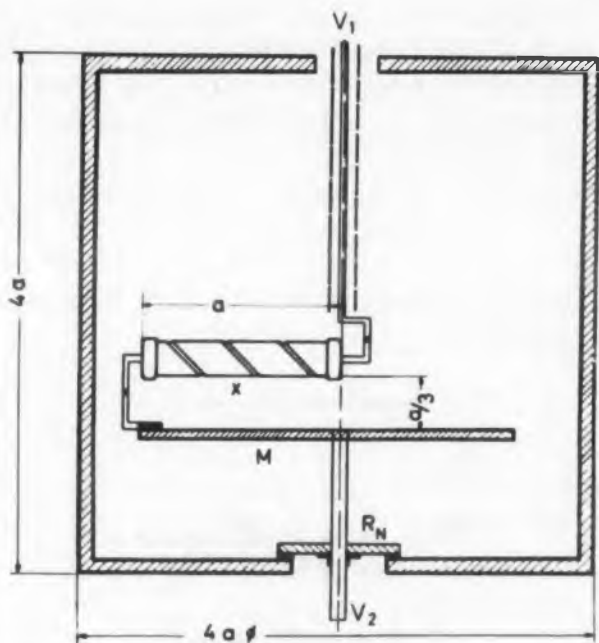


Fig. 2. Schematic of an objective measuring apparatus for impedance measurement.

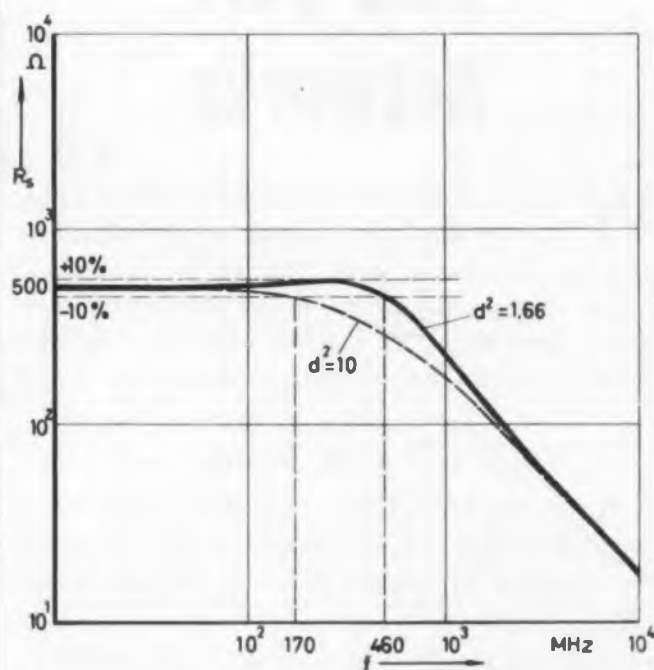


Fig. 3. Impedance as a function of frequency for a 500-ohm resistor. The solid curve is obtained as a result of compensation.

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GERMAN ABSTRACTS

off frequency can be used to define the useful range of resistor application. Using the ratio $r = Z_x/R_o$, this cut-off frequency is related to r by

$f_o = R_o (r^2 - 1)^{1/2} / 2\pi L$ for low-ohm resistors and by

$f_o = (1 - r^2)^{1/2} / (2\pi R_o C r)$ for high-ohm resistors.

For intermediate values, a typical impedance curve is shown in Fig. 3. Using the technique of wideband amplifiers, it is possible to extend the bandwidth considerably. Defining $d^2 = R_o^2 C/L$, a value $d^2 = 1.66$ results in the widest band.

For example, a helical 500-ohm resistor has $C = 1$ pf and $L = 0.025$ mh and a cut-off frequency of 170 mc with $r = 0.9$. If the helix is changed so that $L = 0.15$ μ h, the band extends to 460 mc (Fig. 3).

Skin effect, for even the thickest carbon deposits, has no influence below 10 kmc.

Abstracted from an article by A. Debel and L. Hechler, Frequenz, Vol. 14, No. 6, June, 1960, pp 193-197.

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WHEN a chain of identical two-ports is cascaded, Fig. 1, it is frequently desirable to express the transfer properties of the cascade in terms of the properties of the individual two-ports. Each two-port is most conveniently characterized by its cascade matrix, A, B, C, D where

$$\begin{aligned} E_{n-1} &= AE_n + BI_n \\ I_{n-1} &= CE_n + DI_n \end{aligned}$$

The coefficients A, B, C, D are complex numbers when E_k and I_k are phasors and functions of the complex (or imaginary) frequency variable s

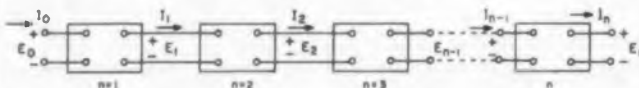


Fig. 1. A cascade of n identical two-ports.

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(or $j\omega$) when E_k and I_k are Laplace (or Fourier) transforms.

For the entire two-port chain one defines the cascade functions A_n, B_n, C_n, D_n where

$$\begin{aligned} E_o &= A_n E_n + B_n I_n \\ I_o &= C_n E_n + D_n I_n \end{aligned}$$

While the coefficients A_n, B_n, C_n, D_n can be found by repeated matrix multiplication (raising the cascade matrix to the power n), this procedure is tedious. It can be avoided by using the formulas deduced from appropriate difference equations. Various cases, depending on the value $[AD-BC]$, that the determinant of the cascade matrix takes on, can be distinguished.

Case 1 $[AD-BC] = 1$. For this case one defines

$$\cosh \tau = (A + D)/2 \neq \pm 1$$

$$S_n = \frac{\sinh n\tau}{\sinh \tau}$$

then

$$A_n = \frac{1}{2}(A - D) S_n + \cosh n\tau$$

$$B_n = B S_n; C_n = C S_n$$

$$D_n = \frac{1}{2}(D - A) S_n + \cosh n\tau$$

The rational algebraic character of the coefficients can be made explicit by the use of Tschebyscheff polynomials. Letting

$$x = (A + D)/2$$

since

$$T_n(x) = \cos(n \arccos x)$$

$$S_n = \frac{T_{n+1}(x) - T_{n-1}(x)}{2x^2 - 1}$$

and

$$\cosh n\tau = T_n(x)$$

If the two-parts are symmetrical, the coefficient $A_n = D_n = \cosh n\tau$

Case 2: $[AD-BC] = d$ where d is not 0 and not necessarily 1. In this case define

$$\cosh \tau' = \frac{1}{2}(A + D) d^{-1/2}, S'_n = d^{n/2} \frac{\sinh n\tau'}{\sinh \tau'}$$

then

$$A_n = \frac{1}{2}(A - D) S'_n + d^{n/2} \cosh n\tau'$$

$$B_n = S'_n B; C_n = S'_n C$$

$$D_n = \frac{1}{2}(D - A) S'_n + d^{n/2} \cosh n\tau'$$

Case 3 $[AD-BC] = d = 0$. For this condition

$$A_n = D_n = (A + D)^n, B_n = C_n = 0$$

Abstracted from an article by G. Doetsch, Archiv red Elektrischen Übertragung, Vol. 14, No. 8, August 1960, pp 335-340.

