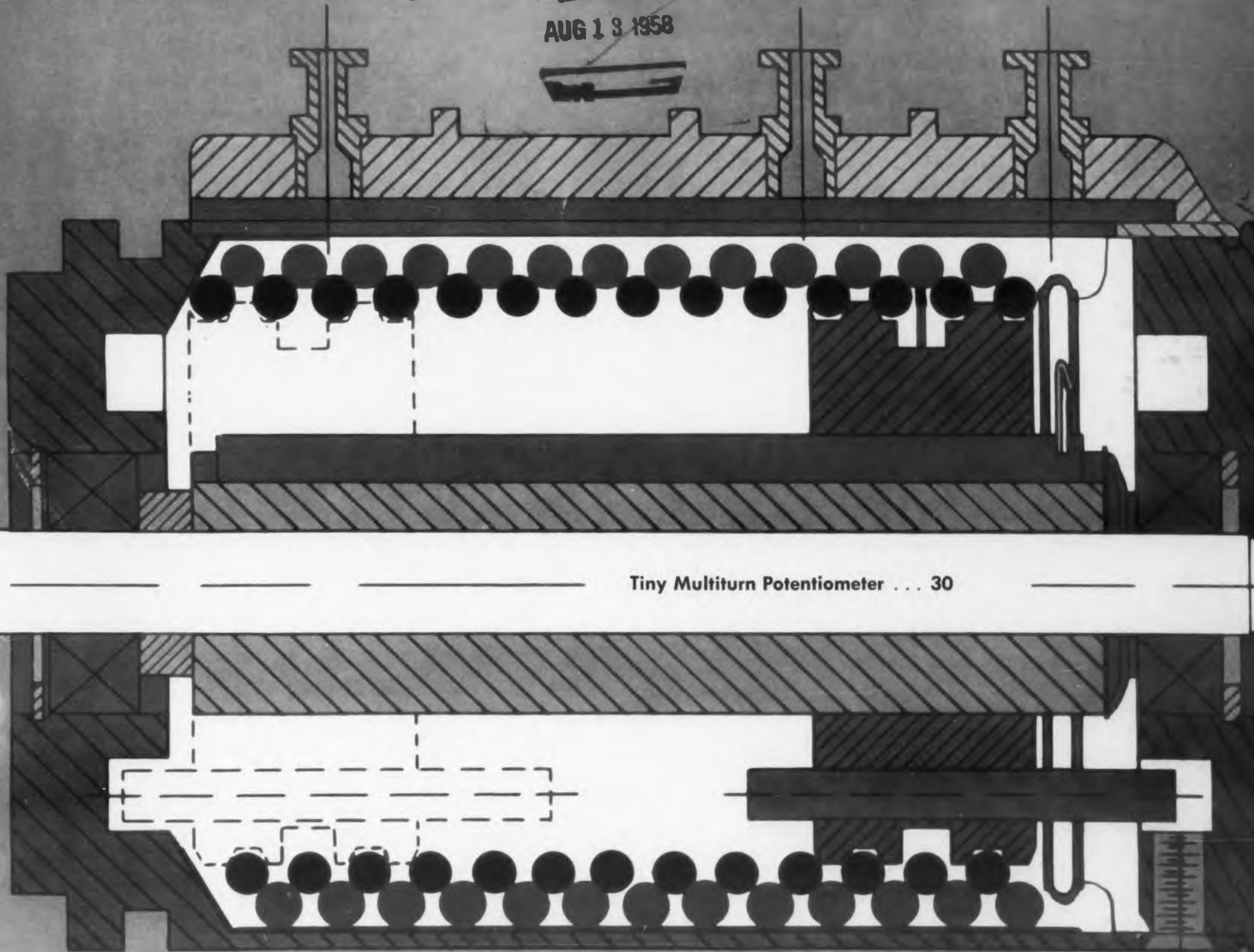


# ELECTRONIC DESIGN

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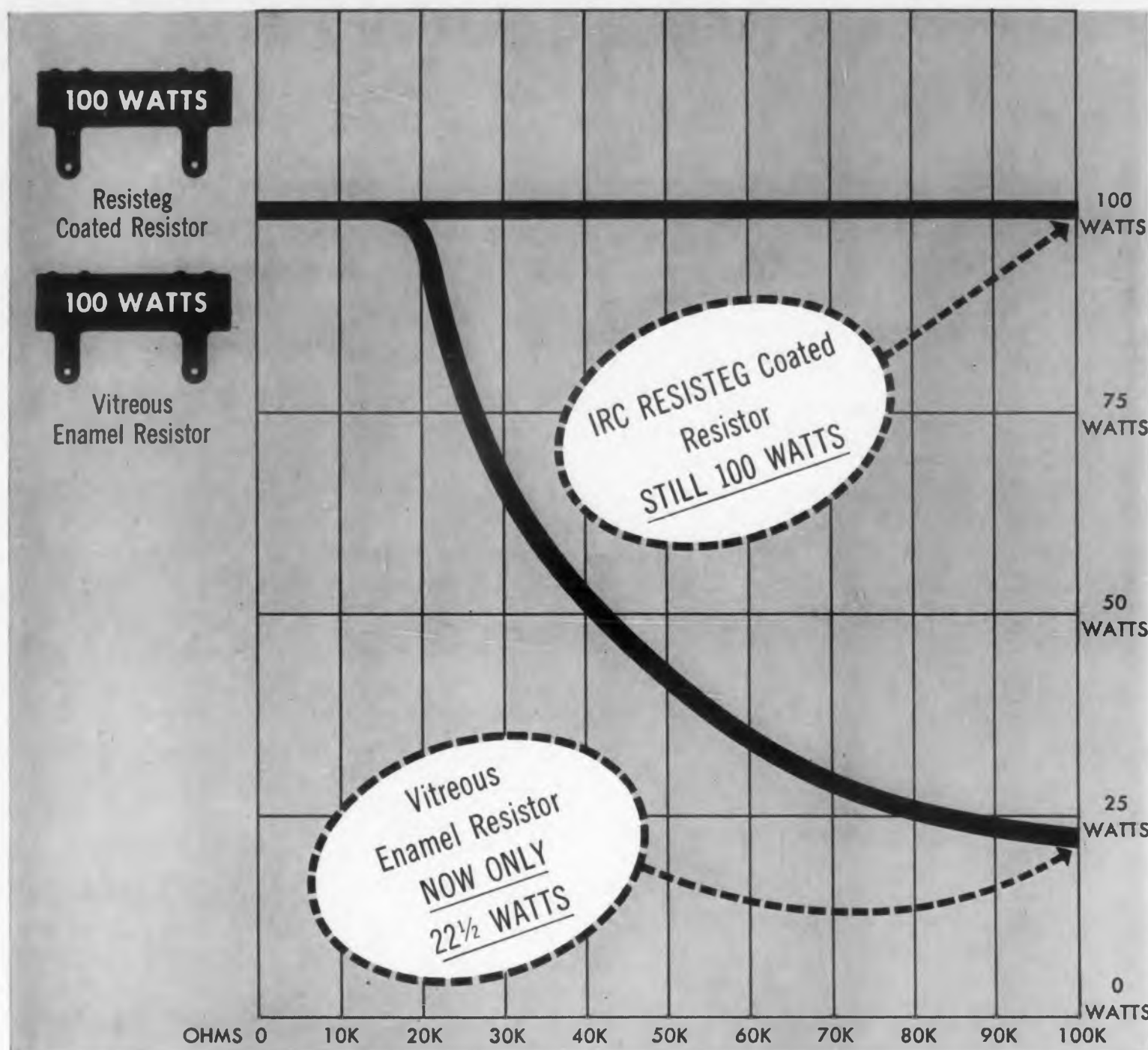
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AUG 13 1958



Tiny Multiturn Potentiometer . . . 30

# The "Inside Story" of Power Wire Wound Resistors



## WHY IRC POWER RESISTORS WITH RESISTEG COATING NEED NO DERATING

The big reason is *lower curing temperature!* IRC's exclusive RESISTEG Coating cures at only 205°F! Think of it... nearly 1000° lower than vitreous enamel coatings! This means the curing operation doesn't change the position of the wire... winding turns do not shift together. Wire is not "work-hardened", since no stretching is necessary to prevent shifts. No break-downs from arcing-over. *Even at high values,* IRC Wire Wound Power Resistors need no derating... offer greater stability and longer life. Write for Catalog C-1!

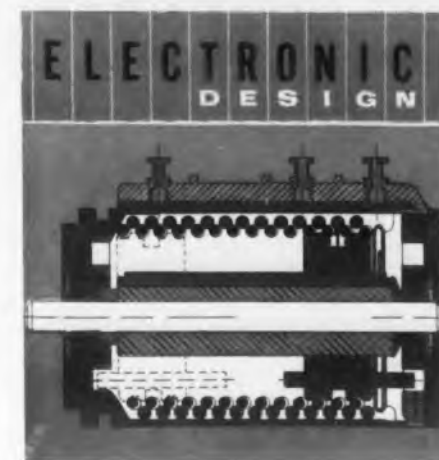


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INTERNATIONAL RESISTANCE COMPANY • Dept. 337, 401 N. Broad Street, Philadelphia 8, Pa.

CIRCLE 1 ON READER-SERVICE CARD

### HIGHLIGHTS OF ISSUE



#### Concentrated Filter Passbands, Part 1 . . . . . 22

In this, the first part of Mr. Schaner's three part article, he describes the characteristics peculiar to mechanical filters. He shows where they are used to best advantage. In parts 2 and 3, he discusses the crystal filter and the LC filter.

#### Tiny Multiturn Potentiometer Uses Radical Construction (cover) . . . . . 30

Unusual construction techniques provide this very small multiturn potentiometer with big pot performance.

#### Class B Complementary Symmetry Amplifier . . . . . 32

Here is a discussion by RCA's C. Frank Wheatley of the application of the complementary-symmetry principle to the design of a Class B system. The author covers basic principles first, then shows how to achieve optimum performance of such a system.

#### Omni UHF and VHF Antennas 44

A. G. Hultum, Jr. discusses the unusual problem of eliminating signals in one direction from an omnidirectional antenna. His method applies both to receiving and transmitting antennas.

August 6, 1958 Vol. 6  
Number

# 16

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## CONTENTS

<b>Editorial</b>	<b>21</b>	Drawing The Line in Computer Design
<b>WESCON Show Meeting Report</b>	<b>20</b>	WESCON Program
<b>Engineering Review</b>	<b>56</b>	Telemetry Industry Prepares for Frequency Band Shift
<b>Washington Report</b>	<b>5</b>	Jupiter IRBM Re-entry
<b>Features</b>	<b>18</b>	AMB Rises to the Challenge
	<b>26</b>	Application of Coaxial Bar Hybrids
	<b>30</b>	Tiny Multiturn Potentiometer
	<b>32</b>	Class B Complementary-Symmetry Audio Amplifiers, C. F. Wheatley
	<b>38</b>	Minimize Local Oscillator Drift, Part 2, W. Y. Pan, D. J. Carlson
	<b>42</b>	Relay performance improved by "Laying it on the line"
	<b>43</b>	Electromechanical Indicator for reliable readout
	<b>44</b>	Omni UHF and VHF Antennas, A. G. Holtum, Jr.
	<b>48</b>	High Input Impedance Transistor Amplifier, G. Franklin Montgomery
	<b>50</b>	Ferrites Can Be Replaced with Yttrium-Iron Garnet
	<b>52</b>	Transistorized High Frequency Chopper Design, R. Roy
	<b>160</b>	Index of Articles January 8th through June 25th, 1958
<b>Background for Designers</b>	<b>22</b>	Concentrated Filter Passbands, Part 1, F. A. Schaner
<b>Ideas for Design</b>	<b>172</b>	Difference Voltmeter Uses Digital Techniques
<b>Russian Translations</b>	<b>180</b>	What the Russians Are Writing
<b>German Abstracts</b>	<b>190</b>	Loading the Transistor Oscillators
	<b>191</b>	Stabilized High Voltage Supplies
<b>Abstracts</b>	<b>192</b>	Electrostatically Focused TWT
	<b>193</b>	TWT Beam Focusing
	<b>196</b>	Thermo-Compression Bonding
<b>Departments</b>	<b>20</b>	Meetings <b>176</b> Report Briefs
	<b>58</b>	New Products <b>199</b> Careers Section
	<b>170</b>	Patents <b>200</b> Advertisers' Index

New Speed...Versatility...Reliability...



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### Optimum performance in virtually all tape handling applications

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- Up to 47 channels
- All functions remotely controllable

The 906 may be supplied with a transistorized Record-Playback Amplifier featuring a separate module for each channel. Electronic switching from record to playback function is available as an optional feature.

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CIRCLE 2 ON READER-SERVICE CARD



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WHY YOU SHOULD BUY

**RAYTHEON** SILICON  
TRANSISTORS



1. NPN as well as PNP — *only Raytheon offers both* — with characteristics so similar as to permit use in complementary circuits



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5. Low noise type available in both PNP and NPN



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PNP SILICON TRANSISTORS Temperature Range $-65^{\circ}\text{C}$ to $+160^{\circ}\text{C}$	JETEC-30 Type	Reverse Current at $-20\text{V}$		$V_{CE}$ Max. Volts	$H_{FE}$ ave. at $I_B = -0.1\text{mA}$ , $V_{CE} = -0.5\text{V}$	Base Resistance ohms	Collector Resistance kilohms	Noise Figure db (max.)	Collector Capacity $\mu\text{f}$	Alpha Freq. Cutoff KC
		Collector $\mu\text{A}$	Emitter $\mu\text{A}$							
	2N327A	0.005	0.005	-40	15	1200	500	30	65	200
	2N328A	0.005	0.005	-30	30	1400	500	30	65	300
	2N329A	0.005	0.005	-20	60	1500	500	30	65	400
	2N330A	0.005	0.005	-20	25	1300	500	15	65	250

NPN SILICON TRANSISTORS Temperature Range $-65^{\circ}\text{C}$ to $+160^{\circ}\text{C}$	JETEC-30 Type	Reverse Current at $20\text{V}$		$V_{CE}$ Max. Volts	$H_{FE}$ ave. at $I_B = 0.5\text{mA}$ , $V_{CE} = 1.5\text{V}$	Base Resistance ohms	Collector Resistance kilohms	Noise Figure db (max.)	Collector Capacity $\mu\text{f}$	Alpha Freq. Cutoff KC
		Collector $\mu\text{A}$	Emitter $\mu\text{A}$							
	2N619	0.005	0.005	40	15	2000	500	30	35	200
	2N620	0.005	0.005	35	30	2500	500	30	35	350
	2N621	0.005	0.005	30	60	2700	500	30	35	500
	2N622	0.005	0.005	30	25	2400	500	15	35	300

All ratings are for  $25^{\circ}\text{C}$ . All types measured at  $V_C = 6\text{V}$  and  $I_E = 1\text{mA}$ . For all types: Dissipation Coefficient in air,  $0.35^{\circ}\text{C}/\text{mW}$ ; infinite sink,  $0.20^{\circ}\text{C}/\text{mW}$ .



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CIRCLE 3 ON READER-SERVICE CARD

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# ENGINEERING REVIEW

For more information on developments, described in "Engineering Review," write to the address given in the individual item.

## Jupiter IRBM Re-entry

Photographs of the spectacular re-entry into the Earth's atmosphere of the Jupiter IRBM were recently released.

This missile firing marked the first successful recovery of a full-scale Jupiter nose cone.

These pictures were taken as part of "Operation Gaslight," the armed forces project for investigating the physics associated with the re-entry of the Jupiter missile.

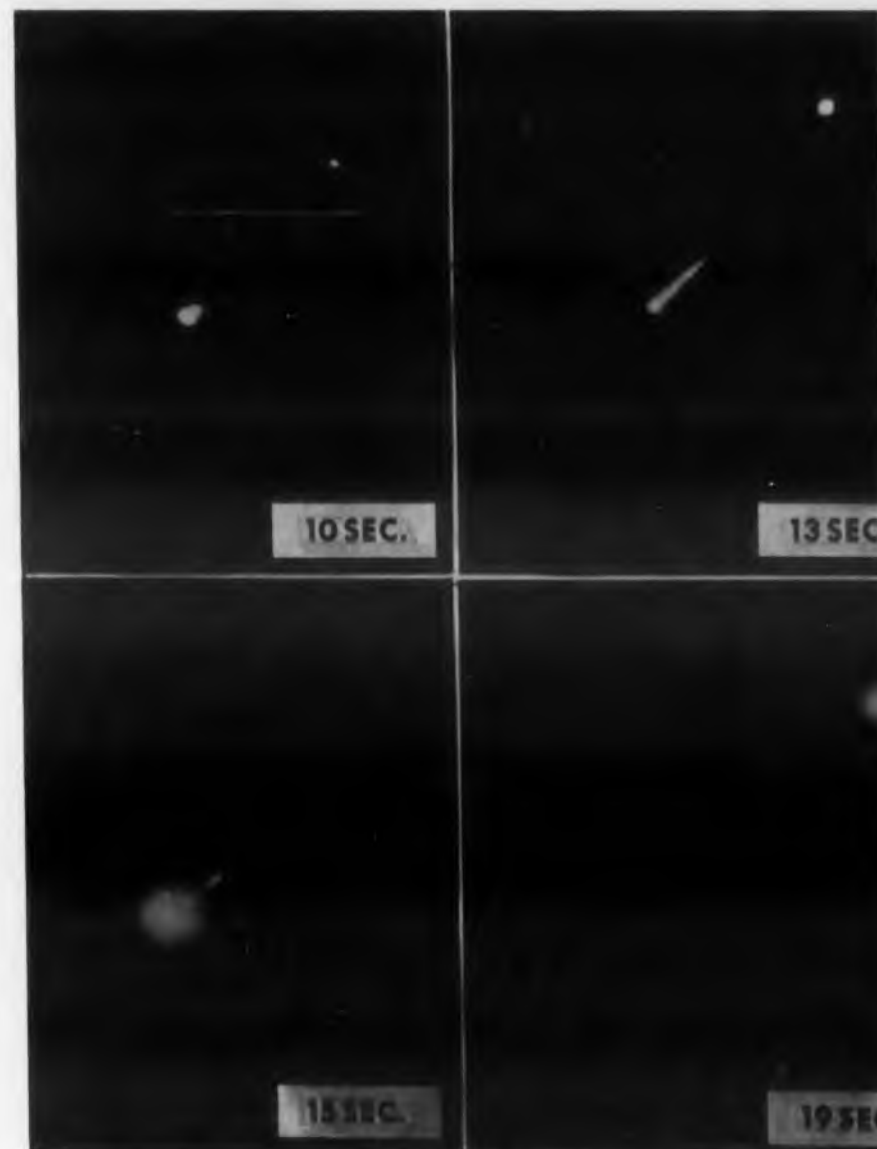
Photographs showed that, within seconds after

the first re-entry light was observed, the phenomena had blossomed into three distinct objects. The brightest object, which resembled a huge magnesium flare, was assumed to be the booster (rocket body). The light emitted by this object definitely pulsated. At one time, the object's trajectory was nearly in line with the planet Jupiter, and was estimated to be at least 1000 times brighter.

(Continued on following page)



**Spectral Meteor Camera** was one of the major instruments used in "Operation Gaslight." It is made up of a cluster of six-F-8 Aerial Cameras equipped with spectral gratings and arranged so as to afford a panoramic view of a large portion of the sky. This meteor camera is shown mounted on the 5 in. guns of the USS Stickell.



**First photographs** ever released of the re-entry of the Jupiter IRBM into the earth's atmosphere. At 19 seconds, the instrument package (out of picture) has completely burned out, and the distance between the nose cone and rocket body increases rapidly.



**Radiometer** is one of the instruments used to measure the radiation from the Jupiter IRBM as it re-entered the atmosphere.

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Volt Amperes	Diameter	Height	Nominal Weight	% Regulation
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3.0	1"	9/16"	1 oz.	15
6.0	1"	1 1/16"	1 1/2 oz.	10
9.0	1"	1 1/8"	2 oz.	8
16.0	1 1/8"	1 1/4"	4 oz.	7
25.0	1 3/8"	1 3/8"	5 oz.	6

Other V.A. ratings, secondary voltages and constructions engineered to your specifications.

### STANDARD RATINGS

Standard Voltage Ratings Pri/Sec.	1.5 - 9.0 V.A. size Terminal End Mounting Secondary Centertapped	16 & 25 V.A. size Terminal End Mounting Secondary Centertapped
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115/10	TW (VA) D 10 T.	TW (VA) F 10 T.
115/26	TW (VA) D 26 T.	TW (VA) F 26 T.
115/115	TW (VA) D 115 T.	TW (VA) F 115 T.
115/200	TW (VA) D 200 T.	TW (VA) F 200 T.
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115/300	TW (VA) D 300 T.	TW (VA) F 300 T.

### FEATURES & SPECIFICATIONS

1. Designed to MIL-T-27A, Grades 1 & 4, a. Class R (105°C.) b. Class S (130°C.) available
2. Primary voltage: 115V ± 10%
3. Frequency: 400 cps ± 5%
4. Sec. voltage tolerance (@ 115V IN): ± 3%
5. Hermetically sealed.
6. High efficiency.
7. High shock construction.
8. 55-2000 cps vibration.
9. Save up to 30% in size and weight over conventional designs.

### HOW TO ORDER:

Order by catalog numbers as follows:

TW    25    D    6.3    T  
TW    (V.A.)    (Case Style)    (Sec. Voltage)    (Sec. C. T.)

Centertaps: If no C. T. is desired, replace "T" with "X".

Alternate mounting: If mounting studs opposite terminals surface are desired, refer to case style "E" (1.5 to 9.0 V.A. only).

Electrostatic shields: Can be supplied but generally at small increase in size. Add "S" to end of catalog number.

Send for our TINYMAX catalog for more complete details.



## ENGINEERING REVIEW

The second brightest visual object was assumed to be the instrument compartment. The trajectory of the instrument compartment during its burning stage was much shorter than the booster and nose cone. During the last few seconds of the visible flight, the booster and nose cone moved behind a large cumulus cloud to the south of the USS Stickell. The radiation was so intense that the whole cloud was illuminated.

Barnes Engineering Co., Stamford, Conn. performed spectral and radiometric measurements on the re-entering bodies of the missile.

## Colleges To Get Nuclear Reactor Simulators

Four Universities will be supplied with nuclear reactor simulators by Minneapolis-Honeywell Regulator Co. The schools—University of West Virginia, University of Minnesota, University of Oklahoma, and Wayne State University in Detroit—will use the simulators to train prospective nuclear engineers in all phases of reactor operation. Incorporating a working full-scale model of an automatic control system for power and research reactors, the simulator also features an electronic computer circuit which recreates reactor operational characteristics.

With the simulator, electrical signals can be generated similar to those obtained from sensing elements in a nuclear reactor. Interchangeable plug-in circuitry permits simulations of either U-235, U-233, or plutonium fuel. The simulated signals are amplified, recorded, and automatically controlled with the same instruments used on real reactors. The control system has a control permit circuit that prevents switching to automatic control unless the power level is within 10 per cent of the control setting. Range of the simulator is 0 to 150 per cent of reactor design power.

◀ CIRCLE 4 ON READER-SERVICE CARD

## Tilted Underwear— Origin of Telemetry?

Demonstration of imaginative historical research into the origination of telemetry caught our attention at the National Telemetry Conference held recently. Gen. Earle F. Cook, US Army Signal Corps R & D Chief, explained: "It winds back to a Carthaginian officer in 200 BC, who fell upon the science when his orderly laundered his fighting undergarments one night and hung them out to dry. Next morning at dawn, the officer peered from his tent and observed a blustery wind blowing them mightily on the line. Taking a look at the vectors at work, he promptly decided his course of action. 'To hell with it,' he said, 'I'm not going out to fight today.' And don't think it was in the least empirical—the force and angle of wind components lifted the before-mentioned underpants in a true sin-and-cos relation, with relative humidity disclosed by extrapolation-in-reverse from the time of laundering. Ergo: in early warfare man deduced the parameters of weather from a comfortable distance—increase of said comfortable distance being something the science has been after ever since."



## Inchworm

Installation at Torrington Needle Bearing plant controls centerless grinding operations to consistent accuracy within a tolerance of 50 millionth of an inch. The motor, manufactured by Airborne Instruments Laboratory, Mineola, N.Y., is a linear actuator which replaces the lead-screw in mechanisms requiring micro-inch dimensional controls. "Inchworm" operations are push-button controlled.

ELECTRONIC DESIGN • August 6, 1958



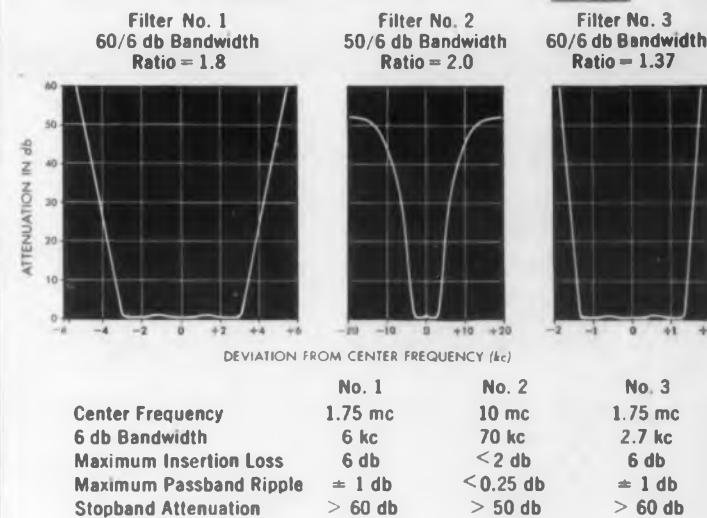
## new performance levels set by Hughes precision crystal filters

Hughes Products now offers high performance crystal filters previously available only for special military developmental contracts and Hughes-built systems. Utilizing unique design and advanced manufacturing techniques, these Hughes crystal filters provide a degree of performance previously unattainable.

With center frequencies of 30 kc to 30 mc and fractional bandwidths of 0.01% to 6%, these crystal filters have seven distinct advantages:

1. High frequency filtering
2. High selectivity
3. Low passband ripple
4. Low insertion loss
5. Small size and weight
6. Excellent temperature stability
7. Excellent shock and vibration stability

### SPECIFIC PERFORMANCE CHARACTERISTICS FOR TYPICAL FILTERS



For further information please write HUGHES PRODUCTS, Crystal Filters, International Airport Station, Los Angeles 45, Calif.

Creating a new world with ELECTRONICS

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NEW  
NEW  
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MODULAR  
**MICRO-TIME**  
PULSE  
GENERATOR



Designed by specialists in electronic instrumentation, the new modular construction of the Micro-Time Pulse Generator offers ease of repair and diversification of use. Component units can be used as individual sources or as a complete modular instrument.

**Electrical Performance Features**

- Pulse amplitude . . . . 0-100 V Continuously Variable
- Output impedance . . . 93 Ohms
- Pulse width . . . . . 0.15 to 50  $\mu$ s
- Rise time . . . . . better than 0.02  $\mu$ s when terminated in 93 Ohms
- Decay time . . . . . better than 0.05  $\mu$ s when terminated in 93 Ohms
- Overshoot & ringing . . less than 3%
- Pulse droop . . . . . less than 5% at any pulse width setting
- Duty cycle . . . . . to 5%
- Stability . . . . . when used with a marker generator, the unit provides an output pulse which is stable with respect to the 50 megacycle markers.

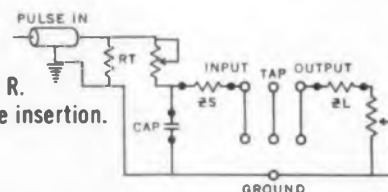


**DELAY LINE TEST UNIT**

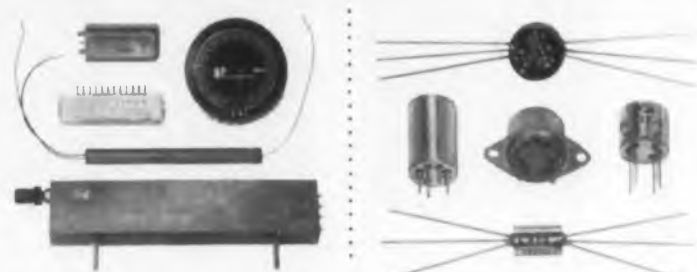
Test jig for inserting adjustable source and load impedance into a circuit when testing delay lines.

**Features**

- Plug-in Resistors (no switches for minimum capacity).
- Potentiometer in series with resistor for adjusting to exact R.
- Binding Posts connect to delay lines to allow scope probe insertion.
- Plastic assembly minimizes stray capacity to ground.
- Plug-in capacitor for adjusting input rise time.



**MICRO-TIME** INC. 18228 Parthenia Street, Northridge, California

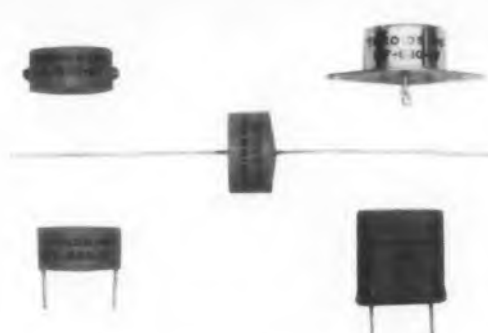


**PCA DELAY LINES and PULSE TRANSFORMERS**

Top quality, precision components of proven dependability, designed to withstand shock and vibration and to meet military environmental requirements. All Delay Lines and Pulse Transformers come in a variety of standard models or can be manufactured to specification.



**PCA ELECTRONICS, INC.**  
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Leading Manufacturer of CUSTOM-DESIGNED Delay Lines and Pulse Transformers in the Electronic Industry.



**SUBMINIATURE TOROIDS**

Four cores, covering an inductance range from .056 millihenry to 1.0 henry and a frequency range from 1000 cycles to 500 KC, provide a high "Q" factor and keep use of space and weight to an absolute minimum. Toroids are hermetically sealed or plastic encapsulated.

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18228 Parthenia Street, Northridge, California

SEE OUR DISPLAY AT THE WESCON SHOW IN BOOTH 815

CIRCLE 6 ON READER-SERVICE CARD

ENGINEERING REVIEW



The new **IBM 88 Collator**, a high-speed card filing machine, arranges punched cards in any desired sequence at rates of up to 1300 cards per min.

**New Filing Machine Arranges Punched Card Sequence Rapidly**

Punched cards may be arranged in any desired sequence at speeds better than two and one-half times faster than its predecessors by a new card filing machine.

Principal function of the new IBM 88 Collator is to compare two files of punched cards simultaneously in order that the cards can be matched, merged, selected, and sequence-checked for subsequent accounting operations. With the device, cards are entered into the machine from card feeding devices at each end. The primary or main feed consists of a file feed device that can hold up to 3600 cards, and the secondary feed is a conventional card hopper. Cards enter from each feed device at the rate of 650 per min., so that with both feeds in use, up to 1300 cards per min can be processed.

One major feature of the Collator is its non-stop stackers which enable the operator to remove cards from any of the five card pockets without the need for stopping the machine and with no danger of card jams. Other features are the error detection circuits which guard against double punches and blank columns on the card record, and the sequence-checking units built into the card feeding devices, enabling the IBM 88 to perform identical or completely different operations in each feed at the same time.

CIRCLE 523 ON READER-SERVICE CARD





**ANATHERM** can be used at any hottest-spot temperature over the range of 105°C to 155°C. It can save you money . . . and save you space.

## More horsepower per pound—it's yours with 155°C Anatherm

First polyester high temperature enamel magnet wire available in complete range of sizes—round, square, rectangular.

Of course you don't fry eggs on them, but motors are being run hotter today. These higher operating temperatures can put you on a *hot spot* with your customers—if motors fail.

Solution: Anaconda Anatherm Magnet Wire. Anatherm is a new polyester film-coated wire—fully tested for use at "hottest spot" temperatures up to 155°C. With this new higher level of thermal stability, Anaconda Anatherm is the first film-coated wire to meet the newly adopted 155°C (AIEE Class F) rating!

Greater thermal stability—plus excellent abrasion-resistance, chemical stability and dielectric strength—make Anatherm ideally suited for a variety of applications. It's especially practical where

maximum performance and reliability are required from smaller equipment operating at higher temperatures.

As a polyester magnet wire, Anatherm can be used equally successfully at any hottest-spot temperature from 105°C to 155°C.

Available in standard film-thickness of round wires, sizes 8 to 46, inclusive, and in a full range of sizes of square and rectangular wires. For more information, see the Man from Anaconda. See "Anaconda" in your phone book—in most principal cities—or write: Anaconda Wire & Cable Co., 25 Broadway, N. Y. 4, N. Y.

58161

ASK THE  
MAN FROM **ANACONDA**<sup>®</sup>  
ABOUT **ANATHERM MAGNET WIRE**

*For you. Anatherm can mean smaller electrical equipment . . . higher operating temperatures. See details on reverse side—*

**ANALAC** 105°C (AIEE Class A)  
solderable magnet wire

**VITROTEX** 130°C (AIEE Class B)  
glass-insulated, high heat resistance

**PLAIN ENAMEL** 105°C (AIEE Class A)  
low cost enameled magnet wire

**NYFORM** 105°C (AIEE Class A)  
superior windability

**EPOXY** 130°C (AIEE Class B)  
general compatibility



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1958



# MAGNET WIRE DATA SHEET

from  
Anaconda Wire & Cable Co.

## IMPORTANT FACTS FOR YOUR WORK...

### ...about Anatherm 155°C (AIEE Class F) Magnet Wire

When proper advantage is taken of Anaconda Anatherm's higher 155°C characteristics, electrical equipment can be improved in these ways:

**RAISES LIMITING OPERATING TEMPERATURES.** Anatherm raises limiting operating temperatures to 155°C. This high heat resistance means extra protection . . . longer equipment life . . . wider range of applications.

**REDUCES FRAME SIZE.** Anatherm gives more horsepower from the same space or the same horsepower from a smaller motor. Costs are cut for you, and your customers benefit from smaller over-all components.

**INCREASES HORSEPOWER RATINGS.** Anatherm is the best of the polyesters. Its high heat resistance means higher permissible operating temperatures, greater horsepower rating.

**UPGRADING.** Anatherm helps upgrade standard equipment. Gives added heat insurance through thermal stability. Particularly suited for overloads.

**COMPATIBILITY.** With polyesters, importance must be placed upon a completely compatible system. Varnish manufacturers have recently developed polyester varnishes which allow a compatible polyester magnet wire system. A number of varnishes other than polyester are compatible with Anatherm, but consultation with varnish suppliers before use is recommended.

winding equipment. Anatherm offers excellent flexibility and adherence properties. It meets NEMA snap test requirements and exhibits excellent adherence to the conductor.

#### ELECTRICAL PROPERTIES

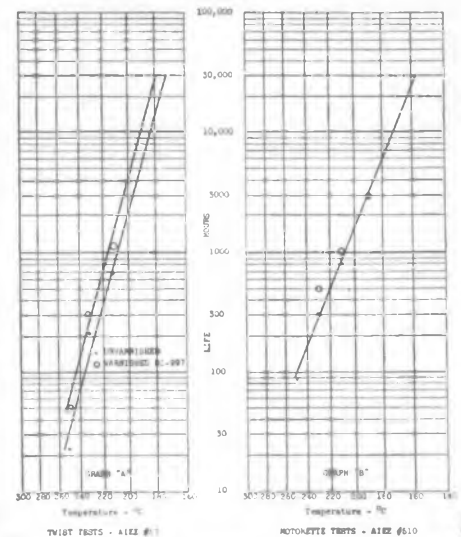
Anatherm maintains its dielectric strength under prolonged heating at high temperatures. It consistently exceeds dielectric strength requirements for NEMA dielectric twist test.

#### CHEMICAL PROPERTIES

Anatherm will resist toluol, VM & P Naphtha, Ethyl Alcohol and 5% Sulphuric Acid. Anatherm is a polyester and exhibits the best characteristics of this class of chemical compound. However, all polyesters must be used with certain precautions where moisture and/or enclosed systems are concerned. Similar precautions must be taken where chlorine-base supporting insulations, such as neoprene and polyvinyl chloride, are present. Polyesters should not be used in applications subject to exposure to concentrated alkalis.

#### THERMAL PROPERTIES

Anatherm is offered as a 155°C (AIEE Class F) magnet wire based on AIEE #57 and #510 test methods. These tests, performed by Anaconda engineers, show Anatherm as being capable of a 30,000-hour life at 157°C in an unvarnished state and the same life at 175°C when treated with a silicone or polyester type varnish. Thus Anatherm, when suitably varnished, has reserve stability even above the 155°C rating at which it is being offered. The thermoplastic flow temperature for Anatherm, based on MIL-W-583A, is very high (250°C). Anatherm also shows outstanding retention of flexibility after aging. Wire can be heated 168 hours at 175°C and then wound on three times its own diameter without cracking. Its heat-shock characteristics are exceptionally good for a polyester wire: Anatherm will withstand a 1x mandrel wrap at 155°C for one hour.



## TECHNICAL PROPERTIES

### MECHANICAL PROPERTIES

Anatherm has unusually high abrasion-resistance. This characteristic allows it to be wound on both conventional and automatic



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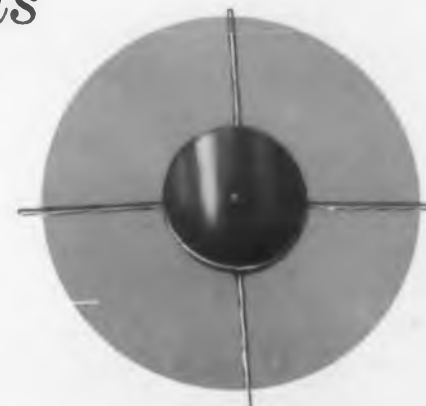
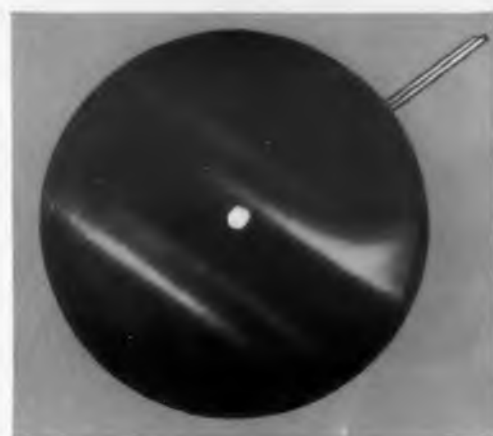
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to meet your circuit needs



All components shown actual size.

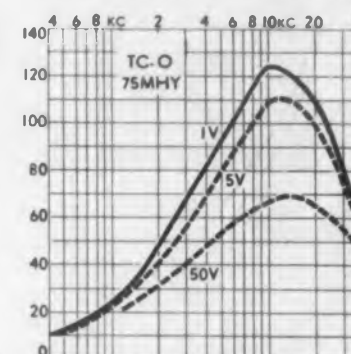
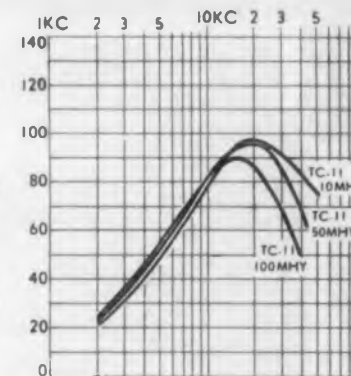
Burnell & Co., pioneers in the development of toroids, filters and related networks now offer the most complete—the most reliable line of encapsulated toroids.

Burnell encapsulated toroids include the only encapsulated adjustoroids available anywhere—satisfy the toughest circuit demands in serviceability—light weight—miniaturization.

Burnell encapsulated toroids are particularly useful in guided missile and similar miniaturization fields where space and mounting are highly critical factors. Send for free, new Catalogue No. 104 covering scores of applications with schematics and performance curves.

COIL CHART

TYPE	NOMINAL UNCASED DIMENSIONS	WEIGHTS UNCASED (OUNCES)	MOULDED DIMENSIONS
TC 0	1" x 13/32"	5/8	1 1/16" OD x 1/2" H
TC 1	1 5/8" x 5/8"	less than 3	1 3/4" OD x 3/4" H
TC 2	2 9/32" x 15/16"	10	2 3/4" OD x 1/8" H
TC 3	1 1/2" x 5/8"	2 1/2	1 3/4" OD x 3/4" H
TC 4	1 7/32" x 19/32"	less than 2	1 5/16" OD x 23/32" H
TC 5	1 7/32" x 19/32"	less than 2	1 5/16" OD x 23/32" H
TC 6	1" x 13/32"	5/8	1 1/16" OD x 1/2" H
TC 7	1" x 13/32"	5/8	1 1/16" OD x 1/2" H
TC 8	1 9/16" x 5/8"	less than 2	1 3/4" OD x 3/4" H
TC 9	1" x 3/8"	less than 1/2	1 1/16" OD x 1/2" H
TC 10	1 3/32" x 15/32"	1	1 1/4" OD x 5/8" H
TC 11	5/8" x 9/32"	1/4	3/4" OD x 1/2" H
TC 12	5/8" x 9/32"	1/4	3/4" OD x 1/2" H
TC 13	5/8" x 9/32"	1/4	3/4" OD x 1/2" H
TC 14	5/8" x 9/32"	less than 1/4	3/4" OD x 1/2" H
TC 15	1 7/8" x 7/8"	5	2" OD x 1" H
TC 17	1 3/32" x 15/32"	less than 1	1 1/4" OD x 5/8" H
TC 20	1 3/32" x 15/32"	1	1 1/4" OD x 5/8" H
TC 27	1 9/16" x 11/16"	2 1/4	1 3/4" OD x 3/4" H



The Solaris is the first hearing aid to be placed on the market that uses the sun's rays for power. Arrow indicates silicon cells on temple bar.

## New Hearing Aid Operates On Solar Energy

A revolutionary new eyeglass hearing aid, the Solaris, that operates on power from ordinary sunlight is now available.

Using silicon cells of the same type used to power the radio transmitter in the Vanguard satellite, the Solaris automatically cuts into a battery supply when light is insufficient. The storage battery is made of nickel-cadmium and weighs only a fraction of an oz according to Zenith Radio Corp., Chicago, Ill.

Bright sunlight will recharge the battery. The instrument is equipped with four silicon cells which are mounted in tandem under a plastic covering on top of one of the eyeglass bars.



## ... 3999, 4000 ... All There

More than 4000 bits of information can be stored on this five-in.-sq "memory frame" being produced by RCA for a new high-speed electronic computer used by the AEC. The frame is composed of thin strands of insulated copper wire and tiny ferrite cores, 83,000 of which weigh only a pound. The cores are subjected to temperatures of 1100 to 1350 C. They are then strung on fine insulated copper wires to form a frame-like assembly. The frames are being made at the RCA Materials Development Lab, Needham Heights, Mass.

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ELECTRONIC DESIGN • August 6, 1958

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## ENGINEERING REVIEW



Idlewild Airport as seen on the Airborne Instruments ASDE radar scope.

### Idlewild Airport Installs Surface Detection Equipment

Airport Surface Detection Equipment (ASDE) has been made a part of the traffic control system at Idlewild Airport. Mounted atop the cab at the summit of the 187-ft control tower, ASDE's antenna sweeps the 5000-acre expanse to give air traffic control crews a complete picture of the changing conditions on the surface of the field. An experimental model was successfully tested there in the fall of 1952, and the present equipment incorporates many refinements suggested by that trial performance.

ASDE has a maximum range of four miles, though its 16-in. (diam) scope usually displays an area of only two miles about the control tower. With a resolution of more than 1000 lines per diam, the display tube can distinguish objects separated by as little as ten ft. Two men standing at arms length from each other, 1500 ft away from the tower, will also be clearly defined. To achieve the necessary bandwidth for such resolution, ASDE operates at frequencies in the 24,000 mc range. These frequencies, though highly susceptible to absorption by weather conditions, are not seriously impaired at ASDE's short operating range.

The antenna reflector is 12 ft wide and obtains a radar beam 0.25 deg wide, reportedly the narrowest beamwidth used in any present radar system. The antenna scans the field at a rate of 60 rpm and is designed to operate in

ELECTRONIC DESIGN • August 6, 1958

winds up to 50 mph, and will be able to operate in 120 mph gales because of the enclosure of a radome made of dacron coated with polyethylene.

ASDE was designed and built by Airborne Instruments Lab, 160 Old Country Rd., Mineola, N.Y.

### Radioactivity Used To Inspect Assemblies for Hidden Parts

Radioactivity is being used for the first time to inspect production line assemblies for the presence of hidden vital parts.

The U. S. Army Ordnance Corps has purchased the first model for checking artillery-shell fuse heads to make sure they contain a complete firing-pin assembly. Developed by Nuclear Corp. of America, 400 Park Ave., New York, the Atomonitor as it is called, searches for parts which are plated with 1/100th of a microcurie of radioactive silver. This material presents no health hazard even in great quantities. Its radioactive longevity, however, is such that Atomonitor inspection is possible up to a year after plating.

Assemblies to be inspected are transported on a conveyor at the rate of up to 3000 per hour. A scintillator in the device checks each unit for the presence of radioactivity. If it finds none, it automatically ejects the assembly into a bin below. Counters on the machine's control panel indicate how many units have been inspected and how many rejected. If desired, the machine also will keep track of the rejection rate and ring an alarm if it exceeds a predetermined maximum.

The unit built for the Ordnance Corps has an accuracy of 9,999,999 out of 10-million as far as detecting incomplete fuse heads is concerned. The probability of its mistakenly rejecting a good assembly is 1 in 100,000.



Atomonitor inspects production-line assemblies for the presence of hidden vital parts.



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**Transparent, colorless slide** produces a full-color picture on the screen by means of a new projection technique. A special projector translates "color information," which has been recorded in tiny ripples on a clear gelatin film, into primary colors which are projected simultaneously onto the screen.

### Transparent Screen Records Color Information

A colorless, transparent slide which produces a full-color photograph when projected on a screen may have eventual importance in color TV.

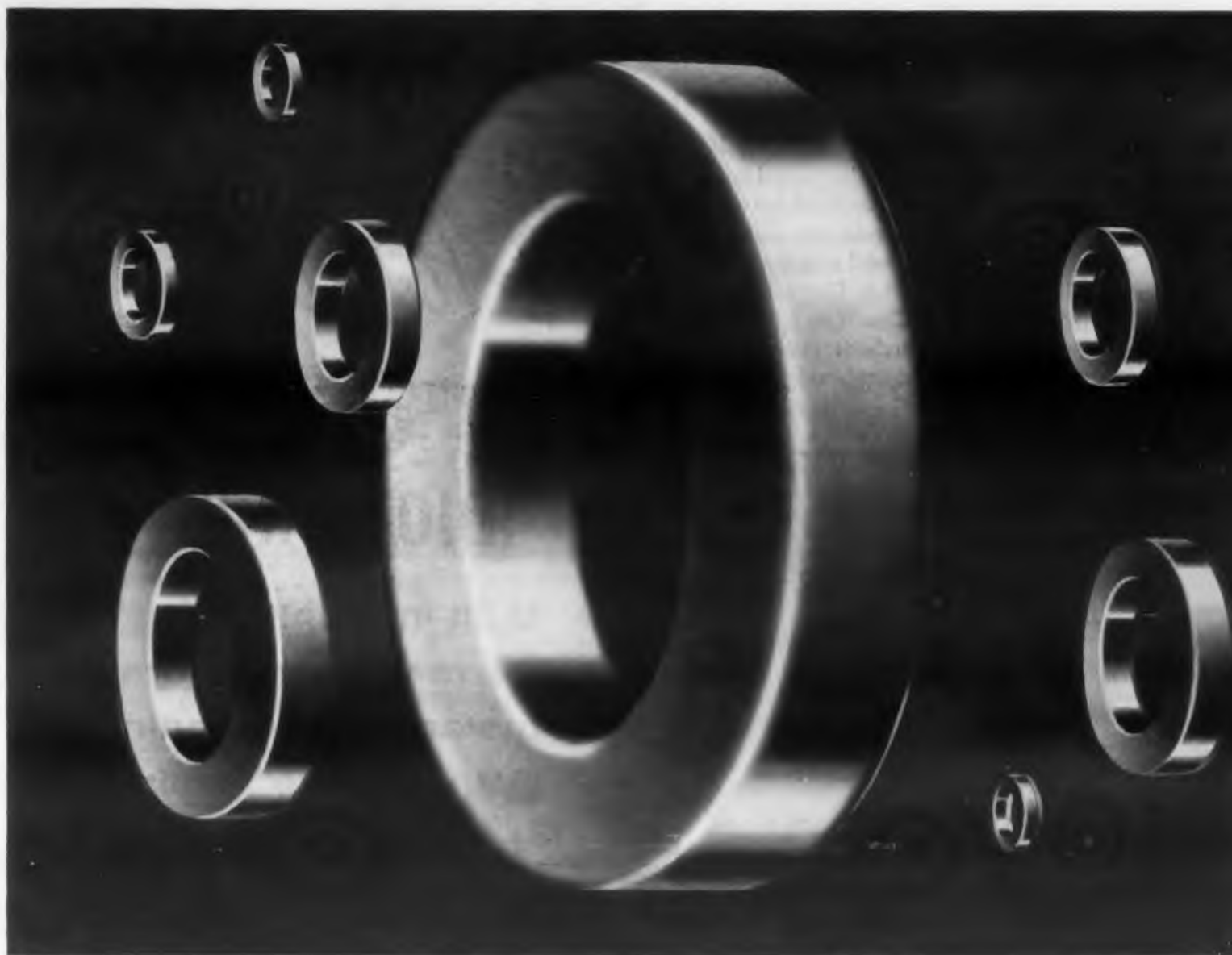
Color information is recorded in tiny ripples on a clear gelatin film, according to Dr. William Glenn, a physicist at the General Electric Research Lab., Schenectady, N.Y., who developed the system. The ripples in the film serve as a diffraction-grating system, and a special projector is used to "translate" the diffraction patterns—overlapping series of light waves—so that brilliant primary colors are projected on the screen at the same time. In a recent demonstration, Dr. Glenn used slides in the standard 2 x 2 size, and because the diffraction ripples were only a thousandth of an inch apart, the projected picture had a resolution comparable to a good TV picture.

Color information may also be recorded on black-and-white film by placing a special mask in front of the film in an ordinary camera. The diffraction-grating system produces a "positive" color picture if the monochrome slide is either positive or negative. Dr. Glenn explained that the technique has not yet been developed for wide use in photographs.

An unusual aspect of the system is that it makes possible a full-color picture produced by two primary colors, one fixed and one variable, instead of the usual system of three fixed pri-

# IT'S NEW AND NEWS from **ARNOLD**

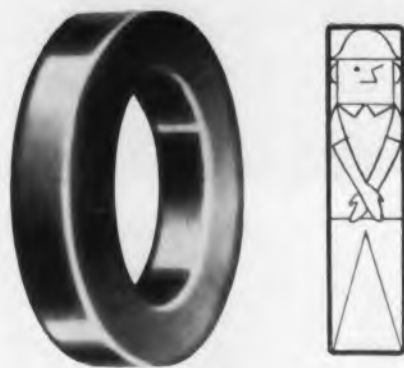
Arnold Tape-Wound Cores now offer you  
every feature you've been looking for  
...at no added cost to you



1

## NEW COMPACTNESS in Aluminum-cased Cores

Now you can build your designs around the last word in improved tape cores of high-permeability materials. Arnold 6T Cores incorporate a new type of aluminum core box construction, with overall dimensions smaller than older types of aluminum cases, and comparable in size with ordinary plastic-cased cores. *Result:* along with the distortion-free strength of the aluminum case, that resists winding stresses, you now get the compactness and miniaturization possibilities you've wanted.



2

## HERMETICALLY SEALED, with Built-in Protection against Shock and Vibration

Magnetic properties of Arnold 6T Cores have the most complete protection available on the market. The cores are surrounded by an inert shock absorbent inside the cases, and then hermetically sealed: your best assurance of trouble-free performance, a strong consideration where the service involves long periods of standby. Inherent in the design, of course, is the further guarantee that you can vacuum-impregnate your coils.



3

## 1000-VOLT BREAKDOWN GUARANTEED!

The revolutionary new type of core box construction developed for Arnold 6T Tape Cores employs a strong, inert covering for which 1000-volt breakdown is guaranteed. This covering possesses a hard gloss finish, and gives a suitable radius on all corners. The elimination of sharp corners insures against cutting through the insulation of the winding wire. The hard, non-cold-flowing finish protects against the wire cutting through the case covering, a double guarantee against shorted wiring.



4

## MEETS MILITARY "SPECS" for Operating Temperatures and Temperature Rise

Arnold's new type of hermetically-sealed aluminum core box construction fully meets the requirements of military specifications Mil-T-5383 or Mil-T-7210, wherever applicable. This involves a positive guarantee that the case construction will withstand ambient temperatures to 170°C, and a 25°C temperature rise.



Arnold 6T Tape Cores will be available in all standard sizes, and special sizes may be made to order... all guaranteed for size, hermetic seal, dielectric strength and temperature of operation.

### THE ARNOLD ENGINEERING COMPANY



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maries. For the clear and transparent "color slides," diffraction-grating ripples are printed on chromated gelatin. Black-and-white "color slides" utilize fine-grain photographic film. Dr. Glenn suggested that the Swiss Eidophor System for black-and-white TV projection, in which diffraction gratings are written onto an oil film by an electron beam, might be modified for simultaneous color projection using the new technique. Possible advantages of the new system in color television would include high brightness, perfect color register, and greater simplicity than color-TV systems now in use.

## Commercial Solar Energy Converter Developed

Practical conversion of sunlight into electrical power for communication and signal devices is now possible. Basic component of the new commercial solar system, developed by the Hoffman Electronics Corporation's Semiconductor Div., Evanston, Illinois, is a 12 by 20 in. aluminum panel containing 144 wafer-thin, circular silicon solar cells. This energy is either fed into storage batteries or used directly. The modular units may be connected together to produce multiples of 5 w either as a direct power supply, or for charging continuously over an indefinite time 6, 12, or 24 volt storage batteries.



Solar converter, shown connected to a voltmeter, is reportedly the world's first practical solar energy unit designed to convert sunlight directly into commercially usable quantities of electric power.

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## CLUTCHES AND CLUTCH BRAKES



DUO END

Input and output shafts at opposite ends of housing. Shafts coupled when clutch is energized. Output torques, 8 to 80 oz. -in.; brake torque, 8 to 10 oz. -in.



SINGLE END

Concentric input and output shafts at one end of housing. Available with shafts coupled either with clutch energized or de-energized. Output torques up to 80 oz. -in.; brake torque, 8 to 10 oz. -in.



TRIPLEX

Single input, dual output. Energizing each coil couples input shaft to its respective output shaft. Output torques up to 80 oz. -in.



MINIATURE

(Advanced engineering.) 0.75" O.D.,  $1\frac{3}{8}$ " long, single end, engaged when energized. Output torque, 8 oz. -in.

Brand new units in BuOrd sizes 11 and 18 are available from stock with standard flat or crown-tooth cou-

plings. Operating voltages from 1.5 to 300 Vdc. Individual brakes are available, too.

## GEARHEADS AND REDUCERS



T612 GEARHEAD (BUORD SIZE 8)

Input Pinion (motor): 13-tooth, 120-pitch  
Maximum Ratio: 178:1  
Backlash: 30 minutes (max.)  
Output Torque: 25 oz. -in. (max.)



T617 GEARHEAD (BUORD SIZE 11)

Input Pinion (motor): 13-tooth, 120-pitch  
Maximum Ratio: 1267:1  
Backlash: 30 minutes (max.)  
Starting Torque: .01 oz. -in. (max.)  
Output Torque: 80 oz. -in. (max.)



T6123 SINGLE END SPEED REDUCER

Maximum Ratio: 14,730:1  
Backlash: 30 minutes (max.)  
Starting Torque: .01 oz. -in. (max.)  
Output Torque: 100 oz. -in. (max.)  
Diameter:  $1\frac{1}{16}$ "



T6017 DUAL END SPEED REDUCER

Maximum Ratio: 1267:1  
Backlash: 30 minutes (max.)  
Starting Torque: .01 oz. -in. (max.)  
Output Torque: 80 oz. -in. (max.)  
Diameter:  $1\frac{1}{16}$ "

An extensive variety of gear heads and reducers is available from stock in BuOrd sizes 18, 15, 11, and 8.

Ratios to 14,730:1. Reducers in single and double-ended types.



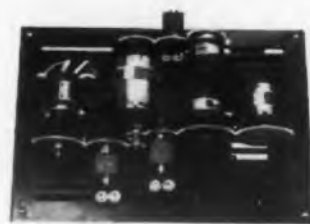
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## ENGINEERING REVIEW

### Navigation Simulator Trains Students

Dead reckoning, celestial, and pressure pattern navigation are being taught by a new navigation simulator. The IA19 Celestial Navigation Trainer is designed for flights at all latitudes including polar, 100,000 ft altitude, 1500-knot air speed, 300-knot winds, and vertical speeds up to 10,000 fpm. Large face operating instruments are mounted on the classroom wall in front of the student body. All students can therefore read continuously their barometric altitude, radio altitude, compass, free air temperature, air speed, and time. The system is so designed that the compass may represent correctly either a magnetic compass or a slaved gyro or free gyro compass. The air speed indication may be in terms of either indicated air speed or true air speed. One observation booth is provided in which the students may observe selected stars. The training device can present any heavenly body as seen from any point on earth from any type of aircraft at any time. Reflectone Corp., Stamford, Conn., developed the device in conjunction with U. S. Naval Training Devices Center, Port Washington, N.Y.

### Microwave Equipment Airlifted

Atop a 9,800 ft peak in northwestern New Mexico there sits a pipeline microwave system, the result of an unprecedented airlift by jet helicopter. Installed by General Electric's Communication Products Department of Syracuse, N.Y., the system will help control the surge of crude oil through pipe extending from Utah to California, a route of more than 850 miles. Especially designed for high altitudes, the Republic Aviation aircraft lifted nearly three tons of equipment. Decision to fly the material to the mountain peak was made by engi-

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neers when weather conditions made it virtually impossible to reach the top over rough, snow-clogged roads which extended only part way up the rocky mountain.

The communications system includes 100 per cent rf and multiplex standby equipment. Vhf repeaters facilitate voice communication from the pipeline's office at Los Angeles to its facilities at Farmington, New Mexico, not far from the mountain location. Included in the communication plans are a dial-selective party-line telephone-type channel form and a private channel.

### Auto Radar Undergoing Tests

Auto radar may soon warn the driver of traffic hazards. Tests are now being conducted under actual road conditions and a production version of the device is under development. A radar antenna about the size of a hollowed-out steak platter is mounted in the front radiator grill of the car. Signals are sent out which are converted into an automatically regulated "beep-beep" sound. The driver is thereby told whether he is closing the gap too rapidly between his car and the one in front, if he is approaching an object on a possible collision path, or if cross traffic threatens collision.

If a motorist is overtaking another car at moderate speed, or if the other car is still some distance away, the "beep-beep" warning is very light, the engineers said. But as the other car gets nearer, the radar warning signal becomes progressively louder and more insistent.

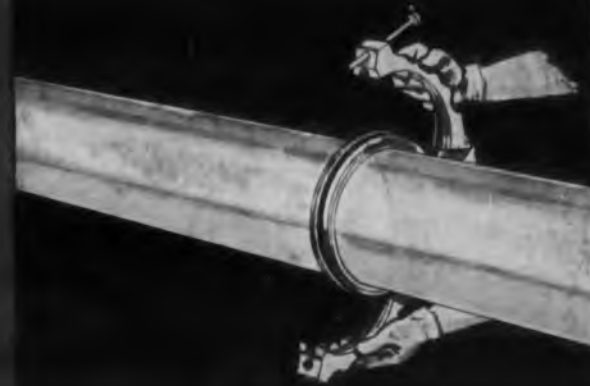
Developed by Bendix Aviation Corp., Detroit, Mich., the new device limits the signals to objects within the car's safe stopping distance, ignores situations in which the car in front is within dangerous distance but is pulling away, permits adjustment for open-country or congested-traffic driving and reduces background noises that would confuse the signal.

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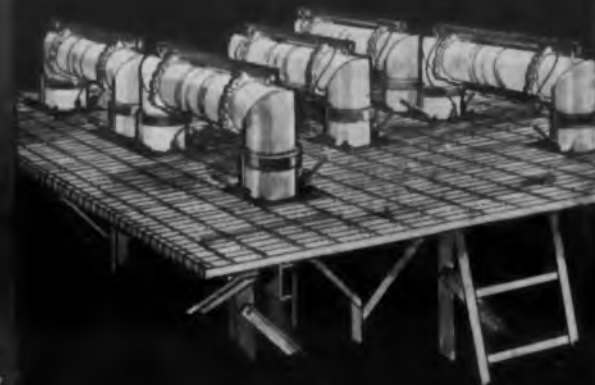


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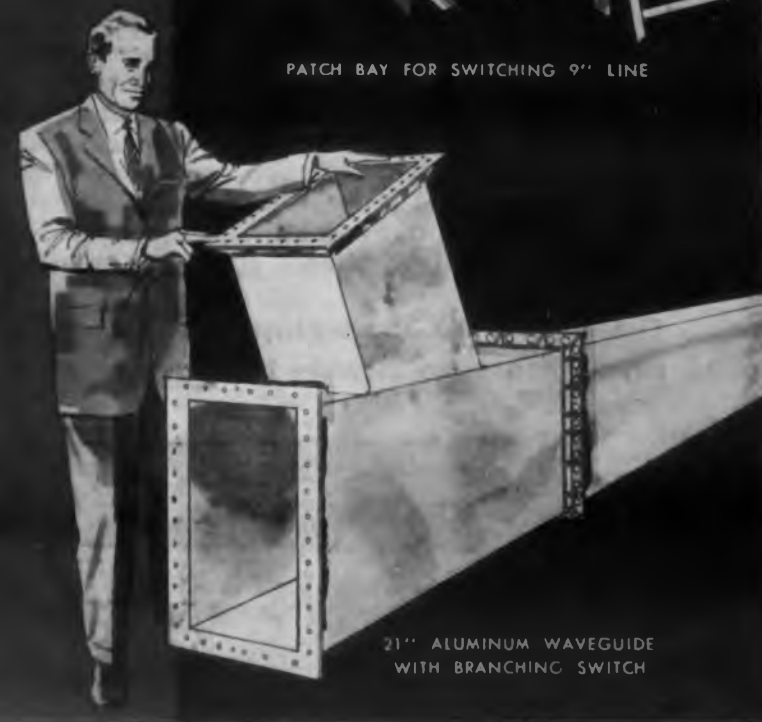
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Calls For  
New  
High Power



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WITH SINGLE BOLT FLANGE CLAMP



PATCH BAY FOR SWITCHING 9" LINE



21" ALUMINUM WAVEGUIDE  
WITH BRANCHING SWITCH

ANDREW CORPORATION offers a wealth of engineering experience in the field of super power RF transmission devices. A broad line of standard equipment is offered and ANDREW facilities for the development and production of special equipment are without equal.

Available on a production basis is antenna equipment in all of the new, very large waveguide and transmission line sizes, including high power coaxial lines designed with specially shaped inner conductors and insulators to substantially increase voltage ratings.

Typical too, of this equipment are patch panels such as the 9" line model

shown above, used for occasional rearrangement of antenna and transmitter connections.

For high speed circuit switching, ANDREW has developed peak reliability, non-contacting waveguide switches such as the 21" model above. Similar switches are also supplied with transitions for use with coaxial line.

Of definite advantage to you is the completeness of the ANDREW line which permits a systems approach with integrated equipment for best performance of the overall system.

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## ENGINEERING REVIEW



**Talos missile** being fired from Talos Defense Unit during test at White Sands Missile Range, N. Mex. on Dec. 13, 1957. The target was a drone flying far down range at medium altitude. A direct hit was scored.

### Most Accurate Radar In Talos Defense Unit

Details of the Talos Defense Unit, the first fully automatic base for firing and guiding missiles to their target, were revealed recently by RCA.

The system uses what is reportedly the most accurate instrumentation radar—the AN/FPS 16—which can distinguish a 5 in. object at a distance of 1 nautical mile with an error margin of 1 in.

At present, the radar can track aircraft or missiles to approximately 290 statute miles. Extension of the range to beyond 500 miles will be possible by addition of a modification now being developed, RCA reports.

The AN/FPS 16 uses a monopulse tracking system and operates at C—band. The operating console is designed so that a single operator can control every operation of the radar. A three-color video display is used in the main fire control console to permit simultaneous engagement of several targets.

Standardization of the AN/FPS 16 at the various test ranges has been effected.

The Talos Defense Unit is capable of automatically handling, loading and launching the missile. Elimination of the necessity of personnel in the missile launching area is thereby assured.

Disclosure of the Unit was attended by ceremonies in which RCA was awarded the Navy's Certificate of Merit for its development of this automatic base.



Inside view of GE's new no-filament high-temperature tube.

## Miniature Vacuum Tubes Operate in 600 C Range

Transistor-sized ceramic vacuum tubes have been developed by the General Electric Research Laboratory, Schenectady, N.Y. Not much larger than a shirt button, the new tube operates only at ambient temperatures in the 600 C range. It contains no filament. Cathode heating is supplied by high ambient temperatures outside the tube.

This is the latest in a series of developments that have been aimed towards two goals:

- Reduce the bulk of present vacuum tubes and eliminate the glass envelope;
- Construct tubes to withstand the same high temperatures as GE's newly-developed high-temperature components.

Disadvantage of the tubes, of course, is their inability to work at temperatures below about 500 C. Their use will be limited to applications where high ambient temperatures are prevalent, such as high-temperature industrial processes and in missile electronics. The design is still in the laboratory stage and no tubes are commercially available at this time. The table lists some characteristics of two experimental models.

### Characteristics of New Miniature Ceramic Tube

	Tube A	Tube B
<b>Entire Tube</b>		
Temperature	600 C	600 C
Mutual Conductance	250 micromhos	250 micromhos
Plate Current	0.5 ma	5 ma
Grid Voltage	0	0
Plate Voltage	50 volts	50 volts
	over	over
Grid Current	0.1 microamp	0.1 microamp
Amplification Factor	15	100

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CIRCLE 14 ON READER-SERVICE CARD

# WASHINGTON REPORT



Herbert H. Rosen

## AMB Rises to the Challenge

Contracts, impending legislation, and a new test center mark the progress made so far by the Air Modernization Board. Established during the last session of Congress, AMB has already awarded over \$10 million in contracts and has others under negotiation. In addition, more than \$30 million will be appropriated the new agency for more R & D in air traffic control during fiscal year 1959.

General Precision Laboratory, Inc. appears to have the inside track on the development of control equipment. Last February, a \$4.3 million contract was awarded to them for an enroute portion of an air traffic control data processing central. Early in June, a \$3.97 million supplemental contract went to GPL for the transition and terminal portion of the data processing central. Moreover, GPL is expected to help RCA in the development of AGACS—an automatic ground-air-ground communication system. Initial contract cost is more than \$1 million. The program, ultimately should run around \$5 million.

Keystone to AMB's equipment development program is to be GPL's data processing and display equipment. The transition and terminal equipment contract calls for computers, controller consoles, flight-strip printers and display equipment "that will permit programmed landing sequences and take-offs of aircraft so that minimum landing delays and holding at terminals are experienced."

The AMB-GPL contract also calls for installation of the equipment for "interchange of SAGE data and to permit trials of Air Defense Command operations . . ." While initial tests will be limited to the New York area, AMB is setting up its own test center. Late in June, the Navy Air Station at Atlantic City became the National Aviation Facilities Experimental Center—the "Cape Canaveral" of civil aviation.

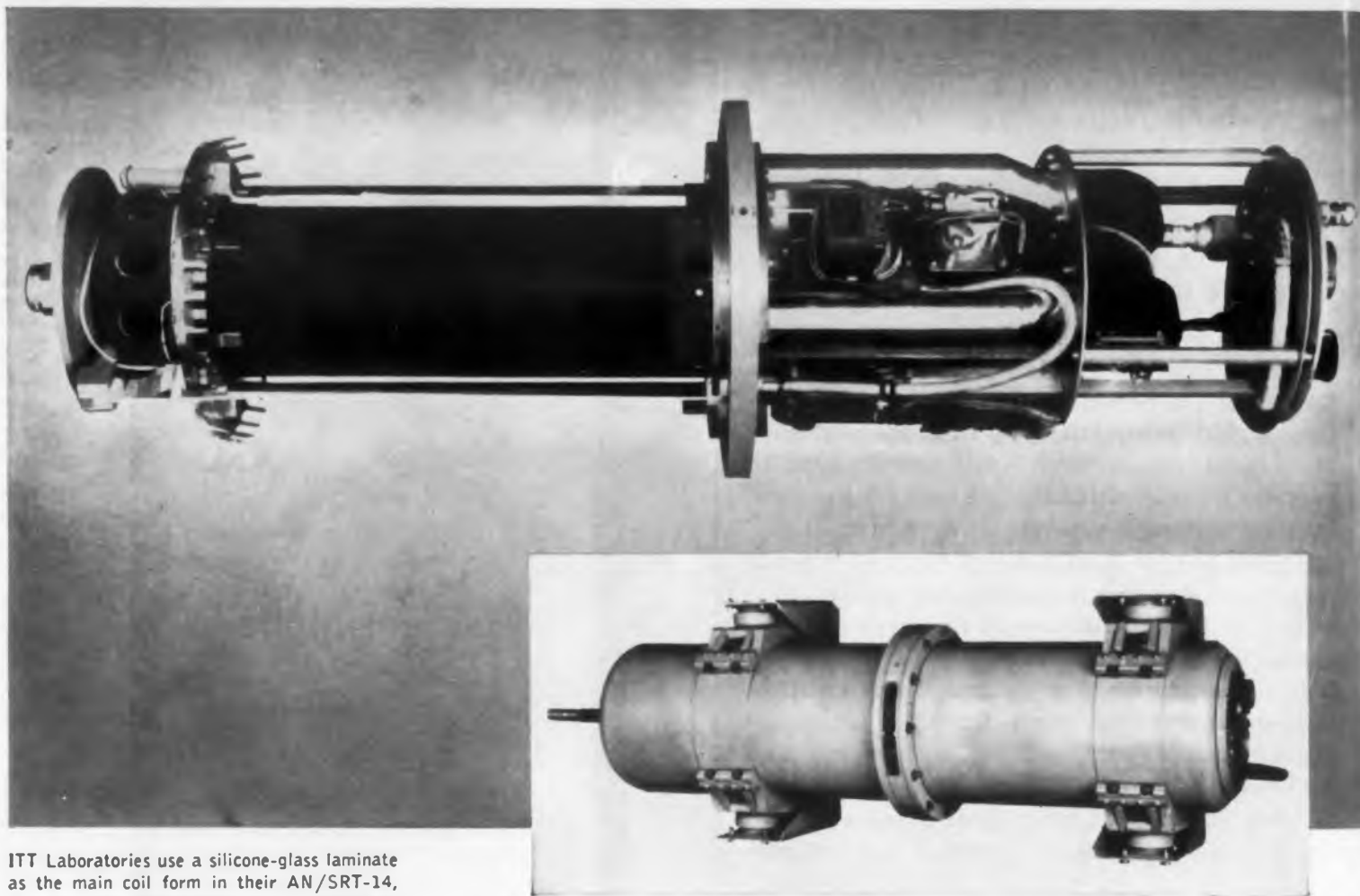
A housekeeping contract has been awarded to Ole Hansen & Sons, Inc. of Pleasantville, N.J. It is estimated that the first year's operations will cost about \$1.5 million.

All of this shows progress is being made—at least engineering talent is being bought to develop vitally needed equipment. Meanwhile, in response to more recent tragic air crashes, Con-

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Flexural Strength, psi	
at 25C . . . . .	24,000
at 260C after 100 hr at 260C . . . . .	4,600
Water Absorption, percent . . . . .	0.05
Electrical Strength, volts/mil	
initial . . . . .	310
after 200 hr at 260C . . . . .	327
after 5000 hr at 260C . . . . .	180
Dielectric Constant at 10 <sup>6</sup> cycles	
Condition A <sup>1</sup> . . . . .	3.67
Condition D <sup>2</sup> . . . . .	3.68
Dissipation Factor at 10 <sup>6</sup> cycles	
Condition A <sup>1</sup> . . . . .	.002
Condition D <sup>2</sup> . . . . .	.004

\* As measured on samples 1/8 inch thick.

<sup>1</sup> As received.

<sup>2</sup> After 24 hr immersion in water at 23C.

Laminates made with glass or asbestos cloth and Dow Corning silicone resins make excellent dielectric materials. These strong, lightweight laminates maintain their properties at continuous operating temperatures of 250 C . . . for short periods will withstand greater heat. Silicone-glass laminates have good mechanical strength in addition to low loss factor, low water absorption, superior resistance to arcing, corona, corrosive atmospheres and contaminants. They can be laminated in very thin sections; have fine machinability. Supplied as tubes, sheets, punched or molded shapes by leading laminators. Write for free booklet.

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Southwestern Industrial Electronic's S-16 Geophone.

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Resistors by Tru-Ohm Division of Model Engineering and Manufacturing Co.

## SILICONE VARNISH MAKES IMPROVED RESISTOR CEMENT

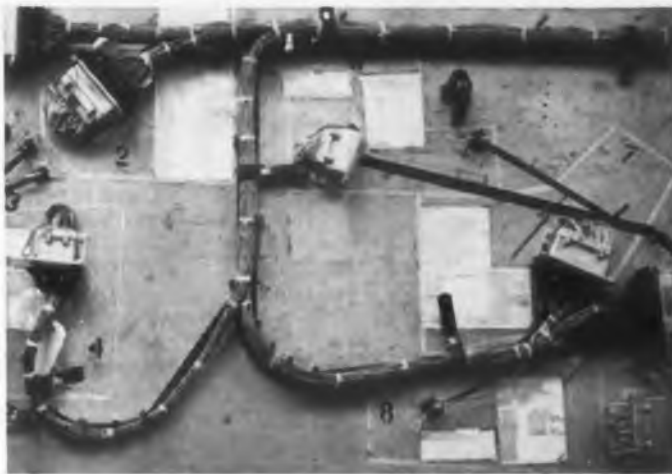
Heat-stable and exceptionally moisture-resistant, Dow Corning varnishes make very good bonding cements. In addition, they can take fairly high loadings of inorganic fillers without loss of properties. An appropriately filled Dow Corning varnish is often far superior to conventional materials for sealing wire wound resistors and other electronic devices. Set-up time is good.

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CIRCLE 543 ON READER-SERVICE CARD



Wiring panel for Convair B-58 Hustler.

gress is quickly considering passage of a Federal Airway Act. Senator Warren G. Magnuson (D-Wash) dusted off a bill he had been saving—S-3880—and hearings by Senate Finance Committee were begun. It appears that the bill is virtually guaranteed passage during this session.

In the words of the President: "All functions now carried out by the Civil Aeronautics Administration . . . Airways Modernization Board . . . safety divisions of the Civil Aeronautics Board . . . (and) parts of the Department of Defense . . . should be transferred to the new Agency." A congressionally-approved Administrator and Deputy shall be in full control of the Federal airways—in about every manner conceivable. Further, provisions are to be made to have both civilians and military personnel on the staff

With all of this activity as background, General Precision Equipment Corp. came to Washington to demonstrate its new HIDAN—High Density Air Navigation method. It has two major components: an airborne, automatic navigator called RADAN; and a small computing device which "instantly indicates the position of the aircraft and, when programmed for a flight, continuously calculates the divergence of the actual position of the aircraft from its planned position. This divergence is shown instantaneously on an indicator in the cockpit." The RADAN portion—a Doppler instrument giving ground speed and drift angle—has been produced by GPL for the Air Force since 1948.

Adoption of a HIDAN-type system would seriously reduce the need for large numbers of the proposed VOTAC systems now being installed along the Federal skyways. It could also cut into the TACAN units.

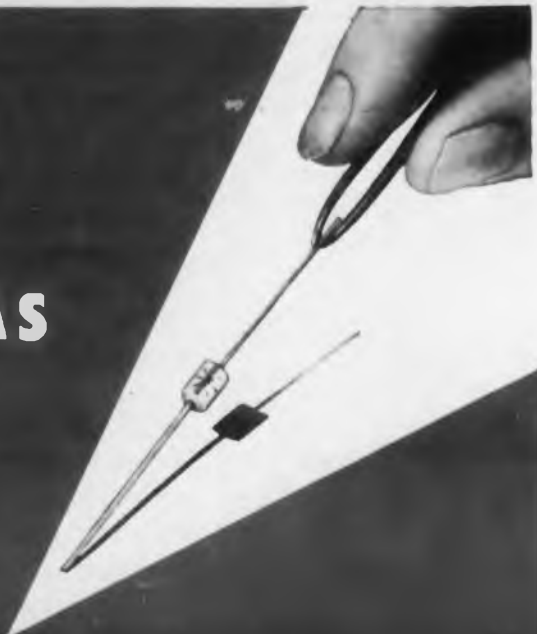
## BuAer Issues Circuit Standards

A new military standard—MIL-STD-439 (AER)—calling for the use of preferred circuits, will soon be a standard requirement in Navy Bureau of Aeronautics contracts. Thirty of the preferred circuits for miniature tubes developed by the National Bureau of Standards make up the specification. All are single function circuits—multivibrators, i-f strips, block oscillators, video, pulse and audio amplifiers and similar circuits.

Navy engineers waited more than three years before incorporating the circuits into a specification. In that time, tests and experiments were conducted to check them out. In the process, two NBS circuits were eliminated. Officials estimate that a preferred circuits specification for subminiature tubes is about a year away. Recently the Navy started a program that will ultimately lead to preferred transistor circuits. NBS is coordinating the program and making final tests and selection of standardized circuits.

For further information on these products write Dept. 168

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	STA-182	2.0	15	18
	STA-167	1.5	20	24
	STA-172	1.3	30	36
	STA-177	1.0	35	42
40J SERIES	STA-457	7	10	12
	STA-462	4	15	18
	STA-467	3	20	24
	STA-472	2.4	30	36
	STA-477	2	35	42
300 SERIES	STA-257	17	10	12
	STA-262	11	15	18
	STA-267	8	20	24
	STA-272	6	30	36
	STA-277	5	35	42
200 SERIES	STA-357	70	10	12
	STA-362	45	15	18
	STA-367	35	20	24
	STA-372	25	30	36
	STA-377	20	35	42

\*Standard Capacity Tolerances are minus 15%, plus 25%.

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## Aug. 19-22: WESCON

Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, Calif. Sponsored by Seventh Region of the IRE and WCEMA. More than 200 technical papers will be presented in 42 sessions at the Ambassador Hotel. The concurrent exhibit of electronic equipment and services will occupy more than 900 booths in the Pan-Pacific Auditorium plus four special pavilions. Included in the technical program will be two "invited" and two "special" sessions. Topics of the invited sessions are "Parametric Amplifiers and Masers" and "Industry Looks at Fusion Power." An evening ses-

sion on "Biological Measurement in Space Travel" is scheduled with a second evening session topic yet to be announced. There will also be panel sessions on "Contract Implications of Military Electronics Reliability Requirements" and "Modern Management Problems in an Increasingly Complex Technology." A complete breakdown of technical sessions will be found below. For more information write Western Electronic Show and Convention, 1435 S. La Cienega Blvd., Los Angeles 35, Calif. For complete convention coverage, read ELECTRONIC DAILY, published every day during the show.

### WESCON Program

All A.M. sessions begin at 9:30, P.M. sessions at 2:00, Eve. sessions at 8:00 P.M.

**Abbreviation Key:** Ballroom (Ba), Boulevard Room (Bo), Embassy Room (E), Sunset Room (S), Venetian Room (V).

Session and Number	Time and Location	Session and Number	Time and Location
<b>Aeronautical Electronics</b>		<b>Microwaves</b>	
Airborne Electronic Devices (8)	Tues pm-Bo	Microwave Theory and Technique	
Antenna Arrays (27)	Thurs am-V	Session I (5)	Tues am-V
Antennas and Propagation (35)	Fri am-Bo	Session II (10)	Tues pm-V
Antennas (40)	Fri pm-Bo	Parametric Amplifiers and Masers (11)	Wed am-E
Audio (15)	Wed am-V	Microwave Propagation (20)	Wed pm-E
Radio and TV (32)	Thurs pm-V	Microwave and High Power Tubes (24)	Wed pm-V
Advanced TV Techniques (37)	Fri am-V	Microwave Ferrites (30)	Thurs pm-Bo
<b>Circuit Theory</b>		<b>Medical Electronics</b>	
Circuit Analysis and Design (9)	Tues pm-Ba	Biological Measurements in Space Travel (21)	Wed Eve-E
Circuit Design (14)	Wed am-Ba	Medical Electronics (39)	Fri pm-S
Transistor Circuits (17)	Wed pm-S	<b>Military Electronics</b>	
<b>Communications</b>		Military Electronics (25)	Thurs am-Bo
Communication Systems and Vehicular Communication (42)	Fri pm-V	<b>Nuclear Science</b>	
<b>Components</b>		Industry Looks at Fusion Power—Panel (16)	Wed pm-E
Component Materials (26)	Thurs am-Ba	<b>Production</b>	
Component Parts (31)	Thurs pm-Ba	Production Techniques (34)	Fri am-S
<b>Computers</b>		<b>Reliability</b>	
Computer Applications (1)	Tues am-E	Reliability Session I (2)	Tues am-S
Computer Devices (6)	Tues pm-E	Session II—Panel (7)	Tues pm-S
Analog Computers (23)	Thurs am-E	Solid State Session I (33)	Fri am-E
<b>Control Systems</b>		Session II (38)	Fri pm-E
Automatic Control (18)	Wed pm-Bo	<b>Special Devices</b>	
Industrial Electronics (36)	Fri am-Ba	Special Electronic Devices (28)	Thurs pm-E
<b>Human Engineering</b>		<b>Telemetry</b>	
Human Factors in Engineering (29)	Thurs pm-S	Telemetry (3)	Tues am-Bo
<b>Information Theory</b>		Biological Measurement in Space Travel (21)	Wed Eve-E
Information Theory (4)	Tues am-Ba	<b>Writing and Speech</b>	
<b>Instrumentation</b>		Engineering Writing and Speech (41)	Fri pm-Ba
Instrument Tools (13)	Wed am-Bo		
Instrument Systems (19)	Wed pm-Ba		
<b>Management</b>			
Modern Management Problems (12)	Wed am-S		

# EDITORIAL

## Drawing The Line In Computer Design

In our editorial of June 25 we asked if we must always start from scratch every time we faced a design problem. Could not some aspect of digital circuit design be considered "standard?" After surveying the views of digital computer designers, we concluded that the majority of designers of military systems felt it was too premature to standardize on any specific designs but that some sort of flexible standardization was desirable. In this editorial we will look at some of the areas suggested as starting points.

- Standardize on modular units. The most reasonable view seems to be to emphasize the modularization concept but to put no restrictions on dimensions or construction techniques.

- Consider logical circuits. The odds are against agreement on picking the optimum ranges for some dozen characteristics of circuits and physical modules, but a tabulation has never been made. If a reasonable number of requirements fall within one or two groups, standardization is feasible and not difficult. Since each logical step is small, modularization should be applied to a function rather than a basic step.

- Standardize machine language for data processing machines. There is little or no likelihood of standardizing input and output devices. Such equipment which "communicates" with other devices will be almost impossible to pin down.

Experienced military designers feel that each circuit is a compromise between simplicity, low cost, and performance. These factors complicate attempts to determine appropriate standards.

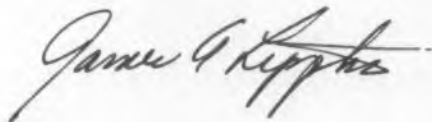
Forceful arguments against standardization of even sub-assemblies is the large number of such "standardized" units offered by each manufacturer of commercial building blocks. Attempts to get a small number of building blocks does not appear to be successful. Although useful for breadboarding, they are not ideal for production runs.

Before arguments for or against standardization can be weighed objectively, a study of exactly what is involved is necessary. Until this is done, the retort to pleas for standardization will continue.

Time spent on determining standards and getting manufacturers to agree on them would be better spent improving the product.

If there are to be standards for military computers, the military will have to take the lead. This subject will be discussed in a future editorial.

Over 200 papers will be given this month at the West Coast's annual big electronics meeting. Running from Aug. 19th through 22nd, WESCON also boasts over 700 exhibitors this year. Might be a good place to discuss your standards problems.



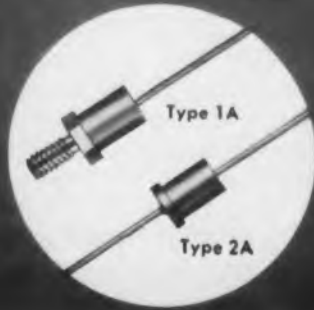


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# Concentrated Filter Passbands

## Part 1

### *Mechanical Filters*

For many years, engineers have tried to find better ways to form straight-sided, flat-topped passbands without cumbersome, cascade transformers and tubes used in i-f amplifiers, and without RC and iron-core/capacitor combinations used in low frequency work.

Three distinct filter types have evolved. Each is effective for certain applications; none is effective for all. They all are passive, and provide all the required selectivity. To reduce noise, they are normally applied before any amplification.

The three types are: ■ Mechanical; ■ Crystal; ■ Electrical or LC

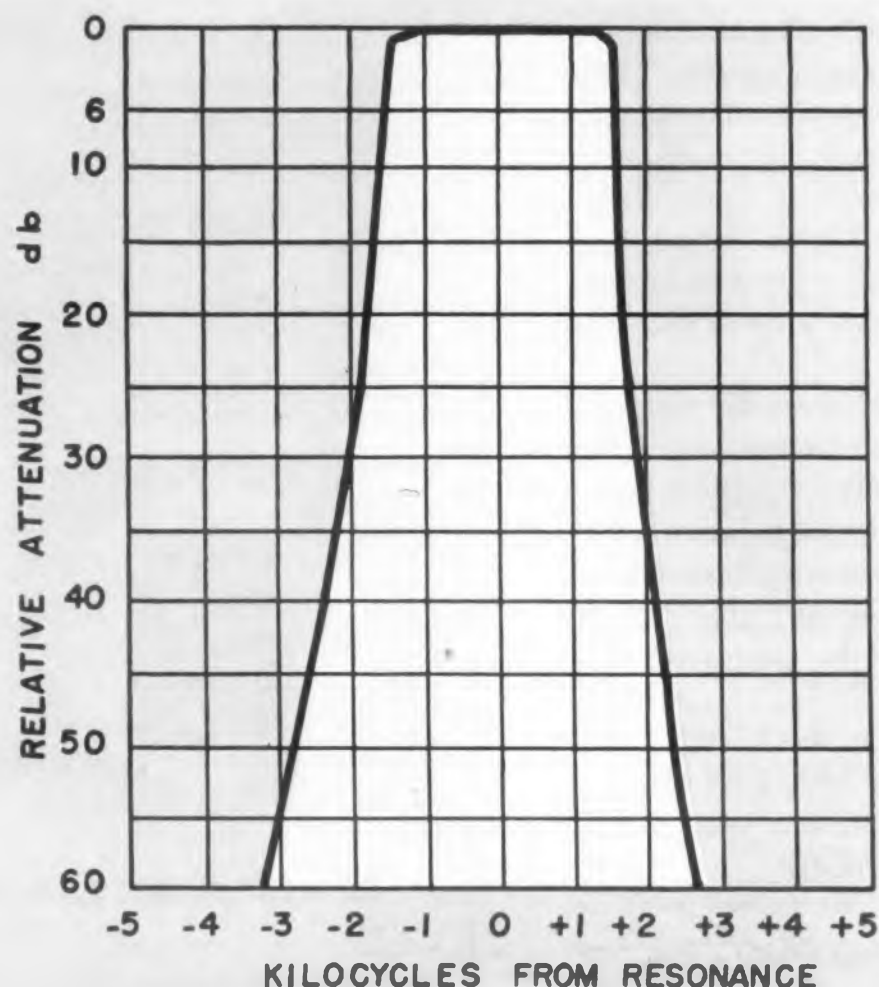


Fig. 1. Selectivity of a typical six disk mechanical filter.



**Frederick A. Schaner**

The Daven Co.  
Livingston, N. J.

**M**ECCHANICAL filters can provide characteristics unobtainable with electrical circuits. While electrical elements have relatively high losses, mechanical elements can have Q's of 5000 and more. This permits treating mechanical filters as lossless elements.

Their frequency characteristics are permanent, so no adjustment can be made after final alignment.

All mechanical filters consist of input and output transducers, and a resonant mechanical section in between. Many structures have been used as mechanical resonators. Of these, three types are the most common.

#### Filter Types

1. One type has a number of rectangular resonant plates, interconnected by fine wires.
2. Another type has a cylindrical rod, machined to form alternate necks and slugs. In this case, either the necks or the slugs can be used as resonators.
3. The third type is a cylindrical arrangement of disk resonators, interconnected by coupling wires.

Four methods of electromechanical transduction have been commonly used during the last ten years; electromagnetic, electrostatic, magnetostrictive, and piezoelectric.

■ Electromagnetic and electrostatic transducers were used in early filters. Since they are lumped constant devices, their use has been restricted to the lower frequency range because parasitic resonances limit their high frequency performance.

■ Magnetostrictive and piezoelectric transducers are basically distributed constant systems, so they can be used at radio frequencies when proper dimensions are chosen. Magnetostrictive transducers are most frequently used in mechanical filters today for their efficiency, economy and stability.

#### Frequency Characteristics

The excellent frequency characteristics of a resonant mechanical section provide an almost rectangular selectivity curve. The input and output transducers serve only as electrical-to-mechanical and mechanical-to-electrical coupling devices and do not affect the selectivity characteristics. These are determined only by the resonant elements.

An electrical signal at the input transducer is converted to a mechanical vibration by magnetostriction. This mechanical vibration travels through the resonant mechanical section to the output transducer where it is converted back to an electrical signal by magnetostriction.

A small permanent magnet in each transducer helps provide optimum electrical-mechanical coupling. It supplies magnetic bias to the transducer core. The impulses then add to or subtract from this magnetic bias, causing vibration of the filter elements corresponding to the input signal. The vibration, of course, is almost imperceptible.

For a restricted frequency range, magnetostrictively driven filters have several advantages over electrical equivalents. From 60 to 600 kc, the mechanical elements are extremely small, so a mechanical filter with better selectivity than the best conventional i-f systems can be pack-

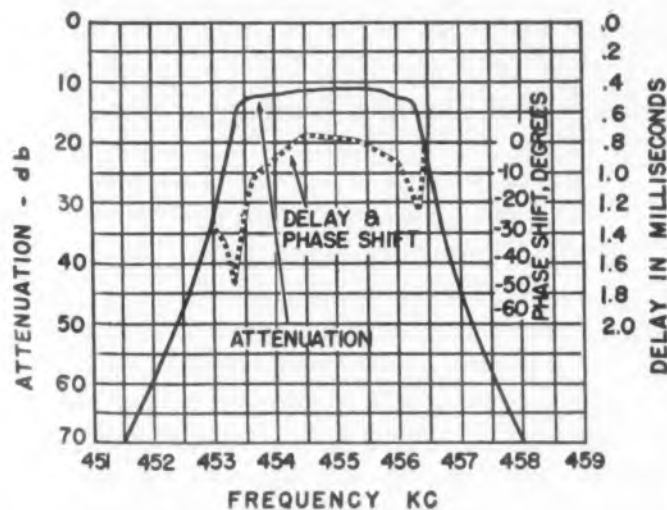


Fig. 2. Time delay and attenuation of a typical six disk filter.

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1N662

1N643

EIA TYPE	Minimum Saturation Voltage (volts) @ 100 $\mu$ A	Minimum Current Forward @ +1.0v	Maximum Reverse Current ( $\mu$ A)		Reverse Recovery Characteristics	
			25°C	100°C	Reverse Resistance (ohms)	Maximum Recovery Time ( $\mu$ s)
1N663	100	100	5(75v)	50(75v)	200K	0.5
1N662	100	10	1(10v) 20(50v)	20(10v) 100(50v)	100K	0.5
1N643	200	10	.025(10v) 1(100v)	5(10v) 15(100v)	200K	0.3

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CIRCLE 23 ON READER-SERVICE CARD

aged smaller than a single broadcast receiver i-f transformer.

It is almost impossible to distinguish the relative advantages and disadvantages of the three common types of resonant elements. All three perform equally well, the principal difference between them being that they are the result of separate investigations. For convenience, one can consider the resonant disk type only.

#### Performance Characteristics

Table I shows the performance of a typical 6 disk mechanical filter. This filter has a center frequency of 455 kc and a 3.1 kc bandwidth between the 6 db points. The shape factor of this filter (ratio of bandwidth 60 db down from the highest peak to bandwidth 6 db down) is less than 2.1.

This low value of shape factor permits unusually high rejection of unwanted signals. The broad nose of the curve passes portions of the signal which would be attenuated in a standard rounded i-f selectivity curve.

To realize full benefit from a mechanical filter's selectivity characteristics, shielding is necessary

between the external input and output circuits. This shielding should be able to reduce the energy transfer between these circuits at least 100 db. If the input circuit couples energy to the output around the filter, the selectivity will deteriorate and the passband will be distorted.

As with almost any mechanical resonant circuit, elements of the filter have multiple resonances. These produce spurious transmission paths through the filter and produce minor passbands at frequencies on either side of the primary passband. Careful filter design reduces these sub-bands to a low level and removes them from the immediate area of the major passband.

However, where increased attenuation is needed at the spurious frequencies, additional selectivity can be added with tuned circuits before or after the mechanical filter. Two conventional i-f transformers usually suffice. Their passbands should have nearly constant attenuation in the band of the mechanical filter to obtain full benefits from the flat passband characteristics.

Mechanical filters with different bandwidths can be switched into a circuit. This can provide

### OPERATING CHARACTERISTICS OF TYPICAL MECHANICAL FILTER

OPERATING FREQUENCY	455 ± .25 KC
NOMINAL BANDWIDTH AT -6 DB	3.1 KC
MAXIMUM BANDWIDTH AT -60 DB	6.5 KC
SHAPE FACTOR 60DB TO 6DB LESS THAN	2.1/1
MAXIMUM RESPONSE VARIATION WITHIN PASSBAND	3 DB
OVERLOAD SIGNAL INPUT VOLTAGE	2 VOLTS RMS
INSERTION (TRANSMISSION) LOSS 10DB NOM.	
OPERATING TEMPERATURE RANGE	-40°C TO +85°C
INPUT & OUTPUT IMPEDANCE	14 K OHMS RESISTIVE AT RESONANCE
CASE SIZE	3/4 DIA. X 2 5/8 LONG

TABLE 1

variable selectivity. One receiver, for example, has plug in provision for 800, 1500, 3100, or 6000 cps filters. A front panel switch selects the desired filter. The 3100 cps filter is ideal for phone signals, including single side band.

#### Signal Requirements

The maximum signal input for a particular filter is one which provides an output voltage 0.5 db below what it would be if the filter's input-output voltage relationship were perfectly linear. (In a specified range, the filter's output is essentially proportional to its input.) Momentary surges of several times the maximum signal input will not damage the filter.

The filter's transducer coils are usually designed to carry up to 20 mADC. The effect of dc in the coils is analogous to increasing the fixed grid bias on a tube. Assuming optimum performance with zero current, the maximum signal swing without distortion becomes more limited when the dc current is increased.

#### Operating Requirements

The input and output transducer coils must be resonated. The value of resonating capacity should be specified for any filter. This value includes the total external capacity of tubes, stray and wiring. The specified value is nominal, and the filter itself should be resonated at its nominal center frequency.

Since the filter has a high impedance, source and load impedances should be about ten times the resonant input and output impedances.

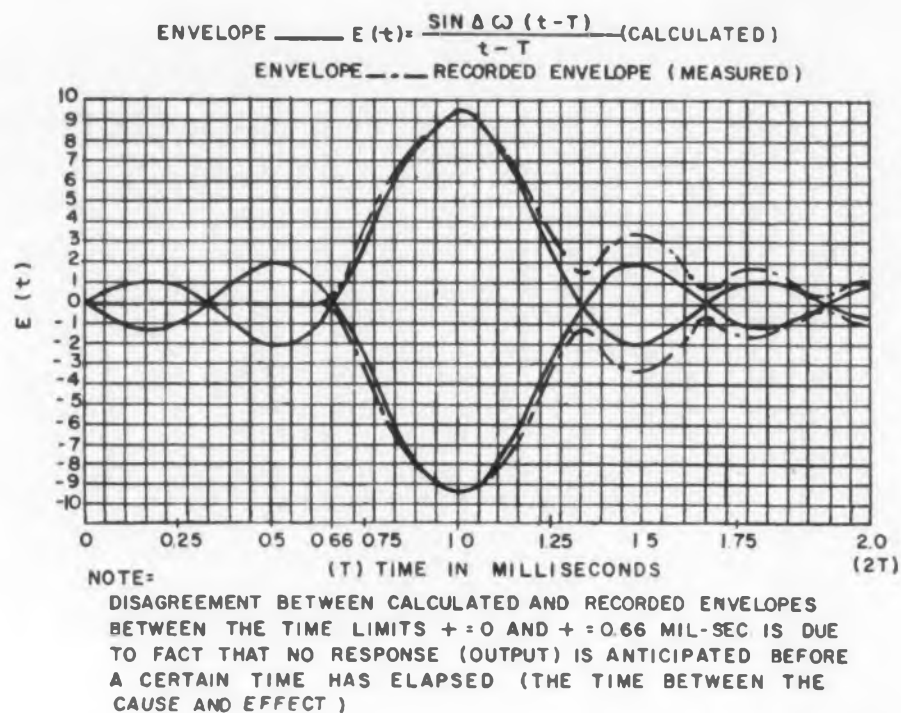
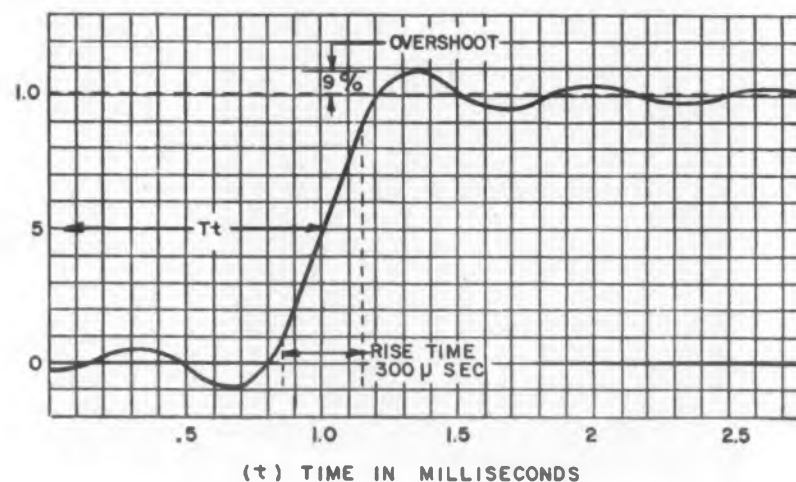


Fig. 3. Impulse response. Solid line represents calculated value. Dashed line is measured value.

Fig. 4. Step function response of a six disk filter with a pulse modulated carrier input.



### Time Delay

Fig. 2 shows the plot of time delay in a mechanical filter. It is obtained by passing a modulated signal through the filter and measuring the resultant modulated envelope phase shift through the filter. The delay is then computed from

$$t_d = \frac{\theta}{360 f_m}$$

where  $t_d$  is the time delay in seconds,  $\theta$  is the phase shift of the modulation envelope in degrees, and  $f_m$  is the modulating frequency in cps.

The time delay shows rapid variations near the edges of the passband as shown in Fig. 2. But the delay across the passband is of primary interest. A typical commercial filter has a phase shift variation of 5 deg over 75 per cent of the passband. This is equivalent to a time delay variation of about 0.2 milliseconds.

As an approximation, time delay varies inversely with bandwidth for a given center frequency, that is,  $t_d \propto 1/B$ , with  $f_c$ , the center frequency, constant, and  $B$ , the filter bandwidth.

### Impulse and Step Response

The response to both impulse and step functions is shown in Figs. 3 and 4. The filter whose response is shown has a 3.1 kc bandwidth and has six disks. As with all practical filters, mechanical filters have a finite rise time. It depends only on the bandwidth, and is given by  $t_r = 0.90/B$ ,  $t_r$  is the rise time in msec and  $B$  is the filter bandwidth in kc.

A step function, applied to any mechanical filter, results in a theoretically constant overshoot. In the case of one manufacturer's filters, this overshoot is 9 per cent.

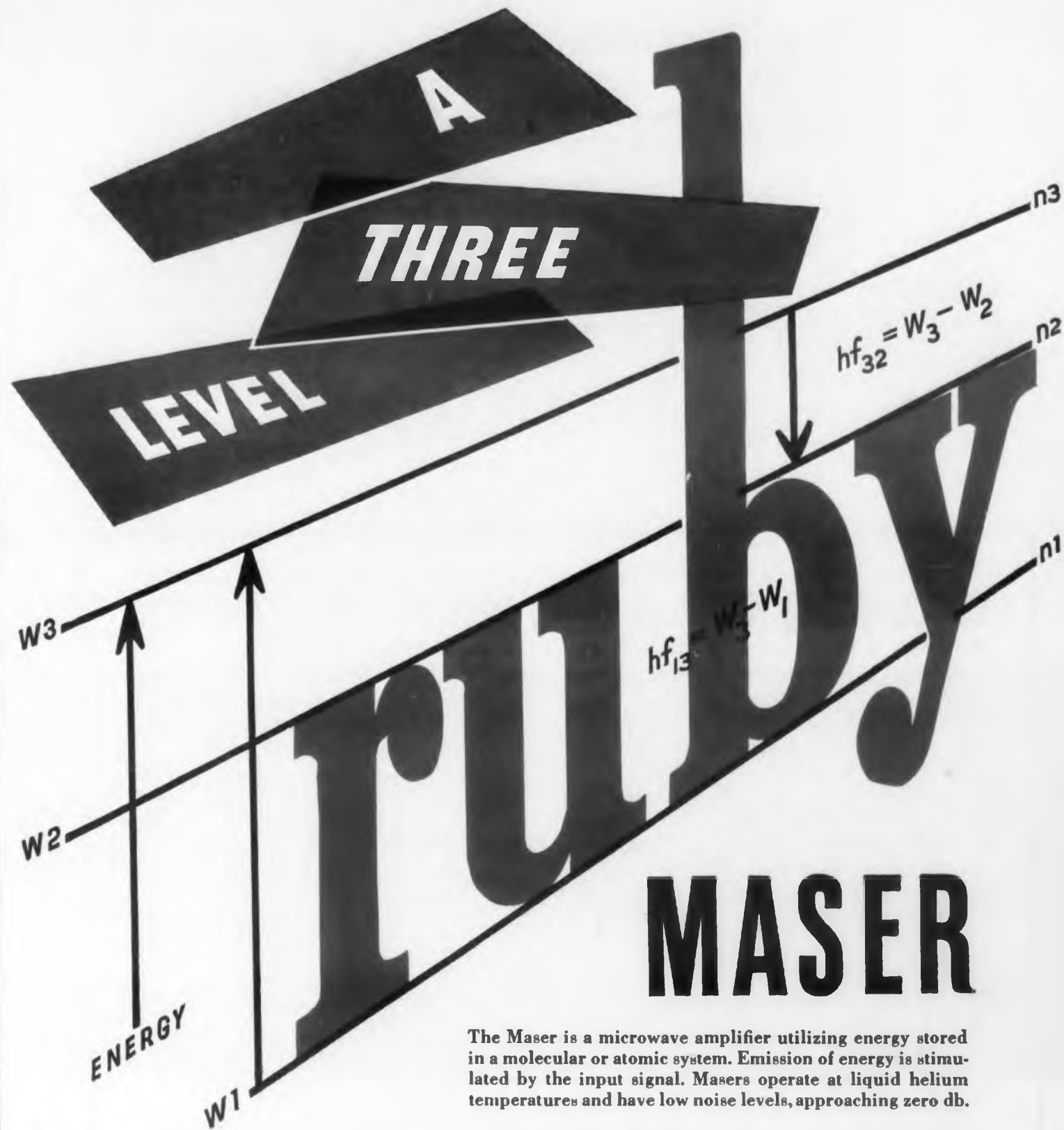
The anticipatory transient duration from time zero of the applied step function to a point half way up the rising slope of the filter output, depends on the filter bandwidth and the number of disks. The transient time is  $t_t = N/2B$  where  $N$  is the number of disks.

The impulse response shown includes the calculated and measured response. The transient time from time zero of the applied impulse to the peak of the filter output pulse is the same as the calculated transient time for the step function response.

### Environmental Effects

Mechanical filters are as rugged as ordinary receiving tubes. They operate satisfactorily when subjected to continuous vibration with a total excursion of 0.060 in. over a vibration frequency range from 10 to 55 cps. They can take 15 g shock lasting 11 msec.

Their shift with temperature can be held to within 10 ppm per deg C. Since they are hermetically sealed, humidity has no effect.



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For more information, write Crystal Products Department, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

†Maser Action in Ruby, by G. Makhov, C. Kikuchi, J. Lambe, and R. W. Terhune. "Physical Review," Vol. 109, No. 4, p. 1399, Feb. 15, 1958.

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# Application Of Coaxial Bar Hybirds

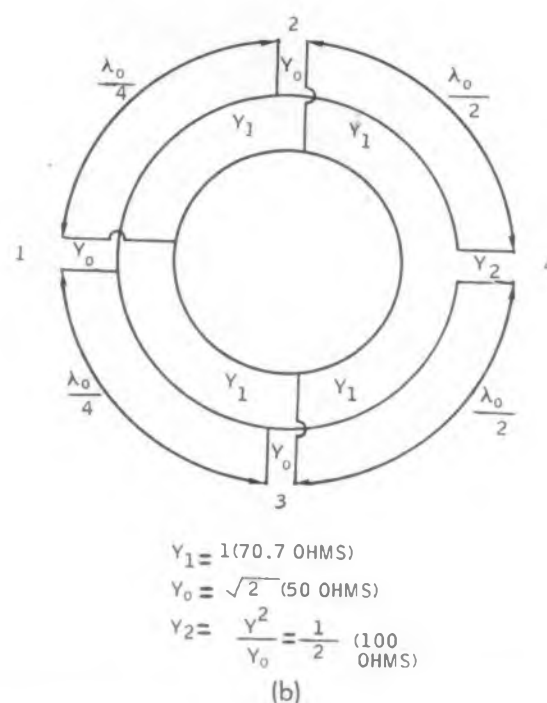
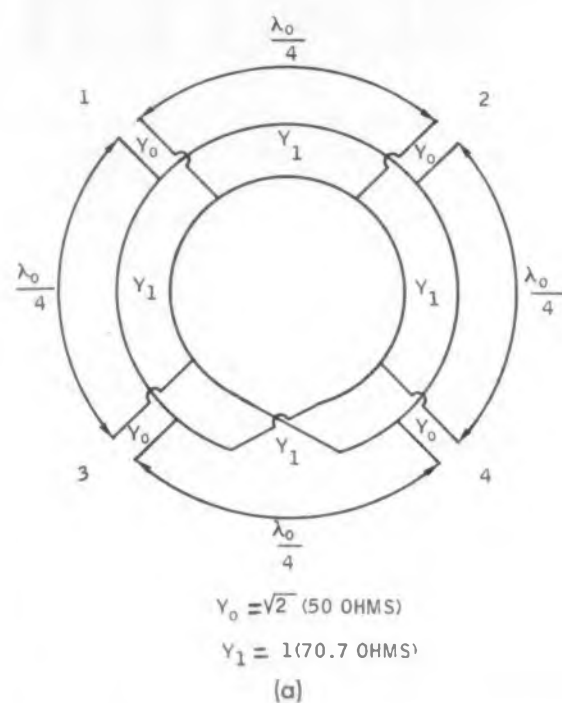


Since Bogart Mfg. Co. announced their new coaxial bar hybrids (ELECTRONIC DESIGN, March 1, 1957, p. 38) many new applications have been disclosed. This article discusses a number of applications evolved by engineers in the field.

A hybrid is, basically, a four-terminal device which has the following properties:

- Opposite arms are isolated from each other.
- If power is fed into any of the arms, it will divide evenly between the two remaining unisolated arms.
- The division of power is independent of the phase of the impedances on the output arms if the degree of mismatch is identical.
- Power from one input arm arrives in phase at the two output terminals. The power fed from the second input arm arrives at the outputs with a 180 deg phase difference.
- The conventional coaxial hybrid (a) has the form of a ring with spacings of a quarter-wave-

length between three arms with a spacing of three-fourths wavelength between the second and fourth arms. Each arm is shunt connected to the main ring and the properties outlined above are achieved by the spacings between arms. In the series-shunt hybrid of the Bogart type (b) three of the arms are shunt connected, but the fourth arm is fastened in series to the main line. Arm 4 can be matched to  $Y_0$  if the admittance of a portion of the ring is altered. The essential hybrid properties are, therefore, practically independent of frequency since phase reversal from the fourth arm does not rely on sections of transmission line.



## Miniature, Broadband Balanced Mixer

Apply the received signal to arm 1 and the local oscillator to arm 4. If crystal holders, (nominally matched to 50 ohms) are attached to arms 2 and 3, the device becomes a mixer. The received and local oscillator signals may be interchanged at arms 1 and 4. Most local oscillators, especially in the lower frequency bands, have coaxial outputs. Also, broadband coaxial crystal mixer arms have been designed by Bogart to work with these units, and are now available. For a receiving system, therefore, a coaxial hybrid is much smaller and more convenient than a comparable waveguide unit. (Table 1)

## Power Divider

Apply a signal (such as a transmitter) to arm 1. (Fig. 1) The power will then divide equally between arms 2 and 3 provided that these two arms are matched to 50 ohms, or otherwise have the same degree of mismatch. If, for example, the output arms both have VSWR values of 2/1, they would then receive equal power regardless of the phase of the mismatch, since one of the properties of the hybrid is that isolation exists between opposite arms.

