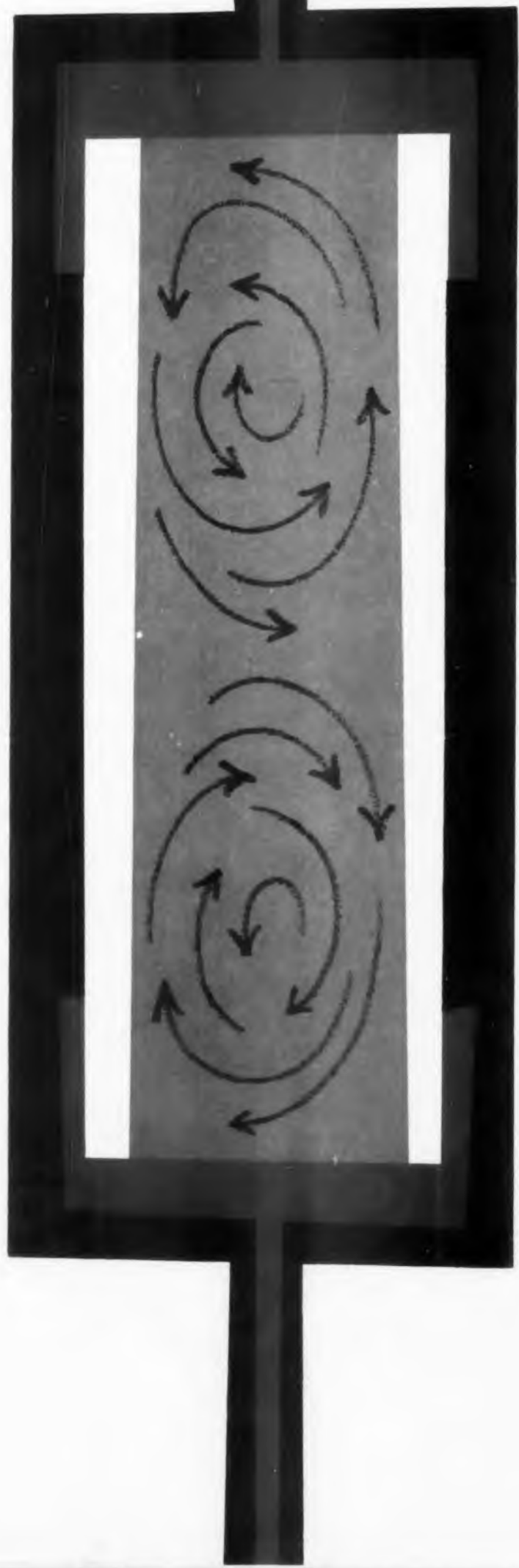


THE LIBRARY OF  
CONGRESS  
SERIAL RECORD

DEC 1 - 1958

8097



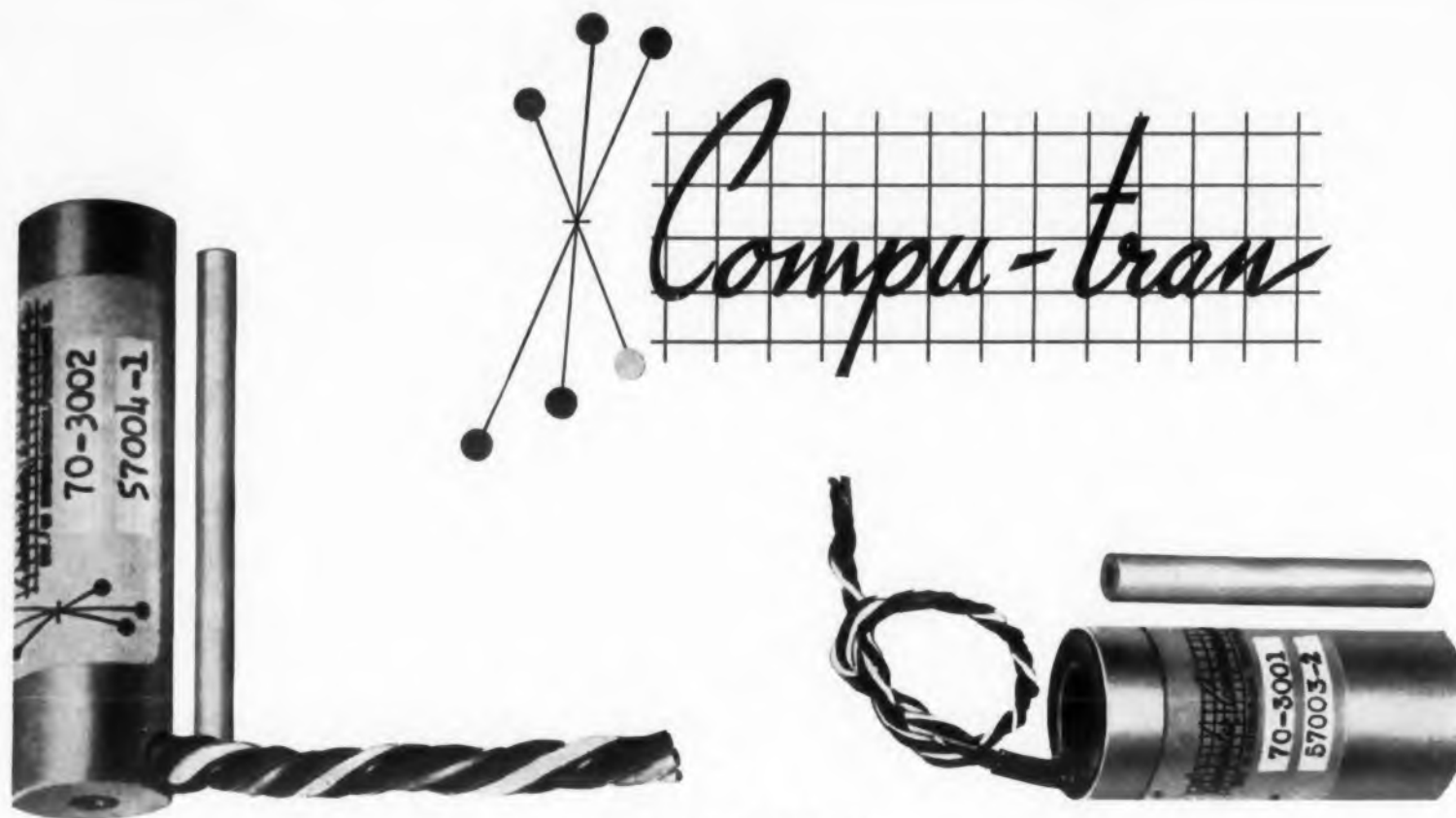
NOV 21 1958

B 743140

D  
E  
S  
I  
G  
N

E  
L  
E  
C  
T  
R  
O  
N  
I  
C

NOVEMBER 20, 1958



IRC SERIES 70-3000

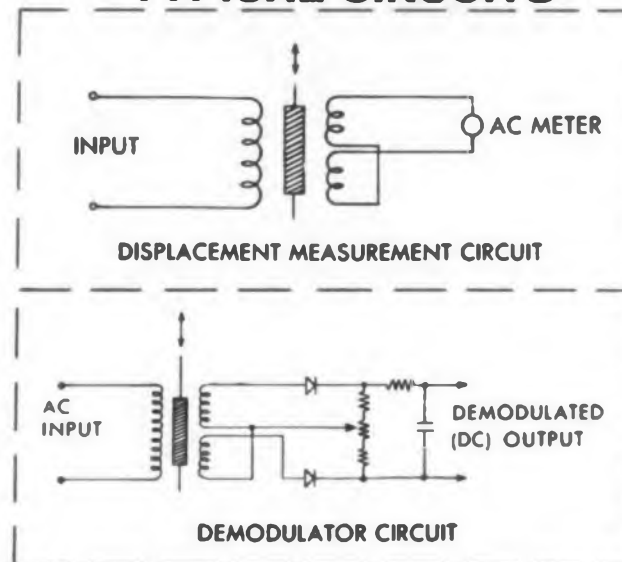
## DISPLACEMENT TRANSDUCER

The IRC Displacement Transducer offers many new advantages, including lower cost. Its higher sensitivity and 0.1% linearity is specially suited to military instrumentation applications. The output is completely stepless and null voltage is 0.25% or less of total output. In addition, the output of standard IRC Displacement Transducers is high...2 MV/Volt Input/Mil; all offer high output voltage in relation to size. Input voltages can be obtained up to 110 v. AC.