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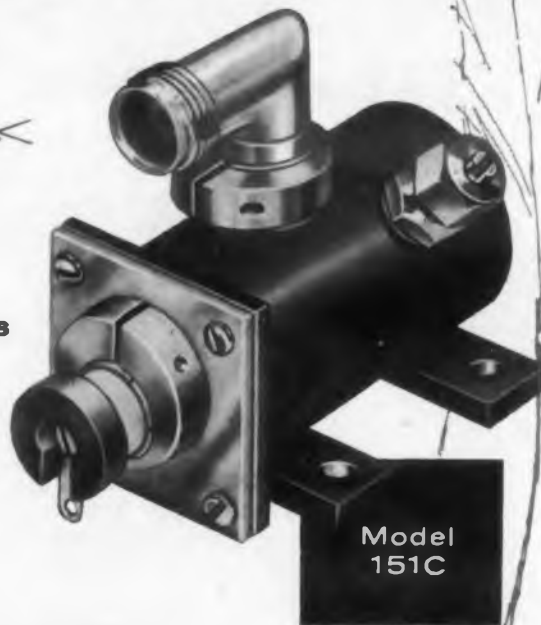
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REPORT BRIEFS

Telemetry System Study

Discussed in this report are the results of a program designed: (1) to forecast the individual flight requirements for test-range telemetry in the next decade, and, the effect of heavy traffic on multiple-range operation; (2) to recommend suitable operating frequencies for further telemetry systems; (3) to examine various modulation or coding methods and recommend an optimum technique for future systems; (4) to investigate the performance of present systems and recommend improvements.

Experimental telemetry-system test setups for a number of modulation systems are presented. A summary of telemetry interference measurements made in the 225-260 mc, 1435-1535 mc and the 2200-2300 mc frequency bands is given, and the results of a transmitter frequency stability study to determine feasibility of .001 percent operational stability in near-future applications for the 2200-2300 mc frequency band is reported. *Telemetry System Study, Volume I (of I)*, C. Harrison Smith, J. W. Capps and others, *Aeronutronic, Newport Beach, Calif., Dec. 1958, 112 pp, Microfilm \$6.00, Photocopy \$18.30. Order PB 147629 from Library of Congress, Washington 25, D.C.*

Transistor-Diode Logic

Design features of direct-coupled transistor-diode logic are discussed. The discussion includes comments on the effect of diode reverse transients on circuit performance, the dependence of the number of gate drives on transistor and diode properties, and isolation obtained between input- and output-gate terminals for the circuit presented. The unique feature of the circuit is the use of the low collector-to-emitter transistor as a replacement for a diode clamp. *Transistor-Diode Logic*, R. A. Carlsen, *Michigan University Research Institute, Ann Arbor, Mich., Oct. 1958, 22 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 146942 from Library of Congress, Washington 25, D.C.*

Thermionic Energy Converters

High-vacuum and gas-filled thermionic energy converters are reviewed. Emphasis is placed on the significant phenomena underlying the operation of these two classes of converters. A treatment of fundamental thermionic emitter characteristics is given. The complex variety of simultaneous processes occurring in the plasma of gas-filled converters is illustrated together with principal problem areas existing in the field

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of both converter types. The present state of the art in this field is discussed in connection with the results obtained with small-sized device samples developed up to date. Future applications of thermionic converters are projected, and the report refers to the current need for continued applied research efforts aimed at advancing the state of the art from the presently available thermal conversion efficiency of about 10 per cent up to the theoretically feasible level of approximately 30 per cent. *Thermionic Energy Converter, Walter L. Knecht, Electronic Technical Laboratory, Wright Air Development Div., Wright-Patterson AFB, Ohio, March 1960, 54 pp, \$1.50. Order PB 161713 from OTS, Washington 25, D. C.*

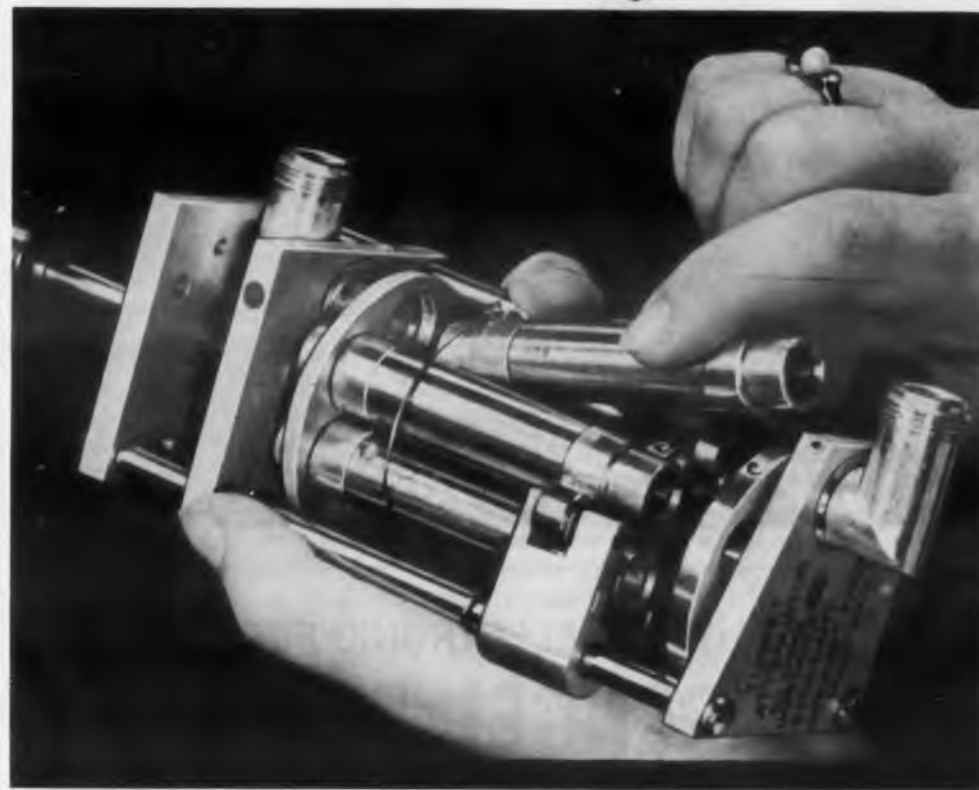
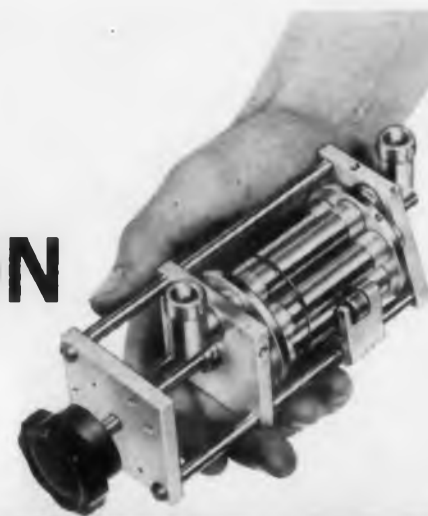
Dynamic-Pressure Transducers

A survey was made of commercially available dynamic-pressure transducers. The more important characteristics of these transducers taken from the manufacturers' literature are grouped according to principle of operation. For each group listed, the names and addresses of representative manufacturers of the transducers are included. Users of dynamic-pressure transducers will find the information useful for selecting one which will best serve for a particular measurement. *A Guide To Selection And Use Of Dynamic Pressure Transducers, Arthur Hausner, Diamond Ordnance Fuze Laboratories, Washington, D. C., Sept. 1959, 17 pp, Microfilm \$2.40, Photocopy \$3.30. Order PB 146137 from Library of Congress, Washington 25, D.C.*

Slow-Wave Measurements

Recent developments in traveling-wave solid-state masers point up the utility of slow-wave circuits in comparison with cavities for magnetic resonance measurements. Among other advantages, slow-wave circuits are ideally suited for broadband or multifrequency measurements without loss of sensitivity. They readily produce circularly-polarized fields over large volumes. Measurements of χ' and χ'' , which involve measurements of resonant frequency and Q in a cavity, reduce to generally simpler measurements of attenuation and phase shift. This paper also discusses slow wave-circuit characteristics which are especially relevant to magnetic resonance measurements. *Traveling-Wave Techniques For Microwave Resonance Measurements, A. E. Siegman, Stanford Electronics Laboratories, Stanford University, Calif., Oct. 12, 1959, 11 pp, Microfilm \$2.40, Photocopy \$3.30. Order PB 146227 from Library of Congress, Washington 25, D.C.*

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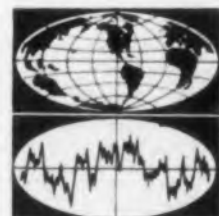
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**STANDARDS
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Sherman S. Hubelbank

**RF Coils: Test Procedures
Described in MIL-C-15305**

Test procedures for measuring inductance, Q , and self-resonant frequency are described in detail in this new issue of MIL-C-15305. Standard test fixtures and test frequencies are also specified. The color coding for rf choke coils has been changed. The standard quality assurance provisions have been incorporated. The high-frequency vibration test has been added on a "when specified" basis. MIL-C-15305B, Radio-Frequency Coils and Intermediate-Frequency and Radio-Frequency Transformers, 15 April 1960.