This situation would have practical significance in the case of two identical antennas fed from the same transmitter with unequal lengths of cables between antennas and inputs. Arm 4 is terminated in a matched load. The input signal could also be applied to arm 4 with arm 1 terminated, although the construction of the hybrids is such that arm 4 cannot handle the same level of power as arm 1. The standard hybrid utilizes a smaller coaxial cable on arm 4. Arms 1, 2, and 3 employ a larger cable about 3/8 in. diam.

## Signal Addition in a Single Load

If two signals of different frequencies are applied to arms 1 and 4, and the output loads on arms 2 and 3 are matched to 50 ohms, or, closely matched to each other, then the power will divide equally between them with good isolation (greater than 30 db) maintained between arms 1 and 4. If it is desired to feed two transmitters into a single antenna (Fig. 2), the antenna may be placed at either arm 2 or 3 with a dummy load (matched to the antenna) on the remaining arm. It should be noted that there will be a 3 db loss in output since half of the power is dissipated in the dummy load.

## Variable Power Divider, Attenuator, or Phase Comparator

If two outputs may be taken from a single generator and fed into arms 1 and 4 with zero phase shift between them, and if arms 2 and 3 are matched, the two signals will add in one of the arms and subtract in the other. If the two signals were equal to begin with, one of the output arms will, therefore, receive no power and the other arm will receive the total sum of the two powers. If a variable, lossless, phase shifter is placed in one of the lines, as shown, then the proportion of power delivered to arms 2 and 3 may be varied so that any power ratio may be obtained. If two outputs cannot be obtained directly from the generator, two hybrids may be used in tandem, as shown in Fig. 3.

The hybrid may also be used as a phase comparator where the magnitudes of output signals at arms 2 and 3 can be related to the relative phase between two equal input signals and the phase relationship between the signals accurately measured.

## General Monopulse Application

The coaxial hybrid may be used in any application where an in-phase, out-of-phase relationship, is desired between two inputs. One such ap-

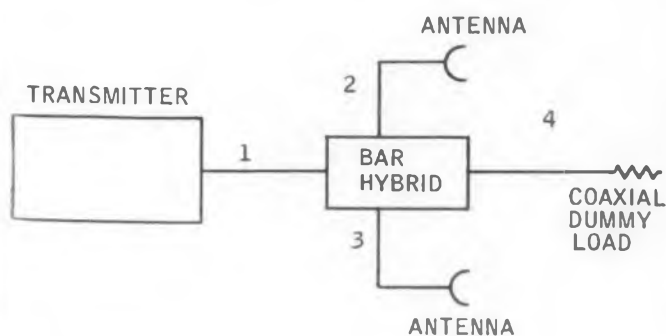


Fig. 1. Using a coaxial bar hybrid as a power divider.



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# Application of Coaxial Bar Hybrids

continued

plication exists in a monopulse system where it is necessary to add and subtract two rf signals. A transmitter signal fed into arm 1 (Fig. 4) will divide equally, and in phase, to arms 2 and 3. Received signals may be fed back into arms 2 and 3 of the hybrid. Arm 4 will then yield a difference signal, and arm 1 a sum signal.

## Hybrid Duplexer

Many of the applications mentioned have long been used in conventional waveguide hybrids commonly termed "Rat Races." Coaxial hybrids, however,

have the advantage, in many applications, of a much broader bandwidth. One such application is in a duplexer design for TR-ATR application. Referring to Fig. 5:

- A transmitter is sending power into arm 1 (hybrid 1) which splits up evenly at arms 2 and 3 and fires the TR tubes.
- All power is reflected back into the main line and out of phase because of the differential  $\lambda/4$  arm in arm 3.
- The power then enters arm 4 and the antenna with little or no power re-

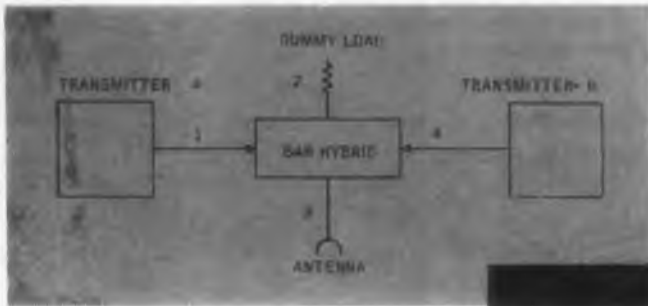


Fig. 2. Adding signals in a single load.

Fig. 3. Bar hybrids in tandem.

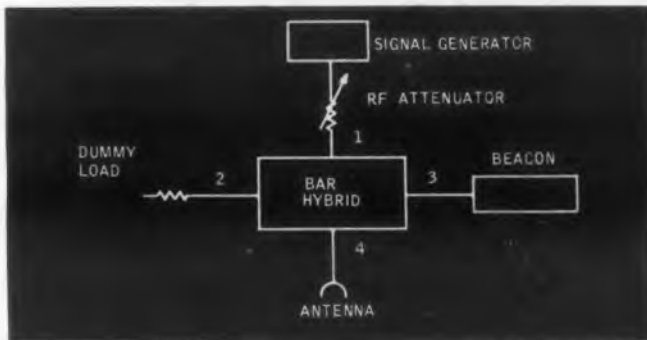


Fig. 4. Applying bar hybrids in a monopulse system.

flected back to arm 1.

- During receive time, echoes picked up by the antennas enter arm 4 and since the TR tubes are no longer firing, split up evenly at arms 2 and 3.
- These two signals are now fed through two lengths of line, different in length by  $\lambda/4$  to equalize phase, to arms 2 and 3 of hybrid 2.
- All energy is summed in arm 1 with a termination placed on arm 4 to absorb any small residual signals.
- The output of arm 2 is now fed to arm 1 of hybrid 3 which is simply used as a balanced mixer.

## Beacon Switching Device

A signal generator applies to a low-level signal to arm 3 of the hybrid through a variable attenuator (Fig. 6). This signal splits evenly between arms 1 and 4 with half the power being dissipated in the dummy load terminating arm 4. The portion of the signal entering arm 1 triggers a beacon transmitter which sends a high-level signal back into the hybrid. The beacon signal splits evenly between arms 2 and 3. The attenuator at arm 3 absorbs the signal and arm 2 is attached to an antenna for transmission to the aircraft or missile.

Table 1. Typical Characteristics of S-Band Hybrids

S-Band	Bar Hybrid	Magic Tee	Short Slot Hybrid
Approx. bandwidth (%)	50	12	12
Max vswr	2.00	2.00	1.12
Max balance (db)	0.2	0.25	0.25
Max isolation (db)	30	35	30
Approx. wt (oz)	12	48	33
Dimensions (in.)	4 x 3 1/2 x 1	11 x 10 x 8	15 x 8 x 4

Fig. 5. Puplexer design for TR-ATR applications.

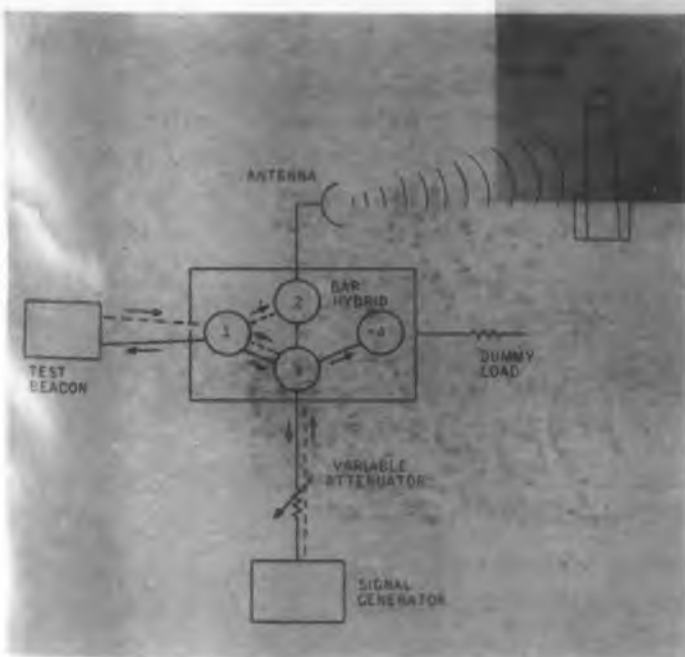
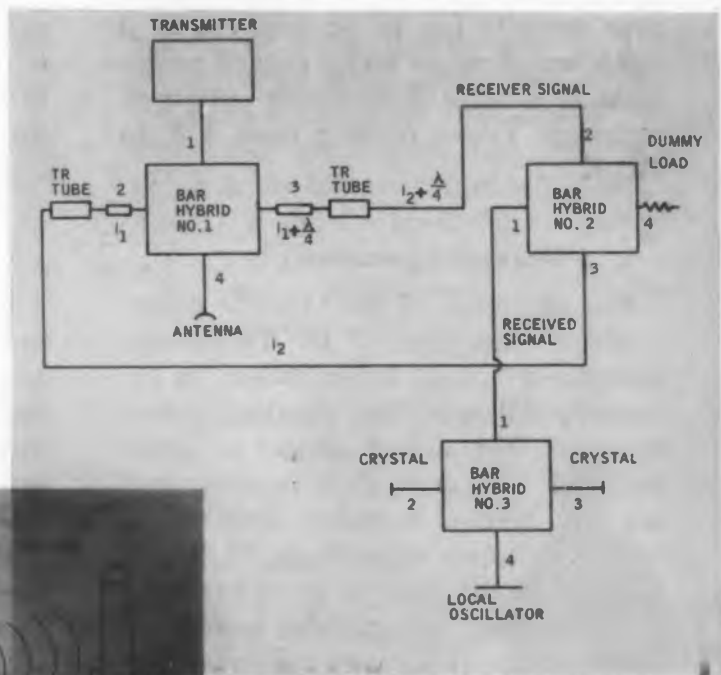


Fig. 6. Beacon switching device using a bar hybrid.

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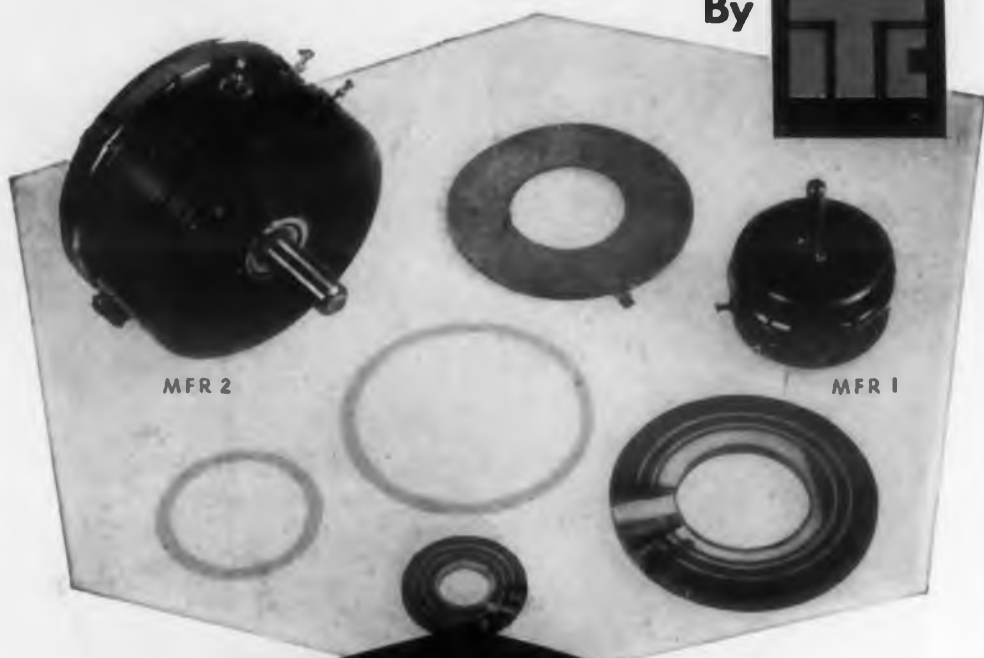
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## **Unusual Operation . . .**

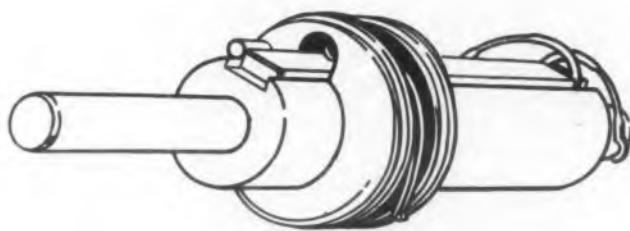
The operation of the M10T09 potentiometer manufactured by Technology Instrument Corp., Acton, Mass., is essentially different from standard potentiometers. The sliding contact is shown in Fig. 1. The shaft, shaft insulator and key are bonded together with epoxy cement to form a rugged unit. The slider is keyed to the shaft to permit translational motion, yet prohibit rotational motion of the slider with respect to the shaft.

The thread on the OD of the slider is identical with the thread on a wire guide. This forces the wiper contact to follow the helical pattern of the resistance winding. See Fig. 2. The electrical path from winding contact to external terminal is completed through the key to the slip ring contact, from the slip ring contact to the slip ring and from the slip ring to the external terminal.

## **. . . and Unusual Construction**

Engineers at TIC decided upon a new technique to lay the windings into the base of the potentiometer. They felt that the usual method of buffing insulated wires with some abrasive compound to permit contact between the wiper and winding inevitably scratched the surface of the windings and disturbed the uniform spacing of the individual turns. This resulted in lower linearity and more noise.

Accordingly, bare wire is used as the



**Fig. 1.** Rotating subassembly showing sliding contact, shaft, shaft insulator, and key.



resistance element to completely eliminate the need for buffing. By spacing the bare wires slightly farther apart than for the case of insulated wire, shorting between turns is avoided.

The method of laying in the windings is both ingenious and simple:

- A 30 in. piece of insulated magnet wire is laid under tension along the groove portion of the plug shown in Fig. 3. This wire is actually the guide for the wiper assembly.

- The bare resistance wire is then wound around a copper rod. The copper rod is removed and the bare winding is now laid down under tension, in the grooves formed by the guide wire.

- A coating of epoxy cement is applied to the subassembly and then properly cured to hold the winding and wire guide securely in place. Teflon washers prevent the cement from adhering to another surface.

- Insulation between the winding and the base is provided by a piece of Mylar, 0.005 in. thick. With the winding plug in place in the base, additional epoxy cement is applied between the winding and the Mylar insulation. When cured, this cement locks the winding firmly in place in the base. The plug now screws out simply and easily without disturbing either the winding or the wire guide.

The result is that at no time through the entire process has the portion of the winding that is contacted by the wiper, been exposed to contamination by adhesives or other foreign matter. The cleaner wiper action due to this process results in a low noise resistance of 100 ohms max at 4 rpm. The resolution sacrificed by this technique is negligible. For a 1 K unit the resolution is 0.000255 (reciprocal of number of turns).

For more information, turn to the Reader-Service card and circle 26.

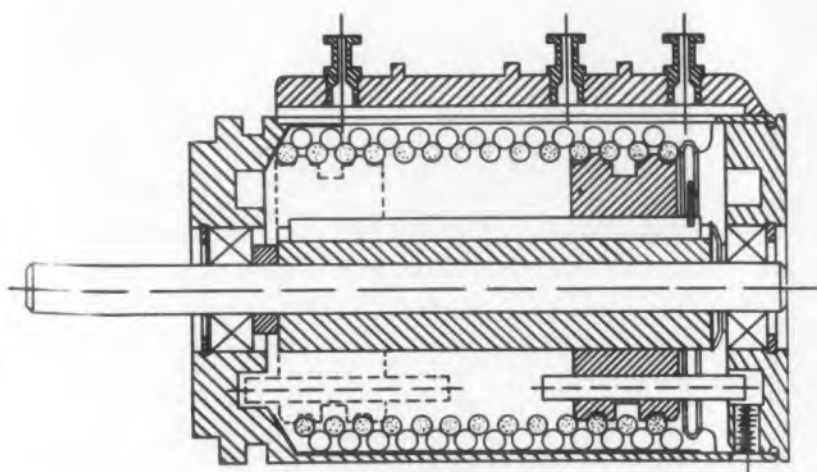


Fig. 2. (above) Cutaway view of the M10T09 potentiometer.



Fig. 3. (right) The winding plug on which the bare resistance wire and the wire guide are wound.

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Design Considerations for . . .

# Class B Complementary-Symmetry

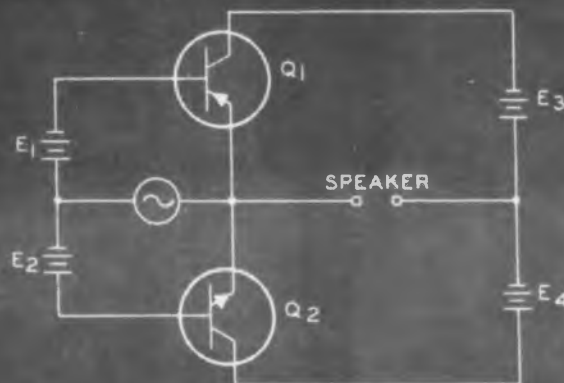
## Audio Amplifiers

C. F. Wheatley

Rodio Corporation of America  
Semiconductor and Materials Division  
Somerville, New Jersey

In this basic complementary-symmetry circuit, the pnp transistor  $Q_1$  receives base bias voltage from  $E_1$  and collector voltage from  $E_3$ . The npn transistor  $Q_2$  receives a base bias voltage from  $E_2$  and collector voltage from  $E_3$ . A positive voltage from the generator increases the collector current in  $Q_2$  and decreases the collector current in  $Q_1$ , thereby producing an output signal across the load. The quiescent collector currents caused by voltages  $E_1$  and  $E_2$  determine the class of operation—class A, Class AB, or Class B.<sup>1</sup>

This article applies the basic complementary-symmetry principle to the practical design of a Class B system having optimum performance. Optimum performance is considered to be achieved when a maximum clipping-level power output is obtained for a given load and supply voltage with a maximum power gain from the driver input to the load. Distortion is not considered of prime importance because it can be modified considerably in a given circuit by the degree of matching of transistors, the quiescent idling current, and the presence of negative feedback (at some sacrifice of power gain). It is assumed in the design that a single voltage supply is desired.



TWO BASIC circuits that approach optimum performance, together with their mid-frequency equivalent circuits, are shown in Figs. 1 and 2.

In Fig. 1, the collector supply,  $E_{cc}$ , is at ac and dc ground with respect to the input, and, therefore, full supply voltage is available for earlier stages. However, the over-all efficiency of the circuit shown in Fig. 2 is higher because the circuit is not driver limited and the full power-output capabilities of transistors  $Q_1$  and  $Q_2$  may be realized. In addition, the dissipation rating of transistor  $Q_3$  may be much lower in the circuit of Fig. 2 because a voltage rating of only a few volts is required for  $Q_2$ , rather than the full supply voltage required in the circuit of Fig. 1. Much higher values of collector-to-base intrinsic capacitance and conductance may also be tolerated in the circuit of Fig. 2. Both circuits are equally satisfactory with regard to over-all power gain, distortion, and input impedance.

### Circuit Parameters

In the design of conventional Class B circuits, the supply voltage, power-output rating, and load impedance are usually all given for a fixed application. For a push-pull design in which the output transformer is omitted, however, only two of these three parameters may be given be-



### ABOUT THE AUTHOR:

C. Frank Wheatley entered the University of Maryland and received the B.S. degree in Electrical Engineering in 1951. The same year, he joined the Tube Division of RCA in Harrison, N.J. as a design and development engineer working on transistors. He was a production engineer on transistors from 1953 to 1954, and has since been working as an application engineer in the Semiconductor and Materials Division.

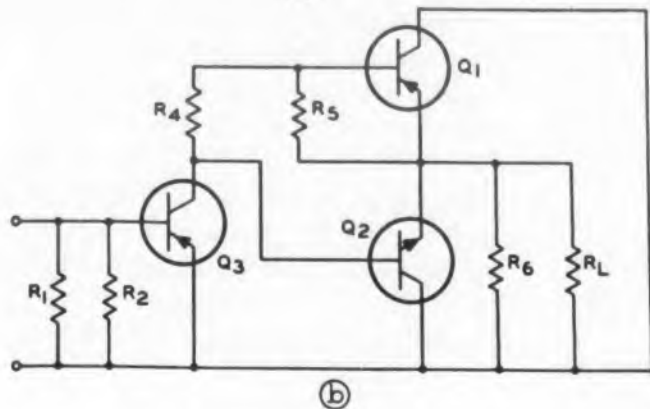
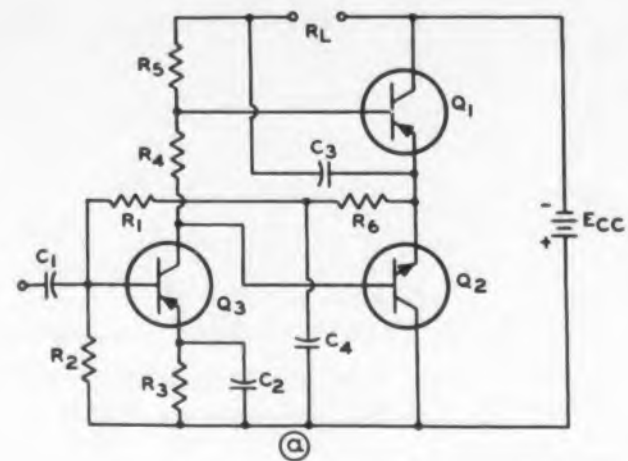


Fig. 1. A practical complementary symmetry 10 w circuit (a) and its ac equivalent (b).

cause they are related by a simple equation. For Fig. 2:

$$P_o = \frac{(V_{cc} - V_1 - V_2)^2}{8 R_L} \quad (1)$$

For Fig. 1:

$$P_o = \frac{(V_{cc} - V_1 - V_3 - V_4 - V_5)^2}{8 R_L} \quad (2)$$

where  $P_o$  is the power-output at the point of clipping;  $V_{cc}$  is the collector supply voltage;  $V_1$ ,  $V_2$ , and  $V_3$  are the collector-to-emitter saturation voltages (often referred to as the "knee") of  $Q_1$ ,  $Q_2$ , and  $Q_3$ , respectively;  $V_4$  is the base-to-emitter saturation voltage of  $Q_2$ ;  $V_5$  is the dc voltage drop across  $R_3$ ; and  $R_L$  is the load impedance.

If rated power output is defined at the 10 per cent distortion level rather than clipping level, equations (1) and (2) should be multiplied by a factor of 1.2. This factor is derived on the basis of other considerations not pertinent to this article.

When germanium-alloy transistors are used,  $V_1$ ,  $V_2$ , and  $V_3$  are essentially independent of collector current and have a value of about 0.3 v. For silicon-alloy transistors, their value is about 0.6 v.

If grown-junction transistors are used, the

TABLE I

Circuit of Fig. 2 Power output = 175 milliwatts	Circuit of Fig. 1 Power output = 10 watts
$R_1 = 4700$ ohms	$R_1 = 680$ ohms
$R_2 = 3900$ ohms	$R_2 = 220$ ohms
$R_3 = 330$ ohms	$R_3 = 24$ ohms
$R_4 = 82$ ohms	$R_4 = 8.2$ ohms
$R_5 = 1200$ ohms	$R_5 = 390$ ohms
$R_6 = 270$ ohms	$R_6 = 2200$ ohms
$R_L = 50$ ohms	$R_L = 16$ ohms
Peak $I_o = 100$ milliamperes	Peak $I_o = 1.1$ amperes
$P_{1Q1} = P_{2Q2} = 60$ milliwatts	$P_{1Q1} = 3$ watts
$\beta_{min} = 45$	$P_{1Q2} = 3.5$ watts
$V_{cc} = 9$ volts	$P_{1Q3} = 0.81$ watt
7.2 volts at 2 milliamperes supplied to earlier stages	$V_{cc} = 38$ volts
	$\beta_{min} = 40$

emitter and collector bulk resistances add from 0.1 to 1 v to  $V_1$ ,  $V_2$ , and  $V_3$ , depending upon the transistors and their peak currents. The value of  $V_4$  varies from about 0.25 to 0.5 volt for germanium-alloy transistors. The effect of emitter bulk resistance adds about 0.05 to 0.5 volt if grown-junction transistors are used.  $V_4$  is about 0.4 volt higher for silicon transistors than for germanium transistors. Specific values of  $V_1$ ,  $V_2$ ,

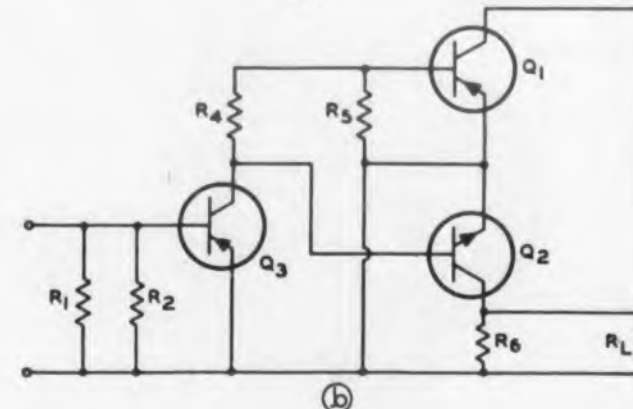
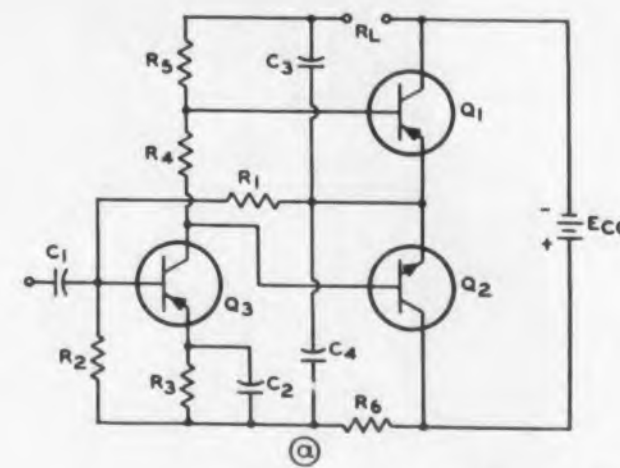


Fig. 2. A practical complementary symmetry 175 mw circuit (a) and its ac equivalent (b).

#### NOMENCLATURE

$P_o$ = output power at the clipping level
$V_1, V_2, V_3$ = collector-to-emitter saturation voltages of $Q_1, Q_2, Q_3$
$V_4$ = base-to-emitter saturation voltage of $Q_2$
$V_5$ = dc voltage drop across $R_3$
$V_{eff}$ = an idealized supply voltage equal to the peak-to-peak output voltage at the clipping level
Peak $I_o$ = peak collector current of $Q_1$ or $Q_2$
$P_{1Q1}$ = maximum dissipation of $Q_1$ in the circuit of Fig. 1
$P_{1Q2}$ = maximum dissipation of $Q_2$ in the circuit of Fig. 1
$P_{2Q1}$ = maximum dissipation of $Q_1$ in the circuit of Fig. 2
$P_{2Q2}$ = maximum dissipation of $Q_2$ in the circuit of Fig. 2
$I_{o1}, I_{o2}$ = quiescent collector current of $Q_1, Q_2$
$I_{oo3}$ = the collector-to-base leakage current of $Q_3$
$\beta_1, \beta_2, \beta_3$ = base-to-collector current amplification factor (beta) of $Q_1, Q_2, Q_3$
Peak $I_b$ = peak base current of $Q_1$ or $Q_2$
$I_{o3}$ = operating collector current of $Q_3$
$r_{bb'1}, r_{bb'2}, r_{bb'3}$ = base-lead resistance of $Q_1, Q_2, Q_3$
$V_{be1}, V_{be2}, V_{be3}$ = base-to-emitter voltage of $Q_1, Q_2, Q_3$ under quiescent conditions
$I_{b3}$ = operating base current of $Q_3$
$R_e$ = emitter bulk resistance (plus any unbypassed emitter resistance)
Peak $V_{b2}$ = peak base voltage required to drive $Q_2$ to peak $I_o$
$I_4$ = dc current supplied to earlier stages
$I_5$ = dc current through $R_2$
$V_6$ = dc voltage supplied to earlier stages
$\tau_1, \tau_2, \tau_{12}$ = low frequency time constant caused by $C_1, C_2, C_3$ and $C_4$

$V_3$ , and  $V_4$  can be obtained from the characteristic curves of the particular transistors selected.

$V_5$  is a self-bias voltage for transistor  $Q_3$ . The larger the value of  $V_5$ , the greater the thermal stability and interchangeability of  $Q_3$  (assumed that  $R_2$  is fixed).  $V_5$  should not usually be less than 0.1 v. A typical value is about 0.5 v. Large values of  $V_5$  (Fig. 2) do not adversely affect performance, and values approaching  $V_{cc}/2$  may be used.

Load impedance,  $R_L$ , (Fig. 3) is shown as a function of effective collector supply voltage,  $V_{eff}$ , for values of maximum undistorted sinusoidal power output ranging from 10 milliwatts to 100 watts (assumed that "linear" transistors are used). Actual supply voltage ( $V_{cc}$ ) for Fig. 2 is given by:

$$V_{cc} = V_{eff} + V_1 + V_2 \quad (3)$$

For Fig. 1:

$$V_{cc} = V_{eff} + V_1 + V_3 + V_4 + V_5 \quad (4)$$

#### Transistor Parameters

Due to avalanche multiplication effects,<sup>6,7</sup> transistors  $Q_1$  and  $Q_2$  may have two collector-to-emitter voltage ratings—one rating under forward-bias conditions, and the other under reverse-bias conditions. For a resistive load under Class B operation, the forward-bias rating must equal or exceed  $V_{eff}/2$  while the reverse-bias



# Important Features of

AMPHENOL

# MINNIE

CONNECTORS



actual size



1

The "E" construction of AMPHENOL's miniature, multi-contact electrical connectors *pass a tough, new altitude-moisture resistance test* which accurately simulates performance conditions in new aircraft and missiles. Connectors are submerged in salt water and altitude-cycled to 80,000 ft., to 65,000 ft. and then returned to room ambient pressure. Cycle lasts one hour; test is comprised of ten cycles. At the end of the test AMPHENOL MINNIE's have a minimum insulation resistance of 1000 megohms, approximately ten times greater than that acceptable under MIL-C-5015C after moisture.

2

MINNIE's have *stainless steel* bayonet slots and pins, providing greater durability and eliminating the wear encountered with "hardcoat" and similar surface treatments of softer base metals.

3

Both #16 and #20 size socket contacts in MINNIE connectors *resist test prod damage*. The entering end of the socket has a one-piece stainless steel hood that excludes the entrance of a pin .005" larger than the diameter of the mating male contact.

AMPHENOL's Authorized Industrial Distributors stock MINNIE and other standard components, provide immediate service.

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rating must equal or exceed  $V_{eff}$ . For most applications however, reactive loading is occasionally present (near speaker resonance, turn-on transients, and turn-off transients). With a reactive load the voltage and current are out of phase, causing the transistor to be forward-biased at voltages well in excess of  $V_{eff}/2$ . Where high excitation under reactive loading may be encountered, the forward-bias voltage rating must approach  $V_{eff}$  to prevent transistor destruction under transients.

The peak collector current ( $I_c$ ) rating for  $Q_1$  and  $Q_2$  must be equal to or greater than:

$$\text{Peak } I_c = \frac{V_{eff}}{2} \left( \frac{1}{R_L} + \frac{1}{R_6} \right) \quad (5)$$

It should be noted that  $R_6$  is not the same for the circuits shown in Figs. 1 and 2. Normally, the value of  $R_6$  in the circuit of Fig. 1 will not appreciably affect the peak collector current. In the circuit of Fig. 2, however,  $R_6$  may contribute 15 to 20 per cent of the value of peak  $I_c$ . The actual value of  $R_6$  will be determined later. For the purpose of defining  $Q_1$  and  $Q_2$  peak current ratings,

the following equations are sufficiently accurate. For Fig. 1:

$$\text{Peak } I_c \cong \frac{V_{eff}}{2R_L} \quad (6)$$

For Fig. 2:

$$\text{Peak } I_c \cong \frac{1.15 V_{eff}}{2R_L} \quad (7)$$

Maximum power dissipation of  $Q_1$  and  $Q_2$  under sine-wave excitation is, in many cases, almost the same as the average power dissipation when speech or music is programmed. Consequently,  $Q_1$  and  $Q_2$  must be able to withstand the full dissipation given by the following equations on a continuous basis. (A complete analysis of transistor dissipation under Class B operation will appear in a forthcoming issue of ELECTRIC DESIGN.)

In the circuit shown in Fig. 1, the maximum dissipation of  $Q_1$  is given by:

$$P_{1 Q_1} \cong \frac{(V_{eff} + 2 V_1)^2}{40} \left( \frac{1}{R_L} + \frac{1}{R_6} \right) + \frac{(V_{eff} + 2 V_1)}{2} (I_{o1}) \quad (8)$$

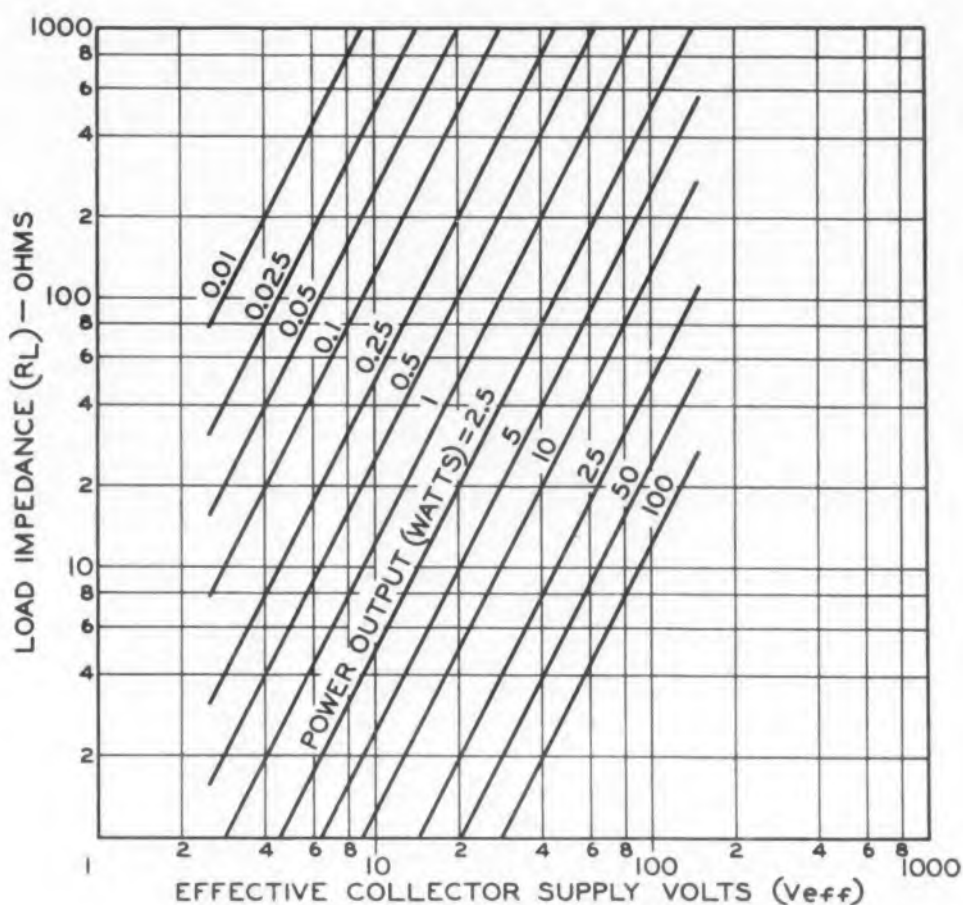


Fig. 3. Load impedance versus effective collector supply voltage for various output power levels.

and the maximum dissipation of  $Q_2$  by:

$$P_{1 Q_1} \cong \frac{(V_{eff} + 2V_3 + 2V_4 + 2V_5)^2}{40} \left( \frac{1}{R_L} + \frac{1}{R_6} \right) + \frac{(V_{eff} + 2V_3 + 2V_4 + 2V_5)}{2} (I_{o2}) \quad (9)$$

In Fig. 2, the maximum dissipation of  $Q_1$  is given by:

$$P_{2 Q_2} \cong \frac{(V_{eff} + 2V_1)^2}{40} \left( \frac{1}{R_L} + \frac{1}{R_6} \right) + \frac{(V_{eff} + 2V_1)}{2} (I_{o1}) \quad (10)$$

and the maximum dissipation of  $Q_2$  by:

$$P_{2 Q_2} \cong \frac{(V_{eff} + 2V_2)^2}{40} \left( \frac{1}{R_L} + \frac{1}{R_6} \right) + \frac{(V_{eff} + 2V_2)}{2} (I_{o2}) \quad (11)$$

Here,  $I_{o1}$  and  $I_{o2}$  are the quiescent collector currents (idling currents) of  $Q_1$  and  $Q_2$  respectively. These currents will vary appreciably with temperature unless special provisions are made, as will be discussed later.

Because  $R_6$  is normally much greater in the circuit of Fig. 1 than in the circuit of Fig. 2, the dissipation of  $Q_1$  is normally less in the circuit of Fig. 1, all other conditions being equal. A direct comparison cannot be made between the circuits for  $Q_2$  dissipation because of the effects of  $V_2$ ,  $V_3$ ,  $V_4$ , and  $V_5$ .

The mid-frequency equivalent circuits in Figs. 1 and 2 show that  $Q_1$  is driven from a source having an impedance equal to  $R_5$  and  $Q_2$  from a source having an impedance equal to  $(R_4 + R_5)$  (both transistors are operated in the common-emitter configuration). This statement assumes that the output impedance of  $Q_3$  is practically infinite, which is a reasonable assumption. Normally,  $R_4$  is quite small compared to  $R_5$ ; therefore, the source impedance may be considered to equal  $R_5$  for both  $Q_1$  and  $Q_2$ . Because  $R_5$  shunts some of the signal current from the bases of  $Q_1$  and  $Q_2$ , it is desirable to make  $R_5$  large relative to the input impedance.  $Q_1$  and  $Q_2$  may then be considered to be driven from a current source. Consequently, it is desirable to match the base-to-collector current amplification factors, or "betas," of  $Q_1$  and  $Q_2$ . The distortion introduced by beta-mismatch is even-order distortion which, except for intermodulation effects, can be accepted in rather large amounts. The per cent

second-harmonic distortion (% 2nd) is given by<sup>8</sup>:

$$\% \text{ 2nd} = 42 \frac{\beta_1 - \beta_2}{\beta_1 + \beta_2} \quad (12)$$

where  $\beta_1$  is the beta of  $Q_1$  and  $\beta_2$  is the beta of  $Q_2$ .

The driver transistor,  $Q_3$ , must supply signal current to the bases of  $Q_1$  and  $Q_2$  and also to  $R_5$ . The peak base current ( $I_b$ ) of the output stage,  $Q_1$ , is given by

$$\text{Peak } I_b = \text{Peak } \frac{I_c}{\beta_1} \quad (13)$$

In order to determine the maximum drive needed, it is necessary to determine peak  $I_b$  for the minimum value of  $\beta_1$  anticipated. The value of  $\beta_1$  should be evaluated for a dc collector current at, or near the peak  $I_c$  given previously.

Because the driver distortion is a function of the ratio of the ac current to the dc current (among other things), it is desirable that the driver dc current be large compared to peak  $I_b$ . However, the value of  $R_5$  will vary inversely with the driver dc current, and it is desirable to keep  $R_5$  as large as possible to maintain maximum over-all gain. For a satisfactory balance between distortion and sensitivity, the driver current ( $I_{c3}$ ) should be equal to:

$$I_{c3} = 1.5 \text{ Peak } I_b \quad (14)$$

#### Determination Of Resistances

When the value of  $I_{c3}$  is known (or assumed), the value of resistor  $R_5$  may be determined as follows:

$$R_5 = \frac{1}{I_{c3}} \left[ \frac{V_{eff}}{2} + V_1 - V_{be1} - I_4 R_6 \right] - R_6 \quad (15)$$

where  $V_{be1}$  is the base-to-emitter bias voltage required to establish the quiescent collector current  $I_{o1}$  in transistor  $Q_1$ , and  $I_4$  is the dc current necessary for earlier stages (Fig. 2). When alloy-junction transistors are used,  $V_1$  is about equal to  $V_{be1}$ . In addition, the product  $I_4 R_6$  is usually small, and  $R_5$  is normally much larger than  $R_6$ . On the basis of these approximations, therefore, equation (15) can be simplified as follows:

$$R_5 \cong \frac{V_{eff}}{2 I_{c3}} \quad (16)$$

The value of  $R_4$  is given by

$$R_4 = \frac{(V_{be1} + V_{be2})}{I_{c3}} \quad (17)$$

where  $V_{be2}$  is the emitter-to-base bias voltage required to establish the quiescent collector cur-

rent  $I_{o2}$  in transistor  $Q_2$ . The values of  $V_{be1}$  and  $V_{be2}$  need not be identical to obtain the quiescent collector current required to reduce cross-over distortion (i.e., the transfer characteristics of  $Q_1$  and  $Q_2$  at low collector currents need not be matched). This method of biasing permits greater variation of  $V_{be}$  for individual transistors than conventional Class B operation.

Because  $V_{be}$  must be reduced by approximately two millivolts per C temperature rise to maintain a constant  $I_c$ , the resistance  $R_4$  should be temperature sensitive. Best performance is obtained when  $R_4$  consists of two properly designed semiconductor diodes operated in the forward mode. Satisfactory results may also be achieved by the use of a thermistor-resistor network, and, in some cases, with merely a fixed resistor.

Cross-over distortion at high frequencies is not caused by quiescent current level, but may be traced to two contributing factors<sup>8</sup> (if it is assumed that transformers are not used). If the distortion is essentially independent of amplitude, a beta-frequency-response mismatch is responsible. If the distortion is a perturbation in the cross-over region, the minority carrier storage is responsible.

The value of resistors  $R_1$ ,  $R_2$ ,  $R_3$ , and  $R_6$  must be determined separately for the circuits shown in Figs. 1 and 2. For the circuit of Fig. 1:

$$R_3 \cong \frac{V_b}{I_{c3}} \quad (18)$$

where it is assumed that  $I_{c3} \cong I_{c3}$ .

For good thermal stability,  $R_2$  should not be much greater than ten times  $R_3$  (and should be smaller, if practical). If  $R_2$  becomes too small, however, it shunts the input impedance of  $Q_3$ . The input impedance of a transistor ( $R_{in}$ ) is given by

$$R_{in} = r_{bb'} + \frac{\beta}{I_c} \left( \frac{KT}{q} \right) + \beta R_e \quad (19)$$

where  $r_{bb'}$  is the equivalent base-lead resistance,  $K$  is Boltzmann's constant,  $T$  is the temperature in degrees Kelvin,  $q$  is the charge of an electron, and  $R_e$  is the emitter bulk resistance (plus unby-passed emitter resistance, if present).

Intrinsic collector-to-base conductance is neglected in this expression. The value of  $KT/q$  is 25.9 millivolts at 300 K. The value of  $R_2$  must be selected to provide a good balance of sensitivity and thermal stability. If good thermal stability is not obtained, the dc potential at the emitters of  $Q_1$  and  $Q_2$  will change rapidly with temperature, thereby causing unsymmetrical clipping and a considerable reduction in the output power. If difficulty is encountered in determin-

ing a suitable value for  $R_2$ , it may be advantageous to choose a larger value of  $V_5$ .

Resistors  $R_1$  and  $R_6$  establish bias on  $Q_3$  and provide dc feedback to maintain the emitter potential of  $Q_1$  and  $Q_2$  at the desired level.

The current flowing through  $(R_1 + R_6)$  is the sum of the base current of  $Q_3$  and the current through  $R_2$ . The base current of  $Q_3$  is given by:

$$I_{b_3} \cong \frac{I_{c_3}}{\beta_3} - I_{c_{o_3}} \quad (20)$$

where  $I_{c_{o_3}}$  is the collector leakage current of  $Q_3$ . The current through  $R_2$  is given by:

$$I_{R_2} = \frac{V_5 + V_{be_3}}{R_2} \quad (21)$$

where  $V_{be_3}$  is the base-to-emitter voltage of  $Q_3$  when  $I_{c_3}$  flows. The voltage across  $(R_1 + R_6)$  is

$\left[ \frac{V_{eff}}{2} + V_3 + V_4 - V_{be_3} \right]$ . The total resistance  $(R_1 + R_6)$ , therefore, is given by:

$$(R_1 + R_6) = \frac{(0.5 V_{eff} + V_3 + V_4 - V_{be_3})}{I_{b_3} + I_{R_2}} \quad (22)$$

Ideally,  $R_1$  should be large compared to the input impedance of  $Q_3$ , and  $R_6$  should be large compared to  $R_L$ , both consistent with equation (22). As  $R_6$  is increased in value,  $C_4$  is reduced in value because the pertinent decoupling time constant is essentially proportional to  $R_6 C_4$ .

The dissipation of transistor  $Q_3$  in the circuit of Fig. 1 is given by:

$$P_{1Q_3} = I_{c_3} (0.5 V_{eff} + V_3 + V_4 - V_{be_2}) \quad (23)$$

In the circuit shown in Fig. 2, it is desirable to choose  $R_6$  first. The larger the value of  $R_6$ , the less shunting effect it has upon  $R_L$ , and the smaller  $C_4$  may be. As  $R_6$  is made larger, however, the voltage available for  $Q_3$  and earlier stages is reduced. A value of  $R_6$  between five and ten times  $R_L$  is usually satisfactory, although the actual value is determined by the specific application. It may, for example, be desirable to let  $R_6$  equal  $R_L$  in the form of another speaker.

The voltage available to earlier stages drawing a total current of  $I_4$  (as previously defined) is given by:

$$V_6 = V_{eff} + V_1 + V_2 - (I_{c_3} + I_4) (R_L + R_6) - I_5 R_6 \quad (24)$$

where  $I_5$  is the current through  $R_2$  (normally,  $I_5 < 0.2 I_{c_3}$ ). This voltage,  $V_6$ , must be considered, therefore, in determining  $R_6$ . As shown below,  $V_5$  must also be considered.

The collector-to-emitter voltage supplied to  $Q_3$



Fig. 4. Phase shift is responsible for diagonal clipping.

must be sufficient to avoid driver limiting. For most applications, this voltage is equal to:

$$\text{Peak } V_{b_2} \cong \text{Peak } I_{c_1} \left( R_{e_2} + \frac{\tau_{bb_2}}{\beta_2} \right) \quad (25)$$

Variations from one transistor to another should be considered when determining peak  $V_{b_2}$ . Fortunately, when  $\beta_2$  is small,  $\tau_{bb_2}$  is usually small also. Therefore, the variation in peak  $V_{b_2}$  should be relatively small.

In order to drive  $Q_2$  to the clipping point:

$$V_5 \leq 0.5 V_{eff} + V_2 - V_3 - \text{peak } V_{b_2} - V_{be_2} - (I_{c_3} + I_4 + I_5) R_6 \quad (26)$$

The larger the value of  $V_5$ , the lower the dissipation of  $Q_3$ . The dissipation of  $Q_3$  is given by:

$$P_{2Q_3} = I_{c_3} [0.5 V_{eff} + V_2 - V_{be_2} - V_5 - (I_{c_3} + I_4 + I_5) R_6] \quad (27)$$

Thermal stability and transistor interchangeability may also be improved more readily when a relatively large value of  $V_5$  is used. The value of  $R_3$  is given by:

$$R_3 \cong \frac{V_5}{I_{c_3}} \quad (28)$$

where it is assumed that  $I_{c_3} \cong I_{c_3}$ .

The parallel combination of  $R_1$  and  $R_2$  (relative to  $R_3$ ) determines the thermal stability and interchangeability. For good thermal stability, the parallel combination of  $R_1$  and  $R_2$  should not be much greater than ten times  $R_3$  (and should be smaller, if practical). However, because the input impedance of  $Q_3$  is shunted by  $R_1$  in parallel with  $R_2$ ,  $R_1$  and  $R_2$  should be chosen large compared to the input impedance equation (19).

If the parallel combination of  $R_1$  and  $R_2$  is defined as  $R_x$ , the value of  $R_2$  is given by:

$$R_2 = \frac{R_x}{1 - \frac{(V_5 + V_{be_3} + I_{b_3} R_x)}{[0.5 V_{eff} + V_2 - (I_{c_3} + I_4 + I_5) R_6]}} \quad (29)$$

and the value of  $R_1$  is given by:

$$R_1 = \frac{R_2 R_x}{R_2 - R_x} \quad (30)$$

An assumption was previously made regarding the approximate value of  $I_5$ , the dc current through  $R_2$ . The value of  $I_5$  may now be determined as follows:

$$I_5 = \frac{V_5 + V_{be_3}}{R_2} \quad (31)$$

If the value of  $I_5$  determined from equation (31) causes an appreciable change in the assumed total of  $(I_{c_3} + I_4 + I_5)$ , a re-evaluation will be in order.

#### Capacitance Values

Although it may be desirable to choose  $C_1$ ,  $C_2$ ,  $C_3$ , and  $C_4$  empirically, some effects of the capacitors must be considered. In addition, an empirical derivation of the capacitors should allow for the rather wide tolerances normally encountered with electrolytic capacitors.

If all capacitors except  $C_1$  are assumed to equal infinity, and if  $R_1$  and  $R_2$  are assumed large as compared to  $R_{in}$ , the low-frequency time constant is given by:

$$\tau_1 \cong C_1 (R_g + R_{in}) \quad (32)$$

where  $R_g$  is the resistance of the generator driving the amplifier, and  $R_{in}$  is given by equation (19). Although a large value of  $R_g$  permits a small value of  $C_1$  for a given low-frequency response, the terminal voltage at the generator is subject to the low-frequency time constant,  $R_{in} C_1$ . Consequently, an appreciably greater dynamic range may be required for the generator in order to employ the capacitor predicted by equation (32).

If all capacitors except  $C_2$  are assumed to equal infinity, and if  $R_1$  and  $R_2$  are assumed large compared to  $R_{in}$ , the low-frequency time constant is given by:

$$\tau_2 \cong \frac{C_2}{\left[ \frac{1}{R_3} + \frac{\beta_3}{R_g + R_{in}} \right]} \quad (33)$$

Normally:

$$R_3 \gg \frac{R_g + R_{in}}{\beta_3} \quad (34)$$

Therefore, equation (33) may be rewritten: . . .

$$\tau_2 \cong \frac{C_2}{\beta_3} (R_g + R_{in}) \quad (35)$$

As in the case of  $C_1$ , a large value of  $R_g$  may permit a small value of  $C_2$ , but create a problem of low-frequency dynamic range. The voltage on

$Q_3$  must be sufficient to accommodate  $C_2$ .

In most applications,  $R_1$  and  $R_2$  are large compared to  $R_{in}$ , and inequality (34) is realized. In such cases, the low-frequency time constant can be expressed simply:

$$\tau_{12} \cong \frac{C_1 C_2 (R_o + R_{in})}{(\beta_3 C_1 + C_2)} \quad (36)$$

If  $C_1 = C_2/\beta_3 = C$

equation (36) can be simplified:

$$\tau_{12} \cong \frac{C (R_o + R_{in})}{2} \quad (37)$$

When the reactance of  $C_3$  becomes significant compared to  $R_L$ , the load on the output stage becomes complex. Because an elliptical load line is then produced, diagonal clipping of the output results at high power levels. This type of distortion is shown in Fig. 4. The dynamic range of  $Q_3$  is also reduced. The  $C_3 R_L$  time constant should be large compared to the lowest frequency at which full power output is desired.

$C_4$  affects the frequency response and the dynamic range of the amplifier in a complex manner. Although  $C_4$  may be calculated, an empirical solution is recommended.  $C_4$  will normally be larger for the circuit of Fig. 2 than for the circuit of Fig. 1.

#### Typical Values

Typical component values (Table I) are given for two circuits designed by this method. The 175-milliwatt circuit employs the circuit of Fig. 2, while the 10-watt circuit employs the circuit of Fig. 1. These examples do not show any preference of circuit as a function of power level, but merely present two of the infinite possibilities. Capacitor values are not given because they depend upon the particular application.

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# Minimize Local Oscillator Drift\*

## Part 2

W. Y. Pan and D. J. Carlson  
R.C.A. Victor Television Division  
Cherry Hill, N.J.

Part 1 of this article introduced an analysis of local oscillator drift.

In this, the concluding part, the analysis is applied to practice in a "step-by-step" stabilization of a typical uhf and vhf local oscillator.

HERE is a procedure to stabilize a local oscillator commonly used in commercial vhf television receivers. The same approach should hold for local oscillators in receivers operating up to and including the uhf band.

### The Original Oscillator

**Circuitry.** The original, uncompensated vhf television oscillator circuit is shown in Fig. 1. Its frequency varies from 101 mc at channel 2 to 257 mc at channel 13. The inductances  $L_2$  and  $L_3$ , at channel 13, are short-circuited. Under these conditions the inductance  $L_1$  and the circuit capacitances constitute the frequency-determining elements. At channel 7 however, only  $L_3$  is short-circuited. Consequently,  $L_2$  tunes from channels 7 to 13 inclusive, whereas  $L_3$  tunes from channels 2 to 6 inclusive. All capacitances external to the oscillator tube are not temperature-sensitive.

**Frequency Characteristics.** When installed in a commercial vhf color tv receiver, the frequency characteristics of the original local oscillator at channel 6 are illustrated by the  $\Delta f$  (overall) curve in Fig. 2 which exhibits two distinct changes in slope. Accordingly, there are at least two major components of frequency deviations.

1. The fast-acting component is

$$\Delta f_1 = \alpha_1 (1 - e^{-\beta_1 t})$$

where  $\alpha$  = maximum oscillator frequency deviation, and  $\beta$  = the rate of change of oscillator frequency. The fast-acting component is caused by the changes of tube capacitances during the early minutes of operation. To evaluate this component, all associated circuit elements of the original oscillator are replaced by a single inductance  $L_0$  made of Milvar wire, having an extremely low coefficient of thermal expansion.  $L_0$  and the tube capacitances then constitute the frequency determining elements. The corresponding frequency deviations are

$$\Delta f_1 = -0.00475 f (1 - e^{-0.55 t}) \quad (1)$$

It is evident that the frequency deviation,  $\Delta f_1$  is directly proportional to the oscillator frequency. At channel 6, the oscillator frequency is 126 mc; so  $\alpha_1 = -0.610$  mc and  $\beta_1 = 0.55$  which is independent of the oscillator frequency.

2. The slow-acting component is

$$\Delta f_2 = \alpha_2 (1 - e^{-\beta_2 t})$$

The difference between the instantaneous overall frequency deviation  $\Delta f$  and the fast-acting component  $\Delta f_1$  gives the slow-acting component  $\Delta f_2$ . At channel 6,

$$\Delta f_2 = -0.500 (1 - e^{-0.04 t}) \quad (2)$$

**Requirements for Frequency Stabilization.** To obtain good frequency stabilization of the original local oscillator, the following requirements must be met.

■ At least two compensating elements, A and B, are needed — A to compensate for the fast-acting component  $\Delta f_1$ , and B to compensate for the

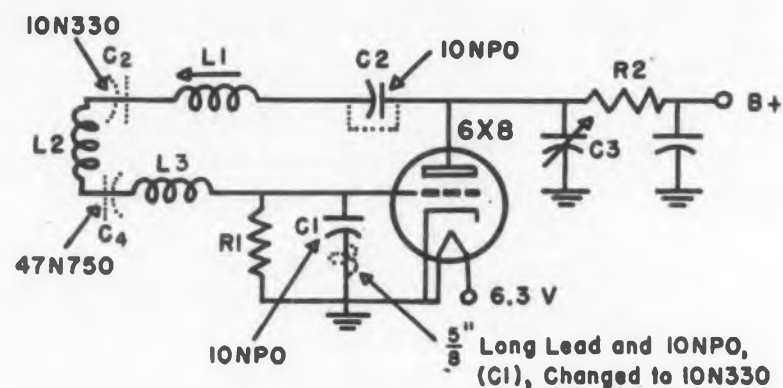


Fig. 1. Local oscillator circuit of vhf tv receivers. The dotted components are for stabilization.

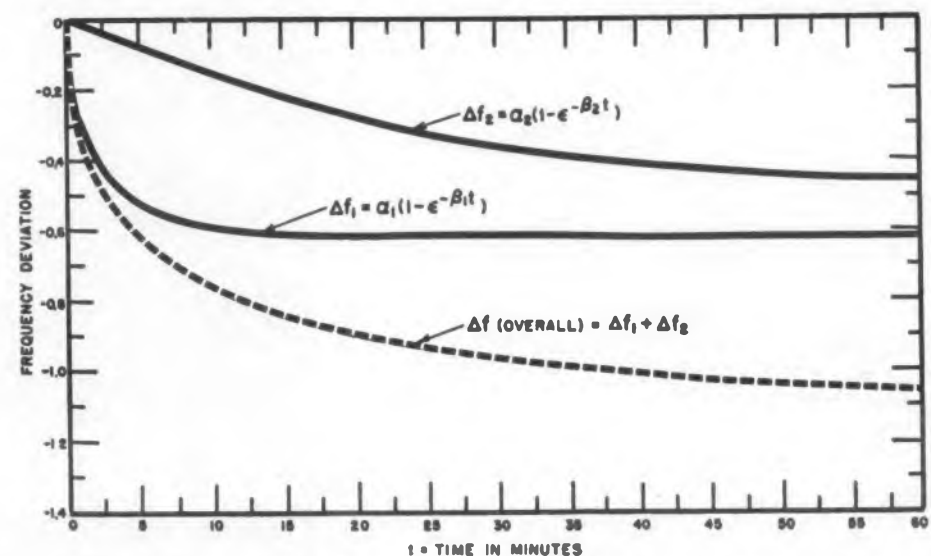


Fig. 2. The original frequency characteristics of the vhf local oscillator, with the fast-acting ( $\Delta f_1$ ) and slow-acting ( $\Delta f_2$ ) deviation components.

\* By courtesy of Product Engineering, Radio Corporation of America.

slow-acting component  $\Delta f_2$ . The expressions for  $A$  and  $B$  are, respectively

$$\Delta f'_1 = \alpha'_1 (1 - e^{-\beta'_1 t}) \text{ and}$$

$$\Delta f'_2 = \alpha'_2 (1 - e^{-\beta'_2 t})$$

■ These two compensating elements must be so situated in the oscillator circuit that  $\beta'_1$  of  $A$  approaches the value of  $\beta_1$  of  $\Delta f_1$ , and  $\beta'_2$  of  $B$  approaches the value of  $\beta_2$  of  $\Delta f_2$ .

■ The compensating elements must exhibit negative temperature sensitivities, in this case, to raise the oscillator frequency with temperature rise.

■ The magnitudes of  $\alpha'_1$  of  $A$  and  $\alpha'_2$  of  $B$  must approach those of  $\alpha_1$  of  $\Delta f_1$  and  $\alpha_2$  of  $\Delta f_2$ .

**Stabilization Procedures.** The stabilized oscillator circuit is again shown in Fig. 1, with the modifications indicated by the dotted components.

1. The capacitance  $C_1$  (replaced with 10N330 and a lead of 5/8 in.) compensates for  $\Delta f_1$ , the fast-acting component of the oscillator-frequency deviation. For perfect compensation

$$\Delta f'_1 = \Delta f_1$$

$$\text{or } \Delta f'_1 = -\alpha_1 (1 - e^{-\beta_1 t}) \quad (3)$$

To make  $\beta'_1 = \beta_1$ , the capacitance  $C_1$  must be as close as possible to the source of the heat flow. It is therefore placed at the grid pin of the oscillator tube. The resultant  $\beta'_1$  value is 0.29 as compared to  $\beta_1$  of 0.55 for the fast-acting component. The discrepancy between  $\beta'_1$  and  $\beta_1$  unavoidably introduces a compensation error,  $\xi$  where

$$\xi = \Delta f_1 + \Delta f'_1 \quad (4)$$

(Continued on following page)

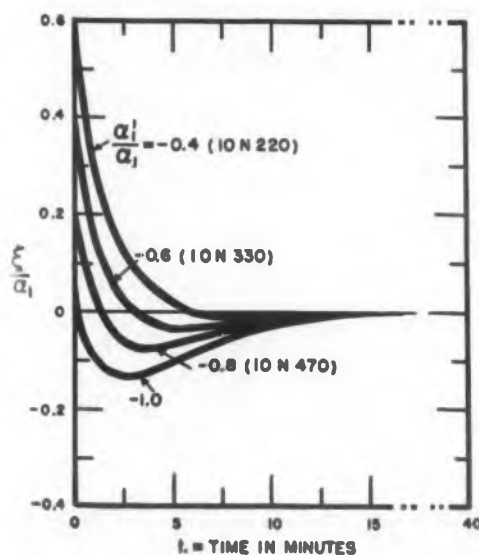


Fig. 3. The compensation error with

$$\epsilon = \alpha_1 (1 - e^{-\beta_1 t}) + \alpha_1 (1 - e^{-\beta_1 t})$$

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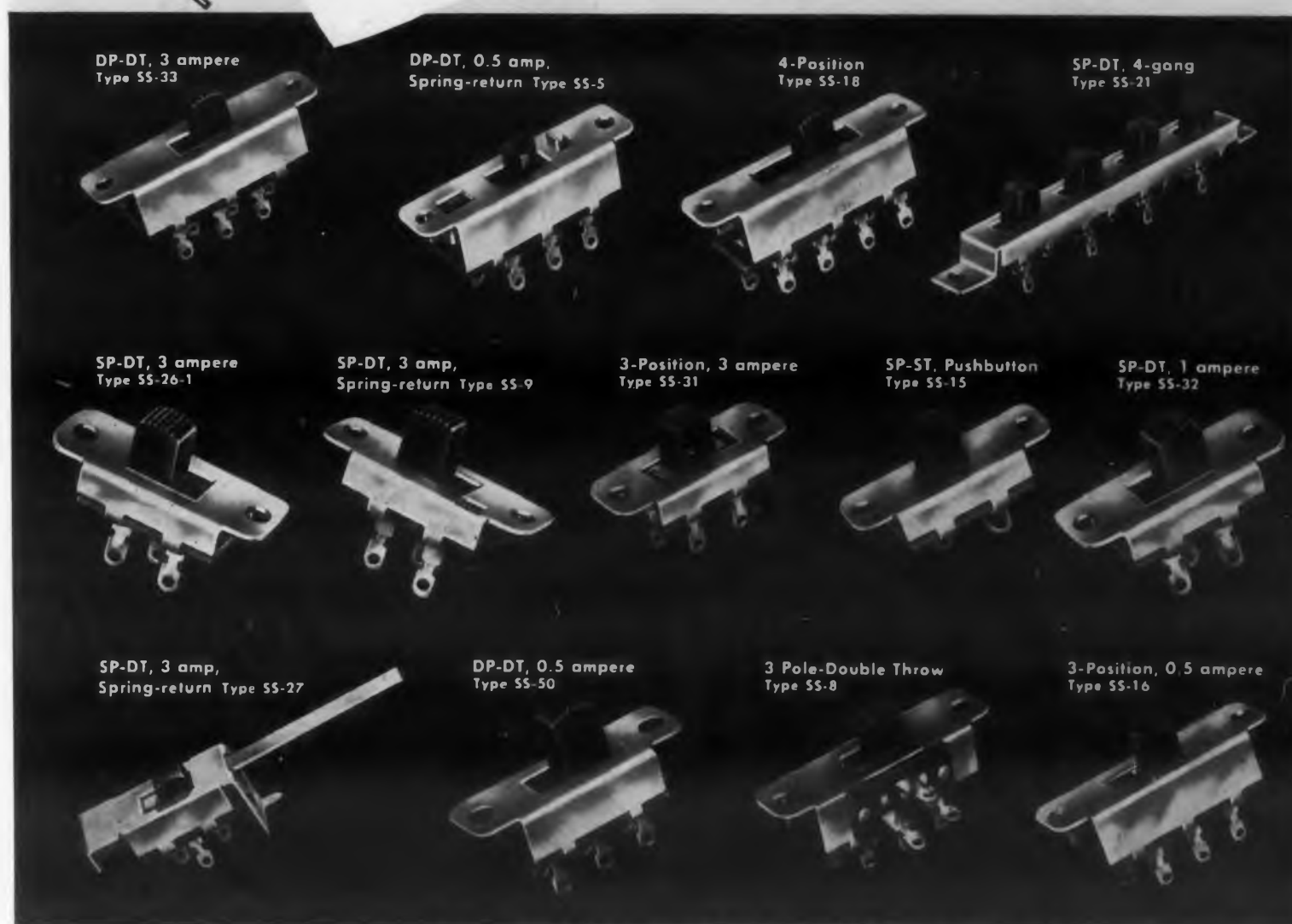
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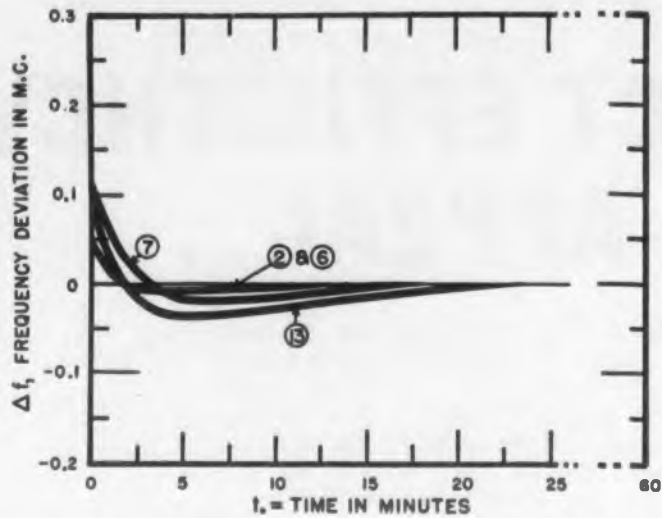


Fig. 4. Frequency characteristics of a stabilized vhf tv local oscillator.

The compensation error expressed in eq. (4) is evaluated in Fig. 3 with values for  $\alpha'_1$  to be  $-0.4$ ,  $-0.6$ ,  $-0.8$  and  $-1.0$  of the  $\alpha_1$  value. The error is minimum when  $\alpha'_1 = -0.6 \alpha_1$ . At channel 6,  $\alpha_1 = -0.610$  mc according to eq. (1). The corresponding compensating error, after two minutes of operation is  $-0.04 \alpha_1$  or  $-0.025$  mc, and  $\alpha'_1 = -0.6 \alpha_1$  or  $0.360$  mc. A compensating capacitance of 10N330 produces these results approximately.

The added inductance, consisting of a  $5/8$  in. lead of  $C_1$  makes  $\alpha'_1$  proportional to the oscillator frequency, as  $\alpha_1$  does, at all channels. 2. The capacitance  $C_2$  (replaced with 10N330) compensates for the slow-acting component for channels 7 to 13. At these upper vhf channels, the inductance  $L_3$  and capacitance  $C_4$  are short-circuited. Again for perfect compensation,

$$\Delta f'_2 = \Delta f_2$$

$$\text{or } \Delta f'_2 = -\alpha_2 (1 - \epsilon^{-\beta_2 t}) \quad (5)$$

$C_2$  is situated among the associated circuit elements of the local oscillator where the rate of temperature rise is relatively low. Hence the value of  $\beta'_2$  is approximately equal to  $\beta_2$ . The capacitance and temperature sensitivity of  $C_2$  are determined in a manner analogous to that for  $C_1$  and the corresponding  $\alpha'_2 = \alpha_2$  at all upper vhf television channels.

3. The added capacitance  $C_4$  (47N750), together with  $C_2$  are effective in frequency stabilization at the lower vhf channels. Owing to the difference in  $L/C$  ratios at the lower oscillator frequencies,  $C_2$  is not sufficient to compensate for the frequency deviation. The addition of  $C_4$  makes  $\alpha'_2$  (at lower channels)  $= \alpha_2$ . The  $\beta'_2$  value of  $C_4$  is about equal to the  $\beta'_2$  value of  $C_2$  because the locations of these two elements are equally distant from the heat source.

**Residual Frequency Deviations.** A typical production vhf television receiver incorporating

these compensating elements behaves as shown in Fig. 4 at channels 2, 6, 7, and 13. The maximum residual frequency deviation is less than  $\pm 50$  kc after a period of two minutes, and all channels become almost completely stabilized within 30 minutes. This residual frequency deviation during the early minutes of operation is principally caused by the discrepancy between the  $\beta'_1$  value of the compensating element and the  $\beta_1$  value of the fast-acting component.

To further minimize local oscillator drift, oscillator tubes other than the miniature type must be used or the compensating element  $C_1$  must be built inside the oscillator tube to produce a  $\beta'_1$  value about the same as  $\beta_1$ . Due to constructional differences, the  $\beta_1$  of the RCA pencil triode tube, for instance, is 0.32 which is so close to the  $\beta'_1$  value of 0.29 that any local oscillator using a pencil triode tube can be compensated more exactly than shown by Fig. 4.

#### Considerations For UHF Local Oscillators

The same approach used to stabilize a vhf television local oscillator applies equally well to uhf local oscillators. Appropriate compensating elements can again be secured by analyzing the original frequency characteristics of the oscillator with the aid of the analytical representation expressed in

$$Q = \alpha (1 - \epsilon^{-\beta t})$$

where  $Q$  is the instantaneous cathode-to-grid radiation;  $\alpha$  is the total radiated power; and  $\beta$  is a

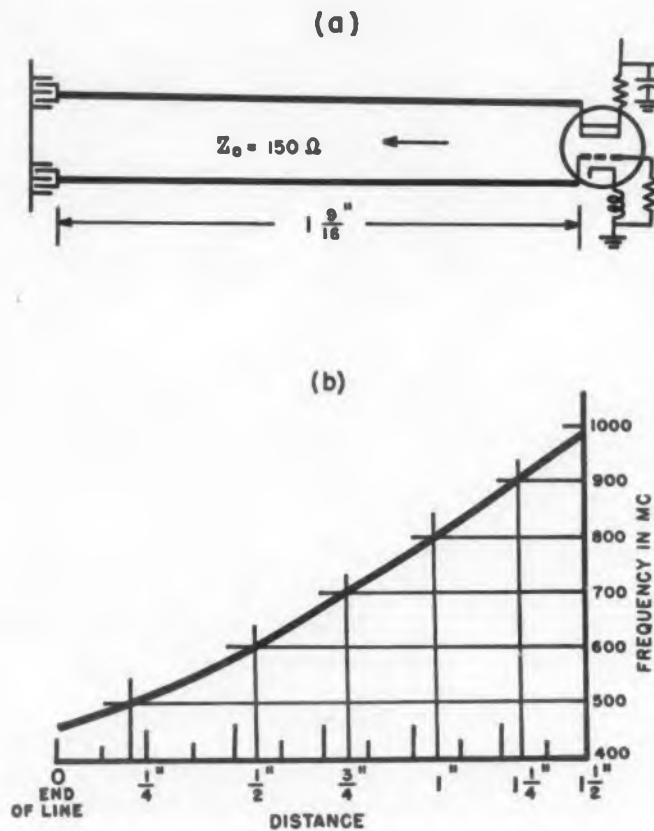


Fig. 5. A typical uhf tv local oscillator (a), with the associated null points along the transmission line (b).

time constant, determining the rate of heat flow from cathode to grid.

**Dimensional Resonances.** The stabilization procedures at uhf, however, are further complicated by the fact that some of the associated circuit elements of the local oscillator may have electrical lengths comparable to a quarter wavelength of the local oscillator frequency. To illustrate this complication, a typical uhf commercial tv local oscillator is shown in Fig. 5a. It covers a continuous frequency range from 517 mc at channel 14 to 931 mc at channel 83 by means of a variable ganged capacitor. This is coupled to the 6AF4A oscillator tube by a transmission line having a characteristic impedance of approximately 150 ohms.

At the socket pins of the 6AF4A, the oscillator voltage between the grid and plate falls to a minimum value at approximately 1000 mc. Any temperature sensitive element placed across these two points would affect the oscillator frequencies either above or below that frequency. At 1000 mc the effect is theoretically zero. Since the oscillator line is  $1-9/16$  in. long, the voltage minimum or null point at the other end of the line corresponds to 500 mc.

If the distance at the junction between the oscillator line and the stator assembly of the ganged capacitor is assumed to be zero, then the null points along the line are illustrated in Fig. 5b. For instance, the 725 mc null point occurs at  $7/8$  in.

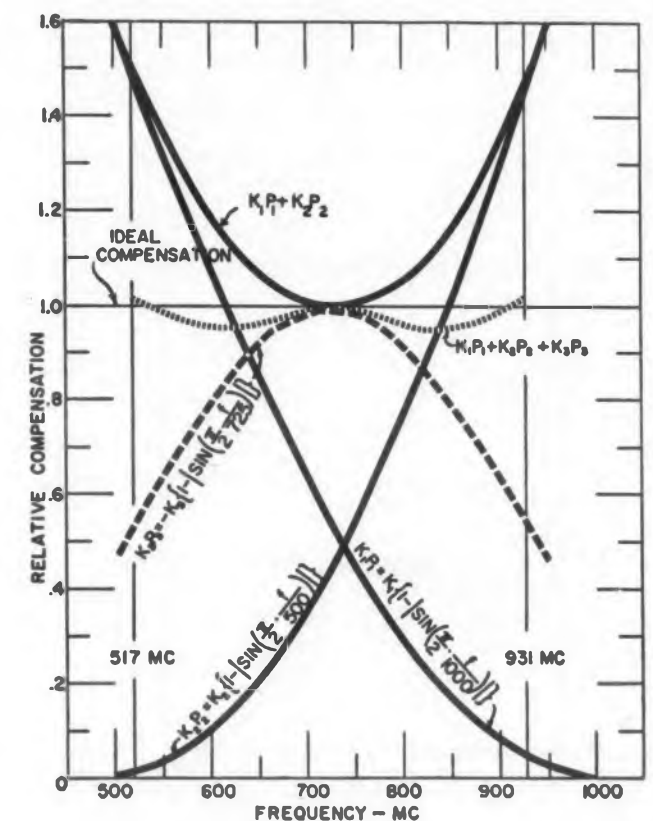


Fig. 6. Three point compensation curves for the uhf local oscillator.



**Relative Effectiveness of Compensating Elements.** By placing an appropriate temperature-sensitive capacitor at any point  $x$  along the oscillator line, the relative effectiveness of frequency compensation ( $P_x$ ) at an oscillator frequency ( $f$ ) is determined by

$$P_x = 1 - |\sin \theta|$$

where  $\theta = 1/2 \pi f/f_x$

and  $f_x =$  null frequency corresponding to point  $x$ .

**Three-Point Compensation.** One compensating element, when properly placed in the uhf oscillator circuit, is sufficient only in receivers designed for a single-frequency or very narrow frequency range operation. To cover an extended band of frequencies, three compensating elements are required for good stabilization. Let compensating capacitances  $C_1$ ,  $C_2$ , and  $C_3$  be connected at points along the oscillator line corresponding to null frequencies of 1000, 500, and 725 mc respectively. The relative compensations of  $C_1$  ( $f_{x1} = 1000$  mc) and  $C_2$  ( $f_{x2} = 500$  mc) on the oscillator frequency are given by the  $K_1P_1$  and  $K_2P_2$  curves respectively in Fig. 6. The  $K_1P_1 + K_2P_2$  curve shows the combined effect of  $C_1$  and  $C_2$ .

It must be stressed that the temperature sensitivities and capacitances of these compensating elements depend on the  $\alpha$  values needed at these frequencies. The constants  $K_1$ ,  $K_2$ , and  $K_3$  take into account the differences in temperature sensitivities and capacitances of these three compensating elements. Furthermore, since the oscillator line is a good heat conductor, the  $\beta$  values at these three locations do not differ too much.

The contribution of  $C_3$  ( $f_{x3} = 725$  mc having a positive temperature sensitivity) is represented by the dashed curve  $K_3P_3$  which leads to an overall compensation marked  $K_1P_1 + K_2P_2 + K_3P_3$ . Several commercial uhf television receivers have been stabilized with three-point compensation. The residual frequency deviations are less than  $\pm 100$  kc at any uhf television channels.

#### Automatic Recorders Can Help

With the aid of the automatic recording equipment, the analytical expression for frequency deviations greatly simplifies local oscillator stabilization.

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Frequency Characteristics of Local Oscillators, W. Y. Pan, *RCA Review*, Vol. XVI, No. 3, Sept. 1955.

Practical Aspects of Local Oscillator Stabilization, W. Y. Pan and D. J. Carlson, *RCA Review*, Vol. XVII, No. 4, Dec. 1956.

Vacuum Tube Oscillator, W. A. Edson, John Wiley & Sons, Inc., New York 1953.

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3 db Bandwidth	8-11 MCS	8-10 MCS	8-9 MCS
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Tuning Range	8500-9600 MCS	8500-9300 MCS	8500-9000 MCS
3 db Bandwidth	8-11 MCS	8-10 MCS	8-9 MCS
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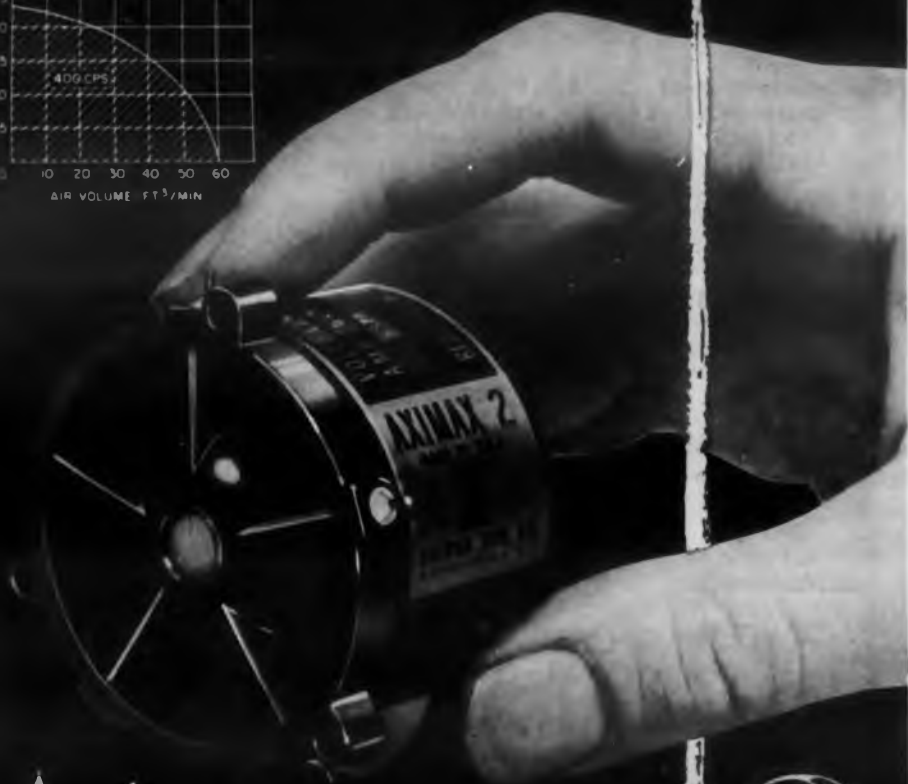
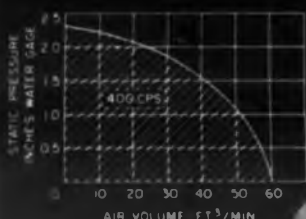
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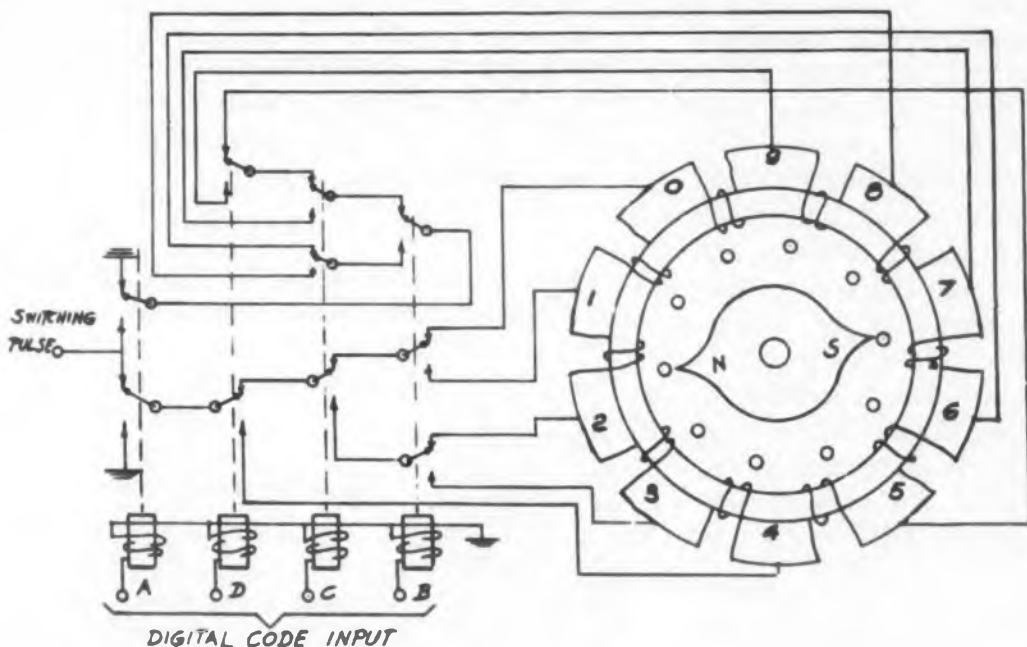
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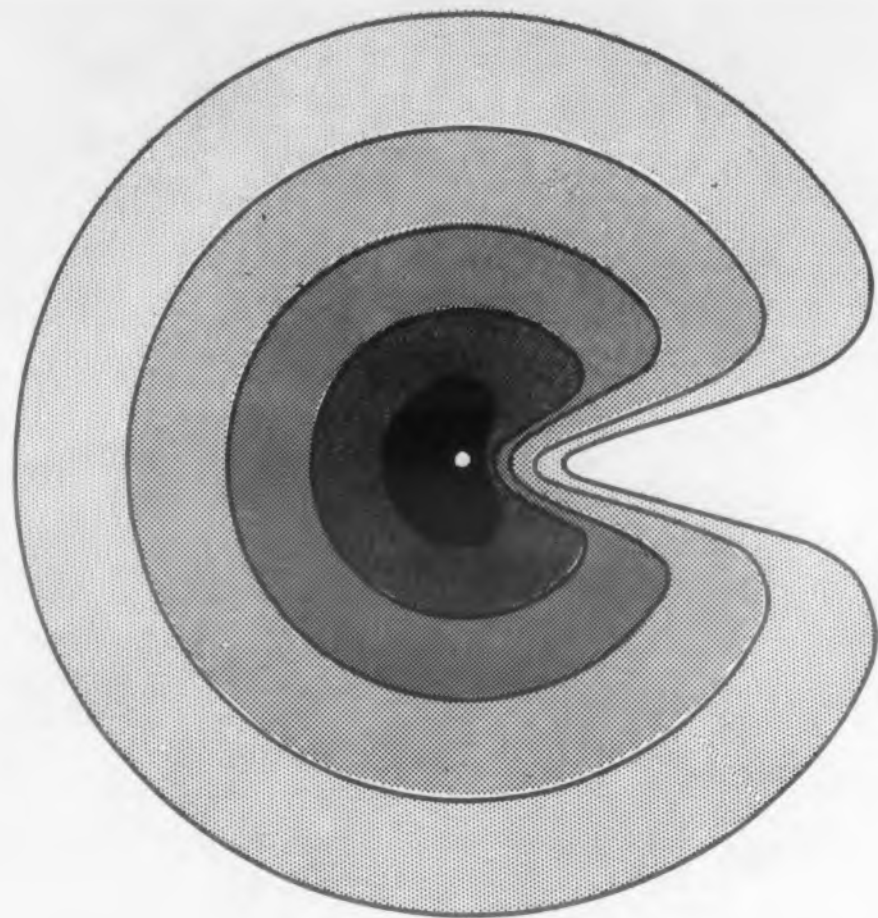
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Chief Engineer  
Andrew Corp.  
Claremont, Calif.

**Unwanted signals in vertically polarized omnidirectional uhf and vhf antennas can be eliminated. A null in the desired direction can be created by synthesizing an array with "off the shelf" antennas. Techniques employed to adjust the parameters of such an array are discussed in this article.**

Originally an Easterner, Al Holtum, Jr. moved West in two steps. After World War II, he worked in the Signal Corps Engineering Labs at Fort Monmouth, N.J. He specialized in antennas.

In 1954 he became chief of the Radio Communications Division at the Signal Corps Electronic Proving Ground, Ft. Huachuca, Ariz. There, he was concerned with testing and evaluating communication systems and concepts.

Recently Al left the sunny Arizona desert and moved over the mountains to often sunny Claremont, Calif. Here he is chief engineer of Andrew California Corp., an affiliate of Andrew Corp. They design and manufacture antennas and antenna systems.



**E**LIMINATION of a uhf or vhf signal in one direction from an omnidirectional antenna is possible by forming an array using the omnidirectional radiator and one unidirectional radiator properly phased and graded. It is possible to synthesize a pattern which is essentially omnidirectional except for an incremental null in one direction. If the radiation pattern of the unidirectional antenna is known, we can, with certain simplifying assumptions, compute the synthesized pattern.

Consider, for example, a corner reflector with a gain of 6 db over that of a unipole and ground plane. If these antennas are positioned as shown in Fig. 1, the expression for the resulting free space field strength for any direction in azimuth is:

$$E \cong \frac{k}{r} [1 + A |f(\phi)| e^{i(\rho - \delta\beta)}] \quad (1)$$

This assumes there is no interaction or mutual effect between the antennas and is an approxi-

mation of the free space pattern in the horizontal plane.

If the parameters are adjusted so that there is a null in the  $\phi = 0$  position,  $A$  will have the value  $-1$ , and  $f(\phi)_{max} = |f(0)| = 1$ . Note that the antennas are mounted in a plane perpendicular to the direction of the desired null. This aspect effects maximum phase change per unit angle resulting in a smaller increment between minimum and maximum field strength.

Then, if  $A = -1$ ,  $|f(0)| = 1$ , and  $f(\phi)$  is defined for all values of  $\phi$ , we have all the information necessary to compute the pattern. Assuming that the corner reflector is mounted such that its phase does not vary appreciably with  $\phi$ , i.e.  $\rho \cong 0$  we have from (1)

$$E \sim 1 - |f(\phi)| e^{-j\beta s \sin \phi} \quad (2)$$

which gives the relative value of  $E$  (field strength) at a constant distance  $r$ , ( $r \gg \lambda$ ) from the antenna. Fig. 2 (a) is a plot of the pattern for  $s = \lambda$ ; Fig. 2(b) shows the relative pattern for  $s = 5 \lambda$ .

### Feed Systems

To properly grade and phase the antennas forming the array, it is necessary to employ some sort of attenuator or power dividing network and a phase shifter (Fig. 4). The attenuator is needed to adjust the magnitude of the field strength produced by the corner reflectors to equal that of the omnidirectional antenna; the

phase shifter is required to adjust the phase of the corner reflector to 180 deg with respect to the omnidirectional antenna.

### Best Spacing

Spacing of the antennas determines the width of the incremental null in the composite pattern. As spacing approaches zero, the width of the null approaches the order of the beam width of the corner reflector. As spacing increases, the width of the null becomes smaller, and additional nulls are introduced (Fig. 2).

Assuming that secondary nulls which are formed will not perturb the pattern beyond given limitations, an optimum value for spacing can be found.

Assume that the pattern perturbation is to be limited so that secondary nulls will not reduce the field strength by more than 3 db below that of the omnidirectional antenna alone. From equation (2):

$$E_{min} \sim 1 - |f(\phi)_1| \quad (3)$$

And from a graph of the normalized function, the value of  $\phi$ , for which  $|f(\phi)| = 0.3$ , (making  $E \cong 0.3$ ). Using Equation (2) secondary nulls can be determined from

$$\beta s \sin \phi = 2\pi n, \text{ where } n = 1, 2, 3 \dots$$

and the first secondary null will occur for

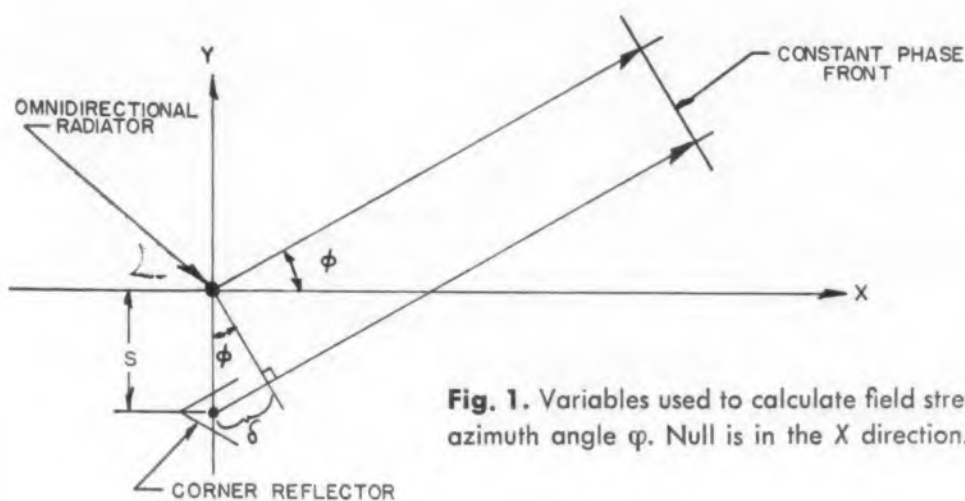


Fig. 1. Variables used to calculate field strength at any azimuth angle  $\phi$ . Null is in the X direction.

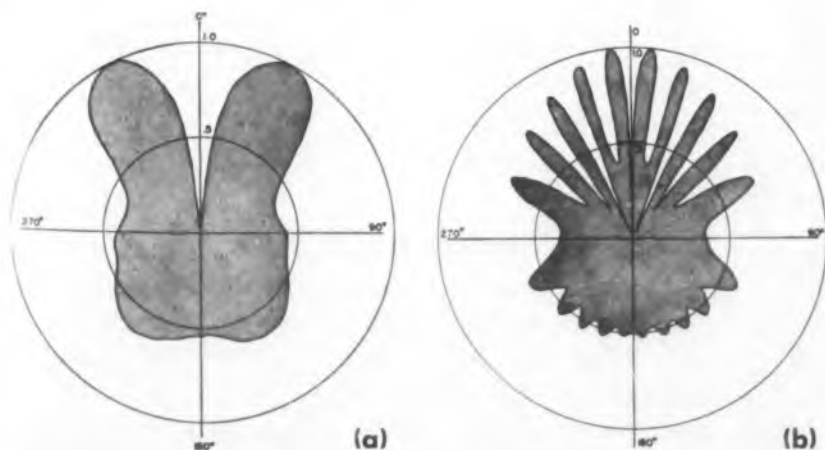


Fig. 2. Field strength pattern using a unipole and corner antenna at a spacing of one wavelength (a) and 5 wavelengths (b).



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No need to be foiled in efforts to establish a reliable pole beacon for missile checkout equipment, rapier-witted friend Sherman claims. Our new Model 82 Signal Generator Series, with one power supply and five plug-in r-f oscillators, can parry any problem of instrumentation inflexibility with one thrust (or five), depending upon the scope of your frequency requirements.

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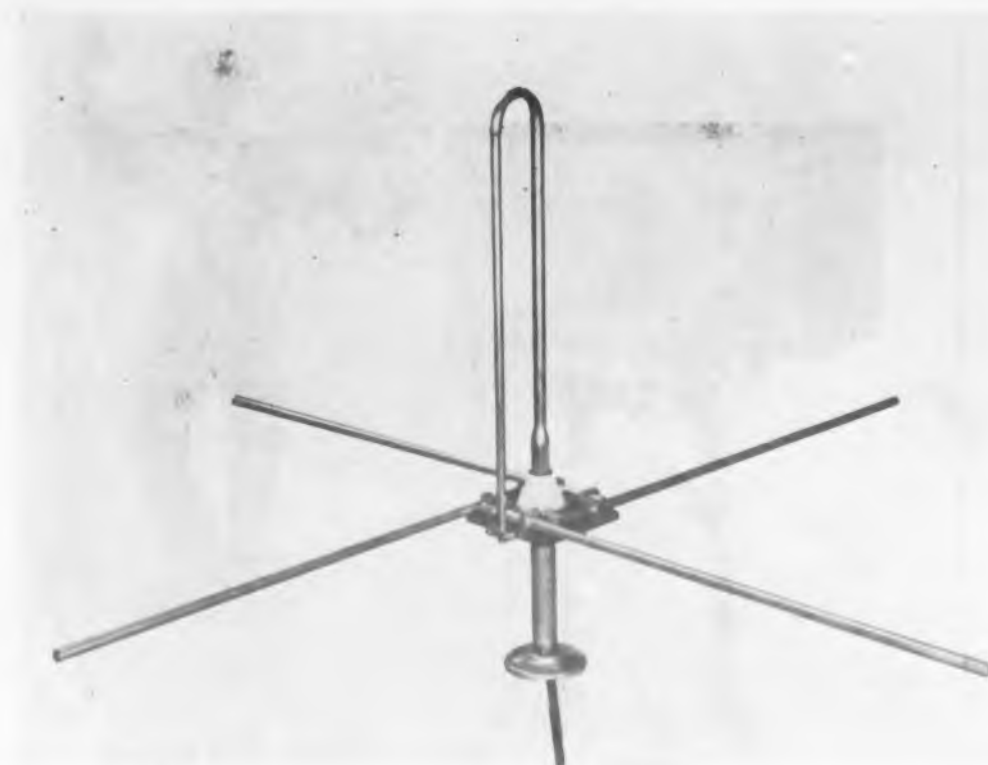
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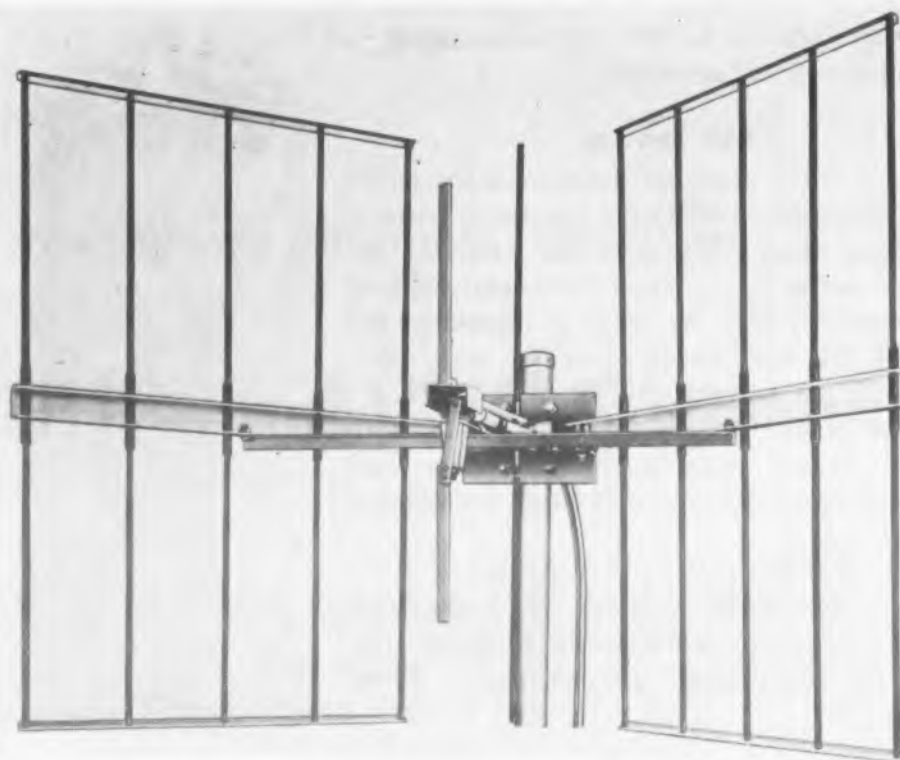
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(a)



(b)

Fig. 3. Typical "off the shelf" Andrew Corp. antennas used in the array. Omnidirectional type 925-4, (a), is used with corner type 3605, (b).

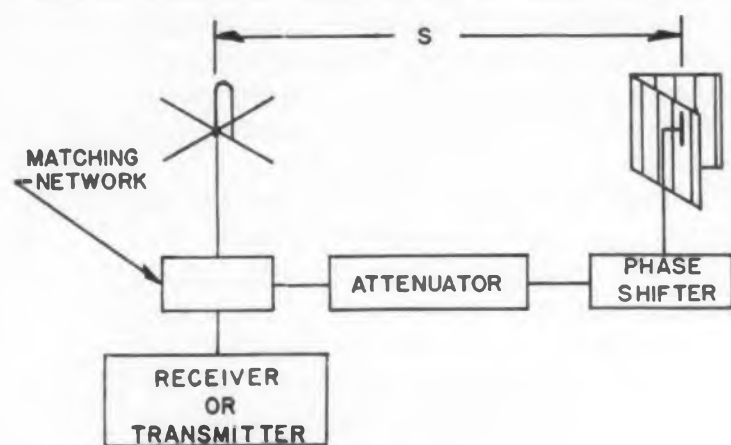


Fig. 4. Functional circuit used to grade and phase antennas forming the array.

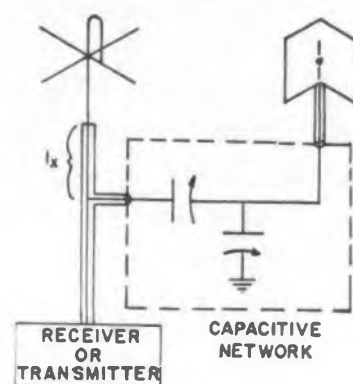


Fig. 5. Block diagram of both antennas and their phasing network.

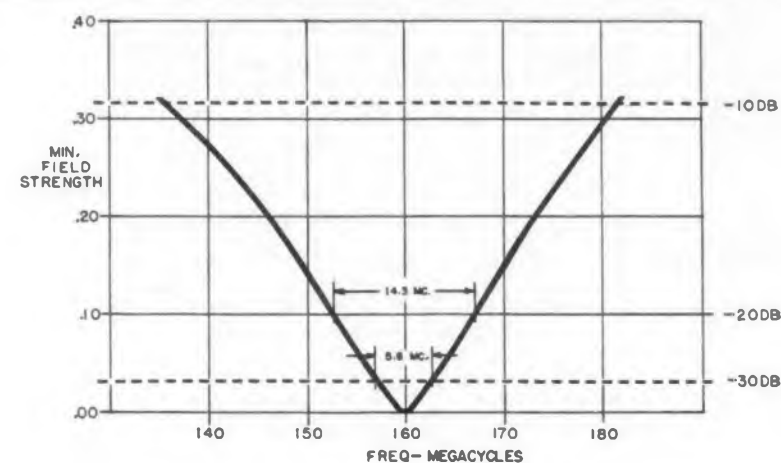


Fig. 6. Null or field strength vs frequency based on a perfect null at a center frequency of 160 mc.

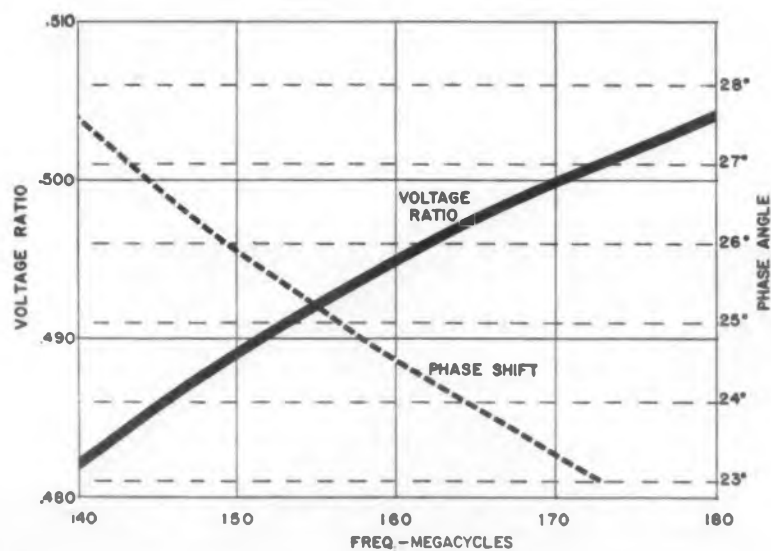


Fig. 7. Attenuation of the capacitive L-network vs frequency.

$s = \frac{\lambda}{\sin \phi_1}$  where  $\phi_1$ , is the angle chosen. Suppose:

$$|f(\phi)| = 0.3 \text{ at } \phi_1 = 80^\circ$$

Then:

$$s = \frac{\lambda}{0.98} \cong \lambda$$

#### Perturbation Due to Reflections

Our simplified expression, Equation (2), is for the relative field strength in free space. In practice, when the array is mounted, reflections from objects and the ground plane will perturb this pattern somewhat. The perturbation will be

most significant at the null itself, but this can be "tuned" out by readjusting the feed line parameters slightly and "minimizing" the unwanted signal.

#### Practical Installation

Using standard antenna components (Fig. 3), an array was erected by this method. An L-network of two variable capacitors in combination with a differential in transmission line length (Fig. 5) can be adjusted to give the appropriate attenuation and phasing to the signal impinging on the array.

In analyzing this circuit the approximate bandwidth was computed assuming matched conditions for both antennas. Plot of the null or field strength in the direction of the null versus frequency (Fig. 6) is based on a perfect null at a center frequency of 160 mc. Fig. 7 shows the voltage ratio or attenuation and phase shift of the capacitive network versus frequency.

In this circuit, the differential in transmission line lengths is added in such a way so that incremental changes in frequency will cause compensating changes in phase in the line differential,  $l_x$ , with respect to the L-network of capacities. This technique broadens the effective bandwidth.

Using the technique described, it may be possible to synthesize to good approximation many special radiation patterns using a combination of standard antennas. To predict the possibilities more accurately, accurate phase, amplitude, and gain measurements must be made of standard antenna types.

#### Acknowledgement

The author is indebted to Dr. Victor J. Andrew who conceived the basic idea.

#### Nomenclature

$A$  = proportionality constant  
 $\beta =$

$$\frac{2\pi}{\lambda}$$

$\delta = S \sin \varphi$

$f(\varphi) =$  radiation function of directional antenna

$k =$  constant, dependent upon radiated power

$\lambda =$  wavelength in free space

$r =$  distance from antenna

$\varrho =$  phase angle, associated with

$$f(\varphi) = \frac{1}{\epsilon^{1/p}}$$

$s =$  spacing between antennas

$\varphi =$  azimuth angle

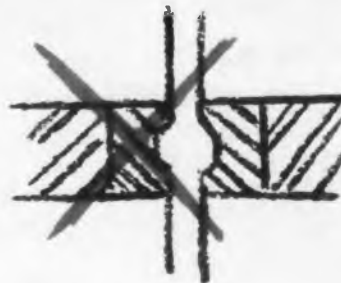
## Makes News in Sealing Relays



Some very vital "guts" in this miniature relay are resistance welded to the internal electrodes of the glass-to-metal hermetic header. If the electrodes should twist in the glass when the external ends are bent or crimped . . . or when the relay is undergoing adjustment before sealing the unit has "had it."

ONE MANUFACTURER of this type of relay using an ordinary "compression only" header had a specification like this.

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Of particular importance for many applications, Hetherington Switch/Light combinations make it easier for operators to keep closer tabs on crowded panels without confusing control functions. By connecting the light to an externally controlled circuit the illuminated button virtually cries, "Push Me," to attract the operator's attention at the right time. In other models, lamp circuits are controlled by the main switch contacts or by a second set of auxiliary contacts.

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The lamp and its circuit can be "checked-out" simply by pressing on the spring-mounted plastic lens cap. This makes contact through a separate third terminal circuit. When cap is released, the lamp functions through the regular circuit.

The long plastic lens of the L3200 gives wide, 180-degree visibility with either standard or edge-lit panels. Uses AN3140 lamps. For more details, write for Bulletin L-2b.

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### BETTER SWITCHES FOR BETTER APPLIANCES

A good electrical product deserves a good switch—and for types in the 5 to 50 ampere range that means Hetherington. Sturdy, good-looking switches—both push button, toggle, rotary, and other types—for unique operating or mounting requirements have long been a Hetherington specialty. Chances are, Hetherington switch engineers can recommend something out-of-the-ordinary that will enhance the appearance and saleability of your electrical products while assuring long, happy switch performance.

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The basic switch can be fitted with any of eight different anodized aluminum mounting adapters, such as those illustrated, to meet virtually

any mounting or design requirement.

Two-circuit, three-terminal, SP-DT, and other contact arrangements are available with ratings up to 10 amps, 28 volts dc. Ask for details on Hetherington Series W100.

Similar switches for non-MIL and industrial applications are available in over 1800 different types as Hetherington Series "JR."

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designed for use where one failure is one too many

# High Input Transistor

G. Franklin Montgomery National

INPUT impedance in transistor circuits from 50 to 100 meg can be obtained by using cascaded emitter-follower stages. A cascade of two common-collector stages is shown in Fig. 1. It has an input resistance of approximately  $\beta_1 \beta_2 R$ , where  $\beta_1$  and  $\beta_2$  are the current amplifications of the first and second transistors, and  $R$  is the load resistance at the emitter of the second transistor. In parallel with this input resistance is the collector resistance of the first transistor and the effective resistance of its biasing network. If  $\beta_1 \beta_2 R$  is large, the parallel resistances establish an upper limit on the total input resistance.

Stampfl and Hanel<sup>1</sup> have shown how feedback may be applied from the second emitter to the first collector to reduce the shunting effect of the collector resistance. The same technique can be used to reduce the effect of the bias network as well. Additional coupling components are needed to supply the feedback.

If the power supply is permitted to float, the feedback can be obtained with only two additional components. Fig. 2 is a typical arrangement. CK722 transistors demonstrate the performance obtainable with inexpensive units. With the output open-circuited, the voltage amplification in the audio-frequency range is nearly unity, and the input resistance is about one meg. With an output load of 1000 ohm, the

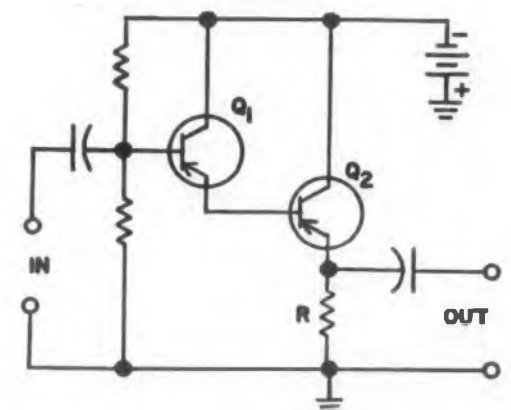


Fig. 1. A cascade of two common-collector stages.

# Impedance Amplifier

Bureau of Standards Washington 25, D. C.

voltage amplification is 0.8, and the input resistance is about 150,000 ohm. With high-gain transistors having low leakage current, the bias resistances can be increased, and input resistances of 50 to 100 meg can be obtained.

An experimental amplifier is in use with the following parameters:

- Transistors: type 2N105
- Bias resistors: 4.7 meg collector to base; 2.2 meg base to battery. Collector and emitter resistors in second stage: 15K each.
- Power gain into 12K load: 34 db
- Input impedance: with 12K load resistance, 33 meg; with infinite load resistance, greater than 50 meg.
- Battery voltage: 22 v.

In applications where noise figure is important, it is sometimes erroneously supposed that this type of amplifier requires a large source impedance. For a low noise figure, the source impedance should be that which is optimum for the same amplifier operated without feedback, usually about 1000 ohm.

#### References

1. Transistor Amplifier with Extremely High Input Impedance, R. A. Stampf and R. A. Hanel, Proceedings of the National Electronics Conference, Vo. XI, pp 1-7, Oct. 1955.
2. A High Input Impedance Transistor Circuit, Philip J. Anzalone, ELECTRONIC DESIGN, pp 38-41, June 1, 1957.

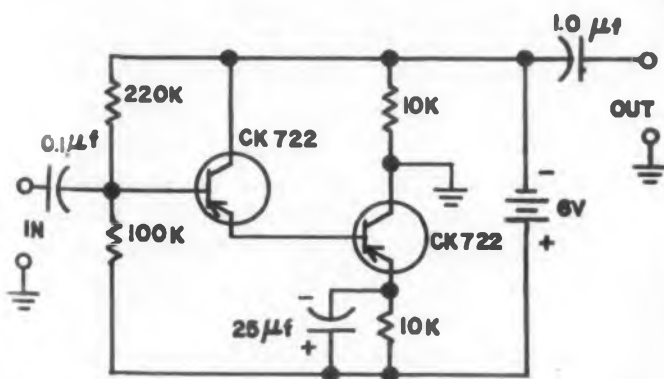


Fig. 2. A typical feedback arrangement where an input impedance of 1 meg is obtained with the output open-circuited.

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### 3 POWER GROUPS

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	LT-5093	LT-5102	LT-5111	LT-5120	Diamond
80	LT-5092	LT-5101	LT-5110	LT-5119	Male
	LT-5091	LT-5100	LT-5109	LT-5118	Female
	LT-5090	LT-5099	LT-5108	LT-5117	Diamond
40	LT-5089	LT-5098	LT-5107	LT-5116	Male
	LT-5088	LT-5097	LT-5106	LT-5115	Female
	30V	60V	80V	100V	

Minimum Breakdown Voltage†

#### 30-WATT GROUP Types Available

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	LT-5058	LT-5067	LT-5076	LT-5085	Female
	LT-5057	LT-5066	LT-5075	LT-5084	Diamond
60	LT-5056	LT-5065	LT-5074	LT-5083	Male
	LT-5055	LT-5064	LT-5073	LT-5082	Female
	LT-5054	LT-5063	LT-5072	LT-5081	Diamond
30	LT-5053	LT-5062	LT-5071	LT-5080	Male
	LT-5052	LT-5061	LT-5070	LT-5079	Female
	30V	60V	80V	100V	

Minimum Breakdown Voltage†

#### 20-WATT GROUP Types Available

Current Gain	LT-5028	LT-5034	LT-5042	LT-5051	Diamond
60	LT-5027	LT-5033	LT-5041	LT-5050	Male
	LT-5026	LT-5032	LT-5040	LT-5049	Female
	LT-5025	LT-5031	LT-5039	LT-5048	Diamond
40	LT-5024	LT-5030	LT-5038	LT-5047	Male
	LT-5023	LT-5029	LT-5037	LT-5046	Female
	LT-5022	2N157	2N157A	LT-5045	Diamond
20	LT-5021	LT-55	LT-5036	LT-5044	Male
	2N156	2N158	LT-5035	LT-5043	Female
	30V	60V	100V	120V	

Minimum Breakdown Voltage†

‡Minimum large-signal current gain: 40-watt group at 1.0 A, 30-watt group at 0.75 A, 20-watt group at 0.50 A.