Compu-Tran Displacement Transducers show high resistance to moisture and shock... are available in 23 standard and sub-miniature sizes with a temperature range of  $-65$  to  $+225^{\circ}\text{F}$ . Also, IRC's Compu-Tran Displacement Transducers are the only units available completely encapsulated in a protective unit.

Designers of accelerometers and other measuring, indicating, gaging and process control devices will be especially interested in Compu-Tran Bulletin R-3. Write for your copy today.

### TYPICAL CIRCUITS



NOTE—Special units available as follows:  
 • Long linear range unit (4" range in 6" shell)  
 • Power unit (110 volts, output 10 to 12 volts)  
 • Temperature compensative unit (insensitive to changes through range of  $-65^{\circ}\text{F}$  to  $+225^{\circ}\text{F}$ )



INTERNATIONAL RESISTANCE COMPANY

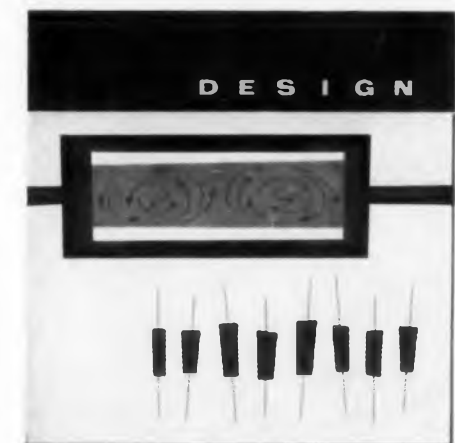
COMPUTER COMPONENTS DIVISION

Dept. 3312 401 N. Broad St., Philadelphia 8, Pa.

In Canada: International Resistance Co., Ltd., Toronto, Licensee

CIRCLE 1 ON READER-SERVICE CARD

### HIGHLIGHTS OF ISSUE



#### Sealed-in Gas Shrinks Resistor's Size . . . . . 30

Sealed-in gas helps reduce the size of these hollow tube, metal film resistors. The gas permits more heat to be dissipated in a given volume. Heat generated in the resistor is carried by the gas to the terminals which act like heat sinks. The gas, which is inert, also prevents oxidation of the resistive element.

#### Graphical Design of Transistor Bias Circuits . . . . . 16

Graphical shortcuts are shown which simplify the design of transistor bias circuits.

#### Reflectionless Bead for Symmetrical Strip Transmission Line . . . . . 20

The design and fabrication of a reflectionless bead for supporting the center conductor of a strip transmission line are described. The SWR is extremely low over the full useful frequency range of most practical symmetrical strip transmission lines.

#### Simulated Doppler Effects for Radar System Testing . . . 22

Here's a method for simulating frequency shifts in a radar system, so as to test the receiver tracking capability.

#### Transistor Variable Gate With High Stability . . . . . 26

The compensation scheme used to improve the linearity and accuracy of a variable gate circuit is applicable to different forms of the multivibrator circuit. Many circuits that were previously put aside as unsatisfactory, now become acceptable.

November 26, 1958

Vol. 6

Number

24

## SUBSCRIPTION POLICY

ELECTRONIC DESIGN is circulated only to qualified electronic design engineers of U. S. manufacturing companies, industrial consultants, and government agencies. If design for manufacturing is your responsibility, you qualify for subscription without charge provided you send us the following information on your company's letterhead: Your name and engineering title, your company's main products, and description of your design duties. The letter must be signed by you personally.

ANY ADDRESS CHANGES FOR OLD SUBSCRIBERS NECESSITATES A RESTATEMENT OF THESE QUALIFICATIONS. Subscription rate for non qualified subscribers—\$15.00 for 1 year only.

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

## CONTENTS

<b>Editorial</b>	15	Seek Ye Not The Truth
<b>Behind the News</b>	5	New TWT Gives 100 mw Output at 55 kmc
<b>Washington Report</b>	12	The Poor, Poor Army
<b>Features</b>	16	Graphical Design of Transistor Bias Circuits, G. V. Woodley
	20	Reflectionless Bead for Symmetrical Strip Transmission Line, K. S. Packard
	22	Simulated Doppler Effects for Radar System Testing, J. E. Toffler
	24	Comparing Illuminated In-Line Readouts
	26	Transistor Variable Gate with High Stability, E. R. James
	30	Sealed-in Gas Shrinks Resistor's Size
	36	Transistorized Bridge
	38	Use Mil Components in Miniaturized Circuits, G. Pellegrino, Jr.
	40	One Size Relay
	42	Minified Millivoltmeter
<b>Meeting Report</b>	32	Reduce RFI with Education
<b>Ideas for Design</b>	84	Testing Magnets with an Oscilloscope
<b>Russian Translations</b>	96	Nonlinear and Parametric Phenomena in Radio Engineering, Part 6, A. A. Kharkevich
	98	What the Russians Are Writing
<b>German Abstracts</b>	104	Design of Quartz Crystal Oscillators
	104	Errors in Binary Transmission
	105	Operating Temperature of Transistors
<b>Departments</b>	44	New Products
	74	New Literature
	80	Patents
	82	Books
	94	Report Briefs
	106	Meetings
	108	Careers Section
	110	Advertisers' Index

THE LIBRARY OF  
CONGRESS  
SERIAL RECORD

DEC 1 - 1958



ELECTRONIC DESIGN is published bi-weekly by Hayden Publishing Company, Inc., 830 Third Avenue, New York 22, N.Y., T. Richard Gascoigne, President; James S. Mulholland, Jr., Vice-President & Treasurer; and David B. Landis, Secretary. Printed at Hildreth Press, Bristol, Conn. Accepted as controlled circulation publication at Bristol, Conn. Additional entry, New York, N.Y. Copyright 1958 Hayden Publishing Company, Inc. 32,000 copies this issue.

B 743140

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



**TRANSISTORIZED DIGITAL  
MAGNETIC TAPE HANDLER  
MODEL 906**

**Optimum performance  
in virtually all tape handling applications**

The advanced design of the completely transistorized Potter Model 906 Tape Handler provides improved performance in virtually any tape handling application.

Replaceable Capstan Panel permits use as Perforated Tape Reader with a remarkable new brake capable of stopping on the stop character at speeds up to 1000 characters per second. Using a small vacuum loop buffer, Model 906 features:

- Complete front accessibility—single panel construction
- Pinch rollers capable of 100 million start-stop operations
- In-line threading, end of tape sensing and tape break protection
- Speeds up to 150 ips
- As many as 4 speeds forward and reverse
- Capable of continuous cycling at any frequency from 0 to 200 cps without flutter
- Rewind or search at 300 ips
- Better than 3 ms starts
- Better than 1.5 ms stops
- Tape widths to 1-1/4"
- 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.

Potter also manufactures a complete line of Magnetic Tape Handlers, Perforated Tape Readers, High Speed Printers, Record-Playback Amplifiers and Record-Playback Heads.

*Contact your Potter representative or call  
or write direct for further information.*



*The mark of  
Engineering Quality*

**POTTER INSTRUMENT COMPANY, INC.**

Sunnyside Boulevard, Plainview, N. Y.  
Overbrook 1-3200

Potter has career opportunities for qualified engineers who like a challenge, and the freedom to meet it.

CIRCLE 2 ON READER-SERVICE CARD



YOUR COMPUTER DESIGNS ARE BETTER  
 YOUR COMPUTERS PERFORM BETTER  
 when you draw from this comprehensive  
 range of

# RAYTHEON RELIABLE COMPUTER TRANSISTORS

Raytheon PNP Germanium Fusion-Alloy Computer Transistors are approved for military applications. They provide:

- $H_{FE}$  control at high currents
- High voltage ratings
- Fast switching speed
- Low saturation resistance
- Temperature range  $-65^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$

## ONE AMPERE, HIGH FREQUENCY, HIGH GAIN SWITCH

JEDEC-30 Type	Punch through Voltage min.	$f_{ab}$ ave. Mc	$H_{FE1}$ ave.		$H_{FE2}$ ave.		$I_{CO}$ at $-12\text{V}$ $I_C = -1\text{mA}$ $V_{CE} = -6\text{V}$ $\mu\text{A}$	$r_b'$ ohms	$C_{ob}$ $\mu\text{f}$
			$I_B = 1\text{mA}$ $V_{CE} = -0.25\text{V}$	$I_B = 10\text{mA}$ $V_{CE} = -0.35\text{V}$	$I_B = 1\text{mA}$ $V_{CE} = -0.25\text{V}$	$I_B = 10\text{mA}$ $V_{CE} = -0.35\text{V}$			
2N658	-24	5	50	40	2.5	60	12		
2N659	-20	10	70	55	2.5	65	12		
2N660	-16	15	90	65	2.5	70	12		
2N661	-12	20	120	75	2.5	75	12		
2N662	-16	8	30 min	50	2.5	65	12		