**New Test Methods
For Electronic Components**

Revision B of MIL-STD-202B makes the following changes and additions:

- Method 105B. Adds test condition E for an altitude pressure of 150,000 ft.
- Method 107A. Adds test conditions D and E for temperatures of -65 to $+350$ C and -65 to $+500$ C.
- Method 108. Standardizes temperatures, tolerances, and time durations specified in individual life tests.
- Method 109. Adds test method for determining whether a part will ignite in an explosive atmosphere.
- Method 110. Adds test method for determining electrical and mechanical effects from dust-laden atmospheres.
- Method 204A for high-frequency vibration. Changes 1-1/2 hr to 1-1/3 hr, sweep time and duration, in each of three mutually perpendicular directions. The title of MIL-STD-202B is Test Methods for Electronic and Electrical Component Parts. When available, it will be distributed by Armed Services Electro-Standards Agency, Fort Monmouth, N.J.

**Revision of Resistor Spec Changes
Resistance Tolerance From $\pm 10\%$ to $\pm 5\%$**

This spec for adjustable wirewound power resistors changes the resistance tolerance from $\pm 10\%$ to $\pm 5\%$. In addition, the spec:

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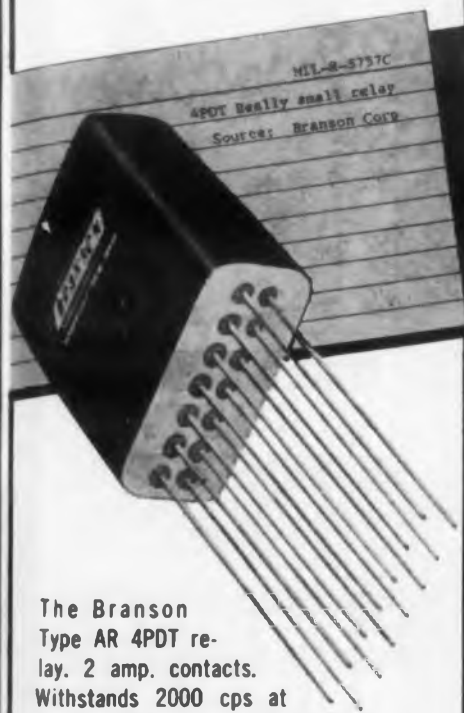
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■ Modifies dimensions to correspond to fixed-resistor styles in MIL-R-26C such as RW29, RW32, RW33, RW35, RW36, RW37, RW38, and RW47.

■ Adds moisture-resistance test.

■ Deletes separate low-frequency vibration test that was part of the moisture-resistance test.

■ Adopts the 24-number decade for standard resistance values.

■ Revises groups B and C inspection to agree with MIL-R-26C.

■ Revises Quality Assurance Provisions, incorporating standard paragraphs on responsibility for inspection.

Designated MIL-R-19365C, the spec is titled Resistors, Adjustable, Wirewound, Power. When available, copies will be distributed by Armed Services Electro-Standards Agency, Fort Monmouth, N.J.

Standard for Industrial Control Apparatus Is Revised

A revision of C19.1-1943, the new standard reflects changes that have been made since 1943 in industrial-control apparatus. The standard covers electric, electronic, magnetic, and mechanical devices which govern the power delivered to industrial devices which operate on 750 v dc or less or 500 v ac or less. Some of the controls included are photoelectric relays, push-button switches, electromagnetic brakes, solenoids, and magnets. The standard sets down performance requirements and test methods. Sponsored by the American Institute of Electrical Engineers and the National Electrical Manufacturers Association, the standard is called American Standard for Industrial Control Apparatus, C19.1-1959. It is available from the American Standards Association, 10 E. 40th St., New York 16, N.Y. at \$2.50 per copy.

MIL-C-11693A Is Revised, Adds 15 New Capacitors

A total of 15 new capacitor types, including three 150-C units, have been added in this revised spec, MIL-C-11693B. Dielectric materials such as paper-plastic, metallized-paper, and metallized-plastic have also been added to the spec. The Quality Assurance Provisions now assign the responsibility for inspection to the supplier; the inspections include additional requirements and test methods. The title of the spec is Capacitors, Feed Through, Radio-Interference Reduction, AD and DC (Hermetically Sealed in Metallic Cases), MIL-C-11693B. When available, copies will be distributed by Armed Services Electro-Standards Agency, Fort Monmouth, N.J.

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Models listed are stock units. Special designs also available to customers specifications. Write for literature and quotations.

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Model No.	Output Volts	Current Ma-Max	Case Size*		Net Price**	
			60 Cps	400 Cps	60 Cps	400 Cps
TR5	5	0-200	D	C	\$ 70.00	\$ 95.00
TR10	10	0-200	D	C	70.00	95.00
TR20	20	0-200	D	C	70.00	95.00
TR30	30	0-150	D	C	70.00	95.00
TR40	40	0-150	D	C	70.00	95.00
TR50	50	0-150	D	C	70.00	95.00

ADJUSTABLE VOLTAGE TYPES

Model No.	Voltage Range	Output MA	Case Size*		Net Price**	
			60 Cps	400 Cps	60 Cps	400 Cps
TR5A	5-10	0-200	D	C	\$ 80.00	\$105.00
TR10A	10-20	0-200	D	C	80.00	105.00
TR20A	20-30	0-150	D	C	80.00	105.00
TR30A	30-40	0-150	D	C	80.00	105.00
TR40A	40-50	0-150	D	C	80.00	105.00
TR50A	50-55	0-150	D	C	80.00	105.00

*400 cps units designated by prefix "R" (ie, TR5R, etc.)

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STANDARDS AND SPECS

Eight New Filters Replace Those Listed in MIL-F-15733C

MIL-15733D replaces all six types of filters listed in MIL-F-15733C with eight new types. Two of the eight are tubular, having current ranges of 1 to 30 amp at 100 v dc and 1 to 50 amp at 400 v dc or 125 v ac; the other six are bath-tub types, having ranges of 1 to 50 amp at 100 v dc, 400 v dc or 125 v ac, and 600 v dc or 250 v ac. The type designation now includes symbols for current rating, insertion-loss characteristic, terminal identification, operating-temperature range, and vibration grade. Also included are seven insertion-loss characteristics, varying from 40 to 70 db at 1.5 mc and 50 to 80 db at 1,000 mc. The spec is titled MIL-F-15733D, Filters, Radio Interference. When available, it will be furnished by Armed Services Electro-Standards Agency, Fort Monmouth, N.J.

First Amendment To Capacitor Spec Substitutes 20-V Rating For 18-V

The first amendment to MIL-C-3965B for fixed-tantalum capacitors substitutes a 20-v rating for the 18-v rating. In addition, the following requirements in test specifications have been added.