†Minimum breakdown voltage, collector to base with emitter open.

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## Ferrites Can be Replaced With Yttrium-Iron Garnet

YTTTRIUM-IRON garnet, YIG, a rare earth expected to replace ferrites in microwave applications, is commercially available for the first time.

Produced by Microwave Chemicals Laboratory Inc., 282 7th Ave., New York, YIG has extremely low loss, much lower than conventional microwave ferrites in the microwave region. This polycrystalline material also manifests a much narrower ferrimagnetic resonance line width. Compared to ferrites which have line widths of more than 200 oersteds at 9000 mc, YIG shows a line-width of 55 oersteds at this frequency.

Saturation magnetization of YIG is 1750 gauss. It is noted, however, that some parameters may be varied by introducing other rare earths into the formulation. For example, the saturation magnetization can be held approximately constant, and the line width varied by the introduction of samarium. Similarly, line-width may be held constant and saturation magnetization reduced with the addition of gadolinium. Saturation magnetization values between 450 and 2000 gauss have been obtained by changing the chemical construction.

YIG, which weighs only slightly more than ferrites, has 97 per cent of the



Off-the-shelf samples of yttrium-iron garnet, a rare earth expected to replace ferrites in microwave applications.

theoretical X-ray density. No special machining problems are encountered, though YIG is harder than ferrites.

Available in either rectangular or cylindrical shape, the standard bar size is 1 in. x 1 in. x 3 to 6 in. long.

Among the typical applications cited for this ferrimagnetic material which take advantage of its non-reciprocal properties are: switches, isolators, circulators, paramagnetic amplifiers, radar, ferrite-tuned resonance cavities, modulators and ferri-directional couplers. Though costing more than ferrites, YIG promises to reap many more benefits.

For more information, turn to the Reader Service card and circle 39.

#### Data on YIG

Density	5.05 ± 0.05
Hardness	8.5
4π M <sub>s</sub>	1750 gauss/cc
Typical resonance line width	9 kmc 55 oersteds
Dielectric loss tan (20mc)	3 kmc 30 oersteds
Curie temperature	0.003
g factor	300 C
	2.00 (10 kmc)

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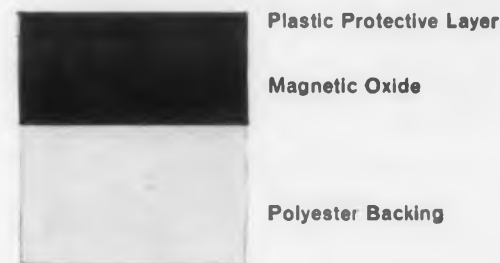
Here's the solution to the problem of excessive wear and ruboff—"SCOTCH" BRAND Sandwich Instrumentation Tapes. These tapes have a thin layer of plastic over the magnetic coating. This layer protects the iron oxide to produce a smooth, low-frictional head-to-tape operation that eliminates ruboff, head buildup and connected problems.

The addition of this protective layer (50 micro-inch thickness) naturally modifies the magnetic properties of the tapes somewhat. This amounts to a slight (but not critical) reduction in the high frequency or short wave length response. The medium and long wave length responses are completely unaffected. In all applications where extremely high frequency response is not required, "SCOTCH" BRAND Sandwich Tapes offer the ultimate in performance, combined with new freedom from maintenance problems.

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- #189—Standard output level with 50% more recording time. 1.0 mil polyester base, 0.35 mil magnetic coating, 50 micro-inch protective layer.

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# Transistorized High Frequency Chopper Design

**Rob Roy**  
Control Instrument Co., Inc.  
Brooklyn, N. Y.

Here is a high frequency chopping technique which balances out unsymmetrical transistor switch impedances and undesirable carrier leakage.

**B**Y SEPARATELY chopping positive and negative halves of modulating signals, transistorized choppers can operate well beyond the usual 60 or 400 cps. Here is how to design one to chop at 275 kc with minimum carrier leakage.

## The Grounded Emitter Chopper

The transistor, with its low saturation impedance, and high cutoff impedance, is ideal for a chopper. The grounded emitter configuration requires least carrier drive for effective switching. Fortunately, this matches the requirement for low carrier leakage with zero signal.

To analyze the operation of a transistorized chopper, the large signal equivalent circuit of a grounded emitter pnp transistor is shown in Fig. 1. The pertinent loop equations are

$$V_b = (r_e + r_b) I_o + r_e I_c \quad (1)$$

$$V_{ce} = (r_e - \alpha_e r_c) I_b + [r_e + (1 - \alpha_e) r_c] I_c \quad (2)$$

Fig. 2 shows the linearized characteristics which correspond to eq (2).

The limits of chopper operation are defined by the switching of either the emitter or collector diode. The emitter diode switches (corresponding to transistor cutoff) when

$$I_e = -(I_b + I_c) = 0 \quad (3)$$

or 
$$I_b = -I_c$$

Then eq (2) reduces to

$$\begin{aligned} V_{ce} &= r_c I_c \\ I_c &= -\alpha_e I_e \quad \text{or} \end{aligned} \quad (4)$$

Rob Roy has been particularly active in character recognition work. His latest work is on a machine which will read typewritten characters, even on a mutilated page, and convert them to teletype code.





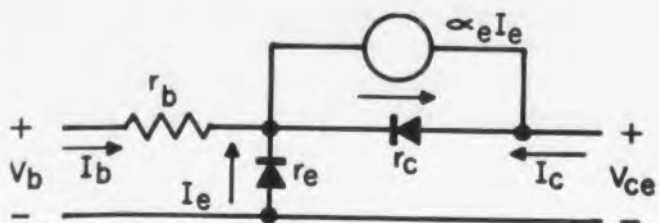


Fig. 1. Large signal equivalent circuit of grounded emitter pnp transistor. Here  $\alpha_e = \alpha + (r_b/r_c)(1 - \alpha)$ , with  $\alpha$  defined as  $-(\delta I_c/\delta I_e)$  with collector voltage constant.

Fig. 2 shows this as line *OC*.

The collector diode switches when

$$I_b = \left( \frac{1 - \alpha_e}{\alpha_e} \right) I_c \quad (5)$$

For this condition eq (2) reduces to

$$V_{ce} = r_e I_c / \alpha_e \quad (6)$$

which is plotted as line *OB* in Fig. 2.

These two lines, *OB* and *OC*, define saturation and cutoff respectively. The active region for the transistor lies between them.

If a loadline is drawn on these characteristics, its intersection with *OB* and *OC* define transistor chopper operation. If a load *R* is assumed in series with a source  $(-V_{cc} + V_s)$ , with  $V_{cc}$  the collector supply voltage, and  $V_s$  the modulating signal, then

$$V_{ce} = -I_c R_L - V_{cc} + V_s \quad (7)$$

One sees from eq (6) that at point *A* of Fig. 2

$$I_c = \frac{(-V_{cc} + V_s) \alpha_e}{\alpha_e R_L + r_e} \quad (8)$$

$$I_b > \frac{(1 - \alpha_e)(-V_{cc} + V_s)}{\alpha_e R_L + r_e}$$

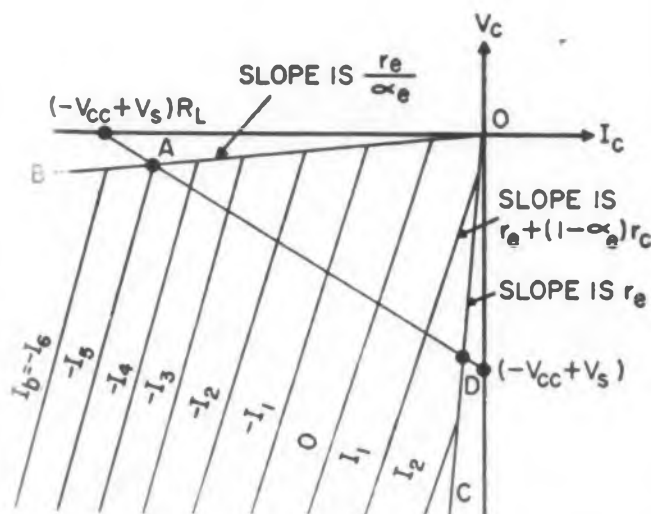


Fig. 2. Line *AD* is the load line in the switching region of the linearized collector-emitter characteristics.

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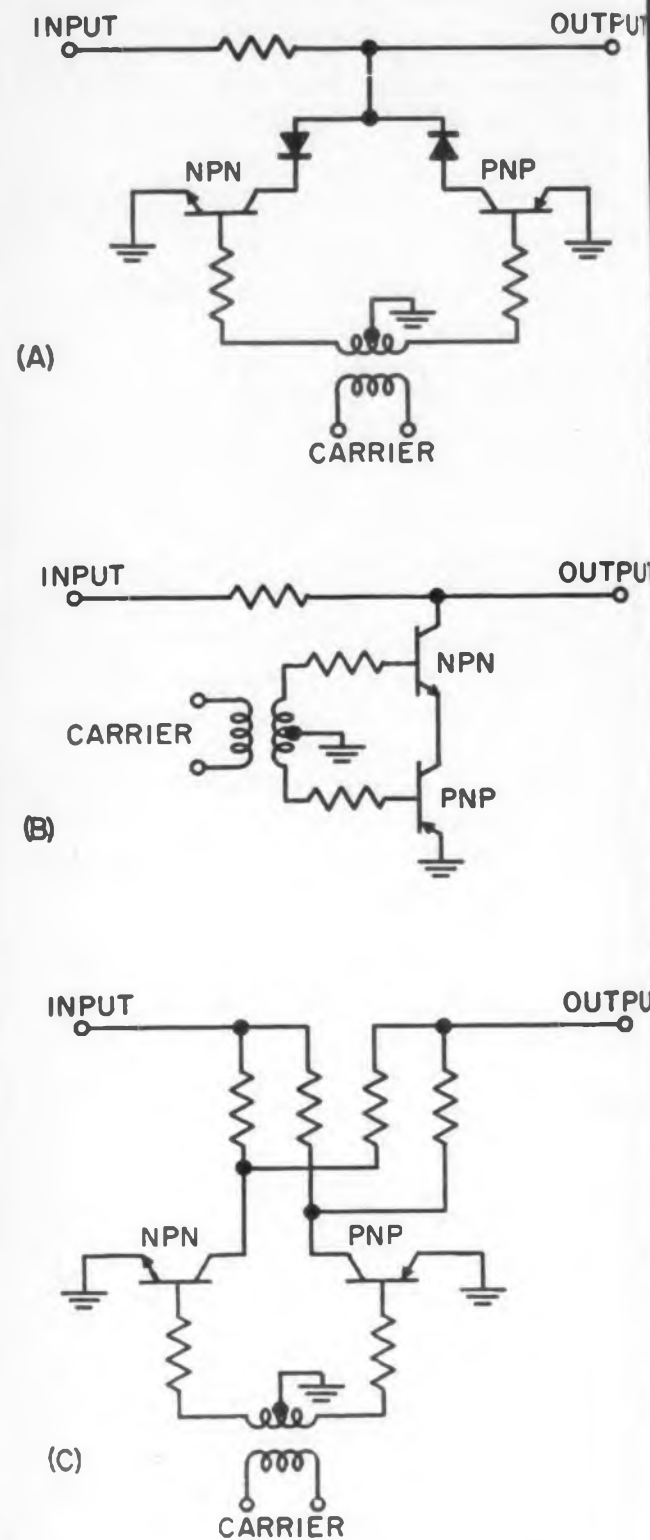
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Equations (7) and (8) define the chopper's saturation state, while eq (3) holds for cutoff. The slopes of lines *OB* and *OC* define the switch impedances.



**Fig. 3.** Three basic chopper configurations.

**A.** The diodes separate the incoming audio into positive and negative halves and the complementary transistors chop the individual halves of the signal.

**B.** A tandem transistor combination. Each transistor alternates chopping with its dual.

**C.** Here the positive and negative signals are chopped individually, and summed in the output.

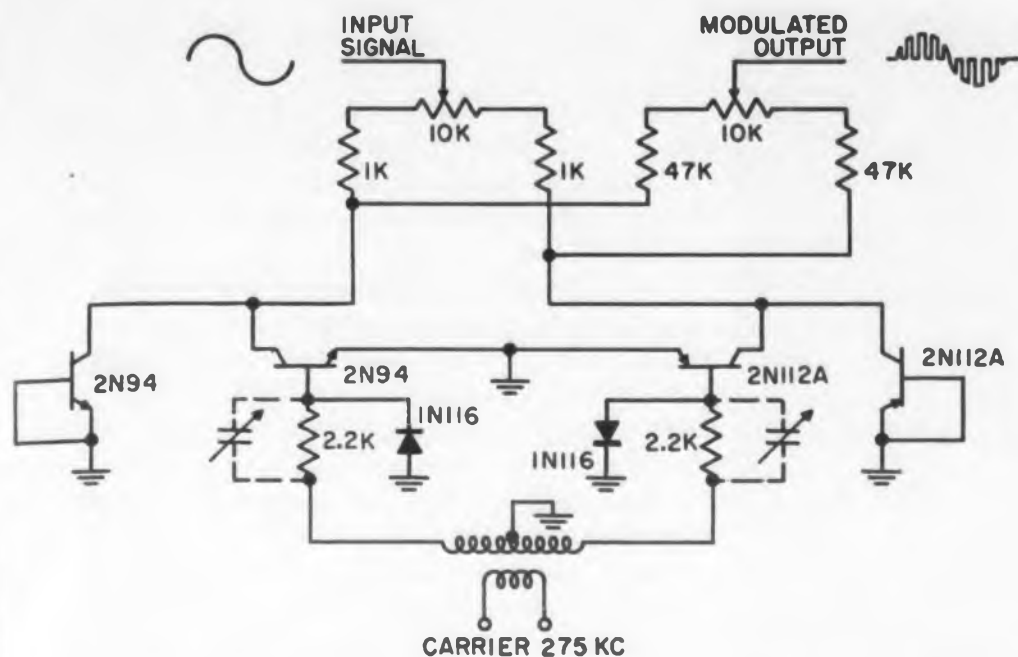


Fig. 4. This high frequency chopper minimizes carrier leakage.

### Three Chopper Configurations

Fig. 1 shows that for a positive collector to emitter voltage, the collector diode switches, leaving the base without switching control. But for bilateral operation, one must separate the incoming signal into its positive and negative halves, and separately modulate each polarity. Fig. 3 shows three possible chopper configurations.

- Method A uses separation diodes to separate the incoming audio signal into its positive and negative parts. Complementary transistors then chop the signal. The npn transistor chops the positive half, while the pnp chops the negative half.

- Method B uses a unique tandem combination of pnp's and npn's. Each transistor alternates the chopping operation with its dual. The npn shorts the negative audio signals and chops the positive audio signals. The pnp works exactly in reverse, shorting the positive signals and chopping the negative.

- Method C chops the positive and negative signals individually, then sums the two outputs. Since the "off" impedance of an npn transistor differs from the "off" impedance of a pnp, the method requires balancing the output signal. This is shown in Fig. 4.

### Carrier Leakage

Due to resistive and capacitive leakage between collector and base, there is a small carrier level at the output when there is a zero input signal. This carrier signal, if it is as large as the weakest modulating signal, can seriously distort it. For a system which depends on correlation techniques, the signal waveshape must be preserved.

Method A causes a small distortion at the low

signal end, due to the finite voltage differential required for diode switching.

Method B, though novel, has little provision for eliminating carrier leakage.

Thus, method C is the only remaining choice. Fig. 4 shows that the carrier leakage on each collector is approximately 180 deg out of phase. By summing and balancing, one can practically eliminate any carrier at the output. A small capacitor of about 5 to 15  $\mu\text{f}$ , across one base resistor, is used to phase shift one carrier slightly. This can improve the zero signal carrier suppression even further.

The rather unusual use of transistors on the collectors of each half of the chopper provide an extremely low impedance clamp for very small reverse polarity modulating signals. Crystal diodes require too large a voltage differential for effective clamping. The transistor configuration clamps to within tenths of a volt.

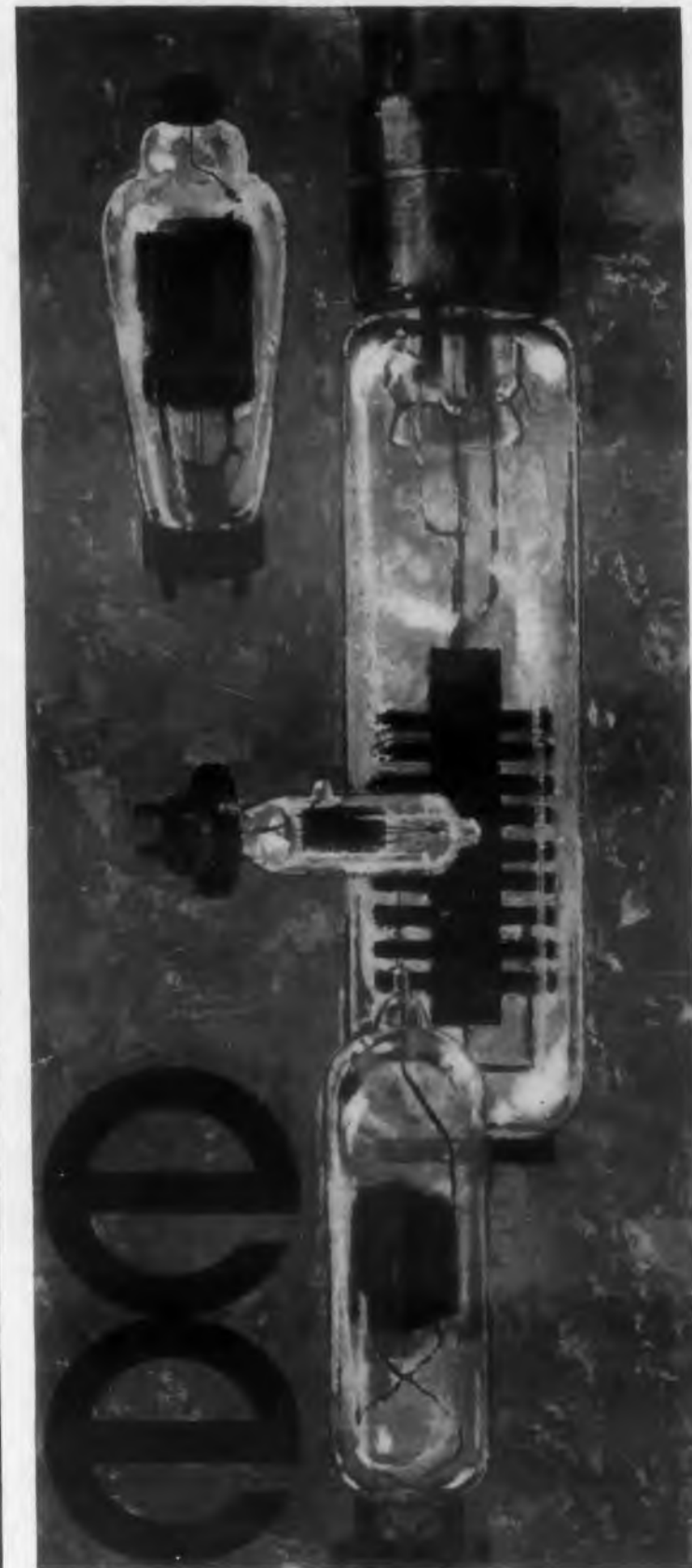
### Circuit Performance

The chopper in Fig. 4 is designed for a 275 kc carrier frequency, but the carrier can be changed from 100 kc to 350 kc with no more than a two per cent change in leakage. At lower frequencies, even down to 400 cps, this chopper is more than adequate.

The chopper takes modulating signals from 1/2 to 20 v, a 40 to 1 range. The maximum carrier leakage is 40 db below the output of the weakest modulating signal, and the deviation from an ideal linearity curve is no more than two per cent. With a 400 cps carrier, the deviation doesn't exceed one per cent, with input signals from 1 mv to 20 v.

### Acknowledgment

The author is indebted to Carl Mengani for his many valuable suggestions.



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# Telemetry Industry Prepares For Frequency Band Shift

**Ben Patrusky**

Assistant Editor

**R**ECOMMENDATIONS made recently to the Dept. of Defense in a classified report may hurl telemetry equipment manufacturers into hectic R & D activity. The report, prepared by Aeronutronics Systems, Inc., Glendale, Calif., as part of an over-all probe into military telemetry needs, will be released shortly. According to informed sources attending the National Telemetry Conference, it suggests that all telemetry activity on the 215 to 260 mc band cease by 1970, with phase-out from 215 to 225 mc by Jan. 1, 1960.

The new frequency band recommended for telemetry is in the 1300 mc band. Certain telemetry applications requiring long-range and

very narrow bandwidths will be permitted on the old band on a non-interference basis.

No enforcement agency is involved in this evaluation. The report is supposedly a primer for industry. Publication of the report probably will be considered tantamount to establishing a government equipment purchasing policy.

Manufacturers attending the Telemetry Conference indicated what they felt the implications of these recommendations were to them:

- Accelerate development of microminiature components and equipment.
- Necessitate design of new transmitters and receivers, since there is at present no such equipment available within this new range.

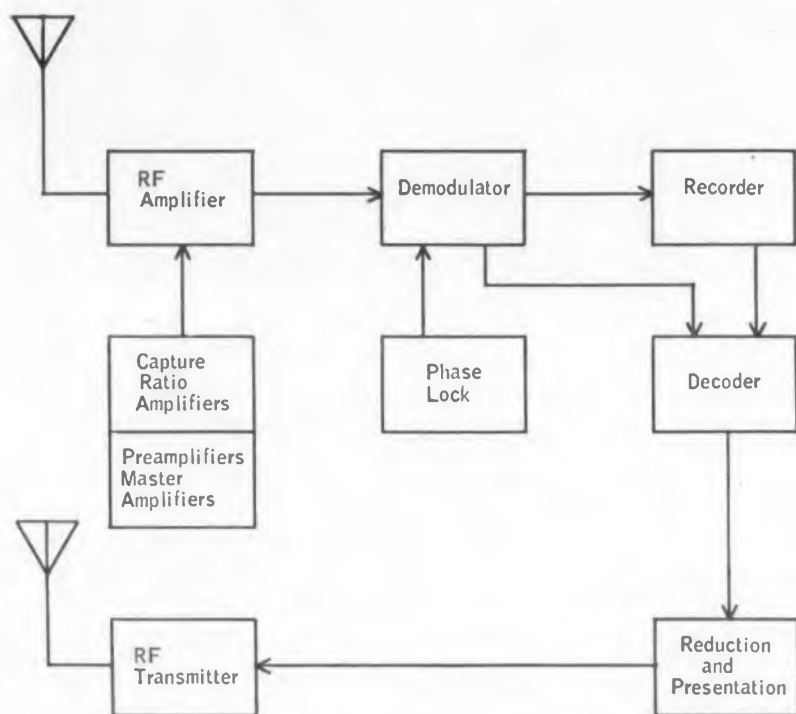
- Increase use and development of pcm telemetry.

Several manufacturers did indicate that programs are at present underway to develop equipment to meet these new recommendations. Particular emphasis, they report, is being placed on antenna design.

Design for the new frequency was not the only recent R & D stimulant administered to the industry. Gen. Earl F. Cook, Army Signal Corps R & D Chief, gave conferees a look at the long-range military tactical telemetry needs. This is what the military wants, he said:

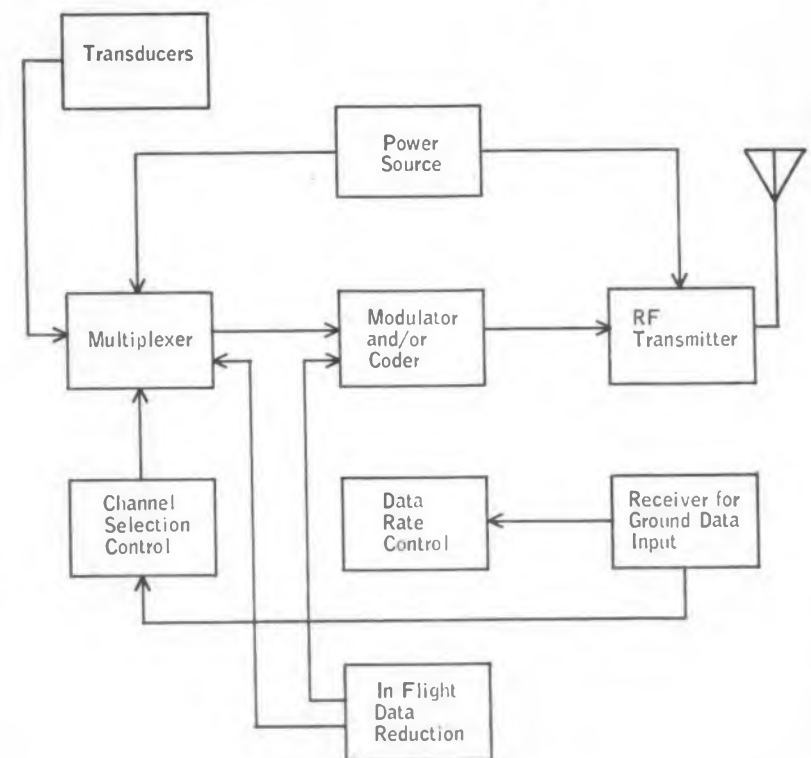
- A "telesensory soldier" reporting strategic data from the battlefield.
- Ground-based automatic weather stations to give synoptic weather data.
- Constant-level balloons which move across wide areas at predetermined heights to record weather information horizontally.
- Drone aircraft with sufficient power to telemetry data back from behind enemy lines while remaining secure from enemy counter-measures.
- New concept of conveying mass data and pictures across space.

These needs, the General contended, are "musts" in the event of modern warfare. He explained that battles will be fought "in layers" by foot soldiers, aircraft, missiles, and space vehicles. Ground forces will be spread thin and instead of massed front lines, "you will see a porous battlefield, perhaps fifty miles in depth." Information from the sparsely inhabited battlefield—everything from radioactive fallout to cloud cover data—will have to be telemetered back, he said. He pictured the telesensory soldier as a



Block diagram (left) of complete ground station telemetry system incorporating features yet to be achieved.

Block diagram (right) of Mr. Gardenhire's proposed airborne telemetry system.



"grounded satellite talking only when queried . . . with a built in IFF so he won't talk to strangers . . . something we could use for soldiers on 6-hr pass in Paris or Algiers."

Also needed will be advanced telemetering equipment for remote automatic weather stations. Wide-ranging balloons at the same time could "shoot" the weather horizontally and replace such devices as vertical sounding balloons carrying radiosondes. The General added that "signals from present telemetering gear simply are not strong enough to cover the wide sweeps our equipment would make into enemy territory."

Getting telemetered data back from drone aircraft without alerting the enemy is another problem to be solved. "We need relative immunity to countermeasures," said Cook, "some shield against enemy deception, jamming or modulation of our sensor elements. Otherwise we have a bandit by the bank teller's cage."

Delegates were also urged "to get ready to send an electronic picture back from the moon . . . a photograph of environment and operations." The General estimated that power requirements for sending an 8 x 10 glossy photograph or TV picture back would be about 208,000 w.

Meanwhile, the telemetering industry attempted to crystallize their own equipment problems. At a panel discussion, I. Gardenhire of Radiation Labs, Inc., Orlando, Fla., outlined, en toto, the needs of telemetering facilities in both the ground and airborne installations.

As far as data collection is concerned, he cited the following:

- High-gain small antenna.
- Airborne receivers.
- Beyond the horizon reception.
- Wide-band phase lock.
- Video recorder demodulator.
- In-flight data reduction.

As for information acquisition:

- Microminiaturization.
- Integrated construction.
- Planned redundancy of information.
- Solid-state design.
- High-power efficiency.
- Stabilized directional antenna.

Acquisition at very low elevation is another major requirement. With regard to the airborne vehicle itself, Mr. Gardenhire cited needs such as:

- Equipment to transmit back to the vehicle to tell it what to do.
- Channel selection control.
- Data rate control.

Real time data reduction is necessary in the ground installation.

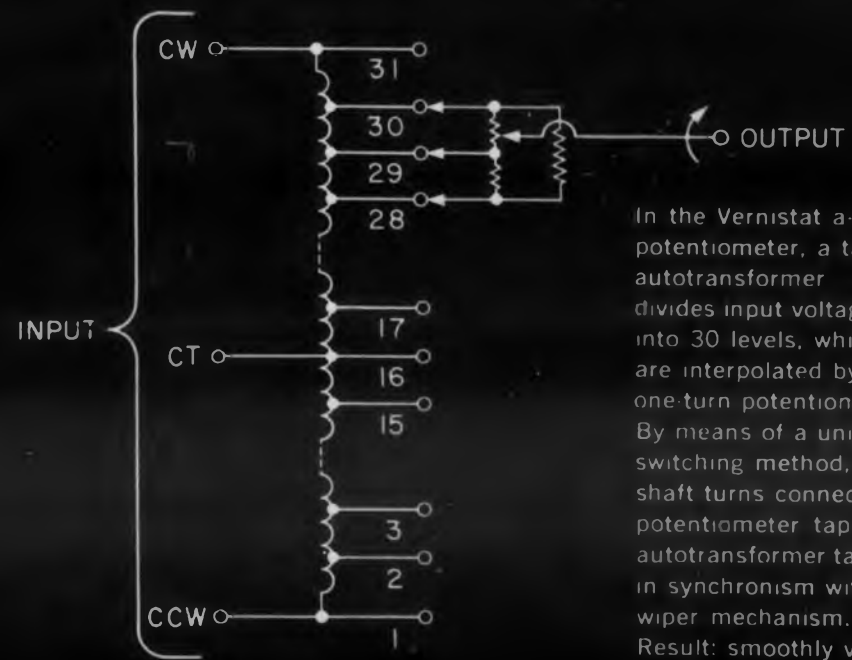
Accompanying block diagrams describe the complete receiving and transmitting systems as spelled out by Mr. Gardenhire.

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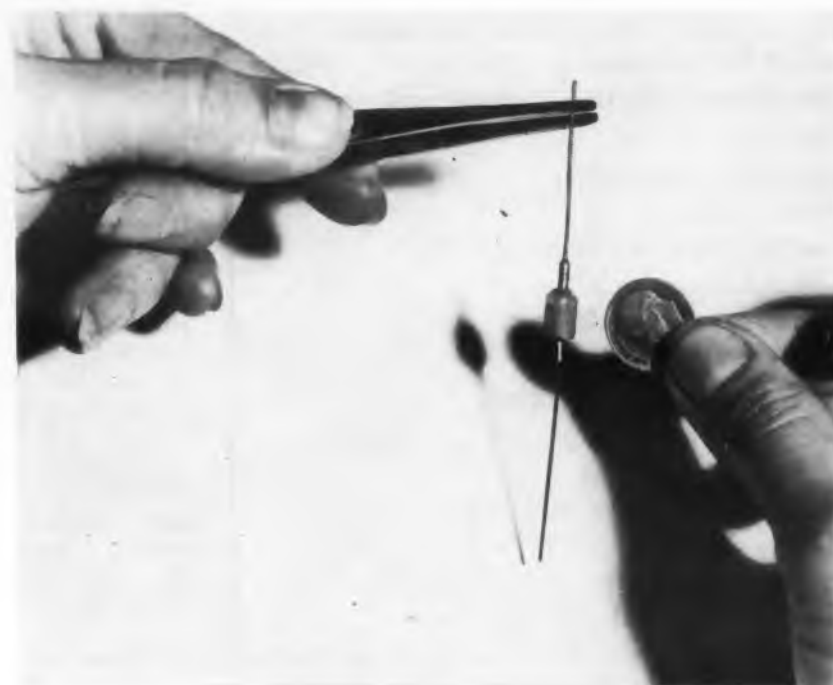
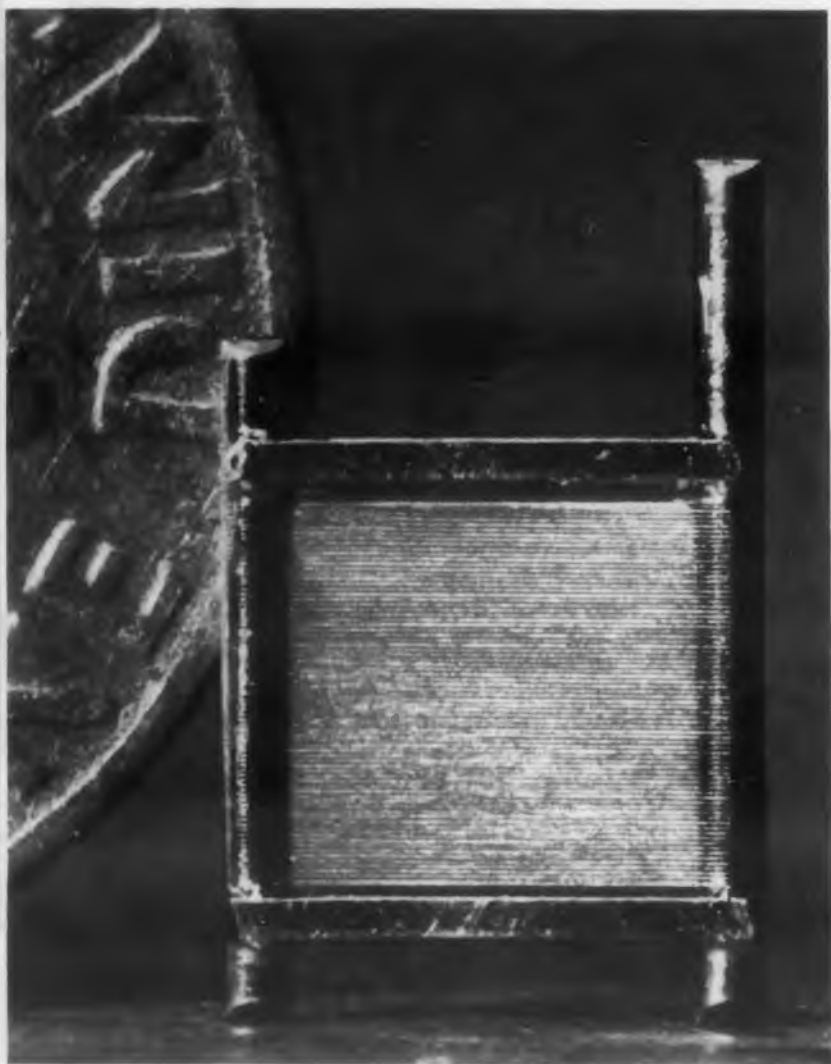
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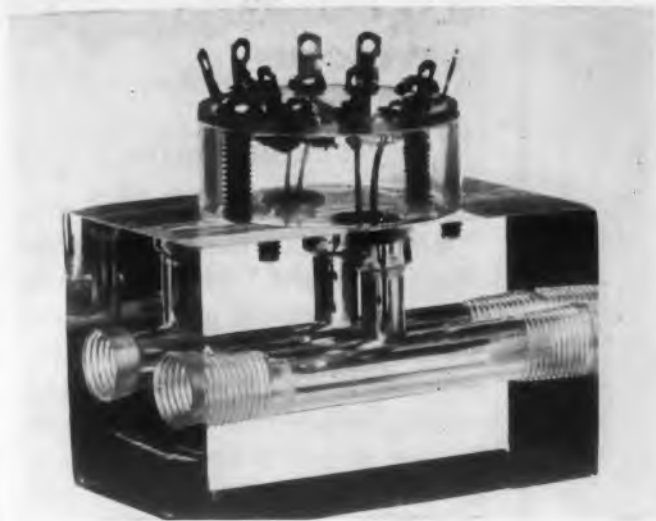
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The 7200 Multiplier Phototube is a 9-stage type with S-19 response. Range is 1800 to 6000 angstroms.

Also being introduced is the 7212 Beam Power Tube for use under severe shock and vibration. The tube has a max plate dissipation of 25 w under ICAS conditions in modulator service and in cw service. In the latter service, it can be operated with full input to 60 mc and with reduced input to 175 mc.

Radio Corp. of America, Electron Tube Div., Dept. ED, Harrison, N.J.

Wescon Booth 1635-36

CIRCLE 470 ON READER-SERVICE CARD

## Ultrasonic Power Supply

1500 w continuous output

The D-1320 ultrasonic motor-generator power supply is rated for 1500 w continuous output at 15,000 to 25,000 cps. Instant operation, no sliding contacts, long bearing life, and class H insulation are features.

D & R Ltd., Dept. ED, 402 E. Gutierrez St., Santa Barbara, Calif.

Wescon Booth 635

CIRCLE 56 ON READER-SERVICE CARD

## Insulating Boards

Pre-punched in different patterns

An addition to a line of pre-punched insulating board, the G pattern has 0.062 in. diam holes on a 0.1 in. grid with alternate holes missing. This pattern is designed for mounting transistor circuits since the holes match the JETEC transistor lead spacing.

Vector Electronic Co., Dept. ED, 1100 Flower St., Glendale 1, Calif.

Wescon Booth 1244

CIRCLE 57 ON READER-SERVICE CARD

CIRCLE 58 ON READER-SERVICE CARD ➤

A  
F  
V  
H  
F

**EIMAC  
FIRST**

**Covering the Spectrum**

**with Reliable Ceramic Tubes**

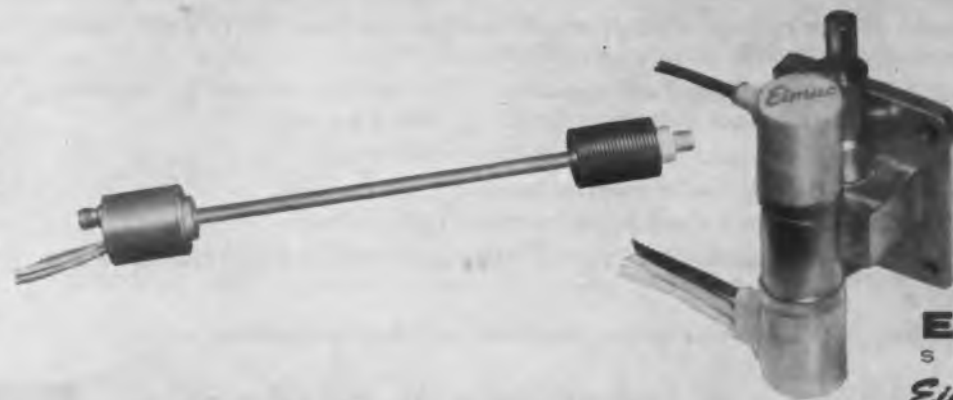


U  
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S  
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F

From audio into super high frequencies, Eimac covers the RF spectrum with modern ceramic tubes. This incomparable ceramic electron tube family—more than one-third of the Eimac line—includes reflex and amplifier klystrons, negative grid tubes, rectifiers, pulse modulators, receiving tubes, and traveling wave tubes. The tubes illustrated are typical of more than 40 Eimac ceramic tube types that are being selected by leading equipment manufacturers for use in all types of applications—from tropo-scatter to industrial heating, from single sideband to pulse.

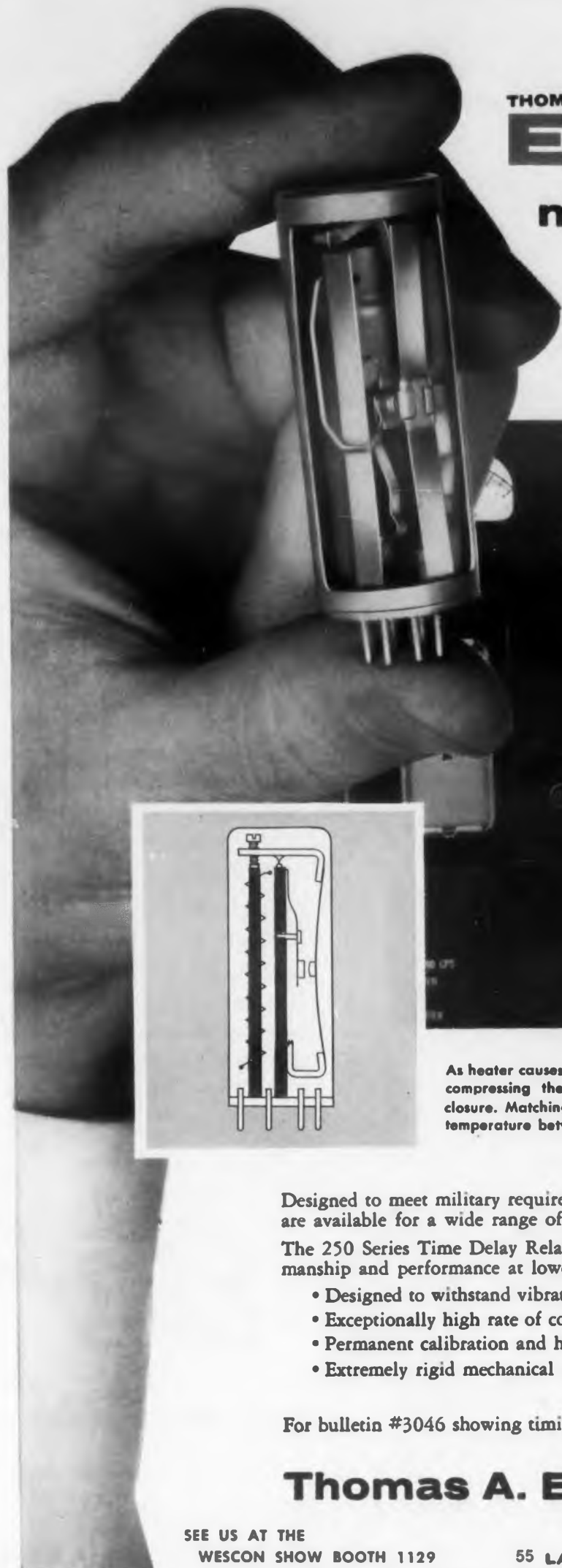
Visit the Eimac booths, 1230-31 and 1234-35, at WESCON, August 19 to 22, in Los Angeles. Operate the unique demonstrator which hammers impact shocks upon a live Eimac ceramic tube—and prove to yourself the superiority of ceramics in electron tubes.



**EITEL-McCULLOUGH, INC.**  
SAN BRUNO, CALIFORNIA  
*Eimac First with ceramic tubes that can take it*

PRODUCTS DESIGNED AND MANUFACTURED BY EIMAC  
Negative Grid Tubes  
Reflex and Amplifier Klystrons  
Ceramic Receiving Tubes  
Traveling Wave Tubes  
Vacuum Tube Accessories  
Vacuum Switches  
Vacuum Pumps

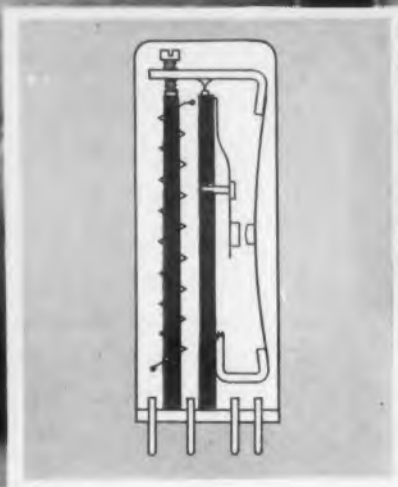
Includes the most extensive line of ceramic electron tubes



THOMAS A.

# EDISON'S

## model 250 miniature time delay relays are shock and vibration resistant



As heater causes the expansion member to stretch, lever pivots on its hinge, compressing the bow spring at a high rate in the direction of contact closure. Matching expansion member compensates for external changes in temperature between  $-65$  and  $+100^{\circ}\text{C}$ .

Designed to meet military requirements, Edison's line of miniature time delay relays are available for a wide range of electronic applications.

The 250 Series Time Delay Relays combine in one unit superior design, top workmanship and performance at lowest cost. Check these advantages:

- Designed to withstand vibration frequencies to 500 CPS.
- Exceptionally high rate of contact closure.
- Permanent calibration and hermetic seal.
- Extremely rigid mechanical structure using high-strength, high-expansion alloys.

For bulletin #3046 showing timing ranges and operating performance write to:

### Thomas A. Edison Industries

INSTRUMENT DIVISION

SEE US AT THE  
WESCON SHOW BOOTH 1129

55 LAKESIDE AVENUE, WEST ORANGE, N. J.

CIRCLE 59 ON READER-SERVICE CARD

## NEW PRODUCTS at WESCON

### Magnet Wires

Two new types

Two types of magnet wire, S-Y Bondeze and Nyleze, will be displayed. The first type is a tough, self bonding solderable wire which winds a self-supporting, bobbinless coil without special adhesives. Nyleze is an all purpose wire used on high speed automatic winding equipment, or where varnish and compound treating conditions are extreme. Dimensions and price are same as Formvar.

Phelps Dodge Copper Prod. Corp., Inca Mfg. Div., Dept. ED, Fort Wayne, Ind.

Wescon Booth 213-14

CIRCLE 60 ON READER-SERVICE CARD

### Rotary Switch

12 positions, up to 5 sections

Type MA-12 miniature rotary switch provides 30 deg indexing, 12 contact-positions, up to 5 sections, with current-carrying capacity of 3 amp. Interrupting rating is 1/2 amp 115 v ac. Designed to meet MIL-S-3786. The switch can be furnished with up to six poles per section; rotation may be unlimited, or limited from 2 to 12 positions. It measures 3/4 in sq; with 5 sections, the back-of-panel depth is 2-3/4 in.

R-F Electronics, Inc., Div. of Electro Switch Corp., Dept. ED, King Ave., Weymouth 88, Mass.

Wescon Booth 741

CIRCLE 61 ON READER-SERVICE CARD

### Energy Storage Capacitor

Low inductance of 0.01  $\mu\text{h}$

The energy storage and discharge capacitor line now includes a new design of high voltage, low inductance types for thermonuclear equipment and similar fast discharge and energy storage applications. Self-inductance of less than

0.01  $\mu$ h is the lowest now available and provides optimum efficiency of operation. Voltage ratings are available from 10 to 50 kv with capacitance values from 1 to 25  $\mu$ f. The capacitors have a standard case weighing less than 75 lb.

General Electric Co., Dept. ED,  
1 River Rd., Schenectady 5, N.Y.  
Wescon Booth 529-30

CIRCLE 62 ON READER-SERVICE CARD

## Transistors

### Diffused base silicon types

NPN diffused base silicon transistors, manufactured by a combined alloy and gaseous diffused process for good mechanical stability and electrical characteristics.

Units possess an alpha cutoff frequency of 50 mc, voltage breakdown of 60 v, low frequency current gain of 50 and power gain of approximately 18 db at 12.5 mc. Also featured are low saturation resistance which makes them ideal for large as well as small signal applications at temp to 165 C.

Raytheon Mfg. Co., Dept. ED,  
55 Chapel St., Newton 58, Mass.  
Wescon Booth 639-40

CIRCLE 63 ON READER-SERVICE CARD

## Impedance Bridges

### 40 cps to 250 mc range

Impedance bridges, precision oscillators, microwave equipment and resonant cavity wave meters will be exhibited by this newly-established subsidiary of Wayne Kerr Co., Ltd., of England.

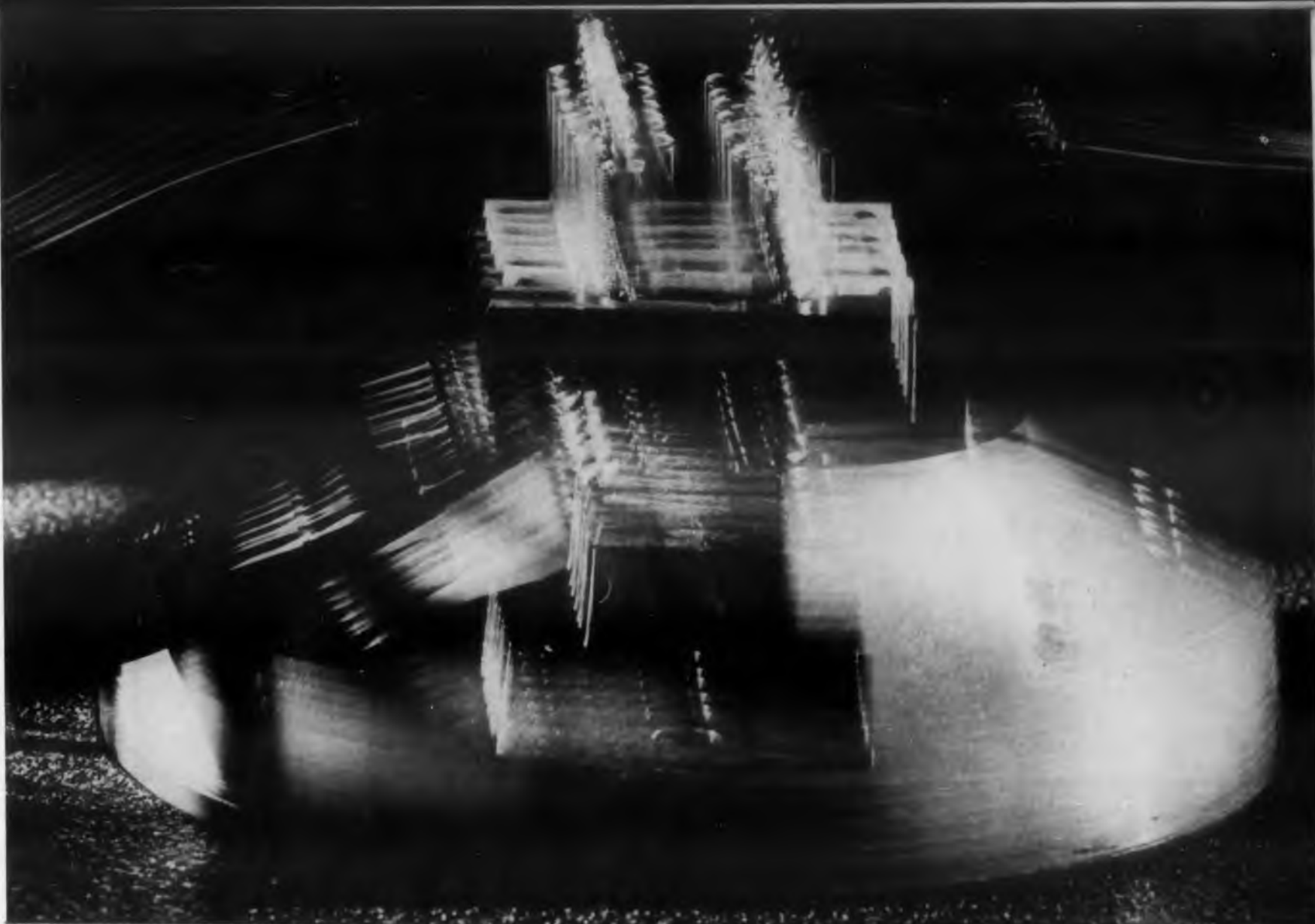
The impedance bridges run from 40 cps to 250 mc and feature vhf bridges used for admittance measurements for cables, transmission lines, feeders, antennas and with special application in transistor parameter measurements.

Wayne Kerr Corp., Dept. ED,  
2920 N. Fourth St., Philadelphia 33, Pa.

Wescon Booth 840

CIRCLE 64 ON READER-SERVICE CARD

CIRCLE 65 ON READER-SERVICE CARD



Two Type 7191's receive special "D.C. hold-off" vibration test. All Tung-Sol/Chatham miniature hydrogen thyratrons — 7190, 7191, 7192 — must "hold off" while subject to 15G

vibration, swept from 50 to 2,000 cps in 4 minutes. Tubes also are shocked at 48° hammer angle in Navy high-impact flyweight shock machine, equal to 720G/1 millisecond shock.

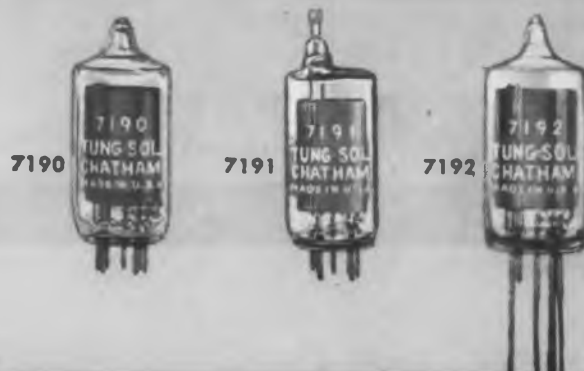
# Tung-Sol/Chatham miniature hydrogen thyratrons supply test-proved ruggedness for missile use!

Extensive in-factory tests assure designers Tung-Sol/Chatham miniature hydrogen thyratrons — 7190, 7191, 7192 — can withstand the severe shock and vibration met in missile flight. Performance of these tubes in several operational missiles gives in-use proof of their ruggedness.

In radar modulators and tracking beacons, these compact tough tubes supply 10 KW, replace bulkier types. Broad range of pulse repetition rates widens design choice . . . zero bias simplifies circuitry and

triggering requirements. Tubes hold off high voltage, pass high peak current with low tube voltage drop. Three types available: 7190 — pin base, 7191 — top anode connector, 7192 — flexible leads.

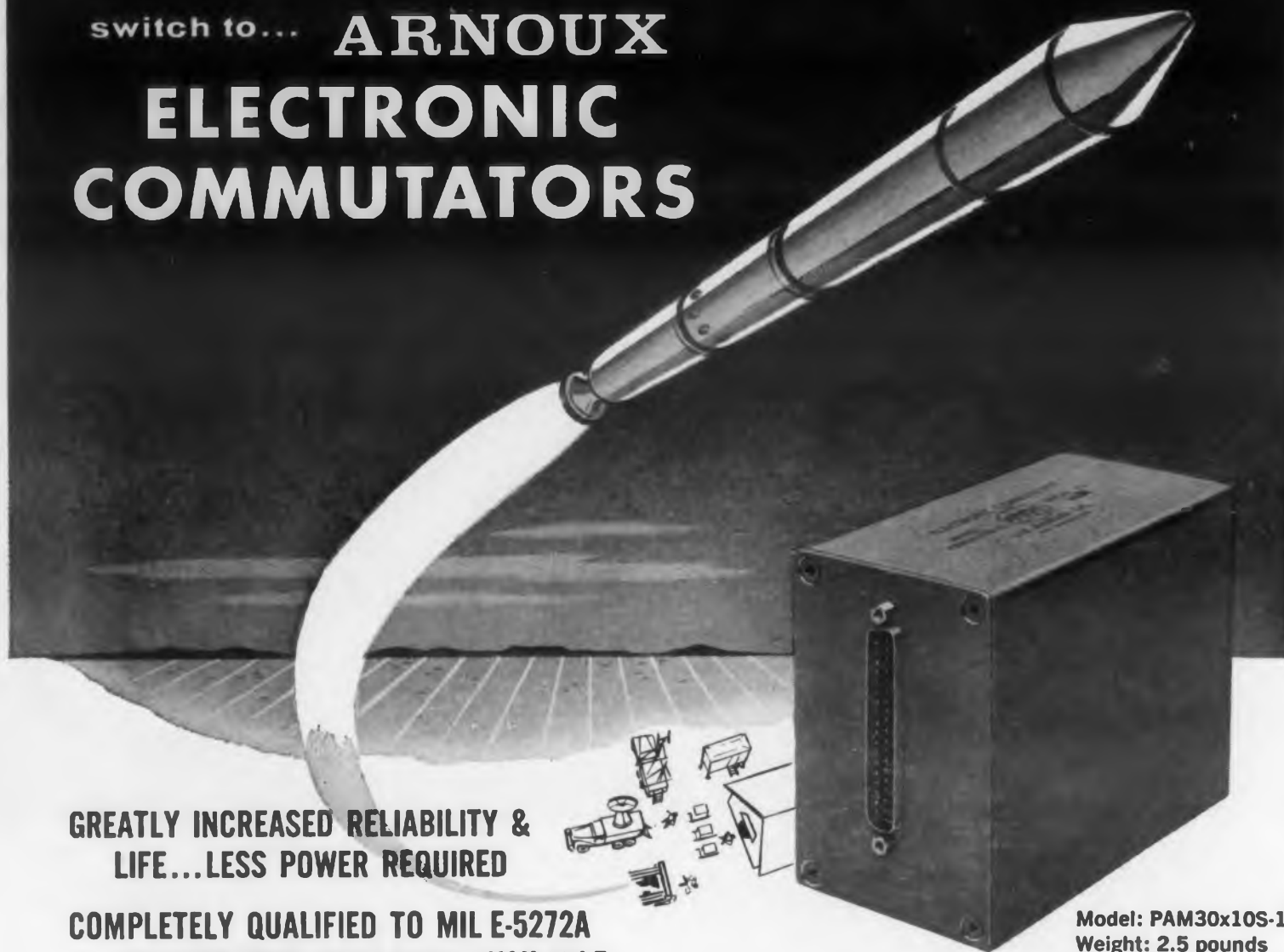
Tung-Sol, only producer of miniature hydrogen thyratrons for missiles, can supply you immediately. For complete data on these types . . . on special-purpose tubes of all types, phone or write. Tung-Sol Electric Inc., Newark 4, New Jersey. Commercial Engineering Offices: Bloomfield and Livingston, New Jersey; Culver City, California; Melrose Park, Illinois.



**ts TUNG-SOL®**

WHY COMPROMISE RELIABILITY?

switch to... **ARNOUX**  
**ELECTRONIC**  
**COMMUTATORS**



**GREATLY INCREASED RELIABILITY & LIFE...LESS POWER REQUIRED**

**COMPLETELY QUALIFIED TO MIL E-5272A QUALIFICATION TEST DATA AVAILABLE**

**Now in production...New rectangular case "DASH 10" series'  
Available in 30, 45, 90 Channels PDM and PAM**

THESE ADVANTAGES make Arnoux electronic commutators a must: long life, reliability, low noise level, and low power requirements.

The ETC commutator has a guaranteed service-free life of 5000 hours. Without vacuum tubes—built of all solid-state elements—the ETC has no moving parts. There are no switching transients. The frequency variation does not exceed  $\pm 5$  percent throughout the operating temperature and voltage ranges.

There is no radio interference; the ETC meets MIL-I-6181C specification. Signal noise (less than 0.05 percent) and crosstalk (less than 0.01 per-

cent) values are guaranteed; by actual test, these values are so low they cannot be measured.

Power requirement is only 2 watts (150 vdc at 12 ma) for the 30-channel unit.

The small, lightweight ETC can be used as a direct replacement for mechanical commutators in 0-3 v and 0-5 v airborne telemeter applications. It meets all IRIG requirements, exceeds MIL-E-5272A specification, and is available in all PAM and PDM sampling rates. A signal limiting feature, with the ETC, makes limiters unnecessary elsewhere in the telemetry system.

Write for Arnoux Bulletin 700

Sales Offices: Los Angeles, Seattle, Dallas, Bryn Mawr (Pa.), Arnprior, Ontario (Canada)



**ARNOUX CORPORATION**

Designers and Manufacturers of Precision Instrumentation

11924 WEST WASHINGTON BLVD. • LOS ANGELES 66, CALIFORNIA

CIRCLE 66 ON READER-SERVICE CARD

**NEW PRODUCTS**  
at **WESCON**

**Bridge Rectifiers**  
Miniature selenium types



An expanded line of selenium bridge rectifiers includes two new types for use in magnetic amplifier, light industrial and radio-tv applications. Type 61-4037 is a single phase bridge rectifier rated to provide 100 ma output into a resistive load, with a max input voltage of 260 v rms. Designed for use directly from a 117 v ac system, type D-3575M is a single-phase full-wave bridge rated to deliver an output of 9 w, continuous duty.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

Wescon Booth 1447-48

CIRCLE 67 ON READER-SERVICE CARD

**Space Room**

For uhf-vhf testing



A prefabricated free space room for all types of uhf-vhf microwave antenna or radome testing. The room consists of wooden frames supplied predrilled and with bolts for assembly, including a flush door with necessary hardware. The absorbing material is supplied in sections

ELECTRONIC DESIGN • August 6, 1958

bonded to aluminum foil. Absorbing material can be supplied for frequencies from 50 to 50,000 mc.

McMillan Lab, Inc., Dept. ED, Brownville Ave., Ipswich, Mass.

Wescon Booth 903-04

CIRCLE 68 ON READER-SERVICE CARD

## Test Equipment

Eight models introduced



Eight electronic measuring instruments will be introduced at the show. The equipment includes a signal generator, two voltmeters, a clip-on milliammeter, two electronic counters, a digital delay generator and a dual trace oscilloscope.

Model 524D electronic counter provides for measurements from 0 cps to 10 mc automatically and directly in one self-contained unit, without calculation or interpolation. Crystal oscillator stability is 5 parts in  $10^8$  per week. The 524C electronic counter (shown), is similar to the 524D, except that it is equipped with a nixie readout.

Model 122A oscilloscope is a low frequency scope giving a dual trace presentation by use of an alternate sweep or chopped sweep arrangement. It has a max sensitivity of 10 mv/cm. Bandwidth is 200 kc.

Model 606A signal generator covers a range 50 kc to 65 mc. Output is 3 v full range, and may be continuously attenuated to 0.1  $\mu$ v.

Model 405A digital voltmeter indicates voltages to three places, shows sign and automatically places decimal point.

The 428A clip-on milliammeter measures dc currents as low as 3 ma full scale without the need to break leads.

Model 218A digital delay generator produces two exact time intervals or pulse delays independently adjustable from 1 to 10,000  $\mu$ sec in 1  $\mu$ sec steps. Continuous interpolation between steps is calibrated in tenths of microseconds.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Rd., Palo Alto, Calif.

Wescon Booth 1450-51

CIRCLE 69 ON READER-SERVICE CARD

## ONLY ONE POTENTIOMETER THIS SMALL GIVES YOU THESE 5 FEATURES

Mount 16 units per square inch—cross-section only 0.190" x 5/16"

1. High temperature operation—to 175°C.
2. Humidity-proof—new plastic molding technique makes possible a smaller, fully-sealed potentiometer exceeding specifications of MIL-STD-202A, 10 days.
3. Power rating: one watt at 70°C.
4. Standard mounting holes on one-inch centers.
5. Easier, more accurate settings—25 turn screw driver adjustment gives you 33 times the adjustability of single-turn potentiometers, easy repeatability. Settings are stable and self-locking.



SEE US AT THE WESCON SHOW, BOOTH 1104

SEE US AT THE WESCON SHOW, BOOTH 1104

## IT'S THE NEW BOURNS TRIMPOT® MODEL 224

Available immediately from factory or distributors' stock with insulated stranded leads, solder lugs or printed circuit pins. Resistances: 100 $\Omega$  to 50K. Exceeds military shock and vibration specs. For data on the new Model 224 TRIMPOT write to:

**BOURNS Laboratories, Inc.**

P.O. Box 2112F, Riverside, California

EXCLUSIVE MANUFACTURER OF TRIMPOT® AND TRIMIT® • PIONEERS IN POTENTIOMETER TRANSDUCERS FOR POSITION, PRESSURE AND ACCELERATION

CIRCLE 70 ON READER-SERVICE CARD

BEYOND ACCEPTED STANDARDS OF TUBE RELIABILITY. 50,000 high-reliability tubes at a time—a half million a month—receive a special burn-in at General Electric's 5-Star factory. Tube performance is stabilized. Early-life inoperatives are weeded out. Every G-E 5-Star Tube also has passed rigid mechanical and electrical tests before shipment.



## BE SURE YOU GET STABILIZED TUBES WHEN YOU PAY FOR HIGH RELIABILITY!

Only General Electric stabilizes all high-reliability tubes by factory burn-in. What does this 5-Star process mean to you, a manufacturer of electronic equipment with critical sockets?

It's extra protection against production-line shut-downs in your plant, because stabilizing helps weed out any early-life tube inoperatives. Likewise, it's a special safeguard that your radar, communication, or other equipment will prove dependable from the start, when placed in service.

Stabilizing also promotes more uniform tube performance . . . your designers can count on 5-Star Tubes meeting rated requirements at all times. This helps assure that your equipment will continue to perform reliably—building a solid reputation that

will lead to repeat orders for new equipment.

When you specify high-reliability tubes, be sure you get the superior quality that only General Electric *stabilized* 5-Star tubes offer! Any G-E Receiving Tube Department office listed below will be glad to supply further information. Phone today!

EASTERN REGION	CENTRAL REGION	WESTERN REGION
200 Main Ave., Clifton, N.J.	3800 N. Milwaukee Ave.	11840 W. Olympic Blvd.
Phones:	Chicago 41, Illinois	Los Angeles 64, Cal.
(Clifton) GRegory 3-6387	Phone: SPring 7-1600	Phones: GRanite 9-7765
(N.Y.C.) WI. 7-4065, 6, 7, 8		BRadshaw 2-8566

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**  
12-11-204

## NEW PRODUCTS at WESCON

### Cable Jacket

For temperatures to 3000 F

An addition to the Zippertubing line, Thermazip will withstand 2000 F continuously and 3000 F for brief periods.

Manufactured of an aluminized reflective asbestos fiber, Thermazip cable jacket is closed by a plastic or metal zipper track stitched to the fiber with high temp Teflon thread.

The Zippertubing Co., Dept. ED, 752 S. San Pedro St., Los Angeles 14, Calif.

Wescon Booth 320

CIRCLE 72 ON READER-SERVICE CARD

### Terminals

Printed circuit types

Two printed circuit terminals have been added to the existing line. Types 2228 and 2420 are precision-machined in brass and finished with copper flash and a 0.003 in. tin-lead solder plating. Also announced are printed circuit coil forms, types 2525, 2530, 2540, 2550, available with four terminals and made completely of class H materials.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

Wescon Booth 1139

CIRCLE 73 ON READER-SERVICE CARD

### Laminated Plastics

Paper-base

Type EP-22 is an industrial laminated plastic possessing excellent electrical characteristics over a wide range of humidities and temperatures. The material is an Alpha paper filler impregnated with epoxy resin. It is available in sheets and strips from 1/32 to 1/4 in. thick, and in sheet sizes 36 x 36 in. and 36 x 72 in.

Synthane Corp., Dept. ED, 12 River Rd., Oaks, Pa.

Wescon Booth 302

CIRCLE 74 ON READER-SERVICE CARD

← CIRCLE 71 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

## Epoxy Resin Systems

Easily used

PRH 308, a single component thixotropic system, is a filled system composed of Resin 21. Because the curing agent is incorporated into the resin, neither mixing nor weighing are required.

PRH 400, a flexible epoxy protective coating, is a solvent based epoxy system which is recommended as a protective coating for printed circuits and other electrical and electronic components.

Permacel-LePage's Inc., Dept. ED, New Brunswick, N.J.  
Wescon Booth 126

CIRCLE 75 ON READER-SERVICE CARD

## Potentiometers

Three liquid-filled types

Three liquid-filled potentiometers include the 10-turn, 1-1/16 in. model 4203; 10-turn, 2 in. model 4613 and the 3-turn, 2 in. model 4713. These pots offer a life span of at least 10-million shaft revolutions, increased dielectric strength, greater heat dissipation, extremely low noise throughout life, and operation under water.

Beckman Instruments, Inc., Helipot Div., Dept. ED, Newport Beach, Calif.

Wescon Booth 1351-52

CIRCLE 76 ON READER-SERVICE CARD

## Analog-Digital Converter

Converts ten low-level inputs

The Panec system sequentially converts up to 10 low level inputs to digital form at a rate of up to 20 conversions per sec. The output of any one or all ten channels in sequence can be recorded on an analog strip chart recorder, or presented visually in numerical form on an in-line digital readout, or recorded on a digital printer, tape punch or card punch. Resolution of the system is 10  $\mu$ v.

Cohu Electronics, Inc., Cohu Research Div., Dept. ED, 14743 Hill St., Van Nuys, Calif.

Wescon Booth 1458-59

CIRCLE 77 ON READER-SERVICE CARD

CIRCLE 78 ON READER-SERVICE CARD

## BETA

130 at 1 amp

30 at 5 amps

$V_{CBO}$  -40V, -60V, or -80V

$I_{CO}$  2mA max at rated voltage

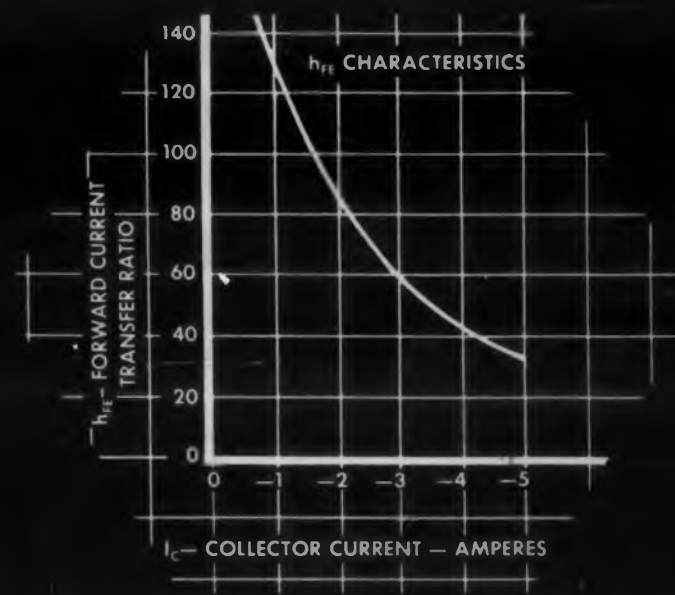
$R_{CS}$  less than .05 ohms

TI GERMANIUM POWER TRANSISTORS



You get high current gain and power output with linear transconductance and extremely low distortion when you specify TI PNP germanium power transistors. Assurance of performance as specified results from checking  $I_{CO}$  at half as well as full rated voltage, and by checking beta again at low voltage ( $V_{CE} = 1.5V$ ) and at two current ratings (1 amp and 5 amps). Ideally suited for your audio amplifier, current switching, and power conversion applications, TI 2N456, 2N457, and 2N458 germanium power transistors dissipate 50 watts with -40, -60, and -80V<sub>CBO</sub> ratings.  $BV_{CBO}$  ratings average 20 volts higher for each transistor.

Check the specifications below for the unit most appropriate to your particular requirements.



maximum ratings at 25° C*		2N456	2N457	2N458	unit
$V_{CBO}$	Collector to Base ( $I_C = -2.0mA$ )	-40	-60	-80	V
$V_{CEX}$	Collector to Emitter ( $V_{BE} = +0.2V, I_C = -2.0mA$ )	-40	-60	-80	V
$V_{EBO}$	Emitter to Base ( $I_E = -2.0mA$ )	-20	-20	-20	V
	Total Dissipation†	50	50	50	W
$I_C$	Collector Current	5	5	5	A
$I_B$	Base Current	3	3	3	A
$T_j$	Junction Temperature	95	95	95	°C

typical characteristics at 25° C*		2N456	2N457	2N458	unit
$BV_{CBO}$	Collector to Base Breakdown Voltage ( $I_C = -10mA, I_E = 0$ )	-60V	-80	-100	V
$h_{FE}$	Forward Current Transfer Ratio ( $I_C = -1.0A, V_{CE} = -1.5V$ )	130	130	130	-
	( $I_C = -5.0A, V_{CE} = -1.5V$ )	30	30	30	-
$R_{CS}$	Common-Emitter Saturation Resistance ( $I_C = -5.0A, I_B = -1.0A$ )	0.048	0.048	0.048	Ohm
	Thermal Resistance from Collector Junction to Mounting Base	1.1	1.1	1.1	°C/W

\* Temperature is measured on mounting base.

† For operation at higher temperatures refer to the Derating Curve.

AVAILABLE NOW IN PRODUCTION QUANTITIES

NEW 310,000 sq. ft. SEMICONDUCTOR COMPONENTS DIVISION HOME



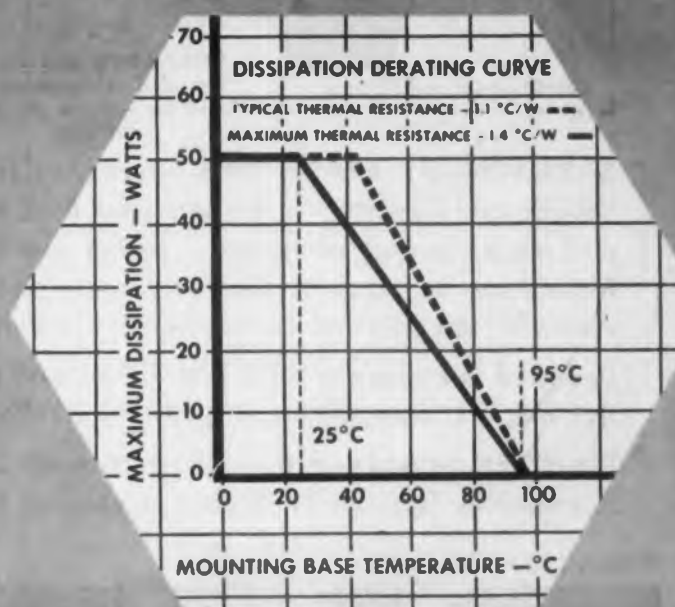
ADVANCED FACILITIES FOR THE MOST ADVANCED COMPONENTS TO MAKE YOUR GOOD PRODUCTS BETTER



TEXAS INSTRUMENTS

INCORPORATED

SEMICONDUCTOR - COMPONENTS DIVISION  
POST OFFICE BOX 312 • DALLAS, TEXAS

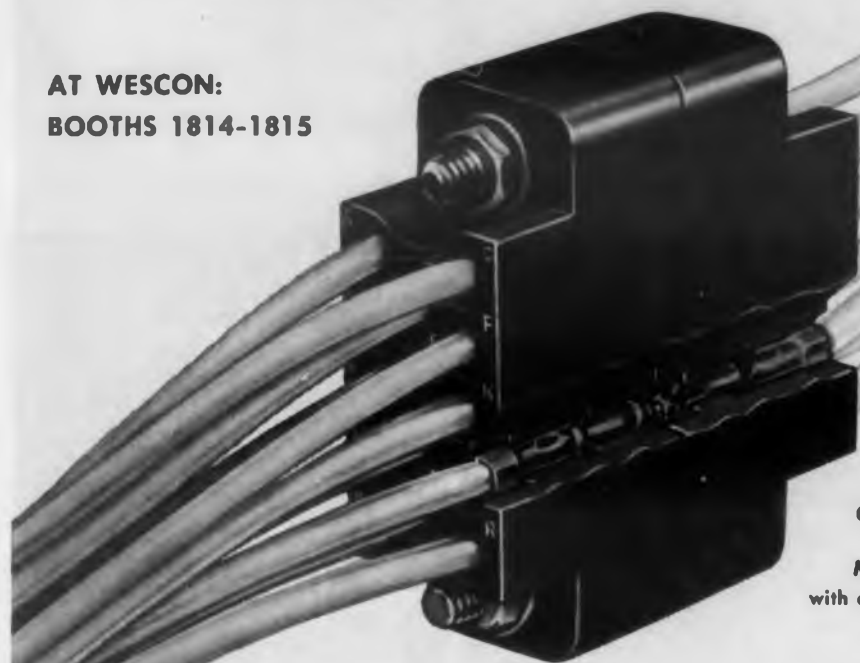


# HYFEN<sup>TM</sup>

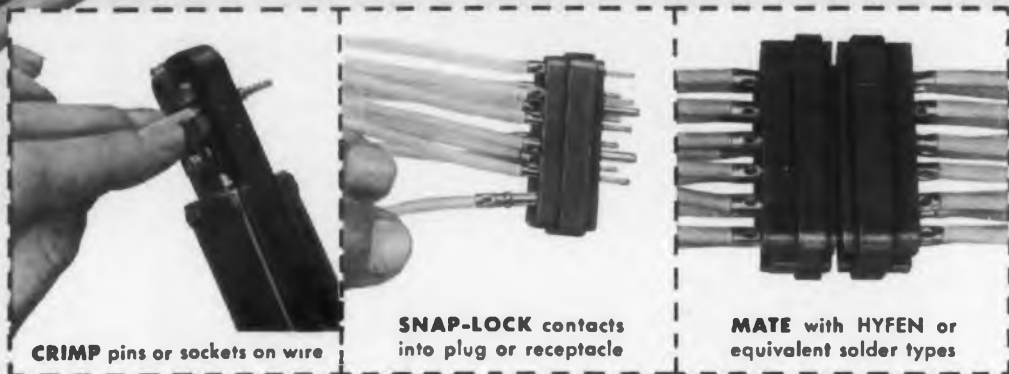
## CONNECTORS

*with crimped, snap-locked contacts*

AT WESCON:  
BOOTHS 1814-1815



Cutaway view of  
MINIATURE  
MS-type HYFEN  
with closed-entry sockets  
(enlarged)



CRIMP pins or sockets on wire

SNAP-LOCK contacts  
into plug or receptacle

MATE with HYFEN or  
equivalent solder types

**SAVE WEIGHT, SPACE, TIME**—Burndy's HYFEN method brings added Reliability and Versatility to the connector field, allowing the design of lighter and more compact equipment...saving space, weight and time. Pins and Sockets can be bench-installed on the wire and can be snap-locked in place even after the Plug and Receptacle have been mounted on the equipment.

Designed to replace or mate with virtually all existing connectors, including AN, MS, and other Miniature types, the HYFEN meets or exceeds MIL specs.

The HYFEN method ends the high rejection rate inherent with the use of solder...especially important in today's continuing trend toward miniaturization.

OMATON DIVISION

# BURNDY

For detailed information Write or Wire BURNDY, Norwalk, Connecticut, or Toronto, Canada...in Europe: Antwerp, Belgium

58-14

CIRCLE 96 ON READER-SERVICE CARD

## NEW PRODUCTS

at WESCON

### Resistance Bridge Indicator

Self-balancing



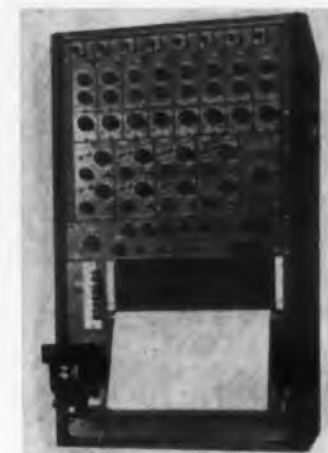
Model A resistance bridge indicator is a self-balancing, accurate, and compact instrument for measuring outputs of resistance bridge transducers in the range of 50 to 1000 ohms. Outputs from either full or half bridges with 1, 2, or 4 active arms are read from a digital display without necessity for external accessory equipment or manual null-balance operation.

Calibrated to read directly in micro-inches per in. strain with strain gage inputs.

Datran Electronics, Div. of Mid-Continent, Dept. ED, 1836 Rosecrans Ave., Manhattan Beach, Calif.

Wescon Booth 1615-16

CIRCLE 97 ON READER-SERVICE CARD



### Recording System

Very high sensitivity

Type R Dynograph all-transistor direct-writing recording assembly, features a high sensitivity of one microvolt per division for dc or ac signals, a frequency response from dc to 160 cps flat within 10 per cent and available with one, or more, of the following recording systems: ink curvilinear, electric curvilinear, heat rectilinear or electric rectilinear recording. The assembly can be supplied with a wide variety of input couplers to enable transducers to be coupled directly. No external excitation, bridge balance or calibration controls are required external to the assembly.

Offner Electronics Inc., Dept. ED, 5320 N. Kedzie Ave., Chicago 25, Ill.

Wescon Booth 632-33

CIRCLE 98 ON READER-SERVICE CARD



## Power Transistor

Dissipates 12 w



The 2N553 is a germanium power transistor with a thermal resistance between junction and mounting base of 1 C/watt typical, 2 C/watt max. It is capable of dissipating 12 w at a mounting base temperature of 70 C.

Delco Radio Div., General Motors Corp., Dept. ED, Kokomo, Ind.

Wescon Booth 826

CIRCLE 121 ON READER-SERVICE CARD

## Servo Gearhead

For size 10 or 11 servos



A precision gearhead primarily for size 10 servo motors, but also available with size 11 mounting dimensions. Output shaft is displaced off center. Ratios from 6.1 to 274:1 are available.

Clifton Precision Products Co., Inc., Dept. ED, Marple at Broadway, Clifton Heights, Pa.

Wescon Booth 749-50

CIRCLE 122 ON READER-SERVICE CARD

## DC Amplifiers

Chopper stabilized or non-stabilized



Model 3120 system contains five model 3101 dual amplifiers, providing ten chopper-stabilized dc amplifiers. The system is also available with model 3102 dual non-stabilized amplifiers.

Donner Scientific Co., Dept. ED, Concord, Calif.

Wescon Booth 1211-12

CIRCLE 123 ON READER-SERVICE CARD

# OHMITE<sup>®</sup> industry's most complete line of WIRE-WOUND RESISTORS

WRITE ON COMPANY LETTERHEAD FOR CATALOG 58

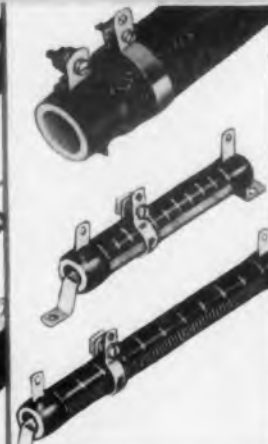
### Ohmite has exactly the resistor you need

Ohmite offers the most complete line of high quality resistors on the market . . . fixed, adjustable, tapped, noninductive, and precision resistors in many sizes and types of terminals . . . in a wide range of wattages and resistances. All-welded construction. Ohmite application engineers will be pleased to help you in selecting the resistors for your job.



#### FIXED

Resistance wire is wound on a ceramic tube and protected by a vitreous-enamel coating. Many kinds of terminals available. May be single winding, tapped, or multisection. Watts, 3 to 1000; ohms, 0.1 to 1,700,000.



#### DIVIDOHM ADJUSTABLE

Vitreous-enamelled resistors with the wire exposed in a strip along one side for contact with adjustable lugs. Most Ohmite resistors can be ordered adjustable. Watts, 10 to 1000; ohms, 1 to 100K.



#### AXIAL LEAD

Small vitreous-enamelled resistors with wire leads axially welded to caps on ends of the units. Also TUBEOHM ceramic jacketed style. Watts, vitreous 3 to 10; Tubeohm, 5 to 25; ohms, vitreous 1 to 50K; Tubeohm 1 to 25K.



#### THIN

Resistance wire is wound on a core of flattened oval cross section and protected by vitreous enamel. Several sizes. Fixed, adjustable or tapped. Watts, 10 to 75; ohms, 0.1 to 100K.



#### NONINDUCTIVE

Tubular vitreous-enamelled resistors with special winding. Dummy antennas consist of assemblies of several resistors. Watts, 5 to 1000; ohms, 1 to 5000.



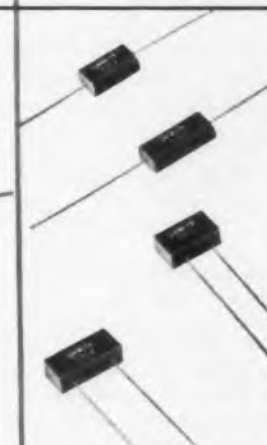
#### HIGH CURRENT

CORRIBS have exposed corrugated ribbon wound and enamelled on a tubular core. POWR-RIBS have bare coil of edgewise wound ribbon or round wire.



#### PRECISION WIRE-WOUND

Pie-wound resistors, encapsulated, impregnated, or hermetically sealed in glass. Also standard resistors wound to close tolerance. Watts, 1/8 to 2; ohms, 0.1 to 5 megohms.



#### PRECISION METAL FILM

Consists of a unique metal film permanently bonded to a glass plate. The assembly is sealed in a high-temperature resistant plastic case. Watts, 1/4 at 150°C to 1/2 at 105°C; ohms, 25 to 350K.



#### SPECIAL VARIETIES

Ohmite can provide toroids, flat strips, plaques, special-sized tubes, or tubes with mixed terminals, etc. Watt ratings and resistances are available as required.

RHEOSTATS RESISTORS RELAYS  
TAP SWITCHES TANTALUM CAPACITORS  
R. F. CHOKES VARIABLE TRANSFORMERS

OHMITE MANUFACTURING COMPANY

3643 Howard Street, Skokie, Illinois

CIRCLE 124 ON READER-SERVICE CARD



Synchros...another Kearfott capability

accuracy...reliability



SIZE 8

### SYNCHROS FOR EVERY APPLICATION

Kearfott offers the widest range of synchros in the industry. Ruggedly constructed of corrosion-resistant materials, they give unequalled performance under every environmental condition. For best characteristics and reliability, specify Kearfott for all your synchro requirements. Here are a few typical models:

**Size 8:** .750" x 1.240". 1.75 oz. -54C to +125C. Available as transmitter, control transformer, resolver, and differential. Max. error from EZ: 10, 7 and 5 minutes.

**Size 11 Standard:** 1.062"x1.766". 4 oz. -54C to +125C. Available as transmitter, control transformer, repeater, resolver and differential for 26v and 115v applications. Max. error from EZ: 10,7 and 5 minutes standard, 3 minutes in 4-wire configurations.

**Size 11 MIL Type:** Dimensions and applications same as above. Meets Bu. Ord. configurations: max. error from EZ: 7 minutes.

**Size 15 Precision Resolver (R587):** With compensating network and transistorized booster amplifier, provides 1:1 transformation ratio, 0° phase shift. Max. error from EZ: 5 minutes.

**Size 25 Ultra-Precise:** 2.478" x 3.187". 45 oz. Available as transmitter, differential, and control transformer. Max. error from EZ: 20 seconds arc.

*Engineers: Kearfott offers challenging opportunities in advanced component and system developments.*

# Kearfott

PRECISION  
EQUIPMENT  
CORPORATION  
GPE

**KEARFOTT COMPANY, INC., Little Falls, N. J.**

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION  
SALES AND ENGINEERING OFFICES: 1378 MAIN AVE., CLIFTON, N. J.  
MIDWEST OFFICE: 23 W. CALENDAR AVE., LA GRANGE, ILL.  
SOUTH CENTRAL OFFICE: 6211 DENTON DRIVE, DALLAS, TEXAS  
WEST COAST OFFICE: 253 N. VINEDO AVENUE, PASADENA, CALIF.

CIRCLE 86 ON READER-SERVICE CARD

## NEW PRODUCTS at WESCON



### Force-Balance Unit

Used in air data  
computers

This force-balance transducer operates on the principle that two coplanar forces acting at right angles to each other determine a resultant force which acts at some angle whose tangent is their ratio. The unit implements this principle by mechanically balancing two pressures or forces through a linkage system, to provide a shaft rotation functional to their ratio. This shaft rotation is used to drive such output devices as potentiometers, synchros, or coded discs. After each step of input, the sensing elements of the system return to their null position.

The accuracy and range of the instrument make it suitable for such uses as air speed computation, altimeters, and mach indication.

G. M. Giannini & Co., Inc., Dept. ED, Pasadena, Calif.

Wescon Booth 1665-66

CIRCLE 87 ON READER-SERVICE CARD



### Recording Systems

Modular amplifiers and  
discriminators

Amplifiers and discriminators are the features of these precision magnetic tape recording systems. All units are modular. One to seven of any assortment of models plug into a common, rack-mounted power supply. One recording amplifier gives either direct or PWM modulation at turn of a switch.

Minneapolis-Honeywell Regulator Co., Davies Labs Div., Dept. ED, 10721 Hanna St., Beltsville, Md.

Wescon Booth 501-02, 505, 543-44

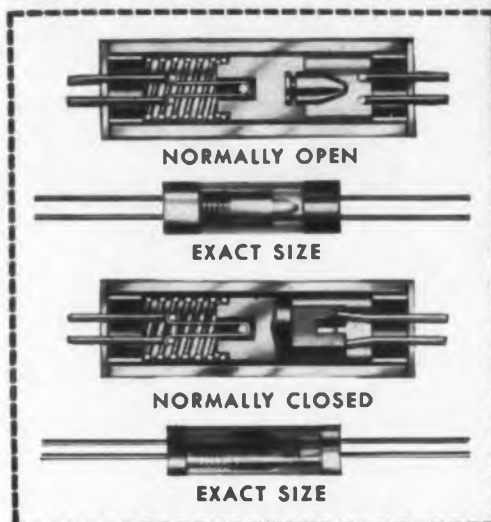
CIRCLE 88 ON READER-SERVICE CARD

# MINIATURE THERMAL RELAYS

with  
99.99% Plus  
Reliability

SERVICE-FITTED  
SERVICE-TESTED  
SERVICE-APPROVED

*Our complete  
environmental  
testing laboratory  
samples and certifies  
daily production.*



**New NORMALLY CLOSED RELAYS NOW AVAILABLE.** They both meet or exceed requirements for guided missiles and complex electronic gear.

They are hermetically sealed by bonding metal headers to high thermal, shock resistant glass housings.

They open or close a circuit positively in 0.1 second or other delay times.

They can also be safely used as a "squib" or timing mechanism.

#### Typical Characteristics

Temperature:  $-100^{\circ}\text{F. to } +450^{\circ}\text{F.}$   
Vibration: 20-3000 CPS at 40 G's  
Shock: 250 G's

*Brochure containing complete characteristics and specifications available upon request.*

## NETWORKS ELECTRONIC CORPORATION

14806 OXNARD ST., VAN NUYS, CALIF.

*Original designs for highest reliability in glass housed miniature Relays and Resistors for all purposes*

Booth 1710—Wescon

CIRCLE 89 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

**NEW**

# wire-wound RESISTORS\*

**Crafted with Precision  
for Reliability**



For critical military and industrial applications.

Hermetically sealed by bonding glass-kovar headers to high thermal, shock resistant glass housings. 100% humidity-proof.

NETWORKS' new, truly accurate, precision Resistors are available in 1/4, 1/2, 1 and 2 watt ratings at 105°C ± 0.1 to 1%. Units for 125°C available on special order. Lug types or flexible leads. Test results prove substantial improvement over MIL specs. They combine remarkable stability, under load and on the shelf, with exceptionally low temperature coefficient.

\*Patented

**Reliability  
Conservative Ratings  
Stable Characteristics**



Engineering Bulletin with complete specifications available upon request.

**NETWORKS  
ELECTRONIC  
CORPORATION**

14806 OXNARD ST., VAN NUYS, CALIFORNIA

Booth 1710—Wescon  
CIRCLE 91 ON READER-SERVICE CARD

# Reliability

**IS THE COMMON DENOMINATOR OF ALL  
NETWORKS MAGNETIC COMPONENTS**



## CURRENT TRANSDUCTORS

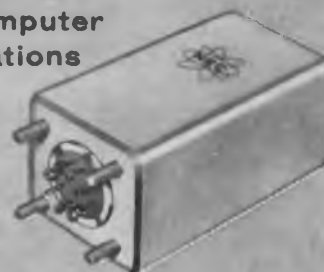
For plating and other high current applications

Function as DC current transformers for metering large DC currents without conventional shunts and to isolate DC bus from metering circuit. Units rated for bus currents from 100 to 2000 amps with 2500 to 1 current ratio. Accuracy from ± 1/2 to 2% depending on current rating.



## OVER AND UNDER CURRENT SWITCHES

For computer applications



Combination magnetic amplifier and transistor switching device with extreme sensitivity and reliability. 3 to 5 milliohm insertion resistance. Switch is NC (conducting) and opens with incremental current change of 40 ma or more from preset values. Current ranges 100 ma to 10 amps available. Temperature range -55°C to +85°C.



## FREQUENCY SENSITIVE RELAYS

For guided missile applications

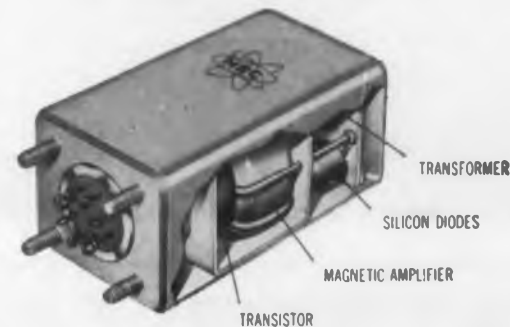


DPDT contacts actuated when frequency of supply varies ± 1% from 400 cps; will tolerate line voltage variation of ± 20%. Other center frequency values available. Temperature range -55°C to +85°C. Nominal voltage input 115V ± 20%. Other voltage ranges available. Withstand vibration up to 20g from 20 to 2000 cps. Shock of 400g for 1 millisecond in all planes.



## SENSITIVE ELECTRONIC SWITCHES

For general applications



Both current and voltage sensitive versions available. Sensitivities of control circuit as low as 750 microwatts. Control resistance from 3 milliohms to 2500 ohms. No moving parts. Switch circuit handles up to 40 V DC at 2 amps. Temperature range -55°C to +85°C. Meet or exceed all applicable military specifications.

- Patents Pending -

COMPLETE SPECIFICATIONS AVAILABLE UPON REQUEST

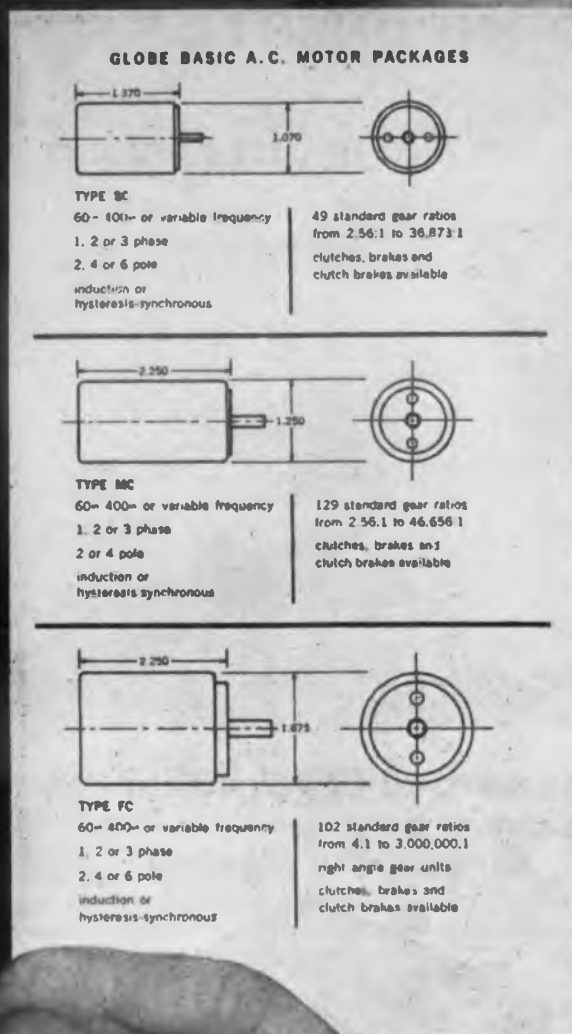
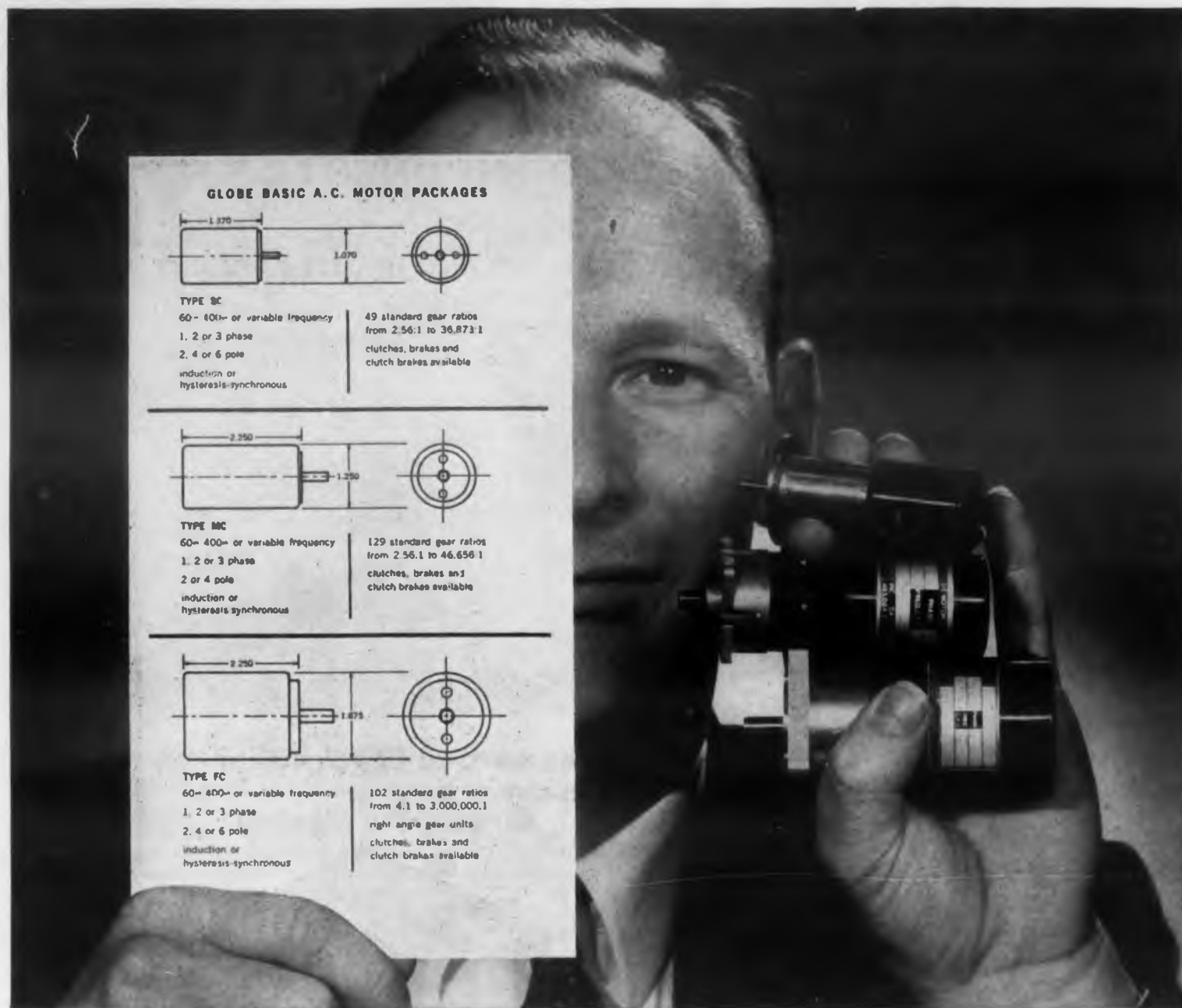
Concepts of proven reliability - yesterday... today... tomorrow.  
Standard or custom designs for airborne and ground applications.  
Engineers, Designers and Manufacturers of All-Magnetic Components.



**NETWORKS ELECTRONIC CORPORATION**

14806 OXNARD STREET • VAN NUYS, CALIFORNIA • STate 5-8805

BOOTH 1710—WESCON  
CIRCLE 90 ON READER-SERVICE CARD



## GLOBE A.C. MOTORS / GEAR REDUCERS / PACKAGES

In precision miniature motors, gear reducers, and small-package devices using clutches, brakes, and other components, Globe Industries has the hardware to meet your requirement. From a single source you can get fast 2 to 4 week prototype delivery of standard units. Modular design, interchangeable precision parts, and an efficient special order department are specific, unique reasons why you get what you need before your design grows cold.

Three basic A.C. motors are shown above. With their integral gear reducers they reliably span the torque range to more than 2000 in. oz. Custom modifications are a specialty.

Globe motor packages were chosen for the Army's Jupiter C, and as you read this, at least one such package is circling the earth. Ask the largest precision miniature motor manufacturer first. Request the Globe A.C. Motor Catalog now. GLOBE INDUSTRIES, INC., 1784 Stanley Avenue, Dayton 4, Ohio. Baldwin 2-3741.

CIRCLE 83 ON READER-SERVICE CARD

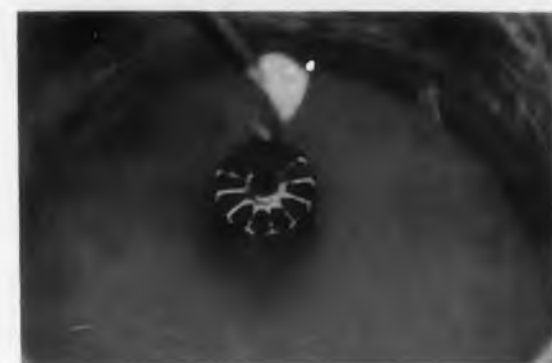


## NEW PRODUCTS

at **WESCON**

### Powdered Epoxy Resin

500 v per mil dielectric strength



For applications using an aerated bed, spray coating equipment or preformed resin slugs, XR-5005 epoxy resin is a rigid, overcuring resin with a dielectric strength of over 500 v per mil. No molds are needed in application; and no mixing is required.

Units to be coated are heated from 300 to 400 F, and dipped into the suspended powder, which is bubbled by compressed air. The heat of the unit melts the resin surrounding it, causing a layer of resin to cling to it.

Minnesota Mining and Mfg. Co., Dept. ED, 900 Bush Ave., St. Paul 6, Minn.

Wescon Booth 606-07

CIRCLE 84 ON READER-SERVICE CARD

### Power Supply

28 v dc, 0 to 5 amp



This transistorized regulated power supply provides 28 v dc, 0 to 5 amp, and operates from a 115-v, single-phase, 60-cps power source. Regulation is 0.1 per cent from no load to full load with 10 per cent change in input. Ripple is 0.1 per cent peak-to-peak. Voltage drift per deg centigrade rise is approximately 0.01 per cent.

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

Wescon Booth 515-16

CIRCLE 85 ON READER-SERVICE CARD

## Transistors

### Bilateral and drift types

Germanium alloyed junction transistors, for medium and high speed switching applications, and a diffused base drift transistor will be exhibited. The germanium alloyed types include two pnp types 2N592 and 2N593, and three npn types 2N594, 2N595 and 2N596. Collector to base voltage range is 20 to 40 v, and alpha cutoff frequency range is 1.5 to 5 mc.

General Transistor Corp., Dept. ED, 91-27 138th Place, Jamaica 35, N.Y.

Wescon Booth 1756-57

CIRCLE 79 ON READER-SERVICE CARD

## Laminated Plastic

### Phenolic glass base grade

GH-871, a phenolic glass base grade designed for short time, very high temperature applications, retains more than 95 per cent of its strength after half hour exposure at 500 F. It will withstand higher temperatures for shorter time periods. Another material, phenolite grade G-11, is a glass base epoxy.

National Vulcanized Fibre Co., Dept. ED, Box 311, Wilmington, Del.

Wescon Booth 304-05

CIRCLE 80 ON READER-SERVICE CARD

## Water Loads

### SL, S and X bands

Three waveguide water loads provide a convenient and accurate means of measuring microwave power when used with the model 190A calorimeter and model 189A thermopile. The loads can also be used independently as high power, low vswr terminations at the applicable waveguide frequencies.

Sierra Electronic Corp., Sub. of Philco Corp., Dept. ED, 3885 Bohannon Dr., Menlo Park, Calif.

Wescon Booth 1355-56

CIRCLE 81 ON READER-SERVICE CARD

CIRCLE 82 ON READER-SERVICE CARD ➤

DESIGNED TO MEET MIL-E-1

# MILITARY TYPE

# AUTOMATIC silicon rectifiers

JAN  
TYPES

1N253

1N254

1N255

1N256



WRITE TODAY FOR  
ENGINEERING  
"SPEC" SHEETS  
FOR ANY TYPE.

The reliability demanded by the rigid electrical, mechanical and environmental specifications of MIL-E-1 is now assured with Automatic's JAN TYPE silicon rectifiers . . . offered in production quantities at prices reflecting volume output.

Automatic offers, in addition to these JAN types, a complete line of Silicon Rectifiers for industry . . . including magnetic amplifiers, power supply, high voltage, germanium replacement and general purpose types.

### TYPICAL VALUES FOR AUTOMATIC MILITARY TYPE SILICON RECTIFIERS

Type No.	Peak Reverse Voltage (VDC)	DC Output Current (MA)	Maximum Reverse Current (MA)	Mounting	MIL-E-1 Technical Spec. Sheet No.
1N253	100	1000	0.1	Stud-Mount	1024A
1N254	200	400	0.1	Stud-Mount	999B
1N255	400	400	0.15	Stud-Mount	990B
1N256	600	200	0.25	Stud-Mount	991B

\* CASE TEMPERATURE 135°C.

\*\* AVERAGED OVER 1 CYCLE FOR INDUCTIVE OR RESISTIVE LOAD WITH RECTIFIER OPERATING AT FULL RATED CURRENT.

Available JAN TYPES: 1N253, 1N254, 1N255, 1N256

**AUTOMATIC  
MANUFACTURING**

MASS PRODUCERS OF  
ELECTRONIC COMPONENTS

AUTOMATIC MANUFACTURING  
DIVISION OF GENERAL INSTRUMENT CORPORATION  
65 GOUVERNEUR ST.  
NEWARK 4, N. J.

A COMPLETELY NEW *Concept* IN

# BOBBINLESS RESISTORS\*

New Subminiature Precision Wirewound Bobbinless Resistors feature exceptional stability, reliability and performance

General Transistor has developed a new concept for precision bobbinless resistors incorporating these exclusive features . . . the bobbinless construction eliminates wire stress and strain . . . a special viscous medium is used providing extreme shock and vibration resistance . . . welded case for positive hermetic sealing . . . the temperature coefficient of resistance of the finished resistor is the same as the wire and is not affected by the container. This insures repeatability and minimum hysteresis of resistance characteristics with temperature cycling.

These positive hermetically sealed units are designed for printed circuit boards and subminiature assemblies for airborne and missile applications.

The quality of materials and production superiority of these resistors is the same that has made General Transistor the Fastest Growing Name in Transistors.

Write today for complete technical information.

SEE US AT WESCON—  
BOOTH NOS. 1756 and 1757.

## SPECIFICATIONS

	Style R-2	Style R-5
Resistance Range	0.1Ω to 750KΩ	0.1Ω to 750KΩ
Resistance Tolerance	±0.05% min. at 25°C	±0.05% min. at 25°C
Power Rating	¼ watt continuous in free air (increased dissipation possible with heat sink)	½ watt continuous in free air (increased dissipation possible with heat sink)
Temperature Range	-65°C to +125°C	-65°C to +125°C
Maximum Operating Voltage	250V, DC	500V, DC
Temperature Coefficient of Resistance	±20 parts per million/°C	±20 parts per million/°C
Insulation Strength	500V rms, winding to case	1000V rms, winding to case

Construction - Terminations: - Welded



ACTUAL SIZE



\* PAT. PENDING

## GENERAL TRANSISTOR CORPORATION

91-27 138TH PLACE JAMAICA 35, NEW YORK

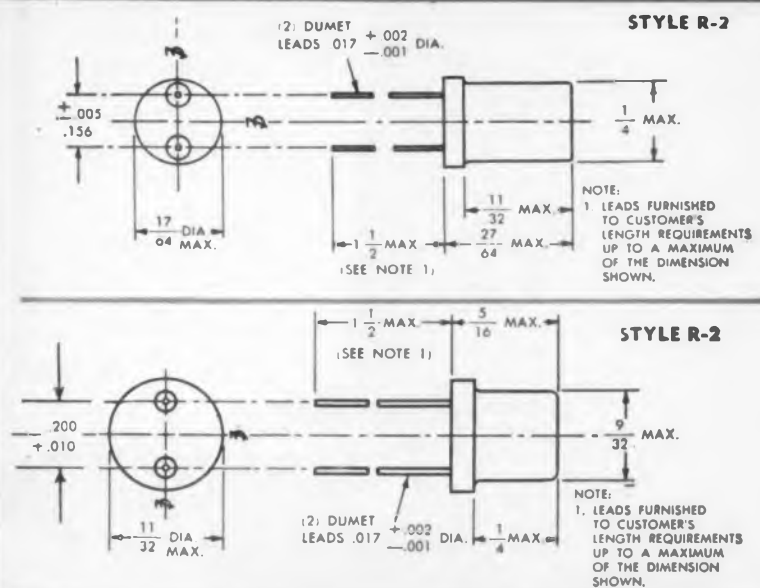
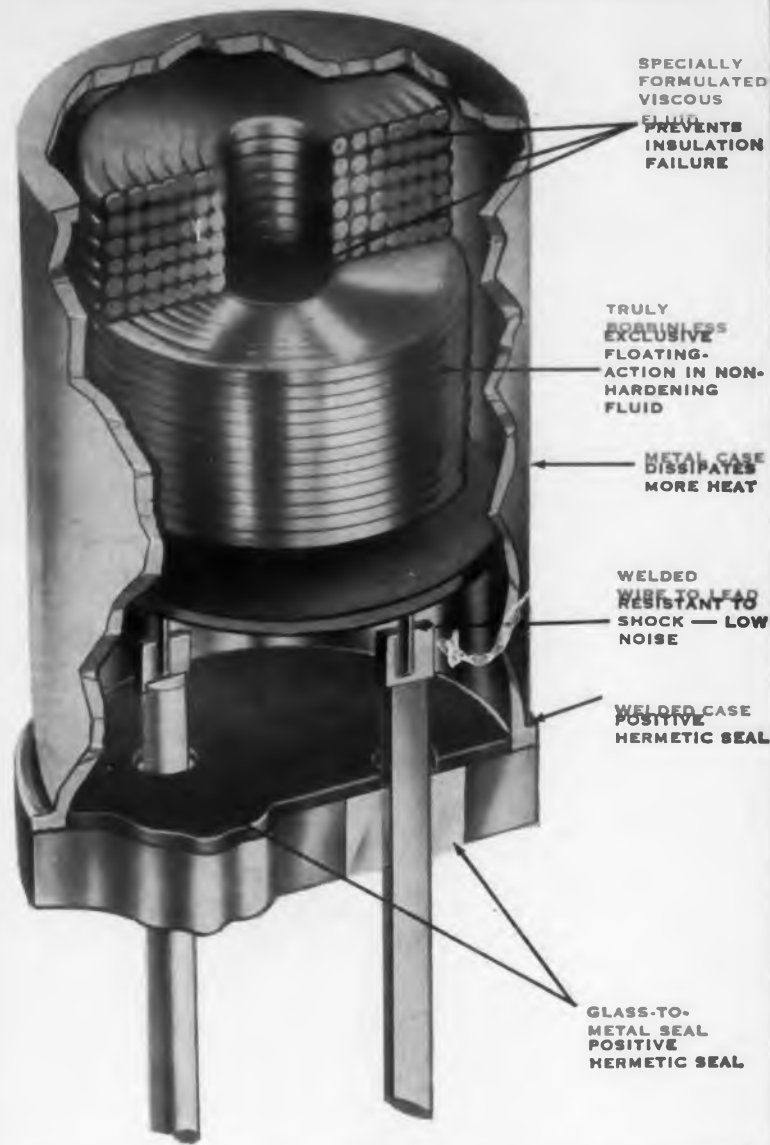
IN CANADA: DESSER E-E LTD., 441 ST. FRANCIS XAVIER, MONTREAL 1, QUEBEC

FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED GENERAL TRANSISTOR DISTRIBUTOR

OR GENERAL TRANSISTOR DISTRIBUTING CORP., 95-27 SUTPHIN BLVD., JAMAICA 38, NEW YORK

FOR EXPORT: GENERAL TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK

another QUALITY PRODUCT FROM GENERAL TRANSISTOR



## NEW PRODUCTS

### Millivolt Source

For calibration of instruments



This portable millivolt source has two ranges: 0 to 10 mv and 0 to 100 mv. It remains within 0.25 per cent accurate over a reasonable period of time.