## MEDIUM CURRENT, HIGH FREQUENCY, HIGH GAIN SWITCH

JEDEC-30 Type	$V_{CE}$ max. volts	$f_{ab}$ ave. Mc	$H_{FE1}$ ave. $I_B = 1\text{mA}$ $V_{CE} = -0.25\text{V}$	$H_{FE2}$ ave. $I_B = 10\text{mA}$ $V_{CE} = -0.35\text{V}$	Rise Time* max. $\mu\text{sec}$
2N404	-24	12	30 min.	—	—
2N425	-20	4	30	18	1.0
2N426	-18	6	40	24	0.55
2N427	-15	11	55	30	0.44
2N428	-12	17	80	40	0.33

\*  $I_C = 50\text{mA}$ ,  $I_B = 5\text{mA}$ ,  $R_L = 200\ \Omega$ ,  $I_{B2} = 5\text{mA}$ ; Grounded Emitter Circuit

SUBMIN Type	$V_{CE}$ max. volts	$f_{ab}$ ave. Mc	$H_{FE1}$ ave. $I_B = 1\text{mA}$ $V_{CE} = -0.25\text{V}$	$H_{FE2}$ ave. $I_B = 10\text{mA}$ $V_{CE} = -0.35\text{V}$	Rise Time* max. $\mu\text{sec}$
CK25	-20	4	30	18	1.0
CK26	-18	6	40	24	0.55
CK27	-15	11	55	30	0.44
CK28	-12	17	80	40	0.33

Ratings at  $25^{\circ}\text{C}$  unless otherwise indicated. Illustrations actual size.  
 Dissipation Coefficients: For 1 Amp types, in air  $0.35^{\circ}\text{C}/\text{mW}$ ; infinite sink  $0.18^{\circ}\text{C}/\text{mW}$   
 For med. current types, in air  $0.40^{\circ}\text{C}/\text{mW}$ ; infinite sink  $0.18^{\circ}\text{C}/\text{mW}$   
 For submin types, in air  $0.75^{\circ}\text{C}/\text{mW}$ ; infinite sink  $0.35^{\circ}\text{C}/\text{mW}$

designed for  
computer service

made for  
computer service

tested for  
computer service

proved dependable in  
computer service

PREFERRED by  
computer designers

## STAFF

Editor	Edward E. Grazda
Managing Editor	J. A. Lippke
Associate Editors	L. D. Shergalis G. H. Rostky H. Bierman
Assistant Editors	T. E. Mount D. S. Viebig L. N. Tolopko M. M. Robinson B. Patrusky A. E. Takacs F. Muehleck
Contributing Editors	S. H. Hubelbank J. G. Adashko E. Brenner B. Bernstein
Editorial Assistants	M. S. Buckley J. R. Feder
Art Director	R. A. Schulze
Technical Illustrator	B. L. Armstrong
Art Assistant	C. Bank
Production Manager	T. V. Sedita
Asst. Prod. Manager	M. P. Hedrick
Production Assistant	M. C. Alexich
Business Manager	M. C. Young
Circulation Manager	N. M. Elston
Asst. Circ. Manager	A. C. Lovett
Reader Service	J. Medina

## CO-PUBLISHERS

T. Richard Gascoigne  
 James S. Mulholland, Jr.

## ADVERTISING REPRESENTATIVES

Advertising Sales Manager  
 Bryce Gray, Jr.

New York: Owen A. Kean  
 830 Third Avenue  
 Plaza 1-5530  
 Richard Parker  
 Blair McClenachan  
 James P. Quinn  
 Charles C. Wadsworth

Chicago: Thomas P. Kavooras  
 664 N. Michigan Ave.  
 Superior 7-8054  
 Fred T. Bruce

Los Angeles: Robert E. Ahrensford  
 3275 Wilshire Blvd.  
 DUnkirk 2-7337  
 Stanley I. Ehrenclou

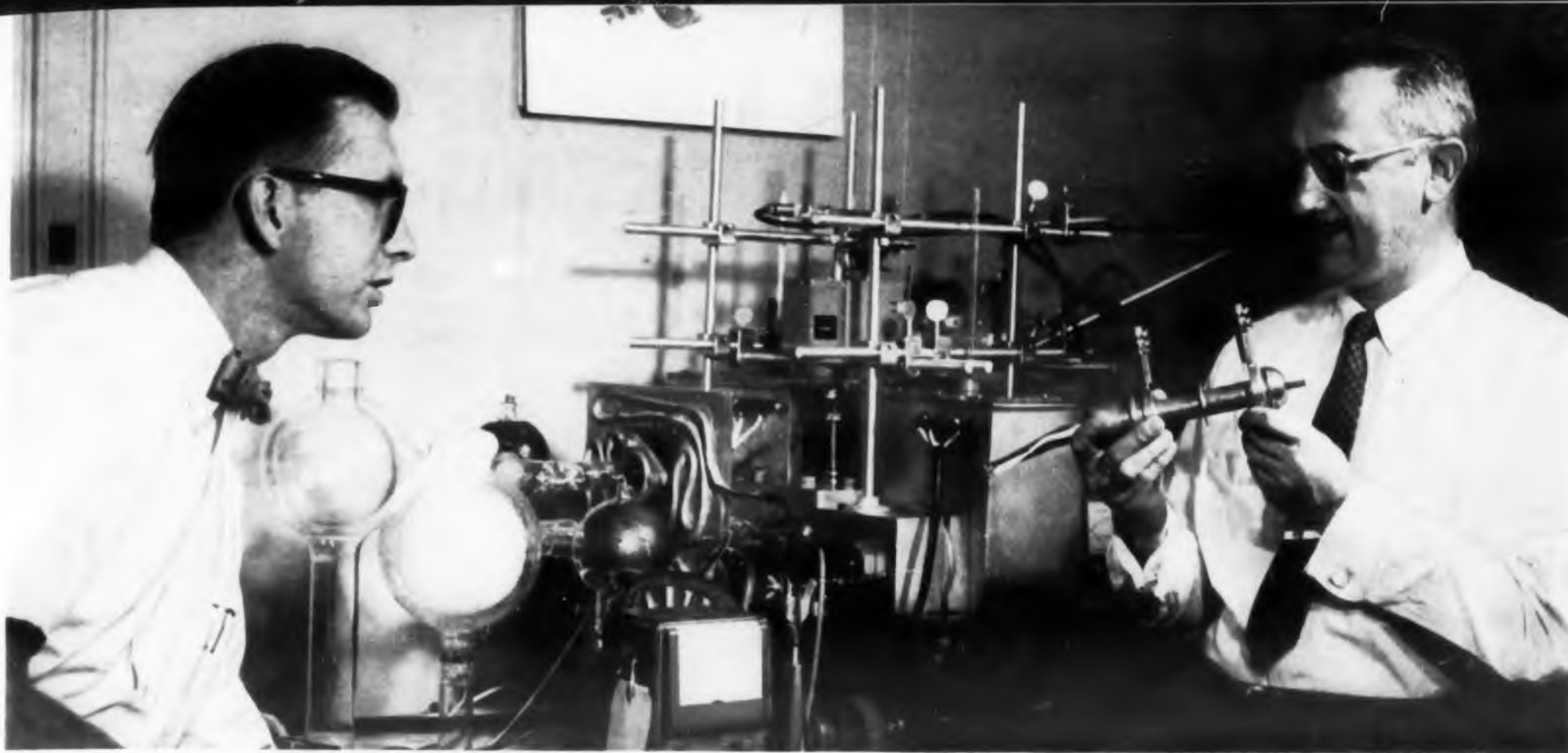
Southeastern: Lucien Neff  
 2808 Middle River Dr.  
 Ft. Lauderdale, Fla.  
 LOgan 6-5656

London, W. 1: Michael B. Horne  
 24 Baker Street  
 England

RAYTHEON SEMICONDUCTOR DIVISION  
 Silicon and Germanium Diodes and Transistors • Silicon Rectifiers

Newton, Mass.....55 Chapel St., Bigelow 4-7500  
 New York.....589 Fifth Ave., Plaza 9-3900  
 Chicago: 9501 Grand Ave., Franklin Park, NAtional 5-6130  
 Los Angeles: 5236 Santa Monica Blvd., NOrmandy 5-4221

CIRCLE 3 ON READER-SERVICE CARD



Bell Labs scientist holds 55,000 mc TWT. In the background is equipment for evacuating and testing the tube.