- Examination of units visually after life test.
- Manufacturers' responsibility for inspection requirements.
- In group A, inspection AQL, allowance for only 0.65% defectives for major classifications and 1.5% for minor.
- In group C inspection, barometric-pressure testing to be conducted after life testing.

In the associated detail specifications, the following changes in types of capacitors have been made.

- 1C. Style CL14 with grounding tab and style CL16 with threaded neck and grounding tab replace style CL15.
- 4B. Styles CL64 and CL65, skirtless types, have been added. A high-capacitance series is also included.
- 9A through 12A. Polar and non-polar, plain- and etched-foil types, in bath-tub construction for 125 C use have been included. Brackets are required for bath-tub units.
- 15 through 18. Polar and non-polar, plain- and etched-foil types, in tubular construction for 125 C use have been added.
- 19 and 20. Tubular units for 175 C use and with 85-C ratings of 30 to 90 v have been added.

The full title of the spec is MIL-C-3965B, Capacitors, Fixed Electrolytic (Tantalum). When

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Standard Covers Method Of Interconnecting Data Terminal Equipment

This standard provides a method of interconnecting data-terminal equipment and a data-communication channel when each is furnished by a different company. It defines a means of exchanging control signals and binary-serialized data signals between data-terminal equipment and a data-communication channel. *RS-232 Interconnection of Data Terminal Equipment with a Communications Channel is available from Electronic Industries Assoc., Engineering Dept., 11 W. 42nd St., New York 36, N.Y. Price is \$0.50.*

Coil and Transformer Spec Standardized Measuring Procedures

This spec standardizes test procedures for measuring inductance, Q, and self-resonant frequency in rf-choke coils. Standard test fixtures and test frequencies are also specified. Other changes include the incorporation of a high-frequency vibration test, method 204 of MIL-STD-202, and modification of color-code markings. The spec is called MIL-C-15305B, Coils, Radio Frequency; And Transformers, Intermediate Frequency And Radio Frequency. When available, copies will be furnished by Armed Services Electro-Standards Agency, Fort Monmouth, N. J.

Mil Spec Standardizes Switch Boots

The newly issued MIL-B-5423B covers the requirements for molded silicone-rubber boots that can be used on toggle and push-button switches, rotary-actuated parts (such as rotary switches, variable resistors, capacitors, inductors) and transformers. Supplement 1 lists the applicable detail specs for the individual boot types and styles. This is a new spec that supersedes MIL-B-005423(ASG) and MIL-B-19257(SHIPS). Boots, Dust and Water Seal (For Toggle and Push-button Switches and Rotary-actuated Parts), MIL-B-5423B, 5 August 1960.

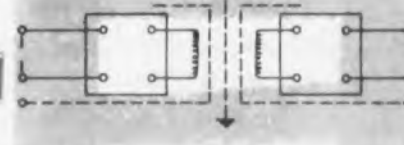
Material Listings Standardized

MIL-STD-30A establishes minimum requirements for the preparation of lists of material or parts lists, data lists, and index lists, separate from, or used in association with engineering drawings prepared by, or for, the Department of Defense. MIL-STD-30A, Associated Lists, Lists of Material, Data List, Index List.

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TYPE	FULL SCALE POWER RANGES IN WATTS	FREQ. RANGE KMC	VSWR MAX.	MEASURING TIME	ACCURACY
CB-33	15, 30, 60	DC - 4 KMC	1.25	1 min. or less	1%
CB-34	25, 50, 100	DC - 4 KMC	1.25	1 min. or less	1%
CB-35	50, 100, 200, 400	DC - 4 KMC	1.25	1 min. or less	1%
CB-36	125, 250, 500, 1000	DC - 4 KMC	1.25	1 min. or less	1%

Other Calorimeters available with Waveguide Loads for the frequency range between 1 to 24 KMC. Write for literature and prices on these and all other Calorimeters.

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ELECTRONIC DESIGN • November 23, 1960

YOUR CAREER NEWS AND NOTES

A firm in the Minneapolis-St. Paul area is teaching its employees to read faster and allowing the public to sit in on the course.

The firm is the Minnesota Mining and Manufacturing Co., which sponsors a 12-week televised education course in "Efficient Reading."

The "class" is held each Tuesday from 4:30 to 5 pm. A total of 166 employees enrolled in the course view the instruction at six company receiving locations.

In addition, an undetermined number of the general public watch from their homes. The company has received 401 requests for the \$3 workbook used with the course, and has received ten inquiries about the course from other firms in the area.

The course is given by Dr. James I. Brown, professor of rhetoric at the University of Minnesota.

Many college students who want to be engineers don't understand the engineer's job, according to Dr. John R. Ragazzini, dean of New York University's College of Engineering.

Insufficient differentiation among the professional roles of chemists, mathematicians, physicists and the engineering profession in the minds of college students has often led to frustration in the early years of professional life, Dean Ragazzini said at a recent career conference.

"The loose use of the labels 'science' and 'scientist' in the public press in connection with space programs has done much to cloud the issue of who does what in some of today's more vital technical projects," he added.

A California personnel consulting firm is offering to companies a device that supposedly keeps engineers marching to the company tune. National Business Aids, Santa Monica, offers, at low cost to companies, a pamphlet for distribution to company technical personnel.

National Business Aids bills the booklet as "a unique human-relations publication—specifically designed for engineering and technical personnel . . . combines humor with the teaching of good human relations. Chuckle-provoking cartoons and pithy observations that pack plenty of punch and get across one important message in each issue."

The problem this pamphlet will eliminate is described in National's advertising literature as follows:

"How to keep engineers—and other technical

personnel—happy is a major problem faced today by top management across the country. Anything you can do to keep morale high, tempers calmed down, and increase the cooperation among engineers—as well as cooperation with other departments—pays off in increased production, better original thinking, and a more satisfied engineering staff."

The first of these pamphlets, to be issued twice monthly, preaches the doctrine, "Join the Team." On the opening pages, a cartoon-character infielder is catching the ball from a smiling teammate. Separating them is the rejoinder, "Know anything nicer to watch than smooth, closely coordinated team play?" and the answer, "Whether it be baseball, basketball or football—no matter what the sport, team play makes a winner every time. And the same applies to industry—especially to those of us in the engineering profession."

The need for more systems engineers led Washington University, St. Louis, to give a course in systems last month to chemicals engineering instructors.

The course, financed by the National Science Foundation, aims to alleviate a shortage of systems engineers by training college teachers who can, in turn, include the material in their curricula, according to Dean Earnest Brandenburg, of the university.

The course included time- and frequency-response methods, stability analysis, non-linear systems analysis, and computer applications.

Eighty-five engineers from New York University are convinced that behind every man is a woman. New York University, where engineers received their bachelor's degrees by attending evening session classes, recently cited each man's wife for "the assistance she has rendered her husband in the completion of his program of higher education."

The "Good Wife" certificates were awarded by the student council. They were signed by the student council president and the appreciative husband. One wife described the wives' role as follows: "A lot of fellows drop out, not because they couldn't do the scholastic work, but because their wives couldn't stand the grind."

The General Motors Institute, Flint, Mich., will award bachelor's degrees in electrical engineering for the first time in 1963. The curriculum, according to the institute, will be oriented

towards product design, plant engineering, and process engineering.

The institute is run by General Motors, and attendance is open to any high-school graduate who can get sponsorship by a company subdivision or automotive dealer. The school is accredited by the state of Michigan. Students take courses on a cooperative basis—studying part time and working for GM part time.

The better-known mathematical and scientific principles are found in all texts. Here are several equally important, but less often publicized rules that are useful in practical engineering or engineering administration:

LAW OF PERVERSITY—In any circuit where a number of possibilities for error exist, the most damaging possibility will occur.