Westronics, Inc., Dept. ED, 3605 McCart St., Ft. Worth, Tex.

CIRCLE 100 ON READER-SERVICE CARD

### Cathode Ray Tubes

Provide resolution of over 800 lines



Five flying spot scanners for black and white or color applications are added to a line of cathode ray tubes. Types 5AKP24, 5AUP24, 5BNP16, 5WP15, and 5ZP16 all have precision aligned guns which provide resolutions of over 800 lines at maximum anode ratings.

Raytheon Mfg. Co., Dept. ED, 55 Chapel St., Newton 58, Mass.

CIRCLE 101 ON READER-SERVICE CARD

### Electric Printer

Accepts parallel or serial input

Electric printer that accepts parallel or serial input and prints from 6 to 9 columns of digits in one or two copies. Output rate from

◀ CIRCLE 99 ON READER-SERVICE CARD

From PHILCO Transistor Center, U.S.A.

# New Medium Frequency Transistor Family!

parallel input is 3 lines per sec; from serial input, 4 digits per sec. Unit accepts over 100 ft of paper 3 in. wide.

Taller & Cooper, Inc., Business Automation Equipment Div., Dept. ED, 75 Front St., Brooklyn 1, N.Y.

CIRCLE 102 ON READER-SERVICE CARD

## Resistor

For printed circuit use



A low operating temperature, 5 w resistor, the type PC-5 is recommended for a printed circuit board mounting in circuits requiring a wirewound resistor with an actual wattage dissipation of 5 w or less, and for any circuit requiring a wirewound resistor capable of 7 w continuous operation.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

CIRCLE 103 ON READER-SERVICE CARD

## Quadrature Rejection Unit

Rejection ratios to 1000



This quadrature rejection unit has rejection ratios of 1000 for 0-9 v input and 800 for 9-15 v input. Input impedance is 20 k; input voltage 115 v, 400 cps. Weight is 1-1/4 lb.

Thompson Prod. Inc., Dept. ED, 2196 Clarkwood Rd., Cleveland 3, Ohio.

CIRCLE 104 ON READER-SERVICE CARD

CIRCLE 105 ON READER-SERVICE CARD



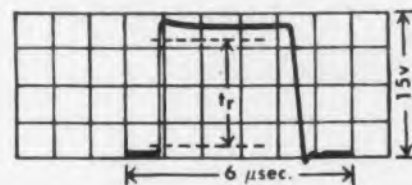
PERFORMANCE DATA

Type	General Performance		Max. Ratings		"ON" Switch Performance	
	Minimum $f_{ab}$	Typical $h_{FE}$	$I_C$	$V_{CB}$	Max. $V_{CE}$	Max. $V_{EE}$
2N597	3 mc	$V_{CE} = -1v, I_C = -100 ma$ 35	400	30	0.2	0.34
2N598	5 mc	$V_{CE} = -1v, I_C = -100 ma$ 30	400	30	0.2	0.34
2N599	12 mc	$V_{CE} = -1v, I_C = -100 ma$ 105	400	30	0.2	0.34

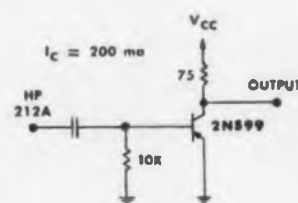
Total Device Dissipation at 25°C = 250 mw

TYPICAL RISE TIME CIRCUIT

2N599

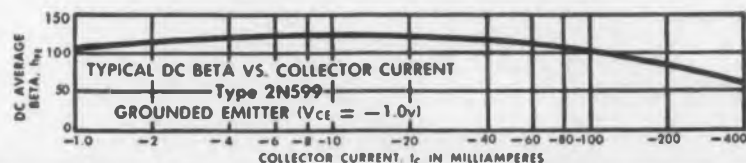


SWITCHING TIMES



TEST CIRCUIT

TYPICAL DC BETA VS. COLLECTOR CURRENT



- High Dissipation: 250 mw at 25°C
- High Current: Max.  $I_C = -400 ma$
- High Temperature: 100°C Max.
- High Voltage: Max.  $V_{CB} = -30v$
- High Frequencies: Min.  $f_{\alpha b}$  to 12 mc

Announcing a new Philco family of PNP germanium alloy junction transistors (In TO-9 [JETEC 30-type] housing). These transistors feature a unique, patented, cold-welded copper housing and internal construction that result in lower junction temperatures at normal operating power levels. Design of the 2N597, 2N598 and 2N599 insures improved life and reliability at temperatures as high as 100°C. Available in production quantities.

The high beta of these transistors at high currents makes them particularly applicable to medium speed flip-flops, logic gates, drum writers and core-driver circuits. The 30v collector rating provides the high level logic swings required in many data processing equipments. At 200 ma of collector current typical rise time for the illustrated circuit is 0.05  $\mu sec$ .

Make Philco your prime source for all transistor information and prices. Write Dept. ED-858

See us at WESCON, Booths 710 and 711.

**PHILCO CORPORATION**  
**LANSDALE TUBE COMPANY DIVISION**  
**LANSDALE, PENNSYLVANIA**





## NEW PRODUCTS at WESCON

### VHF Sweep Generator

Provides several functions



Model SV-6 VHF sweep generator features high reliability etched circuits and quick access cabinet styling. Available with many variations of functions, such as front panel sweep width and centering controls, single or multiple attenuator positions, sine wave or sawtooth horizontal sweep output voltage, etc. An r-f output voltage of 1 v rms across 75 ohms is provided, with crystal controlled audio and video on the 12 vhf channels and i-f.

Telonic Industries, Inc., Dept. ED, 73 N. 2nd Ave., Beech Grove, Ind.  
Wescon Booth 1643

CIRCLE 106 ON READER-SERVICE CARD

### Servomotors

High performance size 8 units

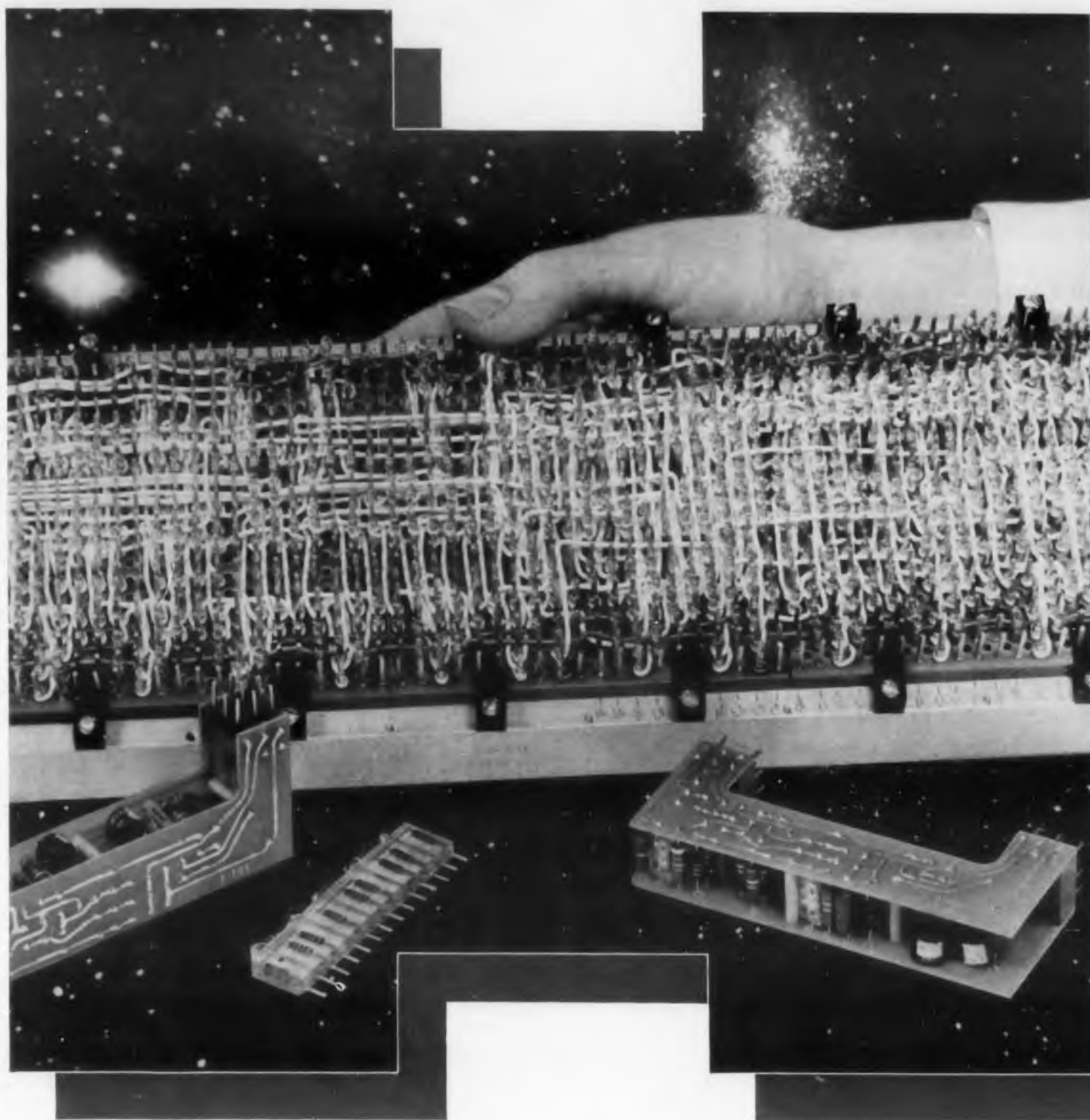


A line of size 8 servos include two motors, two inertia-damps, two velocity-damps and a motor-generator; available in 26-v models and (except for the motor generator) in 115-v models as well. A typical unit, the 8 mg 420/410 is a 26-v, 400-cps, servomotor rate generator. Torque at stall is 0.25 oz in.; power input, 2.3 w; rotor inertia, 0.16 gm-cm<sup>2</sup>; acceleration at stall, 110,000 rad/sec<sup>2</sup>.

Helipot Corporation, Div. of Beckman Instruments, Inc., Dept. ED, Newport Beach, Calif.  
Wescon Booth 1351-52

CIRCLE 107 ON READER-SERVICE CARD

## LIFELINE FOR



# THE LEAP INTO OUTER SPACE

Our only link with outer space is the advanced Communications System. Our progress in space technology has become dependent on solving the vast network of new problems which the Space Age has imposed on the field of Communications.

To meet these problems the Hughes Communications Systems Laboratories is drawing upon its continuing efforts in the field of Global Airborne Communications. Such newly devised Hughes hardware, at left, for example, illustrates the use of high-reliability wire wrapping to replace soldered connections and the use of inexpensive miniaturized "cordwood" circuit modules to make possible high component density.

New methods, such as Hughes-pioneered digital techniques, are being formulated to achieve the long-range goal of developing communications systems capable of deflecting their signals from meteors, artificial satellites, and even the moon. Still other methods are being devel-



**Electromagnetic positioning** of cutting edges is directed by this etched metal bar, a significant innovation which aided in the Hughes Products development of the first all-electronically controlled machine tool line.

**Data processors** under development at Hughes Fullerton will monitor the action of hundreds of aircraft and store the changing tactical situation in electronic memories for high-speed assignment of defense weapons.

*the West's leader in advanced electronics*

## HUGHES

© 1958, HUGHES AIRCRAFT COMPANY

**Wescon show.** Visit our booths 1401, 1402, 1812, and 1813 or the Hughes recruiting suites at the Chapman Park Hotel.

CIRCLE 551 ON READER-SERVICE CARD

oped for systems which will transmit intelligence through media impervious to radio frequencies by modulating frequencies far up the electromagnetic spectrum.

Advanced thinking, diversification, and expansion are also taking place in other areas of the Research & Development Laboratories, of which Communications is a part . . . in Hughes Products, the commercial activity of Hughes . . . in Hughes Fullerton, where three-dimensional radar systems are under development . . . in Hughes El Segundo, the manufacturing facility for complex electronics systems . . . and in Hughes Tucson, where guided missiles are manufactured.

Never before have the opportunities at Hughes been more promising!

*New commercial and military contracts have created an immediate need for engineers in the following areas:*

Nuclear Electronics	Field Engineering
Microwaves	Vacuum Tubes
Communications	Crystal Filters
Reliability	Systems Analysis
Circuit Design	Computer Engineering

*Write in confidence to Mr. Phil N. Scheid,  
Hughes General Offices, Bldg. 6-U, Culver City, California.*



HUGHES AIRCRAFT COMPANY  
Culver City, El Segundo,  
Fullerton and Los Angeles, California  
Tucson, Arizona



## Wire Markers

Provide permanent marking

Called Mini-Markers, this wire marker gives positive and permanent identification to wires, coated wires, and components under 5/32 in. OD.

Westline Products, Div. of Western Lithograph Co., Dept. ED, 600 E. 2nd St., Los Angeles, Calif.

Wescon Booth 231

CIRCLE 108 ON READER-SERVICE CARD

## Welder

Resistance type



The VTW-17 is a resistance type welder capable of welding molybdenum and tungsten rod up to 0.08 in. diam.

Vacuum Tube Products Co., Inc., Dept. ED, P.O. Box 810, Oceanside, Calif.

Wescon Booth 1303-04

CIRCLE 109 ON READER-SERVICE CARD

## Magnetic Amplifier

Proportional control



The PA5E proportional amplifier is a sensitive magnetic amplifier capable of proportional control of up to 90 w output power with input power of a few millimicrowatts. This amplifier was designed specifically to provide a reliable miniaturized temperature control system for devices such as hermetic integrating gyroscopes.

Magnetic Controls Co., Dept. ED, 6405 Cambridge St., Minneapolis 16, Minn.

Wescon Booth 1108

CIRCLE 110 ON READER-SERVICE CARD

# Visual and Electronic error-free decade counters



\*NOW WITH LESS THAN ONE  
MICROSECOND RESET  
AND 10 OUTPUTS



NIXIE  
ALL  
ELECTRONIC  
READOUT  
TUBE

Model shown  
Booths #822 & 823.



## MADE POSSIBLE BY BEAM SWITCHING TUBES

### NOTE THESE OUTSTANDING FEATURES

- NIXIE READOUT IN-LINE FIGURES VISIBLE 30-40 FT.
- RELIABILITY OF BEAM SWITCHING TUBE
- OPERATION WITH FULL TOLERANCE VARIATION OF ALL COMPONENTS
- SMALLEST PANEL HEIGHT (3 3/16")
- MINIMUM HEATER WATTAGE
- PLUG-IN DESIGN
- PROVISION FOR MECHANICAL OR ELECTRONIC ZERO-SET
- UNITS CASCADED DIRECTLY

MODEL	DC-101	DC-102	DC-103	*DC-105
Input	Negative 2.5 $\mu$ s 125V 1/2 Sine Wave Or Output of DC-101 DC-102	Negative 50 Volts Less than 1 $\mu$ sec rise time Duration at least 2 $\mu$ sec	Negative 110 Volts Less than 0.5 $\mu$ sec rise time	Negative 110 Volts Less than 0.5 $\mu$ sec rise time
Output	Drive DC-101	Drive DC-101	Drive DC-102	Drive DC-105 and 10 Individual Outputs
Resolution of Paired Pulses	Less than 10 $\mu$ sec	Less than 10 $\mu$ sec	Less than 1 $\mu$ sec	Less than 1 $\mu$ sec
Reset to Zero	Manual on Switch Closure or Electronic with Suitable Pulse	Manual on Switch Closure or Electronic with Suitable Pulse	Manual on Switch Closure or Electronic with Suitable Pulse	Manual on Switch Closure or Electronic with Suitable Pulse
Construction	Plug-In-Winchester Type MRE9P For Insertion in Type MRE9S	Plug-In-Winchester Type MRE9P For Insertion in Type MRE9S	Plug-In Winchester Type MRE9P For Insertion in Type MRE9S	Plug-In Printed Circuit Board For Insertion in U. S. Components UPCR93-D10
Maximum Counting Rate	10 KC	100 KC	1 Mc	1 Mc
Count Indication	Nixie "in-line" Numerical Readout — Type 6844A	Nixie "in-line" Numerical Readout — Type 6844A	Nixie "in-line" Numerical Readout — Type 6844A	Nixie "in-line" Numerical Readout — Type 6844A
Power Requirements	300 V — 18 ma DC 6.3 V — 0.3 A AC	300 V — 28 ma DC 6.3 V — 0.6 A AC	300 V — 30 ma DC 6.3 V — 0.9 A AC	300 V — 30 ma DC 6.3 V — 0.9 A AC
Tube Complement	Type BD300 Beam Switching Tube Counter — 6844A Indicator	Type BD300 Beam Switching Tube Counter — 6844A Indicator — Type 6201 Flip-Flop	Type BD300 Beam Switching Tube 6844A Indicator 5670 Flip-Flop 5963 Buffer	Type BD300 Beam Switching Tube 6844A Indicator 5670 Flip-Flop 5963 Buffer

Write for new brochure S1-4 that includes the Burroughs "Beamplexor" high speed 10 position electronic switch.

ANOTHER ELECTRONIC CONTRIBUTION BY  
**Burroughs Corporation**

ELECTRONIC TUBE DIVISION  
Plainfield, New Jersey

## NEW PRODUCTS

### Rotary Switch

Locks in position



When the key which operates the type JR switch is taken out, the switch locks in position and affords tamper-proof protection of complex electrical circuits. The switch provides control of up to three sections and eight positions.

Electro Switch Corp., Dept. ED,  
167 King Ave., Weymouth 88,  
Mass.

CIRCLE 112 ON READER-SERVICE CARD

### Flying Spot Scanner

Has bi-potential lens

Type 5ZP16 flying spot scanner features bi-potential focusing which minimizes spherical aberrations and results in a fine spot capable of high resolution. The 40-deg magnetic deflection crt has anode ratings of 30 kv.

Sylvania Electric Products Inc.,  
Dept. ED, Seneca Falls, N.Y.

CIRCLE 113 ON READER-SERVICE CARD

### Servo Elements

Miniature

Two light miniature servo elements: Model 08M10A1 26 v 400 cps size 08 servomotor has a no load speed of 6500 rpm. The 11M16A1 115 or 26 v 400 cps size 11 Linvar has an output proportional to rotor angle rising to 42.5 v.

Muirhead Instruments Inc., Dept. ED, 677 Fifth Ave., New York 22, N.Y.

CIRCLE 114 ON READER-SERVICE CARD

← CIRCLE 111 ON READER-SERVICE CARD

NEW PRODUCTS  
at WESCON

Traveling Wave Oscilloscope  
Can detect frequencies to 2000 mc



Type 2236A traveling wave oscilloscope is designed to display transient and repetitive phenomena in the millimicrosecond region. Frequencies as high as 2000 mc and voltage levels of 40 to 50 mv can be detected.

This type of oscilloscope utilizes a traveling wave type of deflection system. Helix pitch is adjusted to make the signal propagation speed down the tube match the beam velocity, thus achieving a high frequency response.

Edgerton, Germeshausen & Grier, Inc., Dept. ED, 160 Brookline Ave., Boston, Mass.  
Wescon Booth 1627

CIRCLE 115 ON READER-SERVICE CARD

PC Connector  
Built-in spacer



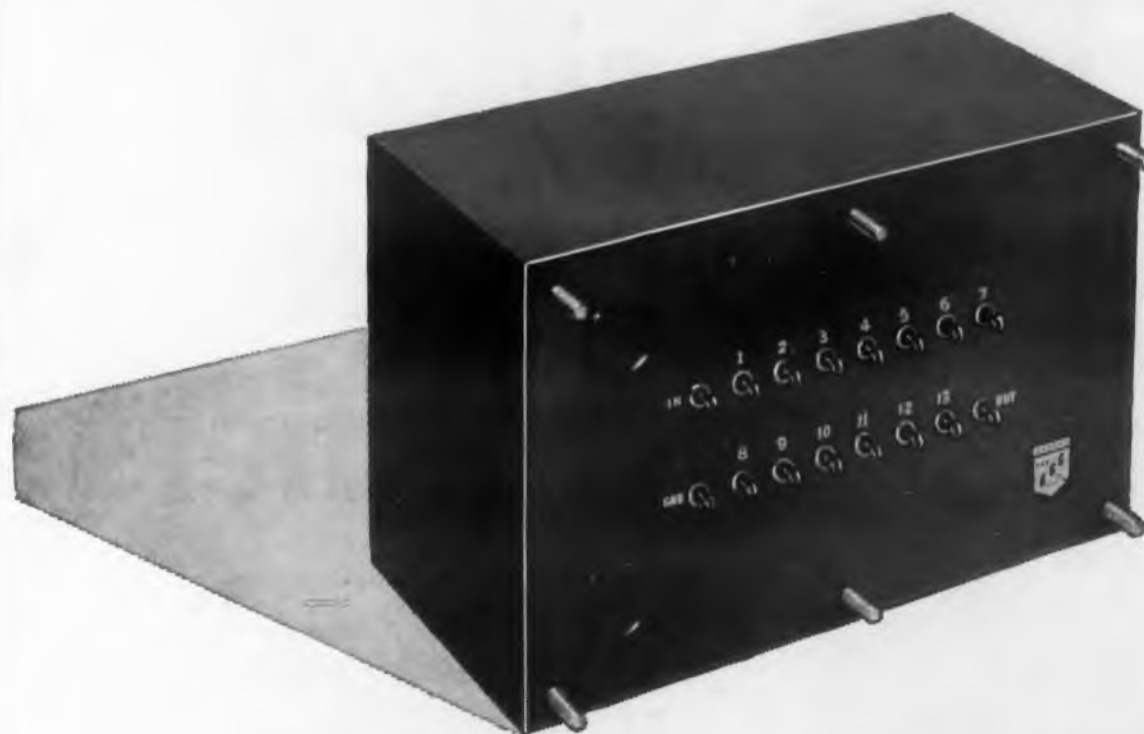
An insulating spacer molding has been designed into this 15-contact printed circuit connector to prevent the possibility of bending, twisting or shorting the contacts during assembly. The spacer is an integral part of the connector and assures uniform spacing of contacts. Connectors are supplied with the standard Bellows Action contacts.

DeJur-Amsco Corp., Electronic Sales Div., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N.Y.  
Wescon Booth 1521

CIRCLE 116 ON READER-SERVICE CARD

Because its 145 to 1 delay-to-rise-time ratio was considered impossible

# THIS IS THE DELAY LINE THAT COULDN'T BE MADE



## ... BUT ESC MADE IT!

Compare the new ESC Delay Line Model 51-43 with these competitive units:

TYPE	TOTAL DELAY	RISE TIME	VOLUME, INCHES	Zo OHMS	MAX. NO. PULSES	PULSES PER CU. IN.	TOTAL INSERTION LOSS	INSERTION LOSS PER PULSE	MERIT* FACTOR	MIN. PULSE LENGTH
**Commercial Air Core Delay Line	4.6 $\mu$ s.	0.1 $\mu$ s.	92.7	430	23	.248	7 db	.304 db	0.816	.2 $\mu$ s.
**Commercial Ferrite Core Delay Line	12 $\mu$ s.	0.26 $\mu$ s.	41.2	500	23.1	.56	2 db	.0866 db	6.45	.52 $\mu$ s.
**Commercial Ferrite Core Delay Line	200 $\mu$ s.	4.4 $\mu$ s.	74.4	500	22.8	.306	2 db	.0876 db	3.5	8.8 $\mu$ s.
**Commercial 1350 Ohm Distributed Line	12 $\mu$ s.	0.44 $\mu$ s.	77.7	1350	13.6	.175	12.4 db	.911 db	0.192	.88 $\mu$ s.
**RG 65 U	8 $\mu$ s.	0.31 $\mu$ s.	820	950	12.9	.0157	11.5 db	.892 db	0.0176	.62 $\mu$ s.
ESC Delay Line Model 51-43	20.3 $\mu$ s.	.14 $\mu$ s.	115	470	72	.625	2 db	.0278 db	22.5	.28 $\mu$ s.

\* Merit Factor =  $\frac{\text{Pulses In.}^2}{\text{Insertion loss per pulse}}$

\*\*J. R. Anderson, "Electrical Delay Lines for Digital Computer Applications" Transactions of the I.R.E.—June, 1953



# ESC CORPORATION

534 Bergen Boulevard, Palisades Park, New Jersey

CIRCLE 117 ON READER-SERVICE CARD

exceptional employment opportunities for engineers experienced in pulse techniques

SEE YOU AT THE WESCON SHOW—BOOTH #927

**ITT****Components Division Announces**

CONSERVATIVELY  
RATED FROM  
5 TO 70 AMPERES\*  
50 TO 800V PIV  
OPERATING RANGE  
65 C TO 175 C  
AMBIENT

\*NORMAL CONVECTION  
COOLING. INSTEAD  
OF STUD TEMP.  
MUCH HIGHER  
FORWARD CURRENT  
PERMISSIBLE WITH  
FORCED AIR COOLING.

AVAILABLE IN  
FLEXIBLE LEAD  
SOLDER LUG  
STACK

**FEDERAL  
GOLD CROWN**

**DIFFUSED JUNCTION**

# silicon power rectifiers

## FEATURES

- ADVANCED DIFFUSION TECHNIQUES
- STANDARD AND PROPOSED JETEC CASE STYLES
- HIGHEST EFFICIENCY
- MEETS MILITARY SPECIFICATIONS
- MAXIMUM RELIABILITY AND STABILITY

ITT's new concept in semiconductor device design has resulted in unique features which afford design engineers a superior silicon rectifier with highest electrical efficiency and maximum operating reliability.

These newly developed devices are available in styles shown and include these features . . . dual positive hermetic sealing . . . standard case designs permit mechanical interchangeability . . . designed for optimum heat transfer . . . controlled environmental assembly conditions . . . and improved engineering techniques.

The quality of materials and production superiority of these silicon rectifiers is the same that has made Federal the leader in selenium rectifiers.

Write today for technical and engineering data.

**ITT****Components Division**

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

P. O. BOX 412, CLIFTON, N. J.

SEE US AT BOOTH 1403 AND 1404 WESCON SHOW

CN

**NEW PRODUCTS  
at WESCON**

## Microwave Reflector Omnidirectional



This three dimensional microwave radar reflector device when illuminated from any azimuth or any angle in space, returns the total energy as reflected power. Based upon the Eaton Lens, the unit is effective up to X-band frequencies.

Also displayed is a do-it-yourself microwave absorber material, available as a light weight pack-in-place lossy dielectric. When formed into the proper shape and cured, it becomes a very effective microwave absorber for any pre-selected frequency.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

Wescon Booth 326

CIRCLE 119 ON READER-SERVICE CARD

## Servo Motor Inertial damped



A new version of an inertial damped servo motor will be shown. The permanent magnet and cup are both free to rotate and no damping develops when the magnet and cup are traveling at the same speed. When there is a relative change between the cup and the permanent magnet, torque is developed in the cup and this provides the damping. The corner frequency normally specifies the inertial damping and the product of this frequency in radians per sec and the motor time constant equals unity.

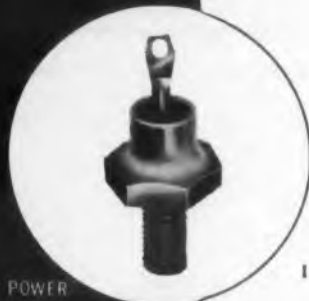
Daystrom, Inc., Transicoil Div., Dept. ED, Montgomery County, Worcester, Pa.

Wescon Booth 729

CIRCLE 120 ON READER-SERVICE CARD



STACKED  
CONFIGURATION  
CENTER TAPPED  
BRIDGE, THREE  
PHASE  
PARALLEL PH



MEDIUM POWER  
SERIES, SOLDER  
LUG STYLE, UP  
TO 20 AMPERES,  
50 TO 800V  
PIV

## NEW PRODUCTS

### Storage Batteries

Nickel Cadmium



Illustrated are individual storage cells with capacities of 64, 5, 2, and 1 amp hr. A nominal discharge of 1.2 low internal resistance (0.001 ohm for 10 AH type cell) permits high discharge currents.

Nicad Div., Gould-National Batteries, Inc., Dept. ED, Easthampton, Mass.

CIRCLE 93 ON READER-SERVICE CARD

### Rectilinear Recorders

Choice of ranges, chart drives

Rectilinear recorders in double, standard, and small sizes provide inkless and ink recording in one unit, 3-speed transmission plus 60 to 1 speed change, and 1 per cent accuracy for moving coil movement. They come in a wide choice of ranges and chart drives.

Curtiss-Wright Corp., Electronics Div., Dept. ED, 631 Central Ave., Carlstadt, N.J.

CIRCLE 94 ON READER-SERVICE CARD

### Digital Indicator

5 digit visual readout

Model 347 null-balance digital indicator is designed for input range of 0.5 to 4 mv dc. Output is 5 digit, illuminated visual and electrical digital. The unit has an accuracy of 0.05 per cent of full scale, resolution of 1/14,000 counts, and response rate of 12,000 counts per minute.

Dynametrics Corp., Dept. ED, Northwest Industrial Park, Burlington, Mass.

CIRCLE 95 ON READER-SERVICE CARD

CIRCLE 92 ON READER-SERVICE CARD

# ALLIED'S NEW ADDITIONS TO THE KH SUBMINIATURE LINE

## Types KHJ and KHY GENERAL FEATURES:

### Contact Data:

Contact Arrangement—DPDT

Contact Rating—

Low-level up to 2 amps at 29 volts d-c,  
1 amp at 115 volts a-c 400 cps  
non-inductive or 0.5 amp inductive.  
Life—100,000 minimum at 125°C

Also available 3 amps at 29 volts d-c,  
2 amps at 115 volts a-c 400 cps  
non-inductive or 1 amp inductive.  
Life—100,000 at 3 amps or 500,000  
minimum at 2 amps at 125°C.

### Initial Contact

Resistance—0.05 ohms maximum

Contact Drop—1 millivolt maximum

at low level rating, initial and during  
low level miss test

### Operate Data:

D-C Coil Resistance—up to 10,000 ohms

Nominal Power—1.2 watts

Pull-in Power—240 milliwatts (standard)

100 milliwatts (special)

Operate Time—5 milliseconds max.

Release Time—3 milliseconds max.

### Dielectric Strength:

1000 volts rms at sea level

500 volts rms at 70,000 feet

350 volts rms at 80,000 feet

### Insulation Resistance:

10,000 megohms minimum at 125°C

## ENVIRONMENTAL FEATURES

### Vibration:

5 to 10 cps at 0.5 inch double amplitude

10 to 55 cps at 0.25 inch double amplitude

55 to 2000 cps at 20 g

Shock: 100 g's operational • 200 g's mechanical

Ambient Temperature: -65°C to +125°C

## MECHANICAL FEATURES

Weight: 0.5 ounces

### Terminals:

Hooked Solder • Plug-in • Printed Circuit

### Mountings:

2 or 4 hole brackets at base or center of gravity

1 or 2 stud on top or side of housing

## MILITARY SPECIFICATIONS

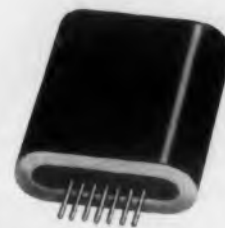
MIL-R-25018 • MIL-R-5757C

## ACTUAL SIZES

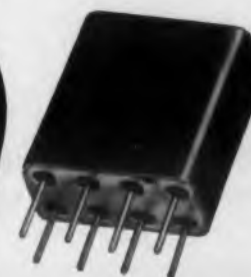
### Type KH

First  
Subminiature  
Relay

ORIGINATED BY  
ALLIED IN  
1952

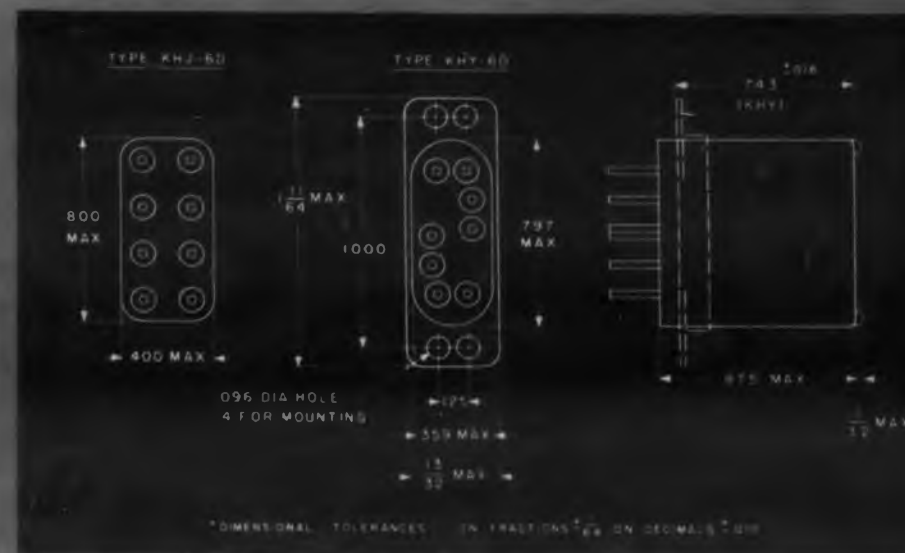


Type  
KHY



Type  
KHJ

Allied's type KHJ and KHY subminiature relays were developed to meet the present "Automation" need for relays with incremental grid spaced terminals and with improved performance. These relays have a higher contact rating and are designed to meet the increased vibration and shock requirements of the latest MIL specs. They are available with mounting brackets that are interchangeable with Allied's present type KH subminiature relay.



# ALLIED CONTROL



ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N. Y.

*Small...sensitive...high-speed*

## POLAR RELAY

for billions of  
maintenance-free  
operations

**H**ERE'S A 2-position Polar Relay that can be depended upon for switching a single circuit at high speeds through billions of operations—without readjustment.

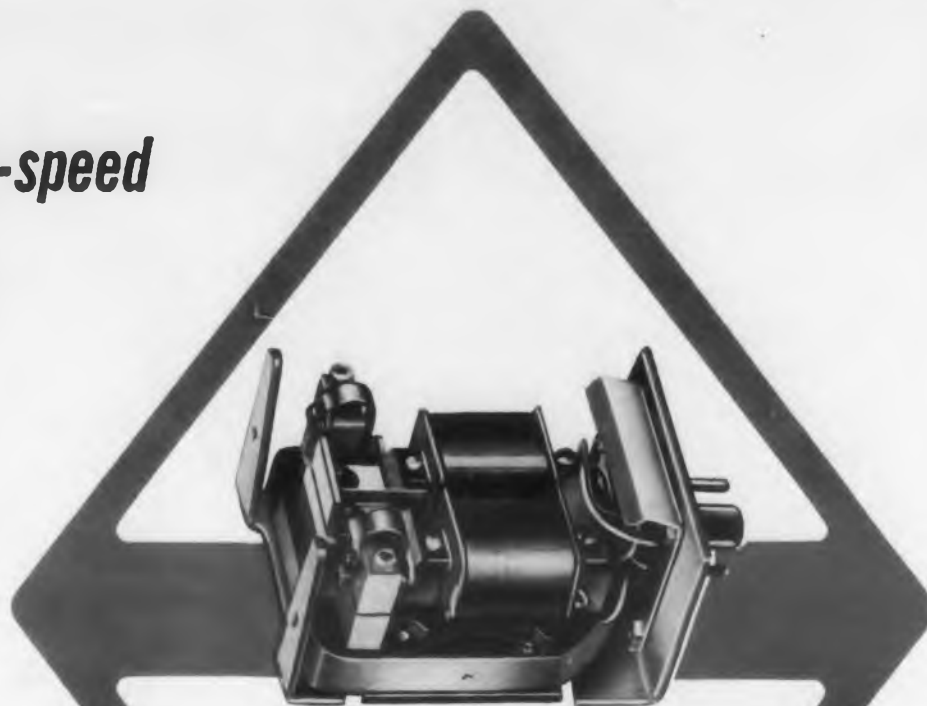
Substantially smaller than other polar relays, the Automatic Electric Series PTW is designed for telegraph and teleprinter circuits—teletypewriter switching—teletypewriter repeater circuits—plus other industrial and military applications. Type 203 is completely interchangeable with Western Electric 255A relays.

### Check these unique advantages

Because of its simple design and compact construction, the PTW costs substantially less than other relays you may have been using. It delivers lightning response (travel time as little as 0.7 of a millisecond!). And its design assures adjustments that stay put practically forever.

Series PTW Polar Relays are available with various type terminals to fit both new and existing applications—including surface mounting of Type 202 in replacement of Western Union Type 17 relay.

For full information, call or write Automatic Electric Sales Corporation, Northlake, Illinois. *In Canada:* Automatic Electric Sales (Canada) Ltd., Toronto. Offices in principal cities.



New Type 204 Series PTW Polar Relay has octal plug mounting for universal use. Height,  $2\frac{3}{16}$ " plus  $\frac{1}{16}$ " projection of mounting plug; width,  $2\frac{3}{32}$ " x  $1\frac{1}{16}$ ". Type 202 has standard banana-type terminals; Type 203 has pin-type terminals.



Automatic Electric Polar Relay is used in selector cabinet of Tele-register Corp. stock-quotation system. Teleregister design engineer, Jim Hartelius, shows how snap-on cover can be removed for visual inspection. He reports "... complete reliability ... almost infinite life ... virtually never gets out of adjustment."

# AUTOMATIC ELECTRIC

Northlake, Illinois • Subsidiary of GENERAL TELEPHONE

CIRCLE 125 ON READER-SERVICE CARD

## NEW PRODUCTS at WESCON



### Cable Tester

Tests branching circuits

Complex, branching circuits are simultaneously high potted, tested for continuity, and measured for leakage resistance between each circuit and all others by this cable tester. Calibrated front panel controls allow independent settings of all test parameters. Checking at a rate of 5 wires per second in automatic operation, the tester stops when a faulty circuit is found.

California Technical Ind., Div. of Textron Inc., Dept. ED, 1444 Old County Road, Belmont, Calif.

Wescon Booth 1213-14

CIRCLE 126 ON READER-SERVICE CARD

### Power Supply

0.05 per cent regulation



A fully transistorized power supply, model 62-121 has a regulation of 0.05 per cent for a line change of 105 to 125 v. Circuitry provides a high degree of freedom from spikes and transients.

Output range is 0.5-36 v dc at 15 amp, with full current available down to 0.5 v.

Dressen-Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena, Calif.

Wescon Booth 1435

CIRCLE 127 ON READER-SERVICE CARD



### Relay

Mercury-wetted contacts

Type HGS relay is similar to type HG and type HGP relays in that it comprises a sealed

ELECTRONIC DESIGN • August 6, 1958

pressurized switch capsule, with mercury-wetted contacts. It retains the long life and reliability features of those relays, with the added advantages of higher speed (up to 200 operations per sec) and more sensitive operation.

C. P. Clare & Co., Dept. ED, 6047 Hollywood Blvd., Los Angeles 28, Calif.

Wescon Booth 1603

CIRCLE 128 ON READER-SERVICE CARD

## Rectifiers

High voltage packaged units



Rated to provide voltages as high as 100,000 v, these units have ratings from 1 ma to 1 amp. The rectifiers are assembled with either silicon or selenium types, packaged in hermetically sealed housings, and operable in temperatures to 150 C.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

Wescon Booth 1447-48

CIRCLE 129 ON READER-SERVICE CARD

## Pulse Amplifier

Supplies up to 5 amp



Designed for a wide range of magnetic, crystal, and capacitance element testing, model 325A pulse amplifier is a wide band unit with output versatility. The instrument is compatible with the 5000 and 5100 series pulse code generating equipment, for tape core, memory, and matrix testing applications.

The instrument provides  $\pm 50$  ma to  $\pm 5$  amp ground ground.

Electro-Pulse, Inc., Dept. ED, 11861 Teale St., Culver City, Calif.

Wescon Booth 1645-46

CIRCLE 130 ON READER-SERVICE CARD

SERIES ... ③ ...

# radar relay switch noise problem

solved by  
**ASTRON**  
custom engineered  
26  
r. f. filter networks

The filters pictured were specifically developed to suppress radiated and conducted noise pulses generated from a coaxial relay switch. In this particular case Astron found it necessary to filter each contact of the switching network individually. The result was a single compact unit housing 26 different filters. A twelve-terminal line filter was also required to absorb residual noise. Both filters were hermetically sealed and compliance with all applicable military and environmental requirements was achieved.

These particular filters are one example of many custom built by Astron . . . We bring them to your attention not to demonstrate an unusual filter problem, but rather to demonstrate a very usual result of Astron's engineering skill.

Regardless of the complexity of your filter applications . . . the severity of the existent environmental conditions . . . Astron will design and produce RF noise suppression filters to your exact requirements.

IF YOU HAVE A FILTER PROBLEM — WRITE TODAY FOR ASTRON'S "FILTER SPECIFICATION CHECK LIST."



**ASTRON**  
CORPORATION

SEE US AT BOOTH  
1729  
WESCON SHOW

255 GRANT AVE. E. NEWARK, N. J.

SKOTTIE ELECTRONICS CORPORATION  
PECKVILLE, PENNSYLVANIA  
A WHOLLY-OWNED  
SUBSIDIARY OF ASTRON CORPORATION

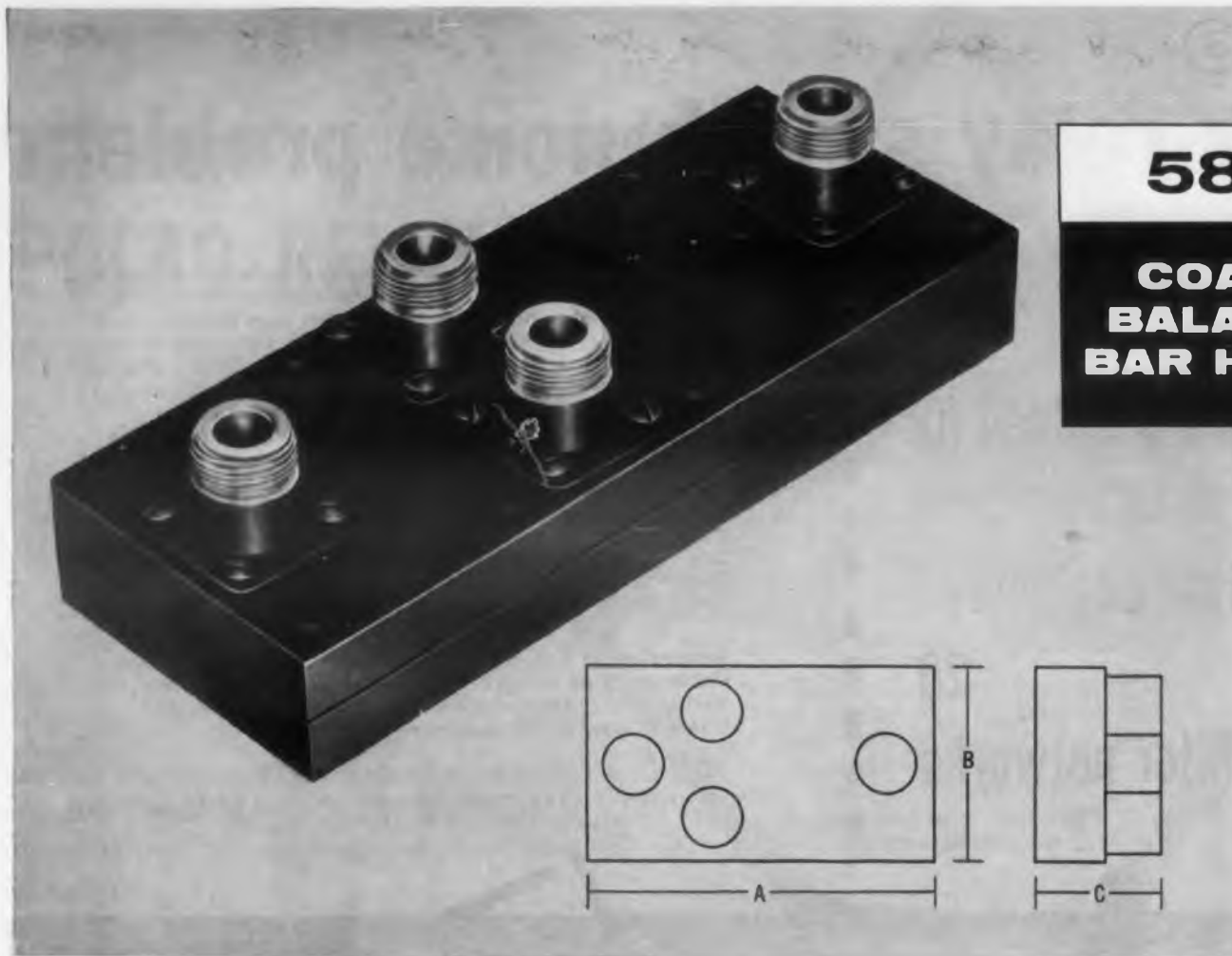
EXPORT DIVISION  
ROCKE INTERNATIONAL CORP.  
13 EAST 40TH ST.  
NEW YORK, N. Y.

IN CANADA  
CHARLES W. POINTON  
8 ALCINA AVE.  
TORONTO, ONTARIO



SOLVING YOUR FILTER REQUIREMENTS FROM THE PROBLEM TO THE PRODUCT.  
CIRCLE 131 ON READER-SERVICE CARD





**5805**  
**COAXIAL  
BALANCED  
BAR HYBRID\***

**MODEL NL5805**

The growth of the guided missiles field has provoked increased engineering activity directed towards the miniaturization of microwave components. Special techniques and materials have been developed to conform with severe space limitations and extreme temperatures. The Bogart series of bar hybrids has found wide use in military and commercial applications as **balanced mixers** (coaxial crystal mounts are available as accessory equipment), **power splitters**, **phase comparators**, **variable power dividers**, **fixed and variable attenuators**, **phase shifters** for monopulse work, **duplexers** to permit design of complete coaxial R-F

heads composed entirely of hybrids, and **beacon switching devices**.

A brochure entitled "Applications Employing Coaxial Bar Hybrids", in which the Bogart hybrids are presently used to perform the previously described functions, is available upon request. Special applications of Bogart Bar Hybrids can be designed to meet your specific requirements. Our applications engineers will be pleased to discuss your particular problems with you.

For characteristics of coaxial crystal mounts, refer to Bogart Series 1032.

\*PATENT PENDING

Model No.	Frequency Range (Kmc/s)	Maximum VSWR (Arm 1)	Maximum VSWR (Arm 4)	Average Power Rating (Arm 1) (Watts)	Average Power Rating (Arm 4) (Watts)	Minimum Isolation (Arms 1 & 4) (db)	Power Division (Arms 2 & 3) (db)	Weight (lbs)	(A)	(B)	(C)
NX5805	7.00-10.50	1.75	2.50	200	20	30	±0.2	¾	2½	2	3
NC5805	4.70-7.30	1.75	2.00	200	30	30	±0.2	1	3	2½	3½
NH5805*	3.50-5.00	1.75	2.00	200	30	30	±0.2	1½	3½	3	4
NS5805	2.30-3.70	2.00	2.00	200	30	30	±0.2	1	4	3¼	1
NR5805*	1.50-2.30	2.00	2.00	200	30	30	±0.2	1	5	2¼	1
NL5805	.900-1.50	1.75	1.75	200	30	30	±0.2	1¼	6	2¼	1½
NU5805*	.450-.900	1.50	1.75	200	30	30	±0.2	2½	12	2¼	1½
NV5805*	.225-.450	1.50	1.50	200	30	35	±0.2	4	12	2¼	3

Above data subject to change without notice.

\*Available shortly



**BOGART MANUFACTURING CORPORATION**  
315 Seigel Street  
Brooklyn 6, New York

serving the electronics industry since 1942

design • development • production

CIRCLE 132 ON READER-SERVICE CARD

**NEW PRODUCTS**  
at **WESCON**

**Tantalum Capacitors**  
2 to 240 µf



These solid electrolyte tantalum capacitors have stable capacity, dissipation factor and leakage current over a -80 to +85 C range. Their case sizes cover ratings of 2 µf at 35 working volts to 240 µf at 4 working volts.

International Telephone & Telegraph Components Div., Dept. ED, P.O. Box 412, Clinton, N.J.

Wescon Booth 1404

CIRCLE 133 ON READER-SERVICE CARD

**Recording Heads**

Two track, four channels



Model TR48A Isodex can record and play back four channels on a standard 1/4-in. tape. The unit has two tracks with gaps in-line. The tracks are positioned to permit interlaced operation.

Shure Brothers Inc., Dept. ED, 222 Hart Ave., Evanston, Ill.

Wescon Booth 1306

CIRCLE 134 ON READER-SERVICE CARD

**Carrier Amplifier**

Two channel



Two channel carrier operates on a carrier for

ELECTRONIC DESIGN • August 6, 1958

quency of 5000 cps, with a range of 0 to 1000 cps. Also displayed are two new models of the 906 direct-recording Visicorder oscillograph. Similar in appearance to the 906, model 906A is available in two versions, the 906A-1 and 906A-2.

Minneapolis-Honeywell Regulator Co., Heiland Div., Dept. ED, 5200 E. Evans Ave., Denver 22, Colo.

Wescon Booth 544

CIRCLE 135 ON READER-SERVICE CARD

## Synchros

Size 8 series



A line of size 8 synchros includes control transformers, transmitters, repeaters, resolvers and differentials. The units will feature corrosion resistant construction throughout, conforming to MIL-E-5272 specifications. Standard units will be displayed with 11.8 v, 26 v or 90 v excitation, operating over a -54 to +125 C range.

Daystrom, Inc., Transicoil Div., Dept. ED, Montgomery County, Worcester, Pa.

Wescon Booth 729

CIRCLE 136 ON READER-SERVICE CARD

## Impulse Latching Relay

With manual reset



Type S110DPB relay is available with two double throw contacts, if required. The unit operates on a 15 msec pulse and is available for 60 to 400 cps operation internally rectified. Relay consumes no power after first pulse.

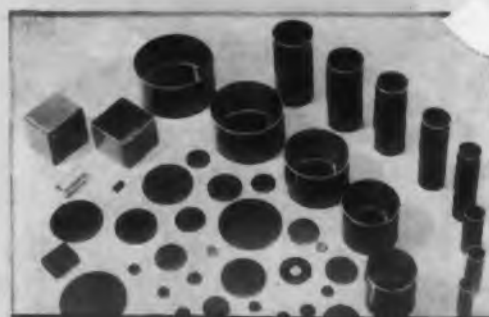
Electro-Mechanical Spec. Co., Inc., Dept. ED, 1016 N. Highland Ave., Los Angeles 38, Calif.

Wescon Booth 638

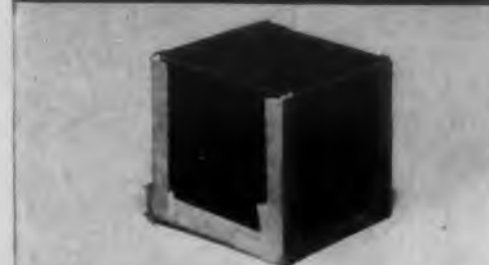
CIRCLE 137 ON READER-SERVICE CARD

# THESE 5 FORMS OF EPOXY

*will solve any component encapsulation problem!*



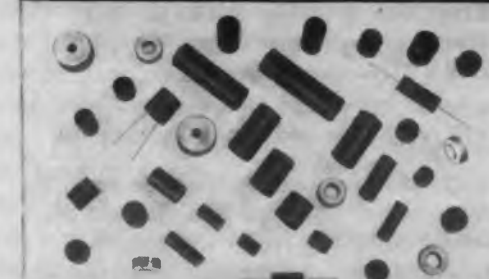
**E-CASE SHELLS AND SLEEVES**— Available from stock in standard sizes. These molded epoxy cases can be machined to special configurations.



**EPOXY SHEET**— Molded epoxy sheets in a variety of thicknesses. When heated to 125°F this material can be formed and cut. Ideal for prototype packaging and short runs.



**E-FORM CASTING POWDERS**— Premixed resin and hardener ideally suited for prototype or short runs. Melts as low as 85°C or as high as 145°C for fast curing.



**E-FORM PELLETS**— All casting powders can be corn pressed into pre metered pellets for production applications. Many pellet sizes available.



**EPOXY LIQUID AND HARDENER**— If application will not tolerate elevated temperatures, liquid resins and hardeners will cure at room temperature.

Shells, sheeting, powder, pellets, liquid—EPOXY PRODUCTS can provide the right form of epoxy to solve your component encapsulation problem. Using these 5 basic forms (the widest line available today) we custom-build an epoxy unit that is just the right size, shape and quality for your component. Once the right encapsulating unit is developed, it can be produced in quantity immediately and placed on your production line. In short, no matter what type of component you are encapsulating, no matter what your facilities are now, there is an epoxy form and method just for you—from EPOXY PRODUCTS! Write today for complete technical data and literature.

*Test epoxy encapsulation in your own lab!*

*A special kit containing generous samples of all 5 forms of epoxy resin, plus instructions, is available. Use it to test epoxy encapsulation on your own products—right in your own lab! Only \$9.93 from your distributor.*

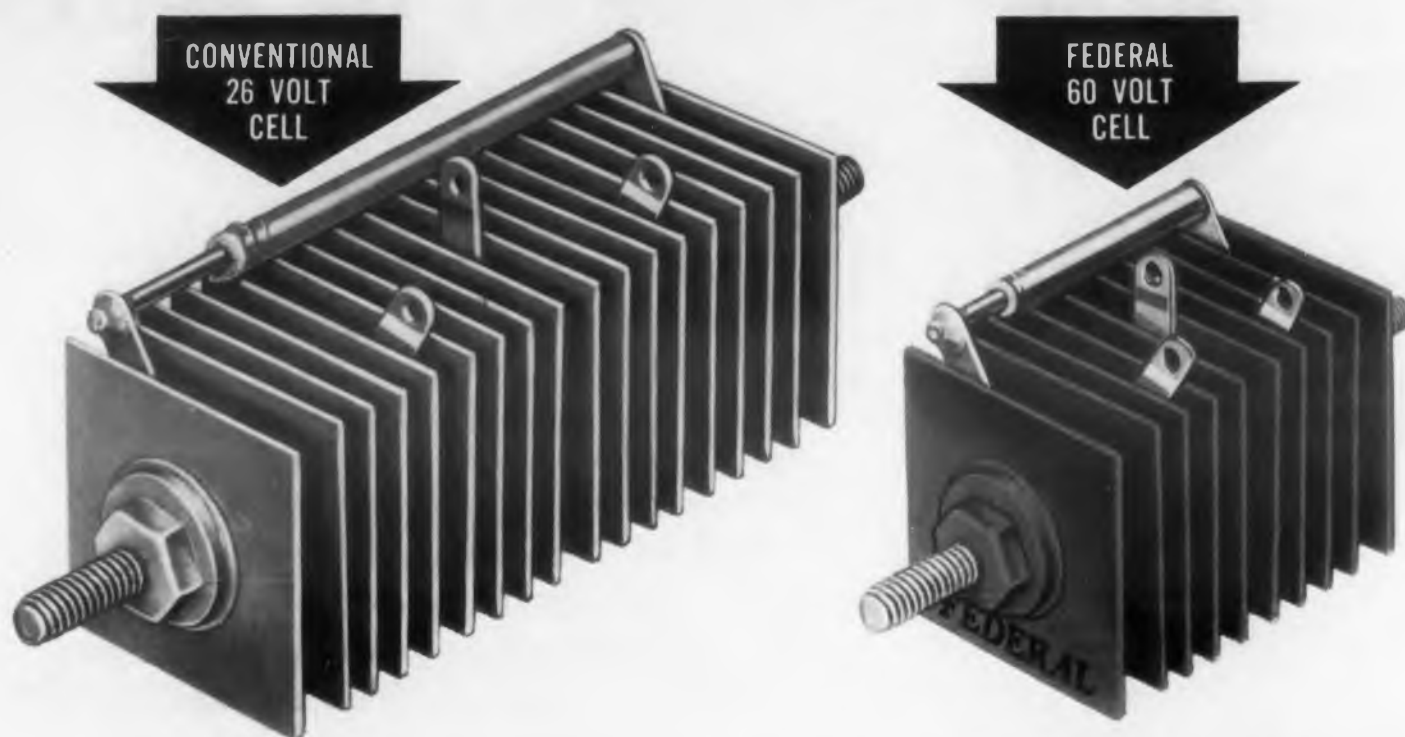


# EPOXY PRODUCTS, INC.

*A Division of Joseph Waldman & Sons*  
137 Coit Street, Irvington 11, New Jersey

CIRCLE 138 ON READER-SERVICE CARD

# At last!



## 60 VOLT SELENIUM RECTIFIERS

**much smaller mounting dimension**

**A LINE WHICH  
REPLACES  
CONVENTIONAL RECTIFIERS  
TWICE AS  
LARGE . . . IN MILITARY &  
INDUSTRIAL APPLICATIONS**

Engineers design scopes can now be broadened with the newly developed Federal Selenium 60 volt cell rectifier — miniaturized in size, light in weight, more efficient for circuitry, reliable for high temperatures and at a realistic cost.

This major selenium advance, achieved through ITT research, affords reliable operation to 150°C ambient with derating and at current ratings from 150 ma to 1 amp — cell sizes from 1", 1¼", 1½", 1¾", 1¾", and 2" are available in all circuit configurations. Other features include long life, low temperature rise, proved mechanical construction, conservative ratings and controlled quality.

The "Federal Selenium 60" is designed to replace rectifiers up to twice as large in military & industrial applications. Miniaturization, with improved electrical characteristics, is due to ITT's exclusive depositing process.

WRITE TODAY FOR TECHNICAL AND ENGINEERING DATA  
ITT COMPONENTS DIVISION

SEE US AT BOOTH  
1403 AND 1404  
WESCON SHOW



*Components Division*

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION  
P. O. BOX 412, CLIFTON, N. J.  
CIRCLE 139 ON READER-SERVICE CARD

## NEW PRODUCTS at WESCON

### High Resolution Potentiometer Over one foot wide



A 15-in. wide single-turn potentiometer, this unit was originally designed for precision testing of aircraft actuators. Model MST-150 is available with linearities to 0.015 per cent and resolution compatible with linearity. Housing is a heat treated aluminum casting. The unit dissipates 8 w at 60 C.

Analogue Controls, Inc., Dept. ED, 39 Roselle St., Mineola, N.Y.

Wescon Booth 812

CIRCLE 140 ON READER-SERVICE CARD

### Digital Voltmeter ac-dc model



Model 402 ac-dc digital voltmeter has a new single-plane, projection type readout; 0.01 per cent dc and 0.1 per cent ac accuracy; dc measurement range from 100 μv to 999.9 v in four automatic ranges; ac measurement range from 1 mv to 999.9 v in four manual ranges; automatic ac over-range indication; ac frequency response 30 to 10,000 cps, and 10 meg input impedance on all ranges.

Cohu Electronics, Inc., Kin Tel Div., Dept. ED, 5725 Kearny Villa Road, San Diego 12, Calif.

Wescon Booth 1413-14

CIRCLE 141 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

## DESIGN ACHIEVEMENTS WITH SUPRAMICA<sup>SM</sup> CERAMOPLASTICS



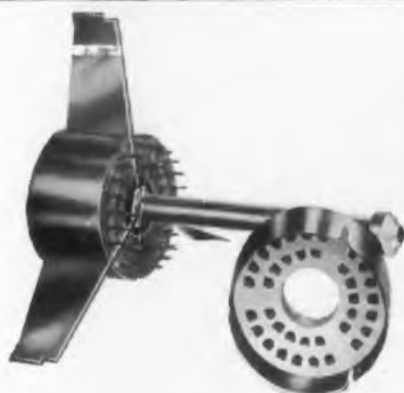
OPTICALLY FLAT CAPACITY COMMUTATOR  
PLATE | SUPRAMICA 500



HIGH-TEMPERATURE AIRCRAFT TERMINAL  
BLOCK | SUPRAMICA 560



HIGH-TEMPERATURE A-N CONNECTOR  
| SUPRAMICA 560



RADIATION RESISTANT AIRCRAFT ENGINE  
CONNECTOR | SUPRAMICA 555



HIGH TEMPERATURE FIREWALL  
THERMOCOUPLE | SUPRAMICA 555



ORGANIC VAPOR FREE HIGH TEMPERATURE  
SEALED RELAY | SUPRAMICA 555

## HIGH TEMPERATURE ceramoplastic INSULATION

### SUPRAMICA ceramoplastics provide broader design scope for product engineers

Increased thermal endurance . . . total, permanent dimensional stability . . . better electrical properties . . . lower density and improved machineability of SUPRAMICA ceramoplastics bridge the design gap between organic plastics and conventional ceramics. The world's most nearly perfect insulation, SUPRAMICA ceramoplastics allow product engineers to meet the requirements of today's thermal problems.

There is no possibility of shrinkage, growth or age polymerization since the materials are completely inorganic, made with SYNTHAMICA<sup>SM</sup> synthetic mica. Metal inserts molded in SUPRAMICA ceramoplastics cannot loosen during thermal cycling because coefficients of expansion are

closely matched. Other desirable properties are high dielectric strength, radiation and arc resistance, low electrical loss, resistance to moisture, oil and organic solvents. In thousands of military and critical industrial applications, SUPRAMICA ceramoplastics are contributing to better, safer, more reliable operation of electrical and electronic equipment.

Write for complete technical information.

SUPRAMICA<sup>SM</sup> 560 — for temperatures up to 500°C (932°F)

SUPRAMICA<sup>SM</sup> 555 — for temperatures up to 350°C (660°F)

SUPRAMICA<sup>SM</sup> 500 — sheet and rod material for machining

\*SUPRAMICA is a registered trademark of Mycalex Corporation of America. 560 and 555 and 500 are trademarks of Mycalex Corporation of America.

SYNTHAMICA is a trademark of Synthetic Mica Corporation, a subsidiary of Mycalex Corporation of America.

**MYCALEX**  
CORPORATION OF AMERICA

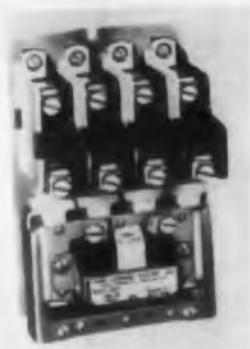
EXECUTIVE OFFICES:  
30 ROCKEFELLER PLAZA  
NEW YORK 20, NEW YORK

GENERAL OFFICES AND PLANT:  
CLIFTON, NEW JERSEY

SALES OFFICES:  
CHICAGO - LOS ANGELES - DAYTON  
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**WORLD'S LARGEST MANUFACTURER OF GLASS-BONDED MICA AND CERAMOPLASTIC PRODUCTS.**

Wescon Show Booth #1440  
CIRCLE 145 ON READER-SERVICE CARD



### Relays 10 amp rating

Type HR solenoid relays are rated at 10 amp, 600 v ac max, and have unitized poles, interchangeable wiping-action contacts, complete parts accessibility, and identical mounting dimensions for all ac and dc styles.

Ward Leonard Electric Co., Dept. ED, 83 South St., Mount Vernon, N.Y.

Wescon Booth 1327

CIRCLE 142 ON READER-SERVICE CARD

### Power Supplies

First of transistorized series



The first two models in this series of transistorized power supplies, LT 2095 and LT 2095M, have ranges of 0 to 32 v dc, 0 to 2 amp. All models are designed to operate at max rating of 50 C ambient temperature without internal blowers or other moving parts.

Lambda Electronics Corp., Dept. ED, 11-11 131st St., College Point, L.I., N.Y.

Wescon Booth 842-43

CIRCLE 143 ON READER-SERVICE CARD



### Hydrogen Thyratron

30 megawatts peak power

Model 1802 hydrogen thyratron produces 30 megawatts peak power in a small, air-cooled ceramic envelope. Salient ratings are: peak voltage, 30 kv; peak current, 1000 amp; life, 1000 hr.

Edgerton, Germeshausen & Grier, Inc., Dept. ED, 160 Brookline Ave., Boston, Mass.

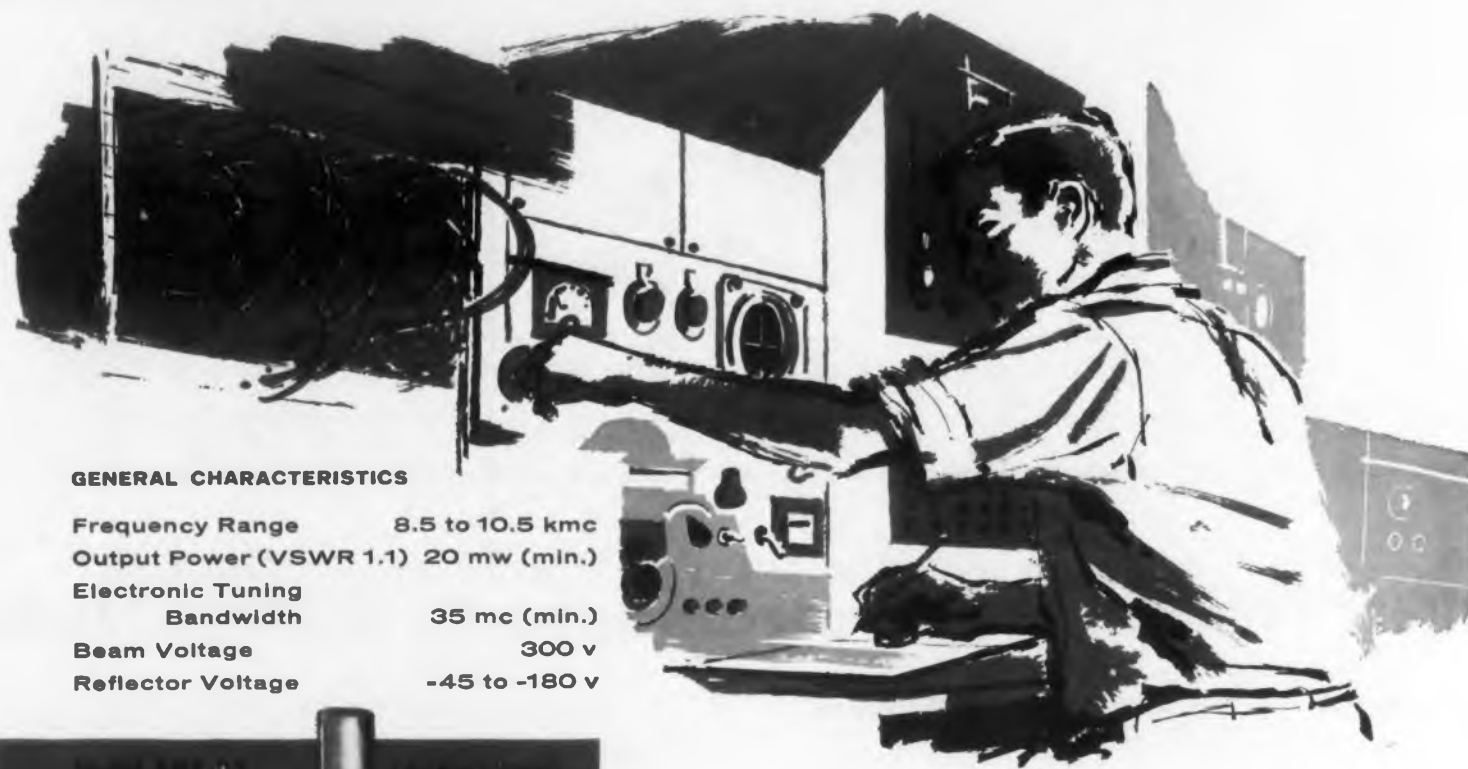
Wescon Booth 1627

CIRCLE 144 ON READER-SERVICE CARD

FOR ANY KLYSTRON NEED SEE SPERRY

SPERRY made microwave radar possible by developing the klystron 20 years ago. Since then, Sperry klystrons have become the design choice in every radar field — from missile guidance to the most accurate radar test equipment. For example:

## Low-voltage reflex klystron for testing X-band radars



### GENERAL CHARACTERISTICS

Frequency Range	8.5 to 10.5 kmc
Output Power (VSWR 1.1)	20 mw (min.)
Electronic Tuning Bandwidth	35 mc (min.)
Beam Voltage	300 v
Reflector Voltage	-45 to -180 v



Here is the ideal signal source for radar test equipment — the SRX-92 reflex oscillator klystron. Offering complete coverage of the frequency range from 8.5 to 10.5 mc, this Sperry tube also serves as local oscillator in microwave receivers and spectrum analyzers, or as a low-voltage bench oscillator.

Spanning 21% of the center frequency, the SRX-92 also features low hysteresis, high thermal stability, and single-screw tuning—in a low-cost package that weighs only 4½ ounces. The SRX-92 meets Navy requirements. Write or phone the nearest Sperry district office for more details and shipping schedules.

**ELECTRONIC TUBE DIVISION**  
**SPERRY GYROSCOPE COMPANY**  
 Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION  
 BROOKLYN • CLEVELAND • NEW ORLEANS • LOS ANGELES • SAN FRANCISCO • SEATTLE,  
 IN CANADA: SPERRY GYROSCOPE COMPANY OF CANADA, LTD., MONTREAL, QUEBEC.

Visit our booths 641-642 at the WESCON Show, August 19-22  
 CIRCLE 146 ON READER-SERVICE CARD

## NEW PRODUCTS

at WESCON

### Strain Gage Amplifiers

Signal level suitable for telemetry



Strain gage signal amplification to voltage levels suitable for direct use in telemetry are provided by models CA3 and CA5 carrier amplifiers. They operate from a 28 v dc supply and provide an output of 0-5 v dc exactly proportional to the quantity being measured.

Statham Instruments, Inc., Dept. ED, 12401 West Olympic Boulevard, Los Angeles 64, Calif.  
 Wescon Booth 621

CIRCLE 147 ON READER-SERVICE CARD

### Potentiometers

Rated up to 250 C



Series 314 miniature potentiometers operate in temperatures from -55 to +250 C, and with stand shock to 20 g in three axes, and vibration of 20 g to 2000 cps. They measure 1/2 in. in diameter and 3/8 in. in length.

Daystrom, Inc., Pacific Div., Dept. ED, 3030 Nebraska Ave., Santa Monica, Calif.  
 Wescon Booth 704

CIRCLE 148 ON READER-SERVICE CARD

### Mercury Pulse Generator

Can be used to test amplifiers

Output pulse height: variable from 100  $\mu$ v to 100 v; shape: exponential rise to exponential decay; rise time: better than 0.05  $\mu$ sec variable over a range of 1000 to 1. Decay time constant: 1, 10, or 100  $\mu$ sec.

Radiation Instrument Development Lab, Inc., Dept. ED, 5737 S. Halsted St., Chicago 21, Ill.

CIRCLE 149 ON READER-SERVICE CARD

## Digital Voltmeter

AC voltages read to 5 digits



A 5-digit voltmeter system for the reading of ac voltages. A dc pre-amplifier increases the input impedance and sensitivity of the meter unit to 10  $\mu$ v per digit. Accuracy of the system is greater than 0.01 per cent. Polarity and voltage ranges are automatic.

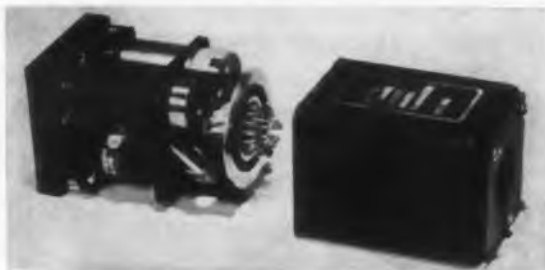
Cubic Corp., Dept. ED, 5575 Kearny Villa Rd., San Diego 11, Calif.

Wescon Booth 1554-55

CIRCLE 150 ON READER-SERVICE CARD

## Resolver-Servo

For missile guidance systems



This miniaturized computer and integrator consists of a dual anti-backlash gear train, a slip clutch, a size 11 temperature compensated resolver, a size 8 motor generator and precision potentiometer, all in a pressure-sealed container measuring 2 x 2 x 3 in.

Thomas A. Edison Industries, Instrument Div., Dept. ED, 61 Lakeside Ave., W. Orange, N.J.

Wescon Booth 1748

CIRCLE 151 ON READER-SERVICE CARD

## Subcarrier Oscillator

Inductance controlled

Inductance controlled subcarrier oscillator Model 0300 can be tuned to any of the 18 RDB telemetering bands in the 400 cps to 70 kc range. Output frequency is varied from its tuned center point by any inductance type transducer with two output leads. The plug-in assembly is compatible with the Bendix TJS-2 adapter.

Datran Electronics, Dept. ED, 1836 Rosecrans Ave., Manhattan Beach, Calif.

CIRCLE 152 ON READER-SERVICE CARD

world's  
finest  
drawing  
pencil



# A.W.FABER-CASTELL

Product of nearly 200 years of uninterrupted experience

The Masters of the drawing board on every continent say that CASTELL #9000 is the world's finest wood-encased pencil.

Why?

Because this green polished perfect drawing tool is saturated with "Black Gold" graphite, the purest black mineral known to man, that assays at more than 99% pure carbon.

Because its low index of friction makes each CASTELL stroke outstandingly smooth, a pleasure to work with.

Because our exclusive microlet-milling process reduces granules to optimum shape and size, producing an opaque adhesion that gives you cleaner, sharper blueprints.

We could talk about CASTELL'S Color-Coding that makes for instant identification — its exceptional lead strength and durability, its fine-grained cedar wood impregnated with rare waxes, its perfectly-graded scale of 20 degrees, 8B to 10H.

But the really significant answer is — almost 200 years of uninterrupted manufacturing experience — since 1761. Perhaps the next 200 years will produce a markedly superior pencil, but if it does you can be sure it will continue to carry the A.W.FABER-CASTELL imprint.

You owe it to your career to use CASTELL. Call your Dealer.

A.W.FABER-CASTELL Newark, N. J.

CASTELL LOCKTITE 9800 with TEL-A-GRADE indicator, for those who prefer a feather-weight holder.

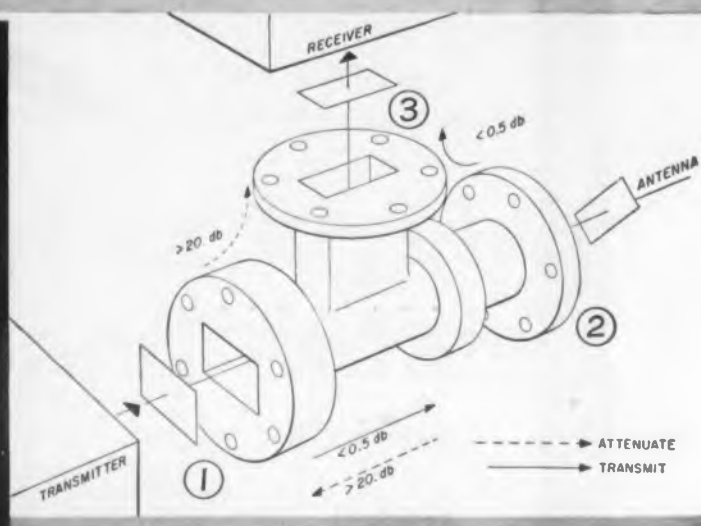
Imported CASTELL 9030 LEAD — with the identical "Black Gold" graphite that made CASTELL #9000 world-famous.



PREFERRED BY PROFESSIONALS IN EVERY CIVILIZED COUNTRY ON EARTH.

CIRCLE 153 ON READER-SERVICE CARD

## Recent Raytheon achievements in Microwave



**THE MICROWAVE CIRCULATOR.** Typical of recent Raytheon developments in advanced microwave equipment and components is the microwave ferrite circulator recently developed by Raytheon's Special Microwave Device Group. **HOW IT WORKS:** in the diagram above, transmitted signals enter arm (1) vertically polarized. They are then rotated 45° from the vertical in a ferrite Faraday rotator with a longitudinal field applied by a small cylindrical permanent magnet. They flow out of the circulator at the antenna arm (2) which is set at the same 45° angle. Received signals fed into the antenna arm are rotated an additional 45° by the ferrite Faraday rotator and can only leave through the receiver arm (3).

## To the man who is looking for FRONTIER PROJECTS IN ELECTRONICS:

As an engineer or scientist who wants to accomplish more in 1958, you naturally want to be where new things are happening.

Whatever your specialized background and interests, chances are you'll find a current Raytheon project that offers exceptional opportunity for you to put your scientific skill and creative imagination to work.

Raytheon's constant expansion during 1958 covers advanced activities in:

**COMMUNICATIONS (Commercial and Military)** — scatter, microwave relay, multiplex, mobile transistorized equipment.

**COUNTERMEASURES**—radar countermeasures equipment, advanced study projects.

**RADAR (Pulse and CW Systems)**—search, fire control, bombing, navigation and guidance, air-traffic control, weather and marine, military and commercial.

**MARINE EQUIPMENT**—submarine, ship and airborne sonar, depth sounders, direction finders, radars.

**GUIDED MISSILES**—prime contracts:  
Navy Sparrow III (air-to-air)  
Army Hawk (ground-to-air)

**MICROWAVE TUBES**—"Amplitrons," magnetrons, klystrons, traveling wave tubes, storage tubes, backward wave devices.

**SEMICONDUCTORS**—devices, materials and techniques; silicon and germanium.

For interview and prompt helpful counsel, please write to  
E. H. Herlin, Professional Personnel Section  
P.O. Box 237, Brighton Station, Boston 35, Mass.



Excellence in Electronics

**RAYTHEON MANUFACTURING COMPANY**

## NEW PRODUCTS at WESCON

### Wattmeter

Offers  $\pm 2$  per cent accuracy



This panel wattmeter has accuracies of  $\pm 2$  per cent at room temperature and  $\pm 5$  per cent over a temperature range of  $-55$  to  $+71$  C. Available in a wide range of meter sizes. Ranges available extend from 25 w or vars to 1 kw or kilovar with common input frequencies.

Luscombe Engineering Co., Dept. ED, 1129 S. Fair Oaks Ave., Pasadena, Calif.  
Wescon Booth 427

CIRCLE 156 ON READER-SERVICE CARD

### Power Supply

For multiplier phototubes



A multiplier phototube power supply, model 30208 has an output of 800 to 2000 v dc at 0-25 ma. Output current enables the unit to operate at least 5 phototubes simultaneously, with adequate bleeder current.

Voltage is continuously adjustable. Unit provides a precise regulation of 0.015 per cent for both line and load, no load to full load.

Dressen-Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena, Calif.  
Wescon Booth 1435

CIRCLE 155 ON READER-SERVICE CARD

### Voltage Regulator

Provides 12 kva output

Model 605 automatic voltage regulator can absorb high overload surges while delivering un-

distorted 0.25 per cent true rms voltage regulation. The unit is designed for 115 v operation, and is capable of stabilizing line voltage variations over a  $\pm 10$  or  $\pm 20$  per cent range. When operating within a  $\pm 10$  per cent correction range, it provides a 12 kva output.

Tel-Instrument Electronics Corp., Dept. ED, 728 Garden St., Carlstadt, N.J.

CIRCLE 157 ON READER-SERVICE CARD

## Oscilloscope

Low frequency



Type 401-A oscilloscope has panel controls for X and Y amplifier, sweep calibration settings, or switching from automatic to driven sweeps. The sweep circuits, designed for positive sync lockout, permit diddle free waveform stability. Sweeps of 2.5 sec full scale are offered.

Allen B. Du Mont Labs, Inc., Dept. ED, 760 Bloomfield Ave., Clifton, N.J.

Wescon Booth 1433-34

CIRCLE 158 ON READER-SERVICE CARD

## Booster Amplifier

For receiver systems



This booster amplifier consists of two fully transistorized amplifiers contained in a relay-type housing measuring 1-1/2 in. diam by 2-1/2 in. high.

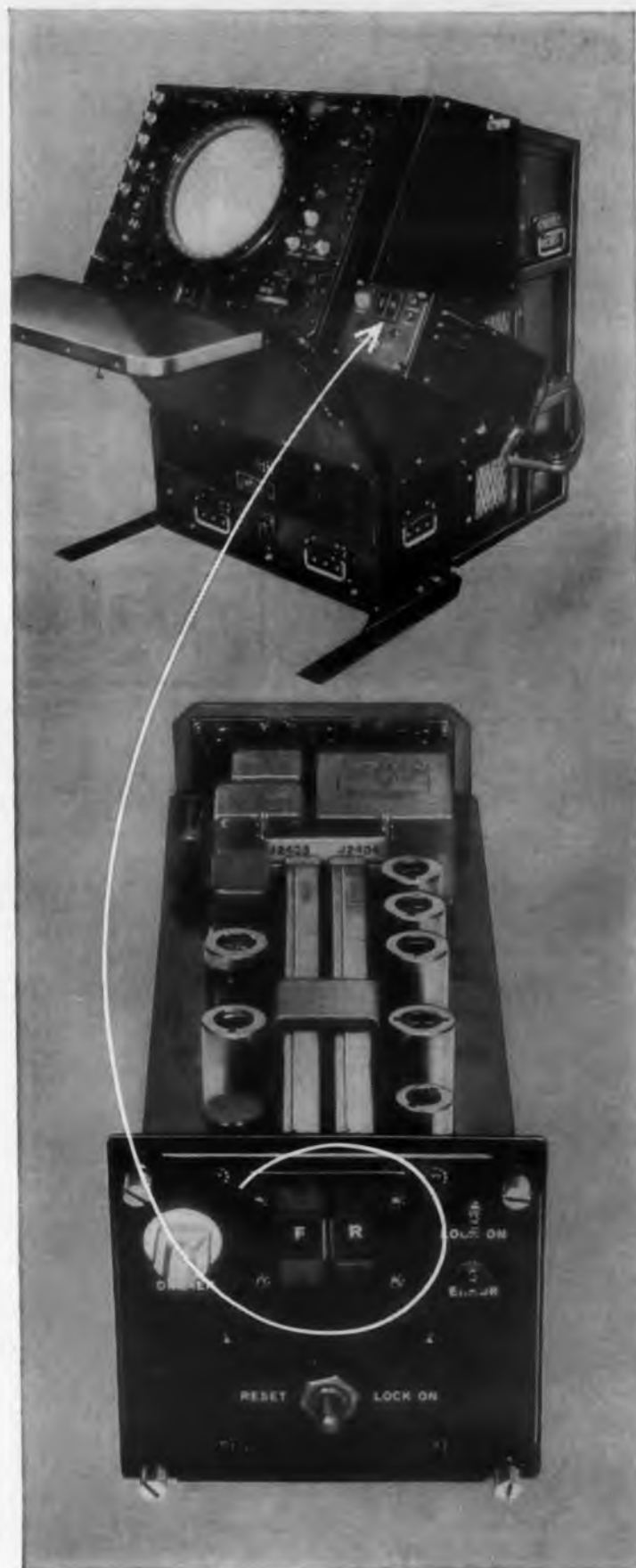
The amplifier has an input impedance in excess of five megohms; and feedback gain of 60 db min.

Reeves Instrument Corp., Dept. ED, Roosevelt Field, Garden City, N.Y.

Wescon Booth 1301-02

CIRCLE 159 ON READER-SERVICE CARD

# Union Indicators help Hazeltine radar-display unit identify aircraft



**Just a glance** at the little black box on the right side of this radar-display unit tells the operator whether an approaching aircraft is friend or foe. The IFF response is processed by radar equipment and is displayed in the Hazeltine unit by Alpha-Numerical Indicators manufactured by Union Switch & Signal. The radar-display unit is manufactured by Hazeltine Electronics Division of Hazeltine Corporation, Little Neck, New York. Hazeltine chose Union Switch & Signal's Alpha-Numerical Indicators because of their compact design and supreme reliability, and for the features listed below.

**Two Types**—Union Switch & Signal makes two types of Data Display Indicators: Digital types, displaying 10, 12, or 16 characters on a wheel, and Alpha-Numerical types, displaying up to 64 characters on a Mylar belt. Character assignments can be furnished as required.

**Translation**—Both Digital and Alpha-Numerical Indicators operate directly on binary codes on a null-seeking basis, eliminating the need for external equipment for translation from binary to decimal code as required for other display devices.

**Visual Read-Out**—The design of the Indicator packages is such that when indicators are mounted in rows, the digital read-out is presented with excellent continuity and visibility.

**Infinite Retentivity**—Since the method of operation is of the null-seeking type, the Indicators require power only during the response time, and once positioned, retain the data both visually and electrically until such time as a new code is transmitted.

**Electrical Read-Out**—The design of the decoding and control portion of the Indicators inherently provides electrical read-out of data in the same form as the input. The data can be read out of the Indicators on a continuous basis or as often as desired without erasing the stored information.

Call or send the coupon for complete information about indicators and other electronic equipment manufactured by Union Switch & Signal.

### COMPLETE FACTS

Union Switch & Signal, Advertising Dept.  
Pittsburgh 18, Pennsylvania

Please send information on the following:

- New 4PDT relay which meets every requirement of MIL-R-25018.
- Catalog of other miniature dc and ac relays.
- Digital and Alpha-Numerical Indicators for data display.

Name \_\_\_\_\_ Position \_\_\_\_\_

Firm \_\_\_\_\_

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See You At The Wescon Show  
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BOOTH #503-504  
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Los Angeles, California



*"Pioneers in Push-Button Science"*  
**UNION SWITCH & SIGNAL**  
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY  
PITTSBURGH 18, PENNSYLVANIA

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## NEW PRODUCTS

at WESCON

### Polarized DC VTVM

250  $\mu$ v full scale sensitivity



The MV-27D polarized dc microvoltmeter has 250  $\mu$ v full scale sensitivity. Its highest range is 0 to kv. On its three lowest ranges, 50  $\mu$ v, 1 mv, and 2.5 mv, the unit uses mid-zero scales. All other ranges are left-zero.

Millivac Instruments, Dept. ED,  
P.O. Box 997, Schenectady, N.Y.

CIRCLE 162 ON READER-SERVICE CARD

### Capacitors

High voltage

High voltage series of Varicap voltage-variable capacitors includes types with high Q factor and 20 to 100  $\mu$ mf capacitance for modulation and afc use; also types for tuning applications in values from 7 through 56  $\mu$ mf.

Pacific Semiconductors, Inc.,  
Dept. ED, 10451 W. Jefferson  
Blvd., Culver City, Calif.

CIRCLE 163 ON READER-SERVICE CARD

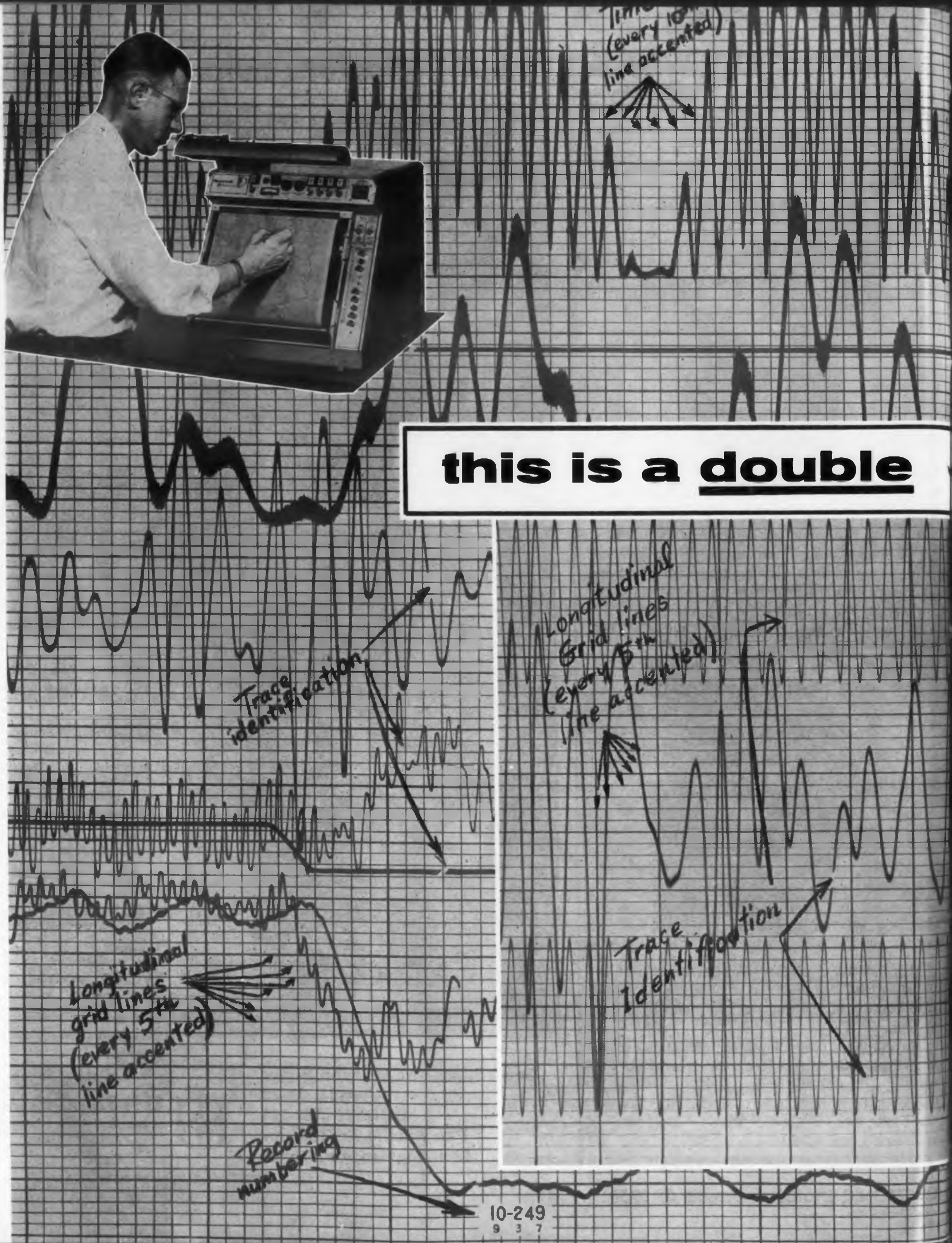
### AF Subcarrier Equipment

Transistorized

This transistorized af subcarrier equipment (the KY-612 tone keyer and TD-635 tone demodulator) transmits binary data over communications circuits. Designed around frequencies starting at 1500 cps, spaced every 3000 cps.

Rixon Electronics, Inc., Dept.  
ED, 2414 Reedie Dr., Silver Spring,  
Md.

CIRCLE 164 ON READER-SERVICE CARD





When the Honeywell Model 906 Visicorder was introduced as the first practical high-frequency direct-writing oscillograph in history, it met with instant success.

Now the new Honeywell Model 1012 Visicorder extends the range and usefulness of the exclusive Visicorder principle. It is a highly sensitive 36 channel instrument with frequencies from DC to 3000 cps. Its exclusive features are many . . . it is the most convenient, foolproof, reliable, broad-

capacity oscillograph on the market today.

And the 906 Visicorder is now available in two new models: the 906A-1 with 14 channels, and the 906A-2 with 8 channels. An accurate time-line system and a simultaneous grid-line recording system are optional in both 906A Models. Both oscillographs are producing superior, clear, reproducible, accurate, high sensitivity, high frequency direct recordings in many varied applications every day.

## record of leadership

The two specimen records—one from a 906A Visicorder and one from the 1012 Visicorder—are reproduced unretouched and life size. They are an accurate indication of the excellence of Visicorder records.

For further information about these dramatic new Visicorders, call your nearest Honeywell Industrial Sales Office.

**Reference data: Write for Visicorder Bulletins 906A and 1012.**

*Minneapolis Honeywell Regulator Co.,  
Industrial Products Group, Heiland Division  
5200 E. Evans Avenue, Denver 22, Colorado*

## Honeywell

 *Industrial Products Group*



CIRCLE 165 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

## NEW PRODUCTS

at WESCON

### Potentiometers

0.3 per cent linearity



Series 570 potentiometers are 1-in. diam 1 turn instruments with  $\pm 0.3$  per cent linearity and up to 265,000 ohm ratings.

As many as 45 extra terminals can be added in addition to the 3 standard terminals. Also being shown is series 230, with both linear and non-linear functions in a compact single-turn size.

Carrier Corp., Spectrol Electronics Div., Dept. ED, 1704 S. Del Mar Ave., San Gabriel, Cal.  
*Wescon Booth 1724-25*

CIRCLE 166 ON READER-SERVICE CARD

### Wattmeter

With meter-relay control



Direct monitoring and control of electrical power is provided by this locking contact wattmeter. With the locking feature, high and/or low limits of wattage may be preset, with control action being initiated when a limit is reached. The instrument was designed by adding a core magnet movement, as used in V.H. meter-relays, to the movement of a standard dynamometer type wattmeter.

Assembly Products, Inc., Dept. ED, 75 Wilson Mills Rd., Chesterland, Ohio  
*Wescon Booth 438-39*

CIRCLE 167 ON READER-SERVICE CARD



# Temco

AIRCRAFT  
DALLAS

## CAN PUT HI-TEMPERATURE STRUCTURES INTO YOUR PRODUCTION



YOUR  
INQUIRY IS  
OUR CHALLENGE  
AT...



When Temco engineered and developed the aft-fuselage and vertical stabilizer section of Convair's B-58 Hustler... the wing section and fuselage panels of Temco's own TT-1 jet trainer... the wings of the air-launched "Teal" missile... the aircraft industry acknowledged Temco as a leader in development and production of honeycomb sandwich and hi-temperature structures. Missile applications currently programmed are substantial recognition of Temco's stature.

At Temco metal and plastic sandwich structures have been employed in all types of airframe applications, with notable development in the field of stronger, higher heat-resistant metal bondings... in improved plastic materials and methods of reinforced plastic honeycomb fabrications.

Other outstanding advances now under development at Temco are a new low-cost process for brazing stainless steel honeycomb structures, employing a revolutionary new concept... and experimental progress in the new field of "cermets."

Since pioneering the "total package" concept of subcontracting... design, tooling and production... Temco's engineering staff and facilities have increased significantly, a growth as rapid and as sound as that of the industry they serve. Today these design support capabilities have been extended to encompass complete systems management. **Whether your need is for a component, a subassembly, or a subsystem, an inspection of Temco capabilities will prove profitable.**

CIRCLE 168 ON READER-SERVICE CARD

## NEW PRODUCTS

at WESCON

### Relay

Heavy duty telephone type



A full yoke type armature hinge with over size bearing surfaces provides long life in 2 class 66 telephone relays.

Available with standard contact combinations to 10pdt, and with bifurcated contacts for reliable switching of low voltage.

Magnecraft Electric Co., Dept. ED, 3352 W. Grand Ave., Chicago 51, Ill.  
Wescon Booth 2222

CIRCLE 169 ON READER-SERVICE CARD

### Components

Miniaturized line



A line of miniature components include i-f transformers, dials, knobs, dial locks, shaft locks, flexible couplings (in 7 types), ceramic terminal strips, binding posts, gear drives, insulated potentiometer mountings, and other components.

James Millen Mfg. Co. Inc., Dept. ED, 150 Exchange St., Malden, Mass.  
Wescon Booth 1324

CIRCLE 170 ON READER-SERVICE CARD

### Temperature Systems

Transistorized

Transistorized temperature measurement subsystems for use with fast-response, 100-ohm-resistance temperature transducers to produce a full 5 v output for a span of 75 F. TME-1SD is single-channel; TME-2SD, a dual-channel unit.

Arnoux Corp., Dept. ED, Box 34628, Los Angeles, Calif.

CIRCLE 171 ON READER-SERVICE CARD

## FLIGHT DATA and CONTROL ENGINEERS

Cross new frontiers in system electronics at The Garrett Corporation.

High-level assignments in the design and development of system electronics are available for engineers in the following specialties:

**1. ELECTRONIC AND FLIGHT DATA SYSTEMS AND CONTROLS** A wide choice of opportunities exists for creative R & D engineers having specialized experience with control devices such as: transducers, flight data computers, Mach sensors, servo-mechanisms, circuit and analog computer designs utilizing transistors, magamps and vacuum tubes.

**2. SERVO-MECHANISMS AND ELECTRO-MAGNETICS** Requires engineers with experience or academic training in the advanced design, development and application of magamp inductors and transformers.

### 3. FLIGHT INSTRUMENTS AND TRANSDUCERS

1) **DESIGN ANALYSIS** Requires engineers capable of performance analysis throughout preliminary design with ability to prepare and coordinate related proposals.

2) **DEVELOPMENT** Requires engineers skilled with the analysis and synthesis of dynamic systems including design of miniature mechanisms in which low friction freedom from vibration effects and compensation of thermo expansion are important.

**4. PROPOSAL AND QUALTEST ENGINEER** For specification review, proposal and qualtest analysis and report writing assignments. Three years electronic, electrical or mechanical experience required.

Forward resume to:  
**Mr. G. D. Bradley**

**THE GARRETT CORPORATION**

9851 S. Sepulveda Blvd.  
Los Angeles 45, Calif.

#### DIVISIONS:

AiResearch Manufacturing—Los Angeles  
AiResearch Manufacturing—Phoenix  
AiResearch Industrial  
Rex • Aero Engineering  
Airsupply • Air Cruisers  
AiResearch Aviation Service

# NEW limit switchless actuators



## Reduce weight and cost 25% below conventional design

A reduction in actuator cost and weight up to 25 per cent, with similar maintenance savings, has been achieved through the advance design of AiResearch electro-mechanical Limit Switchless Actuators for aircraft and missiles.

Elimination of limit switches in power actuators is a result of AiResearch development of superior high temperature motors and resilient non-jamming positive stops.

Limit switches are eliminated by two methods: 1) use of continuous stall high temperature motors, 2) use

of high temperature motors with thermal protectors which permit maximum on time in the duty cycle.

Additional advantages of AiResearch Limit Switchless Actuators: they are smaller, less complex and the possibility of limit switch failure is eliminated.

Development of Limit Switchless Actuators reflects AiResearch experience in producing more than a million rotary and linear units. Current production includes several hundred actuator types, many with high temperature applications.

Your inquiries are invited.

- ▲ Seat Actuator, CONVAIR B-58
- Seat Actuator, LOCKHEED F-104
- Rotor Blade Trim Actuator
- ◻ Elevator Actuator, TEMCO XKDT-1 Target
- 2-Motor Trim Actuator, REPUBLIC F-105
- ◻ General Purpose Linear Actuator
- Dual Purpose Feel Trim Actuator, AVRO CF-105
- ◻ Rudder Trim, AVRO CF-105
- Duct Shutter Actuator, LOCKHEED ELECTRA

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**AiResearch Manufacturing Divisions**

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS  
CIRCLE 160 ON READER-SERVICE CARD

CIRCLE 557 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

## NEW PRODUCTS

at WESCON

### Connectors

Operate at 400 F



A line of up-graded environmentally resistant connectors will be displayed. Named Real E, the connectors are designed to operate continuously at 400 F with limited operation at 500 F while maintaining moisture-resistant performance. Although smaller and lighter than AN/MS types, the connectors utilize AN/MS insert configurations and mate with other E types.

Amphenol Electronics Corp., Dept. ED, Chicago 50, Ill.

Wescon Booth 1150-51

CIRCLE 172 ON READER-SERVICE CARD

### Power Supply

Transistorized, mag-amp type



Model MTRO60-5 is a transistor-magnetic amplifier regulated 0 to 60 v at 5 amp dc power supply. Line regulation is 5 mv static regulation, less than 10 mv dynamic regulation. Load regulation is less than 25 mv static regulation for changes from no load to full load, and dynamic load regulation is approximately 250 mv for no load to full load changes.

Perkin Engineering Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

Wescon Booth 1161-62

CIRCLE 173 ON READER-SERVICE CARD

### Ferrite Circulator

Covers 8.5 to 9.6 kmc frequency band

Model X442A 4-terminal ferrite circulator covers the 8.5 to 9.6 kmc frequency band. Isola-



The Hughes Memo-scope® oscilloscope, just over a year old, already has gained wide acceptance throughout the industry. Over 400 leading firms have purchased this "transient recorder with a memory." Here are just a few of them . . .

# accept

BOEING



CONOCO

MARTIN  
DENVER

FORD INSTRUMENT CO.  
DIVISION OF SPERRY RAND CORPORATION

NORTHROP AIRCRAFT, INC.

WESCON EXHIBIT of the Memo-scope oscilloscope at booths 1401 and 1402.

**IBM**

HOUSTON EQUIPMENT DIVISION - ADVANCE INDUSTRIES, INC.

**CONVAIR**

A DIVISION OF GENERAL DYNAMICS CORPORATION

**Westinghouse**

SERVOMECHANISMS

*Aerojet-General***ALLIS-CHALMERS***Remington Rand*  
DIVISION OF SPERRY RAND CORPORATION

ALLEN-BRADLEY COMPANY

**Aerophysics**

DEVELOPMENT CORPORATION

a subsidiary of Curtiss-Wright Corporation

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# Performance!

ELECTRONIC CONTROL SYSTEMS  
DIVISION OF STROMBERG CARLSON**Beckman****AMERICAN BOSCH  
ARMA CORPORATION****IMR**

Intelligent Machines Research Corporation

*Farnsworth*  
**O.I.T.T.**U. S. DEPARTMENT OF COMMERCE  
NATIONAL BUREAU OF STANDARDS

**APPLICATIONS:** Ballistics, Ultrasonics, Acoustics, Cardiology, Component Characteristics, Environmental Test, Education, Quality Control.

To find out how the Hughes Memo-scope oscilloscope can improve your product and profit picture write: **HUGHES PRODUCTS**, Memo-scope Oscilloscope, International Airport Station, Los Angeles 45, California

Creating a new world with ELECTRONICS

**HUGHES PRODUCTS**

© 1958. HUGHES AIRCRAFT COMPANY

CIRCLE 175 ON READER-SERVICE CARD

tion is at least 20 db; insertion loss is 0.5 db; vswr is 1.20. Unit is capable of 250 kw peak, 250 w average, transmitted power.

Cascade Research, Div. of Monogram Precision Industries, Inc., Dept. ED, 53 Victory Lane, Los Gatos, Calif.

CIRCLE 174 ON READER-SERVICE CARD

## Emergency Switches

Used in escape gear



A rotary arm-actuated switch and a plunger-actuated switch engineered for emergency use in aircraft escape gear. High unit pressure and self-cleaning action enable the switches to function dependably under unfavorable conditions. After two years of dormancy, including 30 days at 95 per cent humidity and 100 hr of salt spray, both demonstrate a max contact resistance of 5 ohm.

Airtron, Inc., Aircraft Accessories Div., Dept. ED, 1096 W. Elizabeth Ave., Linden, N.J.  
Wescon Booth 1564

CIRCLE 176 ON READER-SERVICE CARD

## Synchronous Motor

For timing applications



For use in missile timers and similar precision timing applications, this motor has the same general construction as the standard Synchron line of magnatorc motors approved under AN-M-40.

The governor-controlled motor has accuracy of  $\pm 1\frac{3}{4}$  per cent max error over 24 to 30 v range, -35 to +140 F.

Hansen Manufacturing Co., Inc., Dept. ED, Princeton, Ind.  
Wescon Booth 941

CIRCLE 177 ON READER-SERVICE CARD

# MICROWAVE AND SPECIAL TUBE

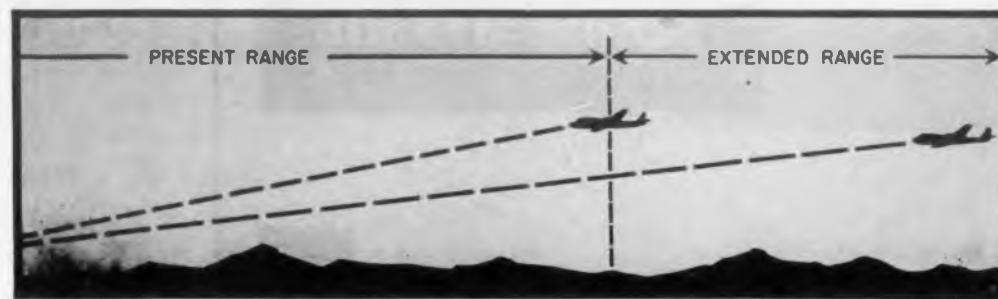
# NEWS

from SYLVANIA

## New Mixer Diodes can extend Radar Range by 18%

Premium 1N78B, 1N26A and 1N53B improve new and existing radar with unmatched ease and economy

Three new microwave diodes covering applications from 13,000 mc to 35,000 mc are now available from Sylvania. The new mixers, types 1N78B, 1N26A and 1N53B, have improved overall noise figures, more uniform RF impedance, and two of the types have greater resistance to burnout. They can extend radar coverage by as much as 18 percent\*, provide more uniform performance from system to system, and increase operational reliability. An equivalent upgrading of



How radar range increases with Sylvania's new premium crystal diodes

equipment by any other means would demand a twofold increase in power.

The new crystals are exact retrofits of preceding types and are comparable in

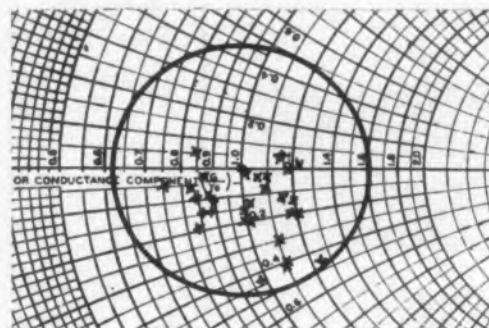
price. Each type is available in matched pairs to Sylvania's specification, which has recently been accepted as the industry standard by JETEC 14.7.

\*2.8 db improvement in overall noise figure of 1N53B yields 18% increase in range.

**Type 1N78B**—Used in applications from 13,000 mc to 16,500 mc, the diode has an overall noise figure of 8.8 db, an improvement of 3 db over the 1N78 and 1 db over the 1N78A. It is being used extensively in doppler navigation equipment and in fire-control radar.

**Type 1N26A**—Designed for use as a mixer in superheterodyne radar receivers in the 24,000 mc region, the type is primarily used in airport traffic control equipment and in air-to-air missiles. Its 11.3 overall noise figure is a 1.8 db improvement over the 1N26. Its burnout resistance rating has been increased threefold to 0.3 erg.

**Type 1N53B**—This miniature coaxial type point contact silicon diode is designed for use as a mixer in the 35,000 mc region. Its major application is in Terrain Avoidance and Mapping Radar. The burnout resistance rating of the 1N53B is double that of the 1N53 and its overall noise figure has been reduced from 13.14 to 10.3. It is tested for a band width of 12 percent to assure good performance in any application in its frequency range. The new diode can also be used as a harmonic generator for very short wave-lengths.



VSWR measurement of a random selection of 1N78B's indicates the positive control over RF impedance of new Sylvania crystal mixers. The circle shows a VSWR of 1.6

**New Edition**—Complete up-to-date technical information on Sylvania's full line of Microwave Crystal Diodes is contained in a new revised edition of the 8-page booklet "Ratings and Characteristics of Microwave Crystal Diodes." Write Sylvania direct or call your Sylvania representative for a free copy of the new booklet.



### Electrical Characteristics & Ratings

	1N78B	1N26A	1N53B
Conversion Loss (db) max.	6.5	7.5	6.5
Output Noise Ratio max.	1.3	2.0	2.0
IF Impedance (Ohms)	365-565	300-600	400-800
RF Impedance (VSWR) max.	1.6	1.6	1.6
Burnout (erg)	0.3	0.3	32.8-37.0
Frequency (kmc)	16	24	0.3



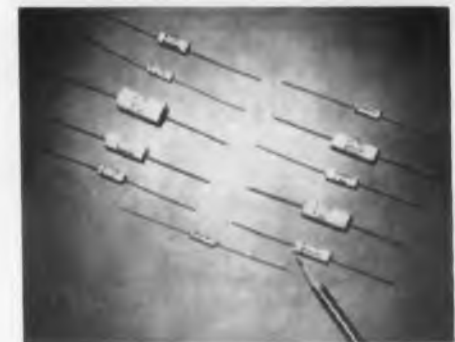
# SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.  
1740 Broadway, New York 19, N.Y.  
In Canada: Sylvania Electric (Canada) Ltd.  
Shell Tower Bldg., Montreal

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY  
CIRCLE 178 ON READER-SERVICE CARD

## NEW PRODUCTS at WESCON

### Film Capacitors High reliability types



These polyester film dielectric capacitors are fixed and enclosed in non-metallic cases for use in blocking, filter and by-pass applications where low failure rates and long life are important. Lectrofilm-B capacitors are compactly wound with high purity aluminum foil and closely controlled capacitor-grade Mylar film.

General Electric Co., Dept. ED, 1 River Rd., Schenectady 5, N.Y.