## DESIGN

# BEHIND THE NEWS

## New TWT Gives 100 mw Output at 55 kmc

**A** TRAVELING-WAVE tube which provides cw powers of 100 mw or more at 55,000 mc with a band-width of 10,000 mc, is in an early stage of development at Bell Telephone Laboratories. It has produced ten times more cw power output than has previously been reported for any other amplifier at this frequency.

Interest in frequencies in this range has been sparked by the possibility of long distance transmission at millimeter wavelengths using a circular electric mode in round wave guide pipe buried in the ground. The tube is intended for use as a power amplifier in such a communication system.

In the Bell Labs' tube, a 7000 v. 3 ma electron beam is projected through a 4 in. long helix having a bore of only 15 mils. This helix is made from copper-plated molybdenum wire wound at 110 turns per inch. With a magnetic focusing field of about 1500 gauss, the beam current intercepted by the helix is held to 5 per cent or less. A converging electron gun is used so that cathode current density

is held to about 1 amp per sq. cm. This value should make a cathode lifetime of thousands of hours possible.

Although similar in principle to helix type TWTs used at lower frequencies, the mm wave tube required a completely new design approach because of the small sizes involved.

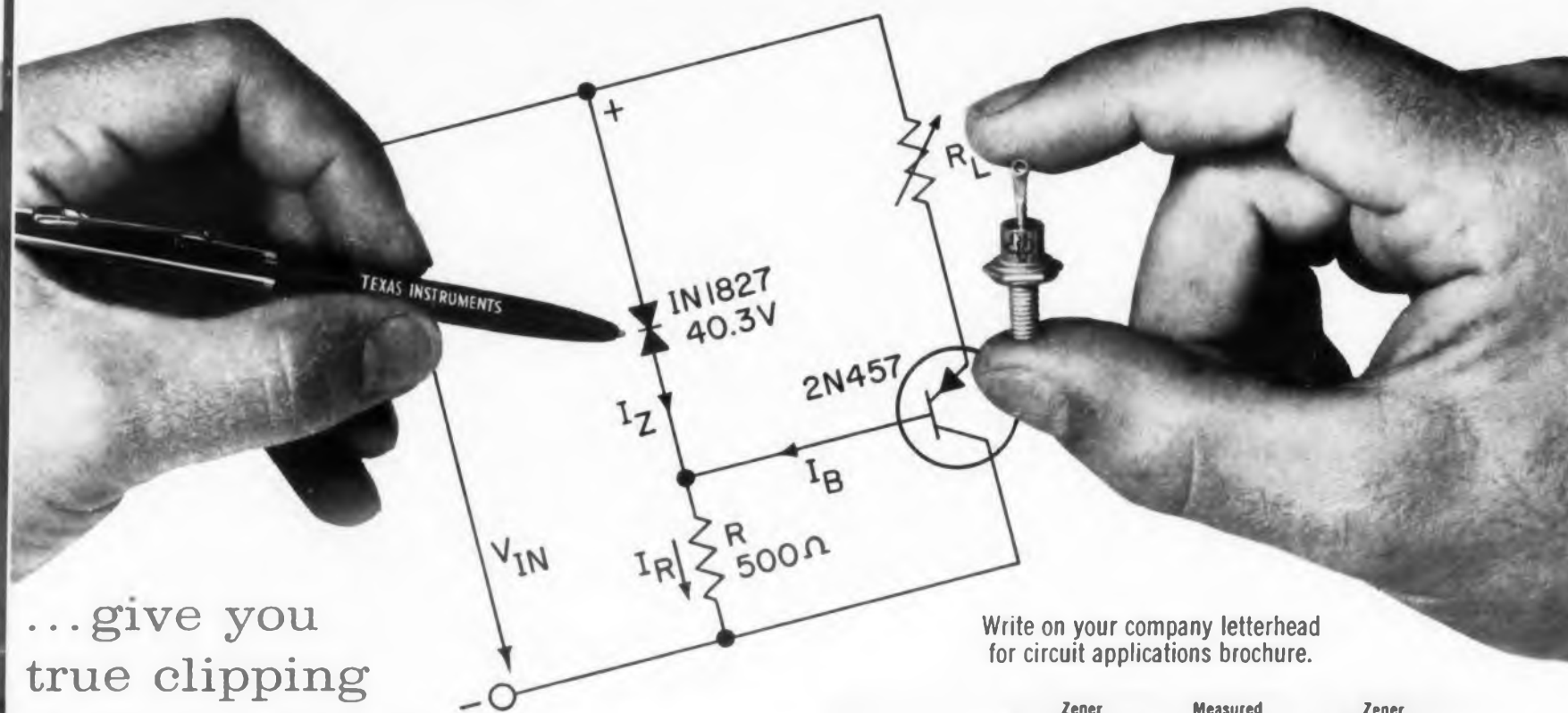
The helix is glazed to a single support rod of low-loss ceramic instead of the more conventional three rods. This rod is spring-loaded against a heat sink which has a direct heat conduction path to the outside of the vacuum envelope. The required degree of precision is obtained by a combination of optical alignment techniques and specially selected machining operations. In this manner, tolerances of the order of 0.0001 in. can be maintained.

Experimental tubes have been tested at 55 kmc and have given cw output powers ranging from 125 to 200 mw. Gain at maximum output is 19 db and at low level is 25 db. Thus the basis has been

*(Continued on following page)*



# NEW 10W VOLTAGE REGULATORS FROM TEXAS INSTRUMENTS



...give you true clipping characteristics!

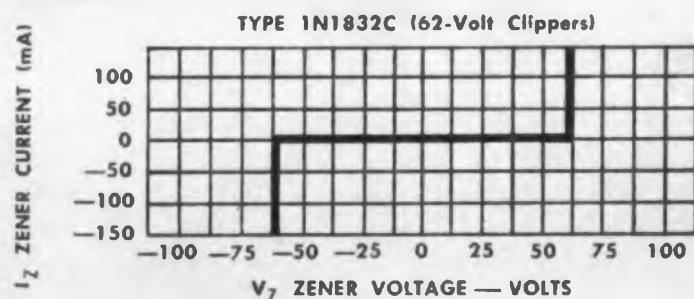
You get true clipping action with TI 1N1816-series double anode voltage regulators. A full line of regulators with dissipation ratings to 10 watts is available in 5 or 10% tolerances over a 13 to 91-volt range.

These stud-mounted silicon voltage regulators give you guaranteed zener impedance,  $-65$  to  $150^{\circ}\text{C}$  operation, and are designed to meet or exceed strict military (MIL-T-19500A) requirements.

This new 1N1816-series provides greater design flexibility for your shunt regulator, surge protection, operating bias, and arc suppression applications. Select from 105 types... 16 voltage ratings... 5 or 10% tolerances... cathode-to-stud or anode-to-stud polarity.

Write on your company letterhead for circuit applications brochure.

Type	Zener Voltage	Measured at $I_Z$	Zener Impedance at $I_Z$
	$V_Z$ Volts	$I_Z$ mA	$Z_Z$ (max) ohms
1N1816	13	500	2
1N1817	15	500	2
1N1818	16	500	3
1N1819	18	500	3
1N1820	20	250	3
1N1821	22	250	3
1N1822	24	250	3
1N1823	27	250	3
1N1824	30	250	4
1N1825	33	150	4
1N1826	36	150	5
1N1827	39	150	5
1N1828	43	150	6
1N1829	47	150	7
1N1830	51	150	8
1N1831	56	150	9
1N1832	62	50	12
1N1833	68	50	14
1N1834	75	50	20
1N1835	82	50	22
1N1836	91	50	35



## 1N1816C — 1N1836C CLIPPER

Types 1N1816C — 1N1836C are specifically designed to clip, and exhibit true double anode characteristics. Each zener is held within 10% tolerance of the specified voltage. See "Typical Clipper Characteristics" curve at left.

## BEHIND THE NEWS

laid for a practical broadband CW amplifier with cw power output of 200 mw or more at 55 kmc.

## Unconventional Sources of Electrical Power Surveyed

Most practical unconventional power sources for converting solar, thermal, chemical, and mechanical energies into electricity, appear to be the oscillating electromagnetic generator, thermopile generator, ion exchange membrane, fuel cell, and photovoltaic battery. This was the conclusion of an Air Force-sponsored survey which has just been released to industry through the Office of Technical Service, U. S. Department of Commerce, Washington 25, D.C. The study involved the theoretical and practical limitations and capabilities of power generation by means other than rotating machinery, conventional batteries, or radioactivity. The data, drawn from the literature and limited laboratory work, was intended to determine where emphasis should be placed in a possible development program. A. L. Betts and P. A. McCollum, of Oklahoma A & M College, conducted the survey for Wright Air Development Center, U. S. Air Force. The report is *Unconventional Power Sources* divided into two parts (PB 131411 and PB 131218) each selling for two dollars.