A LEMMA—If it is absolutely impossible for an error to exist in the circuit, the chances are 100% that one will exist anyway.

STANDARD PROCUREMENT PROPORTION—The longer the lead time, the greater the number of design changes, the longer the delay, the higher the cost.

McINTOSH'S APPROXIMATION—Convert a cost estimate obtained from engineers or engineering data to Mexican pesos at the current rate of exchange. Replace the peso sign with the dollar sign. The result will approach the actual cost of the work to be done.

DESIGNER'S CONSTANT—The time for any given designer to complete one day's work is a constant 8 hours. The time for the same designer to do anything less than a day's work is also 8 hours.

The following appeared in the Letters to the Editor columns of the Charlotte Observer, Charlotte, N.C.:

MISSILEMEN TAKE NOTE

I heard a fellow say the other day that he had fired a thing up about a thousand miles. I am writing to tell you all that I'm getting plum worried about this thing.

Now you know that there's bound to be a war out there somewhere, and one of these days they are going to shoot something too far and bust a hole in it. Then just think of all the mess that might come pouring in! It's like playing around with an air rifle in a balloon.

I want you to put it in your paper for people to start minding themselves about this thing.

Will Whitaker

Kannapolis

ELECTRONIC DESIGN **CAREER INQUIRY SERVICE**

USE BEFORE JAN. 4, 1961

24

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 _____

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Company	City and State	Dates	Title	Engineering Specialty

Outstanding Engineering and Administrative Experience _____

Professional Societies _____

Published Articles _____

Minimum Salary Requirements (Optional) _____

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924
925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949

**Advancement
Your Goal?
Use
CONFIDENTIAL
Action Form**

ELECTRONIC DESIGN's Confidential Career Inquiry Service helps engineers "sell" themselves to employers—as confidentially and discreetly as they would do in person. The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—the same day the resume is received.

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

- All forms are delivered unopened to one reliable specialist at *ELECTRONIC DESIGN*.
- Your form is kept confidential and is processed only by this specialist.
- The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
- All original applications are placed in confidential files at *ELECTRONIC DESIGN*, and after a reasonable lapse of time, they are destroyed.

If you are seeking a new job, act now!

ENGINEERS

WHY SANDERS PROVIDES REAL OPPORTUNITY

GROWTH

- From 11 men to 1400 in only 9 years — and still growing
- Gross sales increasing steadily — \$17 million in fiscal year 1960 — with 50% increase projected for 1961

This means new opportunities year by year for forward-looking, ambitious engineers

STABILITY

- Backlog of \$50 million at time of writing
- Most of the company's developmental work and specific products are in areas of the electronics industry where overall growth outlook is good — military systems, automatic assembly and microwaves' instrumentation and control

Long-term assignments assured on a diversity of contracts

REPUTATION

- PANAR® radar, FLEXPRINT® flexible printed circuits and TRI-PLATE® microwave products paved the way for new prime contracts — \$30 million worth, primarily for production of electronic systems that have emerged from the company's research and development programs.

Increase your own knowledge and professional stature by working with men who rely on new technical concepts rather than traditional approaches

INQUIRE NOW ABOUT POSITIONS IN:**CIRCUIT DESIGN — SENIOR LEVEL**

Particular emphasis on transistor application to analog and digital techniques; data handling equipment; audio, video, RF circuitry and switching.

SYSTEMS

ECM, Radar and ASW. For theoretical studies and hardware implementation. Through Project Engineer level.

PACKAGING

For both airborne and ground based equipment. Experience in vibration, heat transfer, printed circuit techniques.

TRANSMITTER MODULATOR DESIGN

To contribute to the design of the Eagle Missile transmitter modulator. Experience with modulator or transmitter circuits and system design of oil immersed and dry designs on light weight units of ultra reliability. General experience with vacuum tubes and pulse circuits, high voltage design and magnetic circuits.

TEST EQUIPMENT

To design and develop test equipment for both manufacturing and research and development activities. Good knowledge of pulse and low frequency circuits, switch measurements, sweep circuits and the principles of pulse doppler radar.

RECEIVER DESIGN

VHF electronically scanned airborne receivers, filters, problems in spurious response reduction and multiplexing.

*Please address your inquiries to
Mr. Roland Hood, Employment Manager*



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CIRCLE 901 ON CAREER INQUIRY FORM

SYSTEMS ENGINEERS, EE

*Immediate
Opportunities In These
Development & Design
Projects*

FIRE CONTROL SUB-SYS-

TEMS . . . including data handling, computers, display, reference and control equipment for shipborne, submarine, and land-based fixed and mobile weapons systems.

DIRECTORS . . . including pedestals, antennas, power drives, servos and computers, etc.

UNDERSEA ORDNANCE . . . torpedoes, mines and their mobile countermeasures (including seawater batteries), propulsion equipment, guidance and associated test and maintenance equipment.

**RADAR & RADIO TELESCOPE
ANTENNAS . . .**
associated equipment.

INERTIAL GUIDANCE . . .
systems and sub-systems for missiles, space vehicles, surface ships, submarines, land survey vehicles, etc.

*if you're ready
for a career-move in*

PRECISION ENGINEERING

*you can contribute
to the success of
General Electric's
Ordnance Department*

You'll be working in an engineer's department, a new department whose product is manufactured in the mind. You'll be working within a managerial climate that is dedicated to making it easy for you to extend yourself. Small groups, air-conditioned offices are a visible example of this advanced managerial awareness.

You'll be probing sensitive, intricate, and miniaturized inertial navigation systems. Your job will be to generate and apply pioneering technological conceptualization in one or several of the specific problem areas listed below. You will be asked regularly to solve problems lesser men might call impossible. You and your contribution are important at Ordnance.

This is exciting work, and tough. It's for the man who *has it* and seeks only the opportunity to demonstrate and develop his talent, drive and conceptual capacity.

And your rewards will be commensurate with your contribution. Ample opportunity exists for advancement both within the Ordnance Dept. and throughout General Electric, a company now employing 22,000 engineers, anticipating a need for half again as many halfway through the '60's. Even more important, there's ample room for rapid growth within the salary and responsibility structure of the job you'll first undertake with Ordnance. Full tuition refund is available to you if you work as hard at graduate studies as you will on the job itself.

Ordnance is located in the heart of the Berkshires. Halfway between New York and Boston, the Berkshires is one of the country's great cultural, sport, and recreation centers—a plus you'll find important to a rounded family life, the physical and non-technical mental activity you so seek.

Positions are available to take maximum advantage of abilities and interests at most levels of experience and development.

If you are ready for this kind of move—not just vaguely discontent with what you're now doing—send a brief resume to W. B. Walker, Manager—Professional Relations, Dept. 76-SMU.

ORDNANCE DEPARTMENT
of the Defense Electronics Division

GENERAL  ELECTRIC

100 Plastics Avenue

Pittsfield, Massachusetts

CIRCLE 902 ON CAREER INQUIRY FORM

ELECTRONIC DESIGN • November 23, 1960

ENGINEER-IMPROVEMENT COURSES AND SEMINARS

Below are courses and seminars intended to provide the engineer with a better knowledge of various specialties. Our grouping includes several different types of meetings: National Courses—those held on consecutive days and intended to draw attendees from all geographical areas; One-Day Seminars—one-day intensive seminars which move from city to city; and Regional Lectures—regional symposia or lecture series which generally run one night a week for several weeks.

National Courses

Symposium Sponsored By The Texas Division of Collins Radio Co.

A microwave and carrier communication system engineering symposium and exhibit, sponsored by the Texas Div. of Collins Radio Co., is currently being conducted on a nationwide tour which started on Sept. 12, 1960.

Purpose of the symposium is to acquaint management and communication personnel in governmental and industrial circles with the engineering parameter and application techniques of microwave and carrier equipment.