Wescon Booth 529-30

CIRCLE 179 ON READER-SERVICE CARD

### Chassis Latch For heavy equipment



Aluminum alloy electronic chassis latch and adjustable fork, identified as 27L. Designed for heavy duty purposes, the latch is larger and lighter in weight than earlier designs and permits easier handling of heavy equipment.

Camloc Fastener Corporation, Dept. ED, 22 Spring Valley Road, Paramus, N.J.

Wescon Booth 101-02

CIRCLE 180 ON READER-SERVICE CARD

### Audio Oscillator

Covers 18 cps to 1.1 mc range

The 510B-P audio oscillator is assembled on an oversize panel which serves as both mounting

ELECTRONIC DESIGN • August 6, 1958

plate and escutcheon. Total panel area is 7 x 4-3/4 in. Unit covers 18 cps to 1.1 mc range, delivers 10 v output. Frequency accuracy is 2 per cent; response is  $\pm 0.5$  db.

Waveforms, Inc., Dept. ED, 331 Sixth Ave., New York 14, N.Y.

CIRCLE 181 ON READER-SERVICE CARD

## Relays

Current and voltage sensitive types



Series R700 and R780 are, respectively, current and voltage sensitive relays with high resistance to shock, 2 amp resistive contact ratings, and with a temperature range from  $-65$  to  $+125$  C.

Relays are available in four different terminal header styles; straight pin for printed circuit applications, two sizes of solder loops and 3 leads. Switching is either spdt or dpdt.

Iron Fireman Manufacturing Co., Electronics Div., Dept. ED, 2838 S.E. Ninth Ave., Portland 2, Ore.

Wescon Booth 1261-62

CIRCLE 182 ON READER-SERVICE CARD

## Wire Marker

Uses hot stamping



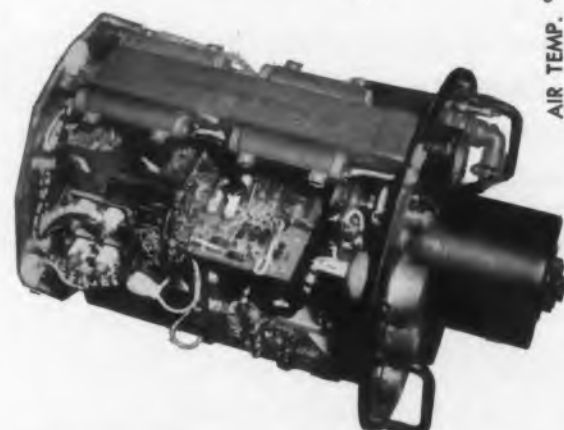
A wire marker will be demonstrated in conjunction with the high speed model CS-6 machine which measures, cuts and strips wire, cord and cable at speeds up to 3000 pieces per hour.

The wire marker has been designed to mark the wire continuously at set intervals. Marking is done by means of the hot stamping method which meets military specifications.

Artos Eng. Co., Dept ED, 2757 S. 28th St., Milwaukee 46, Wisc.

Wescon Booth 324

CIRCLE 184 ON READER-SERVICE CARD

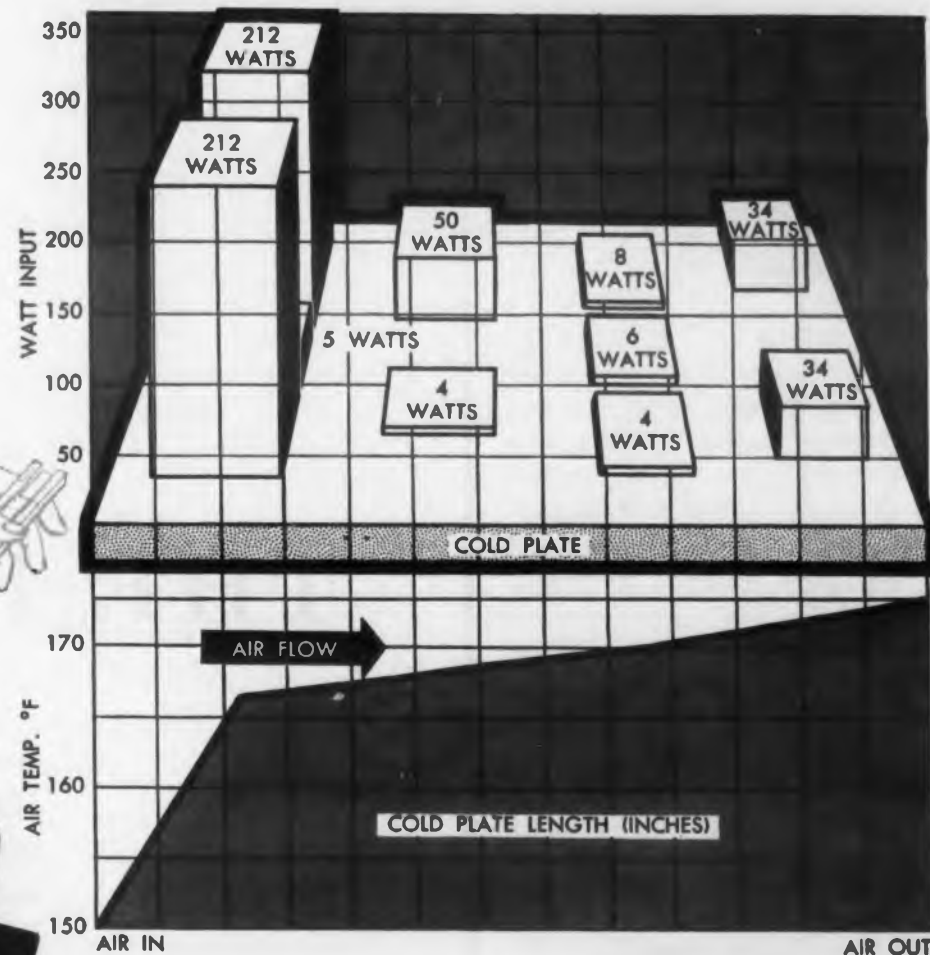


Electronic guidance equipment mounted to both sides of UAP cold plate, contained in UAP pressurized case... for control of air-to-air missile.



# ELECTRONIC COOLING

**Requirement:** Stay within customer's envelope. Dissipate 569 watts thru 13 x 10 in. cold plate and not exceed a plate temperature of 173°F with cold plate air-in temperature of 150°F. Provide areas for circuits to be mounted to cold plate surface between power units.



**Answer:** UAP cold plate configuration designed to provide adequate heat transfer from localized high, medium and low heat concentration areas with air-in temperature at 150°F. All requirements met with room to spare.

The hypothetical conditions as stated above are typical of the problems that have come to us since the advent of electronically controlled supersonic missions.

UAP eminence in the heat exchanger field has been firmly established over the years by delivery of systems and components of proved optimum performance and reliability. Our experience covers the engineering and production of devices for application as cold plates, gas-air heat exchangers, air-liquid heat exchangers, and associated controls; mechanical refrigeration systems and expendable refrigeration systems. These can function in the anticipated environmental conditions and utilize one or more of the following heat sinks; ambient air, expanded bleed air, expanded ram air, ram air, expendable refrigerant, or available liquid.

Make your requirements our responsibility. Call...

CALIFORNIA.....1101 Chestnut St., Burbank, Calif., VI 9-4236  
 NEW YORK.....50 E. 42nd St., New York 17, N.Y., MU 7-1283  
 OHIO.....1116 Bolander Ave., Dayton, Ohio, BA 4-3841  
 CANADA.....United Aircraft Products, Ltd., 5257 Queen Mary Road,  
 Montreal, Canada, Elwood 4131



*a famous family of aircraft essentials since 1929*

**UNITED AIRCRAFT PRODUCTS, INC.**

1116 BOLANDER AVENUE, DAYTON, OHIO

CIRCLE 185 ON READER-SERVICE CARD



## NEW PRODUCTS

### Automatic Gain Control

Plug-in



Mounted on a 3-1/2 x 6 in. plug-in printed circuit chassis, the model DLA-30 automatic gain control unit maintains constant servo loop gain for reference voltage variations from 2 to 100 v. It functions as a variable plate load when used with the DLA-10 servo preamplifier.

Electro Precision Corp., Dept. ED, Arkadelphia, Ark.

CIRCLE 186 ON READER-SERVICE CARD

### Plotter

Traces transistor characteristics



The model 341 power transistor characteristic plotter is for use with both point-contact and junction transistors. It furnishes collector currents up to 6 amp in continuous service and produces the  $r_{23}$ ,  $r_{12}$ , and  $h_{12}$  families of curves on the face of an auxiliary oscilloscope.

Dunn Engineering Associates, Inc., Dept. ED, 225 O'Brien Highway, Cambridge 41, Mass.

CIRCLE 187 ON READER-SERVICE CARD

### Pilot Light

Has built-in resistor

Using the high-brightness neon glow lamp NE-51H, these pilot lights require power of less than

*Advanced missile and space projects*

*require Engineers*

*and Scientists to work on*

# THE FRONTIERS OF SPACE

Lockheed Missile Systems Division, recently honored at the first National Missile Industry Conference as "the organization that contributed most in the past year to the development of the art of missiles and astronautics," holds such important, long-term projects as the Navy Polaris IRBM, Earth Satellite, Kingfisher (Q-5) target missile for the Army and the X-7 ramjet test vehicle for the Air Force.

To carry out such complex projects, the frontiers of technology in all areas must be expanded. High-level engineers and scientists are needed now for responsible positions in our Research and Development laboratories and in our project organizations.

If you are experienced in physics; mathematics; chemistry or one of the engineering sciences, your inquiry is invited. Please write Research and Development Staff, Sunnyvale 29, California. (For the convenience of those living in the East and Midwest, offices are maintained at Suite 745, 405 Lexington Ave., New York 17, and at Suite 300, 840 N. Michigan Avenue, Chicago 11.)

**Lockheed** / MISSILE SYSTEMS DIVISION

SUNNYVALE • PALO ALTO • VAN NUYS • SANTA CRUZ • COOKE AIR FORCE BASE, CALIF. • CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO

CIRCLE 556 ON READER-SERVICE CARD

# E TECHNOLOGY

## FLIGHT IN THREE MEDIUMS

Several things set the Polaris apart from other outer space weapons in the ballistic missile category, for the Polaris program involves a wholly new concept of weaponry.

1. It will be dispatched from beneath the surface of the sea.
2. It will be radically smaller than currently developed land-launched missiles, yet its payload will be as effective and its range the same as other IRBMs.
3. It will be the first operational outer space missile to employ solid fuel as a propellant.
4. It will travel through three mediums in a single flight—water, air and outer space.
5. Its launching base—a submarine—is not fixed but a mobile vehicle.

## OUTER SPACE PROGRAM

Very little can be said about the Earth Satellite program at this time except that its success will necessitate advancing the state of the art in all sciences.

The Earth Satellite Project is perhaps the most sophisticated outer space program to reach the "hardware" stage in the U.S. today.

## ENEMY SIMULATOR

The Lockheed Kingfisher Q-5 is the nation's fastest target missile, developed for the Air Force to test the accuracy of our newest supersonic weapons.

It is a ramjet target vehicle with Mach 2-plus capabilities. The Q-5 not only has speed to match the defensive missiles, but can also simulate a vast array of supersonic enemy missiles and airplanes attacking from great height. It is instrumented to score near misses and even theoretical hits without itself being destroyed.

It is recoverable from flight by parachute to be flown again, permitting weapon system evaluation to be conducted at greatly reduced cost.

1 w on 205 v circuit. They may also be used on dc circuits over 160 v. The required resistor is built in.

Dialight Corp., Dept. ED, 60 Stewart Ave., Brooklyn 37, N.Y.

CIRCLE 190 ON READER-SERVICE CARD

## Switches

### Lighted pushbutton type



Two lighted pushbutton switches are available with 2, 3, or 4 spdt contact structures and 5 amp 125 or 250 v ac ratings. The 53PB8-T2 is a magnetically-held switch which employs a small dc holding coil. The 54PB67-T2 is a two position alternate-action switch.

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

CIRCLE 188 ON READER-SERVICE CARD

## Tunable Noise Generator

500 kc to 55 mc tunable frequency range

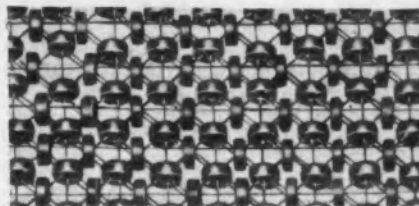


For measurements of the effects of high level noise, this tunable noise generator offers a tunable frequency range of 500 kc to 55 mc. Also useful in noise figure measurement, the unit features attenuation up to 80 db.

General Electronic Labs., Inc., Dept. ED, 195 Massachusetts Ave., Cambridge, Mass.

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## Another Application for FERRAMICS®



Section of typical memory plane enlarged approximately 3 times.

### Ferramic® Cores help IBM Sage Computer Perform Amazing Feats of Memory

General Ceramics Magnetic Memory Cores play an important role in the reliable functioning of the Sage Computer. G-C engineers developed rectangular hysteresis loop ferrites and worked closely with Lincoln Laboratories at MIT and IBM to perfect toroids with the required magnetic properties for this vital defense system.

These dependable components provide increased speed and accuracy for computers and automatic controls. General Ceramics cores and completely assembled memory planes are available for automation systems. For complete information write today to General Ceramics Corporation, Keasbey, New Jersey—Dept. ED.

## GENERAL CERAMICS

Industrial Ceramics for Industrial Progress... Since 1906



FERRAMIC CORES



MAGNETIC MEMORY CORES AND PLANES



PRECISION STEATITES



"ADVAC" HIGH TEMPERATURE SEALS



SOLDERSEAL TERMINALS

CIRCLE 191 ON READER-SERVICE CARD

## NEW PRODUCTS

at WESCON

### Potentiometer

Features low noise



Model HD-11 1-turn potentiometer features striped back coils, tapwelded terminals and Paliney No. 7 contacts throughout. During assembly the entire unit is ultra-sonically cleaned. Design has been pointed towards low noise. Standard linearity is  $\pm 0.5$  per cent and the unit will dissipate 1 w at 40 C.

Hub-Pot, Inc., Dept. ED, 1242 E. Transit St., Pomona, Calif.

Wescon Booth 1513

CIRCLE 192 ON READER-SERVICE CARD

### Angular Position Transducer

Sensitivity of 0.5 min arc



Model 2200 is comprised of a rotary differential transformer and integral demodulator circuit. This instrument provides infinite resolution throughout its entire range and has a sensitivity of 0.5 min of rotation at null. The differential transformer is internally connected to the demodulator to provide a dc output which is isolated from both input and ground.

Bourns Labs, Inc., Dept. ED, P.O. Box 2112, Riverside, Calif.

Wescon Booth 1104

CIRCLE 193 ON READER-SERVICE CARD

### Magnetic Amplifier

7.5 v dc bi-directional output

In 0 series magnetic amplifiers, input is bi-di-

ELECTRONIC DESIGN • August 6, 1958

rectional, dc, for both control windings. Output is bi-directional 7.5 v dc. Gain for each control winding is 2.5 v for a 100  $\mu$ a input. Gain stability is  $\pm 10$  per cent.

Torotel, Inc., Dept. ED, 5512 E. 110th St., Kansas City 34, Mo.

CIRCLE 194 ON READER-SERVICE CARD

### Ferrite Circulator

Compact lightweight unit



Model CKeL1 ferrite circulator is made of aluminum, weighs 6.2 oz and measures 2-3/16 in. long. Typical performance characteristics over a freq range of 13 to 14 kmc and a temp range of 55 to 130 C are: min transmit-receive isolation, 20 db; max insertion loss, 0.5 db; max vswr in any port, 1.2. Model CKeL1 is designed for 5 w average power; a medium power unit is also available.

Raytheon Mfg. Co., Special Microwave Device Group, Dept. ED, Seyon St., Waltham 54, Mass. Wescon Booth 610-11

CIRCLE 195 ON READER-SERVICE CARD

### Gearhead Motor

Withstands 7500 g of shock



Miniaturized gear head motor, model P5B827-P75, for missile application. The motor is designed to withstand 7500 g of shock. It operates on 28.5 to 31.5 v dc, developing 1000 oz in. of torque at  $-65$  C. The gear box is a six-stage, planetary design with a reduction ratio of 13,840:1, giving the output shaft a rotation speed of 1.3 rpm. The motor meets all MIL-E-5272 specification.

Western Gear Corp., Electro Prod. Div., Dept. ED, Box 182, Lynwood, Calif.

Wescon Booth 1722-23

CIRCLE 196 ON READER-SERVICE CARD



## Is there a thinner pressure-sensitive tape that's better-performing ... and at a lower cost?

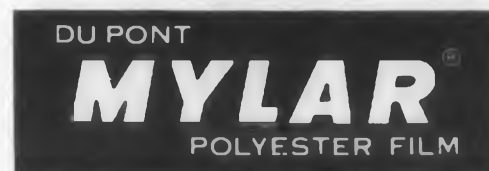
Yes, there is such a tape, and it's made with Du Pont "Mylar" polyester film. For most applications, tough, durable pressure-sensitive tape of "Mylar" *actually cost less*, per linear foot or yard, than tapes made of other materials. That's because "Mylar" permits tape manufacturers to use thinner gauges without any loss in performance.

And what about performance? Here are some of the outstanding properties of "Mylar" found in pressure-sensitive tape:

- THIN, YET STRONG**  
... average tensile strength of 20,000 psi.
- DURABLE**  
... under both high and low temperature use.



BETTER THINGS FOR BETTER LIVING  
... THROUGH CHEMISTRY



- FLEXIBLE**  
... gives snug wrap over irregular surfaces.
- HIGH DIELECTRIC STRENGTH**  
... average 4,000 volts per mil.
- DIMENSIONALLY STABLE**  
... can be used in areas of high humidity.
- MOISTURE-RESISTANT**  
... resists mildew, most chemicals.
- RESISTS EDGE FRAYING**  
... has great tear and impact strength.
- RESISTS HEAT AND COLD**  
... can be used in class B insulation systems.
- NO PLASTICIZER**  
... can't dry out or embrittle with age.

You name the job ... electrical insulating, color coding, masking for electro-

plating, harness-wrapping coils ... and you're sure to find pressure-sensitive tape of "Mylar" can improve performance while lowering costs. What's more, this thinner tape can help decrease weight and size of finished products without any loss in performance!

Pressure-sensitive tape of "Mylar" can now be obtained in a wide variety of gauges, widths, colors, and with different adhesives. Ask your supplier to help you evaluate all the factors involved in cost and performance of tape made with "Mylar". Or, send today for a list of tape manufacturers and a booklet on properties and applications.

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

E. I. du Pont de Nemours & Co. (Inc.)  
Film Dept., Room ED-8, Nemours Building, Wilmington 98, Delaware.

Please send me information on the advantages and uses of pressure-sensitive tape made with "Mylar" (MB-6).

Please send me information on properties, applications and types of "Mylar" available (MB-11).

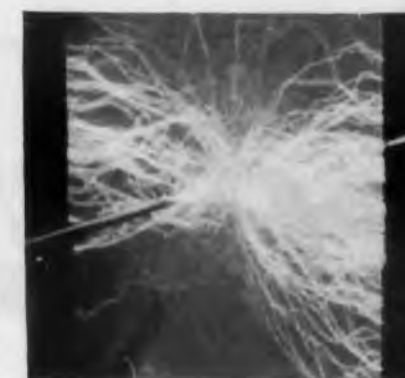
Application \_\_\_\_\_  
Name \_\_\_\_\_  
Firm \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 197 ON READER-SERVICE CARD

"MYLAR" offers a unique combination of properties valuable for electrical design



**HIGH TENSILE STRENGTH.** "Mylar" is the strongest plastic film. Instron tester shows an average strength of 20,000 lbs. psi.

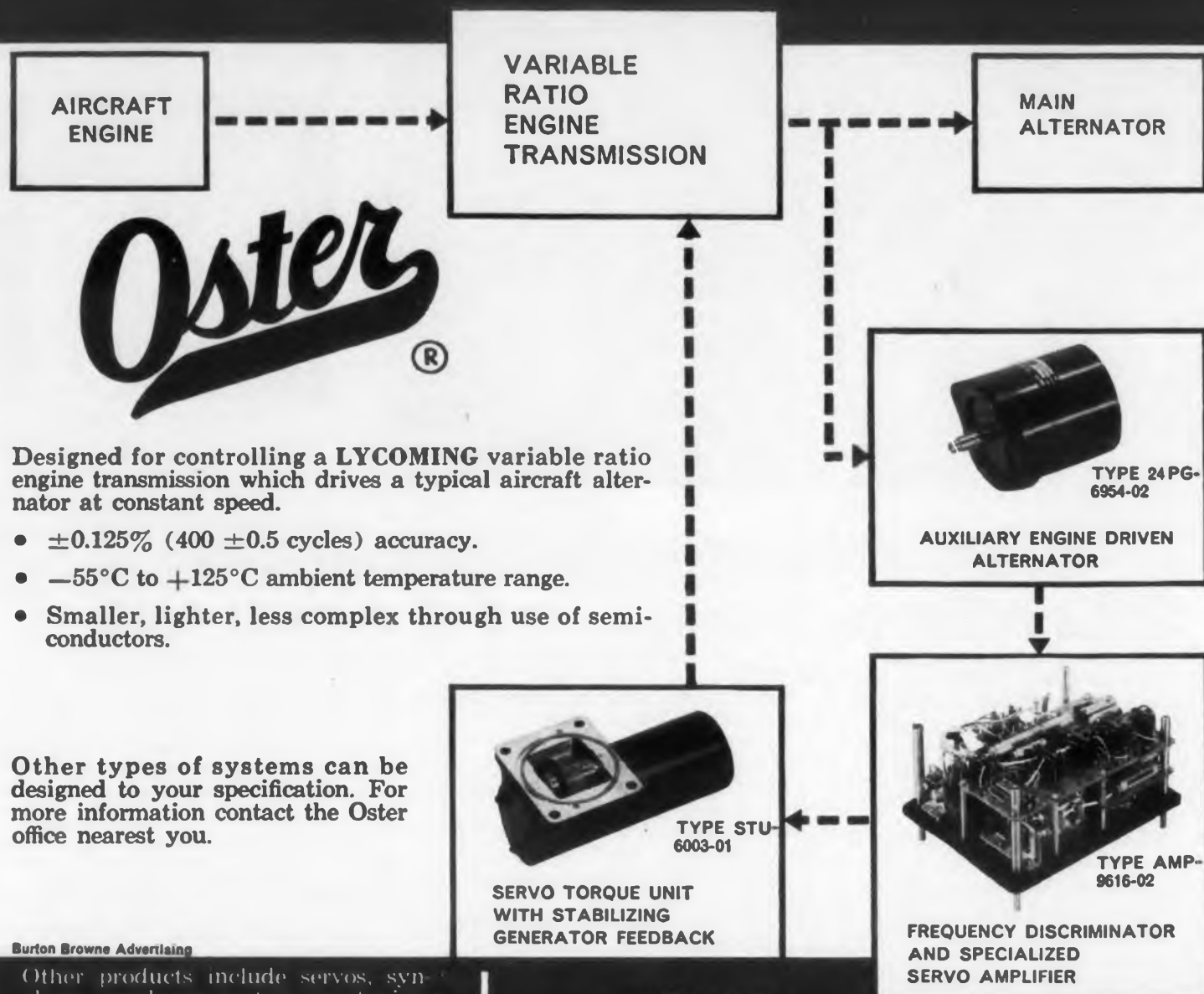


**HIGH DIELECTRIC STRENGTH.** Average of 4,000 volts per mil... average power factor of 0.003 at 60 cycles.

New Transistorized

# FREQUENCY DISCRIMINATOR AND SERVO DRIVEN CORRECTION LOOP

$\pm 0.5\%$  accuracy



**Oster**®

Designed for controlling a LYCOMING variable ratio engine transmission which drives a typical aircraft alternator at constant speed.

- $\pm 0.125\%$  (400  $\pm 0.5$  cycles) accuracy.
- $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  ambient temperature range.
- Smaller, lighter, less complex through use of semi-conductors.

Other types of systems can be designed to your specification. For more information contact the Oster office nearest you.

Burton Browne Advertising

Other products include servos, synchros, resolvers, motor-gear-trains, AC drive motors, DC motors, servo mechanism assemblies, reference and tachometer generators, servo torque units, actuators and motor driven blower and fan assemblies.

**John Oster**

**MANUFACTURING CO.**

Your Rotating Equipment Specialist

Avionic Division

Madison, Wisconsin

**NEW YORK OFFICE**

237 North Main Street  
Hempstead, L.I., New York  
Phone: IVanhoe 3-4653  
TWX Hempstead N. Y. 705

**NEW JERSEY OFFICE**

517 Lyons Avenue  
Irvington, New Jersey  
Phone: ESsex 3-2361

**WESTERN OFFICE**

5333 So. Sepulveda Blvd.  
Culver City, California  
Phones: EXmond 1-5742  
TEXas 0-1194  
TWX S. Mon 7671

Engineers For Advanced Projects:

Interesting, varied work on designing transistor circuits and servo mechanisms.  
Contact Mr. Robert Burns, Personnel Manager, in confidence.

CIRCLE 198 ON READER-SERVICE CARD

## NEW PRODUCTS at WESCON

**VU Meter**  
Immune to stray fields



Model 1332 VU meter uses Cormag mechanisms and can be mounted on magnetic or non-magnetic panels without need for special adjustment. The units are immune to the effect of stray fields, and are not affected by close proximity mounting. The accuracy of these instruments is  $\pm 3$  per cent of full scale.

Daystrom, Inc., Weston Instruments Div., Dept. ED, Newark, N.J.  
Wescon Booth 706-07

CIRCLE 199 ON READER-SERVICE CARD



**Telemetering Antenna**  
Helical drive

Type G-1007 antenna is a beam mode helical type for use in telemetering. Radiating element is attached to aluminum shaft with fibreglas insulator. Frequency range is 215 to 235 mc. Impedance is 50 ohm. Vswr is under 1.5 to 1. Gain is 10.5 db over isotropic source. Beamwidth is 58 deg.

Technical Appliance Corp., Special Products Div., Dept. ED, 1 Taco St., Sherburne, N.Y.

CIRCLE 200 ON READER-SERVICE CARD

**Bacons**

For missile and drone recovery

For missile and drone recovery, these beacons are used in the recovery of missile nose cones.

ELECTRONIC DESIGN • August 6, 1958

Stack beacons in various sizes and shapes, embracing both cw and pulsed techniques. Can be furnished with internal batteries or an internally mounted transistorized power supply.

Simmonds Aerocessories, Inc., Dept. ED, 105 White Plains Rd., Tarrytown, N.Y.

CIRCLE 201 ON READER-SERVICE CARD



### Frequency Multiplier

Features ease of tuning

By flipping a switch on model 504C exciter unit of this multi-band frequency multiplier, the operator can transmit on the 80, 40, 20, 15, 11 or 10 meter bands. Operation requires 6 to 10 v driving power from an external crystal oscillator or vfo between frequency range of 3350 to 4000 kc, and a power supply providing filament and dc plate power. The output of model 504C is a nominal 25 w.

Barker & Williamson, Inc., Dept. ED, Canal St. & Beaver Dam Rd., Bristol, Pa.

CIRCLE 202 ON READER-SERVICE CARD

### RDB Counter

Simplifies telemetering measurements



With model 2503, RDB channels and pushbutton selected and the visually displayed count is normalized to read deviation from midband directly in per cent of the midband period. The unit has five decimal places and uses an internal crystal-controlled, 100-kc time base or external time base. It also measures frequency and ratio either directly or normalized.

G. F. Climo, Dynac, Inc., Dept. ED, 395 Page Mill Rd., Palo Alto, Calif.

CIRCLE 203 ON READER-SERVICE CARD

## connect with CANNON PLUGS

USE  
for  
AIRCRAFT  
and ELECTRONIC  
INSTRUMENTS

TYPICAL DESIGNS



MS, MS-A, MS-B, MS-C... Conforming to Specification MIL-C-5015C. 15 insert diameters and 260 contact layouts. 6 shell styles, MS3100 to MS3108 with all accessories. Also (MS) F.



for VIBRATION  
RESISTANCE  
and MOISTURE-  
PROOF applications



MS-E SERIES...environment resisting. Meets Specification MIL-C-5015C. Resilient inserts. Integral cable clamp. New grounding lugs. Interfacial sealing, improved grommet and new grommet follower.

for GENERAL  
CIRCUITRY and  
QUICK DISCONNECT  
in more rugged  
applications



K, RK SERIES... SPECIAL ACME THREAD. The All-Purpose Series. Conduit and cable clamp entry types. 1 to 82 contacts in 213 different contact layouts. 10-, 15-, 30-, 40-, 60-, 80-, 115-, and 200-amp. silver-plated contacts. High quality phenolic, melamine, and formica insulators. Cadmium-plated aluminum alloy shells.



for  
UNIT-PLUG-IN  
applications...



DP, DPB, DPD, DPD2, DPD2R, DPJ, AND DPS SERIES... Rack/panel/chassis. With and without shells; coaxial and high voltage contacts. Permit quick disconnect, interchange, replacement, testing and inspection of assemblies and sub-assemblies.

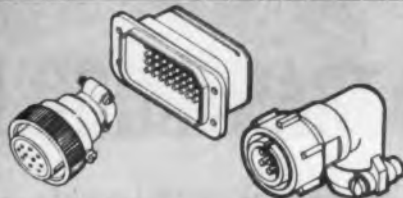
for AUDIO  
and LOW LEVEL  
circuits



P, XLR, XL, XK, O, UA, BRS SERIES... many shell styles and insert layouts. Straight and angle 90° plugs. Latch-lock types. Wall-mounting, panel, lock-nut mounting, and adapter receptacles, single- and two-gang. 10- to 30-amp. contacts, coaxials. UA Series features 3 gold-plated contacts.



for RADIO and  
SUB-MINIATURE  
applications



D, MC, DPA, DPX, AND K MINIATURES... miniatures and sub-miniatures designed for amplifiers, miniature indicators, computer circuits, telemetering equipment, small pre-amps, and general instrumentation where space is limited and current requirements are generally not over 5 amperes. Variety of shell styles, junction shell, and insert arrangements. 3 to 50 contacts, plus coaxials.

for HERMETICALLY  
SEALED  
applications



GS (MS TYPE), KH, RKH, DAH, BFH, TBFH, DBH, KH30... with steel shells and contacts to withstand high pressures from within or without. Insulation is a glass material, fused under high temperature to shell and contacts, thus forming a hermetic seal.

for HIGH  
TEMPERATURE  
and firewall  
applications



MS-K, MS-FW, AND CANNON K-FW STEEL SHELL CONNECTORS... Open flame protection offered in the greatest variety of this type of connector. Wall- or box-mounting receptacles. Straight or angle 90° plugs. Crimp-type contacts. Inserts of glass-filled materials.

Send for AR Condensed Catalog containing illustrations and technical information on all principal series of connectors in the extensive Cannon Line.



CANNON ELECTRIC COMPANY, 3208 Humboldt St., Los Angeles 31, California. Factories in Los Angeles, Salem, Mass., Toronto, Can., London, Eng., Melbourne, Austl. Manufacturing licensees Paris, Tokyo. Representatives and distributors in all principal cities.

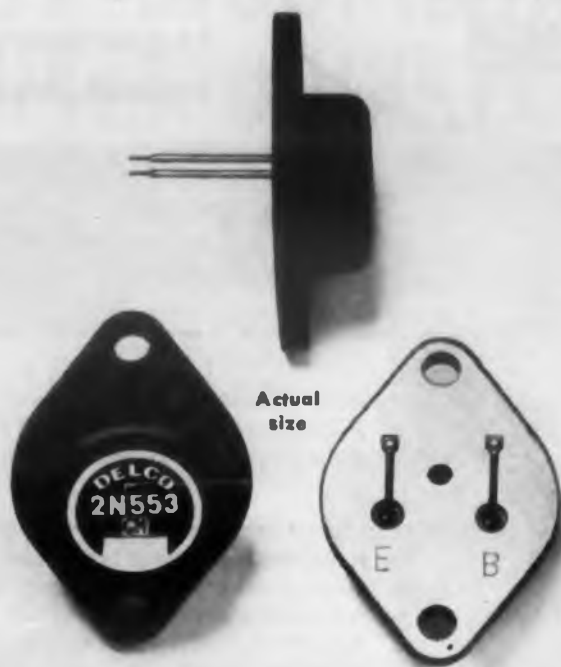
please refer to Dept. 143

**CANNON ELECTRIC**

Since 1915



CIRCLE 204 ON READER-SERVICE CARD



## ANNOUNCING...

the newest addition to the Delco family of PNP germanium transistors! It's ideally suited for high-speed switching circuits and should find wide use in regulated power supplies, square wave oscillators, servo amplifiers, and core-driver circuits of high-speed computers. It's the 2N553!

# NEW HIGH-FREQUENCY POWER TRANSISTOR BY DELCO

*No other transistor offers so desirable a combination of characteristics for applications requiring reliability and consistency of parameters.*

### TYPICAL CHARACTERISTICS T = 25°C unless otherwise specified

Collector diode voltage $V_{CB}$ ( $V_{EB} = -1.5$ volts)	80 volts maximum
Emitter diode voltage $V_{EB}$ ( $V_{CB} = -1.5$ volts)	40 volts maximum
Collector current	4 amps. maximum
Base Current	1 amp. maximum
Maximum junction temperature	95°C
Minimum junction temperature	-65°C

Collector diode current $I_{CO}$ ( $V_{CB} = 2$ volts)	12 $\mu$ a
Collector diode current $I_{CO}$ ( $V_{CB} = -60$ volts)	0.5 ma
Collector diode current $I_{CO}$ ( $V_{CB} = -30$ volts, 75°C)	0.5 ma
Current gain ( $V_{CE} = -2$ volts, $I_C = 0.5$ amp.)	55
Current gain ( $V_{CE} = 2$ volts, $I_C = 2$ amps.)	25
Saturation voltage $V_{EC}$ ( $I_B = 220$ ma, $I_C = 3$ amps.)	0.3
Common emitter current amplification cutoff frequency ( $I_C = 2$ amps, $V_{EC} = 12$ volts)	25 kc
Thermal resistance (junction to mounting base)	1° C/watt

#### BRANCH OFFICES

Newark, New Jersey  
1180 Raymond Boulevard  
Tel: Mitchell 2-6165

Santa Monica, California  
726 Santa Monica Boulevard  
Tel: Exbrook 3-1465

## DELCO RADIO

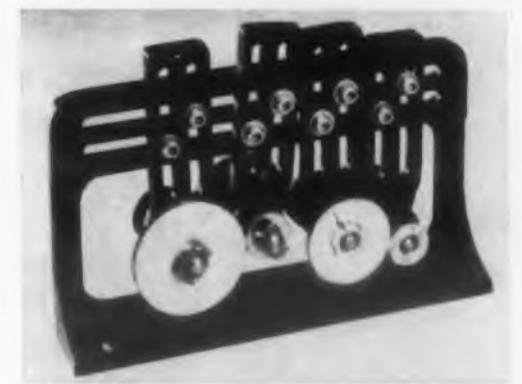
Division of General Motors  
Kokomo, Indiana

CIRCLE 205 ON READER-SERVICE CARD

## NEW PRODUCTS

### Gear Train

Permits quick breadboarding



The mounting centers of this hanger assembly are spaced for use with most existing breadboard plates. It permits the assembly of a complete gear train as an integral unit, which means large reductions can be independently set up prior to mounting on the breadboard plate.

Sterling Precision Corp., Instrument Div., 17 Matinecock Ave., Port Washington, N.Y.

CIRCLE 206 ON READER-SERVICE CARD

### Explosive Actuator

Dimple-motor type



Screw-in type dimple motor Model 1072 comes in a wide range of 100 per cent fire and no-fire actuating currents. The end of the unit is closed with a copper diaphragm which extends 1/16 in. upon actuation.

Holex, incorporated, Dept. ED, Hollister, Calif.

CIRCLE 207 ON READER-SERVICE CARD

### Lever Actuated Switch

Waterproof



This waterproof switch has been designed for

ELECTRONIC DESIGN • August 6, 1958

short cycle operations. It can be made with either normally open or normally closed contacts. Electrical rating is 15 amp resistive at 115 v ac.

Control Products, Inc., Dept. ED, 306 Sussex St., Harrison, N.J.

CIRCLE 208 ON READER-SERVICE CARD

## Recording Head

Has precision lapped heads



Model 303 (3 channel) twin record and playback magnetic head system has precision lapped heads with a 0.002 in. gap for the recording half and a 0.0005 in. gap for the playback half. Mu metal construction utilizing 0.0006 in. lamination provides a balanced magnetic performance for each channel with noise levels from 50 to 60 db. Each of the heads has an impedance characteristic of between 12 to 14 mh at 1 kc.

Lipps Engineering, Dept. ED, 1511 Colorado Ave., Santa Monica, Calif.

CIRCLE 209 ON READER-SERVICE CARD

## Jack

Temperature range from -100 to 500 F



This test jack utilizing Teflon insulation is designed for use at temperatures ranging from -100 to 500 F. It is available with either spade or turret type solder terminals. The jack features beryllium copper spring-pin contact which is inverted to provide extra smooth insertion and firm seating of a standard 0.080 test prod.

Raytheon Manufacturing Co., Commercial Equipment Div., Dept. ED, 100 River St., Waltham, Mass.

CIRCLE 210 ON READER-SERVICE CARD



FOTOCERAM circuit board blanks are made photographically. All holes and shapes are produced by simple exposure to light, heat, and an etching operation.

## This is a FOTOCERAM printed circuit ... an unusual new type of printed circuit board

**Reliable through-plate holes** • The good adhesion of the circuit runs applies also to the through-plate holes because both are produced with one plating operation.

**Excellent resolderability** • We have removed and resoldered components over twenty times on a FOTOCERAM board without damage to circuit runs or through-plate holes. And this is *without* using adhesives to bond the copper to the board.

**Dimensional stability** • Rigid structure of FOTOCERAM prevents unusual design

considerations—eliminates problem of warp and twist.

**Good adhesion** • It takes 12-25 pounds to peel a one-inch copper strip from a FOTOCERAM board.

**Exceptional pull strength** • 1400 pounds per square inch.

**No water absorption** • FOTOCERAM's nonporous—zero water absorption.

**Non-flammable**

**No blisters** • FOTOCERAM never blisters. We put it through repeated 15-second

cycles of copper metallizing at 500°F. and could not find a single blister or sign of peeling or failure.

**Other properties:**

Dissipation factor		
	1mc @ 20°C.	0.006
	@ 200°C.	0.014
Dielectric constant		
	1 mc @ 20°C.	5.6
	@ 200°C.	6.3
Loss factor	1mc @ 20°C.	0.034
	@ 200°C.	0.088

For more information, write for our Data Sheet on FOTOCERAM.

*Corning means research in Glass*

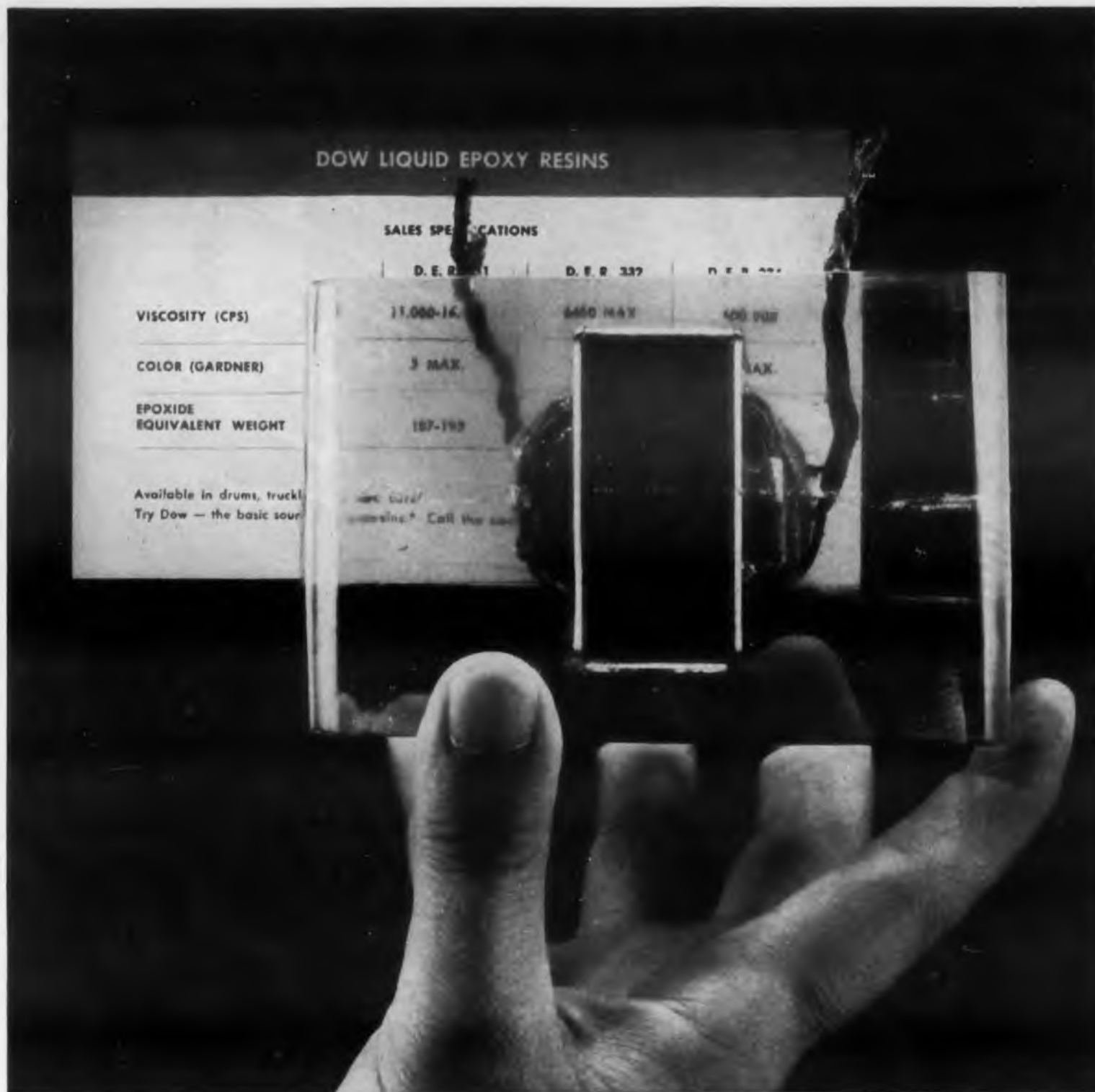


**CORNING GLASS WORKS, Bradford, Pa.**

Electronic Components Sales Department

CIRCLE 211 ON READER-SERVICE CARD





This hand-poured casting was not evacuated to remove bubbles.

## See for yourself the clarity of new Dow Epoxy!

This unretouched photo demonstrates how easy it is to see through several inches of Dow Epoxy Resin 332—and thus how easy it is to visually inspect parts which are encapsulated in D. E. R. 332.

But a perfect inspection "window" is not the only advantage you get when you use D. E. R. 332 for encapsulation. Compared to ordinary epoxies, the high purity of D. E. R. 332 makes possible more uniformity, lower viscosity, longer pot life and greater heat resistance. Of special interest also for electrical applications, D. E. R. 332 and D. E. R. 331 are very low in total and hydrolyzable chlorides.

D. E. R. 331 is a standard unmodified resin designed for customary applications and D. E. R. 334 is a modified low-viscosity resin especially suited for laminating.

All three of these Dow Liquid Epoxy Resins are available for prompt delivery to you in drums, truck or tank car lots. For complete information on Dow liquid and solid epoxies and epoxy novolaks, call your nearest Dow sales office. Or write THE DOW CHEMICAL COMPANY, Midland, Michigan, Coatings Sales Dept. 2262P-1.

YOU CAN DEPEND ON



CIRCLE 212 ON READER-SERVICE CARD

## NEW PRODUCTS



### Acceleration Switch

Actuated by 15 g

Model S 200-0-15G acceleration switch, for use in the ASP systems, is actuated by 15 g acceleration over a delay period of 250 msec. Shock safety limit on the sensitive axis ( $\pm 10$  deg) is more than 1000 g.

Cooper Development Corp., Dept. ED, 2626 S. Peck Rd., Monrovia, Calif.

CIRCLE 213 ON READER-SERVICE CARD

### Accelerometer

Accurate at 50 g



Model 605 features an air-damped spring-mass system which virtually eliminates transverse acceleration error. Acceleration sensitivity perpendicular to the sensitive axis is less than resolution at 50 g. A damping ratio of 0.65 critical is standard and ratios of 0.1 to 1.0 normally can be provided.

Bourns Laboratories, Inc., Dept. ED, P.O. Box 2112, Riverside, Calif.

CIRCLE 214 ON READER-SERVICE CARD

## Wirewound Control

For ambient temperatures to 250 C



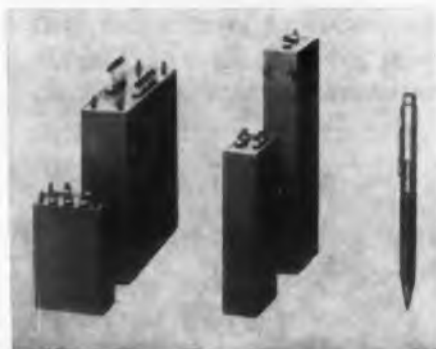
This small, wirewound control meets MIL-E-5272 specs. Hermetically sealed, it is designed for ambient temperatures to 250 C. At 200 C ambient, it is rated at 2.5 w.

P. R. Mallory & Co., Inc., Dept. ED, Indianapolis 6, Ind.

CIRCLE 215 ON READER-SERVICE CARD

## Transformers

Space saving



Construction of L-shaped laminations reduces the volume of Slim-Tran transformers. Units have up to 500 va ratings. In open or in potted, encapsulated, and hermetically sealed types.

Era Electric Corp., Dept. ED, 67 E. Centre St., Nutley, N.J.

CIRCLE 216 ON READER-SERVICE CARD

## Connector

Taper-contact



Miniature environmental taper-contact connectors meet or exceed MIL-C-5015 specs. In 3, 7, 12, 19, 27, 37, and 61 contact arrangements. All plugs in series available with company push-pull locking mechanism.

The Deutsch Co., Dept. ED, 7000 Avalon Blvd., Los Angeles 3, Calif.

CIRCLE 217 ON READER-SERVICE CARD

6 cps to 100,000 cps at  
1,000 WATTS CONTINUOUS DUTY  
...with  
the new  
Genisco-Savage  
high-output  
amplifiers!

Seven models—rugged enough for production line testing; versatile enough for almost all laboratory needs.



The Genisco-Savage Model V1000 Shaker

Here's the new line of quality, high-output amplifiers you've been waiting for! All seven models feature high power output, low distortion, exceptionally high reliability and stability, and excellent output voltage waveform.

The Model KLF, shown at left, is particularly useful as an exciter for vibration testing equipment and as a variable frequency power supply for a multitude of production and laboratory needs. It will operate *continuously* with an output of 1,000 watts from 6 to 2,000 cps.

Components of all Genisco-Savage Amplifiers are mounted on 19" vertical panels to facilitate easy inspection and maintenance. Quick-release grill covers make all tubes readily accessible from the front. Numerous built-in safety features protect the equipment from operator errors.

**Two New Shake Tables Available** The new Model V1000 Genisco-Savage Shaker features a very light moving coil assembly, high thrust-to-weight ratio, automatic impedance matching, and an excellent output waveform. A continuous alternating thrust of  $\pm 600$  lbs. is produced at 1,000 watts control power. Thrust can be increased to  $\pm 750$  lbs. peak by use of a blower (Model V1000B). Both models have been stress-tested to withstand continuous operation at accelerations of 100 G's.

BRIEF SPECIFICATIONS	MODELS						
	BM2	DM2	KM2	10K	KM2S	KLF	KRF
Output	250 w at 50 or 100 v	500 w at 50 or 100 v	1000 w at 50 or 100 v	10,000 w maximum	1000 w at 50 or 100 v	1000 w at 50, 100, or 200 v	1000 w at 25, 50 or 100 v
Frequency Range	50 to 10,000 cps at 250 w	50 to 10,000 cps at 500 w	50 to 10,000 cps at 1000 w	40 to 10,000 cps at 10,000 w	50 to 10,000 cps at 1000 w	6 to 2000 cps at 1000 w	5 to 100 kc at 1000 w
Sensitivity	0.036 v at 600 ohms	0.04 v at 600 ohms	0.1 v at 600 ohms	0.16 v rms at 600 ohms for 10,000 w output	0.1 v at 600 ohms	0.05 v at 600 ohms	0.5 v at 600 ohms
Distortion	1% at 250 w, 1000 cps	0.75% at 500 w, 1000 cps	Less than 0.75% at 1 kw, 1000 cps	Less than 3% at 10 kw, 1000 cps	Less than 0.75% at 1 kw, 1000 cps	Less than 5% at 1 kw, 10 to 1000 cps	

Price and delivery of both amplifiers and shakers are exceptionally good. For complete specifications and prices send for the new four-page illustrated brochure.



Genisco, Incorporated  
2233 Federal Avenue  
Los Angeles 64, California

CIRCLE 218 ON READER-SERVICE CARD

## TEN-TO-ONE THE Copper Clad Laminate YOU WANT IS HERE!

From these ten basic PHENOLITE® Grades, you can select the base material, resin, properties and price to fit your present printed circuit need.

If your problem is finding a suitable cold-punch material, try samples of XXXP-470-1. It's designed for use in automated production equipment. If you are looking for higher heat resistance, check Grades G-10 and G-11.

Out of National's research laboratories come new advances every day. See your National Representative about new products and applications. He can keep you posted on the full line of PHENOLITE Laminated Plastic, Vulcanized Fibre and National Nylon for electronic applications across-the-board. In the meantime, write for our new "PHENOLITE Copper Clad Data" folder. Address Dept. E-8.

**NATIONAL**  
VULCANIZED FIBRE CO.  
WILMINGTON 99, DELAWARE

In Canada:  
NATIONAL FIBRE COMPANY OF CANADA, LTD., Toronto 3, Ontario

SEE NATIONAL AT WESCON . . . LOS ANGELES  
AUGUST 19-22 . . . BOOTH NO. 304-305



### TYPICAL TEST VALUES ON COPPER CLAD PHENOLITE

GRADE	PROPERTIES OF BASE MATERIAL					COPPER CLAD PROPERTIES			RELATIVE COST Based on XXXP on Arbitrary Scale of 1	
	Dielectric Constant	Dissipation Factor	Moisture Absorption 1/16", % 24 Hrs	Flexural Strength Psi	Maximum Operating Temperature Degree F	Copper Bond Strength		Hot Solder Resistance Secs to Dissolve 1" Square > Greater Than		Surface Resistance Megohms, Etched Retma Comb Pattern, 96 Hrs/35°C/90% RH
						Pounds to Pull 1" Strip				
		10 <sup>4</sup> Cycles	10 <sup>4</sup> Cycles			1 Oz	2 Oz		1/16" Thk. 1 Oz. Copper 1 Side	
P-214-B-1	5.3	.040	2.20	18,000	250	8	11	> 10 @ 475°F	100,000	.81
XXP-209-G-1	4.6	.037	1.30	17,000	250	8	11	> 10 @ 475°F	200,000	.92
XXP-239-I PHENOCLAD	4.2	.035	0.67	15,500	250	8	11	> 10 @ 475°F	200,000	.92
XXXP-219-C-1	4.5	.030	0.70	15,500	250	8	11	> 10 @ 475°F	500,000-1,000,000	1.00
XXXP-455-1	4.0	.026	0.55	23,500	250	8	11	> 10 @ 475°F	1,000,000-1,500,000	1.00
XXXP-470-1	3.7	.027	0.48	14,000	250	8	11	> 10 @ 475°F	300,000-500,000	1.00
N-1-852-1	3.3	.030	0.20	16,000	165	8	11	> 10 @ 450°F	2,000,000	2.69
G-5-813-1	6.8	.018	1.00	55,000	300	8	11	—	—	2.98
G-10-865-1	5.2	.012	0.13	60,000	250	10	15	> 30 @ 500°F	1,500,000-2,000,000	3.49
G-11-861-1	4.9	.015	0.17	60,000	300	10	15	> 30 @ 500°F	2,000,000	3.55

CIRCLE 219 ON READER-SERVICE CARD

## NEW PRODUCTS

### Linear Counting-Rate Meter Has seven counting ranges



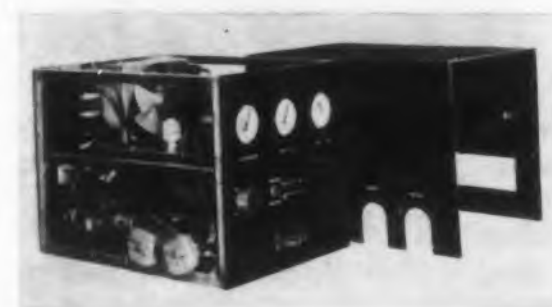
Model DM4 linear-counting rate meter features seven counting ranges, three time constants and a 60-cycle calibrating circuit. A range selection switch on the front panel permits the choice of full scale ranges from 200 through 200,000 counts per min.

BJ Electronics, Borg-Warner Corp., Dept. ED, 3300 Newport Blvd., Santa Ana, Calif.

CIRCLE 220 ON READER-SERVICE CARD

### Cooling System

Achieves cell temperatures to -70 C



Model RS-25, type 100 cooling system for the detecting cell of infrared search systems. Unit achieves cell temperatures down to -70 C and operates up to 85 F and to 5000 ft altitude.

Eastern Industries, Inc., Dept. ED, 100 Skiff St., Hamden, Conn.

CIRCLE 221 ON READER-SERVICE CARD

### Inertia Switches

Reset type



These reset type miniature inertia switches have a single moving part. They can be used as

one-shot closing devices without the use of a relay, or as memories to show a specific acceleration or shock level has been exceeded. The 24 standard models provide acceleration levels from 0.15 to 20 g.

Inertia Switch, Div. of Safe Lighting, Inc., Dept. ED, 527 Lexington Ave., New York, N.Y.

CIRCLE 222 ON READER-SERVICE CARD

## Resistance Calibrator

Measures resistance up to 100 meg



This resistance calibrator permits resistance calibrations up to 100 meg with an accuracy of  $\pm 0.01$  per cent. It enables the transfer of the accuracy of low range standards to the higher ranges with an additional error of transfer of less than  $\pm 0.0001$  per cent per 2 decades up to 10 meg and  $\pm 0.01$  per cent to 100 meg.

International Resistance Co., Hycor Div., Dept. ED, 12970 Bradley Ave., Sylmar, Calif.

CIRCLE 223 ON READER-SERVICE CARD

## Interval Timer

Features low contact bounce

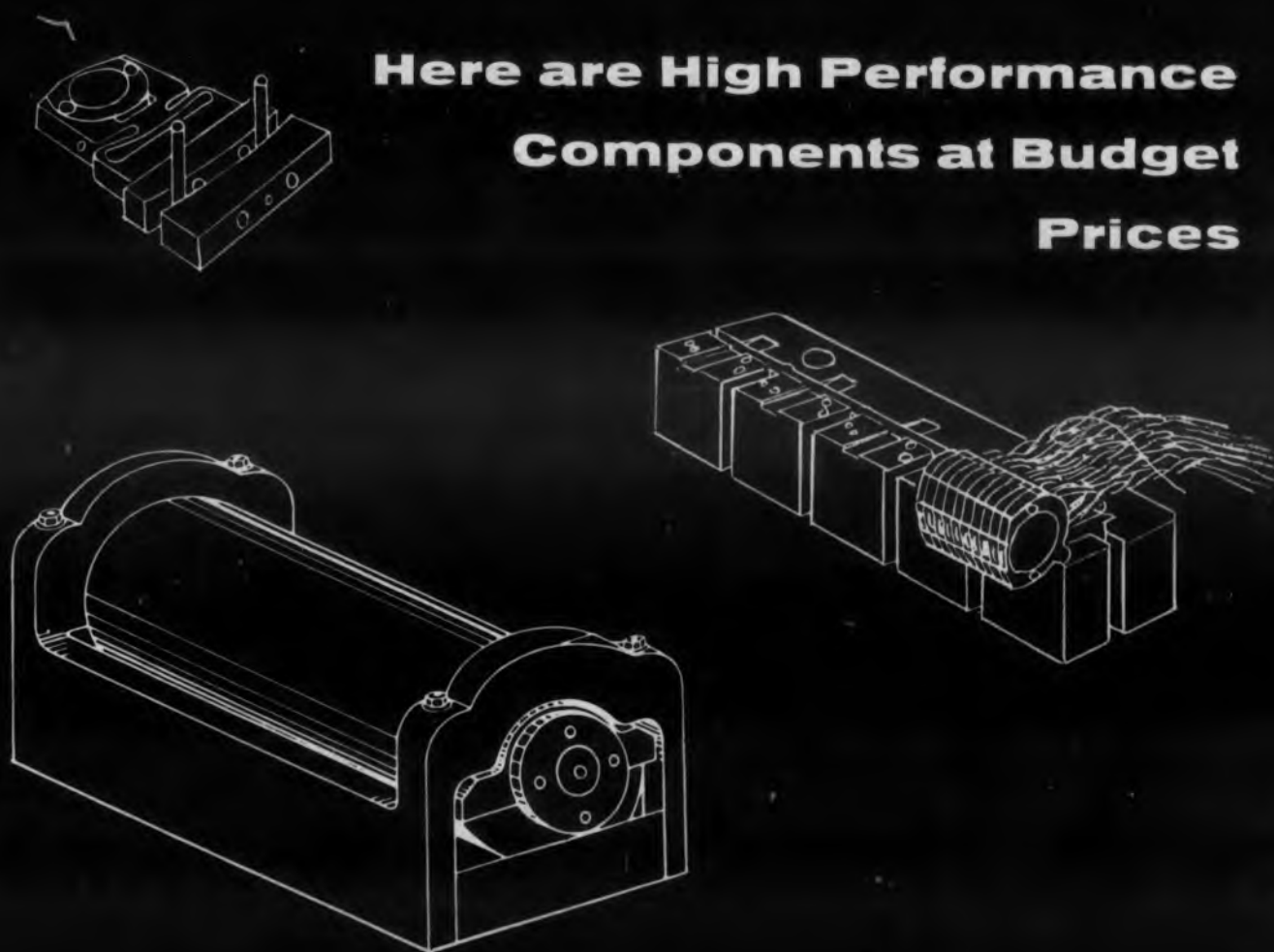


This 5 channel interval timer has a contact bounce of less than 300  $\mu$ sec on make, and less than 50  $\mu$ sec on break. Contacts are designed for a load current of at least 0.5 amp. Because of the asynchronous drive motors, the tolerance of the timing pulses is held to  $\pm 0.2$  per cent or  $\pm 10$   $\mu$ sec whichever is greater. These tolerances are relative to a 60 cycle or 400 cycle time base accuracy.

Western Design & Manufacturing Corp., Div. U.S. Industries, Inc., Dept. ED, Santa Barbara Airport, Goleta, Calif.

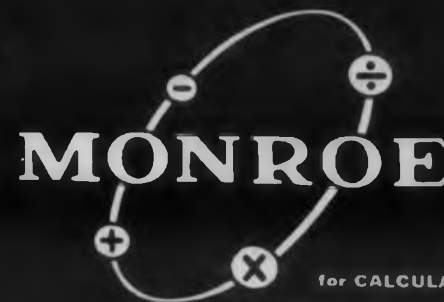
CIRCLE 224 ON READER-SERVICE CARD

## Here are High Performance Components at Budget Prices



Every project engineer can now afford to have his own magnetic storage drum... a truly versatile memory system... to expedite many jobs. Costing less than the price of a good oscilloscope, a Monrobot modular storage unit offers high performance characteristics with near custom-designed flexibility. Drum speed and head layout may be selected by the systems engineer to meet his individual requirements; belt drive models and open head mounting allow field alteration to accommodate major system changes which require different speeds or delay times. Thus, engineers can "prove out" logic without risk of obsoleting the drum before the system is complete.

Both drums and heads have shown high mechanical stability under rough field conditions and over a wide range of temperatures. The drums, offering information storage at a high density, are rigid and stable with a minimum of run-out. The read/record heads feature built-in fine calibration adjustments and can be adjusted over a delay of forty pulses while the drum is rotating. For complete specifications, write: Monroe, Dept. E, Orange, N. J.



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DATA PROCESSING MACHINES

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a **high sensitivity**  
**low cost**  
**spectrum analyzer**  
from **10mc to 44,000 mc**  
with **one tuning head**

employing the latest  
proven developments  
in the Micro-wave field

**PANORAMIC'S**  
advanced new  
MODEL **SPA-4**

A new and welcome addition to Panoramic's long line of widely accepted and completely dependable Spectrum Analyzers, the SPA-4 covers frequencies from 10 mc to 44,000 in one low-cost compact unit that provides better sensitivity than found in typical multi-tuning head spectrum analyzers.

Backed by Panoramic's forward thinking, long and specialized experience in the development of spectrum analyzers, the SPA-4 embodies the human engineering and stable, direct reading displays that facilitate rapid and reliable analyses of measurement problems.

The SPA-4's many unique features, tremendous flexibility and simple operation make it unsurpassed for analysis of FM, AM and pulsed systems, instabilities of oscillators, noise spectra, detection of parasitics, studies of harmonic outputs, radar systems and other signal sources.

Write, wire, phone NOW for detailed specification bulletin.



- Better sensitivity than with typical multi-tuning head spectrum analyzers
- Resolution continuously variable from 1 kc to 80 kc for analysis of wide and narrow pulsed RF signals
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- Constructed to MIL specifications



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524 South Fulton Avenue, Mount Vernon, N.Y.  
Phone: OWens 9-4600

Cables: Panoramic, Mount Vernon, N. Y. State



at **WESCON • Booth 1265-1266**

CIRCLE 226 ON READER-SERVICE CARD

## NEW PRODUCTS

### Displacement Transducers Designed for linear motion measurement



Models 101, 102, and 103 displacement transducers provide output voltage proportional to plunger displacement. Extreme sensitivity and stepless resolution provide accurate measurement of motions as small as 0.000001 in. or over ranges as large as 0.4 in.

Daytronic Corp., Dept. ED, 216 S. Main St., Dayton 2, Ohio.

CIRCLE 227 ON READER-SERVICE CARD



### DC Amplifier Has low drift characteristics

Characteristics of REL-120 dc amplifier are: low heat generation due to an average required input power of only 10 w; and self-contained power supply, which works directly from either 60 or 400 cps.

Rheem Manufacturing Co., Electronics Div., Dept. ED, 7777 Industry Ave., Rivera, Calif.

CIRCLE 228 ON READER-SERVICE CARD

### Silicon Diode

50 to 75 kmc frequency range

Broadband high sensitivity microwave silicon diode Type MA-428 has high tangential sensitivity over the entire 50 to 75 kmc frequency range. It is estimated that system noise figures

between 15 and 18 db can be achieved, using a matched pair of these diodes as mixers in a rat race power divider balanced mixer assembly, in conjunction with a low noise i-f strip.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 229 ON READER-SERVICE CARD



### Diode Handler

Sorts 3000 diodes per hour

This automatic bulk diode handler is capable of sorting up to 3000 diodes per hour into as many as 16 classifications. Diodes are transported automatically from hopper to bins, and bin contents are displayed on counters.

Stromberg-Carlson, Div. of General Dynamics Corp., Electronic Control Systems Div., Dept. ED, 2231 S. Barrington Ave., Los Angeles 64, Calif.

CIRCLE 230 ON READER-SERVICE CARD

### Power Supply

0-36 v dc



Model HP361 is a transistorized instrument supplying voltage from 0-36 v dc at currents from 0 to 1.5 amp at any voltage setting. Recovery time is less than 50  $\mu$ sec for a maximum line or load transient. Peak transient for a load step from zero to maximum load is less than 50  $\mu$ sec. Regulation is less than 20 mv output voltage variation for line changes from 105-125 v ac.

Deltron, Inc., Dept. ED, 2905 N. Leithgow St., Philadelphia 33, Pa.

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## DESIGNED TO FLY

Especially designed to meet the rigid size and weight requirements of airborne instrumentation, Statham's new strain gage carrier amplifiers are transistorized throughout. Operating from normally available 28-volt DC excitation, these units supply excitation to any strain gage transducer of desired range, amplifying and demodulating the transducer's low-level signals to provide an output of from 0 to 5 volts DC. When you require unprecedented accuracy and reliability in the amplification of signals from your strain gage instrumentation, specify a Statham strain gage amplifier.



Model CA3 Strain Gage Amplifier



Model CA5 Strain Gage Amplifier

EXCITATION: 28 volts DC,  $\pm 5\%$   
OUTPUT: 0-5 volts DC  
FREQUENCY RESPONSE: Flat from 0 up to 2000 cps  
NON-LINEARITY AND HYSTERESIS:  $\pm 1/2\%$   
OPERATING TEMPERATURE:  $-65^\circ$  to  $+165^\circ$ F.  
OUTPUT IMPEDANCE: 10K ohms (100K recommended load)  
WEIGHT: 14.5 ounces, approximately

For complete technical data, write to:

*Statham*

INSTRUMENTS, INC.

12401 W. Olympic Blvd., Los Angeles 64, California

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August 19-22

# THE FIRST NEW CONCEPT IN DIGITAL DISPLAY SYSTEMS

## Cubic TRANSISTORIZED SYSTEMS



with built-in  
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\* Cubic's engineering philosophy regards reliability and ease of maintenance as inseparable features of a truly functional system.

### ONLY CUBIC DIGITAL DISPLAY SYSTEMS GIVE YOU:

#### LOW COST OF OPERATION

Proven reliability and practical maintenance features reduce costly down-time to a minimum.

#### VERSATILITY

All systems units standard size: each unit plugs into its own chassis; modifications for special equipment readily available; interchangeable units ideal for rack mounting.

#### RELIABILITY

Accuracy to .01%; resistor stability assured; complete transistorization eliminates warm-up time.

#### EASE OF MAINTENANCE

Stepping switches mounted on horizontal bars — swing up and out for easy access. Slide-out features allow quick replacement if system requirements change.

Compare Cubic Digital Systems . . . compare them for price, reliability and versatility. A fast prove-it-yourself demonstration will show you why Cubic Digital Systems will be your best instrument aid.

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See our Complete Display of Digital Systems at the Wescon Show, Booths 1554-1555.

CIRCLE 233 ON READER-SERVICE CARD

## NEW PRODUCTS

### Vibration Tester

Has 6 ranges of displacement



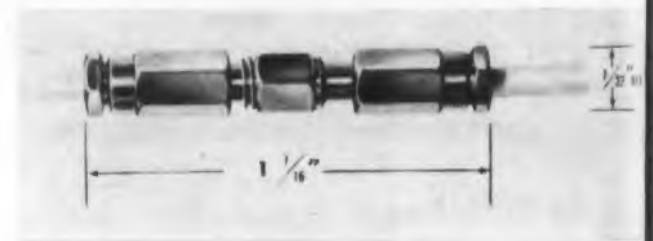
Model LM-1A vibration tester provides 6 ranges of full-scale displacement from 0-.001 to 0-100 in., double amplitude. Full scale velocity ranges from 0-.01 to 0-1000 in. per sec. Full scale acceleration ranges from 0-.1 to 0-1000 g. The frequency range is from 5 to 5000 cps. The meter operates from a velocity pickup.

Ling Electronics, Inc., Dept. ED, 9937 Jefferson Blvd., Los Angeles, Calif.

CIRCLE 234 ON READER-SERVICE CARD

### RF Connector

Simplified breakaway connections



This miniature rf connector may be assembled or disassembled with the fingers and withstands a pull-out strain in excess of 20 lb. Captivated contacts insure proper engagement with mating parts. The clamping parts, insulators, and contacts are readily assembled on the cable before insertion.

Selectro Corp., Dept. ED, 610 Fayette Ave. Mamaroneck, N.Y.

CIRCLE 235 ON READER-SERVICE CARD

### Hook-Up Wire

Eight layers of wrapped Teflon



SPIRAL WRAP  
(1/2 LAP—no overlap)



FLEXOLON WIRE  
(approximately 8 layers)

The method by which Teflon tape is applied to Flexolon hook-up wire makes possible, besides its known flexibility, an average production

length of 750 feet. This is due to the eight layers of tape, which lessen the chance of a single flow in the tape affecting insulation characteristics. Compared to the 100-ft average lengths of extruded Teflon wire, the longer lengths both reduce scrap and minimize set-up time of automatic machinery.

Flexolon wire is available in awg sizes 32 through 20. Nominal wall thickness is 0.010 in. Dielectric strength exceeds 600 v and 1000 v ratings for type E and type EE wires. All types are available in 14 solid colors or 819 stripe combinations.

Tensolite Insulated Wire Company, Inc., Dept. ED, Tarrytown, N. Y.

CIRCLE 236 ON READER-SERVICE CARD

## Ohmmeter

Safe for transistor circuitry



Model 321 ohmmeter is a direct-reading instrument usable safely in all transistor circuitry. It features an absolute minimum of loading (under 30 mv to 300 ohm); wide range of 10 milliohm to 10 megohm in 8 ranges, and 2 per cent accuracy.

Electronic Applications, Dept. ED, 194 Richmond Hill Ave., Stamford, Conn.

CIRCLE 237 ON READER-SERVICE CARD

## Digital Readout

Displays 4 digits plus symbol



The model 471 digital readout displays four digits and a symbol 1-1/8 in. high. Power requirements are 0.25 amp at 6.3 v ac for each symbol that is lit.

Kin Tel, Dept. ED, 5725 Kearney Villa Rd., San Diego 12, Calif.

CIRCLE 238 ON READER-SERVICE CARD



## YARDNEY SILVERCEL® BATTERIES

**ARE 66% LIGHTER, 35% SMALLER THAN ANY PREVIOUS HELICOPTER POWER SOURCE...**

In a drive to increase the valuable "payload" capacity of its 47J Helicopter, the Bell Helicopter Corp. replaced the conventional lead-acid battery with a miniaturized YARDNEY SILVERCEL® Battery. Result: a reliable power source 2/3 lighter, 1/3 smaller and with 1/3 more power output. They also gained freedom of design and extra cranking endurance. With pace-setter Bell proving the point, it's small wonder that today, SILVERCEL® Batteries are being designed into every modern helicopter.

Up to 5 times smaller, 6 times lighter, and with a greater power surge than ordinary batteries of equal capacity, the SILVERCEL® Battery offers many new opportunities for imaginative applications. There are standard SILVERCEL® Batteries for such applications as remote-control work, communications equipment, portable power supplies, telemetering and instrumentation, as well as custom-built batteries for particular requirements. Write today for complete technical data.

WESCON BOOTH # 1739

## YARDNEY ELECTRIC CORP.

"Pioneers in Compact Power"\*

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MANUFACTURERS OF YARDNEY SILVERCEL®, YARDNEY SILCAD® AND YARDNEY ARCTIC® BATTERIES  
CIRCLE 239 ON READER-SERVICE CARD



## NEW PRODUCTS

### Coil For printed circuit wiring



The unit consists of an rf coil with adjustable tuning, and either one or two windings enclosed in a plastic container with leads emerging from the bottom, suitable for mounting in printed circuit boards. An advantage of this coil construction is its low temperature coefficient for inductive drift, usually running in the order of plus 50 parts per million per degree centigrade.

Essex Electronics, Dept. ED, 550 Springfield Ave., Berkeley Heights, N.J.

CIRCLE 241 ON READER-SERVICE CARD

### Decode Unit

Binary to decimal



The Bina-Dec Decoder is for use in circuits requiring a binary-to-decimal conversion. Using a relay tree to perform the translation, the unit will handle four bit codes, two-out of five, and the excess 3 code. Module type construction permits assembly of as many decades as required.

Industrial Electronic Engineers, Dept. ED, 3973 Lankershim Blvd., North Hollywood, Calif.

CIRCLE 242 ON READER-SERVICE CARD

### Sweeping Oscillator

15 to 470 mc range

Vari-Sweep Model 400 has a frequency range, cw or sweeping operation, of 15 to 470 mc continuously variable in 10 switched, overlapping

ELECTRONIC DESIGN • August 6, 1958

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Design Problems



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#### LAMINATED TRANSFORMERS

A variety of types, sizes and packaging... including types standardized by the Armed Services Standards Agency as well as a group of standards for 400 cycle power supplies—Class T units now being supplied. All are designed to meet MIL-T-27A specifications.

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A wide variety of ready-designed and standard low-pass, high-pass and band-pass types. C-A-C filters cover frequencies from the low audio to low megacycle ranges. Custom designs featuring temperature compensation, matched phase, or impedance characteristics and miniaturization are available.

#### TOROIDAL INDUCTORS

Standard or custom designed in regular or sub-miniature series. Uncased, plastic compression molded, encapsulated, or hermetically sealed cases. Standard inductances stocked for immediate delivery.

#### MAGNETIC AMPLIFIERS

Advanced designs in a broad variety of types: operational, relay actuator, temperature control, high power, transistor drive, high speed servo motor drive. Additionally, a line of inverters is available.

## COMMUNICATION ACCESSORIES COMPANY

LEE'S SUMMIT, MISSOURI

PHONE KANSAS CITY, BRoadway 1-1700

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bands. Sweep width is 60 per cent of center frequency to 50 mc, 30 mc maximum from 50 to 400 mc, 20 mc maximum above 400 mc. Rf output is 1 v rms to 220 mc, 0.5 v rms to 470 mc.

Kay Electric Co., Dept. ED, Maple Ave., Pine Brook, N.J.

CIRCLE 243 ON READER-SERVICE CARD

## Power Supplies

±0.5 per cent regulation



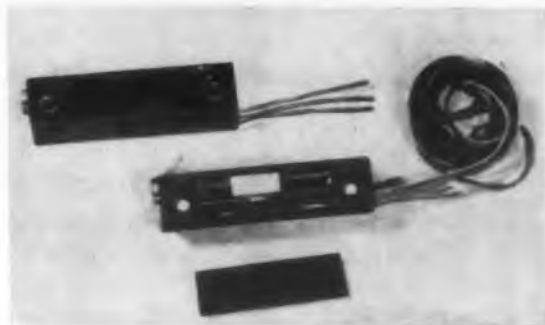
Available in a wide range of output voltages, a series of transistorized voltage regulated power supplies have channels regulated to ±0.5 per cent. The regulatory circuits are referenced to temperature compensated Zener diodes, and vernier adjustments of output voltages are provided. One unit, the Model 7PVR14, operates from a 115 v, 60 cps ac power source and provides three channel outputs: ±2 v dc at 2.5 amp, ±3 v dc at 2.5 amp, and ±20 v dc at 2.5 amp.

Western Gear Corp., Dept. ED, P.O. Box 182, Lynwood, Calif.

CIRCLE 244 ON READER-SERVICE CARD

## Trimmer

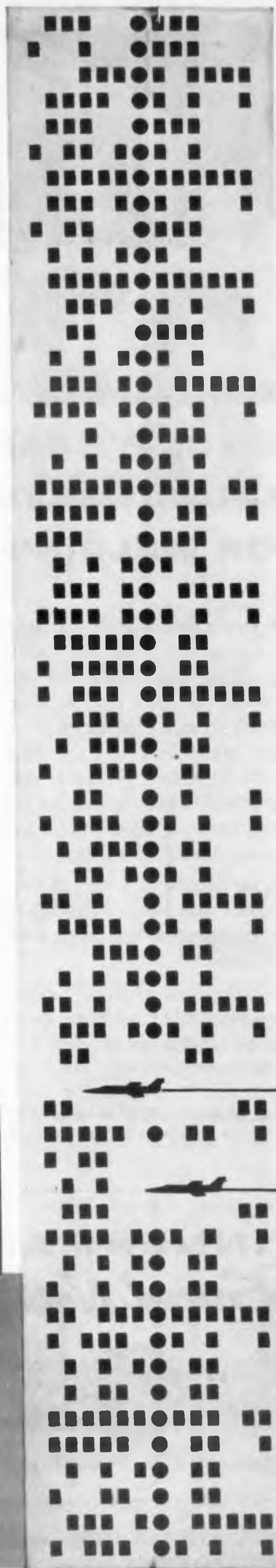
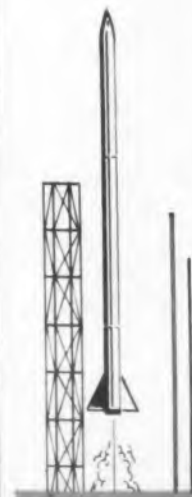
1 w derated at 225 C



Type RTW is a wire-wound trimmer with 25 turn lead-screw adjustment. Resistance range is 50 to 100 K. Power rating is 1 w at 75 C derated to zero at 225 C. Dual stainless steel contacts on winding and slip ring and precious metal take-off and end tabs are included. Other trimmers, type TPC, having similar characteristics are available for printed circuit use.

Technology Instrument Corp., Dept. ED, 531 Main St., Acton, Mass.

CIRCLE 245 ON READER-SERVICE CARD



# maintain and control reliability

with new

## PRE-PROGRAMMED INSTRUMENTATION

### NEW ROBOTESTER — IMMEDIATE AID TO IMPROVE MAINTAINABILITY OF EQUIPMENT RELIABILITY

A bold imaginative concept has evolved from Lavoie Labs in the form of a Programmed Instrumentation Approach with Failure Prediction. Designed for the active control of maintainability and reliability of electronic equipment in aircraft, missile and weapon systems. The universal-tape programmed performance checking Robotester is versatile and flexible and is the basis of this forward-thinking Lavoie program.

The Robotester itself expands checkout capabilities and slashes 80% of final test time. Operational testing and production line check out is accomplished through continuous, high-speed sampling and comparison . . . split-second recognition, isolation and identification of abnormal functions.

Nominal circuit values and specified tolerances are tape-punched in minutes to accommodate voltages (AC and DC) from 0.5 to 500 volts; Hi Pot to 500 volts; resistances from 1 ohm to 9.99 megohms; and tolerances of 1%, 5%, 10% and 20% of nominal. A total in excess of 60000 tests possible . . . the Robotester will check any two circuit points at rates up to 100 tests per minute.

Write today for complete technical information and specifications on the New Robotester.



Write on company letterhead for "Lavoie Programmed Instrumentation" . . . please specify application.

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*Lavoie Laboratories, Inc.*

MORGANVILLE, NEW JERSEY

DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT

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*Engineered by Tinnerman...*

## **NEW CAPACITOR SPEED CLIP® SNAPS IN, ELIMINATES RIVETING OR WELDING!**

Speed up the assembly of capacitor clips to electronic equipment with this new Tinnerman SPEED CLIP. The "heel-and-toe" fastening feature permits the clip to slide into locking position in holes punched in metal, fiber or plastic as easily as your foot slides into a shoe. Once locked in place, the clip stays put, yet can be easily removed and reused over and over again. No riveting, welding or special tools required—no screws to start, no parts to loosen under vibration!

SPEED CLIPS can be provided in various sizes to hold capacitors and other cylindrical parts from  $\frac{3}{8}$ " to  $1\frac{1}{2}$ " in diameter and to fit a wide range of panel thicknesses.

Samples and prices of these SPEED NUT brand fasteners are available from your Tinnerman sales engineer. If he isn't listed in your Yellow Pages, write to:

**TINNERMAN PRODUCTS, INC.**  
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FRANCE: Simmonds S.A., 11 rue de la République, Paris (Seine). GREAT BRITAIN: Simmonds Aeroaccessories Ltd., Treforest, Wales.  
GERMANY: Mecano-Bundy GmbH, Heidelberg.

CIRCLE 247 ON READER-SERVICE CARD

## NEW PRODUCTS

### Coaxial Hybrids Features in-line design



These coaxial hybrids feature an in-line design with output arms parallel and adjacent. Two models have been developed, one for the 3500 to 4200 mc band in 7/8 coax, and a second for the 5000 to 6000 mc band in type N coax. Isolation is in excess of 25 db over most of the band. Output balance is within  $\pm 0.25$  db.

Sage Laboratories, Inc., Dept. ED, 159 Linden St., Wellesley 81, Mass.

CIRCLE 248 ON READER-SERVICE CARD

### Power Supply

Provides 10-14.5 v dc



The TPS-1 power supply delivers 10 to 14.5 v dc at up to 15 amp, regulated within 0.2 per cent over the full input voltage and output current ranges. Ripple is 2 mv (rms) maximum at full load, and recovery time is better than 1 msec. Internal impedance is less than 3 milliohms.

Southwestern Industrial Electronics, Dept. ED, 2831 S. Post Oak Rd, Houston, Texas

CIRCLE 249 ON READER-SERVICE CARD

### DC Voltmeter-Amplifier

10  $\mu$ v to 1000 v

Differential dc voltmeter-amplifier Model 98-A facilitates testing and measuring dc voltages which are off ground or superimposed on larger dc voltages. Direct reading in the 10  $\mu$ v to 1000 v

range, it has a maximum gain of 70 db. Output is  $\pm 0.5$  ma into a 1500 ohm load.

Boonton Electronics Corp., Dept. ED, 738 Speedwell Ave., Morris Plains, N.J.

CIRCLE 250 ON READER-SERVICE CARD

### Infrared Cell Test Equipment

Measures photodetector impedance



This line of infrared photodetector measurement equipment includes: chopper continuously variable between 20 and 8500 cps; electronic instrumentation to measure photodetectors ranging in impedance from 5 ohm to 100 meg; black body sources; and special photodetector test enclosures fitted for various methods of low temperature cooling.

Santa Barbara Research Center, Santa Barbara Airport, Dept. ED, P.O. Goleta, Calif.

CIRCLE 531 ON READER-SERVICE CARD

### Filament Voltage Regulator

Extends tube life



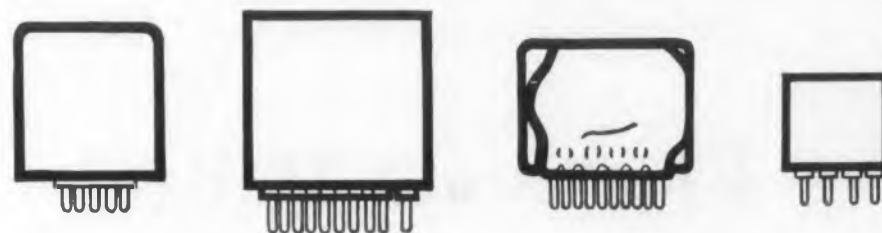
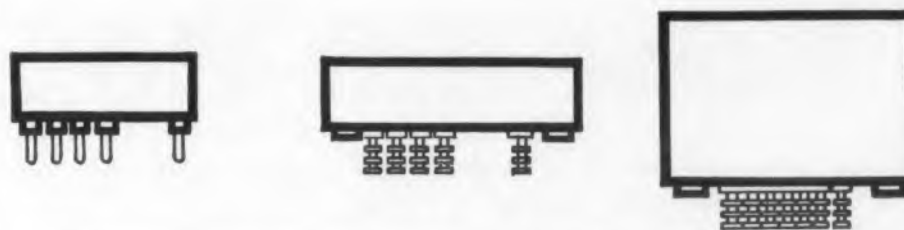
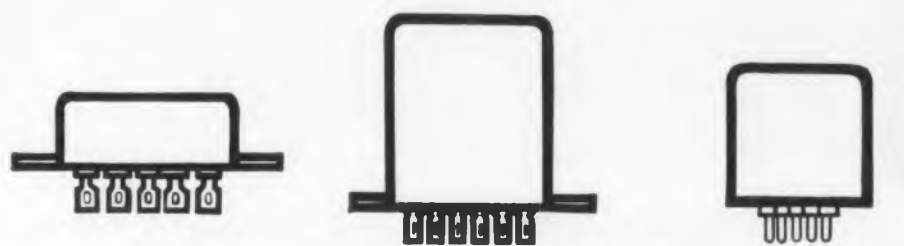
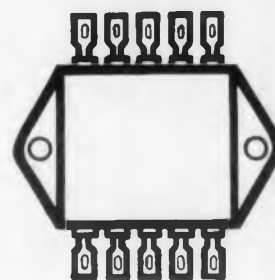
Type EMT25136U automatic voltage regulator provides a gradual power run-up and constant regulated voltage for complex tubes. The unit is for use on nominal 120 or 240 v, 50/60 cps single phase lines. Input voltage range is 108-132 v on 120 v service and 216-256 v on 240 v service. Output voltage is adjustable from 9-24 v with sensitivity within a 1 v band at any setting. Maximum rated output load is 25 amp. Maximum voltage run-up time is 45 sec.

Superior Electric Co., Dept. ED, Bristol, Conn.

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# SHIFT REGISTER ASSEMBLIES

for aircraft  
for missiles  
for computers  
for controls



SPRAGUE MAGNETIC SHIFT REGISTER ASSEMBLIES get the full treatment! Every component that is used in their construction is carefully checked for performance and reliability. Only the very best get by. All complete assemblies are 100% pulse performance tested before they leave the plant... assuring on-the-job reliability and long register life... at the least possible cost.

Sprague register assemblies matched to your specific application requirements are your best buy! You get just the right case styles, type of sealing, number of stages, read and write provisions you need. Standard designs are easily modified to meet most system requirements. For Data Sheets on core-diode type magnetic shift register assemblies, write the Technical Literature Section, Sprague Electric Company, 347 Marshall St., North Adams, Massachusetts.

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There is only one WESCON, and there is only one *Electronic Daily*—published each day during the convention.

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## Electronic Daily

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## NEW PRODUCTS

### Synchronous Motor 60 and 400 cps reversible



This size 11 instrument type synchronous reversible motor can be used for either 60 or 400 cps operation. Pullout torque at 60 cps and 1800 rpm is 0.15 oz-in. At 400 cps and 12,000 rpm, it is 0.085 oz-in. This is achieved by using a 1  $\mu$ fd capacitor for 60 cps operation or a 0.1  $\mu$ fd capacitor for 400 cps. Input voltage is 115 for both 60 and 400 cps.

John Oster Manufacturing Co., Avionic Div., Dept. ED, 1 Main St., Racine, Wis.

CIRCLE 253 ON READER-SERVICE CARD

### Digital Voltmeter

Measures ac or dc



Model DVA-510 modular digital voltmeter for measuring ac or dc voltages consists of a transistorized power module, dc switch module and ac converter module. The unit has a range of 0.0001 to 999.99 v and displays a five digit reading, with automatic ranging, and polarity. It is accurate to  $\pm 0.01$  per cent,  $\pm$  one digit, with 0.01 per cent stability.

Electro Instruments, Inc., Dept. ED, 3540 Aero Ct., San Diego 11, Calif.

CIRCLE 254 ON READER-SERVICE CARD

### Capacitors

For use in filter networks

For use in filter networks, these low cost capacitors feature stability and close tolerance. In

polystyrene, Mylar, or silicon-paper dielectric, units achieve a tolerance of 1 per cent and a temperature coefficient of 100 ppm.

Film Capacitors, Inc., Dept. ED, 3400 Park Ave., New York 56, N.Y.

CIRCLE 255 ON READER-SERVICE CARD

### Precision Timer

Resolution of 1 msec



Model 2400 is a miniature four-decade digital timer having a time resolution of 1 msec and a maximum indicated time interval of 9.999 sec. Glow transfer tubes are used as decade counters and indicators. Pulses derived from a 1000 cps tuning fork are fed to a gated amplifier, which is controlled by miniature start and stop thyatrons.

Erie Resistor Corp., Dept. ED, 644 W. 12th St., Erie, Pa.

CIRCLE 256 ON READER-SERVICE CARD

### Vibration Pickup

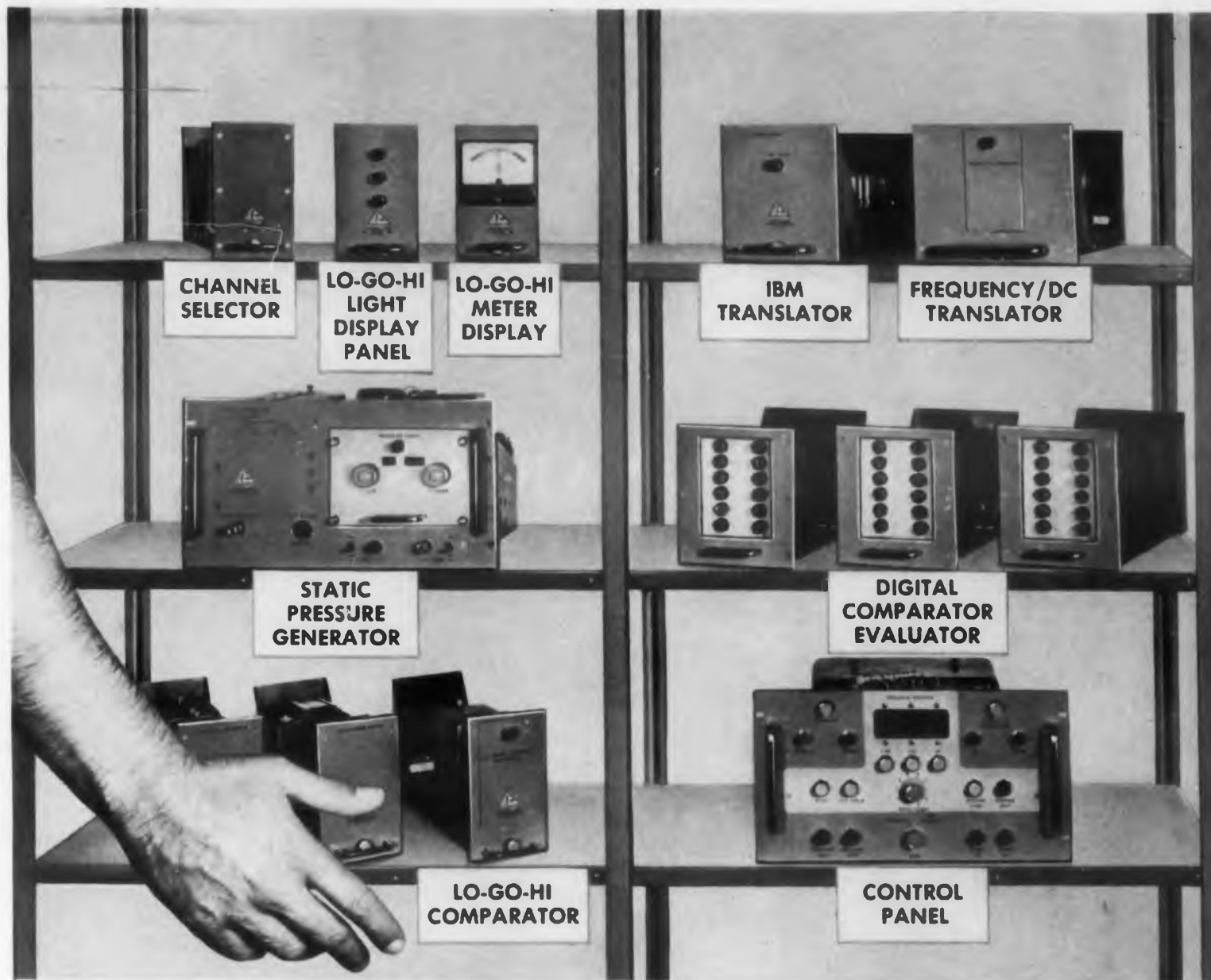
Magnetically damped



Using the basic design of the company's velocity type pickup, the magnetically damped type 128-1 is suitable for use in measuring vibratory motions with up to  $\pm 5$  g unidirectional steady acceleration superimposed, with little change in sensitivity over a  $-65$  to  $+250$  C temperature range. Because of its damping and high natural frequency, it is useful both in measuring higher frequency vibratory accelerations and also in measuring low frequency jerk.

MB Manufacturing Co. Div., Textron, Inc., Dept. ED, P.O. Box 1825, New Haven, Conn.

CIRCLE 257 ON READER-SERVICE CARD



A few of the modules now available

Now...modular components for automatic weapons testing systems come

# off the shelf from AMF!

It's called MATE - Modular Automatic Testing Equipment—for go no-go readout, the first significant step in eliminating obsolescence in automatic testing systems.

After extensive surveys, AMF found all automatic systems, regardless of type or complexity, can be reduced to the same, basic, packageable components.

**Wide range available.** AMF has already designed and produced 19 of these modules—each one a self-sufficient package with a distinct responsibility. Available to you on an "off-the-shelf" basis now are programming and control modules, signal translator modules, comparator-evaluator modules and display devices.

**Universally adaptable.** These modules can be put together to implement any automatic testing program. Or any of them can be integrated with existing equipment of other manufacture.

**Obsolescence eliminated.** After serving their purpose for the system under test, MATE modules can be reintegrated into other systems requiring the same functions. The result: complete flexibility in the most complex systems; low-cost components available on a short delivery basis, pre-designed to accomplish many different tasks; modules that retain their usefulness and validity after the weapons system is modified. *The resulting economies to prime contractors and the military are enormous.*

Visit us at Booth 521 at the WESTCON Show



GOVERNMENT PRODUCTS

Government Products Group

AMERICAN MACHINE & FOUNDRY COMPANY

1101 North Royal Street, Alexandria, Va.

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Your inquiries invited—Write Associated Missiles Products Co. (a division of AMF), 2709 North Garey Avenue, Pomona, Calif.; or to AMF, Government Products Office, Washington, D.C. or Dayton, Ohio; or Los Angeles, Calif.

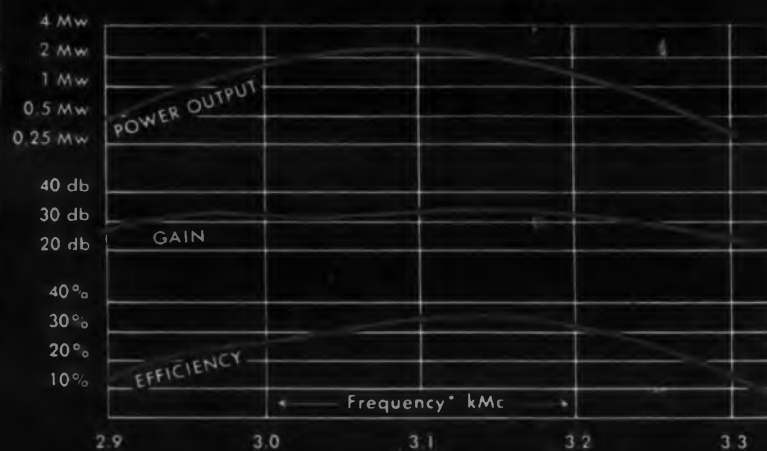
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**ANOTHER**

**VARIAN FIRST**

A MEGAWATT **TWT** AMPLIFIER

VA 125  
S band

TEST DATA AT 110 KV 6  $\mu$ s PULSE



Also available at other S band frequencies

**HIGH EFFICIENCY—30% • WIDE BANDWIDTH—12%**  
**HIGH GAIN—30 db • HIGH PEAK POWER—Over 1 Mw**

Varian is first with a commercially available megawatt Traveling Wave Tube amplifier. This tube gives system engineers greater freedom in radar design—a full megawatt of power over a major portion of the S-band without tuning. Interchangeable with the 1 Megawatt VA-87 Klystron for broadband operation.

Varian makes a wide variety of Klystrons and Wave Tubes for use in Radar, Communications, Tests and Instrumentation, and for Severe Environmental Service Applications. Over 100 are described and pictured in our new catalog. Write for your copy.



**VARIAN** Associates  
FALG ALLOTI, CALIFORNIA

Representatives through the world

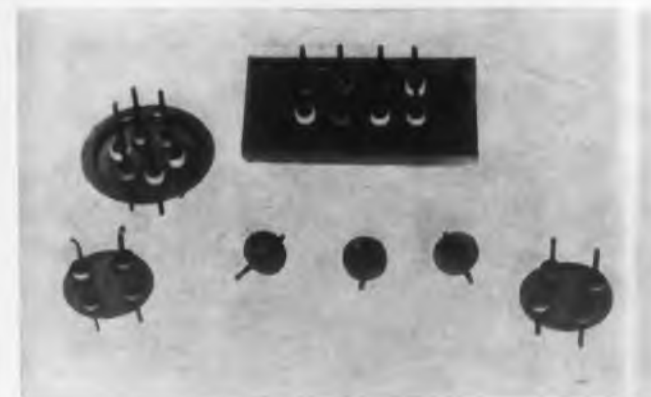
ALFACONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, HIGH VACUUM PUMPS, VACUUM ENCLOSURES, VACUUM SYSTEM COMPONENTS, X-RAY ELECTROMETERS, MAGNETS, MAGNETOMETERS, STANCS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

CIRCLE 259 ON READER-SERVICE CARD

## NEW PRODUCTS

### Terminal Headers

Operate at 1000 C



Standard single and multiple metal-ceramic terminal headers are available for devices requiring vacuum tight, high temperature, ruggedized seals. These copper-brazed alumina to matched alloy assemblies are suitable for operation up to 1000 C, and are all helium leak checked and thermal shock tested.

Radian Engineering Associates, Dept. ED, P.O. Box 454, Mineola, L.I., N.Y.

CIRCLE 260 ON READER-SERVICE CARD

### Servomotor

Size 8 takes 115 v input



For operation on 115 v, model 8 SM 460 servomotor has a low rotor inertia of 0.2 gm-cm<sup>2</sup> and comparatively high stall torque of 0.33 oz-in. The result is an acceleration at stall of 115,000 rad/sec<sup>2</sup>. Power input per phase is 2.9 w. Capable of continuous duty at 200 C total unit operating temperature.

Helipot Corp. Div., Beckman Instruments, Inc., Dept. ED, Newport Beach, Calif.

CIRCLE 261 ON READER-SERVICE CARD

### Linear Potentiometer

±1 per cent independent linearity

Miniature Model 141 Linipot linear potentiometer gives a precise indication of travel position and operates with a high level ac or dc out-

ELECTRONIC DESIGN • August 6, 1958

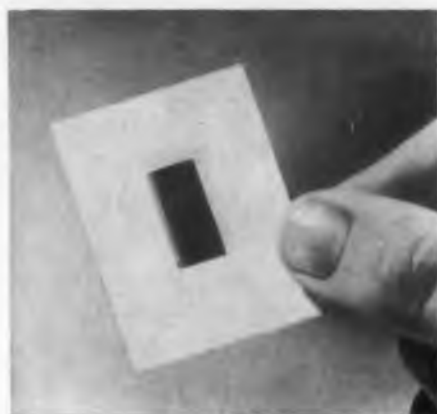
put, needing no amplification. The wirewound unit has an independent linearity of  $\pm 1$  per cent and standard resistance values of 500, 1000, 2000, 5000, and 10,000 ohms.

Bourns Labs., Inc., Dept. ED, Riverside, Calif.

CIRCLE 262 ON READER-SERVICE CARD

## Silicon Solar Cells

Withstand environmental extremes



Type SS solar cells are of the silicon p-n type with average conversion efficiencies of 8 per cent, based on a solar constant of 1400 w per square meter of collecting area under standard testing conditions. They will withstand up to 100 g shock for 0.003 seconds in any direction, and constant 25 g acceleration in any direction. Temperature range is  $-190$  to  $+500$  C.

Hoffman Electronics Corp., Semiconductor Div., Dept. ED, 930 Pitner Ave., Evanston, Ill.

CIRCLE 263 ON READER-SERVICE CARD

## Power Supply

Provides 80 w output



The REL-203 transistorized power supply has an rf filter included in the 28 v input to prevent interference being conducted to radio equipment. The typical rf voltage level is down 50 db at 14 kc. An 80 w output with no heat sink is provided over a  $-75$  to  $+158$  F range. Input voltage is 24 to 30 v dc. Three models provide outputs of 150, 250 and 300 v respectively.

Rhem Manufacturing Co., Electronics Div., Dept. ED, 7777 Industry Ave., Rivera, Calif.

CIRCLE 264 ON READER-SERVICE CARD

# ...the record tells you more

from a

# SANBORN SYSTEM

DESIGNED SPECIFICALLY FOR YOUR TYPE OF WORK



MODEL 276 CHART VIEWER

Permits convenient, variable speed editing and study of Sanborn charts and other types up to 16" wide, 200 ft. long. Single control for direction, paper speeds (15" to 100"/min). Transparent cursor slides left or right, adjusts for accurate alignment with coordinates.

1- TO 8-CHANNELS, 12 PLUG-IN PREAMPLIFIERS

### 150 SERIES

Features of the "150 series" direct writers include: frequency response to 100 cps; linearity 1% overall; inkless recording in true rectangular coordinates by heated stylus on plastic coated Permapaper charts; current feedback driver amplifier and regulated power supply for each channel. Recorder has 9 chart speeds, 0.25 to 100 mm/sec; individual stylus heat controls, time-code marker. Up to 6-channels can be housed in one vertical cabinet. Amplifiers, recorder also available in individual portable cases.



6-, 8-CHANNELS, FLUSH FRONT RECORDER, FREQUENCY RESPONSE TO 120 CPS

### 350 SERIES

New "350" series direct writers with compact plug-in preamps in modules of up to 4; individual power supplies; current feedback transistorized power amplifiers; limiter circuit ahead of power amplifiers; velocity feedback galvanometer damping; enclosed galvanometers. Linearity 0.2 div. over entire 50 divisions. Recorder-power amplifier-power supply package has 0.1 volt/div. sensitivity, can be used separately; pushbutton controls for 9 chart speeds 0.25 to 100 mm/sec; individual stylus heat controls; contacts for remote control; inkless rectangular coordinate recording on Permapaper charts.



6-, 8-CHANNELS

### 850 SERIES

Compact "850" series direct writers use 7" high plug-in preamplifiers in modules of up to eight and "350" flush front recorder package with transistorized power amplifiers, power supply; features velocity feedback galvanometer damping, linearity 0.2 div. over entire 50 divisions; 9 chart speeds from 0.25 to 100 mm/sec controlled by electric pushbuttons; inkless recordings on Permapaper charts. Available preamps include Servo Monitor (demodulator) and DC Coupling. Carrier, Chopper Stabilized and Low Level types are in development.



COMPUTER READOUT . . . AUTOMATIC PROGRAMMING

### 150 SERIES

"150 series" 6-, 8-channel consoles in 46 1/2" high mobile cabinet. Dual-Channel Amplifiers have selectable sensitivity from 0.01 to 10 volts/div.; internal calibration 2 volts  $\pm 1\%$  freq. response flat to 20 cps. Optional Programmer sequences system operation in 20 steps, including recorder turn-on, calibration, computer DC level reading, recording for pre-set time, turn-off and reset.



SELF-CONTAINED UNIT PREAMPLIFIERS TO DRIVE SCOPES, OPTICAL OSCILLOGRAPHS, TAPE RECORDERS, ETC.

Portable "350" series include Carrier, DC Coupling Servo Monitor (demodulator), True Differential DC types; others in development. Mount in portable "450" cases or in four-unit modules in 19" frame. Use individual power supplies. One "450" case and power supply can serve any "350" Preamp.



(ALL DATA SUBJECT TO CHANGE WITHOUT NOTICE)

For complete data, call your local Sanborn Engineering Representative or write the Industrial Division in Waltham.

## SANBORN COMPANY

Industrial Division

175 Wyman Street, Waltham 54, Mass.

PORTABLE INDICATORS FOR STRAIN, ETC.

Model 150-300/700 Wide Band Amplifier and Power Supply accepts "150" series preamplifiers — for use with low power galvanometers, oscilloscopes, panel meter. Freq. range DC to 10,000 cps (but limited by particular preamp range). Panel meter has center zero scale, 25 divisions each side of center.



Visit Sanborn Booths 1454-1455 at WESCON Show  
CIRCLE 265 ON READER-SERVICE CARD





## Just published—bobbin core guaranteed performance limits!

We have just published new data which will light the way to ease, sureness and accuracy for the designer who works with tape wound bobbin cores.

First—and this is a “first”—we have published *guaranteed* maximum and minimum performance limits for all of our bobbin cores. Computer-type designers who would like open-circuit characteristics, guaranteed core flux and guaranteed squareness will find them all here.

Second—and this too is a “first”—we have published the first fundamental data on characteristics of bobbin cores for circuit designers. Need core total flux characteristics as related to core material? Want switching time vs drive levels? How about typical spreads of core characteristics? It's all yours.

Third—and this too is a “first”—we automatically give you test data for prototype orders. With your prototype cores come open-circuit outputs, total flux, and squareness data. You get a basic understanding of the core's characteristics under specific test conditions. More important, when you re-order production quantities, you will be able to duplicate the core around which you designed your circuit.

Last—but still a “first”—to show that we manufacture as well as publish, we have designed the first bobbin core protective cap which will permit normal potting procedures for all sizes of steel and ceramic bobbins. Our “Poly Caps” have virtually no effect on dimensions—and will not soften or deform under manufacturing or operational temperatures. We'd like to show you samples.

At what stage do you want to start? Whether it's design data, prototype data and cores, or production quantities of our “Performance-Guaranteed” bobbin cores—you can get what you need by writing Magnetics, Inc., Department ED-48, Butler, Pennsylvania.

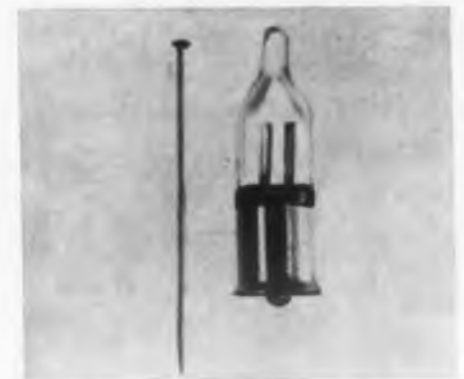


CIRCLE 266 ON READER-SERVICE CARD

## NEW PRODUCTS

### Neon Lamp

Built-in resistor



Measuring 1/4 in. in diameter by less than 1 in. in length, the NE2R neon lamp eliminates the need for an external resistor by having one of its own built in. The glass tip of the lamp envelope is hot formed to symmetrical appearance, and electrodes are longer than in previous types, thus increasing the area of gas excitation and resulting light.

Circon Component Corp., Dept. ED, Santa Barbara Municipal Airport, Goleta, Calif.

CIRCLE 267 ON READER-SERVICE CARD

### Electrometer

High stability



Having a current range from  $10^{-12}$  to  $10^{-3}$  amp full scale, model E-100 features stability of 2 per cent per week on  $10^{-11}$  and higher ranges. Accuracy is 3 per cent on  $10^{-3}$  to  $10^{-11}$  amp ranges and 5 per cent on  $10^{-12}$  amp range. A 10 mv recorder output is provided. Available either rack or cabinet mounted.

Gyra Electronics Corp., Dept. ED, 518 N. Spring Ave., La Grange Park, Ill.

CIRCLE 268 ON READER-SERVICE CARD

### Printed Circuit Connectors

Have wear resistant contacts

The contacts of these printed card receptacles are curved and plated, when necessary, to resist wear. The fatigue problem is solved by use of

heat-treated beryllium-copper to achieve controlled terminal hardness and strength in crucial areas. For range of board thicknesses from 0.062 to 0.103 in.

U. S. Components, Inc., Dept. ED, 454 E. 145th St., New York 55, N.Y.

CIRCLE 269 ON READER-SERVICE CARD

### Pressure Transducers

Withstand 25 g vibration up to 20,000 cps



The oil-filled series 46155 Bourdon tube pressure transducers withstand vibration of 25 g up to 20,000 cps, providing stability of output signal under extreme environmental conditions. They are designed for noncorrosive gas or liquid pressure measurement within the ranges of 0 to 100 psi to 0 to 6000 psi differential or gage.

G. M. Giannini & Co., Inc., Dept. ED, 918 E. Green St., Pasadena E, Calif.

CIRCLE 270 ON READER-SERVICE CARD

### Microwave Tube Power Supply

For voltage tuned oscillators

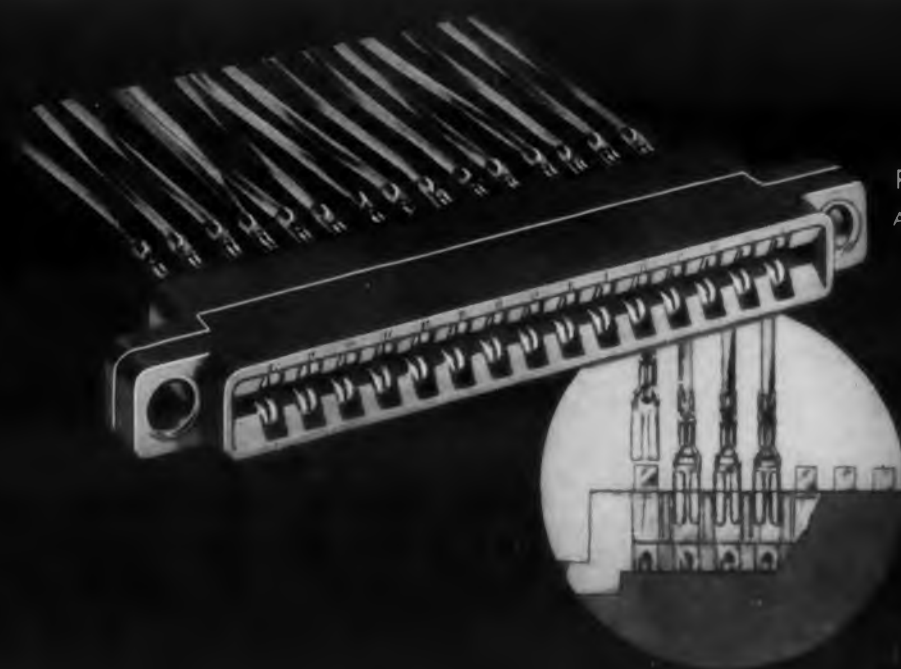


The model 602 sweeping oscillator power supply provides all power for operating voltage tuned microwave oscillator tubes covering frequencies from 1 to 26 kmc. The unit provides exponentially increasing helix voltage varying from 100 to 2500 v at 0 to 60 ma. Sweep rates are adjustable from 10 to 0.01 cps.

Alfred Electronics, Dept. ED, 897 Commercial St., Palo Alto, Calif.