## AM Stereo Radio System Uses Sidebands

An experimental radio broadcasting system is providing full stereophonic sound through a single receiver and dual speakers on the regular a-m broadcast band. The RCA Laboratory stereo a-m system works this way:

Two separate sound channels, picked up by two separate microphones or by a stereo disk or tape pickup at the studio, are trans-



WORLD'S LARGEST SEMICONDUCTOR PLANT



**TEXAS INSTRUMENTS**  
INCORPORATED

SEMICONDUCTOR-COMPONENTS DIVISION  
POST OFFICE BOX 312 • 13500 N. CENTRAL EXPRESSWAY  
DALLAS, TEXAS

◀ CIRCLE 4 ON READER-SERVICE CARD

mitted on the regular broadcast frequency. Each of the stereo channels is carried by one sideband.

In the stereophonic a-m receiver, the two sidebands are separated and fed to two speakers, left and right, to reproduce the stereo effect picked up at the studio. In a present conventional a-m receiver, there would be no separation of the two sidebands, so that the program would be heard in conventional fashion without the stereo effect. The stereophonic receiver also can pick up nonstereo broadcasts and play them through either speaker or both, without any stereophonic effect.

### Advantages and . . .

From a Report on Instrument Sticks—a new packaging concept by James B. Lindgren, Lind Corp. in Princeton, N. J.

"In very unusual cases the addition of beryllium oxide filler to the casting epoxy may be considered. This material is an electrical insulator, with a thermal conductivity comparable to brass. (Its disadvantage is that if one were to attempt repair of a stick, the dust generated in cutting—if not contained—would, when inhaled, prove fatal.)"

*Ed. Note.* Hold your breath.



### Rapid ASCAT

This new electronic tester, designated ASCAT (Analog Self-Checking Automatic Tester), can check aircraft and missile systems in a fraction of the time normally required. Developed by Bell Aircraft Corp., Buffalo, N. Y., the ASCAT accomplishes in only two minutes the same number of checkout operations requiring more than an hour by a crew of six to ten men working with conventional equipment. High speed results from a No Go type of equipment.

... applied to weather radar



#### MAGNETIC DEFLECTION 5" DIAMETER

Representative applications: plan position indicator information; slow-scan television. (Complies with Aeronautical Radio, Inc. specifications.)

... applied to slow-scan television



#### ELECTROSTATIC DEFLECTION 5" DIAMETER

Representative applications: "B" scan radar, oscillography, armament control radar.

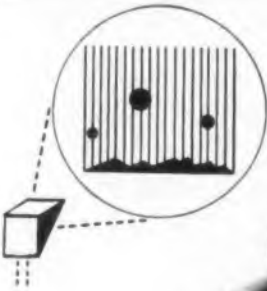
... applied to complex radar systems



#### ELECTROSTATIC DEFLECTION 5" DIAMETER

With two writing guns. Representative applications: multiple "B" scan radar, oscillography, and armament control radar.

... applied to "B" scan projection



#### ELECTROSTATIC DEFLECTION 3" DIAMETER

Representative applications: optical projection systems, miniature radar indicators.

High brightness, multiple halftones, superior storage uniformity, controllable persistence, and compact design are the outstanding characteristics of the Hughes TONOTRON electron tube. All TONOTRON tubes present a complete scale of grey shades for high-fidelity picture reproduction. Hughes offers the only complete line of cathode-ray storage tubes, including the infinite persistence tubes—TYPOTRON® Type 6577 (character-writing storage tube) and the MEMOTRON® Type 6498 (oscillograph storage tube).

Complete technical information—specifications, operating characteristics, suggested circuitry, etc., will be sent you on request. Write: HUGHES PRODUCTS, Marketing Department, International Airport Station, Los Angeles 45, California.

Creating a new world with ELECTRONICS

## HUGHES PRODUCTS

\*Trademark of Hughes Aircraft Company  
© Registered Trademark

© 1958 HUGHES AIRCRAFT COMPANY

CIRCLE 5 ON READER-SERVICE CARD



When a jet screams down the runway fully loaded with fuel and ammo... reliability is the key to safety and "mission accomplished".

Here's where warning of system failures is vital... where Leach reliability proves itself again and again.



## Look to Leach for packaged reliability!

A major airframe manufacturer relies on three types of Leach Relay assemblies in a single dimmer package to solve the problems of pilot safety, visual distraction and eye discomfort for pilots of two of its advanced jet trainers.

The assemblies switch on master caution lights, fire warning lights and other emergency warning lights... each requiring significant differences in intensity to catch the pilot's attention. Each of these assemblies has its own series of resistors and diodes; altogether they serve 27 different circuits.

Clear lamps of fixed light intensity are used behind green, amber and red colored elements. The resistors in the Leach Relay package permit varying degrees of light intensity for instrumentation illumination. They assure control of instrument panel lighting during ground taxiing, under extreme opaque conditions at high altitudes, during night missions and in the strong brightness of daytime flights.

Most important of all, they do not fail. For dependable relays... for packaged reliability, look to Leach!

SEE FOR YOURSELF how Leach relays surpass all others in electrical and environmental specifications. Write today for catalog and complete information.



LEACH RELAY **LEACH**  
CORPORATION

A division of

5915 Avalon Blvd., Los Angeles 3

District Offices and Representatives in Principal Cities of U. S. and Canada

EXPORT: LEACH CORPORATION. INTERNATIONAL DIVISION

CIRCLE 6 ON READER-SERVICE CARD

## BEHIND THE NEWS



In one minute this sheet of paper was printed by the new Army teletypewriter.

### Teletypewriter Prints 3000 Words Per Minute

A teletypewriter which prints at a rate of 3000 words per min was announced. The device, reportedly the fastest general purpose message printer, was developed jointly by the U. S. Army Signal Corps and the Burroughs Corp., Paoli, Pa.

In its essentials, the electrostatic recording process uses a controlled source of electricity to form small charged areas on a high-resistivity surface such as a coated paper.

The electrostatic latent image formed by the charged areas is made visible by application of powdered ink, permanently fixed by the application of heat.

The recording head comprises 35 tiny wires leading into and through a triangular-shaped piece of plastic. The wires are polished flush with one corner of the triangle, or printing head, to form a rectangle seven wires high by five wires wide.

This is the matrix—72 of them in a row to form a printing line. They do not touch the paper but are maintained at a fixed distance from the paper surface.

Electric pulses will selectively charge all 35 wires or any combination of those wires in each head. A normal line of type, such as appears on this page, is made possible by setting up the first

CIRCLE 7 ON READER-SERVICE CARD ▶

ELECTRONIC DESIGN • November 26, 1958

# TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY



## New Fast, Sure G-E Impulse Test Method Safeguards 5-Star Tube Performance under Vibration Conditions



**IMPULSE-TESTING G-E SUBMINIATURES.** R. W. Field, Manager, Finished Tube Quality Control, General Electric Owensboro tube plants, watches test operator take peak and integrated output readings as 5-Star 6111's are tapped by pendulum (circle). To assure accurate readings, the meter pointers remain in indicating position until operator presses the reset button.

Rapidly being applied to 5-Star Tubes—miniatures and subminiatures—General Electric's new impulse test method for measuring vibrational output gives a lower-noise tube in military applications where shock and vibration are definite hazards.

Missile circuits, for example, may incur any one of three kinds of vibration—impulse, random, and periodic. All three can result in tube resonance and variations in output.

In order to weed out those tubes with high output variations caused by vibration, General Electric tube engineers developed a new, fast, and positive method of impulse-testing which interprets tube output in terms of both peak and *integrated* values. Integrated output figures have a close correlation to swept-frequency test results (see chart below).

G.E.'s test thus protects against periodic and random, as well as impulse-type, vibration, insofar as these conditions affect tube performance.

### For 6829 5-Star Twin Triode: Most Advanced General-Purpose MIL Tube Spec Ever Written!

Thirty-nine MIL-spec performance tests for General Electric's 6829 military tube are followed by seven different life tests. Important among these is a special cut-off life test to assure emission capabilities after long periods of cut-off operation.