The exhibit to accompany the symposium will include two terminals of operating microwave and carrier equipment.

Cities and dates of remaining appearances include: Minneapolis, Minn., Nov. 21 to Nov. 25; Denver, Colo., Nov. 28 to Dec. 2; Seattle, Wash., Dec. 12 to Dec. 18; Helena, Mont., Jan. 9 to Jan. 13; Portland, Ore., Jan. 23 to Jan. 27; San Francisco, Calif., Feb. 6 to Feb. 10; Los Angeles, Calif., Feb. 20 to Feb. 24; Albuquerque, N.M., March 6 to March 10; New Orleans, La., March 20 to March 24; Jacksonville, Fla., April 3 to April 7 and Charlotte, N.C., April 17 to April 21.

Problems In Engineering And Management Discussed At U. C. L. A.

Universally applicable problems in engineering and management will be discussed by a universal audience of engineers and managers Jan. 23 to Feb. 2, 1961 at UCLA, Los Angeles, Calif.

The program is designed to help enrollers improve their present effectiveness and to prepare for higher responsibilities. Techniques, practices and principles discussed in the seminars are applicable to the problems of business, industrial



BUT, SIR ISAAC, WE'RE NOT GUIDING APPLES!

Until a ballistic missile is in free fall, our inertial guidance systems must be able to account for both rocket thrust and gravity. Making them this smart is a tough job, but we hit the mark so well on Thor that all of this country's long range missiles will soon be guided inertially. If you would like to help us keep pioneering new guidance systems, and have a BS, MS or PhD in Physics or Math, or an ME or EE, please contact Mr. B. G. Allen, Director of Scientific and Professional Employment, 7929 S. Howell Ave., Milwaukee 1, Wisconsin.

AC SPARK PLUG  THE ELECTRONICS DIVISION OF GENERAL MOTORS



CIRCLE 903 ON CAREER INQUIRY FORM

Small Answer to a Big Problem...



Defending our ships and cities from torpedo or missile attacks by enemy submarines is a problem which will exist as long as the cold war continues. However, Grumman's extensive research, design, development, and production activities in the field of anti-submarine warfare are continually contributing to the solution of this problem, gradually nullifying this threat.

Typical of Grumman activities in this area is the incorporation of the Magnetic Anomaly Detection System in its ASW aircraft. The detection of a submarine by virtue of the minute effect of its metallic mass upon the earth's magnetic field is a method which holds great promise . . . yet poses enormous practical problems. A rubidium vapor cell is the heart of an experimental magnetometer shown above. Diminutive and simple, it is contributing to the solutions of these problems by improving sensitivity and therefore range capabilities of the MAD system and providing a serious threat to enemy submarines.

Grumman Avionics Engineers are today involved with many interesting and intellectually stimulating projects involving our defenses, our retaliatory capabilities, and our vital space activities. If you can contribute to our ASW program or are qualified in the following or similar areas, you are eligible for a place on one of these projects.

ASW SYSTEMS ENGINEERS. Electronic engineers and physicists experienced in sonar or radar techniques are needed to participate in challenging programs in ASW. Work will involve the applications of ASW techniques to airborne, hydrofoil, surface ship and submarine phases of the problem. BSEE or BS in Physics with a minimum of 5 years experience required.

DIGITAL COMPUTER SYSTEMS ENGINEERS BSEE with a minimum of 4 years experience in the analysis, design and development of digital computers. Will participate in the integration of a digital computer into a complex weapons system. A significant part of the effort will be devoted to extensive laboratory and flight development programs.

RADAR DEVELOPMENT ENGINEERS. BSEE with a minimum of 4 years experience in the analysis, design and development of airborne radar systems. Should be capable of analyzing the radar system with the end view of integrating the equipment into a complex weapons system. Will fully participate in laboratory and flight development programs conducted in the finest facilities available in a professional atmosphere.

IN-PLANT AVIONICS LIAISON ENGINEER

To work with and instruct technicians in test and servicing of advanced airborne electronic equipment including digital computers, radar data processing equipment and data link systems both in laboratory and after installation in aircraft. Minimum of 8 years combined technical education and experience is required. Work experience must include digital computers, data processing equipment or data link systems plus one or more of the following: radar, inertial guidance, electronic countermeasures, aircraft instruments, aircraft power systems, automatic flight control systems, doppler navigation equipment.

AVIONICS SUPPORT EQUIPMENT ENGINEERS

Electronic engineers experienced with digital computers, radar and communications who welcome an opportunity to utilize their present skills while they extend their technical background to new areas. These engineers will analyze complex weapons systems to establish test logic and techniques involved in a comprehensive automatic test program utilizing ground support equipment. BSEE with a minimum of 3 years experience required.



To arrange an immediate interview, send your resume to Mr. W. Brown, Manager Engineering Employment, Dept. GR-75. (U.S. citizenship required.)

GRUMMAN AIRCRAFT ENGINEERING CORPORATION
Bethpage, Long Island, New York

CAREER COURSES

and governmental organizations.

Participants will have a choice of 23 subjects that will be taught by 30 professors, industry specialists and managerial consultants. Some subjects offered are: Organization and Administration of an Industrial Engineering Department, Mathematical Bases for Decision and Programming in Industry, Electronic Data-Processing for Business and Industry, Engineering and Research Administration and Accounting for Engineers and Managers.

No formal educational requirements are demanded, but enrollment is limited.

Instructional staff includes: Alexander W. Boldyreff, Professor of Engineering, University of California; George W. Brown, Professor of Engineering and Business Administration and Director, Western Data Processing Center, University of California; Richard G. Canning, Associate Research Engineer, Management Sciences Research Project, University of California; Harry W. Case, Professor of Engineering and Professor of Psychology, University of California; J. Morley English, Vice Chairman-Research, Dept. of Engineering and Professor of Engineering, University of California; Thomas E. Hicks, Associate Professor of Engineering, University of California and Robert N. Lehrer, Professor and Chairman, Dept. of Industrial Engineering, The Technological Institute, Northwestern University.

The \$450 fee includes tuition, books and class materials.

For further information write to: Reno R. Cole, Coordinator, College of Engineering, University of California, Los Angeles 24, Calif.

Graduate Lecture Program Sponsored By Case Institute of Technology

The third annual series of public lectures sponsored by Case Institute of Technology will present four authorities in the arts and sciences.

Open to college students, faculty members and individuals who are interested in various aspects of technological progress, the program is designed to allow for the exchange of ideas among students on the graduate level.

On Feb. 15, Dr. Wallace R. Brode, Science Advisor to the U. S. Dept. of State, will discuss "The Role of Science in Modern Diplomacy." Sir Robert Watson-Watt will discuss "The Pulse of Radar," on March 15. Dr. Boris Goldovsky, Artistic Director of the Goldovsky Grand Opera Theater, will discuss "Technological Flirtations With Music."

The lectures are held in CIT's Strosacker Auditorium at 8 pm. No admission is charged.



COMMUNICATION SYSTEMS . . . *the ultimate integration of the electronic arts*

Among the great names in the telecommunications and electronics industry, Kellogg today is one of the country's strongest sources of advanced communications equipments and systems. We have one major goal — to provide the finest communications that the electronic arts make possible . . . for industrial, commercial and military needs.

The Communication Systems Department of Kellogg, growing by leaps and bounds to keep pace with demands for wholly integrated communications means, provides large-scale communications systems from Alpha to Omega . . . from systems studies through engineering and production. Engineering is concerned with all phases of telephone, radio, data communications and automatic control circuit design. Principal areas of engineering organization include Project Engineering, Applications Engineer-

ing, Development and Systems Evaluation and Utilization and Reliability.