CIRCLE 271 ON READER-SERVICE CARD

# New printed circuit connector with protective taper tab enclosure increases reliability



PCA15-78  
ACTUAL SIZE

## Continental Connectors

A unique molding on Continental Connector's new Series PCA15-78 printed circuit connector provides uniform spacing and insulation, and eliminates bending, twisting or shorting of contacts during assembly. For additional ease of assembly, contact terminations accommodate AMP "78" taper tab receptacles for solderless wiring. Connectors are supplied with patented and exclusive "Bellows Action" contacts in bifurcated construction. Coil spring action of "Bellows" design results in 100% contact area without loss of retention even with undersized or oversized tolerance boards.

For complete technical information and other printed circuit literature write Electronic Sales Division, DeJUR-Amsco Corporation, 45-01 Northern Boulevard, Long Island City 1, N. Y. (Exclusive Sales Agent)

VISIT US AT WESCON SHOW BOOTH 1521

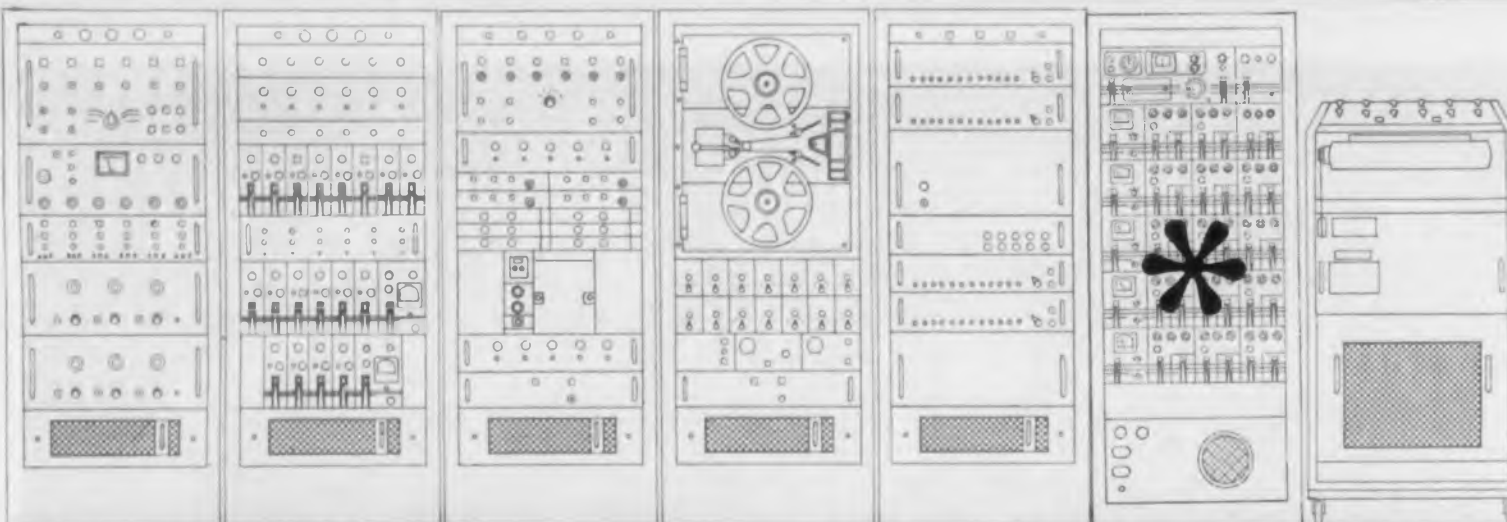
Enlarged cross-section illustrates taper tab wiring and shows special molded body as an integral part of the connector. The body cavities insulate and assure uniform spacing of contacts.

You're  
always  
sure  
with

**DeJUR**  
electronic components

MANUFACTURED BY CONTINENTAL CONNECTOR CORPORATION, AMERICA'S FASTEST GROWING LINE OF PRECISION CONNECTORS

CIRCLE 272 ON READER-SERVICE CARD



We'll see you at the Wescon Show, Booths 412 & 413.

## HALLAMORE PHASE-LOCK DISCRIMINATORS

**ELIMINATE SYSTEM ERRORS... AFFORD ECONOMY AND SPACE SAVING ADVANTAGES—**

This Hallamore developed building-block type FM instrumentation system is designed to condition and utilize signals from any combination or multiplex of the following transducers: potentiometers, flow pickup, bridge, thermocouples, or differential transformers. Hallamore manufactured elements in the system include DC amplifiers, AC amplifiers, universal calibrator, calibrator test instrument, timing system and the discriminator station. Hallamore phase-lock discriminators, Model 0102, reduce subcarrier frequency information to output data, readily undisturbed by noisy signals which contribute to the inefficiency of pulse counting type discriminators.

Designed around a concept entirely new to the telemetry field, the Model 0102 phase-lock discriminator eliminates signal suppression by noise, non-linearity by filtering, and thresholding at low signal-to-noise levels. In addition, the unit occupies less space, reduces overall system cost, and assists in the simplification of operational procedures. For complete specifications and operational data, write Hallamore Electronics Co., Dept. 24J, 8352 Brookhurst Avenue, Anaheim, Calif.



HALLAMORE ELECTRONICS COMPANY

a division of the SIEGLER CORPORATION

Engineers . . . for ideal working conditions with a dynamic, creative organization address resume to Chief Engineer.

CIRCLE 273 ON READER-SERVICE CARD

## NEW PRODUCTS

### Potentiometers

High resolution



In diameters from 7/8 to 3 in., these gold-anodized single turn potentiometers feature one-piece external clamp rings. They have low temperature coefficient wires, high resolution, low noise level (100 ohm max.), good linearity, 1000 v rms 60 cps dielectric strength, and a -55 to +125 C ambient temperature range.

General Scientific Corp., Dept. ED, 1509 First St., San Fernando, Calif.

CIRCLE 274 ON READER-SERVICE CARD

### Strip Chart Recorder

2-5/16 in. scale length



This compact strip chart recorder has a large storage capacity. It has a scale length of 2-5/16 in. and a rated accuracy of 2 per cent of full scale.

Rust Industrial Co., Dept. ED, 130 Silver St., Manchester, N.H.

CIRCLE 275 ON READER-SERVICE CARD

### Variable Voltage Source

For high-speed testing



The A-C Vari-volter is an automatic and manual ac variable voltage power source consisting

ELECTRONIC DESIGN • August 6, 1958

of a motor-driven reversible Variac and an adjustable double-contact meter relay with interlocked motor-drive control relays. It can be operated from any power line ranging in voltage from 90 to 130 v, and the output voltage sweep can be made continuously and maximally adjustable from 0 to 135 v or limited to any narrower range.

Amplifier Corp. of America, Dept. ED, 398 Broadway, New York 13, N.Y.

CIRCLE 276 ON READER-SERVICE CARD

## Control Systems

Electro-mechanical



Available for applications requiring 1/4 to 100 hp, these electro-mechanical control systems have improved dynamic response and high accuracy. Building block type components permit a variety of control arrangements, and output may be either uni- or bi-directional.

Seneca Falls Machine Co., Electronics Div., Dept. ED, Seneca Falls, N.Y.

CIRCLE 277 ON READER-SERVICE CARD

## Regulated Power Supplies

Low output impedance



These regulated transistorized power supplies have low output impedance and good stability. The supplies are available with and without voltmeters and as either single or dual supplies. Two degrees of regulation are available. Input is 105 to 125 v at 60 cps; output is 6 to 30 v dc at 0.5 amp.

Victor Instruments, Inc., Dept. ED, 13214 Greenwood Blvd., Gardena, Calif.

CIRCLE 278 ON READER-SERVICE CARD

# Here's the "workhorse"



## GOOD-ALL

### Metal Enclosed Capacitors are first choice of more and more engineers

Today, "CP" styles per the MIL-C-25A are the "WORKHORSE" capacitors of military electronics. Soon, new specifications such as MIL-C-0025 (USAF) and MIL-C-25B will exert their influence . . . but regardless of the specification number, more and more engineers specify GOOD-ALL for their preferred sources. There are sound reasons why high quality is consistently maintained.

#### HERE'S WHY ENGINEERS ARE CHOOSING GOOD-ALL

- Well engineered designs
- Skilled assembly personnel
- Modern production facilities
- Rigid Quality Control

Good-All Specializes in these tubular types per MIL-C-25A



All popular values are available in stock for immediate delivery.

Good-All tubulars per MIL-C-25A now available at leading industrial distributors.

# Good-All

## CAPACITORS



**GOOD-ALL ELECTRIC MFG. CO.**

OGALLALA, NEBRASKA

A LEADING MANUFACTURER OF TUBULAR, CERAMIC, MISC AND ELECTROLYTIC CAPACITORS

In Canada, 700 Weston Road, Toronto 9, Ontario

CIRCLE 279 ON READER-SERVICE CARD

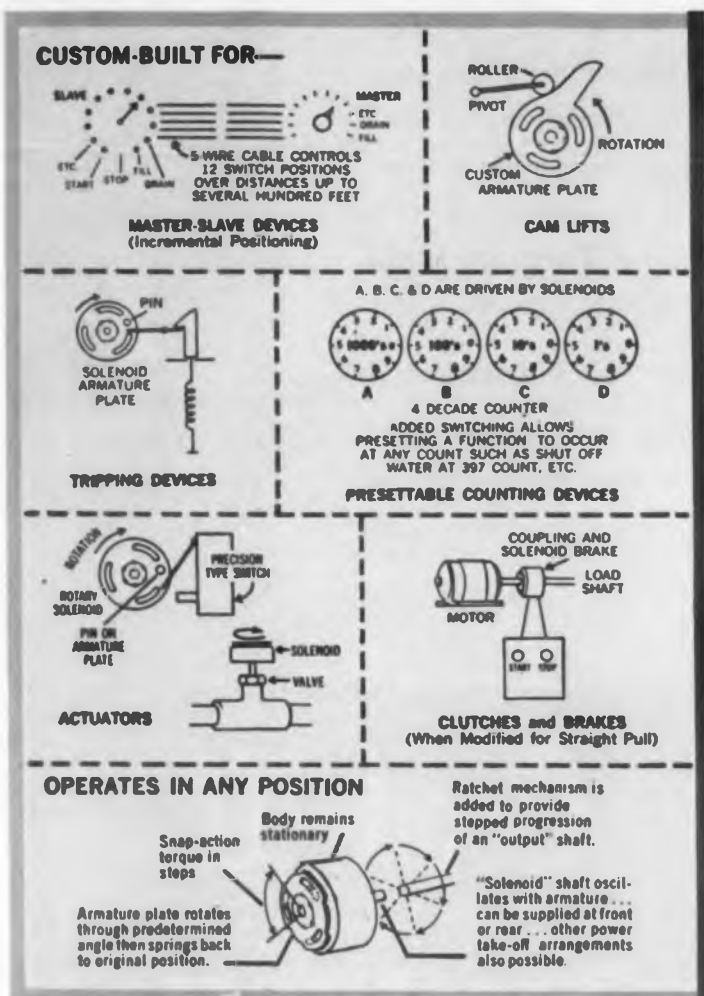
have you checked this  
*Remote Actuator for jobs  
under Shock and Vibration?*

MODEL 5E  
SHOWN  
ACTUAL SIZE



## OAK ROTARY SOLENOIDS

(Mfd. under license from G. H. LELAND, INC.)



Oak rotary solenoids meet such specs as MIL-S-4040A, and are unusually small for the work they can do. Custom-built, they operate on DC and provide stepping torques from 6.4 to 64 inch-ounces on intermittent duty. Standard models step at 25°, 35°, 45°, 67.5° or 95° in either a left or right-hand direction. Why not investigate these remarkable devices for your next job?

**OAK** MFG. CO.

1280 Clybourn Ave., Dept. D.  
Chicago 10, Ill. • Phone: MOhawk 4-2222

CIRCLE 280 ON READER-SERVICE CARD

SWITCHES  
ROTARY SOLENOIDS  
CHOPPERS • VIBRATORS  
SPECIAL ASSEMBLIES

## NEW PRODUCTS

### Counter

Frequency range of 10 cps to 10 mc



This electronic counter provides eight-place Nixie read out over a frequency range of 10 cps to 10 mc. It utilizes magnetic beam switching tubes as decade dividers and scalars.

Lavoie Labs., Inc., Dept. ED, Matawan-Freehold Rd., Morganville, N.J.

CIRCLE 281 ON READER-SERVICE CARD

### Latch Relay

4 w maximum power



This latch relay has dc ratings of 6 through 110 v, ac ratings of 6 through 230 v, 4 w maximum power, and 16,000 ohms maximum resistance. Contact ratings are 5 and 10 amp at 115 v ac noninductive or 26.5 v dc. Arrangements are up to 6 pdt.

Line Electric Co., Dept. ED, 271 S. 6th St., Newark 3, N.J.

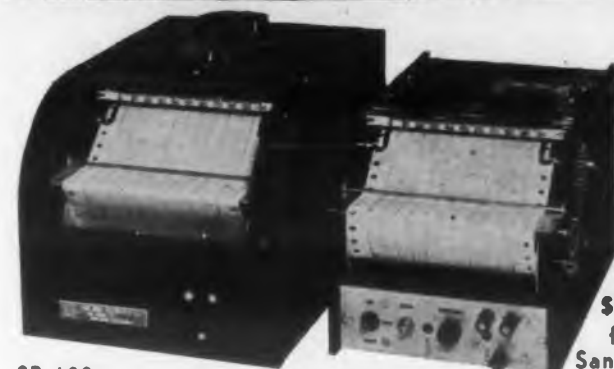
CIRCLE 282 ON READER-SERVICE CARD

### Subminiature Tubes

Fast warm-up

In 10 seconds after initial application of rated voltages to the cold tubes, the plate current will have reached 90 per cent of its final value. Type CK7079 is a twin triode (prototype is CK6111) with an amplification factor of 20 and mutual conductance of 5000  $\mu$ mho at plate voltage of 100 and plate current of 8.5 ma for each section.

STABLE . . . RELIABLE . . .  
ACCURATE . . . PORTABLE



SR-100

\$395  
fob  
San Jose,  
California

### NEW! STRIP CHART RECORDER

A null-balance potentiometer recorder with full scale span at 10 millivolts up to 100.

Design facilitates easy application with any type transducer. These features also available in SR-100 2C dual channel instrument. High-low limits and time event marking available on both models.

## SAN JOSE SCIENTIFIC COMPANY

ELECTRONIC DESIGN ENGINEERS AND MANUFACTURERS  
605 SUNOL STREET  
SAN JOSE, CALIFORNIA

CIRCLE 525 ON READER-SERVICE CARD

One BRIDGE  
TO MEASURE  
*Any*  
IMPEDANCE  
from a short to an open



Measure Real or Imaginary, Positive or Negative, Grounded, Direct, or Balanced Impedances and Admittances.

- ★ Frequency Range 20 Cycles to 20 Kilocycles
- ★ Gives Answers Directly in Ohms or Micromhos
- ★ Ranges: R:  $\pm 1000$  Ohms; X:  $\pm 1000$  Ohms; G:  $\pm 1000$   $\mu$ mhos; B:  $\pm 1000$   $\mu$ mhos
- ★ Convenient Switching and Controls for Fast Operation

Type 1603-A Z-Y Bridge: \$370

Write for Complete Information

**GENERAL RADIO Company**



275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

Broad Avenue at Linden, Ridgefield, N. J. NEW YORK AREA 1000 N. Seward St. LOS ANGELES 38  
8055 13th St. Silver Spring, Md. WASHINGTON, D. C. 1150 York Road, Abington, Pa. PHILADELPHIA  
1182 Los Altos Ave., Los Altos, Calif. SAN FRANCISCO 6605 W. North Ave., Oak Park, Ill. CHICAGO

In CANADA: 99 Floral Parkway, TORONTO 15

CIRCLE 526 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958



Need a **PROVEN** tube that indicates and counts?

# dekatron\*

The only cold-cathode glow transfer counting tube **WITH OVER 10 YEARS OF SERVICE RELIABILITY AND PERFORMANCE.** Simple circuitry. Electronic speed and accuracy up to 20,000 counts/sec. For counting, sorting, programming, unit flow, packaging and many other applications. Continuous visual reference to total count. For detailed information, request Technical Data Sheet IC4001.

\*Trademark



**Baird-Atomic, Inc.**

33 UNIVERSITY RD., CAMBRIDGE 38, MASS.

*Instrumentation for Better Analysis*

CIRCLE 527 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

Type CK7083 is a pentode (prototype is CK5702WA) with mutual conductance of 5000 at plate voltage of 120 and plate current of 7.5 ma.

Raytheon Mfg. Co., Dept. ED, 55 Chapel St., Newton 58, Mass.

CIRCLE 283 ON READER-SERVICE CARD

## AC-DC Power Supplies

5 to 28 and 100 to 300 v dc



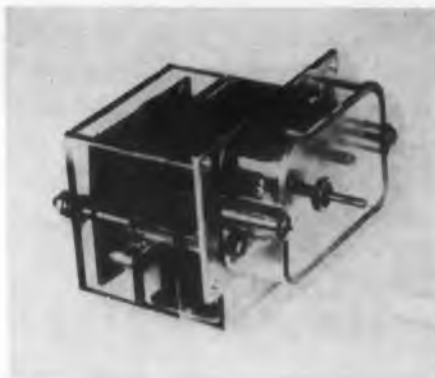
A line of transistorized ac-dc power supplies is available for supplying transistor, plate and filament voltages, either with or without regulation. The units operate from 105 to 125 v 60/cps or 400 cps single phase, or 400 cps three phase. Outputs range from 5 to 28 v dc in power ratings up to 5 amp, and from 100 to 300 v dc in ratings to 400 ma.

Universal Transistor Prod. Corp., Dept. ED, 17 Brooklyn Ave., Westbury, N.Y.

CIRCLE 284 ON READER-SERVICE CARD

## Instrument Motor

Battery operated



This subfractional watt instrument motor, the model TR, occupies about 3 cu in. Stationary field coils furnish the rotative flux and are commutated by transistors. The 6 v model draws 6 ma at rated voltage and operates on power inputs as low as 20 mw. Output torques are of 10 the order of oz in. at 1 rpm.

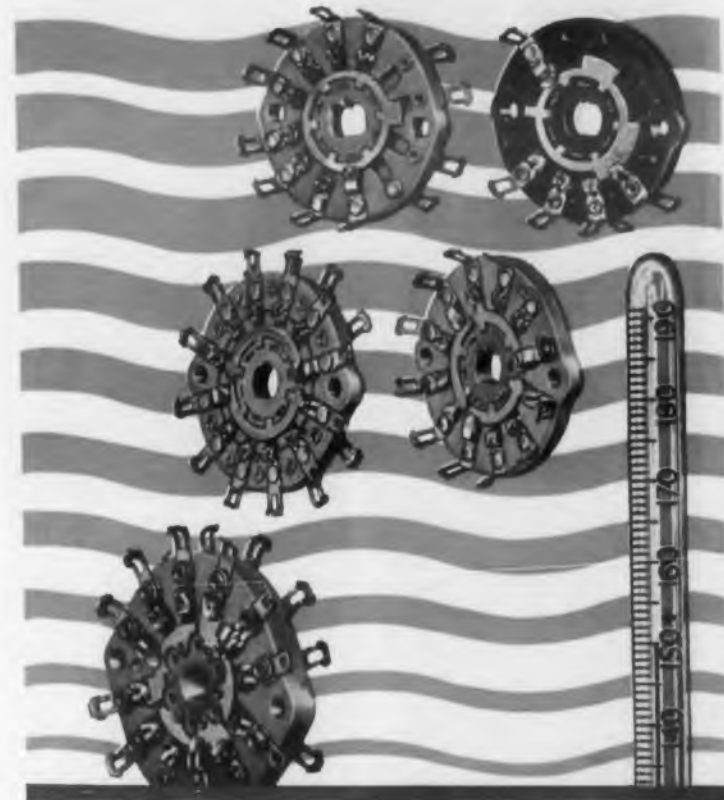
Brailsford & Co., Inc., Dept. ED, 670 Milton Rd., Rye, N.Y.

CIRCLE 285 ON READER-SERVICE CARD

# NEW 150°C

high-temperature, low-power

## SWITCH SECTIONS



**TESTED IN ACTUAL OPERATION FOR OVER 800 HOURS AT A CONTINUOUS AMBIENT TEMPERATURE OF 150°C**

Here's a new development in low-power, rotary switch wafers that gives *high* reliability at 150°C. They show a safety factor of 5 to 1 over the life requirements of MIL-S-3786. This unusual performance is due to a special alloy we have developed for the contact clips. Under all test conditions applied to date, these clips have demonstrated a remarkable ability to maintain spring tension at elevated temperatures. As a result, electrical contact remains uniformly excellent for the life of the switch. Currently, most Oak sections in ceramic or Mycalex insulation can be supplied with this high-temperature clip, offering you a selection of sizes and circuitry to handle most applications.

Contact the Oak Representative in Your Area for Details or Send Us a Description of Your Application

**OAK** MFG. CO. 

1260 Clybourn Ave., Dept. D, Chicago 10, Illinois  
Phone: MOhawk 4-2222

CIRCLE 286 ON READER-SERVICE CARD



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Editor



James A. Lippke,  
Managing Editor



T. E. Mount,  
West Coast Editor



L. D. Sturgalis,  
Associate Editor



## ... see you at WESCON

If you are going to attend this year's WESCON, one stop will put you in contact with 28,000 fellow electronic design, development, and research engineers. Be sure to come to Hayden Booth No. A-445, *Electronic Design's* WESCON headquarters. Our editors will be on hand to discuss your design ideas, answer your questions, and urge you to publish material of interest to our readers.

*Electronic Design* is the magazine that communicates most directly to the working design engineer. The progress you report will be put to use at once by an eager, discriminating, and appreciative audience—equal in number to the entire attendance at last year's WESCON.

WE WILL LOOK FORWARD TO SEEING YOU AT THE SHOW.

## NEW PRODUCTS

### Terminal Bushing

Snaps in



This snap in junction terminal bushing has a quick-connect means for access through housings without pig-tail wire leads or screw terminals. Solder, crimp, and double disconnect brass terminals are available. The wire is fastened to the permanent end of the terminal, which is snap-fastened into the nylon bushing.

Heyman Mfg. Co., Dept. ED, Kenilworth, N.J.

CIRCLE 287 ON READER-SERVICE CARD

### Coaxial Line Stretchers

For 250 to 5000 mc region



Designed to be used in the 250 to 5000 mc region, this line of constant impedance line stretchers employs type N connectors. The line stretchers are part of a group of coaxial tuners including double slug tuners, double stub tuners, and trombone stretchers.

Microlab, Dept. ED, 71 Okner Pkwy., Livingston, N.J.

CIRCLE 288 ON READER-SERVICE CARD

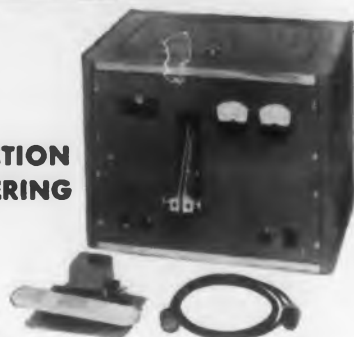
### Switching Transistors

Cutoff frequencies from 5 to 20 mc

Types 2N658, 2N659, 2N660, and 2N661 range in average cutoff frequencies from 5 to 20 mc and their HFE at base current of 10 ma averages as high as 75. These are pnp germanium types in the JETEC-30 package.

Raytheon Mfg. Co., Dept. ED, 55 Chapel St., Newton 58, Mass.

CIRCLE 289 ON READER-SERVICE CARD

**marion**advancement  
in instrument  
design**INDUCTION  
SOLDERING  
UNIT**

Model PM 1

**FOR SMALL PARTS AND ASSEMBLIES**

Simplifies, improves and speeds up component production. Provides local heat to otherwise inaccessible spots. Safe and simple. Max. power input 775 watts, 100 watts standby; 115 volts, 60 cycles. 15 3/4" x 21 1/2" x 15". 150 lbs. Bulletin on request. Marion Electrical Instrument Co., Manchester, N. H., U. S. A.

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**marion**  
meters

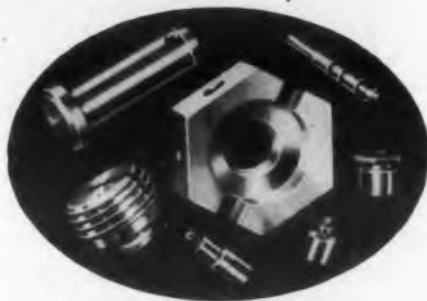
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**Over 3-MILLION  
Screw Machine Parts**

for one customer (Name on request.)

... reject level of  
**LESS THAN .0025%!**

Our record of low rejects means real savings for you. Near-new Brown & Sharpe Automatic Screw Machines, manned by skilled set-up men (not operators), assure you high quality work! We're equipped to do the complete job...design and make our own cams...small assembly work...every detail. Delivery per your schedule.

Mail blueprint for bid or phone.

**INLAND AUTOMATIC, INC.,**

Subsidiary INLAND MFG. CO.,

1108 Jackson St., Omaha 2, Nebr., Phone: HAney 1108

CIRCLE 291 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

**Diode Package**  
Has own mounting

This four diode package has its own means for mounting and offers protection against environmental extremes. Various inverse voltage and forward current ratings are achieved by the selected diodes. Diodes are replaceable without removing the unit from its mounting place or unsoldering the leads. Qualified per MIL-E-5272A, the units have solder type terminals.

Master Specialties Co., Dept. ED, 956 E. 108th St., Los Angeles 59, Calif.

CIRCLE 292 ON READER-SERVICE CARD

**Isolation Amplifier**

±0.5 db, 30 cps to 100 kc



For use with an oscilloscope or voltmeter in measuring floating ac voltages, the model 202 isolation amplifier has a frequency response of ±0.5 db, 30 cps to 100 kc, and 3 db down at 5 cps and 1 mc, approximate. Phase shift at 60 cps is under 5 deg. Isolation of input to output effective capacity is less than 4 μf.

Quan-Tech Labs., Dept. ED, Morristown, N.J.

CIRCLE 293 ON READER-SERVICE CARD

**VHF Preamplifier**

45 db gain from 50 mc to 300 mc

Broadband vhf preamplifier for crystal-video detectors has a gain of about 45 db from 50 mc to 300 mc. Average noise figure is about 7 db. Power input of 70 w is required. Packaged weight is under 4 lb without power supply.

Haller, Raymond, and Brown, Inc., Dept. ED, State College, Pa.

CIRCLE 294 ON READER-SERVICE CARD

YOU CAN DEPEND ON

**DALOHM**  
Ω

Non-pressurized at  
50,000 feet . . . yet retains  
**100% RELIABILITY!**

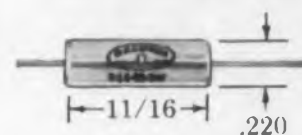
Extreme altitude is only one of many demanding requirements in which DALOHM RSE precision wire wound resistors offer dependable reliability.

The precision resistor element is inserted in a special shock absorbent material and completely sealed in a tough metal tube. It's ready to meet demanding conditions of mechanical shock, moisture and humidity, thermal cycling and power loading.

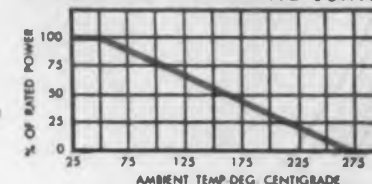
Here are the RSE standard specifications that help you meet demanding electronic requirements:

- Operating temperature range: -65° C. to 275° C.
- Precision tolerance range: 0.05%, 0.1%, 0.25%, 0.5%, 1% and 3%.
- Rated at 2, 3, 5, 7 and 10 watts.
- Resistance range from .5 ohm to 175K ohms, depending on size.
- Temperature coefficient: 0.00002/Degree C.
- Insulation breakdown: 1000 V AC or DC.
- Seven sizes: 11/16 X .220 to 1 61/64 X .395.
- Complete protection from vibration, moisture and salt spray.

Write for Bulletin R-25

SEVEN SIZES;  
FIVE POWER RATINGS

TYPICAL RSE-5 DERATING CURVE



JUST ASK US

DALOHM line includes a complete selection of miniature precision power resistors (wire wound and deposited carbon), precision wire wound miniature trimmer potentiometer and collet fitting knobs. Write for free catalog.

If none of DALOHM standard line meets your need, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production. Just outline your specific situation.

**DALE  
PRODUCTS  
INC.**1328 28th Ave.  
Columbus, Nebr., U.S.A.

CIRCLE 295 ON READER-SERVICE CARD



From Sanders Associates, Inc., Nashua, New Hampshire . . .

## RELIABILITY-PROVED COMPONENTS FOR AIRCRAFT, MISSILES, SPACECRAFT

### FLEXIBLE PRINTED WIRING

Sanders *Flexprint*® Printed Circuit Cables and Harnesses sharply reduce the weight, space and cost of electronic and electrical assemblies . . . eliminate wiring error. Conductors are permanently bonded in thin sheets of flexible plastic: vinyls, polyethylenes, polyesters, silicones, Kel-F or Teflon. All lengths and current carrying capacities. Meets military reliability requirements.



TRADEMARK - SANDERS ASSOCIATES, INC.



### ELECTRO-HYDRAULIC SERVO VALVES

Two-stage internal force-feedback principal converts low input power to high output flow. Valves feature high frequency response and resolution, low threshold, and high internal stiffness of control over the operating range of  $-65^{\circ}\text{F}$  to  $225^{\circ}\text{F}$ . Large-area internal filters in pilot stage assure reliability. Standard flow ranges up to 0-200 gpm (at 1000 psi pressure drop); supply pressures to 3000 psi.

### KEY COMPONENTS PRODUCED BY SANDERS ASSOCIATES

offer advantages of unfailing dependability . . . savings in space and weight . . . superior performance for your guidance, control, and detection systems. They are available in production quantities and may be readily adapted to meet special requirements. Sanders also offers complete creative engineering, design, development, and production services with highly specialized experience, skills, and manufacturing facilities in electronics, hydraulics, and electromechanics. Sanders can produce individual components or complex packaged systems capable of meeting extreme environmental and performance requirements.

### MICROWAVE TRANSMISSION LINE

Sanders *Tri-Plate*® Strip Transmission Line offers broad band operation within the frequency range 100 to 12,400 mc with substantial savings in size, weight, and cost over conventional coaxial and waveguide assemblies. Components in use include variable attenuators, balanced mixers, hybrid rings, directional couplers, low pass filters, power dividers, and receiver and beacon front ends.



### CONSTANT DAMPING RATE GYRO

Sanders Subminiature Rate Gyroscope, Type RGB, has a nominal damping ratio of  $0.5 \pm 0.1$  between  $-30^{\circ}\text{C}$  and  $+100^{\circ}\text{C}$ . Simplified damping mechanism compensates for temperature changes without linkages. Features include: lifelong hermetic sealing, excellent resolution, high sensitivity, small size ( $15/16''$  D x  $2\frac{1}{2}''$  L), lightweight. Input rates up to  $\pm 1000$  deg/sec.



### RADAR ANTENNAS AND SYSTEMS

Sanders *Tri-Scanner*® Conical Scan Antenna provides three-times the information rate of conventional fire control antennas. In use on a major missile system, it is lightweight and statically and dynamically balanced, and offers unusual anti-jam features. Sanders also manufactures photoetched slot and spiral antennas for flush-mounted arrays, beacons, and communication systems.

Call or Write:

 SANDERS ASSOCIATES INC.

CIRCLE 296 ON READER-SERVICE CARD

## NEW PRODUCTS

### Teflon Terminals

Permit strong connections



The type FT-SM-93 ML miniature feed-through Teflon terminal provides a mechanical as well as soldering bond, and is especially for use with finer wires. For security, the connecting wire first passes through a hole and then wraps around the lug. Each end lug is flatted on both sides for tighter wrapping of the wire.

Seaelectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.

CIRCLE 297 ON READER-SERVICE CARD

### Decode Unit

Binary-to-decimal



Decimal coded binary codes that may be translated with the Bina-Dec decoder include four-bit codes, two-out of five, and the excess 3 code. Module type construction permits assembly of as many decades as required.

Industrial Electronic Engineers, Dept. ED, 3973 Lankershim Blvd., North Hollywood, Calif.

CIRCLE 298 ON READER-SERVICE CARD

### Pulse Height Analyzer

Linearity of 0.5 per cent

Model PHA-100/20 pulse height analyzer consists of a 100-channel analog-to-digital converter and 20 channels of glow transfer tube storage capacity. The unit has all components needed for a scintillation spectrometer except phototube

ELECTRONIC DESIGN • August 6, 1958

and crystal. Linearity is 0.5 per cent; deadtime is 500  $\mu$ sec.

Tullamore Electronics Lab, Dept. ED, 6055 S. Ashland Ave., Chicago 36, Ill.

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### Spectrum Analyzer

Covers frequencies from 0 to 15 mc



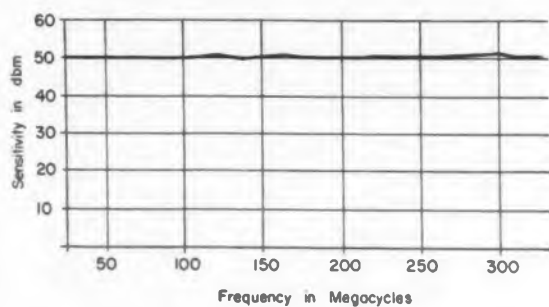
Displaying spectrum segments up to 3 mc wide, centered anywhere between 0 and 13.5 mc, the SPA-3 spectrum analyzer covers an overall frequency range from 200 cps to 15 mc. The unit provides continuously variable resolution from 200 cps to 30 kc and a variable scan rate from 1 to 60 cps. It has three amplitude scales, 100 db calibrated attenuators, 20  $\mu$ v full scale sensitivity, and response flatness of  $\pm 1$  db. Nominal input impedance is 72 ohms.

Panoramic Radio Products, Inc., Dept. ED, 514 S. Fulton Ave., Mt. Vernon, N.Y.

CIRCLE 300 ON READER-SERVICE CARD

### Broadband VHF Preamplifier

45 db gain from 50 mc to 300 mc



This broadband vhf preamplifier for crystal-video detectors has a gain of about 45 db from 50 mc to 300 mc. Average noise figure is about 7 db. The measured tangential sensitivity of a typical vhf crystal-video detector is about -50 dbm for a video bandwidth of 1 mc. The average tangential sensitivity of this same detector using the vhf preamplifier is about -88 dbm. Packaged weight, excluding power supply, is less than 4 lb. Power input of 70 w is required.

Haller, Raymond, and Brown, Inc., Dept. ED, Circleville Rd., State College, Pa.

CIRCLE 301 ON READER-SERVICE CARD



# MICRO SWITCH Precision Switches



## We've Miniaturized the Subminiature!

WEIGHT: 1 gram... 28 switches to the ounce... over 430 to the pound. SIZE: .500" long, .200" wide, .350" high. CUBIC CONTENT: .035 cubic inches. ELECTRICAL RATING: 5 amps-250 vac, 30 vdc. SPDT.

After a long period of laboratory development, MICRO SWITCH announces this new, highly miniaturized precision snap-action switch and a complementary line of actuators.

We call it the "Sub-subminiature!"

This new "SX" basic switch represents an entirely new set of answers to the space-weight problems in dependable precision switching. It combines new small size with more than ample capacity for wide usefulness, meeting the pressing demand for miniaturization combined with reliability.

In its exacting development, many prob-

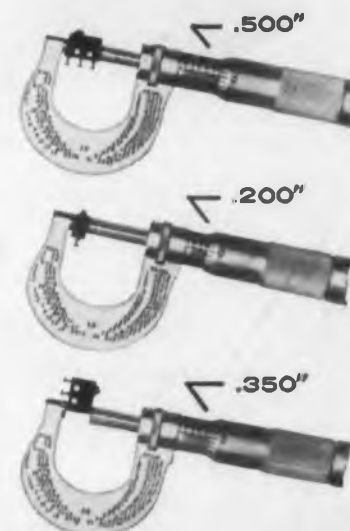
lems of design, testing and quality control presented themselves. However, 23 years of experience proved of immense value. As a result, a new standard has thus been set by which all precision switches must be measured.

This broad experience can prove of equal value to you. Send for more information about this new switch. Request Data Sheet No. 148.

MICRO SWITCH...FREEPORT, ILL.

A division of Honeywell

In Canada: Honeywell Controls, Ltd., Toronto 17, Ontario



# Honeywell

MICRO SWITCH PRECISION SWITCHES

The two-word name MICRO SWITCH is NOT a generic term. It is the name of a division of Honeywell.

CIRCLE 302 ON READER-SERVICE CARD

*Whether you need*  
**SILICON RECTIFIERS**

*rated at 500 mils*



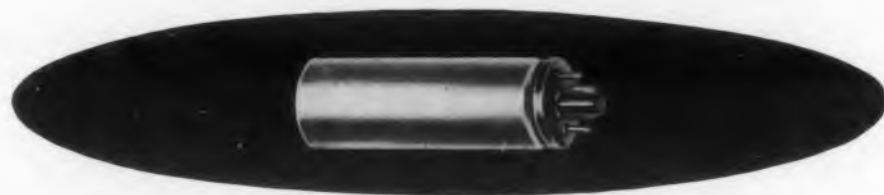
*... or 10 amps*



*... or 200 amps*



*... or tube  
replacements*



**Tarzian**

Silicon Rectifiers cover the complete range. Write for complete information or send an outline of your requirements.

*We'll see you at the Wescon—Booth 1326*

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In Canada: 700 Weston Road, Toronto 9, Telephone Rogers 2-7535

Export: Ad Auriema, Inc., New York City

**CIRCLE 303 ON READER-SERVICE CARD**

## NEW PRODUCTS

### Transistor Tester

Direct reading measurement of small beta



The model 201 transistor tester gives a direct reading measurement of small beta of npn and pnp low power junction transistors in three ranges: 0 to 50, 0 to 250, and 0 to 500.

Hoover Electric Co., Dept. ED, 2100 S. Stoner Ave., Los Angeles 25, Calif.

CIRCLE 304 ON READER-SERVICE CARD

### Multi-Tap Delay Line

2.5 kv dc rating



Featuring a 2.5 kv dc rating, the model F384 lumped constant, multi-tap delay line has a 66  $\mu$ sec total delay with taps every 2.0  $\mu$ sec. Rise time is about 10 per cent of the delay selected at any one of the 33 tap points, and impedance is 9100 ohms. Other models have impedances ranging from 50 to 10,000 ohms.

Control Electronics Co., Inc., Dept. ED, 1925 New York Ave., Huntington Station, N.Y.

CIRCLE 528 ON READER-SERVICE CARD

### Power Supplies

Unusual form

Two power supplies of space-saving design. A multiple output dc to dc supply, semicircular, fits into half of a 6 in. diam, 2-3/8 in. high cylinder. The other half of the cylinder holds the 25.5 to 30.5 v dc source. The unit withstands up to 100 g and operates from  $-55$  to  $+70$  C. It produces 150 v dc at 60 ma  $\pm 1$  per cent, and 180 v dc at 85 ma  $\pm 1$  per cent regulated line and load.

A second supply is 1-1/8 in. in diameter and

## Using Thermistors

Edited by

FENWAL ELECTRONICS

### THERMISTOR PROBE ASSEMBLIES

Fenwal Electronics' new thermistor probe assemblies enormously simplify an engineer's design and development problems. Developed and built by Fenwal to your specifications, each assembly is a ready-to-use, easy-to-handle unit incorporating all the qualities that make Fenwal Electronics' thermistors outstanding — sensitivity, stability, reliability, fast response, light weight, and small size.



Three examples of complete thermistor probe assemblies Fenwal Electronics has designed and built to customers' specifications.

Fenwal Electronics develops and builds complete assemblies to various configurations and temperature ranges for specific applications. Probes can be completely interchangeable, and have identical resistance-temperature characteristics.

*Engineers:* Fenwal Electronics now has a thermistor kit No. G200, which includes 12 different individually packaged thermistors, each with complete data, for development work. \$19.95 f.o.b. Framingham.

Write FENWAL ELECTRONICS, INC., 38 Mellen Street, Framingham, Mass., for Bulletin EM-13, describing nine of the many thermistor probe assemblies Fenwal Electronics can build for you. Or write for the Fenwal Electronics catalog (EMC-2).



Design — Engineering — Production  
of Precision Thermistors

CIRCLE 529 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

takes up less than 4 cu in. It produces 12,000 v dc at  $1 \times 10^{-7}$  amp from a single 1.5 v dc C size battery.

Universal Transistor Products Corp., Dept. ED, 17 Brooklyn Ave., Westbury, N.Y.

CIRCLE 305 ON READER-SERVICE CARD

## Cooling Assemblies

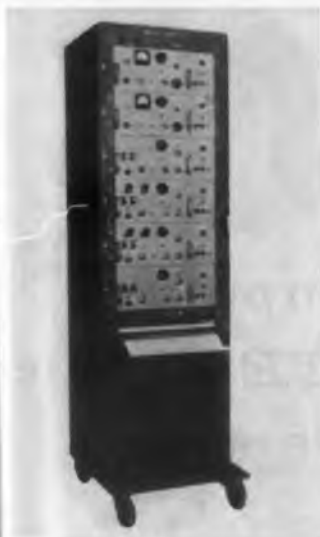
Compact



Shown is one of a line of small packaged cooling assemblies. Capable of 600 w absorption, the unit operates on 115 v ac, single phase, 400 cps current. Liquid temperature range for this model is  $-40$  to  $+250$  F; liquid system pressure is 200 psi maximum; fluid flow rate is 1 gpm at 90 F; and rated delivery is 70 cfm at 2 in. wg static pressure. Other units are available in a variety of sizes and arrangements.

Borg-Warner Corp., Pesco Products Div., Dept. ED, Bedford, Ohio.

CIRCLE 306 ON READER-SERVICE CARD



## Oscillographic Recording System

In one cabinet

This 6-channel direct-writing oscillographic recording system, the model 156-5466, comes in a vertical cabinet 78 x 22 x 25 in. The 150 series system provides 1 per cent overall linearity, current feedback driver amplifiers and regulated power supplies for each channel, and 9 chart speeds from 0.25 to 100 mm/sec.

Samborn Co., Dept. ED, 175 Wyman St., Waltham 54, Mass.

CIRCLE 307 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

# BENDIX "SP" ELECTRICAL CONNECTOR— NEWEST MEMBER OF THE PYGMY FAMILY



*Flange Design Permits Back Panel Mounting*

The new Bendix\* "SP" connector uses an alumilite finish offering superior resistance to abrasion and corrosion. Flange size and location designed to permit back panel mounting with No. 6 screws. Other outstanding features of the new connector are similar to those of the well-known "PT" type.

- Safety wiring completely eliminated
- Mechanically assisted coupling and uncoupling through cam action
- Closed entry, probeproof socket contacts

- Visual and audible inspection of coupling—perfect for "blind" locations
- Three-point bayonet lock; perfect axial alignment of mating parts at all times
- Constant spring tension behind mated insert faces
- Five-key polarization—positive protection against mismatching or cross-plugging
- Resilient inserts, performance-proven in millions of Bendix connectors
- Heavy gold plating over silver on all contacts
- Both pin and socket contacts machined from high-grade copper alloy

- Machined bar stock or impact-extruded shell components
- Alumilite finished to resist abrasion and corrosion—no thread wear—easily withstands 500 hours of salt spray

With the introduction of "SP" Pygmy Electrical Connectors, Bendix again demonstrates its well-known policy of anticipating the needs of industry.

Export Sales and Service: Bendix International Division, 205 East 42nd St., New York 17, N. Y.  
Canadian Affiliate: Aviation Electric, Ltd., 200 Laurentian Blvd., Montreal 9, Quebec

\*REG. TRADEMARK

Scintilla Division

SIDNEY, N. Y.



CIRCLE 532 ON READER-SERVICE CARD



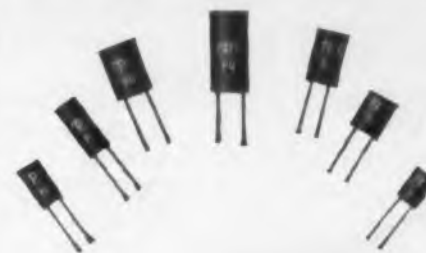
# RESISTORS

PRECISION WIRE WOUND • HIGH VOLTAGE • HIGH MEGOHM • HIGH FREQUENCY



### High Megohm Resistors

Type H Resistors are used in electrometer circuits, radiation equipment and as high resistance standards. Resistance available to 100 million megohms. ( $10^{14}$  ohms). For utmost stability under adverse conditions Type HSD and HSK Hermetically Sealed are recommended. Seven sizes from  $\frac{3}{4}$  inch to 3 inches long are available. Voltage rating to 15,000 volts. Low temperature and voltage coefficients. Standard resistance tolerance 10%. Tolerance of 5% and 3% available. Also matched pairs 2% tolerance.



### Printed Circuit Precision Resistors

To meet the requirements for printed circuitry, RPC has developed Type P Encapsulated Wire Wound Precision Resistors. Miniature, single ended units designed for easy rapid mounting on printed circuit panels with no support other than the wire leads. Many newly developed techniques are employed in the manufacture of Type P Resistors. These units can be operated in ambient temperatures up to 125°C. and will withstand all applicable tests of MIL-R-93A, Amdt. 4. Available in 7 sizes, rated from 1/10 watt to .4 watt.  $\frac{1}{4}$ " diameter by  $\frac{3}{16}$ " long to  $\frac{3}{8}$ " diameter by  $\frac{3}{4}$ " long. Resistance values to 2 megohms. Tolerances from 1% to 0.05%.



### High Frequency Resistors

Used where requirements call for very low inductance, capacitance and skin effect in circuits involving pulses and steep wave fronts. Depending on size and resistance value, these resistors are usable at frequencies to over 400 mc. Resistance values range from 20 ohms to 100 megohms with tolerance of 20% to 5%. 2 types available. TYPE G resistors (shown) are tubular, in 6 sizes from  $4\frac{1}{2}$ " long x  $\frac{3}{4}$ " diameter to  $18\frac{1}{2}$ " long x 2" diameter. With band terminals or ferrules. Power rating 10 to 100 watts. TYPE F resistors (not shown) in 10 sizes from  $9\frac{1}{16}$ " long x 0.10" diameter to  $6\frac{1}{2}$ " long x  $9\frac{1}{16}$ " diameter. Lugs or wire leads. Power rating  $\frac{1}{4}$  to 10 watts.

## RESISTANCE PRODUCTS COMPANY

914 SOUTH 13TH STREET,

HARRISBURG, PENNA.

SPECIALIZING IN  
THE MANUFACTURE  
OF QUALITY RESISTORS  
IN ANY AMOUNT

CIRCLE 308 ON READER-SERVICE CARD

**RELIABLE AND RUGGED**  
shock and vibration resistant



**HG-4SL**

**CONTACTS**  
1, 2, 3 or 4 pole, Form A, B or C  
**CONTACT CURRENT**  
Dry circuit to 10A resistive or 6A inductive  
**CONTACT VOLTAGE**  
Up to 1000 V, depending on current  
**COIL VOLTAGE**  
3 to 250 V DC  
**COIL RESISTANCE**  
Up to 12,000 ohm  
**SENSITIVITY (MAX)**  
350 mw  
**TEMPERATURE RANGE**  
-65°C to +125°C, Std.  
to +150°C or +200°C, Special  
**SHOCK-OPERATING** 100 G  
**NON-OPERATING** 1000 G  
**VIBRATION**  
5 — 2000 cps @ 20 G  
**WILL EXCEED REQUIREMENTS OF:**  
MIL-R-5757C — MIL-R-25018  
MIL-R-6106 — MIL-R-19523



**HG-4R**

**CONTACTS**  
1, 2, 3 or 4 pole, Form A, B or C  
**CONTACT CURRENT**  
Dry circuit to 10A resistive or 6A inductive  
**CONTACT VOLTAGE**  
Up to 1000 V, depending on current  
**COIL VOLTAGE**  
6 to 350 V, 60 cps or 400 cps  
**COIL RESISTANCE**  
Up to 25,000 ohm  
**SENSITIVITY (MAX)**  
350 mw  
**TEMPERATURE RANGE**  
-65°C to +125°C, Std.  
to +150°C, Special  
**SHOCK-OPERATING** 100 G  
**NON-OPERATING** 1000 G  
**VIBRATION**  
5 — 2000 cps @ 20 G  
**WILL EXCEED REQUIREMENTS OF:**  
MIL-R-6106 — MIL-R-19523  
MIL-R-5757C — MIL-R-25018

for information on COMPLETE line, write:



BRADLEY FIELD  
WINDSOR LOCKS, CONN.

CIRCLE 530 ON READER-SERVICE CARD

**NEW! RVG-8T**

**1/2" TRIMMER POT**



...from  
**Gamewell**

**Linearity ±3% and Power Rating 2w @ 85°C derated to 0 at 150° standard — 200°C intermittent operation available**

**RVG-8T Specifications**

- 1/2" Trimmer Pot
- Rating (watts) 2
- Torque (oz.-in.) Max. 1. special high torque available
- Weight (ounces) 1/3
- Resistance Range ±5% 20Ω to 50K\*
- Electrical Function Angle 320°
- Voltage, Max. (insulation) 1000 DC
- Linearity, Standard (%) ±3

\*100K available  
Notes: Shaft lock nut is supplied.

**High Performance and Low Cost**

Improve performance of your electrical and electronic circuitry with this new RVG-8T 1/2" Trimmer Potentiometer.

Excellent performance characteristics for its type and size. Windings are on cards or mandrels, usually with wire temperature coefficient of 20 ppm. Body is one-piece phosphor bronze, nickel plated; terminals are gold plated; stop pins and shaft are of stainless steel; precious metal contacts are

used throughout. Insulation is designed to withstand 1000 volts DC.

**Available now!** RVG-8T is stocked in standard resistance ranges. 100 ohms to 50K ohms — up to 100K ohms available. Can be supplied with precision potentiometer tolerances, servo-mount, or for 200°C intermittent operation. Write for prices and catalog sheet today.

**THE GAMEWELL COMPANY**  
Newton Upper Falls 64, Mass.

**PRECISION POTENTIOMETER DIVISION**



GA8-5

CIRCLE 309 ON READER-SERVICE CARD

## NEW PRODUCTS

### Gyro Test Turntable

For testing low-drift gyros



The T-806 precision gyro test turntable was designed for testing low-drift gyros in either open or closed loop. Accurate tilting permits polar axis drift tests as well as vertical, inverse vertical and horizontal axis drift tests, all without changing the position of the gyro on the turntable.

Sterling Precision Corp., Dept. ED, 17 Matinecock Ave., Port Washington, N.Y.

CIRCLE 310 ON READER-SERVICE CARD

### Transistor Testers

Test forward and back currents



Two instruments, model FT 1 forward current tester and model BT 1 back current tester, have been designed for quantity testing by unskilled operators. Model FT 1, shown, has an output voltage of 0-3 v dc. Line regulation and load regulation are each better than 10 mv. Ripple and noise less than 2 mv peak to peak.

Trans Electronics Inc., Dept. ED, 7349 Canoga Ave., Canoga Park, Calif.

CIRCLE 311 ON READER-SERVICE CARD



## MESA now supplies DIALLYL PHTHALATE plastic in machinable stock

To help engineers engaged in prototype work, Mesa will supply prototype blanks at cost. The blanks are produced in a wide variety of shapes and sizes...in all types of Diall diallyl phthalate, and are guaranteed free of voids, cracks, and porosities.

We offer this service to engineers who wish to have parts machined first, before going to the expense of building dies.

*Send us your requirements.*

**MESA PLASTICS COMPANY**  
11751 Mississippi Ave., Los Angeles 25, Calif.

CIRCLE 312 ON READER-SERVICE CARD



## Sine-Cosine Potentiometer

### Nonlinear type

Type WPSC 1-1/8 nonlinear sine-cosine precision potentiometer provides two 360-deg sinusoidal voltage outputs. The output signals are displaced 90 deg in phase and represent the sine and cosine of the shaft rotation angle.

Waters Mfg., Inc. Dept. ED,  
Wayland, Mass.

CIRCLE 313 ON READER-SERVICE CARD

## Power Line Carrier

### Completely transistorized

This frequency shift power line carrier equipment, all transistorized, can be operated from a 48 v battery source or conventional ac power. Transmitter power input requirements are 22 w at 117 v, or 11 w at 48 v dc.

Motorola Inc., Dept. ED, 4501  
W. Augusta Blvd., Chicago 51, Ill.

CIRCLE 315 ON READER-SERVICE CARD

## Modular Test Equipment

### Wide variety of applications

Modules for easy assembly into automatic synchro testers, inertial guidance system testers, universal radar test sets, universal resolver and synchro test consoles, resistance limit bridge consoles, and other test devices.

Kearfott Co., Inc., Dept. ED,  
1378 Main Ave., Clifton, N.J.

CIRCLE 314 ON READER-SERVICE CARD

## Low-Pass RF Filter

### Weighs under 5 oz

Compact low-pass rf filter designed for low insertion loss in the communication band of 225 to 400 mc with attenuation in the 950 to 1200 mc band of 80 db. Weighs under 5 oz.

Bird Electronic Corp., Dept.  
ED, 1800 E. 38th St., Cleveland  
14, Ohio.

CIRCLE 316 ON READER-SERVICE CARD



Model 62-121

*new*

# **D/B**

## **transistorized power supply**

*the reliability*

*you've been waiting for!*

This latest Dressen-Barnes power supply is fully transistorized, functioning without vacuum tubes or magnetic amplifiers. Its circuitry\* provides superb regulation, and a high degree of freedom from spikes and transients. Unit is short-circuit proof, and the output is double fused to protect the transistors against damage.

**TOP COOLING EFFICIENCY** — the forced-air cooling system intake is located on the panel, where it draws an air supply more than adequate to cool the transistors.

**NO DERATING** for continuous operation — the output range is 0.5-36 VDC at 15 amps, with full current available down to 0.5 volts. Extremely low ripple ... all components conservatively rated for long, trouble-free operation. Sold under a one-year guarantee and competitively priced, this power supply offers outstanding value. Write for Bulletin on Model 62-121.

\*patent applied for

## **dressen-barnes**

DRESSEN-BARNES CORP. • 250 North Vinedo Avenue, Pasadena, Calif.

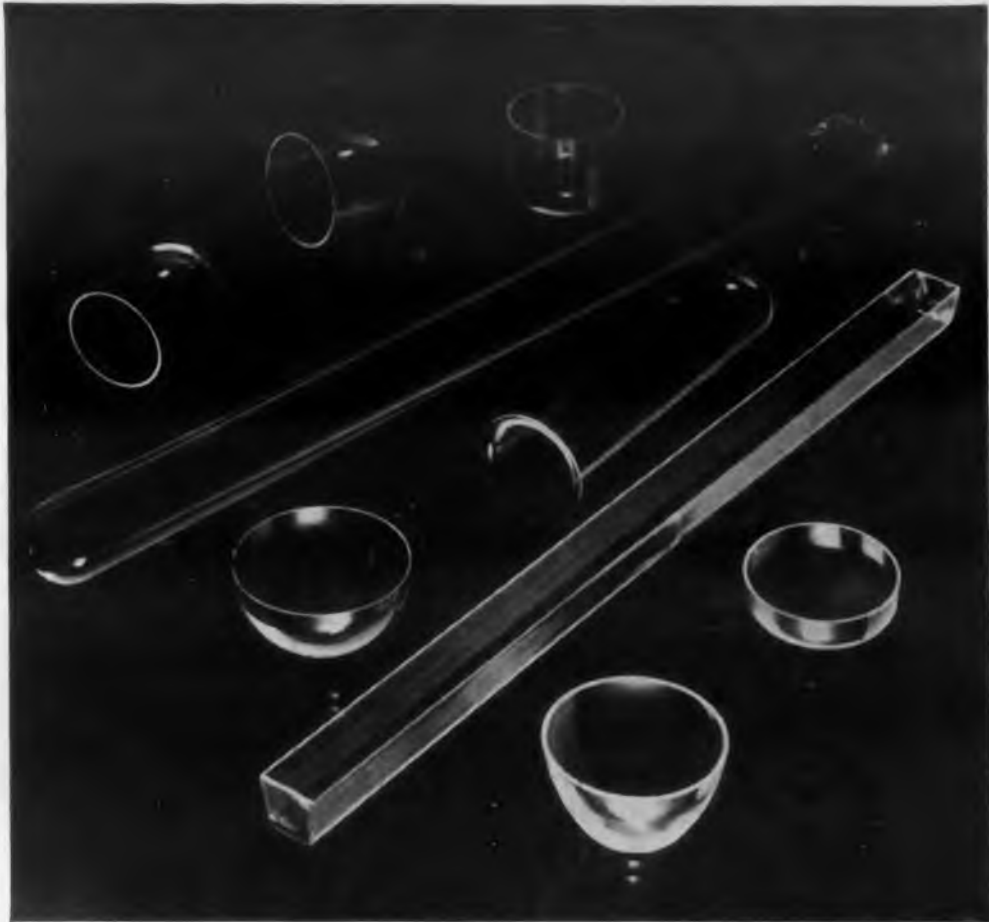
CIRCLE 317 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958



# Need High Purity fused quartz components?

*General Electric offers most  
complete line... plus prompt delivery!*



**HERE'S GOOD NEWS** for anyone in the semi-conductor field making silicon and germanium and using ordinary crucibles or thin wall tubing for zone refining. General Electric offers the industry's most complete line of semi-conductor components of extremely High Purity fused quartz. This enables you to fill all your quartz requirements from a single source—simplifying ordering, stocking and bookkeeping.

**STOCK ITEMS AVAILABLE.** General Electric now has plant facilities devoted exclusively to the making of fused quartz products—and offers a wide

range of stock items for immediate—*yes, immediate*—delivery.

**FREE ENGINEERING ASSISTANCE** General Electric invites your requests for engineering assistance and it's free, without any obligation on your part. By using the know-how and experience of G-E engineers you not only are assured of immediate and expert help, but you also release your own staff for other assignments. Write today, to: General Electric Co., Lamp Glass Department ED-88, Willoughby Quartz Plant, Willoughby, Ohio.

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

CIRCLE 319 ON READER-SERVICE CARD

# put your finger on

## PROFIT



This magnified minuscule electrical part is another Advance Stamping which saved production costs.

Yes—bigger profits from smaller parts are very possible when you engineer in Stampings—especially *Advance Stampings*. As Specialists in Small Stampings, Advance has been helping metal working industries of various kinds attain higher production at lower cost for over 35 years.



Here are typical Advance Stampings which have been fabricated in different materials to meet tolerance specifications, delivery and price.

Send us your blue prints or samples for quotations. Advance engineers are available to consult on ways to improve your competitive position.

Write for Small Stamping Specialists Brochure

**ADVANCE STAMPING CO.**  
12025 Dixie Ave., Detroit 39, Michigan

CIRCLE 320 ON READER-SERVICE CARD

## NEW PRODUCTS

### Color Tolerance Computer

Has range from 0 to 20 NBS units



Designed for use with the IDL color-eye colorimeter, the model No. 100 delta E electronic color tolerance computer has a range from 0 to 20 NBS units. Accuracy is  $\pm 0.1$  NBS unit or 3 per cent.

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

CIRCLE 321 ON READER-SERVICE CARD



### DC VTVM

Accuracy 1/4 per cent absolute

Accuracy of 1/4 per cent absolute (not full scale) is obtained with the MV-57A dc vtvm. Measuring range is 100  $\mu$ v to 1 kv, and input impedance is 6 meg on low ranges, and 60 meg from 1 v up.

Millivac Instruments, Dept. ED, P.O. Box 997, Schenectady, N.Y.

CIRCLE 322 ON READER-SERVICE CARD

### Digital Data Logger

Takes up to 30 go-no-go signals

The DIGIDAC/Logger takes up to 30 go-no-go (on-off) signals and converts them to a one-channel digital pulse output. It can be used with tactical telemetry systems, subcarrier oscillators, checkout systems, DIGIDAC/Converter, and DIGIDAC/Comparator.

Aeronca Mfg. Corp., Dept. ED, Middletown, Ohio.

CIRCLE 323 ON READER-SERVICE CARD

## "SPECIAL" TRANSDUCERS

for over-speed control and precise rpm measurements



Meters liquid rocket fuel.

Generates "tone" or frequency in drones.

Senses over-speed of turbine used in pressurizing jet airliner cabins.

Electro designs and manufactures hundreds of special application transducers to meet any shape or size requirement. These reluctance-type transducers produce a tremendous voltage output when excited by the proximity of moving metal objects. "Specials" can be made using a wide variety of materials, connectors and finishes. Provisions of MIL-Q-5923 can be met when specified.



Let us solve your "special" problem!  
**ELECTRO PRODUCTS LABORATORIES**  
4501-B Ravenswood, Chicago 40, Ill.  
Canada: Atlas Radio Ltd., Toronto

CIRCLE 324 ON READER-SERVICE CARD



### The TREADLITE

Two accurate switching operations in ONE treadle, no larger than a pack of cigarettes. Responds to the slightest pressure.



### The COMPACT

So small it fits in the palm of your hand. Amazingly sensitive, foolproof actuating mechanism can be operated with finger, elbow, knee or foot.

**maximum**  
electrical capacity

**minimum**  
size and weight

in these light duty switches from

# LINEMASTER

**America's**  
**footswitch**  
**leader**

A trio from more than 75 different Linemaster footswitch models, designed to fit every conceivable need. Write for prices and complete catalog or let us quote on your special switch requirements.

### The LEKTRO-LOK

This sensitive 2-in-1 teeter-totter eliminates costly harness assemblies . . . mechanical interlock allows only one circuit to function at a time.



**LINEMASTER SWITCH CORP.**

130 Putnam Road • Woodstock, Connecticut

CIRCLE 325 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958



### Filament Transformer

For Eimac 4CX1000A

Designated as Stancor P-6463, this unit provides center-tapped secondaries of 6, 6.5, or 7 v, at 13 amp. Primary is 117 v, 60 cps. The P-6463 is designed to withstand 2000 v rms and measures 2-13/16 x 3-3/8 x 3-3/8 in.

Chicago Standard Transformer Corp., Dept. ED, 3501 Addison St., Chicago 18, Ill.

CIRCLE 326 ON READER-SERVICE CARD



### AC Power Supply Available in 19 models

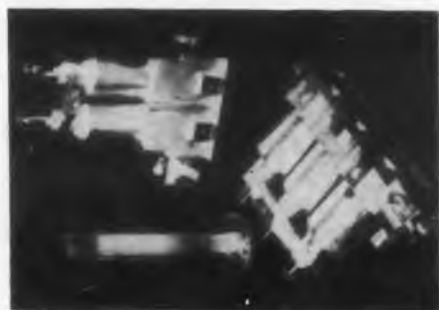
The Series 7000 high-voltage ac power supplies are available in 19 models, operating on 220 or 440 v, 60 cps, single-phase inputs, with output voltages ranging from 0 to 25 to 0 to 150 kv, at 5 to 100 kva.

Beta Electric, Div. of Sorensen & Co., Inc., Dept. ED, Richards Ave., South Norwalk, Conn.

CIRCLE 327 ON READER-SERVICE CARD

### Electroformed Components

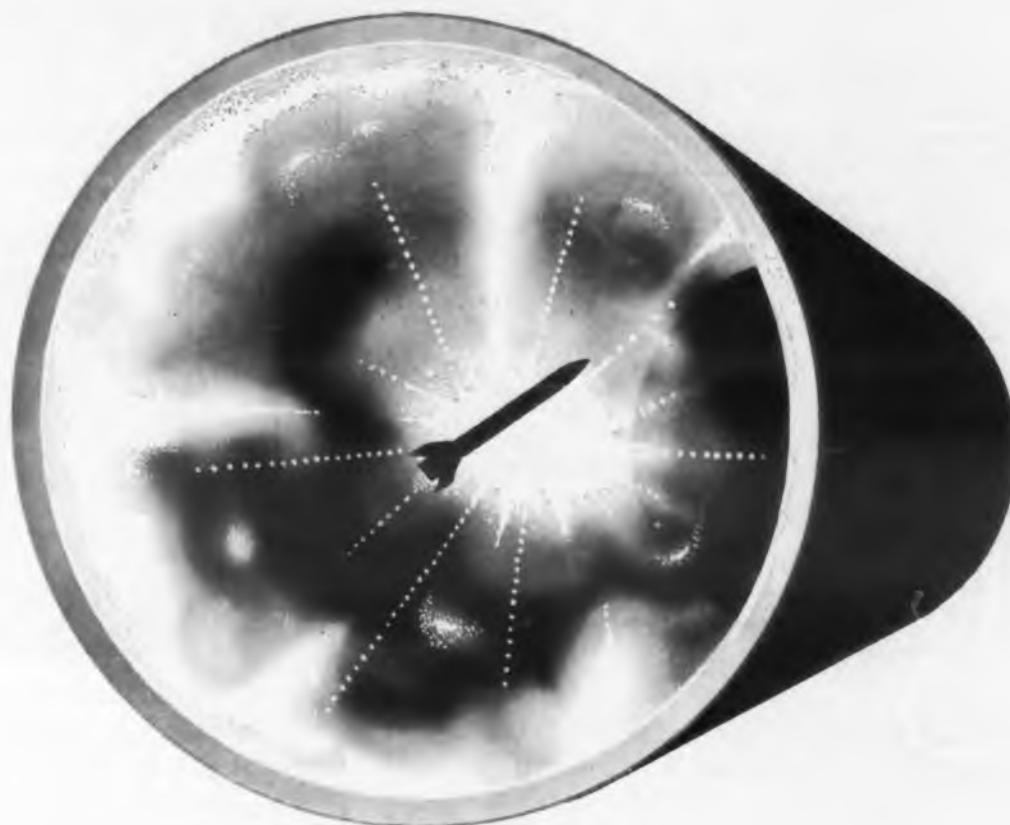
At reduced cost



Electroform process techniques specifically designed for the manufacturer of precise, complex electronic components have reduced costs by eliminating machining operations. Shown are electroformed microwave components.

General Electronic Labs., Inc., Dept. ED, 195 Massachusetts Ave., Cambridge, Mass.

CIRCLE 328 ON READER-SERVICE CARD

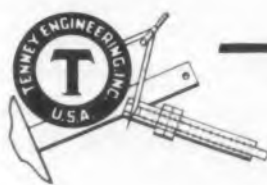


## You name the environment ...TENNEY will simulate it!

Altitude, heat, cold, explosion, vacuum... whatever environment you need, there is an extensively-tested Tenney prototype already built that is very near your specifications. By adjusting the prototype to fit your particular requirements, we can make delivery in a surprisingly short time. In operation, your Tenney chamber will reach ideal environmental conditions quickly, maintain them efficiently throughout the test run, and pro-

vide accurate data for quick, simple evaluation.

Tenney, pioneer in the science of environmental testing, is today the world's largest, most experienced creator of environmental testing equipment. Write today for literature describing Tenney's complete line of prototype chambers, or for information on Tenney's research and development, engineering consultation, and design services.



# Tenney

ENGINEERING, INC.

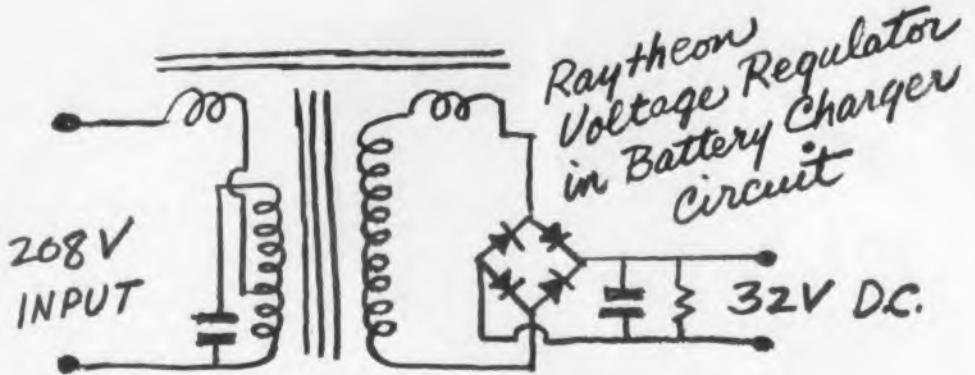
1090 SPRINGFIELD ROAD, UNION, N. J.



PLANTS: UNION, N. J. AND BALTIMORE, MD. • THERE IS A TENNEY CHAMBER TO SIMULATE ALTITUDE, HEAT, COLD, HUMIDITY, VACUUM, EXPLOSION, SAND, DUST, FOG, AND MOST OTHER ENVIRONMENTAL CONDITIONS.

CIRCLE 329 ON READER-SERVICE CARD

# IS CONSTANT VOLTAGE POSSIBLE IN THESE CHANGING TIMES?



...Basically, the problem is a classical one of semantics. Higher minds than ours have pondered this question for centuries.

As a practical exercise, let us examine the case of voltage regulation reference source in the power supply circuit shown above. This passive network corrects input voltage changes of more than  $\pm 15\%$  of rated outputs and controls them to within  $\pm \frac{1}{2}\%$ ...a feature that is highly important in keeping storage batteries alive longer.

The point is that constancy is a relative term understood only against a background of change. The answer then to the initial question is "yes"...constant voltage is possible.

You can get the  about voltage

regulators from the higher minds at Raytheon by writing to:

VOLTAGE REGULATOR MAN  
Raytheon Manufacturing Company  
Magnetic Components Department  
Section 6120  
Waltham 54, Massachusetts



CIRCLE 330 ON READER-SERVICE CARD

## NEW PRODUCTS

### Pulse Transformers

May be impedance matched



Types PT-82 and PT-91 are miniature encapsulated units designed to plug into standard noval sockets. These transformers may be used for isolation, coupling, or blocking oscillator circuits. The windings may be connected in various ways for impedance matching. A typical blocking oscillator performance is a pulse width of 1.1  $\mu$ sec and a pulse height of 70 v. (One winding.)

Berkshire Labs, Dept. ED, 578 Bank Village, Greenville, N.H.

CIRCLE 331 ON READER-SERVICE CARD

### Magnetic Switching Amplifier

Designed for range of  $-67$  to  $+200$  F



The SA6A-1 unit, which operates from 115 v, 60 cps commercial power sources, is specifically designed for such applications as controlling temperatures in hermetic integrating gyroscopes to an accuracy of less than 0.5 F; for use with various types of fuels and liquids in circulating systems and for accurate and reliable oven temperature control. The device is designed for a temperature operating range of  $-67$  to  $+200$  F continuous operation. It meets all requirements of MIL-E-5272C.

Magnetic Controls Co., Dept. ED, 6405 Cambridge St., Minneapolis 16, Minn.

CIRCLE 332 ON READER-SERVICE CARD

ONLY  
 $\pm$  SIX MICROVOLT  
INPUT DRIFT OVER  
AN EIGHT HOUR  
PERIOD

SIZE  
2-15/16" x 6-15/16" x 10"



*high input  
impedance with  
extremely low drift*

The Model REL-120 is a completely transistorized, direct-coupled, instrumentation d-c amplifier featuring:

- (1) long life resulting from the use of such passive elements as transistors and diodes;
- (2) low heat generation from an average required input power of only 10 watts; and
- (3) a self-contained power supply that works directly from either 60 or 400 cycles.

For full specs, write for  
Data File ED-501-1

**RHEEM MANUFACTURING COMPANY  
ELECTRONICS DIVISION**

7777 Industry Avenue, Rivera, Calif.  
phone: RAYmond 3-8971



CIRCLE 333 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958



# HUNTER SPACE HEATERS

**for mobile  
and portable  
military shelters**



- designed and produced in accordance with military specifications for space, equipment and personnel heating requirements.
- 5 basic models — each custom-engineered for a wide variety of applications — for ground control and maintenance equipment in missile systems, radar, microwave and radio communication systems, etc.
- BTU/Hour range: from 15,000 to 60,000.
- multi-fuel-burning models; also models which burn any type gasoline.
- all models air-circulating, thermostatically controlled, all designed for cold starts as low as  $-65^{\circ}\text{F}$ .

*Other Hunter equipment for military applications: engine heaters; unpowered, instant lighting torches; refrigeration units.*

**for complete  
specifications  
and details**

**GET  
THESE  
BROCHURES  
TODAY!**

MH-162 "Hunter Space  
and Personnel Heaters"



MH-166 "Hunter  
Engine Heaters"



MH-167 "Hunter  
Instant Lighting  
Torches"



## HUNTER

MANUFACTURING CO.  
30539 AURORA RD.  
SOLON, OHIO

HEATING AND REFRIGERATION SYSTEMS

CIRCLE 334 ON READER-SERVICE CARD



## Miniature Electrical Connectors

25 modifications  
available

Over 25 modifications of the basic 19-contact miniature electrical connector are now available. All connectors are environmental and meet or exceed the requirements of the latest revision of MIL-C-5015.

The Deutsch Co., Dept. ED, 7000 Avalon Blvd., Los Angeles 3, Calif.

CIRCLE 335 ON READER-SERVICE CARD

## Digital Instrument

Displays numbers on cathode tubes



Model DR-4C is an electronic digital display unit providing digital readout for instrumentation and computers, features printed circuit modular construction. It operates on 115 v, 60 cps, 50 va.

Hoffman Electronics Corp., Semiconductor Div., Dept. ED, 930 Pitner Ave., Evanston, Ill.

CIRCLE 336 ON READER-SERVICE CARD

## Servo Motor

125 C ambient operating temperature



This compact damped 400 cps servo motor in BuORD size 11 provides low cost servo loop damping. Ambient operating temperature is 125 C. Stall torque is 0.60 oz-in. minimum.

Servomechanisms, Inc., Mechatrol Div., 1200 Prospect Ave., Westbury, N.Y.

CIRCLE 337 ON READER-SERVICE CARD

# CONQUEST OF SPACE



There are some who find fulfillment in boundless outer space. And more power to them!

But those of us who still have our feet on the ground also find real challenges in less expansive surroundings.

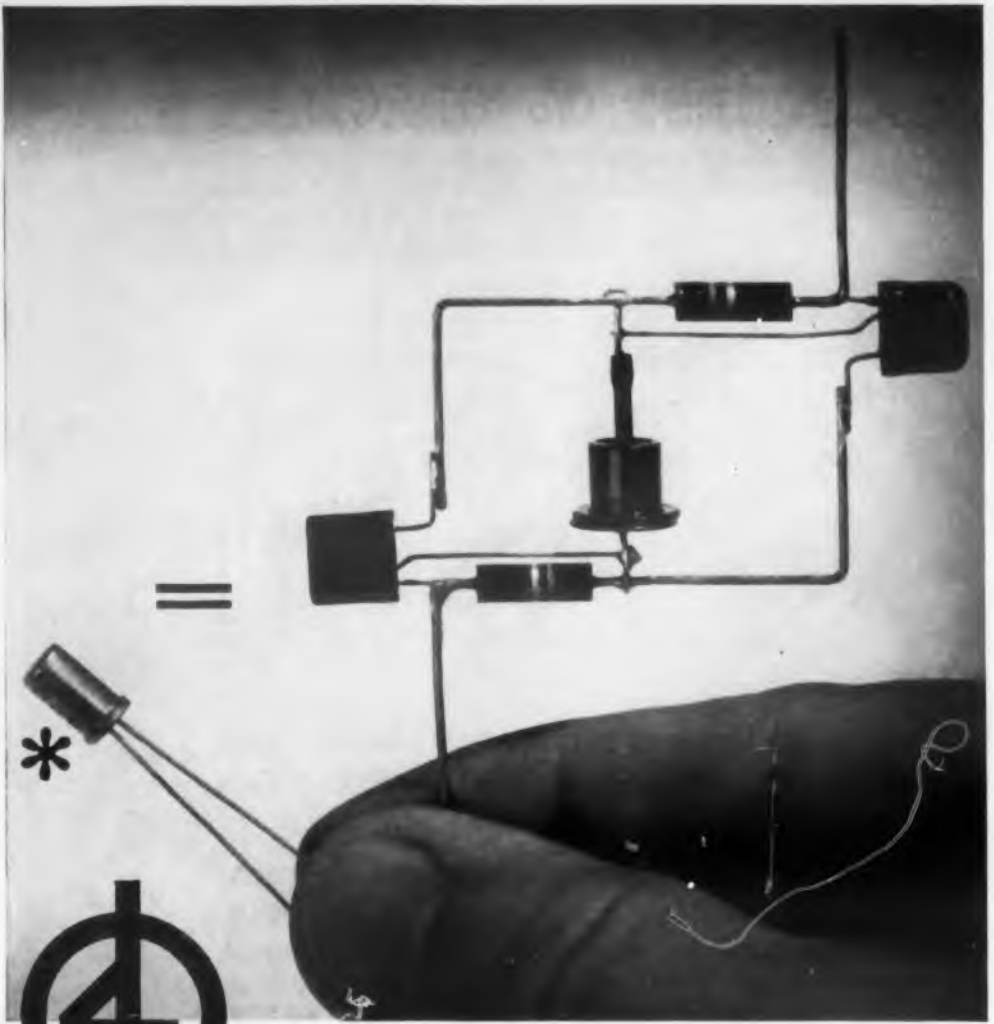
With the aid of a medium-power microscope and several years' experience with fluoro-chemical designs, we successfully pack 4 filter reactors and a 350 VA power transformer into 60 cubic inches of hermetically sealed inner space. Result is 6 pounds of streamlined reliable power for small space platforms...proved in performance in '58-model missiles and (pardon the expression) aircraft.



Have slide rule...  
will travel. You can  
reach us at:

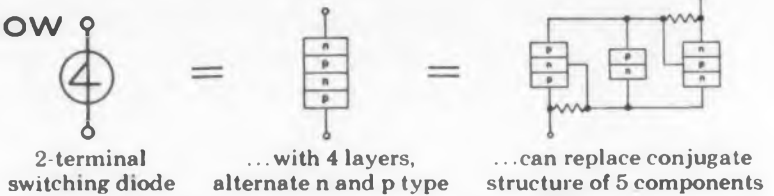
Raytheon Manufacturing Company  
Magnetic Components Department  
Section 6120  
Waltham 54, Massachusetts





**SHOCKLEY 4-LAYER TRANSISTOR DIODE\***  
**SIMPLIFIES SWITCHING CIRCUITRY FOR**  
**COMPUTERS, TELEPHONY, CONTROL**

HERE'S HOW



**RANGE OF CHARACTERISTICS**

$V_b$ (breakdown voltage) . . .	20-100v	$R_h$ ("on" resistance) . . .	< 20 ohms
$I_b$ (breakdown current) . . .	< 500 $\mu a$	(from 1-3 amps., voltage < 1 volt	(from 1-3 amps., voltage < 1 volt
$V_h$ (holding voltage) . . .	< 2V	plus 0.2 to 1.5 ohms times current)	plus 0.2 to 1.5 ohms times current)
$I_h$ (holding current) . . .	< 50 ma	Dissipation . . . . .	$\approx$ 100 mw
		Time to close . . . . .	< 0.1 $\mu sec$
		Time to open . . . . .	< 0.2 $\mu sec$

**STANDARD TYPES AVAILABLE FOR DELIVERY NOW**

No.	$V_b$ Volts	$I_b$ $\mu a$	$V_h$ Volts	$I_h$ ma	$R_h$ ohms
4N20D	20 $\pm$ 5	< 500	< 2	< 50	< 20
4N30D	30 $\pm$ 5	< 500	< 2	< 50	< 20
4N40D	40 $\pm$ 5	< 500	< 2	< 50	< 20
4N50D	50 $\pm$ 5	< 500	< 2	< 50	< 20

**ENGINEERING DATA AND ASSISTANCE**

Our engineering staff, under the direction of Dr. William Shockley, will undertake circuit problems in typical applications such as: sawtooth oscillators, pulse generators, bistable circuits, ring counters and various switching functions. Special types of transistor diodes are being developed to individual specifications. Technical information on request. Write to Dept. 1-2H8.

\*Invented at Bell Telephone Laboratories.

See the Shockley exhibit at WESCON.

**Shockley**

**Transistor Corporation**

1117 California Avenue, Palo Alto, Calif.

A SUBSIDIARY OF BECKMAN INSTRUMENTS, INC.  
 CIRCLE 339 ON READER-SERVICE CARD



## NEW PRODUCTS

### Torque Motor

Has output stroke of  $\pm 0.007$  in.



The model 102 torque motor has a  $\pm 5$  lb mid-position output force;  $\pm 0.007$  in. output stroke; and 800 cps resonant frequency. Hysteresis is 2 per cent maximum. Maximum power required is 2.75 w, and normal temperature range is  $-65$  to  $+350$  F.

American Measurement and Control, Inc., Dept. ED, 240 Calvary St., Waltham, Mass.

CIRCLE 340 ON READER-SERVICE CARD

### Digital Load Indicator

Basic accuracy is  $\pm 0.15$  per cent



Using a precision null balance servo system, the model DLI-2 digital load indicator gives continuous digital presentation directly in desired units. Basic instrument accuracy is  $\pm 0.15$  per cent.

Performance Measurements Co., Dept. ED, 15301 W. McNichols, Detroit 35, Mich.

CIRCLE 341 ON READER-SERVICE CARD

### Recorder

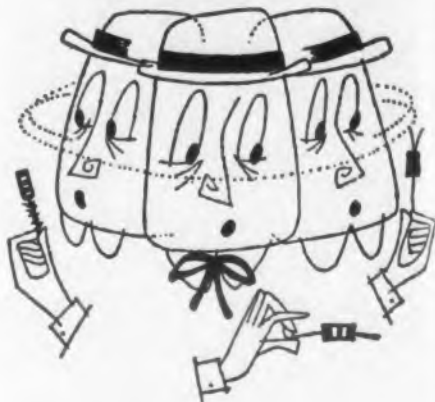
Accuracy is 2 per cent of full scale

Rectilinear recorder with standard chart speed of 1 in. per hr, standard scale of 0 to 1 ma, and rated accuracy 2 per cent of full scale. Response time is 1 sec maximum and galvanometer sensitivity is 1 ma dc full scale. Dry marking process utilizes pressure sensitive paper. Unit contains 63 ft chart roll.

Rust Industrial Co., Inc., Dept. ED, 130 Silver St., Manchester, N.H.

CIRCLE 342 ON READER-SERVICE CARD

## Looking for the right resistor?



Call Speer for a complete line of fixed composition resistors, phenolic coil forms



For detailed information on specifications, characteristics and applications ask for this catalog of Speer Electronic Components!

Automation Soldering your concern? Be sure to send for Speer's Bulletin on this subject.

Other Speer Products for the Electronics Industry

R. F. coils • chokes • fixed composition capacitors • Speer PAC made by Jeffers Electronics. • Also electronic tube anodes • contacts • rocket and missile parts • brushes • battery carbons • graphite plates and rods and graphite products for the steel and chemical industries.



**SPEER RESISTOR DIVISION**  
**SPEER CARBON COMPANY**  
Bradford, Pennsylvania

- Send the Speer Resistor Catalog.  
 Send Automation Soldering Bulletin.

Name \_\_\_\_\_  
Title \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 343 ON READER-SERVICE CARD

# Why do it Yourself?



## It Pays to Standardize on Jeffers R.F. Choke Coils

You can save time, labor, and money by stocking the wide range of Jeffers R.F. choke coils just as you do resistors, capacitors, and other similar components. You can forget tedious, expensive hand assembly from miscellaneous forms, wires, and coatings by using standardized Jeffers coils, completely assembled for use.

Jeffers coils are well made, using insulated copper wire windings... husky molded jackets. All windings are soldered to leads... shorted end turns are completely eliminated.

Put these advantages to work in your circuits! Jeffers Electronics offers you... ready for delivery... a complete line of R.F. choke coils with a complete range of inductance values. Write today for our specification sheets.

**Other Jeffers Products**  
fixed composition capacitors

**Other Speer Products**  
for the Electronics Industry

anodes • contacts • resistors  
discs • brushes • molded notched\* coil forms  
battery carbon • graphite plates and rods

\*Patented



**JEFFERS ELECTRONICS**  
DIVISION  
**SPEER CARBON COMPANY**  
Du Bois, Pennsylvania

**Other Speer Divisions:**  
Speer Resistor, Speer Carbon Products,  
International Graphite & Electrode

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## Slip Rings

Custom molded



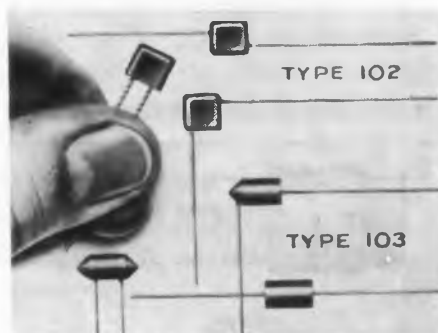
Precision molded from a combination of precious metal alloys and Plaskon Alkyd, these miniature slip rings are spotwelded to the leads to assure permanent, noise free connections. Concentricity is held to 0.002 in. T.I.R. or better.

Electro Development Co., Dept. ED, 14701 Keswick St., Van Nuys, Calif.

CIRCLE 345 ON READER-SERVICE CARD

## Wirewound Resistors

Miniature



Wirewound resistors in this miniature line can be obtained in values from 1 ohm to 1 megohm to tolerances of  $\pm 0.05$  per cent. Standard temperature coefficient is  $\pm 15$  ppm, and power dissipation is 0.15 w.

Ultronix, Inc., Dept. ED, 116 S. Bayshore Blvd., San Mateo, Calif.

CIRCLE 346 ON READER-SERVICE CARD

## Relay

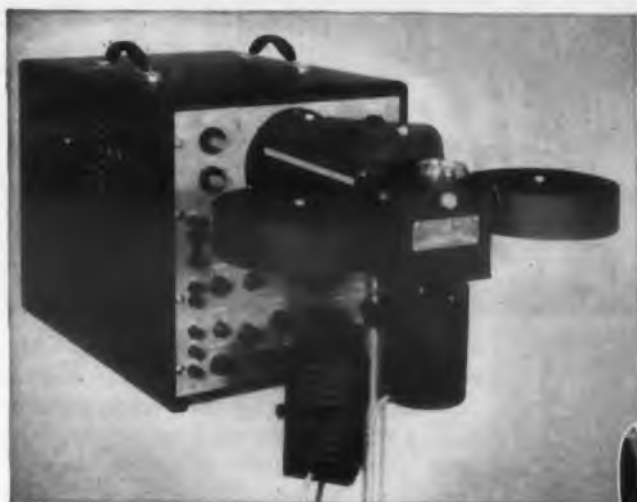
Operates from  $-65$  to  $+125$  C

Model R-9800 sensitive 5 amp dc relay operates from  $-65$  to  $+125$  C. Switch contact: 5 amp resistive load, 3 amp inductive load. Coil sensitivity is from 1 w to 40 mw with coil resistance up to 25,000 ohms. The unit withstands 30 g up to 3000 cps at the pick-up voltage. Life is 100,000 operations (minimum), 50,000 operations at  $+125$  C with 60 mw coil sensitivity.

Hi-Spec Electronics Corp., Dept. ED, 7328 Ethel Ave., North Hollywood, Calif.

CIRCLE 347 ON READER-SERVICE CARD

for versatile 'scope recording...  
**SINGLE FRAME OR MOVING FILM**  
 ... 1/2" TO 12,000" PER MINUTE



- f:1.5 camera, to 1/100 sec.
- adequate film magazine
- universal mounting tripod
- continuously variable motor speed control

ONLY \$985

f.o.b. Phila.

*only one of its kind...*  
**ETC MODEL SM-100**

Accurate records are yours with this sensational, new ETC recording camera. Look at the range. Where else can you find such versatility? Or use the binocular viewer which allows continuous viewing in subdued light during the recording progress.

The ETC Model SM-100 recording camera is designed primarily for use with 5" oscilloscopes, can be mounted either in horizontal or vertical position, with provision also for use with larger, sloping-face console-type 'scopes.

This camera is typical of the pioneering development of ETC in its broad line of industrial and military electronic devices, as well as single- and multi-gun cathode ray tubes.

No matter how complicated your research or testing problem, if it involves electronics, bring it to ETC.

**Headquarters for Multi-Channel Scopes and Multi-Gun CR Tubes**

ETC produces a complete line of standard and special 2- to 8-channel oscilloscopes; power amplifiers; and multi-gun cathode ray tubes with from 2 to 10 guns operating on a single tube face.



Write for complete ETC catalog



SM-100 Camera mounted on 5" ETC oscilloscope. Inset shows tripod mounting and speed control.

**F E A T U R E S :**

- Wollensack f:1.5, 50 mm. coated lens.
- Shutter speeds 1 to 1/100 sec.
- Diaphragm f:1.5 to f:8.
- Object to image ratio 4.5:1.
- Miniature glow lamp provides timing marks on edge of film.
- Lamp excited at line frequency using pulse shaping circuit.
- Connections available for external marker timing pulses.
- Film magazines individually removable.
- Built-in light traps.
- Solenoid actuated drive with magnetic break in supply magazine; reduces film waste.
- 1/15 hp. motor with variac speed control; no warmup time needed.
- Direct reading tachometer in in./min.
- 115V., 50-60 cycles.
- 35 mm. film or paper (perforated or unperforated).
- 400 ft. film capacity (1,000 ft. supply slightly extra).
- Weighs 35 lbs.

**electronic tube corporation**

1200 E. MERMAID LANE

PHILADELPHIA 18, PENNA.

CIRCLE 348 ON READER-SERVICE CARD

# AN UNPRECEDENTED EXPERIMENTAL OFFER!

A standard DC  
100-microampere

## METER-RELAY

at virtually **HALF PRICE!**

Limit is 2  
We pay the freight!  
Immediate air delivery

**\$27.50** each  
Standard Price  
\$53.50



• Every engineer who needs or wants our versatile, most-used, No. 461-C locking-contact Meter-Relay for use or experiment ...but never ordered because of price or wait...can now order at half-price and get immediate delivery by return air mail!

D'Arsonval might say:

"Formidable!  
Incroyable!  
Épatant!"



**Translation:**

- "It is a matter of great amazement to me that Assembly Products can manufacture such a superb version of my sensitive electric meter ...then add the ingenious adjustable contact within the meter
- ...then insure the concise, reliable contact action for 10 to 20 million cycles by means of the unusual locking-unlocking coil
- ...then develop the refinements which make this magnificent device capable of indicating and controlling an infinite variety of electrical, physical and mechanical actions
- ...then build a substantial business by direct sales to the user at most reasonable prices
- ...enjoy unqualified success
- ...AND THEN MAKE THIS UNUSUAL OFFER!"
- "Could I write, I would."

**AT THE WESCON SHOW AND AT  
THE PHILADELPHIA ISA SHOW**

Sold over our counter  
at the same \$27.50!

**OFFER ENDS OCTOBER 1, 1958 (Order postmark date)**

**ALSO REQUEST FREE CATALOG OF COMPLETE METER-RELAY LINE**



**Assembly  
Products**

Phone: HAmilton 3-4436  
HAmilton 3-4446

75 Wilson Mills Road, Chesterland, Ohio

## NEW PRODUCTS

### Magnetic Servo Amplifier

Reversible output



The type III magnetic servo amplifier features rugged construction and encapsulated windings. The half-wave, reversible output amplifier will drive a variety of standard low-impedance, 2-phase servo motors delivering up to 10 w mechanical output.

Reflectone Corp., Dept. ED, Stamford, Conn.

CIRCLE 350 ON READER-SERVICE CARD

### Wafer Bearings

Variety of shaft and housing diameters

Microwafer bearings, narrower than standard, come in bore diameters from 0.0937 to 0.1875 in. housing diameters from 0.2500 to 0.4375 in. Of 440 C stainless steel, they have tolerances of ABEC 7 or better.

New Hampshire Ball Bearings, Inc., Dept. ED, Peterborough, N.H.

CIRCLE 351 ON READER-SERVICE CARD

### Relay

Provides 3pdt switching

Model KM miniature armature type relay occupies about 0.5 cu in. and can operate on 750 mw. With arrangements up to 3pdt, the dc operated unit switches up to 2 amp at 115 v 60 cps resistive loads.

Potter & Brumfield, Inc., Dept. ED, Princeton, Ind.

CIRCLE 352 ON READER-SERVICE CARD

**Conformity to specifications on**  
**precious metal plating**

**AUTOMATIC** equipment with automatic controls makes it possible for Spectronic to provide tighter conformity to specifications. For example, our new Automatic Rack Plater insures uniform plating thickness throughout any piece.

**IF YOU HAVE UNIQUE PROBLEMS CONCERNING THE PRECIOUS METAL PLATING OF A PRODUCT OR COMPONENT, CONTACT SPECTRONIC.**

## SPECTRONIC PLATING CO., INC.

652 Hudson Street, New York 14, New York

CIRCLE 353 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

## Frequency Converter

Input adjustable from 300  
to 900 cps

Transistorized converter for ac and dc power supplies. Full scale input is adjustable from 300 to 900 cps with a minimum frequency of 10 cps. Output is 0 to 5 v dc into a 500 K load; 0 to 100 mv dc into a 10 K load; or 0 to 50 mv dc into a 5 K load.

Fischer & Porter Co., Dept. ED,  
752 Jacksonville Rd., Hatboro, Pa.

CIRCLE 354 ON READER-SERVICE CARD

## Photoelectric Transducer

Pin-point sized

Pin-point sized photo-electric transducer with up to 50 individual outputs per linear inch. For use in reading control signals from tape, digital computation, and evaluating optically measurable quantities.

Waldorf Instrument Co., Dept.  
ED, Huntington Station, N.Y.

CIRCLE 355 ON READER-SERVICE CARD

## Strip Chart Recorder

Provides 1 per cent limit of error

The G-11A strip chart recorder is a small, null-balance potentiometer type. It provides 1 per cent limit of error and 1 sec full-scale balancing time with span adjustable from 9 to 100 mv.

Varian Associates, Dept. ED, 611  
Hansen Way, Palo Alto, Calif.

CIRCLE 356 ON READER-SERVICE CARD

## Toroidal Signal Transformers

For low-level applications

Series 791 miniature toroidal signal transformers are for low-level applications where high impedance, low phase shift, and minimum pickup are required. They can be used with input voltages of 0.5 mv.

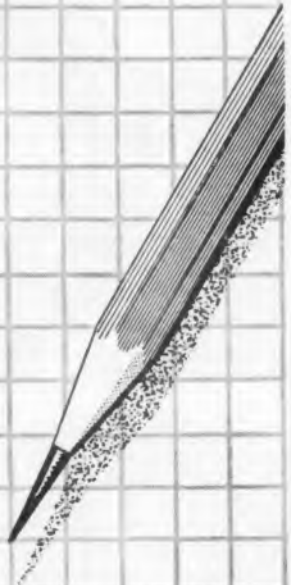
Arnold Magnetics Corp., Dept.  
ED, 4613 W. Jefferson Blvd., Los  
Angeles 16, Calif.

CIRCLE 357 ON READER-SERVICE CARD

*Stop  
transistor  
burnout!*



Model 66 Voltage Limiter



Use your power supply as usual. Set the Voltage Limiter control to any value between 0 and 50 volts. If the pre-set voltage is exceeded, the Voltage Limiter instantaneously clamps the d-c voltage and turns off your power supply. For use with power supplies up to 3 ampere rating. Request Specification Sheet VL 66.

**ELECTRONIC MEASUREMENTS CO., INC.**

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**TOBE**  
CREATIVE  
ENGINEERING

**THE NRG-200  
SERIES OF  
LOW-INDUCTANCE  
THERMONUCLEAR  
ENERGY-STORAGE  
CAPACITORS**



NRG-200 SERIES SPECIFICATIONS				
Type No.	Watt Seconds	Rating		Self Inductance (Microhenries)
		Mfd.	DC Peak	
NRG-201	1000	5.0	20 KV	.04
NRG-202	1500	7.5	20 KV	.045
NRG-203	2000	10.0	20 KV	.055
NRG-204	3000	15.0	20 KV	.06

Tobe now announces the availability of a series of reliable, low-cost energy-storage capacitors for thermonuclear equipment and similar applications. The NRG-200 series capacitors have a minimum life expectancy of 1000 operations, and may be operated at ambient temperatures up to 40°C. Maximum permissible reversal voltage is 90%. They can be discharged into a very low-impedance load with complete safety.

For further technical information or engineering aid, write Tobe Deutschmann Corporation, Norwood, Mass.

**Specify**



TOBE DEUTSCHMANN • CAPACITOR PIONEERS SINCE 1929

Visit us at WESCON Show Booth 1604-5.

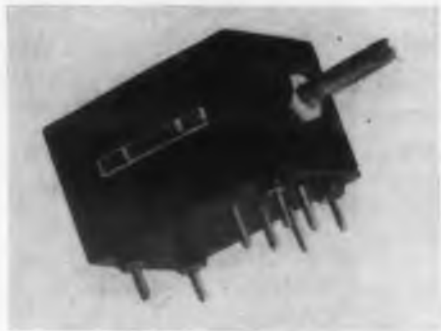
CIRCLE 359 ON READER-SERVICE CARD



## NEW PRODUCTS

### Tuneable Transformers

Encapsulated units for printed circuits



This series of sealed miniature tuneable transformers and reactors for printed circuit use meets MIL-T-27A, Class R, Grade 2 or 3, and may be provided with electrostatic shielding. Construction is available with 2 to 8 functional terminals.

Coil Winders, Inc., Dept. ED, New York Ave., Westbury, N.Y.

CIRCLE 360 ON READER-SERVICE CARD

### Tape Transport System

Fully transistorized

Model 424 transistorized tape transport system has start-stop times under 2 msec, permits tape speeds from 7.5 to 160 ips in both directions. Tape widths from 1/4 to 2 in.; storage bins for 3000 in. of tape.

D. G. C. Hare Co., Dept. ED, 30 Burtis Ave., New Canaan, Conn.

CIRCLE 361 ON READER-SERVICE CARD

### Transistorized Power Supply

Provides 28 v dc, 0 to 5 amp

This transistorized, precision-regulated power supply provides 28 v dc, 0 to 5 amp. Voltage regulation is 0.1 per cent from no load to full load with  $\pm 10$  per cent change in input. Ripple is 0.1 per cent to peak.

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

CIRCLE 362 ON READER-SERVICE CARD

## For extra reliability



-- under  
severest  
operating  
conditions!



A complete range  
25 to 1000 watts

Designed for complete reliability in military and commercial service. Hardwick Hindle "Gray Line" Rheostats provide smooth long-life action with positive electrical contact. Super-rugged construction insures maximum shock resistance; resistance element is ceramic-protected. High temperature enamel bonding withstands greater overload; call or write for catalog.

# H·H "Gray Line" RHEOSTATS



Type H "Gray Line" Rheostats comply with MIL-R-22 Specifications

The Mark  
of Quality  
since 1924



## HARDWICK HINDLE • INC

40 Hermon Street, Newark 5, New Jersey, U.S.A.

SOLD THRU AUTHORIZED DISTRIBUTORS COAST-TO-COAST!

CIRCLE 363 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

## Stretch Cable

### Silicone

Silicone stretch cable extends 200 per cent and retracts to its original size. The wire has a temperature range of  $-150$  to  $+375$  F, dielectric strength of 550 v per mil, and tensile strength of 1500 psi.

Stretch Wire Corp., Dept. ED, P.O. Box 893, New Rochelle, N.Y.

CIRCLE 364 ON READER-SERVICE CARD

## Printed Circuit Holder

### Adjustable



These adjustable combination chassis and work positioners are for

holding printed circuits during assembly of component parts. Boards can be positioned in any plane of a half sphere and instantly locked there.

Wilton Tool Mfg. Co., Inc., Dept. ED, Schiller Park, Ill.

CIRCLE 365 ON READER-SERVICE CARD

## Ferrite Memory Core

### Offers square B-H hysteresis loop

Type IR880 ferrite memory core offers a square B-H hysteresis loop, making it useful for fast switching memory matrices in digital computers. Core magnetic properties are designed for use with driving currents of about 820 ma. Output for a single turn is above 120 mv. OD is 0.08 in.  $\pm 0.003$  in., ID is 0.05 in.  $\pm 0.003$  in., and thickness is 0.025 in.  $\pm 0.003$  in.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

CIRCLE 366 ON READER-SERVICE CARD

# $\frac{1}{3}$ the size .. $\frac{1}{2}$ the cost!

## Metronix

### ELECTRONIC VOLTMETERS Panel-mounted, single and multi-range

FROM  $\frac{1}{3}$  to  $\frac{1}{6}$  smaller than conventional units, these METRONIX instruments occupy no more panel space than the meter.

METRONIX AC and DC models are the smallest available with such a wide choice of ranges. Single-range, military, rack-mounted and plug-in types.

Ask for Bulletin M-602

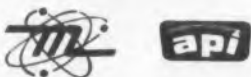
#### MODEL 300 D. C. (illustrated)

RANGES: 0-1/3/10/30/100/300/1000 volts D. C.

ACCURACY:  $\pm 3\%$ , full scale deflection

INPUT RESISTANCE: 10 megohms

PRICE: \$94.50



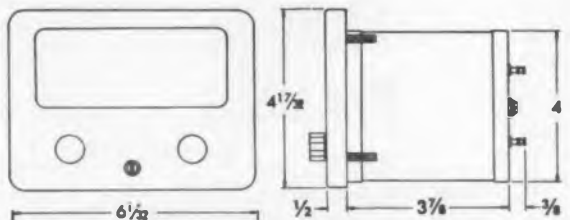
## Metronix INC

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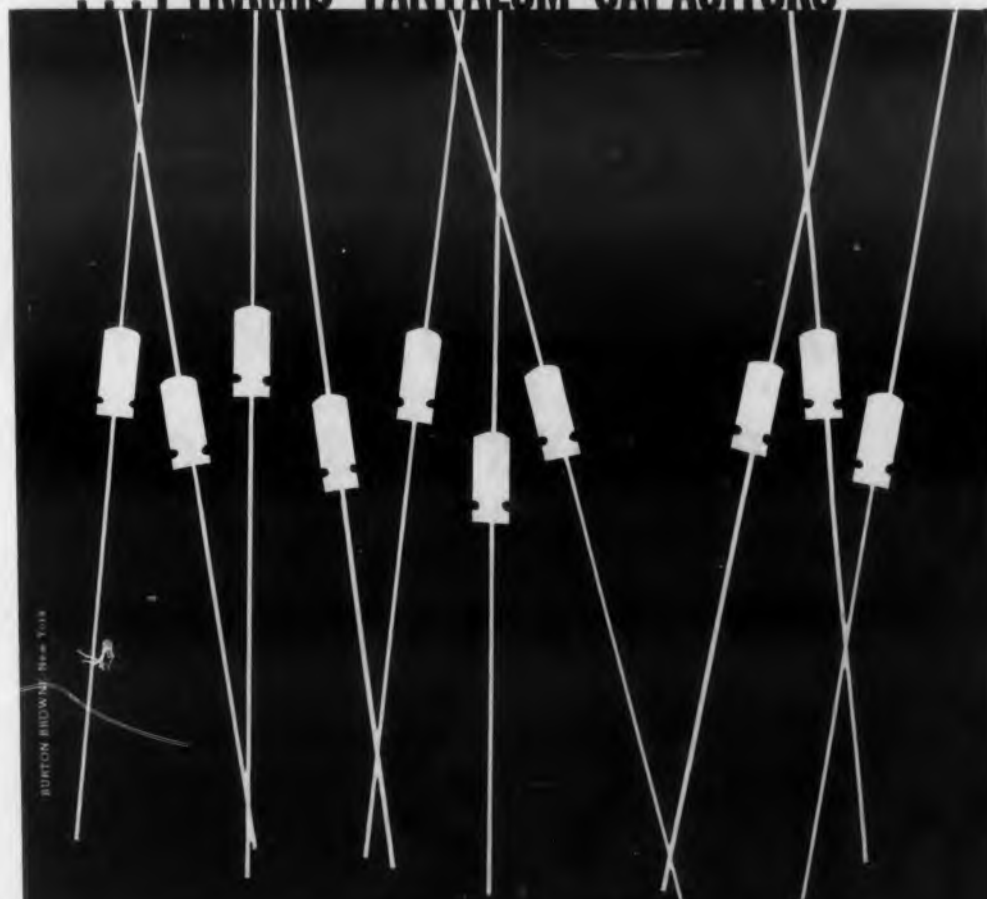
Chesterland 17, Ohio

CIRCLE 367 ON READER-SERVICE CARD



# UP TO 1000 MFD-VOLTS IN LESS THAN 2/100 OF A CUBIC INCH

## ... PYRAMID TANTALUM CAPACITORS



Pyramid Tantalum slug capacitors are miniaturized to provide maximum space economy.

New Pyramid Tantalum slug capacitors have cylindrical cases and contain a non-corrosive electrolyte. Due to the special construction of materials used in the manufacture of Pyramid Tantalum slug capacitors, these units are both seep and vibration proof. In addition, this type of capacitor assures long service life and corrosion resistance — made to meet MIL-C-3965 Specifications.

Commercially available immediately, these new Pyramid Tantalum capacitor units have an operating range between  $-55^{\circ}\text{C}$  to  $100^{\circ}\text{C}$  for most units without any de-rating at the higher temperature.

To obtain complete engineering data and prices for Pyramid Tantalum slug capacitors, write to: Pyramid Research and Development Dept., Pyramid Electric Company, 1445 Hudson Boulevard, North Bergen, New Jersey.

CAPACITORS — RECTIFIERS  
FOR ORIGINAL EQUIPMENT —  
FOR REPLACEMENT

**PYRAMID**  
ELECTRIC COMPANY

NORTH BERGEN, N. J.



## *Progress in the Science of Chronometry*



IN 1714, the British government offered a prize of £20,000 for any means of determining a ship's longitude within 30 nautical miles at the end of a six week's voyage. John Harrison, a self-educated Yorkshire carpenter, won the prize in 1760 with an accurate clock.



IN 1958, ICBMs and earth satellites created the need for new concepts in accurate timing. To fill this need, Hycon Eastern has developed an electronic Timing System with heretofore unattainable timing precision capable of operating anywhere in the world.

## **AN INTEGRATED TIMING SYSTEM FOR TODAY'S GLOBAL CONCEPTS**



WESCON SHOW  
BOOTH NOS. 1565, 1566

Solar or sidereal time is displayed visually and is available for input to automatic computers and indexing data with many types of recorders . . . magnetic tape, oscillograms, photographs and strip charts. Furnishing a time scale with resolutions available to one microsecond, this system is ideally suited for tracking and control of missiles, astronomical measurements, and navigation systems. Write for Bulletin TS-00.



# **HYCON EASTERN, INC.**

75 Cambridge Parkway

Dept. F

Cambridge 42, Massachusetts

CIRCLE 369 ON READER-SERVICE CARD

## NEW PRODUCTS

### Shut-Off Valves

Operate in ambient temperatures of 450 F

Fabrilite series of in-line shut-off valves to control the flow of hot, cold, or mixed air through jet plane ducts. Lighter and smaller than similar types, they operate at duct temperatures from -65 to +850 F against pressures from 5 to 225 psi, and in ambient temperatures of 450 F.

Vapor Heating Corp., Vap-Air Div., Dept. ED, 6644 W. Howard St., Chicago 31, Ill.

CIRCLE 370 ON READER-SERVICE CARD

### Precision Attenuator

Frequency range of dc to 3000 mc

A 10-position turret precision attenuator which features pull-turn-push detent action. Frequency range of dc to 3000 mc on all values to 50 db, and dc to 1000 mc on val-

ues 51 db to 60 db. Any combination of values to 60 db, including fractional values, is available.

Stoddart Aircraft Radio Co., Inc., Dept. ED, 6644 Santa Monica Blvd., Hollywood 38, Calif.

CIRCLE 371 ON READER-SERVICE CARD

### Tantalum Capacitors

6 to 75 v range

Small sintered-anode tantalum electrolytic capacitors with low leakage currents and power factors. Temperature range is -55 to +85 C. Voltage range is from 6 to 75 v. Capacities are from 3.5 to 325  $\mu$ f.

International Telephone and Telegraph Corp., Dept. ED, 100 Kingsland Rd., Clifton, N.J.

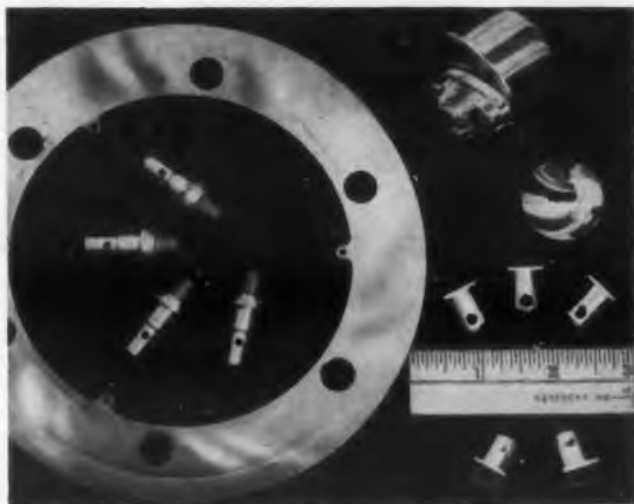
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### Miniature Relay

For printed circuit use

The dpdt Type GS dc relay is an improved version of the G-200. For printed circuit and other use, the

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BART specializes in plating to heavy industrial thicknesses with every type of precious metal. Backed by 44 years of experience and equipped with large modern facilities augmented by one of the most extensive engineering and research organizations in the electroplating field. Bart Manufacturing Corporation can provide an unequalled plating service.

Contact BART today regarding your present precious metal plating problems or future requirements.

**GOLD PLATING:** Specification plating up to .001 inch with conventional or bright gold over complete surface or on specified areas. Heavier deposits on critical areas can be deposited by use of BART-developed techniques. Piece parts up to 6'0" long can be processed. Complete barrel facilities available for small parts.

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ELECTROFORMING • PIPE LINING & COATING • PLATERS  
CHEMICAL PUMPS • ENGINEERING DESIGN SERVICES  
227 Main St., Dept. E, Belleville 9, New Jersey

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ELECTRONIC DESIGN • August 6, 1958

unit has a coil resistance of 600 ohms for 26.5 v dc circuits. Ambient temperature range is -65 to +125 C. Contact rating is 3 amp resistive load at 28 v dc or 115 v ac for 100,000 operations; 2 amp resistive load at the same voltages for 500,000 operations.