Other 6829 MIL-spec life tests cover: 100-hour survival rate, heater cycling, and a stability check for early-life variations in tube characteristics; also long-term reliability tests conducted under Class-A, zero-bias, and pulse conditions.

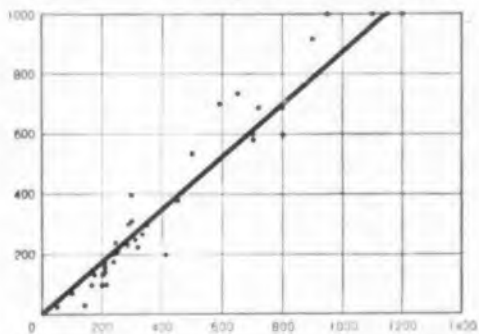
Proved by these stringent factory tests, General Electric 5-Star 6829's

are going into circuits that demand the utmost in tube reliability.

The 6829 has high perveance; uniform, controlled cut-off; high  $\mu$  and high transconductance. These custom-fit the tube for use as a counter in computers, or as a line or core driver in cathode-follower circuits.

In addition, the versatile 6829 is directly suited to amplifier or pulse-generator applications in military controls, communications equipment, and detection systems. Ask any General Electric Receiving Tube Department office listed on the following page for additional information!

Showing Close Correlation Between Impulse and Swept-Frequency Tests



Horizontal: integrated output of impulse excitation, in microvolt-seconds. Vertical: swept-frequency vibration (100 to 10,000 CPS, 10 G peak acceleration), max output in peak-to-peak millivolts. Tube tested, Type 6021, 10 sections,  $E_f$ :6.3 v,  $E_b$ :100 v,  $R_k$ :150 ohms,  $R_f$ :10,000 ohms.



ed by  
E 3000  
ce, re-  
essage  
Army  
Paoli.  
ording  
ity to  
stivity  
y the  
ion of  
pplica-  
wires  
haped  
flush  
head.  
wires  
form  
er but  
paper  
all 35  
each  
ars on  
first  
ARD ►  
1958

**Tear off and keep this sheet for reference. It contains useful tube-application data.**

## TO MINIMIZE TV DISTORTION, ALLOW FOR VIDEO REFERENCE SHIFT!

### Avoid White Compression and Other Picture Faults by Designing for a Video-Amplifier Grid Voltage Range in Excess of Peak-to-Peak Drive!

Study of the diagram at right will show how essential it is for the television designer to provide a linear transfer characteristic with significantly greater dynamic range than apparently is required for a given peak-to-peak video-detector output. This applies when AC coupling is used between video detector and video amplifier.

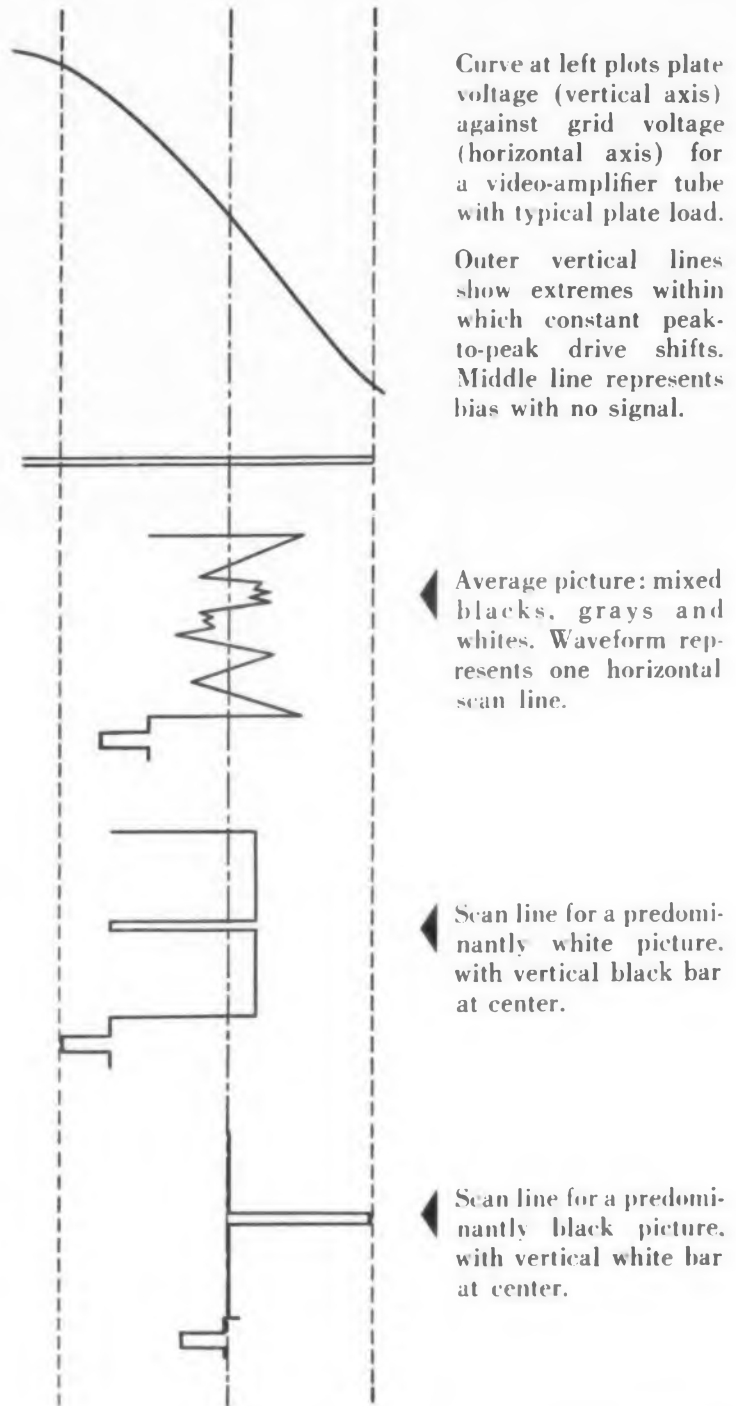
In order to include the two extremes of the picture tone scale—a predominantly white screen image or a predominantly black image—the grid-voltage swing called for is approximately 1.6 times that of the peak-to-peak detector-output voltage.

These two picture extremes are not commonly encountered in home set operation. However, their existence shows that a safety factor should be used when choosing video-amplifier tubes or establishing detector level, in order to assure good picture reproduction over a wide range of image content. The amount of safety factor will depend on the degree of compromise chosen by the designer. A factor between 1.24 and 1.4 times the detector-output voltage might be considered practical.

### Tube Characteristics Vital—Select the Right Type!

Depending on individual circuit requirements, the TV designer should carefully consider a video-amplifier tube's cut-off characteristics and amplification factor insofar as these affect the tube's ability to cover the full desired grid-voltage range efficiently.

General Electric's wide selection of video-amplifier types helps the designer choose exactly the right tube for his circuit. Among G-E types are the popular 6AU8-A . . . 6/8AW8-A . . . 6/8CX8 . . . 6/8EB8 . . . 12BY7-A. Ask any G-E receiving tube office below for expert application counsel!



**For further information, phone nearest office of the G-E Receiving Tube Department below:**

#### EASTERN REGION

200 Main Avenue, Clifton, New Jersey  
 Phones: (Clifton) GRegory 3-6387  
 (N.Y.C.) Wlconsin 7-4065, 6, 7, 8

#### CENTRAL REGION

3800 North Milwaukee Avenue  
 Chicago 41, Illinois  
 Phone: SPring 7-1600

#### WESTERN REGION

11840 West Olympic Boulevard  
 Los Angeles 64, California  
 Phones: GRanite 9-7765; BRadshaw 2-8566

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

12-11-206



character in the line across all 72 heads. The only head that prints is the one selected by a coincident pulse to the back plate, or "anvil." The electrostatic charge can be deposited in one millionth of a second.

The second character in the word would be set up across the line and printed serially in a similar manner. Obviously, a line of 72 characters wide would require only a small fraction of a second.

During the recording stage, the electrical discharge from the printing head to a metal plate—grounded or of polarity opposite that of the printing head—is used as the source of charge to form the electrostatic latent image on the paper surface.

The size of the image depends mainly upon the polarity, the electric field strength and the surface coating on the paper. A relatively low negative voltage applied to the point electrode gives small, round dots.

Operating at a lower speed of 750 words a minute to meet Army Signal Corps requirements, the new electronic messenger will be the major unit in the Army's new family of teletypewriter devices, all operating at 750 words a minute.



### Sized-Down Seismograph

This is the first all-transistorized seismic amplifier system. It reportedly yields weight, power and size savings ranging from 50 to 80 per cent over conventional vacuum tube systems.