Typical of Kellogg's major systems engineering achievements is the provision of complete ground communications for the firing of Titan and Thor ballistic missiles and Discoverer and Samos space satellites at Vandenberg Air Force Base. Similarly, Kellogg has provided for the Atlas ICBM program nine separate systems for communication, control, maintenance and check-out, count-down, voice-recording and fire alarm — all functioning as an integrated system.

If you seek a dynamic organization in which to further your future, write Manager of Technical Staffing, Communication Systems Department, Dept. M-03(3).

ITT KELLOGG Communications Division, International Telephone and Telegraph Corporation
500 North Pulaski Road, Chicago, Illinois



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The national security need for Space Technology Leadership

Space is a medium in which many military missions can be most effectively performed • The U. S. arsenal of ballistic missiles—in being and forthcoming — the Air Force Thor, Atlas, Titan, and Minuteman, the Navy Polaris, and the Army Jupiter, are all designed to deter the outbreak of a nuclear World War III or to retaliate overwhelmingly if it should occur • If our ballistic missiles are to realize their greatest potential in carrying out their dual task, they must be supported by a number of companion space systems for such missions as early warning, reconnaissance, communications, navigation, weather forecasting. Space Technology Laboratories is proud of its contributions to the national space effort as a principal contractor in carrying out major programs for the Air Force Ballistic Missile Division, National Aeronautics and Space Administration, and Advanced Research Projects Agency • The increasing scope of STL's activity is opening up exceptional opportunities for the exceptional scientist and engineer, who will find creativity given encouragement and recognition in an organization synonymous with Space Technology Leadership. Resumes and inquiries will receive meticulous attention.

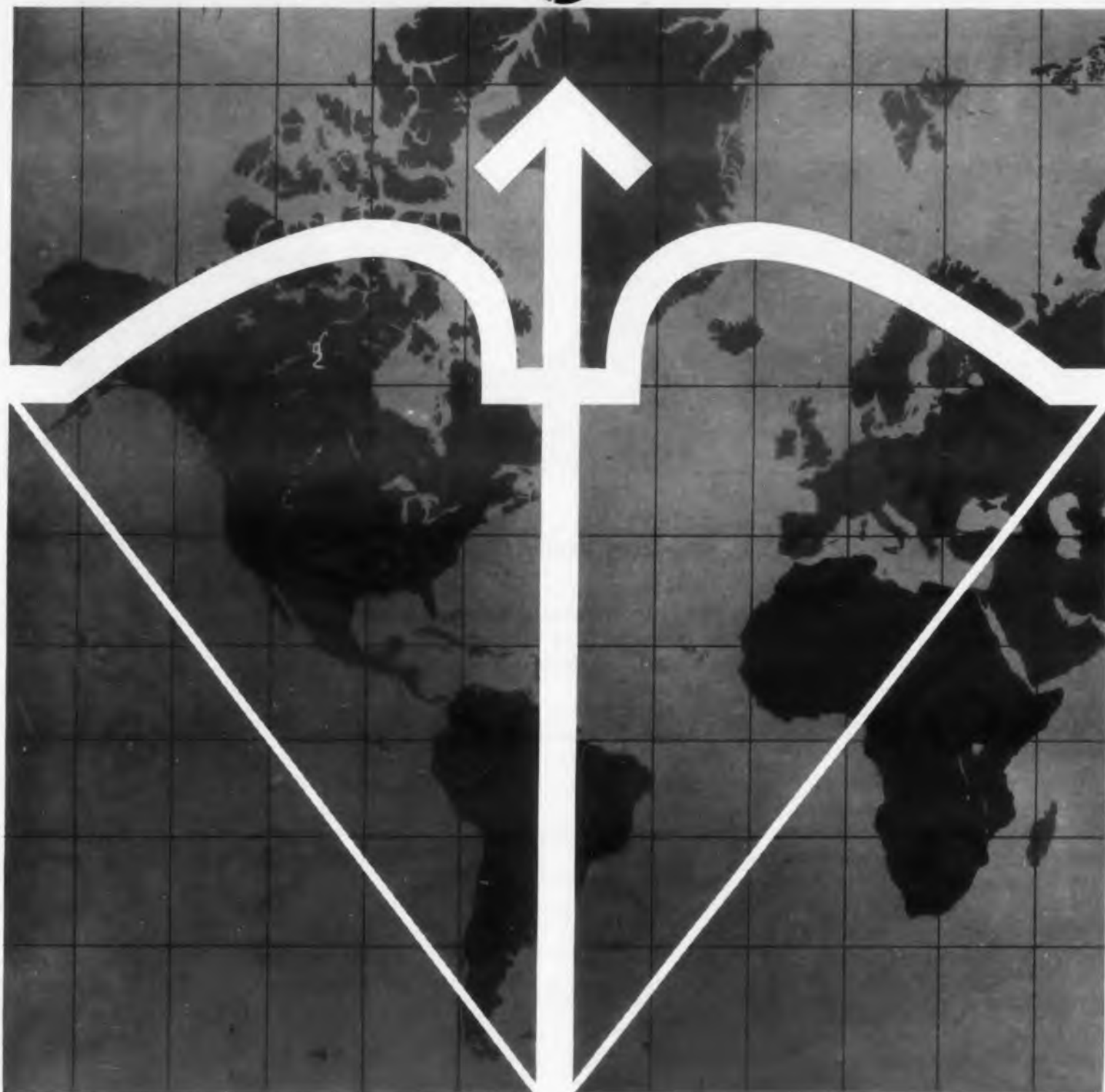
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CIRCLE 906 ON CAREER INQUIRY FORM

PAPER DEADLINES

Convention Program Chairmen have issued the following deadlines to authors wishing to have their papers considered for presentation.

Nov. 30: Deadline for 250-word abstracts for the **Fifth National Symposium on Global Communications**, known as **GLOBECOM V**, to be held **May 22 to May 24, 1961** at the **Hotel Sherman, Chicago, Ill.** Technical papers emphasizing the systems aspects of communications technology and related problems are solicited. Groups of authors are invited to submit related abstracts. Abstracts, with a brief professional record of the author, should be submitted in duplicate to: **Donald C. Campbell, Technical Program Committee, I.T.T.—Kellogg, 5959 S. Harlem Ave., Chicago 38, Ill.**

Dec. 12: Deadline for 500 word summaries for the **1961 National Symposium of the Professional Group on Microwave Theory and Techniques**, to be held **May 15-17, 1961** at the **Sheraton Park Hotel, Washington, D.C.** Papers are solicited in all fields of microwave research, development and application, principally in precision microwave measurements, solid-state microwave devices, and sources and components at millimeter waves. Send summaries to: **Gustave Shapiro, Chairman, Technical Program Committee, Engineering Electronics Section, National Bureau of Standards, Washington 25, D. C.**

Dec. 15: Deadline for detailed summaries of papers for the **1961 Western Joint Computer Conference** to be held **May 9-11, 1961** at the **Ambassador Hotel in Los Angeles, Calif.** Send summaries to: **C. T. Leondes, Associate Professor of Engineering, Dept. of Engineering, University of California, Los Angeles 24, Calif.**

Jan. 1: Deadline for abstracts (500 to 1,000 words) of papers for the **International Symposium on the Transmission and Processing of Information** to be held **Sept. 6 to Sept. 8, 1961** at **M. I. T., Cambridge, Mass.** The purpose of the symposium will be to provide a special occasion for the presentation of significant new theoretical or experimental research contributions. No tutorial papers will appear. Authors will be notified of the preliminary acceptance of their abstracts by **Jan. 20, 1961.** The symposium will be sponsored by the PGIT and the Center of Communication Sciences, Research Laboratory of Electronics, Massachusetts Institute of Technology. Send abstracts to: **Peter Elias, Program Committee Chairman, Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge 39, Mass.**

CAREER OPPORTUNITIES BROCHURES

Emerson Electric



This 12-page illustrated brochure, "Talent Grows At Emerson Electric of St. Louis," depicts the company's activities in the electrical-electronics-avionics industry. Emerson Electric is one of the four biggest producers of motors for appliances and industry and the largest independent supplier of these motors.