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

CIRCLE 374 ON READER-SERVICE CARD

## Shaft Angle Indicator

For telemetering

In the Optisyn shaft angle indicator, the shaft rotation input yields two output wave forms which contain all information needed to measure total shaft angle. Two photo diodes are used in a current push-pull mode for each electrical wave form. With the Optisyn, a shaft position can be telemetered by transmitting two binary wave forms.

Dynamics Research Corp., Dept. ED, 44 Winn St., Woburn, Mass.

CIRCLE 375 ON READER-SERVICE CARD

## Oscilloscope

Has identical X and Y amplifiers

The K-11-R rack-mounted general purpose oscilloscope has identical horizontal and vertical amplifiers and a rectangular crt. The two amplifiers cover a bandwidth from dc to 300 kc with sensitivity from 1 mv per cm to 150 v per cm.

Electronic Tube Corp., Dept. ED, 1200 E. Mermaid Lane, Philadelphia 18, Pa.

CIRCLE 376 ON READER-SERVICE CARD

## Tape Wound Cores

High saturation flux density

Tape-wound cores of Supermendur, a rectangular-loop material in the range of induction from 16 to 22 kilogausses which permits weight and size reduction. An oriented cobalt-iron-vanadium alloy, Supermendur combines high saturation flux density with hysteresis loop rectangularity.

Arnold Engineering Co., Dept. ED, Marengo, Ill.

CIRCLE 465 ON READER-SERVICE CARD

The surest name\* in

## GUN MOUNTS!

- 1 — New 110° deflection gun
- 2 — Electrostatic focus gun
- 3 — Electromagnetic gun
- 4 — Electrostatic deflection gun
- 5 — Special purpose gun
- 6 — New short neck 90° gun



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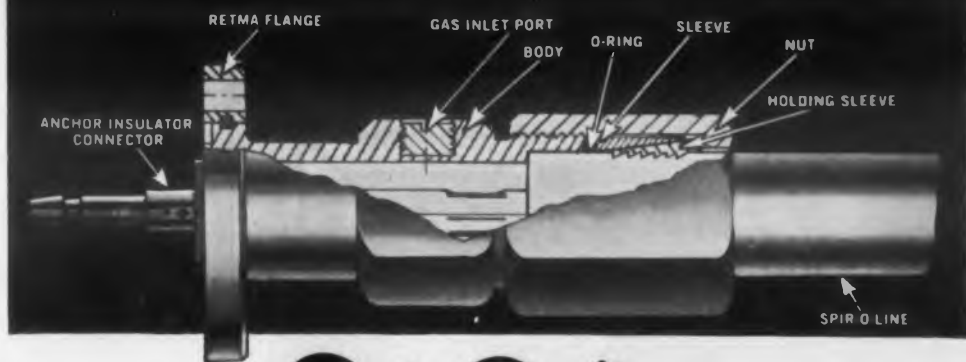
212 PIAGET AVE., CLIFTON, N. J.

CIRCLE 377 ON READER-SERVICE CARD

Prodelin Pioneers an *All-American!*

# Spir-O-lok<sup>®</sup>

## CONNECTORS



AND *Spir-O-line*<sup>®</sup> FOR

## Transmission Line Assembly with 90% Less Work • Consistent, Low VSWR

Here's Prodelin's revolutionary design approach to coaxial transmission line connectors . . . *Spir-O-lok!* Its unique construction makes assembly with the Prodelin combination many times faster than with any other line and connector assembly in the industry . . . while providing consistently reliable VSWR.

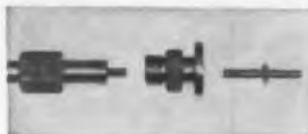
See how easy a *Spir-O-lok* installation is:



**CUT** — With a common tubing cutter, cut the outer conductor of the *Spir-O-line*. Remove. The soft aluminum tubing cuts cleanly and easily.



**TRIM** — With an ordinary jack knife, trim the six dielectric tubes flush to the outer conductor. This is Prodelin's unique construction that simplifies connector assembly while affording best broadband performance, highest power handling, lowest attenuation and VSWR. The 6 tubes keep the *Spir-O-line* inner conductor perfectly centered on bends.



**ASSEMBLE** — So simple, one man can do it in a few minutes. Slide the nut assembly on cable, hold body while tightening nut with wrench. This forms a pressure-tight joint that cannot distort outer aluminum sheath. The connection can be re-made repeatedly without redressing cable or affecting VSWR. Insert inner conductor connector.  
**MATE WITH ANY EIA (RETMA) OR MILITARY SPEC CONNECTORS**



**ELIMINATE TERMINAL CONNECTOR;  
SIMPLIFY CONNECTION PROCEDURE**

Incorporate *Spir-O-lok* in original design of equipment panel or bulkhead to save time, trouble and expense later.



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WITH THE GUARDIAN  
ON-OFF  
LATCHING RELAY**



SERIES 610 LATCHING RELAY

Design Engineers are highly enthusiastic about the positive impulse control performance of this ON-OFF Latching Relay by Guardian. It is ideally suited to positioning devices, T-V remote controls, appliances, lighting controls and applications requiring positive ON-OFF impulse control. Special armature toggle spring reverses position of cam actuator either to open, close, or transfer the snap-action switch. Unit utilizes power only on impulse or coil energization. Replaces costlier ratchet relays, conserves power, saves space, cuts costs, increases the salability of your product.

Thousands of Variations  
in Guardian's Complete Stepper Line



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write for details on Guardian's ON-OFF Relay  
and for Stepper Bulletin P-84

**GUARDIAN ELECTRIC**  
1622-J W. WALNUT STREET CHICAGO 12, ILLINOIS  
CIRCLE 379 ON READER-SERVICE CARD

**NEW PRODUCTS**

**Cooling Unit**  
Capacity to 30 tons



The model 1204 air conditioning unit has a capacity of 30 tons for cooling large electronic computers. To insure continuous operation, six separate identical refrigeration systems are used. Ellis and Watts Products, Inc., Dept. ED, Cincinnati 36, Ohio.

CIRCLE 380 ON READER-SERVICE CARD

**Strain Gauge Amplifiers**

Provide 0 to 5 v dc output



Models CA3 and CA5 strain gauge carrier amplifiers operate from a 28-v dc supply and provide an output of 0 to 5 v dc exactly proportional to the quantity being measured. Frequency response is virtually linear up to 2000 cps, and the unit provides infinite resolution. Transistorized throughout, the amplifiers sustain vibration up to 35 g in any axis as high as 2000 cps without change in response or accuracy. Operating temperature range is -65 to +165 F.

Statham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

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**A MEMO from ERIE**

*Now in stock at your  
Authorized  
Erie Corning Distributor  
for IMMEDIATE delivery*



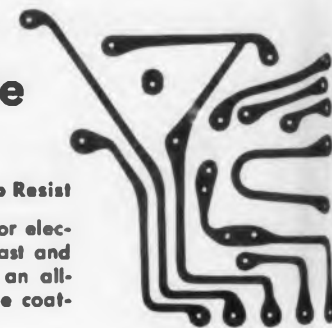
**CORNING TYPE S-20 RESISTORS**  
(1/2 watt—120°C)  
MIL-R-11804 B Specifications  
for Reliable, Stable, Accurate  
Operation up to 120°C.

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**How KPR\*  
helps you make  
etched circuits**



\*Kodak Photo Resist

If you manufacture etched circuits for electronic equipment, you'll like KPR. Fast and easy to use, stable, durable, it is an all-plastic, pre-sensitized, liquid surface coating. Here's how it works...

- (1) Clean metal thoroughly; a power brush saves time here.
- (2) Easiest way to get rid of oxides after scrubbing is with acid rinse.
- (3) Then, coating is easy with KPR. You can spray, dip, or use a whirler. KPR is so stable you can coat plates months in advance, without affecting exposure times.
- (4) Exposure times are short on any metal. Use arc lights, or ultraviolet. Your exposure time stays constant, even through atmospheric changes, protects you against makeovers.
- (5) Rapid, continuous processing can be done in vapor-spray degreaser for economy on large runs—in tanks or trays on shorter runs.
- (6) Use standard copper etching techniques with ferric chloride. KPR protects panel surface image during fabrication, then strips off clean when panel is "skated" on tin-lead solder, leaving excellent solder joints.

There's full information in a new booklet titled "Industrial Uses of Kodak Photo Resist"—yours free for the asking.

No statement or suggestion in this advertisement is to be considered a recommendation or inducement of any use, manufacture, or sale that may infringe any patents now or hereafter in existence.

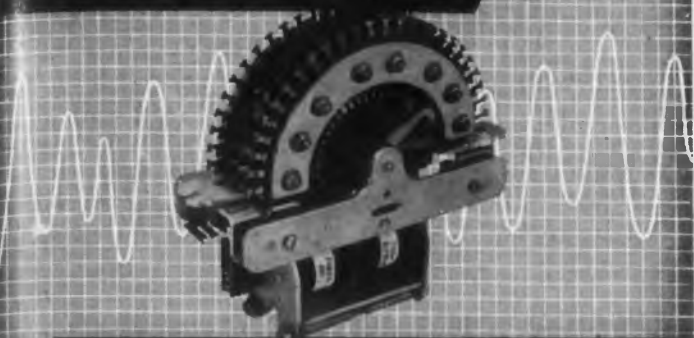
**EASTMAN KODAK COMPANY**  
Rochester 4, N. Y.

Kodak

CIRCLE 383 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • August 6, 1958



## INVESTIGATE the Genalex Two-Way Stepping Switch



**THE ONLY ONE OF ITS KIND!**  
10 MILLION STEPS IN BOTH DIRECTIONS

For: Selection Sequence Control — Counting (including Subtraction) — Totalizing — Pulsing — Step-by-Step Servo Drive.

Self-Cycling or Remote Control Operation. Bridging or Non-Bridging Wipers, or any Combination. Sturdy, compact construction.

Get complete data and price information now on the unique GENALEX Two-Way Stepping Switch — AND the companion 100 Million Step GENALEX One-Way Stepping Switch! Write today, to:

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71 University Rd., Cambridge 38, Mass.

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## Count on SYSTRON RDB COUNTER with in-line readout



### MEASURES

- ★ RDB Channels 1-18
- ★ RPM
- ★ Mass Flow Rate
- ★ Frequencies
- ★ 1 to 100,000 Periods

FREQUENCY RANGE . . . 5 CPS to 100 KC  
ACCURACY . . . ± 1 count, ± 1 part in 10<sup>5</sup>  
READOUT . . . . . Nixie, to 99,999  
SENSITIVITY . . . . . 5 Millivolts rms  
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RDB . . . . . 1/5 second  
CPS . . . . . 1 & 10 seconds  
RATE . . . . . Selectable 0.1ms increments  
to 10 secs.  
PERIOD 1 to 100,000 cycles of input

PRICE . . . . . \$1,550

F.O.B. Concord

**SYSTRON**  
CORPORATION

50 GALINDO STREET CONCORD, CALIFORNIA  
REPRESENTATIVES IN PRINCIPAL CITIES

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ELECTRONIC DESIGN • August 6, 1958

## Precision Resistors

Use alloy grid resistance element

These hermetically sealed, precision resistors use a specially designed metal alloy grid resistance element. Available in three types: CAH, 0.25 w; EAH, 0.5 w; and GAH, 1 w, with full ratings at 100 C ambient temperatures. Standard resistance tolerances are 0.1, 0.25, 0.5, and 1 per cent. Units exceed Mil specs for wire wound and metal film type precision resistors in all tests.

Allen-Bradley Co., Dept. ED, 136 W. Greenfield Ave., Milwaukee 4, Wisc.

CIRCLE 386 ON READER-SERVICE CARD

## Radar Simulator

Maintains signal-to-noise ratio within 1 db

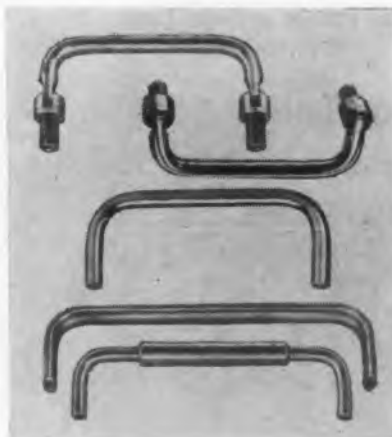
This simulator supplies radar video simulating that of a search type radar. The unit simulates the effects of antenna radiation pattern, target scintillation, and receiver thermal noise with mathematical validity. The signal-to-noise ratio of the simulated target can be adjusted and maintained within 1 db. Output amplitude covers 0 to 5 v range into a 100 ohm load.

Federal Scientific Corp., Dept. ED, 615 W. 131st St., New York 27, N.Y.

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(Advertisement)

## These Handles Give A Lifetime of Service



CAMBION® handles are made to last — carefully manufactured from stainless steel, brass, or aluminum, they are finished with nickel plate highly polished to a "jeweler's finish," black oxide, or black alumilite.

Available in folding, adjustable, and rigid models, in a wide variety of sizes with many special features, Cambion handles meet every specification requirement.

Newest additions are two folding handles with standing heights of 1<sup>13</sup>/<sub>16</sub>". The X2062, a handle series designed for pulling purposes, stands perpendicular to the panel or folds flat against it in either direction. The 1900, designed specifically for lifting, stands perpendicular to the panel or can be folded flat against it in one direction.

Other handles illustrated are X1884, with a standing height of 1<sup>7</sup>/<sub>8</sub>", (1965 with a standing height of 1<sup>3</sup>/<sub>4</sub>"), 2111-D with a standing height of 1<sup>9</sup>/<sub>32</sub>", and X2066 standing 1<sup>9</sup>/<sub>32</sub>". For further information write to Cambridge Thermionic Corporation, 457 Concord Avenue, Cambridge 38, Massachusetts.

CIRCLE 383 ON READER-SERVICE CARD



## New 100- and 150-watt sizes incorporate latest design improvements

Naturally, they give you the same outstanding, proved design features you get in 25-, 50-, and 300-watt sizes. Exclusive "twin-contact" shoes insure uniform contact resistance, extra-smooth resistance change. Sintered, self-lubricating contacts can't gall or seize, insure long, stable operating life.

Ward Leonard Vitrohm vitreous enamel permanently bonds base and core, firmly secures the high-stability resistance wire. Base and core are of high-density, low-porosity molded ceramic of high dielectric strength.

A new ceramic hub design substantially eliminates backlash and makes it easier for you to get fast delivery on special shaft requirements.

For complete data, write for Ward Leonard Bulletin 60RR. Ward Leonard Electric Company, 77 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada, Ltd., Toronto.)

### ENGINEERING DATA

Type	Rating*	Ring Diameter	Max. Depth behind panel	Resistance Range (Stock Values)	Rotational Travel
100R	100 Watts	3 5/32"	1 1/2"	1 to 10,000 ohms	300°
150R	150 Watts	4"	1 3/4"	1 to 10,000 ohms	314°

\*—Ratings based on a 300°C rise in a 40°C ambient.

**Contact Shoe:** "Twin" metal graphite, equipped with integral copper leaf conductor ribbon riveted to the control arm.

**Contact Arm:** Balanced beryllium copper, locked directly to insulating hub.

**Base and Core:** High-grade ceramic of high dielectric strength with toroidally wound wire or ribbon of highest stability.

**Max. Voltage Spacings:** 300 volts in accordance with Underwriters' Laboratories Requirements.

LIVE BETTER...Electrically

WARD LEONARD ELECTRIC CO.

Result-Engineered Controls Since 1892

RESISTORS • RHEOSTATS • RELAYS • CONTROLS • DIMMERS

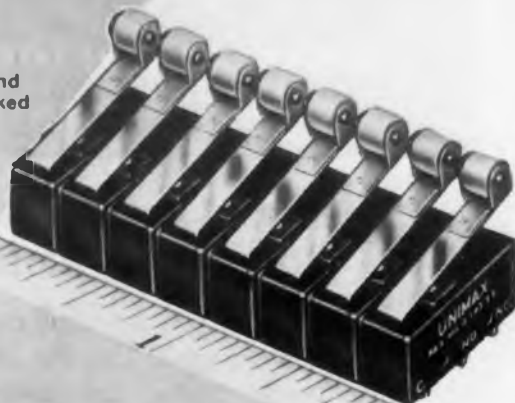


CIRCLE 389 ON READER-SERVICE CARD

These subminiature snap-acting switches have  
*a BIG advantage...*

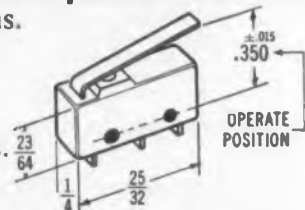
# INTEGRAL ACTUATORS

The leaf or leaf-roller actuator — an integral part of the switch — is pre-adjusted and mechanically locked in the switch assembly during manufacture.



## UNIMAX type USM integral-actuator switch benefits:

- **Saves space** in ganging, no build-up of thickness tolerance: stacking 4 per inch 8 in 2 inches, 12 in three inches, etc.
- **Quickly installed** in miniaturized apparatus or hard-to-get-at places: no auxiliary actuator mechanism to adjust or assemble.
- **High repeatability**, long switch life.
- **Vibration resistant** — integral actuator has no extra parts to shake out of adjustment.
- **Lighter actuating force possible** than with auxiliary mechanisms.
- Leaf and leaf-roller actuator lengths furnished to your requirements.



**ELECTRICAL RATINGS:**  
2½ amp, 30 v. d-c, inductive  
5 amp, 30 volts d-c, resistive,  
5 amperes 125/250 volts a-c.

Write today for information on Unimax subminiature snap-acting integral-actuator switches.



## UNIMAX SWITCH

Division The W. L. Marson Corporation  
IVES ROAD, WALLINGFORD, CONNECTICUT

CIRCLE 390 ON READER-SERVICE CARD

## NEW PRODUCTS

### Power Supply Two ranges



The magnetic and tubeless Model KM-251 delivers an output in the ranges 2 to 8 v, 0 to 30 amp, and 8 to 14 v, 0 to 15 amp. Regulation for line or load is less than  $\pm 1$  per cent. Ripple is less than 0.5 per cent. An additional feature is high conversion efficiency, 75 per cent at full load.

Kepeco Labs, Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 391 ON READER-SERVICE CARD

### PDM Coder

Service-free life of 1000 hours

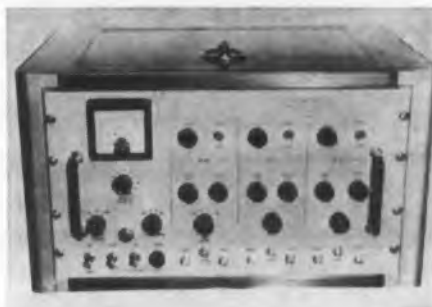
Using two Type 7-501 galvanometers with flat frequency response from 0 to 88 cps, the Type 40-101 Plexicoder has a service-free life of 1000 hr, a commutator life of 2500 hr. The unit provides four operating modes in which the commutation rate equals 112.5 samples per sec.

Consolidated Electrodynamics Corp., Dept. ED, 300 N. Sierra Madre Villa, Pasadena, Calif.

CIRCLE 392 ON READER-SERVICE CARD

### Multiple Radar Target Simulator

Range positioning accuracy of 0.5 per cent



The RP 375 provides a single target, at the true radar range, for two or three nonsynchronous radars. The unit may also be used as a pulse code generator or as a general purpose precision multi-pulse generator. It has a range positioning accuracy of 0.5 per cent of the full scale range, and a range rate accuracy of 0.25 per cent of the selected value.

Remanco, Inc., Dept. ED, 128 Broadway, Santa Monica, Calif.

CIRCLE 393 ON READER-SERVICE CARD



covered by patents

## THIRTEEN BRISTOL HIGH-SPEED RELAYS IN THIS CONVERTER!



Twelve-and-a-half microvolt resolution at 20 readings per second! That's the outstanding feature of the analogue-to-digital converter, developed by Non-Linear Systems, Inc., Del Mar, California, to "digitalize" the output of low-voltage transducers in either ground or airborne service.

It's significant that Non-Linear Systems engineers selected thirteen miniature Bristol Syncroverter\* high-speed relays (inset, top) for use in the converter scanning circuits. This versatile, high-speed, polarized relay has earned an enviable reputation for reliability, long life and immunity to shock and vibration in just such critical low-level, dry-circuit applications.

### Are dry circuits your problem?

If so, we believe we have the answer. Dry-circuit reliability and long life are outstanding features of the Syncroverter high-speed relay. It's unaffected during severe shock and vibration. It has fast pull-in and drop-out and negligible contact resistance, and it operates reliably over a wide temperature range.

### More than 20 models available

You can specify Bristol Syncroverter high-speed relays in an extremely wide variety of operating characteristics and in various case and mounting arrangements. Ask us for complete details. Write: The Bristol Company, 151 Bristol Road, Waterbury 20, Conn.

\*T. M. Reg. U. S. Pat. Off.

## BRISTOL FINE PRECISION INSTRUMENTS FOR OVER 68 YEARS

Come see us in Booth 803 at the Wescon Show.

CIRCLE 394 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958



## NEW Telonic SSX-2 Sweep & Signal Generator

*Offers a Complete Marker System and Provisions for Obtaining Audio and Pulse Modulated CW.*

Telonic's SSX-2 covers the entire low RF and common IF frequencies and simplifies testing of IF and RF amplifiers by combining functions of sweep generator, signal generator, pulsed CW, and marker generator into one extremely accurate, compact and versatile instrument.

### SPECIFICATIONS:

**Sweep Generator:** Tuning: 25 to 75 mc.

**Sweeping:** 0-40%. Leveling: 1-5%.

**Signal Generator:** Tuning: 25 to 75 mc.  
Accuracy:  $\pm .25\%$ .

**Attenuation:** (Sweep and CW) Step to 131 db.  
Vernier: 0-10 db. Output:  $.1 \mu v$  to 1.0 v.

**Variable Marker:** Accuracy  $\pm .25\%$ .  
Calibrations: every 250 kc to 40 mc.  
Every 500 kc to 75 mc.

Up to 6 additional plug-in crystal-controlled markers are available. A birdy-by-pass marker system is provided for exceptional accuracy and stability.

*For complete information write for Technical Bulletin T-206.*

**See the SSX-2 in operation at Booth 1649 WESCON.**

*Telonic*

**INDUSTRIES, Inc.**  
**BEECH GROVE, INDIANA**

CIRCLE 395 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

## Line Terminals

Enables solderless connections



These terminals can be used on both stranded and solid wire and are available in sizes 22 through 16, 16 through 14, and 12 through 10. The design enables solderless connections. They feature small over-all size, wide bell-mouths, and open-end construction.

Buchanan Electrical Products Corp., Dept. ED, Hillside, N.J.

CIRCLE 396 ON READER-SERVICE CARD

## NPN Transistors

For low frequencies

The 2N619, 2N620, 2N621, and 2N622 are npn silicon types. All four types are for low frequency service—the highest has an alpha frequency cutoff rating of about 400 kc. The 2N622 is a low noise type.

Raytheon Mfg. Co., Dept. ED, 55 Chapel St., Newton 58, Mass.

CIRCLE 397 ON READER-SERVICE CARD

## Voltage and Frequency Sensor

Magnetic or transistor amplifier types



The sensors are available in either the magnetic amplifier or transistor amplifier types for monitoring undervoltage, overvoltage, or voltage band, and sensing underfrequency, overfrequency, or frequency band. Nominal voltages range upwards from 18 v ac or dc with accuracy of  $\pm 1$  per cent. Frequencies nominally are 300 cps ac or higher with accuracy of  $\pm 2$  per cent.

Jordan Electronics, Div. of The Victoreen Instrument Co., Dept. ED, 3025 W. Mission Rd., Alhambra, Calif.

CIRCLE 398 ON READER-SERVICE CARD

**High Accuracy  
Mach Information  
in the**

**DC8**



**GIANNINI MODEL 451212  
PRESSURE TRANSDUCER**



**Fast, accurate Mach information** is supplied from two Giannini Model 451212 Pressure Transducers for control purposes in the new Douglas DC-8 jet-liner. This is critically important information for a passenger transport that will operate in the transonic range at 40,000 feet.

The high resistive output of the transducers, which are accurate to within 1% of reading, eliminates the need for a computing servo... *greatly simplifying the instrumentation.*

**SPECIFICATIONS**

- RESOLUTION:** to 2000 wires (0.05%)
- ACCURACY:** Within 1% of reading
- RANGE:** 0-10 to 0-50 psi (absolute, differential, or gage)
- ENVIRONMENTAL:** Meets appropriate MIL-SPECS.

**See Us at WESCON Booth No. 1665 & 1666**

*Giannini measures & controls:*

$\omega$	$\beta$	$\theta$	$\psi$	$\tau$	$\gamma$	$\phi$
$\delta$	$\Omega_r$	$\alpha$	$h$	$P$	$\Delta P$	$T$
$T_s$	$P_s$	$Q_c$	$M$	$T_o$	$P_T$	$TAS$

PRECISION  
INSTRUMENTS  
AND CONTROLS

**Giannini**

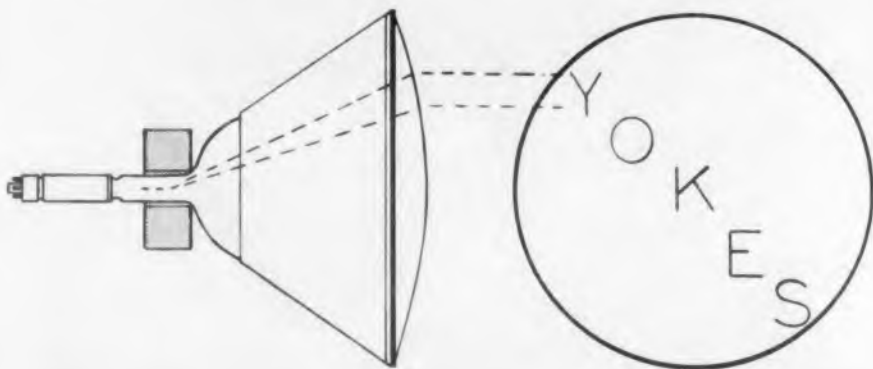
G. M. GIANNINI & CO., INC., 918 EAST GREEN STREET, PASADENA, CALIF.

CIRCLE 399 ON READER-SERVICE CARD

**CELCO** *Specialized*

# YOKES

FOR CHARACTER DISPLAYS



**YEARS AHEAD IN DESIGN PERFORMANCE**

For critical applications, many of our customers have saved years of trial and error in YOKE selection by specifying **Celco YOKES**.

The construction of our yokes makes it possible to achieve **sensitivities, linearities, responses and distortion-free deflecting fields** not possible with the usual types of yoke.

For precision military and commercial displays, Celco also offers standard yokes in  $7/8"$ ,  $1"$ ,  $1\frac{1}{8}"$ ,  $2"$ , &  $2\frac{1}{2}"$  CRT neck diameters.

Write for CELCO DEFLECTION YOKE Catalogue & Design Sheets or for immediate engineering assistance Call your nearest CELCO Plant:

**Celco**



*Constantine Engineering Laboratories Co.*

Mahwah, N. J.  
Davis 7-1123

Miami, Fla.  
Plaza 1-9083

Cucamonga, Calif.  
Yukon 2-2688

CIRCLE 400 ON READER-SERVICE CARD

## NEW PRODUCTS

**MERCURY SWITCH.**—Handles 100 amp current at 115 v, 70 amp at 230 v. Suitable for direct control of motors and generators.

American Designed Components, Inc., Dept. ED, Jericho, N.Y.

CIRCLE 401 ON READER-SERVICE CARD

**SNAP-ACTION SWITCH.**—Minature 5300 series with operating forces from 2 to 20 oz.

Haydon Switch, Inc., Dept. ED, Waterbury 20, Conn.

CIRCLE 402 ON READER-SERVICE CARD

**FERRITE LOAD ISOLATORS.**—X-band. Models with 25, 15, 30, 17, and 12 db isolation.

Rantec Corp., Dept. ED, P.O. Box 18, Calabasas, Calif.

CIRCLE 403 ON READER-SERVICE CARD

**LINE REGULATOR.** — Monitor Model 4.010 detects variations in conditions of voltage, frequency, and phase in power sources.

Electric Regulator Corp., Dept. ED, Pearl St., Norwalk, Conn.

CIRCLE 404 ON READER-SERVICE CARD

**PRESSURE SWITCH.**—Weighs 1 oz, operates from 25 to 1000 psi. Piston type spdt unit rated at 5 amp, 240 v. Alloy Bellows, Inc., Dept. ED, 18125 Roseland Rd., Cleveland 12, Ohio.

CIRCLE 405 ON READER-SERVICE CARD

**CARBON FILM RESISTORS.**—Types 400E and 401E, respectively rated at 1/8 and 1/4 w, are added to deposited-carbon Filmistor line.

Sprague Electric Co., Dept. ED, 347 Marshall St., North Adams, Mass.

CIRCLE 406 ON READER-SERVICE CARD

**SOCKET CAP SCREWS.** — Cold-forged, with chip-free, perfectly formed socket for full gripping area on the hex keys. In sizes 5/8 in. diam.

Set Screw and Mfg. Co., Dept. ED, Bartlett, Ill.

CIRCLE 407 ON READER-SERVICE CARD

**DRAFTING MEDIUM.** — Ageproof Film stands repeated erasures and folding. Impervious to water. Tensile strength is 20,000 psi.

Eugene Dietzgen Co., Dept. ED, 2425 N. Sheffield Ave., Chicago 14, Ill.

CIRCLE 408 ON READER-SERVICE CARD

## What is the TOTAL COST of a plastic part?



First costs often are only part of the total cost of plastic components. Poorly designed or inaccurately produced plastic parts can mean excessive inspection and assembly costs in your plant and a high failure rate, as well. American's *precision production* saves you money by eliminating these hidden cost factors and thus keeping your *total cost per part* to the barest minimum. That is why so many exacting buyers say, "We turn to American *first* for our plastic parts—because they are precision made."

American Plastics is equipped to give you full line service—*injection, compression, extrusion, multiple-shot injection, and low pressure vacuum assisted forming.*

Next time you need plastic parts, try American *first*. Others have for over 50 years! Write or wire Dept. ED.



### AMERICAN PLASTICS CORPORATION

Subsidiary of Hayden Chemical Corporation  
Executive Offices at 342 Madison Avenue  
New York N. Y.

CIRCLE 409 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

**IN-LINE FUSES.**—Vari-Size Fuse-In-Lines allow fuse sizes to be interchanged without tools. They may be spliced into the line close to the source of current or wherever desired.

Signal-Stat Corp., Dept. ED, 523-539 Kent Ave., Brooklyn 11, N. Y.

CIRCLE 410 ON READER-SERVICE CARD

**PHONO JACK.**—No. 8575 may be mounted with single nut and washer.

Richards Electrocraft, Inc., Dept. ED, 4432 N. Kedzie Ave., Chicago, Ill.

CIRCLE 411 ON READER-SERVICE CARD

**RELAY.**—Hi-So dry circuit unit has 10 amp contact rating.

Relay Sales, Dept. ED, P.O. Box 186, West Chicago, Ill.

CIRCLE 412 ON READER-SERVICE CARD

**PACKAGED MERCURY VACUUM SYSTEM.**—Model SEL-3M, capable of ultimate vacuum in the order of  $8 \times 10^{-6}$  mm Hg. Valves can be set to close automatically in case of vacuum spoilage.

Scientific Engineering Lab, Dept. ED, 1510 Sixth St., Berkeley 10, Calif.

CIRCLE 413 ON READER-SERVICE CARD

**MEDICAL SPECTROGAMMOMETER.**—Single-channel pulse height analyzer with linear or logarithmic count rate meter.

Radiation Counter Labs, Inc., Dept. ED, 5121 W. Grove St., Skokie, Ill.

CIRCLE 414 ON READER-SERVICE CARD

**PANEL MOUNT VOLTMETER.**—Model 520A-P ac amplifier/voltmeter mounts interchangeably with the 510B-P audio oscillator.

Waveforms, Inc., Dept. ED, 331 Sixth Ave., New York 14, N.Y.

CIRCLE 415 ON READER-SERVICE CARD

**TRIMMER POTENTIOMETER.**—Model 224 miniature Trimpot operates in the  $-65$  to  $+175$  C range. Standard resistances from 100 ohms to 50 K.

Bourms Labs, Inc., Dept. ED, P.O. Box 2112, Riverside, Calif.

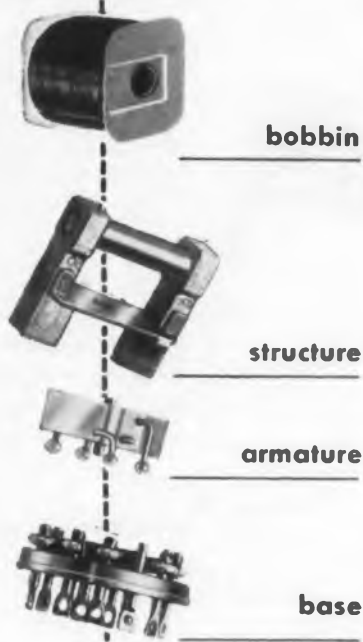
CIRCLE 416 ON READER-SERVICE CARD

**OSCILLOGRAPH.**—Model 606 D/R features flash timing up to 1000 cps, 5 magazine types, extremely fast or slow recording speeds.

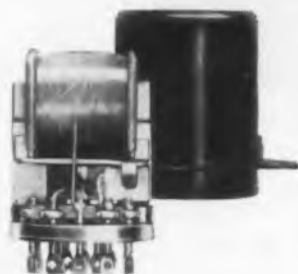
Midwestern Instruments, Dept. ED, 41st and Sheridan, Tulsa, Okla.

CIRCLE 417 ON READER-SERVICE CARD

design  
simplicity...



... **RUGGED  
RELAY**



Couch balanced-armature rotary relays withstand 20G vibration, 75G shock. Answers your dry-circuit switching problems too. Our bulletin #132 tells you more. Write to-day.

*Couch*

**ORDNANCE INC.**

A Subsidiary of S. H. Couch Co., Inc.

3 Arlington Street North Quincy, Mass.

CIRCLE 418 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

# FOUR BRIDGES IN ONE



## MODEL 291 universal IMPEDANCE BRIDGE

*Measure:*

1

**RESISTANCE TO 0.1%**  
0-1200 kilohms in seven ranges.

2

**CONDUCTANCE TO 0.1%**  
0-1200 millimhos in seven ranges.

3

**CAPACITANCE TO 0.2%**  
0-1200 microfarads in seven ranges.

4

**INDUCTANCE TO 0.3%**  
0-1200 henrys in seven ranges.

PRICE: \$775.00

For complete information on the Model 291 Universal Impedance Bridge, see your ESI sales representative or send for ESI catalog sheet C-13.

**esi**

**ELECTRO-MEASUREMENTS, INC.**

7524 S. W. MACADAM AVENUE • PORTLAND 19, OREGON

CIRCLE 419 ON READER-SERVICE CARD

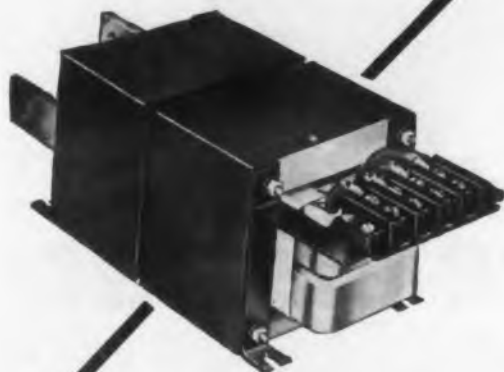


## Voltage Stabilizers . . . . .

Input  
190/200/230  
volts  $\pm 10\%$   
Output  
54 to 77 volts,  
10 amp.



## or Filament Transformers



Input 200/220/240  
volts; Output 6.3  
volts, 600 amps.

**Acme**  **Electric**

## WILL DESIGN TO YOUR PERFORMANCE REQUIREMENTS

When performance and dependability are the most significantly important factors in your requirements, your best source of supply is Acme Electric. Send your prints and outline of application performance for confidential review and quotation.

**ACME ELECTRIC CORPORATION**  
908 WATER STREET • CUBA, NEW YORK

**Acme**  **Electric**  
TRANSFORMERS

CIRCLE 420 ON READER-SERVICE CARD

## NEW PRODUCTS

**TRANSFORMERS.**—For transistor applications, TA-15, TA-16, and TA-17 have been added to the Stancor line.

Chicago Standard Transformer Corp., Dept. ED, 3501 Addison St., Chicago 18, Ill.

CIRCLE 421 ON READER-SERVICE CARD

**CONNECTORS.**—Similar in size to the BNC series, TNC connectors have a positive-locking threaded type of coupling.

Kings Electronics Co., Inc., Dept. ED, 40 Marbledale Rd., Tuckahoe, N.Y.

CIRCLE 422 ON READER-SERVICE CARD

**TRIMMER POTENTIOMETERS.**—Trim-Tite and Trim-Tite Jr. are respectively 1/2 and 3/8 in. in diam. High temperature units rated to 150 C, standard units to 85 C.

Fairchild Controls Corp., Dept. ED, 225 Park Ave., Hicksville, N.Y.

CIRCLE 423 ON READER-SERVICE CARD

**HIGH VACUUM RECTIFIER.**—Ruggedized version of the half-wave 705A unit. For use in airborne radar, electrostatic precipitators, and high voltage power supplies.

Vacuum Tube Products Co., Inc., Dept. ED, 2020 Short St., Oceanside, Calif.

CIRCLE 424 ON READER-SERVICE CARD



...1/2% accuracy!

Accuracy maintained over entire military temperature range of  $-55^{\circ}$  to  $+65^{\circ}$  C. No oven or heater needed.

Time-stable — negligible drift over long periods of time.

Small size — the expansion network projects only 1 1/4". AC or DC units for military or industrial applications. Military units meet all requirements of MIL-M-10304. Off-shelf deliveries. 30 to 45 days on specials.

WRITE FOR LITERATURE.

**VOLTRON** products

1010 Mission St., South Pasadena, Calif.

CIRCLE 425 ON READER-SERVICE CARD

Ready Now...

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Is quick reference for counting, timing, and frequency measuring equipment



CMC's concise short form catalog gives key specifications and condensed buying information for Universal Counters and Timers, In-line-In-plane Readable Readouts, Fast Digital Printers, Frequency and Period Meters, Preset Counter-Controllers, Decade Counting Units, Time-Function Translators, Time Interval Meters, Totalizing Counters, etc.

For your free copy, address Dept. 1986

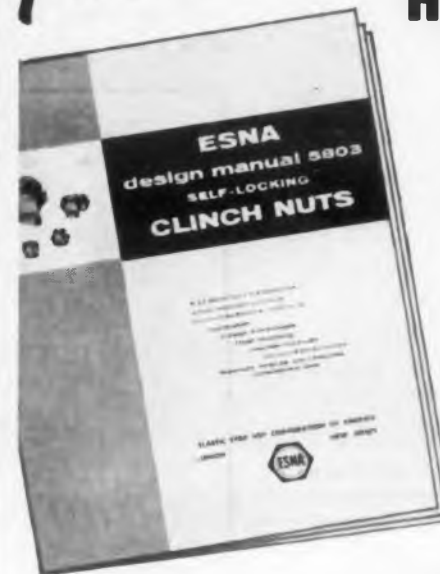


**Computer-Measurements Corporation**

5528 Vineland Ave. • No. Hollywood, California

CIRCLE 428 ON READER-SERVICE CARD

## New ESNA CLINCH NUT HANDBOOK



Here's a brand new design manual giving full information on ESNA's line of self-locking clinch type Elastic Stop® nuts. The manual covers such points as:

Applications  
Design Features  
New Flush mounting Types  
Insertion methods  
Correct part selection  
Plus: Materials, finishes and complete dimensional data

SEND TODAY for your copy.

Dept. 519-857

Stop Nut Corporation of America,  
2330 Vauxhall Road, Union, New Jersey.

This new flush mounting, miniature ESNA Clinch nut is easily installed by a simple flaring operation—becomes a permanent fastener.



**ELASTIC STOP NUT CORPORATION OF AMERICA**

CIRCLE 429 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • August 6, 1958

**SILICON RECTIFIERS.**—Types 1N-1730 through 1N1733, rated at 1000, 1500, and 2000 v at 200 ma and 3000 v at 150 ma.

Pacific Semiconductors, Inc., Dept. ED, 10451 W. Jefferson Blvd., Culver City, Calif.

**CIRCLE 432 ON READER-SERVICE CARD**

**PARTS CONTAINER.**—Vac-Tite box seals out moisture, opens easily. Used to protect electronic components or small ball bearings.

Clover Industries, Inc., Dept. ED, 578 Young St., Tonawanda, N.Y.

**CIRCLE 433 ON READER-SERVICE CARD**

**ROTARY SELECTOR SWITCH.**—Model C-80335-001, hermetically sealed, rated at 1650 v dc and 20 ma.

G. H. Leland, Inc., Dept. ED, 123 Webster St., Dayton 2, Ohio.

**CIRCLE 434 ON READER-SERVICE CARD**

**BETA-GAMMA SCINTILLATION ANALYZER.**—System for analytical measurement of isotopes emitting gamma or hard beta rays or both in solid or liquid samples.

Baird-Atomic, Inc., Dept. ED, 33 University Rd., Cambridge 38, Mass.

**CIRCLE 435 ON READER-SERVICE CARD**

**PHOTO-RECORDING PAPER.**—Tru-Graf 1 high speed projection paper for oscillograph testing equipment. Picks up faint lines without overexposure and blurring of the impulse trace.

Peerless Photo Products, Inc., Dept. ED, Shoreham, N.Y.

**CIRCLE 436 ON READER-SERVICE CARD**

**PRESSURE TERMINALS.**—Stack-Lugs can be nested together in pairs and the pairs stacked vertically, doubling number of terminations on each board.

Panduit Corp., Dept. ED, 14461 Waverly Ave., Midlothian, Ill.

**CIRCLE 437 ON READER-SERVICE CARD**

**MULTI-CIRCUIT CYCLE TIMER.**—In Model WD all adjustments and settings are easily made on panel face.

Zenith Electric Co., Dept. ED, 152 W. Walton St., Chicago 10, Ill.

**CIRCLE 438 ON READER-SERVICE CARD**

**OVERPOTENTIAL TESTER.**—For measuring leakage currents in insulation at voltages up to 120 kv dc. May also be used for breakdown tests.

Peschel Electronics, Inc., Dept. ED, R.F.D. 1, Paterson, N.Y.

**CIRCLE 439 ON READER-SERVICE CARD**

make the acid test!



**GUARANTEED  
LEAKPROOF  
WITH NEW  
SUPERIOR  
SEALING\***



### Sturges Storage Battery

the answer to any portable power problem

- new method used for completely sealing all binding and terminal posts, prevents any leaking or creeping of electrolyte
- can be encased with any electronic units without damage from corrosion
- non-spill in any position
- redesign of "H" type cells increases output capacity a full 20% over catalogued rating
- no liquified gas or vapor is discharged from cells on charge or discharge
- lightweight transparent molded plastic case

Write for **FREE literature** on various types of storage batteries.



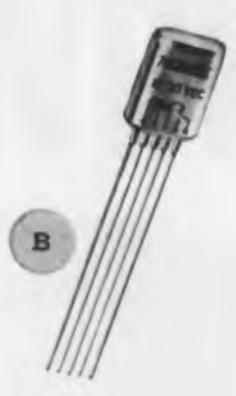
\*Patent's Pending  
**CONSULT US ON ANY SPECIAL  
BATTERY APPLICATION PROBLEMS**

manufactured by **ELECTRONIC BATTERIES, INC.**

Bush Terminal Building No. 4 • 28-34 35th Street, Brooklyn 32, New York

**CIRCLE 440 ON READER-SERVICE CARD**

# sub-miniature relays with high performance characteristics



**A**  
MV  
crystal can  
size

**Vibration:** 10 to 34 cycles per second at maximum excursions of .4". 34 to 2000 CPS 20G's acceleration.  
**Weight:** 0.45 ounce (max.)  
**Size:** .875" high x .797" wide x .359" thick max.  
**Pull-in Power:** 250 milliwatts at 25°C.  
**Contact Rating:** 2 Amps resistive at 32 VDC or 115 VAC.

**B**  
NM  
the famous  
NEOMITE

**Vibration:** 10 G to 500 cps.  
**Weight:** .09 oz.  
**Size:** H: .530" ± .015; W: .392" ± .010"; D: .196" ± .010";  
Lead length: 1.5" ± .0625".  
**Pull-in Power:** 100 Milliwatts.  
**Contact Rating:** .25 Amp at 28 VDC resistive load.

**C**  
... and  
announcing  
the brand-new  
VG

**Vibration:** Low Frequency—10 G's, 10-55 CPS (total max. excursion, .06").  
High Frequency—15 G's, 55-2,000 CPS.  
**Weight:** 1.5 ozs., approximately.  
**Size:** 7/8" ± 1/64" sq. x 1 1/8" ± 1/64".  
**Pull-in Power:** 340 Milliwatts at 25°C.  
**Contact Rating:** 5 Amps at 26.5 VDC or 115 VAC, 60 Cycles resistive load.  
**Shock:** 100 G's, per MIL-R-5757C, Shock Test II.



**Advance** Sub-miniature Relays are ideal for critical aircraft and missile applications. They feature small size, low weight, and high-precision performance. All have low power requirements.



Write today for complete data sheets.

AVAILABLE FROM LEADING DISTRIBUTORS



## ADVANCE RELAYS



A PRODUCT OF ELECTRONICS DIVISION  
ELGIN NATIONAL WATCH COMPANY  
Dept. G, 2435 N. Naomi St., Burbank, California

CIRCLE 441 ON READER-SERVICE CARD

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Dept. ECD

CIRCLE 442 ON READER-SERVICE CARD

## NEW PRODUCTS

**INERTIA-DAMPED SERVOMOTOR.**—Size 15 offers acceleration and deceleration damping for high speed and/or high gain servo systems.

Helipot Corp., Div. of Beckman Instruments, Inc., Dept. ED, Newport Beach, Calif.

CIRCLE 443 ON READER-SERVICE CARD

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Teletype Corp., Dept. ED, 4100 Fullerton Ave., Chicago 39, Ill.

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Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.

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Prestoseal Mfg. Corp., Dept. ED, 37-27 33rd St., Long Island City 1, N.Y.

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Amp Inc., Dept. ED, 2100 Paxton St., Harrisburg, Pa.

CIRCLE 474 ON READER-SERVICE CARD

**LIGHT FLASHER FOR AIRCRAFT.**—Smaller than previous models, the AFS-125 and AFS-126 have long life, are free from radio interference.

P. R. Mallory & Co. Inc., Dept. ED, Indianapolis 6, Ind.

CIRCLE 475 ON READER-SERVICE CARD

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American Silver Co., Inc., Dept. ED, 36-07 Prince St., Flushing 54, N.Y.

CIRCLE 476 ON READER-SERVICE CARD

**TRANSISTOR CLOSURES.**—Closures for transistors, diodes, and other miniature components to specification.

Hudson Tool and Die Co., Inc., Dept. ED, 18 Malvern St., Newark 5, N.J.

CIRCLE 477 ON READER-SERVICE CARD

**INSTRUMENT KNOBS.**—Added to standard line, No. 1068 aluminum knobs have nylon locking bushing. Size is 1 or 1-3/8 in. diam for 1/8 or 1/4 in. shaft.

Vemaline Products Co., Dept. ED, Hawthorne, N.J.

CIRCLE 478 ON READER-SERVICE CARD

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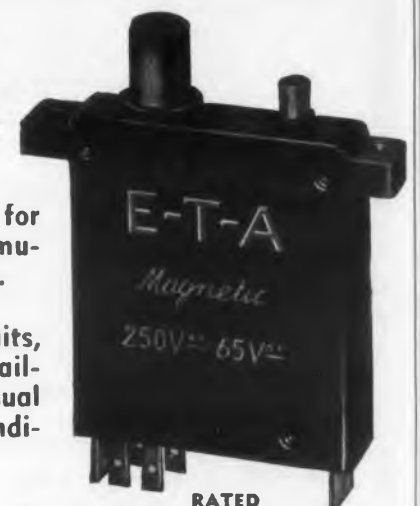
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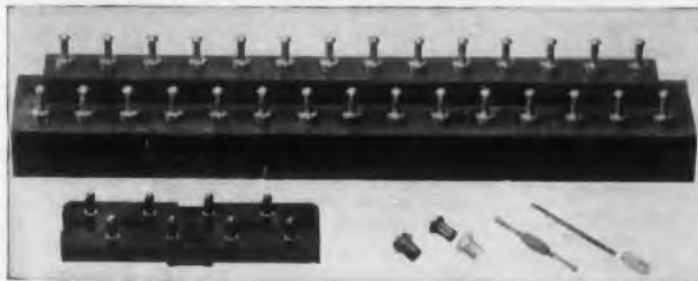
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ELECTRONIC DESIGN • August 6, 1958

**MOBILE RADIO TUBES.**—Industrial tubes for 2-way mobile radio systems operating from 12 v storage batteries: RCA-7054, -7055, -7056, -7057, -7058, -7059, -7060, -7061.

Radio Corporation of America, Electron Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 472 ON READER-SERVICE CARD

**NEON LAMPS.**—NE2K and NE2T high intensity miniature lamps consume 0.25 w at current of 2 ma.

Circon Component Corp., Dept. ED, Santa Barbara Municipal Airport, Goleta, Calif.

CIRCLE 457 ON READER-SERVICE CARD

**TRIMMER.**—Replacing models 120, 130, and 205, the model 200 Trimpot potentiometer has an increased power rating of 0.25 w at 70 C and an increased resistance range of 10 ohms to 50 K.

Bourns Labs., Inc., Dept. ED, P.O. Box 2112, Riverside, Calif.

CIRCLE 458 ON READER-SERVICE CARD

**QUICK CONNECT SWITCH.**—Type V3 spdt has ratings of: 10 amp, 125 or 250 v ac; 0.5 amp, 125 v dc; 0.25 amp, 250 v dc.

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

CIRCLE 459 ON READER-SERVICE CARD

**TUBEAXIAL FANS.**—Compact units for equipment cooling in variety of shapes, sizes, and mounting arrangements. Low cost; not recommended for extreme environments.

American Standard, American Blower Div., Dept. ED, Detroit 32, Mich.

CIRCLE 460 ON READER-SERVICE CARD

**SOLENOIDS.**—Series O1 and O2 miniaturized industrial quality solenoids with multi-million cycle life. In push or pull models, vertical or horizontal mounting.

Detroit Coil Co., Dept. ED, Ferndale, Mich.

CIRCLE 461 ON READER-SERVICE CARD

**MULTIPLIER PHOTOTUBE.**—Type 7200, a 9-stage unit for detection and measurement of ultraviolet radiation. Also useful for low-level light applications.

Radio Corporation of America, Electron Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 473 ON READER-SERVICE CARD

**DC POWER SUPPLIES.**—Model Q28-.5 is added to Q-Nobatron line of transistorized low-voltage high-current dc supplies. Output range is 18 to 36 v dc to 0 to 0.05 amp.

Sorensen & Co., Inc., Dept. ED, Richards Ave., South Norwalk, Conn.

CIRCLE 462 ON READER-SERVICE CARD

**POWER INVERTERS.**—Transistorized sine wave power inverters with 100 va, 150 va, and 500 va outputs.

Jordan Electronics, Div. of Victoreen Instrument Co., Dept. ED, 3025 W. Mission Rd., Alhambra, Calif.

CIRCLE 463 ON READER-SERVICE CARD

## MAMMOTH narda SONBLASTER

America's first mass-produced  
industrial-size ultrasonic cleaner!

**SAVE** 7 ways over costly solvent,  
alkaline or vapor degreasing:

- Clean faster, speed production!
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5-GALLON  
TANK  
\$695**

G-1501 generator, NT-1505 tank.

Other models from \$175.

2-year guarantee on all units.

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Interior Tank size (in.), 10W x 14L x 9½H. Tank Capacity, 5 gallons.

### Submersible Transducers

Model NT-604 — Hermetically sealed heli-arc welded stainless steel case. Radiating face: 27 sq. in. Effective plane of radiation: 40 to 50 sq. in. (approx. 10" x 5"). Effective cavitation of volumes: up to 1200 cu. in. at 24" tank height (5 gal.) and 2400 cu. in. at 48" tank height (10 gal.). Swagelok tube fitting on side or end for internal tank wiring.

Model NT-605 — Same as NT-604 except for bulkhead fitting on back for external wiring. Eliminates electrical conduits in solutions.

Now you can say goodbye to expensive chemicals, solvents, and degreasing equipment... reclaim valuable floor space... eliminate high installation costs... just by installing a Narda Series 1500 SonBlaster. At the same time, you'll get better, faster cleaning, and you'll need fewer people to do the job!

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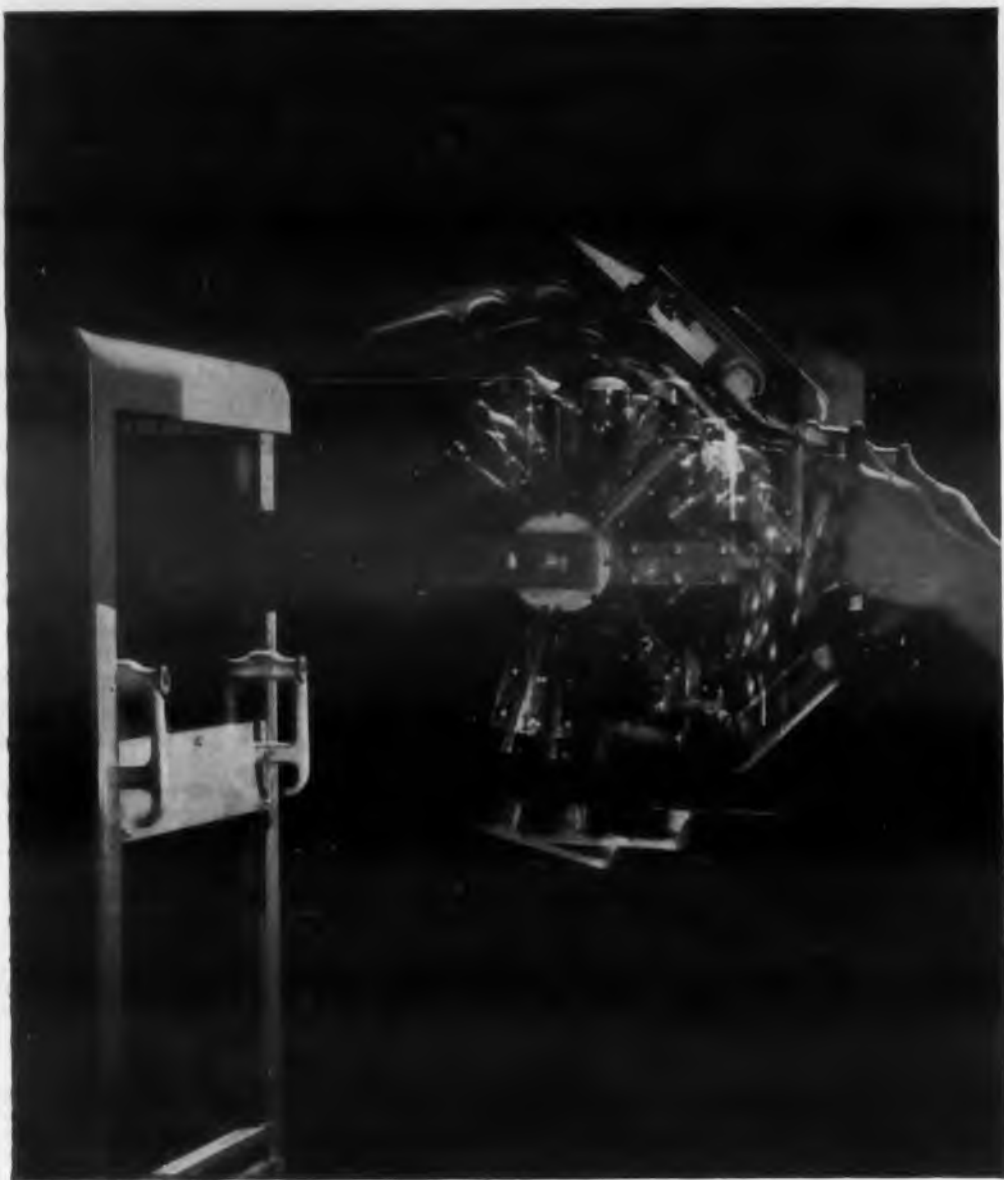
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CIRCLE 464 ON READER-SERVICE CARD



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"Detent" model, locked in one of seven different positions.



For further information, contact:

**525 South Webster, Indianapolis 19, Indiana**  
CIRCLE 430 ON READER-SERVICE CARD

# INDEX OF ARTICLES

January 8th through June 25th, 1958

## Reference Keys

ABS Abstract  
BD Background for Designers  
DF Design Forum  
GA German Abstract  
ID Ideas for Design  
PF Product Feature  
RT Russian Translation

## A

AC Measurements, Pitfalls in Precision, Part 1, p40, May 28; Part 2, p58, June 11  
AC Operation of Magnetrons .. GA, p84, June 25  
Accelerometer, Miniature .....PF, p42, Mar. 19  
**Accuracy Requirements in Sine-Cosine Transmission**, L. Young. Angular accuracy graphically determined in terms of amplifier performance and vice versa .....p32, Mar. 5  
**All-Pass Filter Time and Frequency Response**. Reference equation for two lattice-type all-pass filters .....GA, p96, May 28  
Amplifier, Audio, Transistorized, from 12 v Supply .....ID, p107, Mar. 19  
Amplifier Circuit, Improved Dual Frequency .....ID, p108, Feb. 19  
Amplifier, Fast Square .....ID, p81, May 28  
Amplifier, Feedback, Design with Nichols Chart .....p32, Mar. 19  
Amplifiers, DC, Floating Input and Output .....PF, p56, June 11  
Amplifiers, Photoelectric .....GA, p118, Jan. 8  
Amplifiers, Transistor, DC Feedback Equations for .....p52, Apr. 16  
Amplifiers, Transistor, Non-Linear Distortion in .....GA, p124, Jan. 22  
Amplifier, Two Watt, in Size 8 Can .....PF, p32, May 28  
Analog Solution of Polynomials GA, p102, Feb. 5  
Angular Position Transducer, Telemetry Simplified with .....PF, p48, Feb. 5  
Antenna, Ferrite Core for ADF PF, p102, Jan. 22  
**Applications of Non-Linear Magnetics**, H. F. Storm. One of the world's leading authorities examines applications in other than magnetic amplifiers Part 1, p32, Feb. 19; Part 2, p44, Mar. 19; Part 3, p62, Apr. 16; Part 4, p60, May 14  
**Approximation for Logarithmic Functions** .....GA, p97, May 28  
Attenuation, Microwave, Feedback Controlled .....PF, p54, Mar. 5  
**Automatic Classifier Speeds Selection of Magnetic Memory Cores**. (Rixon Electronics, Inc.) Quality selections made; checks squareness ratio and switching time .....PF, p74, Mar. 5  
Automatic Flight Control Servo System .....ID, p106, Feb. 19  
**Automatic Sequence Tester**. (Optimized Devices Inc.) Automatic go, no-go tester checks out large number of system preset characteristics .....PF, p42, Jan. 22  
Avoiding Crosstalk in Multichannel High Impedance Circuit .....ID, p105, Feb. 19

## B

Bridges, Thermistor .....p40, Apr. 30  
**Billionth Second Timer**. (Eldorado Electronics) Makes nanosecond measurements routine .....PF, p64, May 14  
Breadboard, servo hardware .....p26, June 25

## C

Capacitors, Saving Tantalum ..ID, p144, June 11  
**Card Operated Switch**. (Hickok Elec. Inst. Co.) 187 switches make complex switching easy .....PF, p40, Apr. 16  
Cathode Follower Circuit Design, Simplifying .....p42, Apr. 16  
Chopper Tests, To Determine Operating Characteristics for .....ID, p146, May 14  
Circuit Elements in R-F Couplers ID, p104, Feb. 19  
**Code Matrices for Indexing**, W. C. Tooker. Servo system interconnection reduced to minimum by code matrices .....p34, Mar. 5  
Colloidal Graphite .....ID, p120, Apr. 16  
Colored Glass Threads Identify Magnet Wires .....ID, p106, Jan. 22  
Commutators, Magnetic, Low Level ..p70, Mar. 5  
Compensation Networks, Thermistor, Quick Design of .....p16, Apr. 30  
Components, new developments at 1958 Electronics Component Conference ..p10, June 25  
**Composite Germanium-Silicon Power Transistor**. (Advanced Research Assoc., Inc.) Stable 40,000 gain ratio .....PF, p86, Apr. 15  
**Computer Low-Power "Plug Ins."** Packages requiring far less power and cooling .....ABS, p178, May 14  
Computer, Synchronization of a ....p64, Mar. 5  
Computer Wire Testing .....ID, p100, Jan. 8  
Computers, Building Blocks for ..PF, p54, Jan. 8  
Computing Indicator, Two Galvanometers Make A .....PF, p60, Jan. 8  
Concealed Loudspeaker Has Unusual Sound Pattern .....ID, p150, May 14  
Connector, Multiple-Contact, Improved ..ABS, p136, Apr. 16  
**Cool Canned Power Resistor** (Topaz Transformer Prod.) Dissipates 25 w, gets no hotter than 175 C .....PF, p70, May 14  
**Copper-Metalized Printed Circuit Boards** (Coming Glass) High bond strength withstands 250 C .....PF, p18, Apr. 2  
Core, Ferrite, for ADF Antenna PF, p102, Jan. 22  
Cores, Magnetic Memory .....PF, p74, Mar. 5  
Cost of Missile Unreliability, The ..p22, Feb. 19  
Crosstalk, Avoidance, in High Impedance Circuit .....ID, p105, Feb. 19  
**Current-Carrying Capacity of Printed Wiring**, J. Caroline. Factors affecting design of printed conductors; test procedures and conclusion with specific data on six popular laminates .....p22, Jan. 22  
Current Measurement Without Breaking Into Circuit .....ID, p111, Feb. 19

## D

DC Amplifiers, Floating Input and Output .. PF, p56, June 11  
DC Differential Amp, Wide Load .....PF, p34, Jan. 22  
**DC Feedback Equations for Transistor Amplifiers**, H. Lefkowitz. Design equations supplied for three basic circuit configurations ..p52, Apr. 15  
**DC Transformer Has Continuous Adjustable Ratio**, H. E. Darling. Design details of ratio amplifier .....p40, Mar. 5  
Delay Lines, Millisecond Megacycle (Ferranti Electric) .....PF, p36, Feb. 19  
Delay Line, New (ESC Corp.) ..PF, p38, May 25  
Demodulator Circuits, Using Transistor in, Part 1 .....p24, May 28; Part 2, p52, June 11  
Design, Cathode Follower Circuit, Simplifying .....p42, Apr. 16  
**Design Data for Ultra Low Temperature Thermistor**, H. B. Sachse. Wattage rating, time constant, reliability estimates given ..p30, Apr. 30

Design, Feedback Amplifier with Nichols Chart .....p32, Mar. 19

Design '58. Forecast of '58 design picture from over 75 R & D Engineers .....p28, Jan. 8

Design for Reliability. Three basic ground rules and down for obtaining high reliability ..p126, Jan. 22

Design for Reliability. Staff report—offers never-before published part reliability curve. Included in section following p66, Feb. 19: What Government Is Doing, p2; What Industry Is Doing, p3; Guides to Design, p5; Paper Prediction, p9; Part Reliability Curves, p11.

Design of Multivibrator with Self-Excitation. With handy nomograms and examples ..RT, p92, Feb. 5

Design, Optimums, of Power Transformer and Saturable Reactors, Part 1, p26, Apr. 16; Part 2, p48, May 28

Design, Quick, of Thermistor Compensation Networks .....p16, Apr. 30

Design, Rapid, of Transistorized Regulated Power Supplies .....ID, p104, Mar. 19

Design, Servo, Resisting Transistor for ..p14, Apr. 2

Design, Simplifying, with Floating Power Supply .....p24, Mar. 5

Design Tips for Using High Temperature Precision Potentiometers. R. J. Sullivan. Some factors to help equipment designers insure best system performance .....p54, May 14

Design, Transistor NOR Circuit .....p26, Feb. 5

Design, Wien-Bridge Oscillator, Graphical Method Simplifies .....p20, May 28

Designing An Electronic Filter Servo. J. A. Webb. Filtering extremely narrow bandwidths with good phase stability .....p32, Apr. 16

Designing Components for New Applications. Component development to meet future requirements .....p62, Mar. 5

Desk Top High Speed Printer (Potter Inst.) Prints 28 lines of numbers per sec., maximum printing rate of 1120 numbers per sec. ..PF, p28, Jan. 22

Determination of Transistor Lead in Resistance. Contact resistance measured using "h" parameters .....GA, p122, Jan. 22

Device for Tension Control ....ID, p152, May 14

Differential Amp, Wide Load DC (Kin Tel) ..PF, 34, Jan. 22

Differential Meter Relay (Assembly Products, Inc.) Serves as control device ....PF, p64, Mar. 19

Digital Signal Checker .....ID, p42, Apr. 2

Digital Voltmeter (Servonice, Inc.) ..PF, p44, Jan. 22

Diode Measurements in the X-Band ..GA, p126, Feb. 19

Diode, Silicon, Application Notes, Part 2 ..p58, Mar. 5

Diode, Silicon, Helps Gas Diode Get To Work .....ID, p48, June 11

Diode, Zener Characteristics .....p26, Mar. 19

Diode, Zener, Uses .....ID, p78, May 28

Diodes, Zener .....GA, p170, June 11

Direct Reading Frequency Meter ....GA, p84, June 25

Disc Magnetic Memory. (Autonetics) Air bearing supports memory unit of new computer ..DF, p36, Jan. 22

Distortion, Non-Linear, in Transistor Amp ..GA, p124, Jan. 22

Do It Yourself, Printed Circuit Assemblies, (Gorn Electric Co.) Quick assembly ....PF, p78, Mar. 5

Driver Stage, Push-Pull .....ID, p106, Jan. 22

Dynamic Compression, (Dynamics Instr. Co.) .....BD, p56, Apr. 16

## E

Effects of Processing and Environment on Printed Wiring Laminates. St. J. Bain. Consideration of effects upon electrical and physical characteristics of paper-phenolic and glass fabric epoxy laminates .....p48, June 11

Electrical Characteristics of Printed Circuit Panels. Several copper-clad laminates investigated .....ABS, p120, Mar. 19

Electronics in USSR. Impressions and observations of engineers who toured Russia ..ABS, p48, Apr. 2

Electronic Uses of High Temperature Liquid Dielectrics. C. G. Currin. What to know about and how to use liquid dielectrics for component cooling .....p48, May 14

Environmental Requirements for Electronic Parts. Military .....p26, Jan. 22

## F

Fast Square Amplifier, A .....ID, p81, May 28

Feedback Amplifier Design with Nichols Chart. W. D. Wade. Time saving design tool allows designer to obtain closed loop data immediately from open loop information .....p32, Mar. 19

Feedback Circuit Analysis Using Impedance Concepts. G. Pellegrino, Jr. Visual approach to feedback circuit analysis .....p36, Feb. 5

Feedback Controlled Microwave Attenuation (Airtion Inc.) Splits, attenuate, modulates power at 3 to 10 kmc frequencies ..PF, p54, Mar. 5

Feedback, DC, Equation for Transistor Amplifiers .....p52, Apr. 16

Ferrite Core for ADF antenna ..ID, p102, Jan. 22

Filing, Uniterm System of .....p48, Apr. 16

Filter, All-Pass, Time and Frequency Response .....GA, p96, May 28

Filter, Electronic, Transistorized .....ID, p150, June 11

Filter, Servo, Designing an Electronic .....p32, Apr. 16

Filters, VHF Bandpass .....p20, Mar. 19

Flight Control, Automatic, Servo System ..ID, p106, Feb. 19

Floating Input and Output DC Amplifiers. (Neff Instrument Corp.) Carrier type amplifier uses an electro-mechanical chopper as an input modulator; amplitude of 400 cps squarewave proportional to magnitude of input dc ..PF, p56, June 11

Floating Power Supply, Simplifying Circuit Design With .....p28, Mar. 5

Function Generator for Two Independent Variables. Produces output which is function of two independent input variables ..ABS, p172, June 11

## G

Gear Principle, New, Has Interesting Design Possibilities .....ID, p148, May 14

Generator, Simple Tone .....ID, p105, Jan. 22

Germanium Diodes, Time Delays in Pulsed ..GA, p196, Mar. 5

Graphical Method Simplifies Wien Bridge Oscillator Design. E. D. Grim. Avoids "dogwork" of rigorous mathematical design and sloppiness of trial and error method .....p20, May 28

Ground Strips for Electron Tube, New .....ID, p104, Mar. 19

Growing Thermistor Field. The. A. J. Gizzi. Survey of recent activity and prophesy of things to come in next decade .....p12, Apr. 30

Gyros: Two Gyro Master Reference (Lear, Inc.) Serves as source of both directional and vertical gyro intelligence .....PF, p24, Apr. 2

## H

Handy Use of Dual Nut Plate ..ID, p152, May 28

Heat Sink, Transistor .....PF, p56, Mar. 5

High Speed Printer .....PF, p28, Jan. 22

High Speed Rotary Photoswitch, (Automation, Inc.) No cams, no contacts ..PF, 38, Feb. 19

High Temperature Components. Staff Report. Evaluates state of development of principle components and materials for electronic equipment, May 14 issue. Report includes: How Hot Is Hot?, p24; Tubes and Semiconductors, p28; Resistors, p32; Capacitors, p34; Inductors, p36; Transducers and Electromechanical Devices, p38; Temperature Conversion Chart, p40; Materials and Hardware, p42; Manufacturers of High Temperature Components, p44.

High Temperature Liquid Dielectrics, Electronic Uses of .....p48, May 14



# CONICAL SCANNERS



A STANDARD LINE OF RADAR TRACKING ANTENNAS IS NOW AVAILABLE FOR MISSILES AND AIRCRAFT OR GROUND BASED AND SHIPBOARD APPLICATIONS.



## FEATURING:

- Circular or Linear Polarization
- High Power Handling
- Broad Bandwidth
- Equal E- and H-Plane Beamwidths
- Light Weight
- Simple & Inexpensive
- Reflector Sizes From 7½ inches to 10 feet are available

S, C, X, and K<sub>U</sub>-BAND

Canoga Corporation has a series of tracking scanners available employing a circular feed which provides a circularly polarized or nutating linearly polarized tracking beam. A hollow shaft drive motor and spin reference generator are mounted around the waveguide spindle near the high-speed rotating joint. This direct drive eliminates gears and other drive members and provides minimum weight, maximum reliability, and optimum dynamic balance for high-speed operation. The use of only one moving part, the rotating feed-motor rotor provides the maximum in reliability and long life.

## SPECIFICATIONS

Any reflector size from 8 inches to 10 feet in diameter is available. Any frequency range within the 2700 to 14,000 megacycles range is available.

Bandwidth . . . . .	10 percent
Standing waves . . . . .	Less than 1.2
Gain and side lobes . . . . .	Determined by reflector size
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CIRCLE 533 ON READER-SERVICE CARD

## INDEX OF ARTICLES cont.

High Temperature Precision Potentiometer. Design Tips for Using .....p54, May 14

**High Temperature Relay Designs are Different.** S. M. DePuy. What happens to high temperature relays at lower temperature ..p66, May 14

**High Vacuum Pump** (Varian Assoc.) Completely electronic; 1 x 10<sup>9</sup> mm vacuums ..PF, p40, Mar. 19

**High Voltage Semimetal Thermocouples.** R. W. Fritts. Investigates manufacture, properties, and new electronic applications ....p28, May 28

**How to Correct Phase Distortion With An L-C Lattice.** J. D. Fogarty. Presents universal phase curve to design lattices for controlling distortion .....p20, Apr. 2

**How to Measure FM Bandwidth At Microwave Frequencies.** R. G. Larson. Absorption cavity wavemeter makes for simple technique ..p36, Mar. 5

**How to Minimize Radar Effects on Electronic Circuits.** W. G. Egan. Considers susceptible instruments and corrective techniques to offset Radar effects upon them .....p52, Mar. 19

### I

Impedance Concepts, Feedback Circuit Analysis Using .....p36, Feb. 5

Inverter Design, Static, Transistorized .....p58, Apr. 16

Improved Dual Frequency Amplifier Circuit ..ID, p108, Feb. 19

**Improved Multiple Contact Connector** 20 point connector permits quick circuit connection interchange .....ABS, p. 136, Apr. 16

**Improved Power Fault Protection.** J. T. Mark. Simple circuit provides both dump tube and rectifier-blocking protection .....p46, Mar. 5

Inductor, Variable .....ID, p43, Apr. 2

Industrial Processes, Magnetron for .....GA, p123, Jan. 22

**Information Theory in USSR.** Paul E. Green, Jr. Analysis of Soviet work in cybernetics, math, engineering, filtering, and detection ..p94, Feb. 5

**Inside-Out Motor Makes Shallow Saucer Fan** (Rotron Mfg. Co.) .....PF, p106, Mar. 5

**Interference-Free Switching** (Gray Electronics) 40 db drop in noise level with transistor circuit .....PF, p102, Jan. 8

**Intrinsic Barrier Transistor.** The .....BS, p98, May 28

Inverter Design, Static, Transistorized ....p58, Apr. 16

### L

Laminates, Printed Wiring. Effects on Processing and Environment on .....p48, June 11

L-C Lattice, How To Correct Phase Distortion with .....p20, Apr. 2

L-F Cathode By-Pass Arrangement, Novel ..ID, p81, Feb. 5

L-F High Powered Transmission, Short Pulse Operation of .....ID, p112, Feb. 19

Lead-In Resistances, Transistor, Determination of .....GA, p122, Jan. 22

Liquid Dielectrics. High Temperature, Electronic Uses of .....p48, May 14

Logarithmic Functions, Approximations of ..GA, p97, May 28

Logical Building Blocks, Transistorized ..PF, p54, Jan. 8

Loudspeaker, Concealed, Has Unusual Sound Speaker .....ID, p150, May 14

Low-Cost Transistor Modulator ..ID, p104, Jan. 22

Low-Cost Wien Bridge Oscillator ....ID, p110, Feb. 19

Low Impedance Elements, Noise Voltage Measurement in .....GA, p94, May 28

**Low Level Magnetic Commutators.** D. C. Kalbiell. Function of commutation and conversion from

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CIRCLE 534 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958

analog to digital form combined by using magnetic null detectors in digital feedback loop .....p70, Mar. 5

**M**

Magnet Wire, Identification of...ID, p106, Jan. 22  
 Magnetic Commutators, Low Level...p70, Mar. 5  
 Magnetic Drums, Read and Write Transistor Circuit for, Part 1, p42, Feb. 5; Part 2, p44, Mar. 5  
 Magnetic Memory Cores, Automatic Classifier Speeds Selection of .....PF, p74, Mar. 5  
 Magnetic Memory, Disc .....DF, p36, Jan. 22  
 Magnetic Parts Holder .....ID, p175, Mar. 5  
 Magnetic Toggle Relay, (American Monarch Corp.) Permanent magnets provide holding power .....PF, p20, June 25  
 Magnetics, Non-Linear, Applications of, Part 1, p32, Feb. 19; Part 2, p44, Mar. 19; Part 3, p62, Apr. 16; Part 4, p60, May 14  
 Magnetrons for Industrial Processes, Three German makes noted .....GA, p123, Jan. 22  
 Making Thermistors, Photographs illustrate various steps in manufacture .....p44, Apr. 30  
 Maser Is Here, (Polytechnic R & D Co.) First commercial unit is portable with better than one part in billion accuracy .....PF, p24, Mar. 19  
 Master Reference, Two-Gyro ....PF, p24, Apr. 2  
 Matching Network, VHF, Design ....p20, Mar. 19  
 Materials Change Cut Costs by Two-Thirds .....ID, p78, Feb. 5  
 Megawatt TWT, (Varian Associates) Considerations in the new megawatt twt PF, p38, June 25  
 Memory Cores, Magnetic, Automatic Classifier Speeds Selection of .....PF, p74, Mar. 5  
 Memory, Disc, Magnetic .....DF, p36, Jan. 22  
 Metal Fabrication, Short Cut to ..ID, p79, Feb. 5  
 Meter Rectifier for High Temperature Operation .....ID, p107, Feb. 19  
 Microwave and Optical Properties of Materials. W. G. Egan Analysis to attenuation characteristics of shielding materials .....p52, May 14  
 Microwave Applications of Thermistors, Part 1, L. I. Kent. Investigates thermistor characteris-

tics, thermistor mounts, dc characteristics, broadband mounts, coaxial mounts p26, Apr. 30  
 Microwave Attenuation, Feedback Controlled .....PF, p54, Mar. 5  
 Microwave Frequencies, How to Measure FM Bandwidth at .....p36, Mar. 5  
 Microwave Tubes, Survey of ....GA, p118, Jan. 8  
 Microwaves, Resonant Absorbers for .....GA, p170, June 11  
 Microwaves, TWT Oscilloscope Detects .....PF, p62, Jan. 8  
 Military Environmental Requirements for Electronic Parts. Government provides chart of R & D requirements .....p26, Jan. 22  
 Millisec MC Delay Line, (Ferranti) Electronic delays of 5 msec at 500 kc or 1 msec at 1 mc .....PF, p36, Feb. 19  
 Miniature Accelerometer, (Statham Instruments) Strain gage type .....PF, p42, Mar. 19  
 Miniature Servo Broadboard, (Waldorf Instrument) Describes a new approach in hardware for mounting servo parts ....PF, p26, June 25  
 Minimize Local Oscillator Drift, Part 1, W. Y. Pan, D. J. Carlson Design steps suggested .....p18, June 25  
 Missile Unreliability, Cost of .....p26, Feb. 19  
 Modulator, Transistor, Low-Cost .ID, p104, Jan. 22  
 Multichannel Electronic Switch, (General Devices Inc.) 24 non-shorting channel switch for reliable telemetry .....PF, p50, Feb. 5  
 Multiple Contact Connector, Improved .....ABS, p136, Apr. 16  
 Multiplier Phototube, (RCA) High red to near-infrared response .....PF, p40, Feb. 5  
 Multivibrator, Design of, with self-excitation .....RT, p92, Feb. 5

**N**

New Delay Line (ESC Corp.) Triples delay/rise-time ratio .....PF, p38, May 28  
 New Gear Principle Has Interesting Design Possibilities .....ID, p148, May 14

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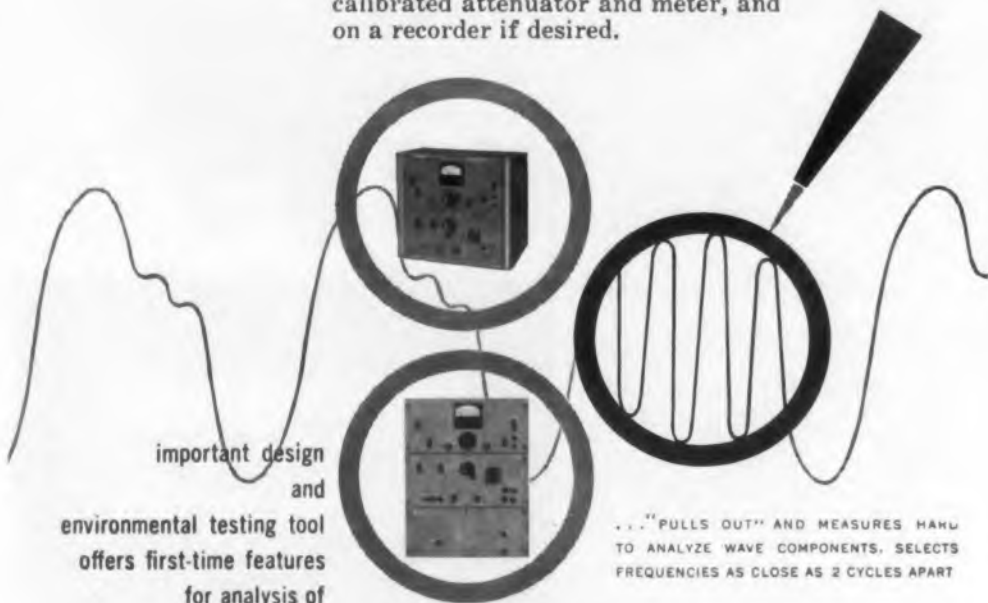
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## INDEX OF ARTICLES cont.

- New Ground Strip for Electron Tubes .....ID, p104, Mar. 19
- New 6000-Line Resolution CRT** (CBS Hytron) .....PF, p30, Apr. 16
- New Terminal Strip Design for Toroid Reduces Scrap .....ID, p11, Mar. 5
- New Visual Recorder** (Tally Register Corp.). Electroplates on paper. Plots up to 12 variables at rate of 30 points /sec/channel ..PF, p34, Feb. 5
- New Waveform Translator** (Transdata). Battery operated device aids quantitative oscillograph measurements .....PF, p30, Feb. 19
- No More Lost Wires .....ID, p81, May 28
- Noise Voltage Measurement in Low Impedance Elements .....GA, p94, May 28
- Non Destructive Transistor Punch Thru Test ..ID, p80, Feb. 5
- Non-Linear Distortion in Transistor Amplifier .....GA, p124, Jan. 22
- Non-Linear Magnetics, Applications of ..Part 1, p32, Feb. 19; Part 2, p44, Mar. 19; Part 3, p62, Apr. 16; Part 4, p60, May 14
- NOR Circuit Design, Transistor .....p26, Feb. 5
- Novel L-F Cathode Bypass Arrangement ..ID, p81, Feb. 5
- Null Detector, Servo .....ID, p42, Apr. 2

### O

- Obtaining Dual Trace on Single Trace Pulse Scope .....ID, p107 Feb. 19
- Optical, Microwave, Properties of Materials ..p52, May 14
- Optimum Design of Power Transformers and Saturable Reactors, Part 1.** T. R. Nisbet. Here's how to design lightest transformer to do job, with nomograms .....p26, Apr. 16
- Oscillator Design, Wien-Bridge, Graphical Method Simplifies .....p20, May 28

- Oscillator, Transistor, for 8 MC .....GA, p176, May 14
- Oscillator, Wien-Bridge, Low Cost .....ID, p110, Feb. 19
- Oscillator, Wien-Bridge, Stabilizing .....ID, p153, May 14
- Oscillator, Sine-Wave, Square Wave Adapter for .....ID, p170, Mar. 5
- Oscillators, local, minimizing drift ..p12, June 25
- Overlap Method Makes Fast Pulses in Transistor Circuits.** M. Smith. Provides very high pulse repetition, very steep use and fall times, and very high quality pulses .....p44, May 28

### P

- Parts Boards Design Considerations.** J. R. Smith. Points to remember in designing subassemblies .....p22, June 25
- Phase Distortion, How To Correct With an L-C Lattice .....p20, Apr. 2
- Photoelectric Amplifier.** A Light amplifier for control system and precision measurements .....GA, p118, Jan. 8
- Photoswitch, Rotary, High Speed PF, p38, Feb. 19
- Phototube, Multiplier .....PF, p40, Feb. 5
- Pitfalls of Precision AC Measurements.** H. A. Poehler. Examines many common errors and corrective techniques, Part 1, p40, May 28; Part 2, p58, June 11
- Plastic, Reinforced, Radar Reflectors Of .....p34, May 28
- Plastic Microphone Diaphragm Solves Moisture Problem .....ID, p174, Mar. 5
- Potentiometers, High Temperature Precision, Design Tips for Using .....p54, May 14
- Power Fault Protection, Improved ..p46, Mar. 5
- Power Resistor, Cool Canned ..PF, p70, May 14
- Power Supplies, Floating, Simplifying Circuit Design with .....p28, Mar. 5
- Power Supplies, Rapid Design of Transistorized Regulated .....ID, p104, Mar. 19

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CIRCLE 538 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 6, 1958



Power Transformers, Optimum Design of  
 .....Part 1, p26, Apr. 16; Part 2, p48, May 28

Power Transistor, Composite Germanium-Silicon  
 .....PF, p86, Apr. 16

**Practical RC Differentiator Design**, L. Saporta, J.  
 Harity. Valuable curves developed which  
 simplify design .....p30, Feb. 5

Precision Clipper .....ID, p113, Feb. 19

Precision Electronic Temperature Controller  
 .....ID, p176, Mar. 5

**Precision Pressure Transducer** (Computer Instr.  
 Corp.) Uses carbon film element ..PF, p68, Mar. 5

**Precision VTVM Reads True RMS** (Trio Lab, Inc.)  
 Uses dynamometer meter movement ..PF, p38,  
 Mar. 5

Pressure Transducer, Precision ..PF, p68, Mar. 5

Printed Circuit Assemblies, Do-It-Yourself  
 .....PF, p78, Mar. 5

Printed Circuit Boards, Copper-Metalized ..PF,  
 p18, Apr. 2

Printed Circuit Panels, Electrical Characteristics  
 of .....ABS, p120, Mar. 19

**Printed Circuit Standardization**, S. Kramer, L.  
 Krauss, J. Monturo. Standards established for  
 printed-wiring design, procurement, and pro-  
 cessing have resulted in highly reliable designs  
 for military .....p22, June 11

Printed-Wiring Laminates, Effects of p48, June 11

Printed-Wiring, Current-Carrying Capacity of  
 .....p22, Jan. 22

**Printed-Wiring Reliability**, (Staff Report) Latest  
 industry practices for achieving reliable  
 printed-wiring. Report includes: Standards, p28;  
 Board Design Techniques, p32; Choosing Board  
 Materials, p36; Proper Care and Handling, p40;  
 Factors in Soldering, p44; Other Forms, p46  
 .....June 11

Printed Wiring Technique Makes Control Panel  
 .....ID, p174, Mar. 5

Printer, High Speed .....PF, p28, Jan. 22

Probes for VTVM .....ID, p102, Feb. 19

Pulsed Germanium Diodes, Time Delays in GA,  
 p196, Mar 5

Push-Pull Driver Stage .....ID, p106, Jan. 22

Q

**Quadratic Equation Nomogram**, P. Gheorghiu. De-  
 sign aid for solving quadratic equations ..p34,  
 June 25

**Quick Design of Thermistor Compensation Net-  
 works**, B. R. Schwartz. Simple three step solu-  
 tion using normalized curves and nomograms  
 .....p16, Apr. 30

R

RC Differentiator Design, Practical ..p30, Feb. 5

**RC Differentiator Nomogram**. Yield amplitude and  
 pulse duration .....RT, p192, Mar. 5

R-F Couplers, Circuit Elements in ID. p104, Feb. 19

R-F Tight Joints at Low Cost .....p102, Jan. 8

Radar Effects on Electronic Circuits, How to  
 Minimize .....p52, Mar. 19

**Radar Reflectors of Reinforced Plastics**, R. L.  
 Mondano. Traces design and development of  
 this highly advantageous structure ..p34,  
 May 28

**Radome Sandwich Using Artificial Dielectric  
 Foam**, W. R. Cuming. Method offers substantial  
 reduction in radome weight ....p36, Apr. 16

Rapid Design of Transistorized Regulated Power  
 Supplies .....ID, p104, Mar. 19

**Rapid Testing of Tube Shorts and Continuity**,  
 (Armor Research Foundation) Short tests for  
 tubes simultaneously .....PF, p36, Mar. 19

Reactances, Transistor-Simulated ....p24, Mar. 5

Reactors, Saturable, Optimum Design of, Part 1.  
 p26, Apr. 16; Part 2, p48, May 28

**Read and Write Transistor Circuits for Magnetic  
 Drums**, Part 1, B. A. Mangan. General ap-  
 proach to design for high reliability ..p42,  
 Feb. 5

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CIRCLE 154 ON READER-SERVICE CARD

# INDEX OF ARTICLES cont.

**Receding Chin Meter Shows Face Only.** (Assembly Products Inc.) Magnetic error of one per cent .....PF, p38, Feb. 19

Recorder, Visual .....PF, p34, Feb. 5

Rectifier Circuit, Silicon, Protects DC Meter Overload .....ID, p76, Feb. 5

Rectifier Meter, For High Temperature Operation .....ID, p107, Feb. 19

**"Reds" Problem for 1958.** Highlights of East German convention citing Communist '58 pursuits .....GA, p52, Jan. 8

Reflectors, Radar, of Reinforced Plastic p34, May 28

Regulated Power Supplies, Rapid Design of Transistorized .....ID, p104, Mar. 19

Relay Conference Stresses Reliability. (Meeting Report) .....p5, June 25

Relay Designs, High Temperature. Are Different .....p66, May 14

Relay, Differential Meter ....PF, p64, Mar. 19

Relay, magnetic toggle type .....p20, June 25

Reliability, Design for .....p126, Jan. 22

Reliability, Design for, (Staff Report) (See Design for Reliability)

**Reliability-Sensitivity Function Analysis.** H. E. Blanton. Shows what part to change to improve system reliability .....p22, Feb. 19

Resistances, Determination of Transistor Lead-In .....GA, p122, Jan. 22

**"Resisting" Transistor for Servo Design.** The. T. R. Nisbet. Device gives twice output of class B stage with 95 per cent efficiency .....p14, Apr. 2

Resistor, Power, Cool Canned .....p70, May 14

**Resonant Absorbers for Microwaves.** Singly, doubly, triply resonant absorbers give reflectionless loading .....GA, p170, June 11

Rotary Photoswitch, High Speed ...PF, p28, Feb. 19

Rotary Switch, Sealed .....PF, p68, May 14

## S

**Safer Solvent Replaces Carbon Tetrachloride.** Methyl Chloroform approved for use as cleaner of electrical and electronic equipment by U.S.N. Bureau of Ships ....ABS, p126, Jan. 22

Saturable Reactors, Optimum Design of, Part 1, p26, Apr. 16; Part 2, p48, May 28

Saving Tantalum Capacitors ..ID, p144, June 11

**Sealed Rotary Switch** (Daven Co.) Consists of free floating wipers and completely watertight 1/2 in. shell .....PF, p68, May 14

Sequence Tester, Automatic ....PF, p42, Jan. 22

Series Regulator Warm-Up .....ID, p177, Mar. 5

Servo Design, Resisting Transistor for ..p14, Apr. 2

Servo, Electronic Filter, Designing An..p32, Apr. 16

Servo Null Detector .....ID, p42, Apr. 2

Servo System, Automatic Flight Control ..ID, p106, Feb. 19

Servo Systems, Code Matrices for Indexing .....p34, Mar. 5

**Shield Insert Keeps Tubes Cool.** (Atlas E-E Corp.) Triangular configuration makes for better heat dissipation .....PF, p76, Mar. 5

Short Cut to Metal Fabrication ID, p79, Feb. 5

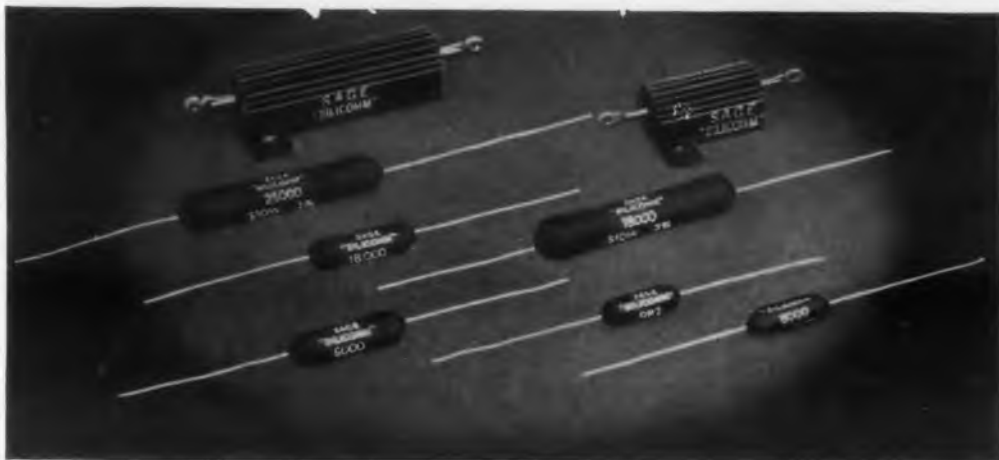
Short Pulse Operation of L-F High Powered Transmitters .....ID, p112, Feb. 19

**Silicon Diode Application Notes.** A. Bergson. Nomogram enables quick inspection adjustment of thermal and electrical variables .....p58, Mar. 5

Silicon Diode Helps Gas Get To Work ....ID, p148, June 11

Silicon Rectifier Circuit Protects DC Meter Up to 1000 Times Rated Current ID, p76, Feb. 5

**Silicon Unijunction Transistor.** S. R. Brown, T. P. Sylvan. Exhibiting open circuit stable negative resistance, new three terminal device, which is primarily useful for switching and oscillator



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application, is explained ..Part 1, p56, Jan. 8;  
Part 2, p30, Jan. 22

Simple Count-down Device ....ID, p70, June 25

Simple Transistorized 1 Per Cent Voltage Regulator .....ID, p71, June 25

Simple Network Reduces Power Supply "Down Time" .....ID, p149, June 11

Simple Tone Generator .....ID, p105, Jan. 22

**Simplifying Cathode Follower Circuit Design.**  
D. W. Moffat. Design of series of circuits noted of particular value to those who have occasion to use cathode follower .....BD, p42, Apr. 16

**Simplifying Circuit Design with Floating Power Supply.** J. F. Walton. Notes many instances in which application most economical and advantageous .....p28, Mar. 5

Slow Speed, Transistor Driven, Stepping Switch .....ID, p80, May 28

**Specifying Military Thermistors.** B. R. Schwartz. Armed services or industry have as yet made no standardization efforts. RCA prepared general spec enabling purchase of reliable devices .....p34, Apr. 30

Square Wave Adapter for Sine-Wave Oscillator .....ID, p170, Mar. 5

Stabilizing Emitter Current ....ID, p151, June 11

Stabilizing Wien-Bridge Oscillator ..ID, p153, May 14

Standards, Transistor Voltage .....p50, Mar. 5

Standardization, Printed Circuit ....p22, June 11

Static Inverter Design, Transistorized ..p58, Apr. 16

Steel Wool Finds Bad Joints ..ID, p147, June 11

Stepping Switch, Slow Speed, Transistor Driven .....ID, p80, May 28

**Survey of Microwave Tubes.** Velocity modulated tubes noted .....GA, p118, Jan. 8

Switch, Card-Operated .....PF, p40, Apr. 16

Switch, Multichannel Electronic ..PF, p50, Feb. 5

Switch, Rotary, Sealed .....PF, p68, May 14

Switch, Stepping, Slow Speed, Transistor Driven .....ID, p80, May 28

Switching, Interference-Free .....p102, Jan. 8

**Synchronization of a Computer.** G. Smoliar, J. Keilsohn. Shift register solves synchronization problem .....p64, Mar. 5

**T**

Tantalum Capacitors, Saving ..ID, p144, June 11

**Tape Recorder Motor Does Almost Everything** .....ID, p71, June 25

**TWT Oscilloscope Detects Microwave** (Edgerton, Germeshausen and Grier, Inc.) Detects 2000 mc, 1/10  $\mu$ sec use time .....PF, p62, Jan. 8

**Telemetry Simplified With Angular Position Transducer** (Ultradyn, Inc.) Infinite resolution .....PF, p48, Feb. 5

Temperature Controller, Precision Electronic .....ID, p176, Mar. 5

Terminal Strip Design, New, for Toroids Reduces Scrap .....ID, p171, Mar. 5

Tester, Automatic Sequence ..PF, p42, Jan. 22

Testing, Rapid, of Tube Shorts and Continuity .....PF, p36, Mar. 19

Tests for Chopper to Determine Operating Characteristics .....ID, p146, May 14

**Thermistor Bridges.** M. L. Miller. Large output thermistor bridges compared to several types of thermocouples .....p40, Apr. 30

Thermistor Compensation Network. Quick Design of .....p16, Apr. 30

**Thermistor Data Chart.** Staff Report. Tabulation of representative groups of thermistors by major manufacturers .....p20, Apr. 30

Thermistor Field, The Growing ....p12, Apr. 30

Thermistors, Design Data for Ultra Low Temperature .....p30, Apr. 30

Thermistors, Making .....p44, Apr. 30

Thermistors, Microwave Applications of, Part 1, .....p26, Apr. 30

Thermistors, Specifying Military .....p34, Apr. 30

Thermocouples, Semimetal, High Voltage ..p28, May 28

These Parts Were Cold Headed ..ID, p172, Mar. 5



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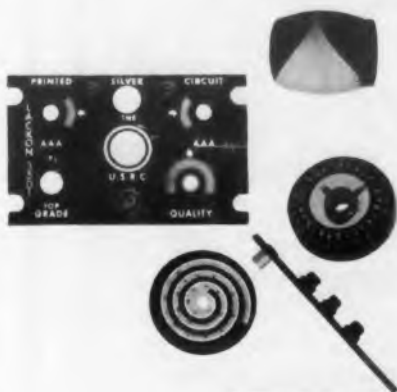
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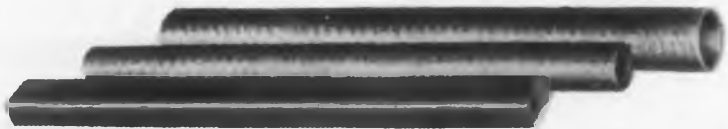
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DIELECTRIC STRENGTH volts per mil, short time	500	225
WATER ABSORPTION % 24 hr. immersion	.20	3.9
AXIAL COMPRESSIVE STRENGTH psi	20,000	13,000
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# INDEX OF ARTICLES cont.

**3D-Rugged Assembly** (Moore Assoc., Inc.) Long life, high production rate without extensive tooling .....BD, p56, Apr. 16

**Thyristor, The.** L. E. Barton. Characteristics and application of thyatron-like transistor ...p48, Mar. 19

Time Delays in Pulsed Germanium Diodes ..GA, p196, Mar. 5

Timer, Billionth Second .....PF, p64, May 14

Tone Generator, Simple .....ID, p105, Jan. 22

Transducer, Angular Position .... PF, p48, Feb. 5

Transducer, Precision Pressure .. PF, p68, Mar. 5

Transformer, DC, Has Continuous Adjustable Ratio .....p40, Mar. 5

Transformers, Power, Optimum Design of, Part 1, p26, Apr. 16, Part 2, p48, May 28

Transistor Amplifier, DC Feedback Equations for .....p52, Apr. 16

Transistor Amplifiers, Non-Linear Distortion of .....GA, p124, Jan. 22

Transistor Circuits, Fast Pulses in, Overlap Method Makes .....p44, May 28

Transistor Circuits, Read and Write, For Magnetic Drum, Part 1, p42, Feb. 6; Part 2, p44, Mar. 5

**Transistor Data Supplement.** Mid-year supplement of July '57 transistor issue—all types introduced from Aug-Oct. '7 .....p38, Jan. 22

Transistor Driven Slow Speed Stepping Switch .....ID, p80, May 28

**Transistor Heat Sinks** (International Electronic Research.) Eliminates large surface transistor mounting .....PF, p56, Mar. 5

Transistor, Intrinsic Barrier ... ABS, p98, May 28

Transistor Lead-In Resistances, Determination of .....GA, p122, Jan. 22

Transistor Modulator, Low Cost ..ID, p104, Jan. 22

**Transistor NOR Circuit Design.** W. D. Rowe. Combination of new NOR logic elements can replace any standard English logic p26, Feb. 5

**Transistor Oscillator for 8 MC** ..GA, p176, May 14

Transistor, Power, Composite Germanium-Silicon .....PF, p86, Apr. 16

Transistor Priority System .....ID, p146, June 11

Transistor Punch Thru Test, Non Destructive ..ID, p80, Feb. 5

Transistor Resisting, for Servo Design p14, Apr. 2

Transistor, Silicon Unijunction, Part 1, p56, Jan. 8; Part 2, p30, Jan. 22

**Transistor-Simulated Reactances.** R. H. Stern. Very large reactances replaced by compact transistor circuits offer large savings .....p24, Mar. 5

**Transistor Voltage Standards.** W. W. Walls. Standardization proposal of power supply voltages for transistor circuits .....p50, Mar. 5

Transistors in Demodulator Circuits Using ...p52, June 11

Transistorized Audio Amplifier from 12 v Supply .....ID, p107, Mar. 19

Transistorized Electronic Filter ID, p150, June 11

**Transistorized Logical Building Blocks** (Avco Research) Complete set of packaged, miniaturized circuits for computer design ....PF, p54, Jan. 8

Transistorized Regulated Power Supplies, Rapid Design of .....ID, p104, Mar. 19

**Transistorized Static Inverter Design.** J. F. Lohr. Delivers large amounts of ac power at efficiency previously considered unattainable p58, Apr. 16

Transistors, Using, in Demodulator Circuits p24, May 28

Traveling-Wave Tube List. Tabulation of twt tubes .....p28, June 25

Tubes, Electron, New Ground Strips for ...LD, p104, Mar. 19

Tubes, Microwave, Survey of .. GA, p118, Jan. 8

**Two Galvanometers Make a Computing Indicator** (Aero Electronics) Instrument indicates three qualities—two independent variables and one which may be function of other two. Serves as an indicating device on a computer .....PF, p50, Jan. 8

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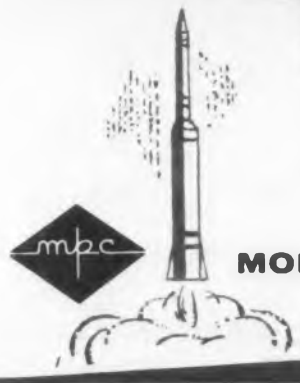
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**Two Gyro Master Reference** (Lear, Inc.) Serves as source of both directional and vertical gyro intelligence .....PF, p24, Ap. 2

**Two Watt Amplifier in Size 8 Can** (Precision components, Inc.) Delivers 2 w of 400 cps power at 100 c ambient with no heat sink ....PF, p32, May 28

**U**

**Unijunction Transistor, Silicon**, Part 1, p56, Jan. 8; Part 2, p30, Jan. 22

**Uniterm System of Filing**, Th. W. D. Bell. Simple, practical filing system makes for rapid retrieval of information .....p48, Apr. 16

**Using Transistors in Demodulator Circuits**, A. N. DeSautels. Discusses half-wave and full-wave phase distortion using transistors and diodes to produce outputs to drive magnetic amplifiers, energize relays, heating coils, hydraulic valves .....p24, May 28

**V**

Vacuum Pump, High .....PF, p40, Mar. 19

Variable Inductor, A .....ID, p43, Apr. 2

**VHF Matching Network Design**, A. E. Sanderson. New method for designing optimum bandpass filters and matching networks ....p20, Mar. 19

VTVM, Precision, Reads True RMS .....PF, p38, Mar. 5

VTVM, Probes for .....ID, p102, Feb. 19

**Voltage Regulator** (Sorenson & Co.). One cycle response: unusual distortion attenuation ..PF, p82, June 11

Voltage Standards, Transistor .....p50, Mar. 5

Voltmeter, Digital .....PF, p44, Jan. 22

Voltmeter, VT, Probes for .....ID, p102, Feb. 19

**W**

Waveform Translator, New .....PF, p30, Feb. 19

West Coast Conferences (Meeting Report). Describes RCA's new micromodules, tenor of Western Computer Conference ..p10, June 25

**What The Russians Are Saying And Writing**. High points of sessions at Russian Radio Engineering Show. Part 1, p118, Jan 22; Part 2, p88, Feb. 5; Part 3, p120, Feb. 19

**Wide-Load DC Differential Amplifier**. (Kin Tel). Offers insensitivity to wide output load variation and good common mode rejection ..PF, p34, Jan. 8

Wien-Bridge Oscillator Design, Graphical Method Simplifies .....p20, May 28

Wien-Bridge Oscillator, Low-Cost .....ID, p110, Feb. 19

Wien-Bridge Oscillator, Stabilizing .....ID, p153, May 14

Wire, Magnet, Identification of ..ID, p106, Jan. 22

Wire Stripper Saves Time .....ID, p103, Feb. 19

Wire Testing Computer .....ID, p100, Jan. 8

Wiring, Current Carrying Capacity of Printed .....p22, Jan. 22

Write, Read, Transistor Circuit for Magnetic Drums, Part 2 .....p44, Mar. 5

**X**

X-Band, Diode Measurements in .....GA, p126, Feb. 19

**Z**

**Zener Diode Characteristics**. List of 321 Zener diodes with electrical characteristics ..p26, Mar. 19

**Zener Diode Uses** .....ID, p78, May 28

**Zener Diodes** .....GA, p170, June 11

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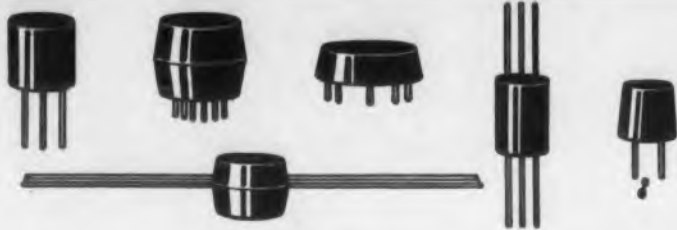
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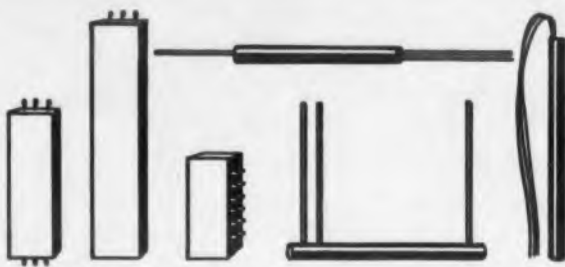
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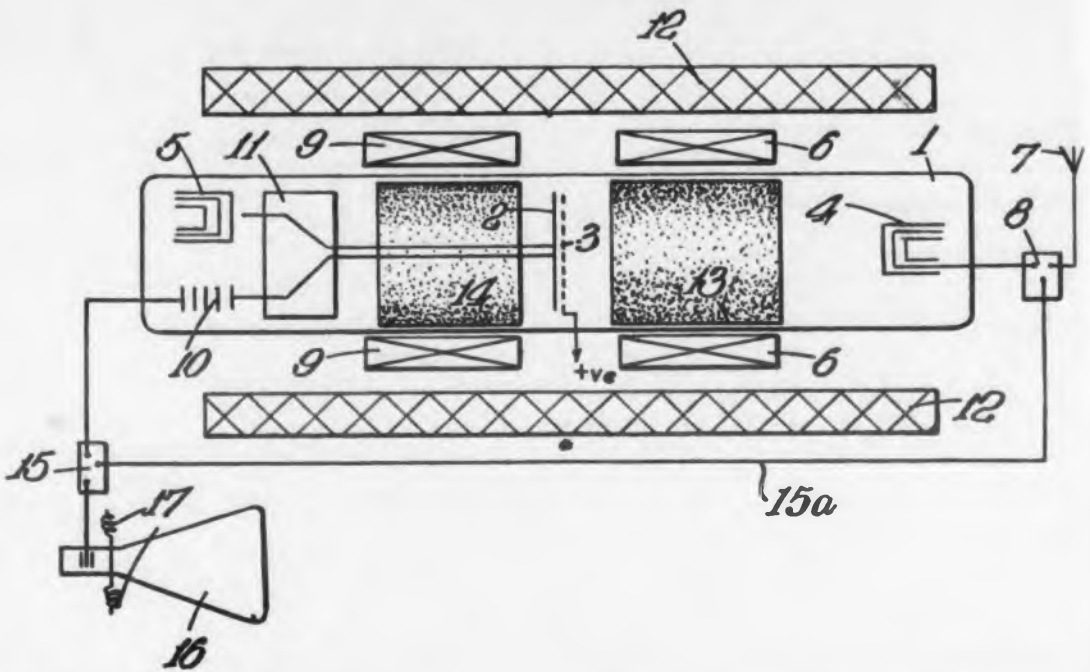


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# PATENTS



## Cathode Ray Tube Apparatus

Patent No. 2,820,921. James D. McGee.  
(Assigned to Electric & Musical Industries Ltd., England)

The persistence of a display on a cathode ray tube is increased by monitoring the repeated writing and erasure of

the signal on a storage mosaic.

An adaptation of the invention is illustrated. Signal input 7 connects to the intensity control of electron gun 4 through switch 8 and the scanning electron beam writes the signal on mosaic 2. A low velocity beam originates at elec-

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ELECTRONIC DESIGN • August 6, 1958

tron gun 5 and scans the back side of mosaic 2 to restore the mosaic to the potential of the cathode of gun 5. The return beam from mosaic 2 is applied to electron multiplier 10 which connects to amplifier 15. The amplified signal is monitored by the display tube 16. Switch 8 connects the output of amplifier 15 to the writing gun 4 and the cycle is repeated to renew the charge image as it is discharged.

### Transistor Oscillator Circuit

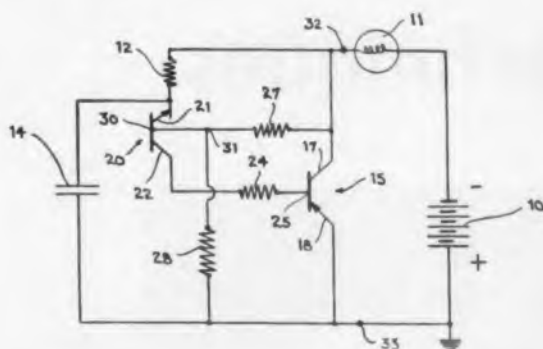
Patent No. 2,829,257. Elishu Root III. (Assigned to R. E. Dietz Co.)

A simple transistor switch provides a stable means which is particularly adaptable for use in a flasher warning lamp ordinarily used by motorists making repairs on the road.

The circuit operates as follows: The lamp 11 is connected to the battery 10 through the pnp junction transistor 15 which is controlled by the npn junction transistor 20. Initially, the voltage division of resistors 27 and 28 in series establishes cut-off of transistor 20 so that transistor 15 is cut-off. A small current

flows through lamp 11 to charge condenser 14 until the emitter 21 becomes slightly more negative than the base 30. Transistor 20 begins to conduct through resistor 24, and the base 25 of transistor 15. As a result, transistor 15 begins to conduct a heavy current through lamp 11, collector 17 becomes more positive, and additional current flows through transistor 20. This provides more load current for transistor 15 which lights the lamp.