The new 24-channel seismograph—complete with control test circuitry—is contained in one waterproof case weighing only 57 lb. An all-transistorized regulated power supply and lightweight 12-v aircraft battery both are contained in another case weighing 45 lb. Vacuum tube seismic amplifier systems weighed in the order of 200 lb. Operator here holds an experimental silicon solar convertor charging 12 v battery in all-transistorized regulated power supply at left, powering the seismograph in center, feeding recording oscillograph at right. Dubbed Explorer, the seismograph was designed and manufactured by Texas Instruments Inc., Houston, Tex.

CIRCLE 7 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1958



## MAXIMUM TELEMETERED RESPONSE THROUGH FLAT AMPLITUDE AND CONSTANT DELAY

In keeping with its reputation as a pioneer in the field of toroids, filters and related networks, Burnell & Co. now offers a complete line of low pass and band pass constant delay filters for standard RDB telemetering channels. These Burnell constant delay filters combine accurate amplitude and phase to effectively limit intelligence distortion and false transients to a minimum. Telemetered signals from off course missiles or those in distant or terminal flight are no longer blocked by attenuation and noise.

### Amplitude and Phase Necessary

For maximum performance of telemetering systems, it is recognized that filtering of sampled data requires both linear phase and flat amplitude in the pass band. However, until recently a combination of the two in one unit had not been available.

### Combination Achieved

Existing sub carrier discriminators afford no better than a choice of flat amplitude pass band with *non-linear* phase in one filter or a constant time delay filter with *distorted amplitude*. In contrast, Burnell constant delay filters combine both—are flat within 3 db over the pass band— $1\frac{1}{2}$  db for the low pass filters—and possess a time delay constant within 5%.

Write for Bulletin CD 051

### TECHNICAL DATA FOR $\pm 7\frac{1}{2}\%$ PASS BAND

- 1 Flat within 3 db over pass band
- 2 21 db at  $\pm 15\%$  of center freq.
- 3 40 db at  $\pm 22\%$  of center freq.
- 4 Time delay over the pass band, constant to  $\pm 5\%$

### FOR $\pm 15\%$ PASS BAND

- 1 Flat to 3 db over pass band
- 2 23 db at  $\pm 30\%$  of center freq.
- 3 40 db at  $\pm 44\%$  of center freq.
- 4 Time delay over pass band constant to  $\pm 7\%$

Input impedance — 500 ohms

\*Output impedance — 500 ohms and high impedance for operation to a grid

\*optional impedance available on special order.

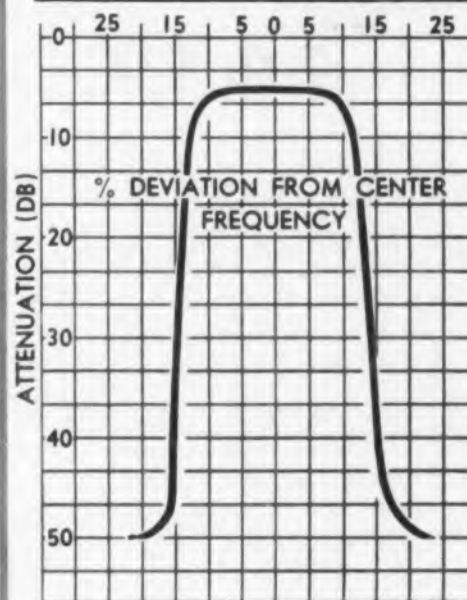
### CONSTANT DELAY BAND PASS

Channel	Frequency	Part #	Delay in ms.	.B/W
1	.4 KC	S-60051	34.00	15%
2	.56 KC	S-60052	24.30	15%
3	.73 KC	S-60053	18.60	15%
4	.96 KC	S-60054	14.20	15%
5	1.3 KC	S-60055	10.50	15%
6	1.7 KC	S-60056	8.00	15%
7	2.3 KC	S-60057	5.93	15%
8	3.0 KC	S-60058	4.40	15%
9	3.9 KC	S-60059	3.38	15%
10	5.4 KC	S-60060	2.44	15%
11	7.35 KC	S-60061	1.80	15%
12	10.5 KC	S-60062	1.26	15%
13	14.5 KC	S-60063	0.91	15%
14	22. KC	S-60064	0.60	15%
15	30. KC	S-60065	0.44	15%
16	40. KC	S-60066	0.33	15%
17	52.5 KC	S-60067	0.252	15%
18	70. KC	S-60068	0.189	15%
A	22. KC	S-60069	.305	30%
B	30. KC	S-60070	.224	30%
C	40. KC	S-60071	.168	30%
D	52.5 KC	S-60072	.126	30%
E	70. KC	S-60073	.096	30%

CASE SIZE—2" x 3 $\frac{1}{2}$ " x 4 $\frac{1}{16}$ "

INPUT IMPEDANCE = 500 ohms

OUTPUT IMPEDANCE = 500 ohms and to grid



**EASTERN DIVISION**  
10 PELHAM PARKWAY  
PELHAM, NEW YORK  
PELHAM 8-5000  
TWX PELHAM 3633



**PACIFIC DIVISION**  
720 MISSION ST.  
SOUTH PASADENA, CALIFORNIA  
RYAN 1-2841  
TWX PASCAL 7578

*Burnell & Co., Inc.*  
PIONEERS IN TOROIDS, FILTERS AND RELATED NETWORKS

CIRCLE 8 ON READER-SERVICE CARD





LECTROFILM\* -B CAPACITORS



General Electric Announces for Missile Use . . .

## New Lectrofilm\*-B Capacitors for 44,000 Hours of Reliable Life

New G-E Lectrofilm-B capacitors offer you maximum reliability at lowest possible cost . . . results of over 3,000,000 unit-hours of life test data (per G-E Spec. MTC-3) indicate a probability of survival in excess of 0.99 for 44,000 hour life under rated voltage at 85C. Under rated voltage at 125C, the indicated probability of survival is in excess of 0.98 for 44,000 hour life.

**LOW FAILURE RATE AND LONG LIFE** of these inexpensive G-E capacitors result from using only the highest quality materials and the closest of process controls . . . units are tightly wound with high-purity aluminum foil and capacitor-grade Mylar† film dielectric. No solder is used, and introduction of contaminants through impregnation is eliminated.

**SMALL, LIGHTWEIGHT ENCLOSURE** consists of tape wrapped around the compact roll and sealed with epoxy resin, forming a rugged case which resists humidity, vibration and shock.

**TO MEET YOUR APPLICATION REQUIREMENTS**, 14 case sizes are available in five ratings—100-, 200-, 300-, 400-, and 600-volts. Capacitance range within each rating is: 0.015 to 0.68 uf in 100 volts; 0.010 to 0.47 uf in 200 volts; 0.0047 to 0.22 uf in 300 volts; 0.0033 to 0.15 uf in 400 volts; and 0.0010 to 0.10 uf in 600 volts.

**GET A QUOTATION TODAY ON NEW LECTROFILM-B CAPACITORS** by contacting your General Electric representative. Ask for your copy of life-test data and G-E Specification MTC-3. Or, write to Section 447-4, General Electric Co., Schenectady, N. Y.

\*Trade-mark of General Electric Co.

†Reg. trade-mark of DuPont Co.

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

### BEHIND THE NEWS

#### Declassify 40 Year Accumulation of Military Documents

More than one million cu. ft. of classified military documents were wrenched from the National Archives and Federal record centers last month. This amount of paper represents most of the letters, reports, films, books, and memorabilia classified and collected by the military services between 1907 and Jan. 1, 1946. Even with this grand sweep, there still remains nearly 10 million cubic feet of paper collected within the last 12 years.

This mountainous accomplishment is made possible through a Defense Department Directive downgrading the tremendous backlog of documentation—with certain exceptions. Among the comparatively short list of exceptions are several of interest to the electronic design engineer: radar scope photography; documents describing electronic countermeasures and counter-countermeasures; those giving structural or performance data concerning Naval vessels or Naval armament and equipment, i.e. proximity fuses, fire control systems having designation MK 35 and numerically higher, including their associated computers and radars.

While the directive brings into the open many old documents, its very existence has tended to make military classifiers more keenly aware of the problems. Under the "needling" of declassification policy-maker Vice Admiral John M. Hoskins, USN (Ret.), guide lines may be established that will make the job of classifying that of the person who knows most about the document.

Meanwhile, in an attempt to stem the tide of classification, Hoskins' office has set up a periodic reporting system with the services. Certain criteria have been set up on an experimental basis. If they do not appear to be doing the job, then others will be developed to do it better.