The heart of Emerson Electric is its engineering department in which creative engineering ideas are developed and brought to production.

For further information write to: The Emerson Electric Manufacturing Co., 8100 W. Florissant Ave., St. Louis 21, Mo.

CIRCLE 870 ON READER-SERVICE CARD

GE's Electronics Laboratory



In this 12-page brochure GE presents a picture of its Electronics Laboratory in Syracuse, N.Y. Scientists and engineers of the Electronics Laboratory are engaged in defense, industrial, and consumer electronics. The Laboratory staff is making significant contributions in such areas as cybernetics, missiles, energy sources and converters, satellites, transportation, entertainment and communications.

Electronics Laboratory, General Electric Co., Dept. ED, Syracuse, N.Y.

CIRCLE 871 ON READER-SERVICE CARD

How Do You Measure Achievement?

TALENT—bold, imaginative talent stimulated by the constant challenge of new concepts—was responsible for this achievement.

However, past achievements are significant only inasmuch as they indicate the path of the future. At DELCO, this path is clearly charted. We are committed—and dedicated—to uphold and maintain our position of leadership in the fields of electronics and Solid State Physics.

Fulfilling this challenge requires a constant infusion of new ideas and new talent—*aggressive new talent*. That's what we're looking for.

We are vitally interested in ambitious men with experience in the following areas:

ELECTRONIC ENGINEERS

Experienced in: transistor, communication and radio circuitry, servo systems and antennas; also, machine controls (relay and/or static) to assist in the development and application of static transistorized controls.

TRANSISTOR PROCESS ENGINEERS

EEs, MEs, and IEs to develop and create new processes for manufacturing germanium and silicon semiconductor devices. Experience preferred.

COMPUTER ENGINEERS

For development of control type, special, or general purpose units. Experience in digital to analog and analog to digital converter design. Or magnetic core or drum type memory. Mechanical engineers for package design. Electronic engineers for test design, servo-analysis, and circuit design.

PHYSICISTS, CHEMISTS AND METALLURGISTS

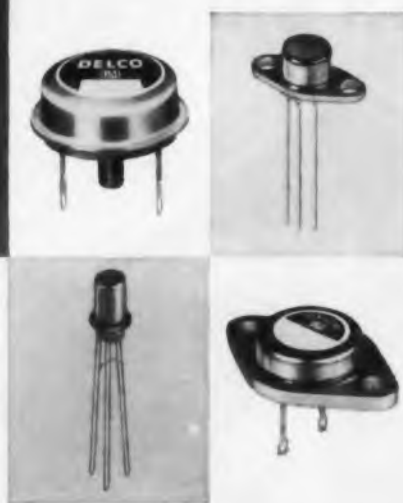
For semiconductor device development. With experience in: semiconductor materials (to lead a program on metallurgical research of new semiconductor materials), semiconductor device encapsulation, alloying and diffusion, chemistry of semiconductor devices.

We're eager to find experienced personnel with a desire for a stimulating challenge and the abilities to fulfill this challenge. Responsible positions are available for those who qualify.

If you're interested in becoming a member of our Delco—GM team of outstanding scientists and engineers, send your resume today to the attention of Mr. Carl Longshore, Supervisor Salaried Employment.

Division of General Motors • Kokomo, Indiana

CIRCLE 907 ON CAREER INQUIRY FORM



These transistors—representing the proven capability of Delco Radio to develop and mass produce the highest power transistor in the industry—are a measure of achievement.

DELCO
DEPENDABILITY
RADIO
RELIABILITY

Choose Your Pursuit From These
**FIVE FACETS
 OF PHILCO IN CALIFORNIA**



A PLACE FOR YOU awaits at rapidly expanding Philco Western Development Laboratories on the San Francisco Peninsula, where new concepts of space communication offer exceptional opportunities to the exceptional engineer . . . with proportionate rewards. Your experience and your interests determine your assignment at PHILCO in the development of the complete system — from the space communication network of space vehicles to the complex data processing equipment of the ground station complex.

For you . . . the opportunity of graduate study on a Tuition Refund basis at any of the excellent surrounding educational institutions, liberal employee benefits, and the facilities of Philco's new, modern R & D laboratories.

For you and your family . . . the perfect climate, whether seasonal or cultural, in which to pursue all-year recreational activities, only 45 minutes from cosmopolitan, dynamic San Francisco.

Immediate openings now exist for graduate engineers with experience in equipment design, systems engineering, analysis and integration. As a first step toward expanding your skills at Philco, send your resumé in strict confidence to Mr. W. E. Daly, Engineering Placement.

**PHILCO CORPORATION
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CIRCLE 908 ON CAREER INQUIRY FORM

**MAKE A
 MILLION**

In Electronic Engineering?

Not likely. Only a few have done it. However, most electronics engineers realize that above average earnings can be theirs in the electronics market. For the man who wants challenging work & earnings reflecting his capabilities, we are retained by 479 top electronics firms (both "giants" and "comers")

FREE — MONTHLY OPPORTUNITIES BULLETIN

If you wish to receive a monthly bulletin of the finest available electronic opportunities, simply send us your name and home address (and if you wish, a review of your qualifications)—Our services are without cost to you through our Chicago office and our Los Angeles subsidiary, Lon Barton Associates.

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"Where More Electronic Executives Find Their Positions Than Anywhere Else In The World."

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**FIGHT
 TB
 WITH
 CHRISTMAS
 SEALS**

ANSWER YOUR CHRISTMAS SEAL LETTER TODAY

CAREER BROCHURES

Alpha Corp.



This 32-page illustrated brochure describes the organization of the Alpha Corp., a subsidiary of Collins Radio Co., in Richardson, Tex. Alpha functions at the systems level, supplying the specialized talent and services needed to integrate the available components, equipment and techniques into operational systems. Systems management by Alpha is directed by outstanding men with both engineering and business experience.

Alpha Corp., Dept. ED, 820 E. Arapaho Road, Richardson, Tex.

CIRCLE 872 ON READER-SERVICE CARD

"Community Sketch Book"

The Sprague Electric Co. presents, through an illustrated brochure, an outline of activities and opportunities offered in its North Adams, Mass. location. They are interested in attracting those who want to learn and grow. First, basic research is conducted on materials and processes; second, new and improved products are developed and the third assignment, engineering itself is primarily directed to the designing and controlling of the standard products made by the company.

Among the cultural attraction of North Adams' Berkshire setting are: a public library; The Berkshire Museum at Pittsfield; the popular Tanglewood, some 30 miles from North Adams; The Williams College theatrical group; harvest fairs, and two famous restorations, Old Deerfield and Old Sturbridge Village.

Opportunities for self improvement are numerous. The company is currently conducting, with the Franklin Institute of Boston, the Sprague-Franklin Technical Institute a series of in-plant night school courses open to employes.

For complete details write directly to Employee and Community Relations in North Adams, Mass.

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*Manufacturers' catalog appears in 1960-1961 ELECTRONIC DESIGNERS' CATALOG

Opportunities in Systems Development



Looking at the sound of words

The plastic model shown here is a 3-dimensional representation of the frequency-energy pattern of the spoken word, "IBM." It is one of several similar models constructed from a computer analysis of speech information.

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Manager of Technical Employment

IBM Corporation, Dept. 555Y4

590 Madison Avenue, New York 22, New York

Representation of the frequency-energy pattern of the spoken word, "IBM." Horizontal axes: frequency and time. Vertical axis: energy. Sampling interval: 0.01 second.

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