Condenser 14 now discharges through transistor 20 until the condenser voltage becomes so low that it cannot maintain conduction of transistor 20. Both transistors are therefore completely shut off, the lamp becomes extinguished and a new cycle begins.



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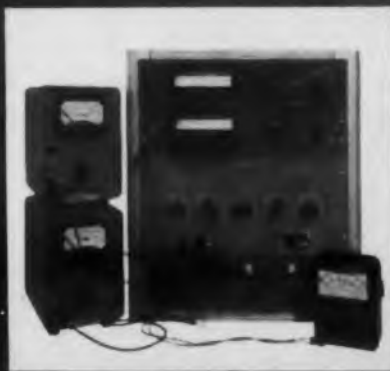
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# Difference Voltmeter Uses Digital Techniques

HERE'S an example of how digital and logical techniques can solve analog problems. We had to make a rock solid voltmeter to measure the potential difference between two dc inputs. These two inputs could be different by only three or four millivolts, or as much as a hundred mv. Our meter was to be very stable and was to stop drifting after a minute of warm up. We also

had to indicate which of the two input signals was more positive.

Here's how it was done. We fed both inputs into a "perfect chopper".<sup>6</sup> The output was a square wave whose phase indicated the polarity of the difference between the input signals. Then we amplified the square wave in an ac amplifier, and detected the output to run a high level vtm.

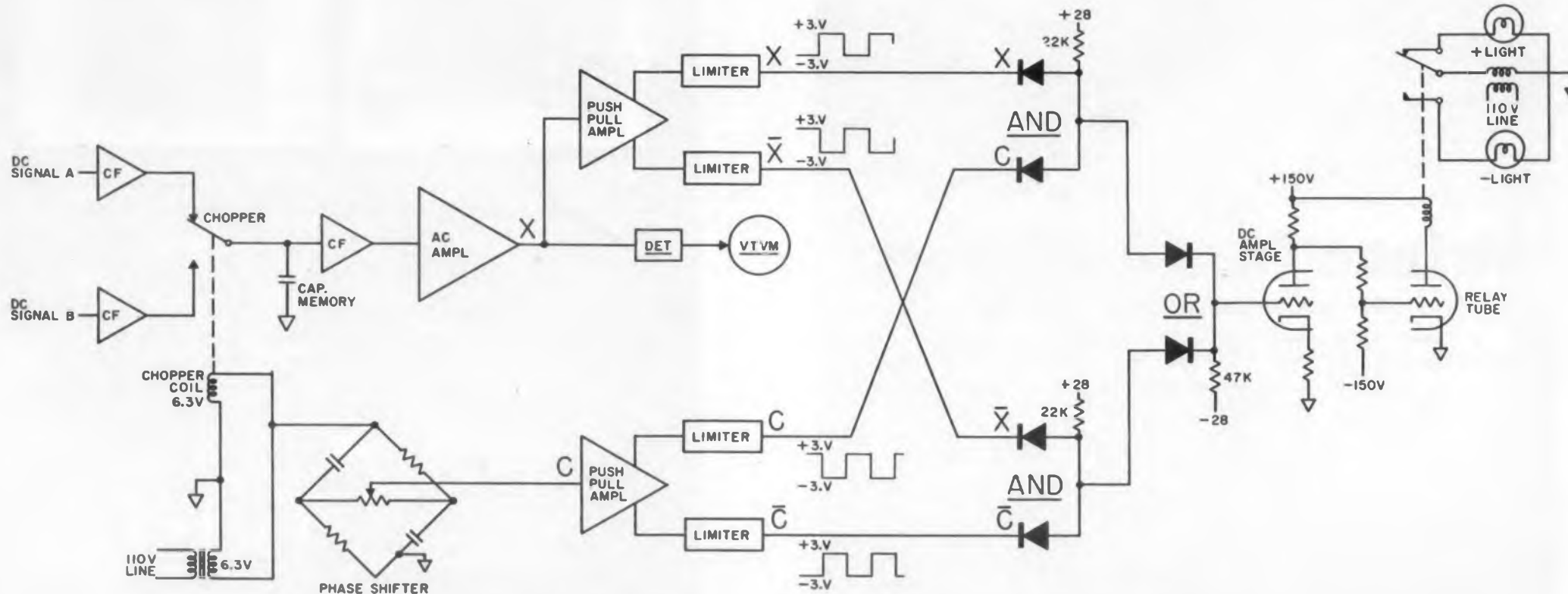


Fig. 4. Logical and digital techniques are used to make a phase sensitive difference voltmeter.

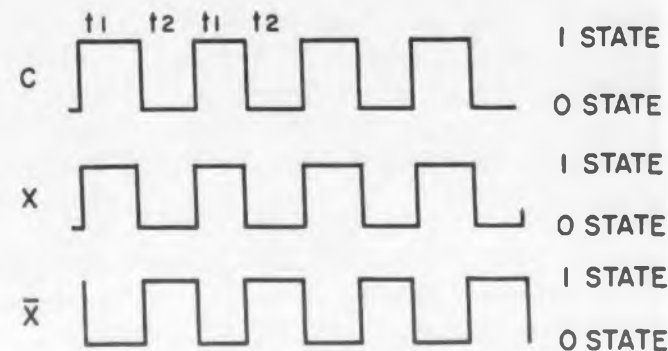


Fig. 1. Timing diagram with X, the clipped amplifier output when in phase with the chopper drive, and X-bar the out of phase output.

Since the vtm does not distinguish polarity, a separate circuit operates two lights to indicate the polarity of the difference signal. This circuit logically compares the amplified and clipped output of the amplifier to the squared up signal that drives the chopper. If these signals are in phase, we get a true output, if not, we get false. These true and false signals are strong enough to saturate or cut off a vacuum tube which drives a relay to control the individual lights.

### Logical Polarity Comparator

The desired performance of the logic box to detect polarity is summarized by the Truth Table in Fig. 2, which refers to the timing dia-

gram in Fig. 1. The table shows that:

With  $X$  true AND  $C$  true, output is true.  
 With  $X$  false AND  $C$  false, output is true.  
 With  $X$  false AND  $C$  true, output is false.  
 With  $X$  true AND  $C$  false, output is false.  
 ( $X$  is a chopped dc input signal.  $C$  is the squared up chopper drive signal.

In logical symbols, the truth table is expressed by Fig. 3. Diode logic and voltage gating are used as in Fig. 4. Here +3 v represents the True or 1 state, and -3v represents the false or 0 state.

David H. Bryan, Senior Electronic Eng., Hughes Aircraft Co., Culver City, Calif.

\*Since a "perfect chopper" wasn't handy, we used a regular chopper with a capacitor memory. This prevented the chopper output from dipping to zero during the transition time of the vibrating reed. Input followers reduced the capacitive coupling between contacts and the reed, since this coupling lowers the contact impedance to ground. An input cathode follower extended the memory time without the need for a huge capacitor.

## TRUTH TABLE

TIME	X	C	DESIRED OUTPUT STATE
t <sub>1</sub>	1	1	1
t <sub>2</sub>	0	0	1
t <sub>1</sub>	0	1	0
t <sub>2</sub>	1	0	0

Fig. 2. Truth table represents the timing diagram conveniently.

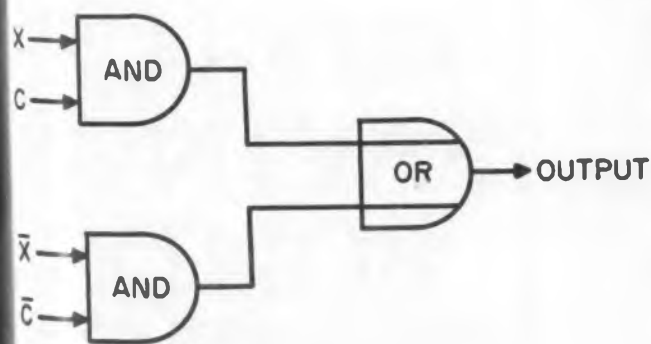


Fig. 3. Logical expression of truth table.

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Temproof Mountings are available as individual isolators or as component parts of complete mounting base assemblies. Full information is contained in Bulletin 710, available from your nearest LORD Field Engineer or the Home Office, Erie, Pa.



All-Attitude Temproof Mountings—may be loaded in any direction; installed on base, bulkhead or overhead. Two sizes—0 and 1—with load ratings from 0.35 to 5 pounds per mounting.

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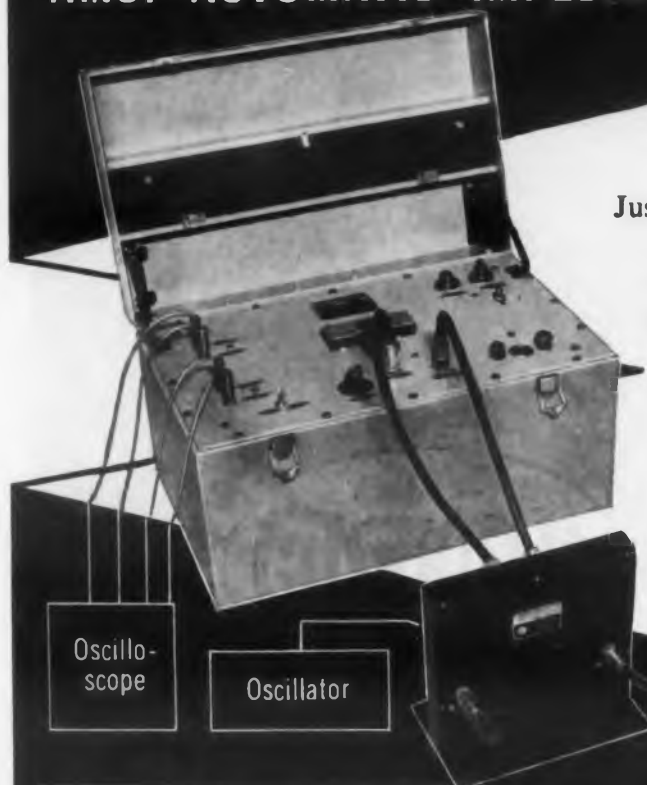
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## IDEAS FOR DESIGN

### Direct Reading "Shock"

Shock levels for different block arrangements on the Barry 150/400 VD sand drop shock machine are not presented directly on the machine. Setting up shock tests necessitates converting manual data to an ordinary scale on the machine. This process is extremely time consuming.

A multiple scale was developed which presents the acceleration levels for each drop height and block arrangement. This scale replaced the ordinary inch scale supplied with the machine. Acceleration levels are presented in increments of 5 g's and drop height in increments of 1 in. The block arrangements and pulse time are presented on a reinforced transparent indicator which is attached to the movable platform. The platform is raised to the desired drop height and the acceleration and pulse time can be determined directly for a particular block arrangement without time consuming data conversion.

David D. Blair, Jr., Senior Systems Design Eng., Chance Vought Aircraft Inc., Dallas, Texas.

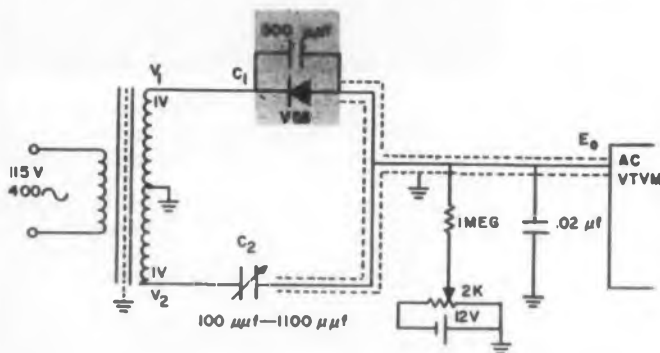
### Bridge To Measure Voltage Variable Capacitors

We needed to measure the range of capacitance variation of the V56 Varicap (Pacific Semiconductor Industries) at 400 cps. This is a silicon pn junction device designed to work as a voltage variable capacitor. We wanted a bridge whose accuracy would not be affected by the impedance of the dc bias control.

The three terminal bridge, shown in the figure, did the trick. Its ac output voltage is

$$E_o = \frac{j\omega(V_1C_1 - V_2C_2)}{j\omega(C_1 + C_2 + C_3)} + 1/R_{dc}$$

At null ( $E_o = 0$ ),  $V_1C_1 = V_2C_2$ , so the bridge accuracy is not affected by the dc supply impedance.  $C_2$  is a calibrated voltage variable capacitor.



Three terminal bridge measures voltage variable capacitors.

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Photograph by Howard Zief

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tor to rebalance the bridge when the dc control function is varied.

The 500  $\mu\text{f}$  capacitor across the voltage variable capacitor brings  $C_1$  to a capacity level in the range of  $C_2$ .

*Jerome Lyman, Electrical Engineer, Liqui-dometer Corp., Long Island City, N.Y.*

## Selecting Tapping Screws

Analyzing design factors instead of using rules of thumb in selecting tapping screws provides easier assembly and greater assurance of sound joints. Fastener specialists point out some of the important factors to consider.

Of the five common types of tapping screws, two are thread forming and three are thread cutting. The thread forming screws, types A and B, should be used with material, ductile enough to permit the deforming action of the screw. Type A is pointed and should be used in pierced rather than drilled holes, and where the exposed point doesn't matter.

Where the material is very hard or thick, types A and B may require too much driving effort. Then one of the thread cutting screws should be used. For hard, ductile materials, type 1 is best; while type 23 is best for soft, friable materials.



Type F, with four equally-spaced longitudinal slots, drives straighter than the other types.

Where load is not a factor, the metal thickness determines the screw diameter. Use a screw whose thread pitch gives at least one full thread engagement in the metal. For example, with metal 1/16 in. thick, any screw with at least 16 threads per inch can be used.

Where the load must be considered, use a screw strong enough to take the load, and one that provides the greatest thread engagement—four or five threads fully engaged, if possible. If a screw large enough to develop enough holding power doesn't have enough thread engagement, use a greater number of smaller screws.

The size of the hole in the metals to be joined is very important. If the hole is too large, the screw cannot develop enough thread depth; if too small, the screw will be hard to drive. The required hole size varies with the material thickness, type of material and style of screw.

*Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, N.Y.*

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- TEMPERATURE RANGE
- CAVITY TEMPERATURE STABILITY
- TEMPERATURE CONTROL
- Less than 0.01°C drift per degree ambient change
- STABILIZATION TIME
- Approximate 10 minutes
- AMBIENT TEMPERATURE RANGE
- Operating at 10 to 50°C
- Storage - 0 to 70°C
- CONSTRUCTION
- STAINLESS STEEL
- 3.75" x 2.75" x 2.75" (95 mm)
- WEIGHT
- Approximately 1.5 lbs (0.7 kg)
- POWER CONSUMPTION
- Approximately 1.5 W
- OPERATING VOLTAGE
- 115V AC, 60 Hz
- OPERATING CURRENT
- Approximately 15 mA
- OPERATING TEMPERATURE
- 10 to 50°C
- STORAGE TEMPERATURE
- 0 to 70°C
- RELATIVE HUMIDITY
- 5 to 95%
- SHOCK
- Approximately 10 g
- VIBRATION
- Approximately 10 g



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Diode Logic	0.7 $\mu\text{sec}$ max
Transistor Logic	1.5 $\mu\text{sec}$ max
Signal Voltage Levels	0 and -6 volts
DC Supply Voltages	$\pm 18$ volts, $\pm 6$ volts
Temperature Range	$-55^{\circ}\text{C}$ to $+75^{\circ}\text{C}$



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## REPORT BRIEFS

### Electromagnetic Research

This paper presents current electromagnetic research efforts and research completed during the past few years at New York University. In the research itself emphasis has been placed on basic problems involving appreciable mathematical methodology. However, this account describes the results from the standpoint of their contribution to microwave problems, ionospheric and tropospheric propagation, diffraction, the inverse propagation and synthesis problems, antenna and waveguide theory, and other physical problems. *Electromagnetic Research at The Institute of Mathematical Sciences of New York University by Morris Kline, New York University, Institute of Mathematical Sciences, Div. of Electromagnetic Research, New York, N.Y., July 1956, 20 pp, microfilm \$2.40, photocopy \$3.30. Order PB 126370 from Library of Congress, Washington 25, D. C.*

### Influence of Magnetic Saturation

In order to investigate the effect of saturation on transients and on voltage regulating properties, transients in a linear machine are compared with those in a machine with saturation. The usual methods for treating a linear machine are developed so that the additional complications arising from losses in the stator circuit and from the damper-winding on the rotor are taken into account. The stability conditions in connection with an actual high-speed regulator are also considered. The effect of saturation on transients is shown by a number of examples and experimental recordings. The stability limit with capacitive impedance load is calculated and checked by tests. Where relevant to working with a long line, practical aspects are discussed. *Influence of Magnetic Saturation on Transients and Voltage Regulating Properties of Synchronous Alternators, with Special Reference to Large Capacitive Loads by Erkki Voipio, Sweden, Kungl. Tekniska Högskolan, Stockholm. 1955, 126 pp, photos, diagrams, graphs, tables, microfilm \$6.30, photocopy \$19.80. Order PB 124923 from Library of Congress, Washington 25, D.C.*

### Two-Channel Receiver

The principles of a matched channel receiver for RDF applications are described where in the incoming signal selection is made by local oscillator tuning only. Several of the design problems are discussed, especially those dealing with the

input circuit and phase and gain matching. The design data and circuits for various parts of the receiver are given. *Phase and Gain Matched Two-Channel Receiver with Signal Selection by Local Oscillator Tuning Only*, by Harold D. Webb, Illinois, Engineering Experiment Station, Electrical Engineering Research Lab., Urbana, Ill. May 1956, 41 pp, diagrams, graphs, tables, microfilm \$3.30, photocopy \$7.80. Order PB 126677 from Library of Congress, Washington 25, D.C.

### Measuring Contact Potential Differences

A widely used modification of the Kelvin method measures the contact difference of potential between two metals by making them the plates of a vibrating condenser and measuring resulting ac flowing in an interconnecting resistor. Such an apparatus is described in which the time changes of the potential difference are to be observed in various controlled gaseous atmospheres. This report describes the factors which influence the improvement of the sensitivity and the stability of the apparatus. A routine reset accuracy of better than  $\pm 1$  mv has been obtained in the determination of the contact potential difference. With stabilized, aged condenser electrodes in a constant atmosphere, an overall stability of  $\pm 5$  mv was measured over 96 hours. *Improvements in The Vibrating Condenser Method of Measuring Contact Potential Differences*, by K. Bewig, U. S. Naval Research Laboratory. Feb. 1958, 10 pp, diagrams, graphs, table, 50 cents. Order PB 131530 from OTS, U. S. Dept. of Commerce, Washington 25, D.C.

### Phase-Frequency Characteristics

Contents: the Taylor approximation in the low interval; an outline of Darlington's approximation method by Chebyshev polynomial series; the "Chebyshev" approximation of an arbitrary low-interval phase; the Taylor approximation of an arbitrary band-interval phase; the Taylor approximation for band-interval attenuation phase; transformations using elliptic functions; Examples of band-interval "Chebyshev" approximation; some mathematical notes; Conclusions. Appendix A: notes on some Chebyshev approximations. Appendix B: the "delay" functions. *On The Approximation of Arbitrary Phase-Frequency Characteristics*, by Victor H. Grinich, Stanford University, Electronics Research Laboratory, Stanford, Calif. May 1953, 151 pp, diagrams, graphs, tables, microfilm \$7.50, photocopy \$24.30. Order PB 126342 from Library of Congress, Washington 25, D.C.

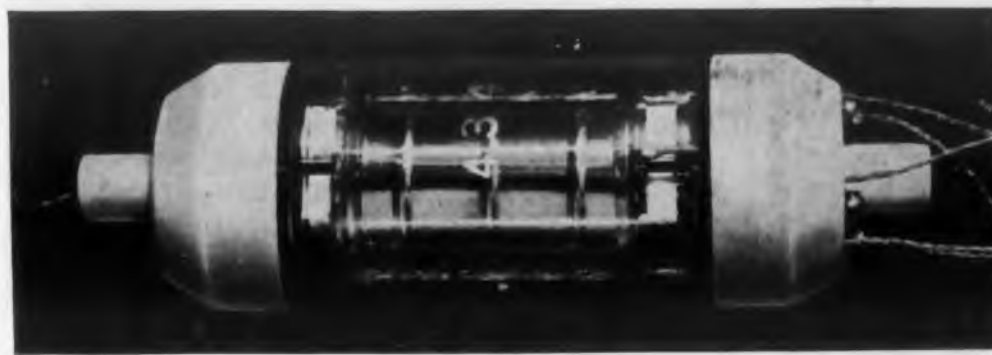
# Nickelonic News



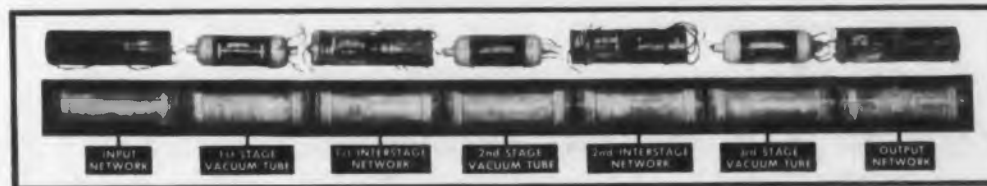
DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS



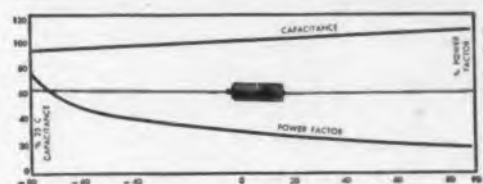
## Underseas two years: Atlantic phone cable amplifier tubes retain full emission, promise 20 years continuous service



175HQ amplifier tube used in underseas phone cable repeaters. There are 306 tubes in the Atlantic cable. All rely on parts made of Nickel.



Nickel parts are essential in the 175HQ tubes, shown in this portion of phone cable repeater unit. Tubes designed and built at Bell Telephone Laboratories, Inc.



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### Small, rugged electrolytic capacitor... Nickel leads boost its strength

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quick, strong spot welding. (2) solders easily — speeds hermetic sealing, and assembly into circuits. (3) meets stringent mechanical specifications — leads (0.0201" diameter) withstand 30 second pull test of 3 pounds, four 90° alternate bends.

Pertinent literature: Write for "Inco Technical Bulletin 544

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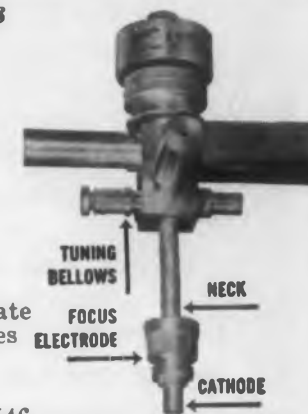
### Non-magnetic Monel "403" alloy aids precise tuning by klystron bellows

SAN BRUNO, CAL.: The low permeability of Monel "403" non-magnetic nickel-copper alloy (1.1 max. at 27°F) in the tuning bellows of this new Eimac X-639 Klystron permits precise frequency adjustment without disturbing the tube's magnetic circuit. And... the good forming and brazing characteristics of Monel "403" alloy make for easy bellows manufacture.

Inco Nickel for the cathode assures stable emission characteristics. Electronic grade "A" Nickel for the focus electrode is readily formed, does not contaminate vacuum. Monel\* nickel-copper alloy for the neck provides strength at elevated temperatures... withstands oxidation and corrosion.

Pertinent literature: Write for Inco Technical Bulletin 546

Nickel and Monel alloys aid manufacture, operation of this Eimac X-639 Klystron by Eitel-McCullough, Inc. Delivers 50 watts in 7100-8500 mc range.

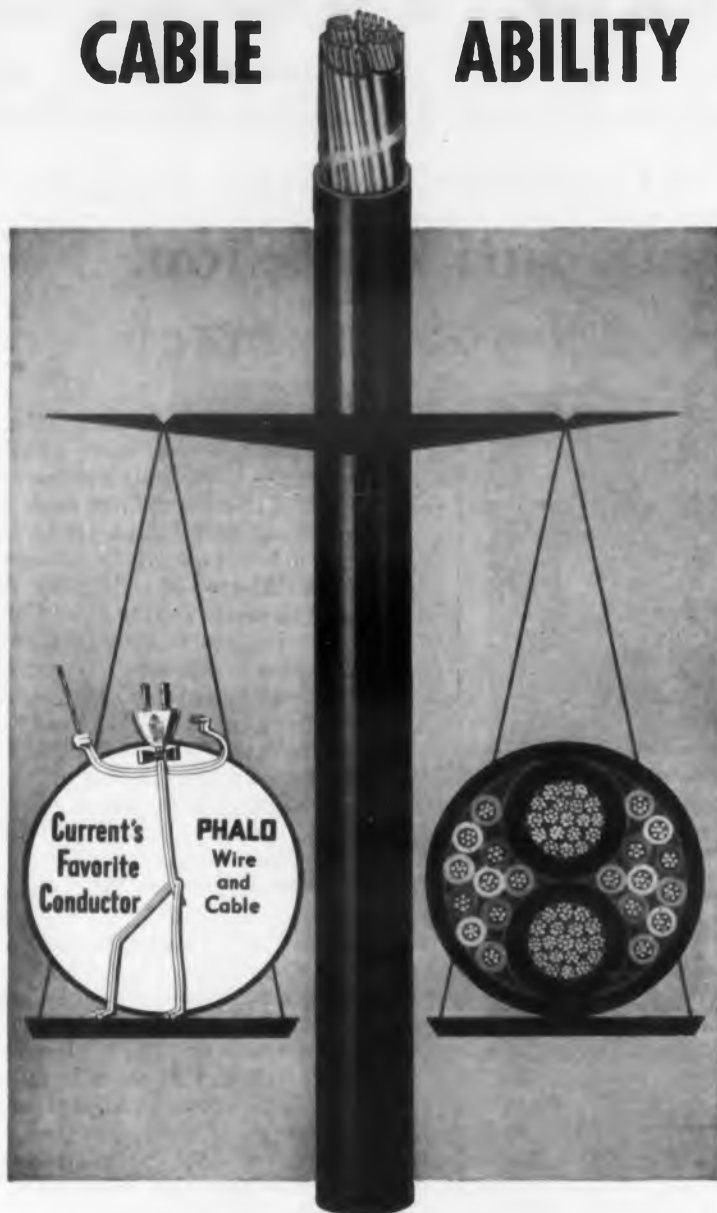


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## REPORT BRIEFS

### Hypersonic Shock Tube

Theoretical and experimental studies were made of the feasibility of using a shock tube for quantitative investigations of hypersonic flow phenomena at temperatures simulating free-flight conditions. Discussions are given of high Mach number production, limitations on the test section Mach number, methods of generating strong shock waves, flows with variable specific heats and dissociation, and types of problems amenable to study with the hypersonic shock tube. The experimental investigations to date have dealt with pressure studies using piezoelectric gages and Schlieren studies of the flow. *Hypersonic Shock Tube*, by Y. A. Yoler, California Institute of Technology, Guggenheim Aeronautical Laboratory, Hypersonic Wind Tunnel, Pasadena, Calif. July 1954, 183 pp, photos, graphs, microfilm \$8.40, photocopy \$28.80. Order PB 126833 from Library of Congress, Washington 25, D.C.

### Dielectric Condensers

The article describes the technical and technological elements which served as a basis for the evolution of two series of metal foil/paper condensers encased in metal housings (parallelepiped shape in one case, and tubular in the other). These items are comparable to better foreign products of the same type. Translated from *L'Onde Electrique*, Vol. 36, No. 348, Mar. 1956, pp 194-213. *Development of "Standardized Series of Impregnated Paper Dielectric Condensers (Capacitors)"*, by C. M. Laurent, translated and edited by F. A. Raven, Sept. 1956, 54 pp, photos, drawings, diagrams, graphs, tables, microfilm \$3.60, photocopy \$9.30. Order PB 124802 from Library of Congress, Washington 25, D.C.

### Antennas

This report states the results of a study of various antenna types having characteristics suitable for use in VHF ionospheric scatter applications for point-to-point communications over distances of approximately 1900 to 2200 km. *Antennas for the Extreme Distance Range of VHF Ionospheric-Scatter Propagation*, Page Communications Engineers, Inc., Washington, D.C. Nov. 1955, 92 pp, diagrams, graphs, tables, microfilm \$5.40, photocopy \$15.30. Order PB 126147, Library of Congress, Washington 25, D.C.

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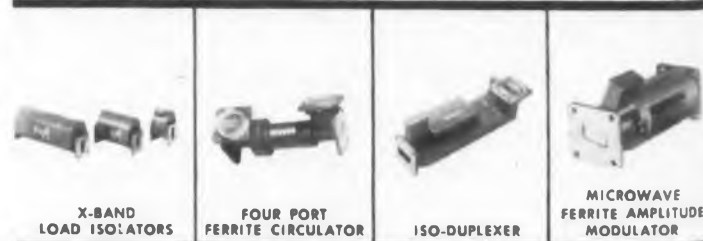
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## Extraction of Noise

Message reliability is formulated in terms of risk, or average cost, associated with the process of extraction of random signals from a white-noise background. The optimum extraction process is obtained for cost criteria of different forms, and expressions for the corresponding risk are presented, together with curves which show their dependence on the signal-to-noise ratio. Extension of the theory to more general cases is briefly considered. *On The Extraction of Noise Like Signals from A Noisy Background*, from *The Risk Point of View*, by Neil Ashby, U. S. Air Force, Air Research and Development Command, Cambridge Research Center, Electronics Research Directorate, Components and Techniques Laboratory, Bedford, Mass. Dec. 1956, 35 pp, graphs, microfilm \$3.00, photocopy \$6.30. Order PB 126376 from Library of Congress, Washington 25, D.C.

## Reflection of Electromagnetic Waves

By solving the integral equation of Hallen it is possible to compute the current which is caused in a straight thin metal strip by an outside incidental electromagnetic field. The present work deals with various methods for approximately solving the integral equation, and the current is represented both in the form of standing waves and in the form of waves continuously reflected. The radiation caused by the current arising has been computed. *Reflection of Electromagnetic Waves from Thin Metal Strips (Passive Antennae)*, by Kristen Lindroth, Kungl, Tekniska Hogskolan, Stockholm, Sweden. 1955. 64 pages, diagrams, graphs. Order PB 124920 from Library of Congress, Washington 25, D. C.

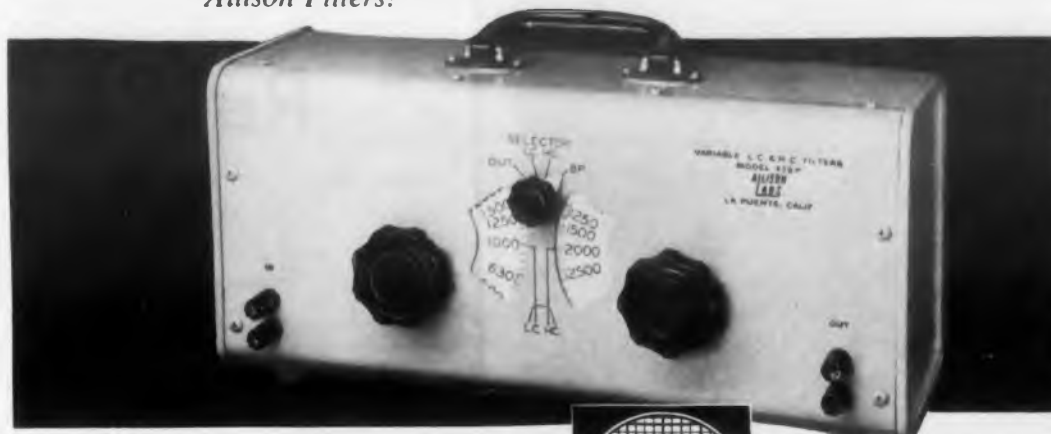
## Fibrous Microwave Absorber

Microwave absorbers made in the form of mats using fibrous materials impregnated with pigmented rubber solutions have been found to give efficient broadband absorption from 2,500 to 30,000 mc with less than 5 per cent of the reflection obtained from a smooth metal plate. Modifications of these absorbers can be made to fill such requirements as fire resistance, mechanical strength, and indifference to water and weathering. These absorbers are adaptable to mass production techniques and have been used successfully in radar dark rooms for antenna research. *Darkflex, A Fibrous Microwave Absorber*, H. A. Tanner, A. G. Sands, and M. V. McDowell, U.S. Naval Research Laboratory. April 1953, 11 pp, microfilm \$2.40. Order PB 130312 from Library of Congress, Washington 25, D.C.

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STYLE	PHOTO-ELECTRIC	DOUBLE BRUSH	BRUSH	BRUSH	DOUBLE BRUSH	BRUSH
RESOLUTION	1 PART IN 512	1 PART IN 8192	1 PART IN 256	1 PART IN 198	1 PART IN 128	1 PART IN 8192
MILLI-AMPS/DIGIT	.075 (MAX.)	10 (MAX.)	10 (MAX.)	15 (MAX.)	10 (MAX.)	10 (MAX.)
CONT. SPEED (RPM)	HIGH SPEED†	150 (MAX.)	150 (MAX.)	150 (MAX.)	150 (MAX.)	50 (MAX.)
OPERATING TORQUE	.05 OZ-IN. (MAX.)	.50 OZ-IN. (MAX.)	.20 OZ-IN. (MAX.)	.22 OZ-IN. (MAX.)	.31 OZ-IN. (MAX.)	.40 OZ-IN. (MAX.)
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# What The Russians Are Writing



J. George Adashko

## INFORMATION THEORY

**Conditions for Obtaining High Carrying Capacity in Communication Channels with Random Variations of Parameters** by V. I. Siforov. EC 1/58, pp 3-8.

Communication channels with a random parameter variation are classified into two kinds, in accordance with their carrying capacity at low level of additive noise. The author introduces the concept of the intrinsic carrying capacity of channels of one of these types. If the total bandwidth of the frequency spectra of all the random-varying parameters of a multiple channel is less than its frequency bandwidth, then its carrying capacity increases without bound as the level of additive noise is reduced without limit. Refers to work by Shannon (The Zero Error Capacity of a Noisy Channel *IRE Transactions*, IT-2, No. 3, 1956) Elias (Predictive Coding, *IRE Transactions on Information Theory* IT-1, No. 1, 1955) and Feinstein (A New Basic Theorem of Information Theory *IRE Transactions*, IGIT-4, 1954).

**Distribution of the Envelope at the Output of a Selective System Under Accidental Frequency Deviations** by A. V. Prosin. EC 1/58, pp 9-14, 3 figs.

A method is given for determining the

distribution curves for the envelope of the amplitudes at the output of selective systems owing to accidental swings of the voltage frequency. The distribution curves are obtained for the output of resonant systems consisting of  $n$  identical networks and  $n$  pairs of coupled networks. The condition is that the modulating voltage has a normal distribution and that the so-called quasi-stationary solution is used for the output oscillations. Simple formulas are obtained for the distribution function of a quantity that is the reciprocal of the voltage amplitude. On the basis of these formulas it is possible to calculate the probability that the envelope will exceed a previously specified value. The probabilities are plotted for various values of both the parameters of the selective systems and of the parameters of the messages. This makes possible an estimate of the requirements that must be satisfied by the amplitude limiters.

**Principle of Quantization of Stochastic Signals with Unlimited Spectrum and Certain Results in the Theory of Pulse Transmission of Communication** by N. A. Zheleznov. REE 1/58, pp 3-18, 2 figs.

The principle of quantization, which establishes the possibility of representing continuous signals with the aid of a

discrete aggregate of quantities, shifted relative to each other with time, is extended to include the case of stochastic signals with unlimited spectrum. A theorem is proved for the optimum expansion of the signals into orthogonal components, yielding a minimum rms error. For the transmission of pulse-modulated signals there exists a maximum possible fidelity, which cannot be exceeded for any modulation method. A method for selecting the characteristics of a transmission line to insure high fidelity is described.

**Interference Immunity of Hamming's Code by G. A. Shastova. REE 1/58, pp 19-26, 8 figs.**

The interference immunity of transmission of discrete communications by the Hamming code, by simple binary codes, and by a code with repetition and protection are compared subject to two initial conditions. The first condition is that the probability of distortion of one symbol be constant, the second is that the energy of the signal, which can be used for the transmission of a single communication, be constant. Conditions are obtained under which the Hamming code insures a higher interference immunity. Refers to work by Hamming (*Bell System Technical Journal*, 1950,

29, 147-160) and Elias (*Transactions IRE PGIT-4*, 1954).

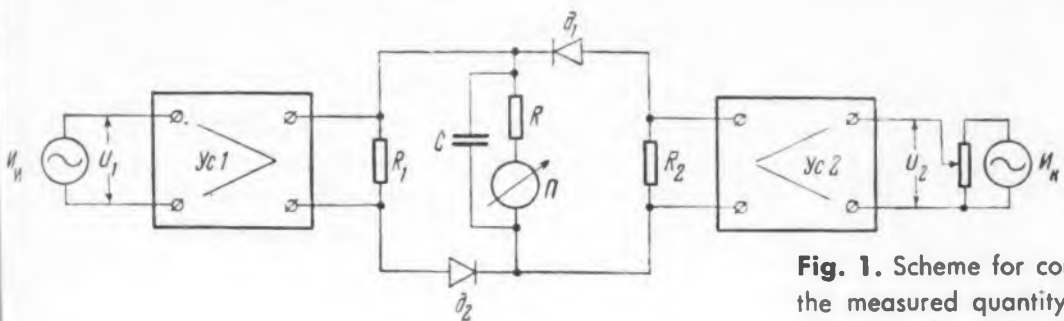
## MEASUREMENTS

**New Method for Measuring Very Small Alternating Electric Quantities by V. S. Voyutskiy. REE 2/58, pp 244-248, 3 figs.**

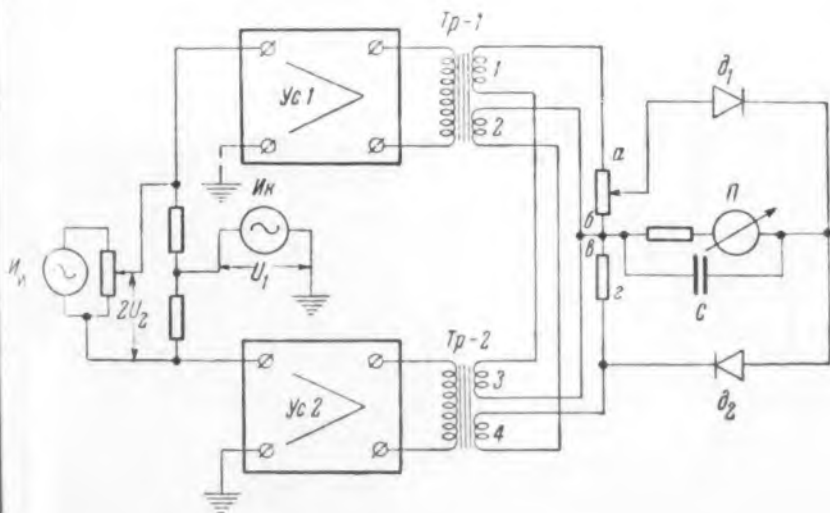
Description is given of a null-type compensation method for measuring very small (noise) electric voltages (or currents), whose level is considerably below the level of the intrinsic noise of the apparatus. This method is equivalent to the modulation method with respect to the freedom of the results from the fluctuations in the apparatus parameters and of the level of the apparatus noise, but does not require computing devices. An analysis of the method is given, circuits are shown, and results of the experiments are reported. See Figs. 1 and 2.

**Sensitivity of a Radio Meter with Automatic Gain Control by N. V. Karlov and P. N. Lebedev. REE 1/58, pp 74-79.**

Expressions are obtained for the sensitivity of a modulation radio meter, in which the sensitivity threshold is reduced by the use of automatic gain control. In practice, this changes the natural sensitivity threshold. The advisability of using automatic gain control



**Fig. 1.** Scheme for comparing the measured quantity on the left with a standard quantity on the right.



**Fig. 2.** The newly proposed comparison circuit.



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## RUSSIAN TRANSLATIONS

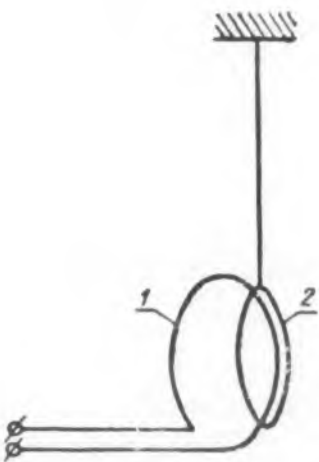
in the presence of fluctuations in the gain and in the case when the receiver has a noise factor is discussed. Reference is made to work by Selove (*Review of Scientific Instruments*, 1954, Vol. 25, page 120), Machin, Ryle, and Vonberg (*Proceedings IRE*, 1952, Part III, Vol. 99, page 177), and Ryle (*Proceedings Royal Society*, 1952, 211 A, 359).

**Measurement of the Bandwidth of the Signal Radiated by a Radio-Telegraph Transmitter by M. S. Gurevich.** *Measurement Engineering, (Izmeritel'naya Tekhnika)*, 1-2/58, pp 62-67, 10 figs.

The bandwidth occupied by the radiation of a transmitter is defined as the frequency band that contains 99 percent of the radiated power. It includes any discrete harmonic, whose power amounts to not less than 0.25 per cent of the total radiated power. The author considers methods for measuring this bandwidth, and gives several experimental results. He also lists various methods used for this measurement.

**Electrodynamic Ammeter for the Measurement of High Frequency Currents by V. R. Lopan'.** *Measurement Engineering (Izmeritel'naya Tekhnika)*, 1-2/58, pp 71-74, 2 figs, 1 table.

Electrodynamic ammeter developed at the Scientific Research Institute for Physical-Technical and Radio Technical Measurements, is described for measuring currents from 5-100 amp in the frequency range from 1 to 100 mc. The various errors in current in such measurements are discussed and tabulated. See Fig. 3.



**Fig. 3.** The meter movement for high current measurements at high frequencies.

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**Phase Sensitivity of Frequency Multipliers** by M. Z. Klyumel'. *Measurement Engineering (Izmeritel'naya Tekhnika)*, 1-2/58, pp 58-62, 2 figs.

The phase-sensitivity of a frequency multiplier is important in designing molecular microwave generators. The article describes briefly the final results of an experimental investigation of the phase sensitivity of multipliers in this range.

### CIRCUITS

**Investigation of the Stationary Mode of Operation of a Regenerative Frequency Divider with a Two to One Ratio** by V. S. Andreyev. *REE* 2/58, pp 214-226, 7 figs.

Although regenerative frequency divider circuits have been in use since 1939 (see R. L. Miller, Fractional-Frequency Generator Utilizing Regenerative Modulation, *Proceedings IRE*, 1939, 27, 7, 446), they have not yet been theoretically investigated, even in the stationary mode. The author uses the "abbreviated" system of equations to derive relations which would permit an analytical calculation of the circuit. The theoretical equations and the characteristics are different for circuits in which the tuned circuit employs an iron-core transformer and for those where an air-core transformer is used. Higher selectivity is obtained with air-core transformers, and higher phase-stability is obtained with iron-core transformers.

**Operation of a Ring Converter at Small Input Signals** by V. S. Andreyev. *RE* 12/57, pp 10-18, 7 figs.

The nonlinear elements of the ring converter are approximated by an exponential function. Relations are derived for the dependence of the output signal and the input impedances on the input signals and on circuit parameters. Numerical methods are used to solve the transcendental equation. It is shown that the purest multiplication of the input signal is reached for certain definite relationships between the circuit parameters.

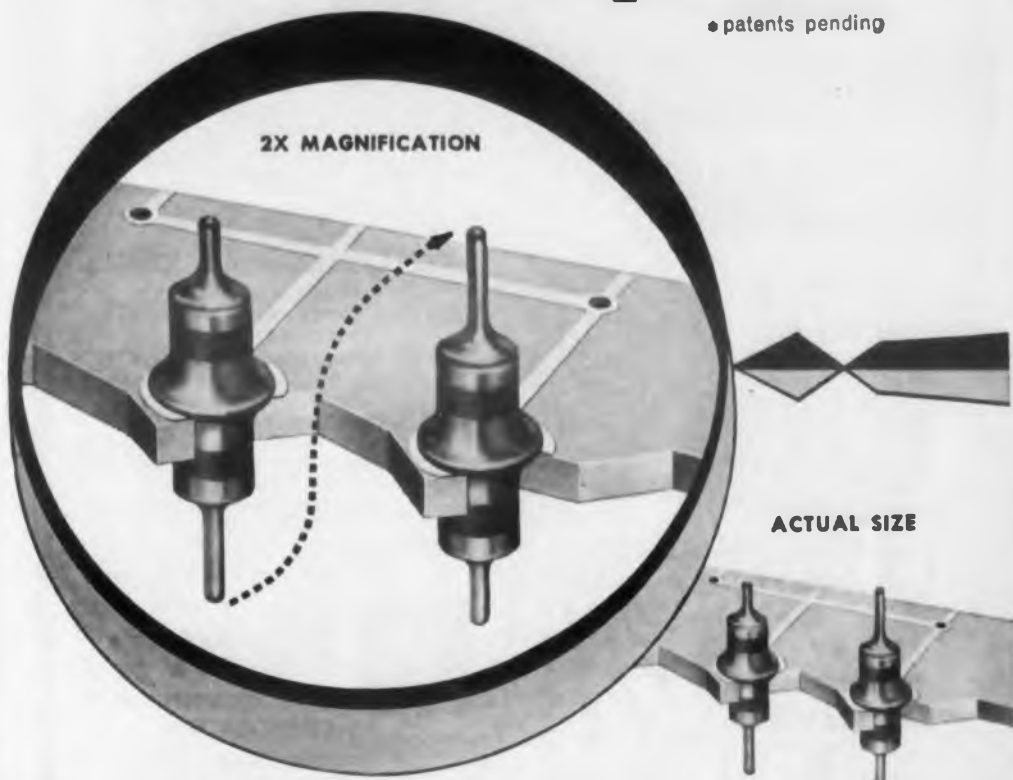
**Synthesis of Mixed Relay Circuits of The Series-Parallel Type** by V. N. Roginskiy. *AT* 12/57, pp 1120-1131, 6 figs.

A Boolean treatment of analytical methods for equivalent transformations of switching circuits. It includes means for obtaining mixed relay systems by introducing elements of finite conductivity. The application of these methods in the synthesis of multi-relay circuits may reduce the number of contacts in the circuits. Reference is made to work by Shekel, "Sketch for an Algebra of Switchable Networks" (*Proceedings IRE*, Vol. 41, July 1953).

(Continued on page 184)

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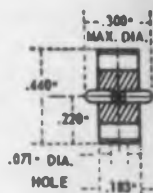
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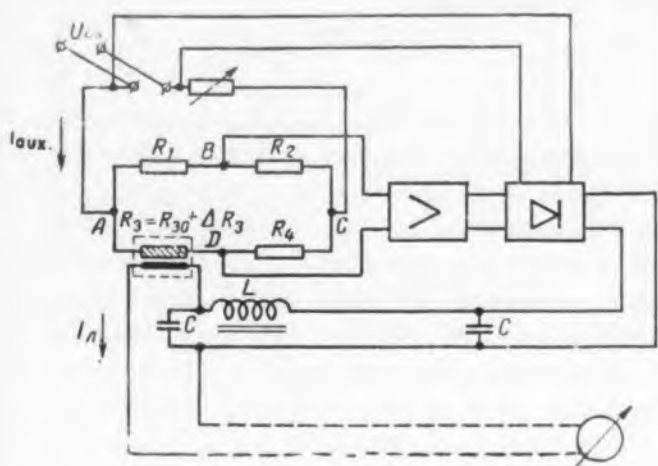
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## RUSSIAN TRANSLATIONS

**Null Type Telemetry System with Static Transmitter by V. S. Popov. Measurement Engineering (Izmeritel'naya Tekhnika), 1-2/58, pp 43-47, 4 figs.**

A telemetry system patented in Russia is described, in which the compensating element is not dynamic, but static (a thermistor). The circuit, shown in Fig. 4, is described in detail, along with the construction of the indirectly-heated thermistor.



**Fig. 4.** The telemetry system with a thermistor as the compensating element.

The telemetry system consists of a bridge, fed from a commercial-frequency source. The line is connected to the output of the bridge through an amplifier, phase-sensitive rectifier, and a LC filter to smooth the pulsating current. A negative feedback loop, insuring automatic balancing of the bridge, is formed by connecting the filament of the thermistor in the line. When the measured quantity changes, the changed resistance of one or several of its arms unbalances the bridge. The resistance arms are so chosen that the bridge balances automatically by change of the filament current over the entire range of measurement.

**Nomogram for the h-Parameters of Transistors by E. M. Manukian. RE 12/57, pp 29-35, 3 figs, 1 table.**

Equivalent two-terminal pair network parameters expressed as  $h$ -parameters are most suitable for low frequency calculations. The article gives the most widely used formulas and a nomogram with which one can calculate the  $h$ -parameters and also convert  $h$ -parameters into equivalent  $T$  circuits. An example illustrates the use of the nomogram. The  $h$ -parameters are treated in detail by Lo and others in "Transistor Electronics," 1955.

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**Certain Problems in the Design of Broadband Discharge Gaps** by L. R. Yavich. REE 1/58, pp 94-104, 11 figs.

A method is proposed for the design of the optimum loaded Q-factor of tuned discharge-gap elements for the protection of receivers and of certain types of four-terminal networks, which have a broadband characteristic. Generalized frequency characteristics that are obtained by this procedure are given. Formulas are derived for the analysis of the equivalent circuits that contain segments of transmission lines. Refers to work by Mumford (*Bell System Technical Journal*, 1948, 4, 684-714), Chen (*RCA Review*, 1954, Vol. 15, pages 204-229), Fano (*Journal of the Franklin Institute*, 1950, pages 57-83 and 139-154).

**Relaxation Oscillators Employing Point-Contact Transistors** by V. N. Yakovlev. REE 1/58, pp 61-73, 16 figs.

Phase plots are drawn for oscillators with emitter-collector and collector capacitances, and their possible operating modes are investigated. Expressions are obtained for the temporal parameters of the pulses. An investigation is also made of the dependence of the duration of the wave front on the parameters of the circuit and of the transistor. Conditions are derived for the occurrence of jumps in the self-oscillation mode. A procedure is indicated for the design of the oscillator. Reference is made to work by Lo (*Proceedings IRE*, 1952, Vol. 40, No. 4, page 1531) and Anderson (*Proceedings IRE*, 1952, Vol. 40, No. 4, page 1541).

**Distortion in the Dynamics of Transmission in a System Consisting of a Compressor, an Intermediate Channel, and an Expander** by V. I. Tsapalina. EC 1/58, pp 58-67, 6 figs, 3 tables.

The effect of increasing the interference rejection of long-distance telephone and broadcast channels, by compressing the dynamic range of the transmission on the transmitting end and subsequently restoring of the level at the receiver is discussed. This involves the appearance of inherent distortion, whose values are approximately determined in this article.

### WAVE PROPAGATION

**Possibility of Amplifying the Power of a Weak Modulating Signal by Means of a Gyromagnetic Medium** by V. A. Fabrikov. REE 2/58, pp 190-197, 1 fig.

The oscillations of a gyromagnetic medium under the circular polarization are discussed, when arbitrary frequency is applied in the di-

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## RUSSIAN TRANSLATIONS

rection of the permanent magnetization of the material. The equations of motion of the gyro-magnetic moment are solved in the first approximation in terms of the amplitude of the weak modulating field. Conditions are obtained under which the imaginary part of the complex magnetic permability of the medium becomes positive with respect to this field. This corresponds to power amplification of the modulating signal on the part of the medium. The resonance relationship between the frequencies causing maximum amplification is determined. Reference is made to work by Codrington, Olds and Torrey (*Physical Review*, 1954, 95, 607), Wangness (*Physical Review*, 1955, 98, 927), Rabi, Ramsey and Schwinger (*Reviews of Modern Physics*, 1954, 26, 167), Kaplan (*American Journal of Physics*, 1955, 23, 585) and Pippin (*Proceedings IRE*, 1956, 44, 1054).

**Effect of Dielectric Film on the Attenuation of  $H_{01}$  Wave in a Straight Nearly-Circular Waveguide** by B. Z. Katsenelenbaum. REE 1/58, pp 38-45.

A thin semiconducting film, placed on the internal surface of a waveguide, causes attenuation of the wave propagating in the guide. An article by Malin (Effect of Semiconducting Film on Attenuation of Waves in a Round Waveguide, *Radiotekhnika i Elektronika*, Vol. 1, 1956, No. 1, page 34) showed that in a round waveguide this attenuation has a different order of magnitude for waves of type  $H_{0m}$  on one hand, and for all other types of waves on the other. In this article the author calculates the additional attenuation for the  $H_{0m}$  mode, due to small deformation of a round waveguide, not accompanied by curvature of the axis. Reference is made to work by Morgan (*Journal of Applied Physics*, 1950, 21, 329), Miller (*Proceedings IRE*, 1952, Vol. 40, No. 9, page 1104), and Sims (*Proceedings IEE*, 1953, 100, Part IV, No. 5, page 25).

**Optimum Linear In-Phase Antenna with Continuous Current Distribution** by I. F. Sokolov and D. Ya. Vakman. REE 1/58, pp 46-55, 8 figs.

Dolph (*Proceedings IRE*, 1946, Vol. 34, No. 6, page 335) developed a method for calculating the optimum linear in-phase antennas, consisting of individual dipoles. This method is extended by the authors to include antennas with continuous distribution of current along the dipole. They derive and analyze formulas for the directivity patterns, for the distribution of the current amplitude, and for the efficiency.



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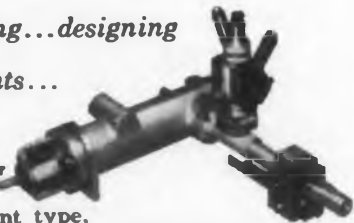
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**Diffraction of Surface Electromagnetic Waves by a Semi-Infinite Impedance Plane by N. G. Trenev. REE 2/58, pp 163-171, 4 figs.**

Diffraction of surface waves by the edge of an impedance half-plane results in surface waves that are both reflected and transmitted downward, as well as in a radiation field. The transmission of the surface waves takes place only if both sides of the half-plane have equal impedances. Equations are derived for the reflection and transmission coefficients.

Reference is made to an article by T. B. A. Senior, Deflection by Semi-Metallic Sheath, *Proceedings Royal Society*, 1952, 22, 1115, 213).

**Diffraction of Electromagnetic Surface Waves by An Impedance Step by N. G. Trenev. REE 1/58, pp 27-37, 5 figs.**

The diffraction of surface *E* and *H* waves by an impedance step is analyzed. Expressions are derived for the reflection and transmission coefficients. The diffraction field is determined, and the radiation characteristics are established. In connection with the great recent interest in waveguides that employ surface waves, it becomes advisable to study such systems, comprising several segments of surfaces, and to analyze the impedance discontinuities that takes place at the edges of these surfaces.

**Power Absorbed by an Antenna from an Incident Non-Plane Wave by E. L. Burshteyn. REE 2/58, pp 186-189, 1 fig.**

An expression is derived for the power absorbed by an antenna from an incident non-plane wave. Certain approximations (equivalent to the Kirchhoff approximation used in the ordinary calculation of the directivity pattern) are used to transform the resultant expression to a simple form, suitable for engineering calculations and estimates.

**Symmetrical Diaphragm of Arbitrary Thickness in Round Waveguide by M. V. Butrov. REE 1/58, pp 56-60, 2 figs.**

The Schwinger variational method is used to analyze the problem of the effect of a round aperture in a diaphragm of arbitrary thickness in a round waveguide, for a  $H_{01}$  mode. Unlike a planar partition, the behavior of a thick partition with an aperture is describable by means of a system of two integral equations for the electric fields specified at the input and output of the diaphragm. The symmetry of the problem makes it possible to transform the system of integral equations into two independent integral equations in terms of a certain combination of

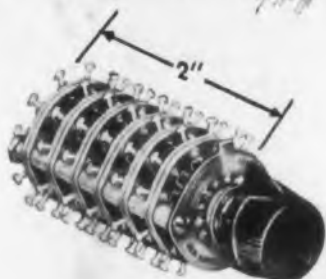




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## RUSSIAN TRANSLATIONS

the fields at the input and the output of the diaphragm. The resultant integral equations are then transformed to a stationary form, with the quasi-static solution being used as a comparison function. Formulas are given for the elements of the equivalent four-terminal network for one particular case. The quasi-static solution was originally obtained by Sheingold (*Journal of Applied Physics*, 1953, Vol. 24, page 4).

**Contribution to the Theory of Scattering of Electromagnetic Waves by a Statistically Uneven Surface** by F. G. Bass and V. G. Bocharov. REE 2/58, pp 180-185.

Scattering of electromagnetic waves by a statistically uneven surface is considered either by methods of geometrical optics (see paper by Rice, *Communication of Pure and Applied Mathematics*, 1951, Part IV, 351), or by perturbation theory (Davies, *Proceedings IEE*, 1954, Part IV, 101, 7, 209). However, neither have carried out the theory to completion, particularly when it comes to small irregularities in the surface, in which the irregularities are on the order of the wavelength or smaller. The authors formulate the boundary conditions, and determines the first-approximation field, the dispersion tensor, the second-approximation field, and the Poynting vector. Reference is also made to an article by Staras, (*Journal of Applied Physics*, 1952, 23, 10, 1152).

## MICROWAVES

**Radio Spectroscope for the Investigation of Rotational Spectra of Molecules** by T. M. Murina. REE 10/57, pp 1271-1278, 6 figs.

A high sensitivity radio spectroscope, operating in the range from 10,000 to 43,000 mc is described. A stabilized klystron is used in the circuit, and the spectrum is automatically recorded.

**Investigation of the Superregenerative Mode in a Magnetron with Slotted Anode** by M. K. Belkin. REE 10/57, pp 1307-1310, 4 figs.

The superregenerative mode can be considered as a regenerative mode in which the damping varies periodically in magnitude and in sign with the superregenerative frequency. This can take place in any circuit consisting of a resonant portion and device with a drooping characteristic, whose slope is controlled by an auxiliary voltage. Normally, such a device in a superre-



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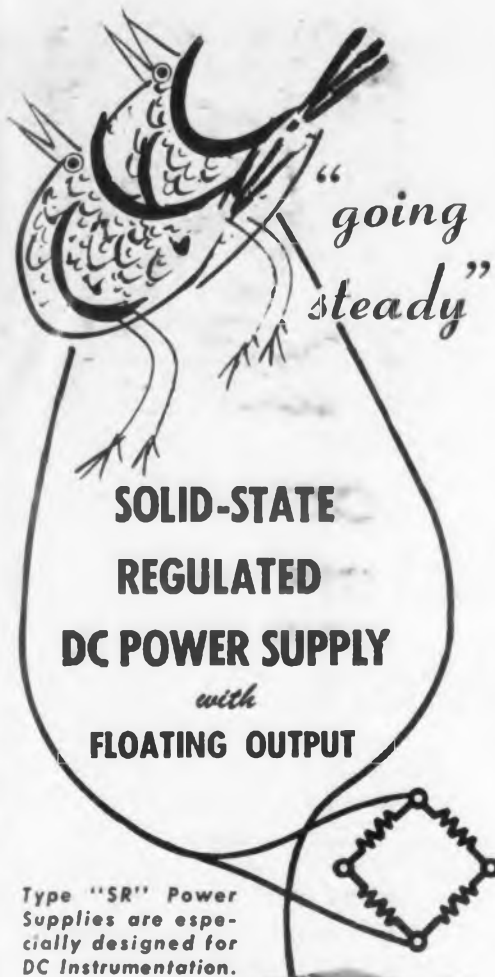
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generative circuit is a triode, on whose anode or grid is applied the superregenerator voltage. A magnetron with slotted anode can also be used.

**TELEVISION**

**Development of a Transmitting Television Network in the USSR by M. Krivosheyev, and V. Vinogradov. R 1/58, pp 35-36.**

Traces the development of the number of television centers in Russia, from two in 1951 to 37 in 1957, listing their location and characteristics. It is proposed to increase the number of television stations to 60 by the end of 1958.

Descriptions are given also of the various communication lines used to interconnect the television centers, the principal television cameras used, and various other improvements proposed for the Russian television system.

**Amplitude Selector for Television Sets by A. Korneyenko. R 1/58, pp 37-40, 9 figs.**

Description of the circuit used for separating the synchronizing pulses from the total television signal. The circuit in general is discussed, and some simplifications are described in detail.

**Instrument for Television Alignment by F. Kuz'miuskiy and S. Sher. R 1/58, pp 41-43, 4 figs.**

The apparatus described in this article can display the frequency characteristic of the amplifier circuits of the television directly on the screen of the kinescope of the television being aligned. The instrument consists of an fm oscillator, a modulator, a marker device, and a mixing stage intended for visual observation of the frequency characteristic. The diagram of the equipment is given as is an external view and operating instructions.

**KEY**

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

- AT** Automation and Telemechanics (*Avtomatika i Telemekhanika*)
- CJ** Communications Journal (*Vestnik Svyazi*)
- EC** Electrical Communications (*Elektrasvyaz'*)
- IET** Instruments and Experimental Techniques (*Probori i Tekhnika Eksperimenta*)
- R** Radio
- RE** Radio Engineering (*Radiotekhnika*)
- REE** Radio Engineering and Electronics (*Radiotekhnika i Elektronika*)

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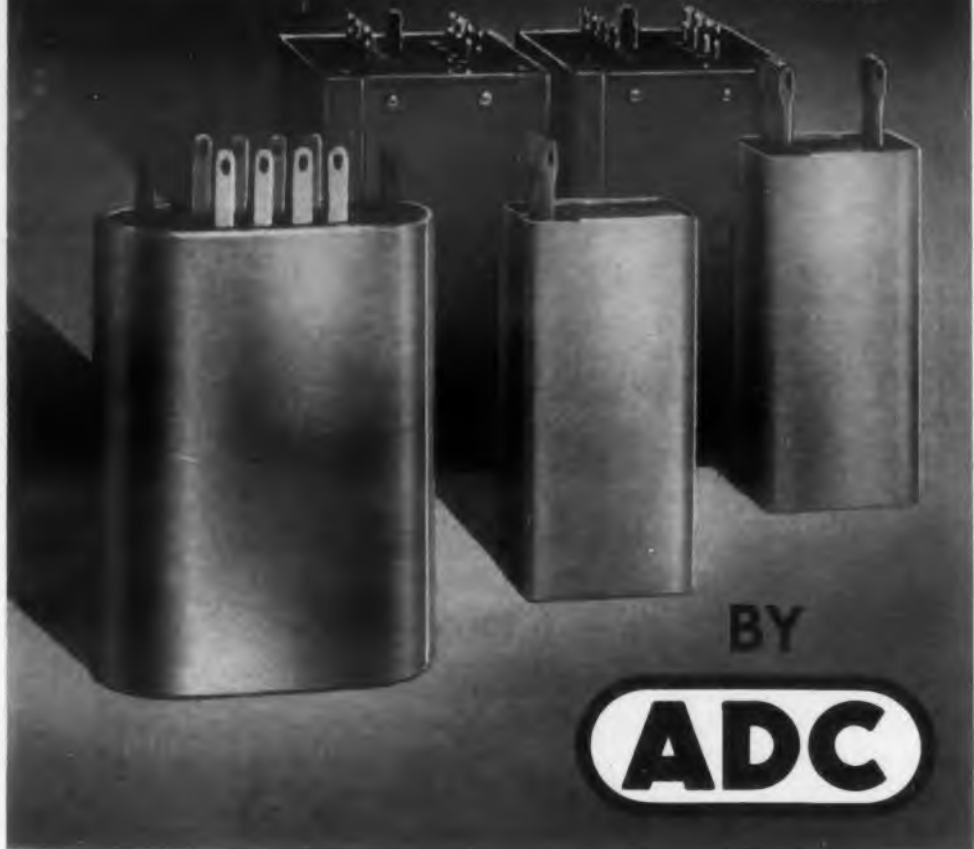
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# GERMAN ABSTRACTS

E. Brenner

## Loading of Transistor Oscillators

USE OF THE four-pole theory makes it possible to design transistor oscillators such that the conditions for oscillations are independent of the load impedance. (A similar procedure for vacuum

tube oscillators was abstracted in the July 23, 1958 issue of ELECTRONIC DESIGN.)

Since the conditions for oscillations can be deduced from linear analysis, an active two-port, such as a transistor, can be described through the short circuit admittance matrix

$$\begin{aligned} I_1 &= y_{11}V_1 + y_{12}V_2 \\ I_2 &= y_{21}V_1 + y_{22}V_2 \end{aligned}$$

In the case of vacuum tubes only the equation for  $I_2$  applies since it can often be assumed that the input impedance at the grid is infinite and that the internal feedback in the tube is negligible.

In addition to the load impedance a passive four-pole is used in conjunction with the transistor, both to furnish the frequency selective network in the feedback loop and to allow adjustment for independence from load impedance. A load impedance can be connected either in series or in parallel with the passive four-pole which is obtained either by addition of the admittance matrices (parallel case) or of the open circuit impedance matrices (series case). The resulting combination can then be placed

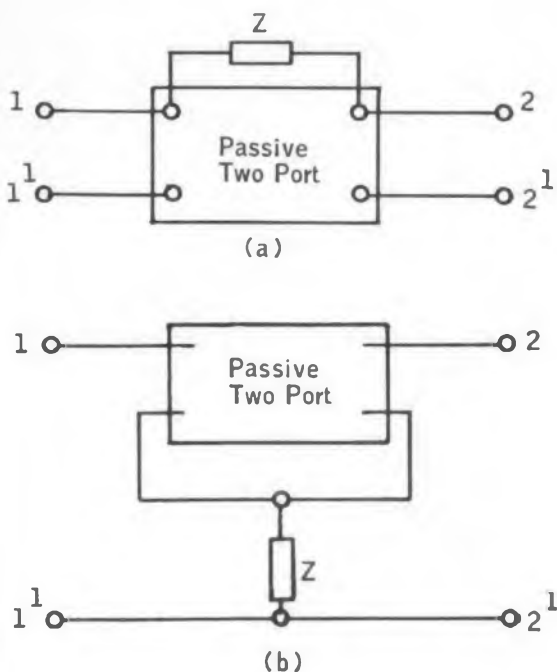
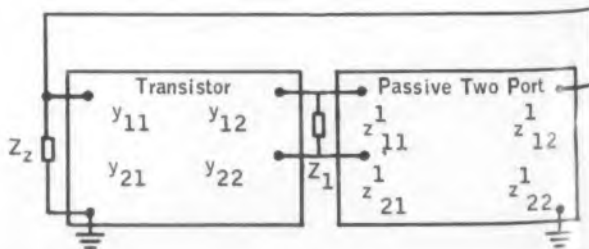


Fig. 1. (a) Parallel connection of a passive two-port and the load impedance  $Z$ ; (b) Series connection of a passive two-port and the load impedance  $Z$ .

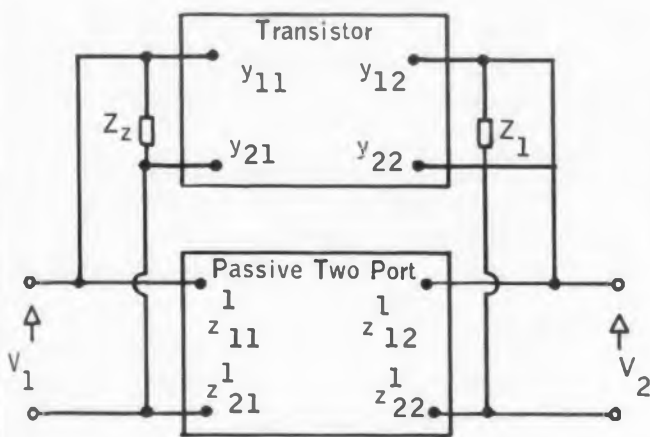
Fig. 2. Cascade connected oscillator. The impedances  $Z_1$  and  $Z_2$  are used to terminate the transistor so that the two driving point admittances are adjustable.



either in cascade with the transistor as in Fig. 2 or in parallel with the transistor as in Fig. 3. Algebraic manipulations then provide the condition for oscillations. These conditions generally involve the load impedance. It is possible, however, to choose the passive elements in the four-pole so that at the frequency of oscillation the load impedance is not involved in the unit loop gain condition.

For the cascade connection shown in Fig. 3 the condition for oscillation is

$$-z_{12}^1 (y_{12} + y_{21}) \geq 1 + z_{11}^1 (y_{22} + Y_1) + z_{22}^1 (y_{11} + Y_2) + \frac{\Delta^1}{\Delta}$$



**Fig. 3.** Parallel connected oscillator. The condition  $v_1 = v_2$  must be imposed in addition to other conditions so that a load voltage is developed, if the passive four-pole is as in Fig. 1a.

where

$z_{11}^1, z_{22}^1, z_{12}^1$ , are the elements of the open circuit impedance matrix of the passive four-pole and

$$\Delta^1 = z_{11}^1 z_{22}^1 - (z_{12}^1)^2; 1/\Delta = (y_{22} + Y_1) / (y_{11} + Y_2) - y_{12} y_{21};$$

where

$$Y_1 = 1/Z_1; Y_2 = 1/Z_2.$$

It is also possible to deduce conditions under which two load impedances are used, neither of which influences the conditions for oscillations.

*Abstracted from an article by W. Herzog, Nachrichtentechnische Zeitschrift, Vol. 10, No. 11, Nov., 1957, pp 564-569.*

## Stabilized High Voltage Supplies

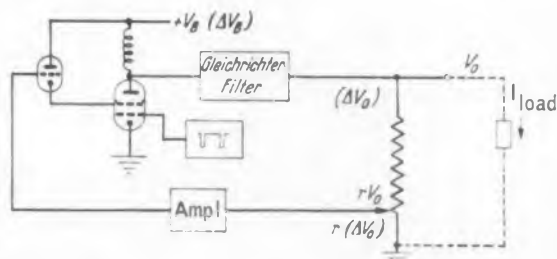
IF A PENTODE is used as a switching tube in a high voltage supply it is possible to build regulated supplies with a stability in the order of 0.01 per cent. The basic schematic is shown in Fig. 1. The original voltage fluctuations which are to be compensated are due to supply voltage fluctuation, fluctuations in pulse durations which cut off the tube, and loading.

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and the inductance, then have appropriately modified amplitudes.

The author cites as examples a 4.5 kv, 5 ma supply and an 8 kv, 1 ma source. Both of these have the required stability (0.01 per cent) with 10 per cent variation in supply voltages.

*Abstracted from an article by W. Mueller-Warmuth, Zeitschrift fuer Angewandte-Physik, Vol. 10, No. 3, March 1958, pp 122-125.*



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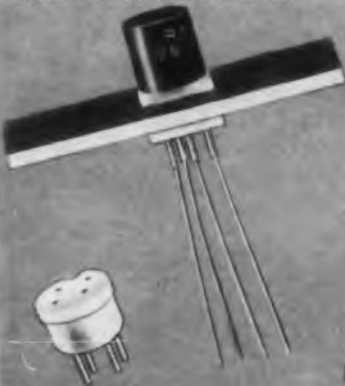
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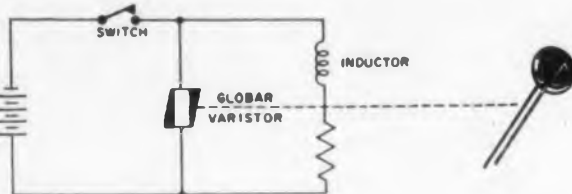
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# Electrostatically Focused TWT

**B**Y APPLYING the principle of bi-periodic beam focusing a new traveling-wave tube, entirely electrostatically focused, has been achieved through the use of a pair of concentric bifilar helices and an annular gun. Experimental dc focusing results have agreed very well with theoretically calculated results. With a non-optimized gun, a beam of perveance  $2 \times 10^{-6}$  amp/volt<sup>3/2</sup> has been focused to 97 per cent current transmis-

sion. An rf gain of 10 db has been obtained at a power level of 100 mw at 2,970 mc.

An experimental traveling-wave tube, the sketch of which is shown, was built for testing the focusing performance and the rf performance. The outer bifilar helix is wound with 0.020 in. tungsten wire on a mean diam of 0.380 in and a pitch of 10 turns per in. To eliminate all possible undesirable rf interaction with the inner bifilar helix, the inner helices are wound with 0.020 in. resistance wire on a mean diameter of 0.200 in. and 10 turns per inch. The alignment between the gun and the helices is uniquely determined by a set of precision quartz rods.

The tube was tested first for its focusing performance. The results obtained are tabulated in Table I.

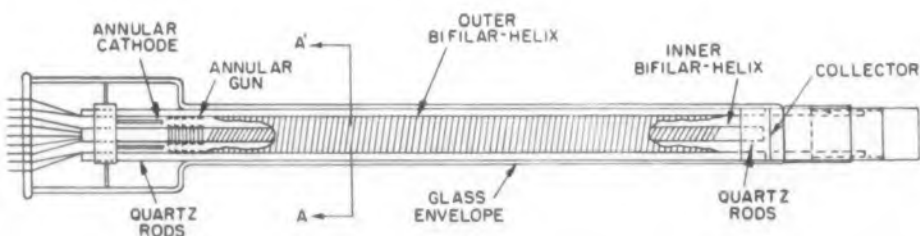
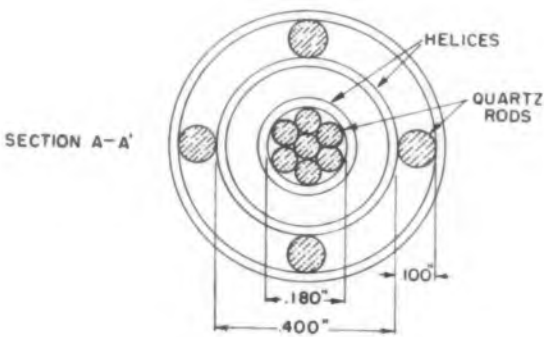
Because of the large diameter of the present tube envelope, the coupling and attenuation could not be optimized. Hence, the above results are considered particularly promising.

Design curves for optimum geometries of the tube for a given perveance using a minimum focusing field are presented in the paper.

*Abstracted from RCA Review Technical Journal, Volume XIX, Mar., 1958, No. 1, by K.K.N. Chang, RCA Labs., Princeton, N.J.*

**Table I—Experimental Results**

DC Performance	
Average helix voltage	200 v.
Bifilar helix voltage	100 v., 300 v.
Collector current	4 ma
Helix-intercepted current	less than .11 ma
Current transmission	97 per cent
RF Performance	
Frequency	2,970 mc
Synchronizing voltage	1,850 v.
Gain	10 db
Output power	100 mw



**Assembly** of the experimental traveling-wave tube.



# TWT Beam Focusing

THE TRAVELING-WAVE tube has an important element located outside the glass envelope—the beam-focusing magnet—which must be precisely designed and its field accurately aligned with the tube axis to insure satisfactory operating efficiency and long life in microwave amplifiers. If the axis of the magnetic field were coincident with the mechanical axis of the magnet and the tube axis, ideal focusing conditions would prevail and the radial field components on the common axis would be zero. However, because the magnetic field builds up to its full value over a finite distance, and because this field may vary somewhat along the axis, there will be radial field components off the axis even under ideal conditions. The principal cause of these transverse field components is in homogeneities of the magnetic material.

Small errors in both positioning the magnetic center and aligning the magnetic axis of the measurement device with respect to the axis of the magnet would result in large errors of measurement. Precise determinations can be made, however, despite errors of positioning and alignment, by a method which is essentially an exploration of the field for axial symmetry. A schematic diagram of the field exploration method is shown in Fig. 1.

A test probe, or search coil, must be used to explore the air-gap field of a magnet. The coil is fixed on a non-magnetic mandrel so that the coil and the mandrel axis are mutually perpendicular. The axis of the mandrel—made coincident with the mechanical axis of the magnet—is the axis of reference. The search coil is connected to a fluxmeter which detects changes in the magnetic flux inter-linking the coil. This flux is due to radial components of the axial magnetic field and to field components resulting from errors in positioning the probe with respect to the mandrel axis.

Thus, the relative position of the probe to the axis remains fixed for all mandrel orientations. The field is axially symmetric if there is no change in flux interlinking the probe when the mandrel orientation is changed by 180 deg. This is true even for large errors of positioning and alignment of the test probe. A resultant change



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in flux interlinkage, therefore, is a direct measure of the transverse field at any point on the reference axis in the plane determined by the mandrel and probe axes.

A recording fluxmeter of high accuracy and sensitivity was used in these measurements. This instrument can record field intensities of the order of a tenth of an oersted with a small probe. Originally developed for tracing magnetization curves and hysteresis loops, the fluxmeter has since been adapted to tracing transverse-field patterns.

The test probe is wound on a brass bobbin 0.25 in. in diam and 0.2-in. long with approximately 2000 turns of 1.5-mil, Formex-insulated copper wire. The probe is mounted in a transverse hole in a 3/8-in. diam bronze rod. This non-magnetic mandrel is in turn supported in accurately fitted bushings, with its axis coincident with the mechanical axis of the magnet. The orientation of the test probe within the air-gap is read on an index head keyed to a slot in the mandrel. The mandrel is linked to a potentiometer and crank so that turning the crank produces simultaneously a longitudinal motion of the rod and a voltage output from the potentiometer. This output indicates the position of the search coil, and when applied to the X-Y recorder of the recording fluxmeter, moves the pen proportionally. The search coil is directly connected to the fluxmeter, and its output due to a change in inter-linking flux moves the paper drum in proportion to the changes in field intensity.

The recorder thus traces a curve of the variation of the resultant of the longitudinal and radial field components parallel to the probe axis. The variation for every point along this axis is recorded as the probe moves with fixed orientation from pole to pole. If the search coil makes the same traversal with a 180 deg change in mandrel orientation, the recorder traces a curve of similar field components parallel to the new probe orientation. The difference in amplitude between these two opposing curves at

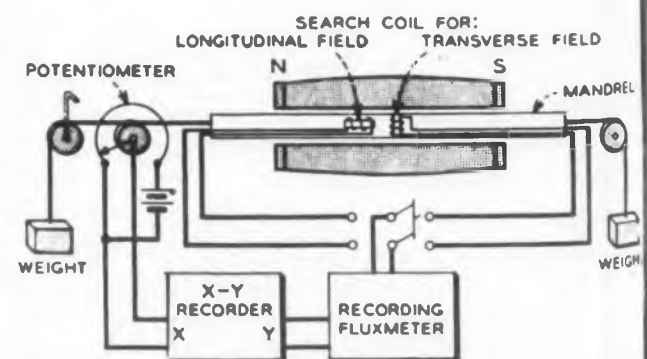
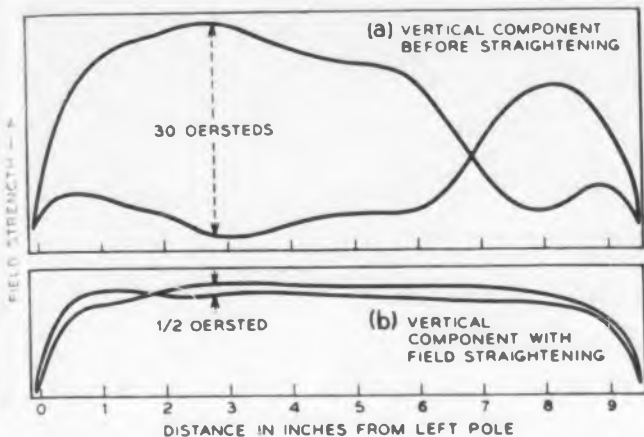


Fig. 1. Schematic diagram of the field-exploration method showing arrangement of components.



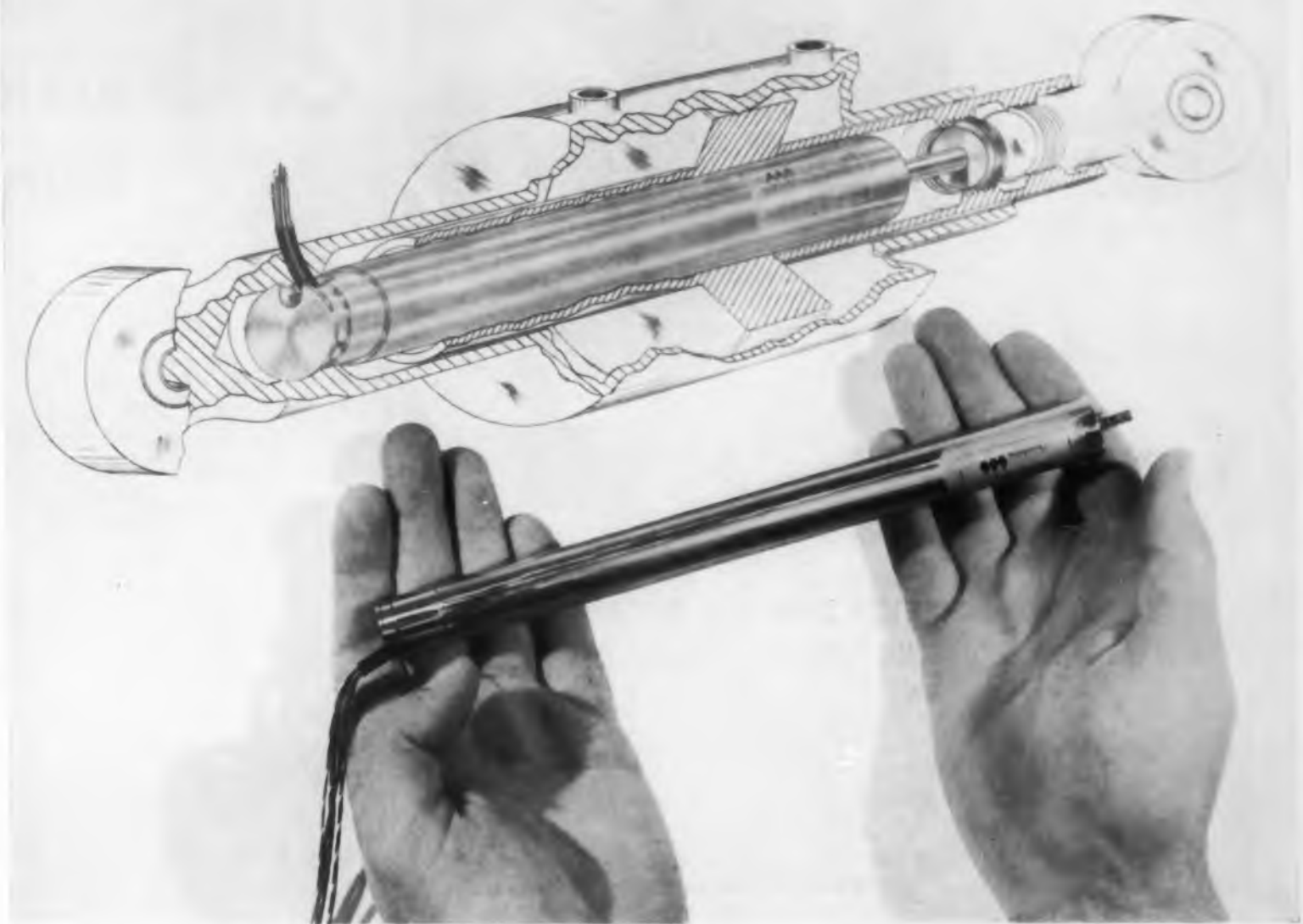
**Fig. 2.** Transverse-field patterns of field before straightening (top), and field after installation of field-straightener in the air-gap (bottom).

any point along the axis is a measure of the resultant radial field—defined earlier as the transverse field. If there were no transverse-field components, the two curves would coincide. To get a complete picture of the transverse-field components present in the air-gap, the distribution patterns in two right-angle planes are generally plotted for each magnet. For plotting the longitudinal field, a second coil is mounted on the mandrel with its axis coincident with the mandrel axis. Longitudinal- or transverse-field distribution curves can then be taken by simply switching the fluxmeter to the appropriate coil. Field misalignments corresponding to transverse fields of thirty oersteds are not unusual, as illustrated by the patterns in Fig. 2

Traverse components of this magnitude would cause complete interception of the electron beam by the helix of the traveling-wave tube.

Although manufactured to very strict specifications and from the best obtainable permanent-magnet materials, beam-focusing magnets cannot be used "as manufactured" because of serious field misalignment. This condition, however, can be counteracted by "field straightening." A very effective field straightening device has been developed at Bell Laboratories. This device consists of an assembly of permalloy discs and aluminum spacers. The field-straightening assembly is inserted in the air-gap along the axis of the magnet. The discs shield the space between them from transverse fields and, as plane-perpendicular, equipotential surfaces, they direct the longitudinal field parallel to the axis. The effectiveness of a permalloy-disc field-straightener is illustrated by a comparison of the transverse-field patterns before and after correction shown in Fig. 2.

*Abstracted from an article by P. P. Cioffi, Bell Laboratories Record, Vol. XXXVI, No. 5, May 1958, pp. 172-175.*



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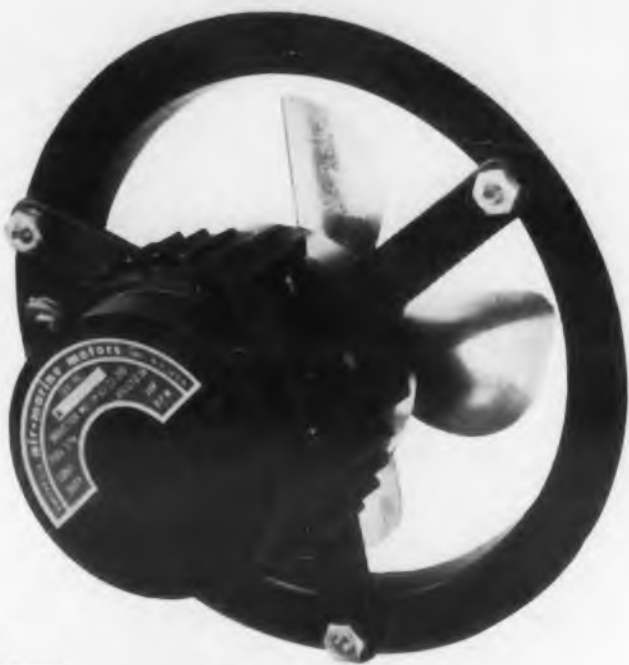


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## ABSTRACT

# Thermo-Compression Bonding

Development of high-frequency transistors has been hampered by the inability to form reliable electrical contacts between extremely fine wires and minute areas of semiconductor crystals. A promising solution to this problem has been found at Bell Laboratories using thermo-compression bonding.

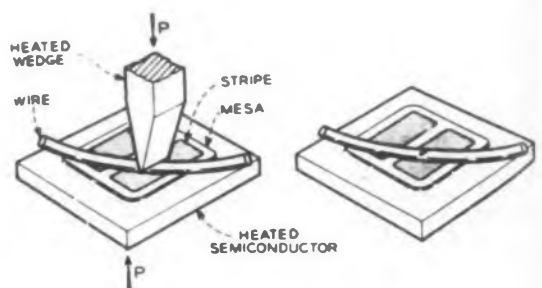
**W**HEN structures are to be fabricated to virtually microscopic dimensions, an imposing mechanical difficulty is that of securing a bond between very thin electrical conductors and the semiconductor. The bond must be accurately positioned in a small area; it must have the least possible effect on the electrical characteristics of the semiconductor; and it must be mechanically strong and reliable. This difficulty is substantially overcome by thermo-compression bonding.

This bonding process does not involve liquid phase formation and hence avoids problems of alloy depth control, wetting and chemical contamination associated with soldering and alloying techniques. As shown in functional schematic form in Fig. 1, it merely involves the application of heat and pressure to the members being bonded. When these are applied for a few seconds, adhesion occurs.

The most important issue involved in application of thermo-compression bonds to semiconductors is the possible mechanical damage to the semiconductor.

Fig. 2 relates temperature and pressure of bonding to brittle fracture and plastic stress of silicon and germanium. The shaded area represents the region of successful bonding; it encompasses all the pressure and temperature conditions used to date to bond gold, silver, aluminum and various alloys of these materials to silicon and germanium.

By noting the distance of the bonding



**Fig. 1.** Representation of the bonding process. Heat and pressure produce the bond with very little contamination of the semiconductor material.

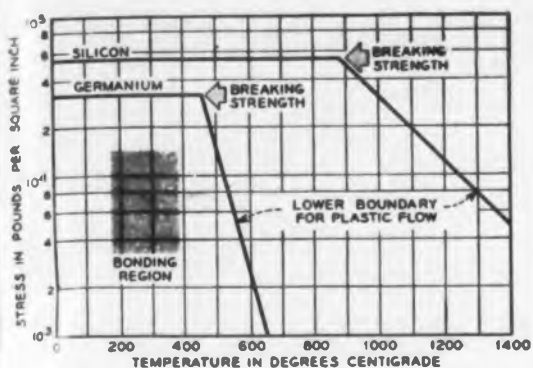


Fig. 2. Tensile-strength curves for brittle fracture (horizontal lines) and plastic yield (steep lines) for germanium and silicon. Bonding region for experiments (shaded area) is well inside these limits.

region from the curve for germanium, it is apparent that sufficient margins exist for both temperature and breaking strength. The curve for the onset of plastic flow in the crystal is at least 100 C from the bonding region, and along the vertical axis, breaking stress is seen to be at least double the highest stress used for bonding. It is also apparent in Fig. 2 that silicon is even better in these respects. Actually, since no compression data for silicon and germanium are available, tensile-strength values are plotted in Fig. 2, which means that the safety factors are still higher. Several thermo-compression bond areas have been studied, and no increase in density of dislocations associated with plastic flow or cracking has been found.

The electrical characteristic of a metal-to-germanium thermo-compression bond is of considerable interest, both for potential application in device technology and also for the investigation of a metal-to-semiconductor interface. When carefully formed, bonds of this sort give either rectifying or nonrectifying (ohmic) contacts in accordance with surface doping produced by the bonding wire.

Fig. 3 illustrates the conditions under which rectification is produced in a thermo-compression bonded contact of an aluminum wire to a block of n-type germanium. For the germanium under this type of bond, curve A shows theoretical values of spreading resistance—the resistance introduced by the crowding of flow lines of electricity in the germanium as they come to the confining area under the bond. Curve A is to be

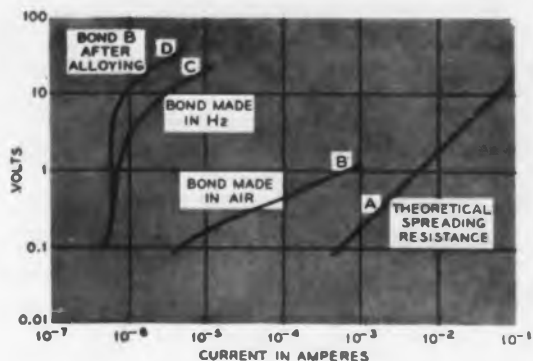


Fig. 3. Theoretical "spreading resistance" (A) compared to actual voltage-vs-current characteristic curves for bonds made by the various methods.

compared with curve B, which represents actual data obtained from a contact bonded in air. As can be seen, this curve is intermediate to curve D. Data for curve D were obtained after bond B was heated to a temperature slightly above the aluminum-germanium eutectic—the lowest temperature that gives a liquid phase when Ge and Al are heated (425 C). Curve C shows the effect of using a hydrogen atmosphere for bonding instead of air. In this case, we have a bond that forms a rectifier which will saturate. The difference between curves B and C is accounted for by the contamination introduced by the air ambient. Trace contamination on either the wire or the germanium surface probably accounts for the difference between curves C and D seen in Fig. 3.

One distinct possibility for application of this type of bond is the process illustrated by curve D. At the expense of introducing a liquid-phase eutectic into the process, we can form both an electrode and a lead in one operation. A measure of control of alloy depth is obtainable in this case because the liquid-phase eutectic forms at one or two degrees above the eutectic temperature, and wetting occurs over the bonded area. Another feature of alloy depth control is the fact that the lead wire can be of eutectic composition, so that it does not require much germanium to go into solution to form the liquid phase.

*Abstracted from the article Electrical Contact with Thermo-Compression Bonds by H. Christensen, Bell Laboratories Record, April, 1958, pp 127.*

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ANA BULLETIN No. 444, DESIGN CRITERIA FOR PILOTED AIRCRAFT ELECTRONIC EQUIPMENT, 26 NOVEMBER 1957

This bulletin supersedes MIL-E-25647(USAF), dated September 4, 1957. Although this spec supersedes MIL-E-25647 there are few changes. One of the major changes is that the title of the spec now is directed strictly toward piloted aircraft applications. The earlier spec was directed toward all airborne electronic equipment. MIL-E-5400 is no longer referenced as an applicable spec. This bulletin now covers the philosophy of design of equipment within the scope of MIL-E-5400. Major policy as a major design factor has been deleted. Hazards to safety have been deleted as a function of reliability. Design considerations have been added to include heat transfer problems and techniques, as well as a cooling



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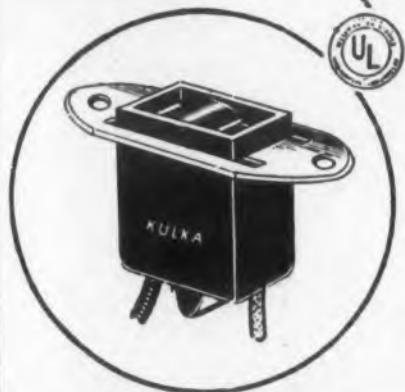
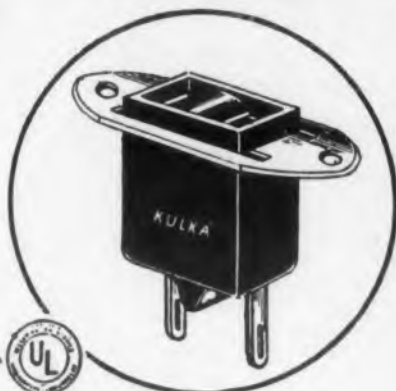
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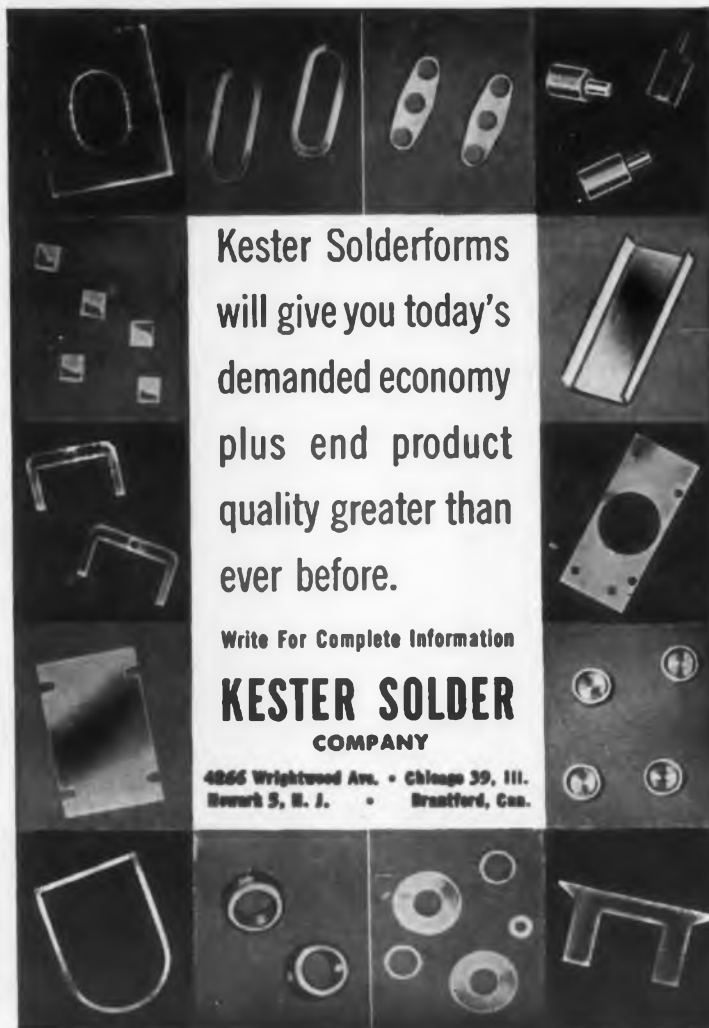


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ELECTRONIC DESIGN • August 6, 1958



system compatible with the aircraft in which the equipment is to be used. Definitions have been added to cover terms such as research model, breadboard model, experimental model, developmental model, service test model, prototype model, preproduction model, and production model.

#### Canadian Standards

CSA CODE C22.1-1958 (7th EDITION), ESSENTIAL REQUIREMENTS AND MINIMUM STANDARDS COVERING ELECTRICAL INSTALLATION FOR BUILDINGS, STRUCTURES, AND PREMISES (ALL POTENTIALS)

This code represents the result of continuous study of current Canadian practices and contemporary codes of practice dealing with electrical installations for buildings, structures, and premises. A voluntary code, it is intended to establish essential requirements and minimum standards for the installation and maintenance of electrical equipment for adoption and enforcement by electrical inspection departments throughout Canada. Copies may be ordered directly from the Canadian Standards Association, 235 Montreal Road, Ottawa 2, Canada, for \$1.50 per copy.

CSA C22.2 No. 11-1957, FRACTIONAL HORSE-POWER ELECTRIC MOTORS FOR OTHER THAN HAZARDOUS LOCATIONS

This standard covers fractional-horsepower electric motors for potentials up to, and including, 600 volts between conductors. These motors are designed for general domestic, commercial and industrial applications in ordinary non-hazardous locations. Copies of this standard may be obtained from the Canadian Standards Association, 235 Montreal Road, Ottawa 2, Canada for \$1.00 per copy.

#### Resistors

MIL-R-11C, GENERAL SPECIFICATION FOR FIXED COMPOSITION (INSULATED) RESISTORS, 31 MARCH 1958

Tests and requirements for acceleration, shock, and high-frequency vibration have been added. Two new styles of resistors have been added. A seal test applicable to styles RC08 and RC22 only has been added.

MIL-R-93B, GENERAL SPECIFICATION FOR FIXED WIREWOUND (ACCURATE) RESISTORS, 31 MARCH 1958

Tests and requirements for acceleration, shock, and high-frequency vibration have been added. A characteristic C specifying a maximum ambient temperature of 125°C at rated wattage has been added. Four new resistor styles have been added.

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CIRCLE 552 ON READER-SERVICE CARD

## ADVERTISERS' INDEX

August 6, 1958

Advertiser	Page
AMP, Inc . . . . .	37
Ace Plastic Co. . . . .	158
Acme Electric Corp. . . . .	156
Advance Relays . . . . .	157
Advance Stamping . . . . .	138
Air Marine Motors, Inc. . . . .	196
Aircraft Radio Corp. . . . .	162
Airpax Products Co. . . . .	43
Alford Mfg. Co., Inc. . . . .	174
Allied Control Co. . . . .	81
Allison Labs . . . . .	179
American Machine & Foundry . . . . .	121
American Plastics Corp. . . . .	154
Amphenol Electronics Corp. . . . .	34
Anaconda Wire & Cable . . . . .	8, 9
Andrew Corp. . . . .	15
Arnold Engineering Co. . . . .	12, 13
Arnoux Corp. . . . .	64
Assembly Products, Inc. . . . .	144
Assembly Products, Metronix Div. . . . .	147
Astron Corp. . . . .	82
Audio Development Co. . . . .	190
Automatic Mfg. Co. . . . .	73
Automatic Electric Co. . . . .	82
B-J Electronics, Borg-Warner Corp. . . . .	45
Baird-Atomic, Inc. . . . .	129, 185
Ballantine Laboratories . . . . .	31
Bart Mfg. Corp. . . . .	148
Bendix Aviation Corp., Eclipse Pioneer Div. . . . .	180
Bendix Aviation Corp., Scintilla Div. . . . .	135
Bogart Mfg. Co., Inc. . . . .	84
Bourns Laboratories . . . . .	65
Bristol Co. . . . .	152
Brush Instruments, Div. of Clevite Corp. . . . .	11
Bud Radio, Inc. . . . .	158
Burndy Corp. . . . .	68
Burnell & Co., Inc. . . . .	9
Burroughs Corp., Electronic Tube Div. . . . .	78
CBS-Hytron . . . . .	49
Cambridge Thermionic Corp. . . . .	151
Cannon Electric Co. . . . .	105
Canoga Corp. . . . .	161
Carborundum Co., The . . . . .	192
Celco Constantine Engineering Labs Co. . . . .	154
Centralab, Div. of Globe Union, Inc. . . . .	183
Ceramaseal Co., The . . . . .	168
Chassis-Trak Corp. . . . .	160
Clarostat Mfg. Co. . . . .	50
Clifton Precision Products Co., Inc. . . . .	17
Communications Accessories Co. . . . .	116
Computer-Measurements Corp. . . . .	156
Constantine Engineering Labs Co. . . . .	154
Corning Glass Works . . . . .	107
Couch Ordnance, Inc. . . . .	155
Cubic Corp. . . . .	114
Curtiss-Wright Corp. . . . .	164
Cutler-Hammer, Inc. . . . .	170
Dale Products, Inc. . . . .	131
DeJur Amsco Corp. . . . .	125
Delco Radio, Div. of General Motors . . . . .	106
Diehl Mfg. Co. . . . .	162
Dow Chemical Co., The . . . . .	108
Dow Corning Corp. . . . .	18, 19

Dessen-Barnes Corp. . . . . 137  
 DuMont, Allen B. Laboratories,  
 Technical Products Div. . . . . 53, 54  
 DuPont, E. I. de Nemours & Co., Mylar Div. 103

ESC Corp. . . . . 79  
 E T A Products Co. of America . . . . . 158  
 Eastman Kodak Co., Graphic Arts Div. . . . . 150  
 Edgerton, Germeshausen & Grier, Inc. . . . . 166  
 Edison, Thomas A., Inc. . . . . 62  
 Eitel-McCullough, Inc. . . . . 61  
 Elastic Stop Nut Corp. . . . . 156  
 Electro-Measurements, Inc. . . . . 155  
 Electro Products Laboratories . . . . . 138  
 Electronic Batteries, Inc. . . . . 157  
 Electronic Enterprises, Inc. . . . . 55  
 Electronic Measurements Co. . . . . 145  
 Electronic Research Associates, Inc. . . . . 165  
 Electronic Tube Corp. . . . . 143  
 Elgin Metalformers Corp. . . . . 29  
 Emerson Electric . . . . . 145  
 Epoxy Products Div. . . . . 85  
 EpSCO, Inc. . . . . 176  
 Erie Resistor Corp. . . . . 150

Faber-Castell, A. W. Co., Inc. . . . . 89  
 Fansteel Metallurgical Corp. . . . . 20, 21  
 Fenwal Electronics, Inc. . . . . 134  
 Frequency Standards, Inc. . . . . 41  
 Fusite Corp., The . . . . . 47

Gamewell Co. . . . . 136  
 Garrett Corp. . . . . 95  
 General Ceramics Corp. . . . . 102  
 General Devices . . . . . 52  
 General Electric Co., Receiving Tubes . . . . . 66  
 General Electric Co., Lamp Glass Dept. . . . . 137  
 General Electric Co., Light Military Div. . . . . 201  
 General Radio Co. . . . . 128  
 General Transistor Corp. . . . . 74  
 Genisco, Inc. . . . . 109  
 Gertsch Products, Inc. . . . . 169  
 Giannini, G. M. & Co.,  
 Electromechanical Div. . . . . 153  
 Globe Industries, Inc. . . . . 72  
 Good All Electric Mfg. Co. . . . . 127  
 Grayhill, Inc. . . . . 159  
 Gries Reproducer Corp. . . . . 198  
 Guardian Electric . . . . . 150  
 Gudebrod Bros. Silk Co., Inc. . . . . 183

Hallamore Electronics Co. . . . . 126  
 Hardwick Hindle, Inc. . . . . 146  
 Haydon, A. W. Co., Inc. . . . . 198  
 Heiland Div., Minneapolis Honeywell . . . . . 92, 93  
 Heinemann Electric Co. . . . . 163  
 Hetherington, Inc. . . . . 48  
 Hewlett-Packard Co. . . . . 202, 203  
 Hi-G, Inc. . . . . 136  
 Hudson Tool & Die Co., Inc. . . . . 16  
 Hughes Aircraft Co. . . . . 7, 96, 97  
 Hughes Aircraft Co.,  
 Research & Development . . . . . 76, 77  
 Humphrey, Inc. . . . . 195  
 Hunter Mfg. Co. . . . . 141  
 Hycor Eastern, Inc. . . . . 148

I T & T, Components Div. . . . . 80, 86  
 Intra Corp. . . . . 151  
 Industrial Instruments, Inc. . . . . 175  
 Inland Automatic, Inc. . . . . 131  
 International Business Machines Corp. . . . . 200



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*National*

Advertiser	Page
International Instruments, Inc. ....	188
International Nickel Co., Inc. ....	177
International Resistance Co. ....	2
J-V-M Microwave Co. ....	187
Johnson, E. F. Co. ....	186
Kay Electric Co. ....	167
Kearfott Co., Inc., Little Falls Div. ....	70
Kester Solder Co. ....	198
Kintel ....	59
Krohn-Hite Instrument Co. ....	185
Kulka Electric Corp. ....	198
Lamtex Industries, Inc. ....	168
Lavoie Laboratories ....	117
Leach & Garner-General Findings & Supply ....	197
Lerner Plastics, Inc. ....	165
Linde Co. ....	25
Linemaster Switch Corp. ....	138
Lockheed Aircraft Corp., Missile Systems Div. ....	100, 101
London Chemical Co. ....	198
Lord Mfg. Co. ....	173
McDonnell Aircraft Corp. ....	10
McLean Engineering Laboratories ....	171
Magnetic Research Corp. ....	194
Magnetics, Inc. ....	124
Magtrol, Inc. ....	174
Marion Electrical Instrument Co. ....	131
Mesa Plastics Co. ....	136
Microdot, Inc. ....	169
Micro Switch ....	133
Millivac Instrument Corp. ....	181
Minneapolis-Honeywell ....	193
Minnesota Mining & Manufacturing Co. ....	51
Monitor Products ....	168
Monroe Calculating Machine Co. ....	111
Moseley, F. L. Co. ....	184
Motorola, Inc. ....	200
Mycalex Corp. of America ....	87
Narda Ultrasonics Corp. ....	159
National Cash Register Co. ....	201
National Vulcanized Fibre Co. ....	110
Networks Electronic Corp. ....	70, 71
Oak Mfg. Co. ....	128, 129
Ohmite Mfg. Co. ....	69
Oster, John Mfg. Co. ....	104
PCA Electronics, Inc. ....	8
Pacific Automation Products, Inc. ....	60
Pacific Semi-Conductors, Inc. ....	23
Panoramic Radio Products, Inc. ....	112
Perkin-Elmer Corp. ....	57
Phalo Plastics, Inc. ....	178
Philco Corp. ....	75
Pierce Precision Plating Co. ....	179
Pioneer Electronics Corp. ....	178
Potter & Brumfield ....	182
Potter Instrument Co. ....	3
Prodelin, Inc. ....	149
Pyramid Electric Co. ....	147
R-F Electronics, Div. of Electro Switch ....	179
Radio Corp. of America ....	204
Radio Frequency Laboratories, Inc. ....	186

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CIRCLE 512 ON READER-SERVICE CARD

Advertiser	Page
Rantec Corp. ....	178
Raytheon Mfg. Co., Magnetic Components .....	140, 141
Raytheon Mfg. Co., Personnel .....	90
Raytheon Mfg. Co., Semi-Conductor Div. ....	4
Resistance Products Co. ....	135
Rheem Mfg. Co. ....	140
Robertshaw-Fulton Controls Co. ....	175
Rotron Mfg. Co. ....	42

Sage Electronics Corp. ....	166
Sanborn Co. ....	123
Sanders Associates, Inc. ....	132
San Jose Scientific Co. ....	128
Sarkes Tarzian, Inc. ....	134
Shockley Transistor Corp., Div. of Beckman Instruments, Inc. ....	142
Sigma Instruments, Inc. ....	189
Sola Electric Co. ....	188
Spectronic Plating Co., Inc. ....	144
Speer Carbon Co., Jeffers Electronics Div. ....	142, 143
Sperry Gyroscope Co., Div. of Sperry Rand Corp. ....	88
Sperry Microwave Electronics Co., Div. of Sperry Rand Corp. ....	27
Sprague Electric Co. ....	119
Stackpole Carbon Co., Electronic Components Div. ....	39
Statham Instruments, Inc. ....	113
Stepper Motors, Div. of Land-Air, Inc. ....	187
Sterling Precision Products .....	14
Superior Electronics .....	149
Sylvania Electric Products, Waltham Div. ....	199
Sylvania Electric Products, Electronics Div. ....	98
Systron Corp. ....	151

Technic, Inc. ....	182
Technical Products Co. ....	164
Technitrol Engineering Co. ....	170
Technology Instrument Corp. ....	30
Telonic Industries, Inc. ....	153
Temco Aircraft Corp. ....	94
Tenney Engineering, Inc. ....	139
Texas Instruments, Inc. ....	67
Tinnerman Products, Inc. ....	118
Tobe Deutschmann Corp. ....	146
Torwico Electronics, Inc. ....	6
Trio Laboratories, Inc. ....	171
Tung-Sol Electric, Inc., Chatham Electronics Div. ....	63

Unimax Switch Div. of W. L. Maxon .....	152
Union Switch & Signal, Div. of Westinghouse Air Brake Co. ....	91
United Aircraft Products .....	99
U. S. Radium Corp. ....	167
U. S. Semi-Conductor Products .....	28
United States Gasket Co., Fluorocarbon Products Div. ....	191


Varian Associates .....	122
Victory Engineering Corp. ....	184
Video Instruments .....	189
Voltron Products .....	156

Ward Leonard Electric Co. ....	151
Whitso, Inc. ....	159

Yardney Electric Corp. ....	115
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7110	8500-9600	hand-tunable	220	0.001	225
7112	8500-9600	remote-tunable	220	0.001	200
7111	8500-9600	hand-tunable	220	0.001	200
A-1127	8500-9600	hand-tunable	280	0.001	200
6865-A	8750-9600	hand-tunable	220	0.001	180
A-1086-G	8750-9600	hand-tunable	240	0.001	160

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