◀ CIRCLE 9 ON READER-SERVICE CARD

## NEWS BRIEFS...

**SEMI-AUTOMATIC DATA PROCESSING SYSTEM** development for military and civil air traffic control proceeding "on schedule," General Precision Laboratories reports. Contracts with the MAB totalling \$8 million awarded earlier this year specify 1960 target date for initial model completion. System will handle both in-route and terminal phases of flight, performing non-decision making functions.

**EYEGLASS HEARING AID** features magnetic pickup in front frame. Sound and visual reception are thus coordinated. Pickup measuring  $1/2 \times 3/8 \times 1/5$  in. is of balanced armature variable reluctance variety. Feeds either monoaurally or binaurally. Acoustic gain is 50-60 db. Developed by Otation Listener Corp. who are now going after military contracts in subminiature components.

**WIRE-GUIDED TORPEDO** developed for the Navy's Bureau of Ordnance by Vitro Laboratories; Silver Spring, Md. Weapon is connected to its launching vessel by a wire that is paid out from the torpedo as it drives through the water. Operators aboard the launching vessel send electrical signals over the wire to guide the torpedo to a "kill." Range of Mark 39 was not disclosed.

**ION AND OTHER ELECTRICAL PROPULSION** for space flight applications will be jointly developed by Marquardt Aircraft Company, Van Nuys, Calif., and Applied Radiation Corporation, Walnut Creek, Calif. Formal agreement was recently made by both companies who bring extensive complementary experience to the union.

**NEW SUPERSONIC AIR-TO-AIR GUIDED MISSILE** climbs higher, flies faster and has a greater range than any of its predecessors. Fourth in the family of Falcon missiles produced by Hughes, the GAR-3 is scheduled to go into operational service as principal fire-power of advanced all-weather jet interceptors of the Air Defense Command. White ceramic nose cone is longer and more pointed than the stubby, rounded radomes of earlier birds. Other external changes include greater length (slightly over seven feet), increased wing span, and extension of stabilizers so that they reach beyond the center of the airframe.



- Memory
- Tone
- Resolution
- Brightness
- (Erase)

*Designed for the most exacting applications of storage and display*

*Federal*

# IATRONS\*

Iatron storage tubes give you a broad range of characteristics around which to design advanced systems for writing, storing, displaying, and erasing information.

*In all-weather radar*, Iatrons have a high order of halftone resolution that facilitates distinguishing of cloud formations.

*In ground radar*, Iatrons permit accurate, convenient daylight viewing because of their high brightness—up to 10,000 foot-lamberts—ample for projection systems.

*In scan conversion systems*, observation of single transients, sequential display of instrument data and similar uses, Iatrons offer resolution up to 80 lines/inch and high writing speeds.

Developed by men who have led in storage device technology, Iatrons are manufactured to the high standards of reliability which have made Federal tubes famous for over half a century. Write today for complete data.

TYPE	DIAMETER	FOCUS	DEFLECTION	WRITING SPEED IN./SEC.	ERASING TIME	VIEWING TIME (MAX.)	RESOLUTION LINES/IN.	BRIGHTNESS FT.-LAMBERTS
7173	4" direct view	electromagnetic	electromagnetic	200,000	3 millisecc.	30 sec.	50	2800
7174	4" projection	electromagnetic	electromagnetic	200,000	3 millisecc.	30 sec.	50	10,000
7175	5" direct view	electrostatic	electromagnetic	250,000	3 millisecc.	40 sec.	80	2500
7176	5" direct view	electrostatic	electrostatic	250,000	3 millisecc.	40 sec.	80	2500



Box F0011, Vacuum Tube Department, Components Division  
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION  
Box 412, Clifton, New Jersey

\*Trademark of International Telephone & Telegraph Corporation.

CIRCLE 10 ON READER-SERVICE CARD



# over 50,000 meters in stock!



**800 sizes and types available for immediate  
delivery through your SIMPSON distributor!**



**YOUR  
DISTRIBUTOR GETS  
24-HOUR SERVICE  
FROM THIS  
HUGE SIMPSON STOCK**

Do you need panel meters in a hurry? You can get Simpson panel instruments from your local electronics parts distributor . . . right off the shelf! And to be sure that you get the model and quantity you want, Simpson backs up your local distributor with a huge stock at its own Chicago plant. This teamwork puts 50,000 meters, in 800 sizes and types, at your finger tips. There's no delay either. Your distributor's orders are shipped from Simpson's warehouse within 24 hours.

But service isn't the whole story. Simpson meters are quality instruments—backed by a 50-year reputation for accuracy and ruggedness.

Your Simpson distributor is one of 1500 located throughout the United States, Canada, and abroad. Check with him on all of your stock meter requirements.

## **SIMPSON ELECTRIC COMPANY**

5202 W. Kinzie St., Chicago 44, Illinois  
Phone: EStebrook 9-1121  
In Canada: Bach-Simpson Ltd., London, Ontario

**INSTRUMENTS THAT STAY ACCURATE!**

CIRCLE 11 ON READER-SERVICE CARD

## **WASHINGTON REPORT**



Herbert H. Rosen

### **The Poor, Poor Army**

Depending on when you listen to their spokesmen, the Army is the greatest, best equipped, most knowledgeable organization in the world—or it is the most logistically starved, down-trodden, sinned-against collection of soldiers anywhere. Recently, the Association of the U. S. Army (AUSA) provided a forum for its members that was singularly blessed with a rather high degree of truth.

General L. L. Lemnitzer, Vice Chief of Staff—and probably Gen. Taylor's successor—set the stage with a reflection on modernization. "In terms of dollars," he said, "approximately 60 per cent of the Army's inventory today was procured during WW II or the Korean War." There's even more pre-WW II equipment still in use. Ancient equipment means serious drain on maintenance resources, besides the more important aspect that such equipment prevents the Army from fighting much of a battle.

But replacement equipment and new items are expensive. And a good proportion of the Army's money is being spent on missiles and missile support. Not the least for consideration is communications-electronics. Here, too, the spectre of too-little-too-late hangs over the Signal Corps. In proudly displaying its latest concept of mobility, the Signal Corps was forced to admit that much of its new equipment is still under development. A new Army Area Communications System requires an automatic electronic switching system—still under development. Tropospheric scatter radio terminals are still under development. So are a "push button" electronic telephone and belt-type pouch combat radio.

In combat surveillance, the Signal Corps is striving to "stitch" the battlefield with all-seeing drones. But, according to R & D Chief, Lt. Gen. A. G. Trudeau, the Army's ability to collect intelligence has not improved in the past few years, especially at jet speeds. He cited the vital need for more drones provided with IR, radar, and TV to keep the battlefield commander constantly aware of enemy troop movements.

Trudeau's outspoken remarks affirmed similarly annoying comments—annoying to the Army, that is—made by the Chairman of the Joint Chiefs

# thousands of "SPECIAL" without DELAY!

THESE 22 SERIES  
OF STANDARD SWITCHES  
WILL HANDLE ALMOST  
ANY LOW-CURRENT  
APPLICATION . . .

## ROTARY



MINIATURE: 8, 10, and 12 positions; up to 18 contacts per wafer.

Series A



SMALL: Up to 12 positions in phenolic, Mycalex, or steatite insulation.

Series F



ADAPTABLE: 8, 10, 12, and 14 positions; many variations; economical.

Series J, K, N



GENERAL PURPOSE: Up to 12 positions; 30°, 45°, 60° throw.

Series H



LOW COST: Up to 12 positions; staked or strut screw construction.

Series QH



18-POSITION: Single or double eyelet fastening of clips.

Series L



24-POSITION: 15° throw handles complex circuits.

Series MF



LOW COST: 2 to 5 positions; fits in limited space.

Series 50, 53



SIMPLE SWITCHING: Up to 5 positions combined with AC switch.

Series 52, 54



SIMPLE SWITCHING: Up to 4 positions; numerous variations.

Series 20



LEVER OPERATED: 2 to 5 positions; numerous versions using std. wafers.

Series 185



CONCENTRIC SHAFTS: Dual and triple shafts with many wafer types.



FOR PRINTED CIRCUITS: Special lug designs for direct insertions.

CUSTOM-MADE  
TO YOUR EXACT  
SPECIFICATIONS  
FROM  
STANDING TOOLS



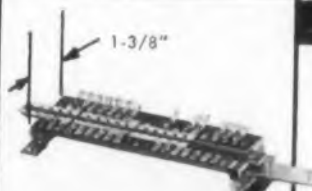
SOLENOID SWITCH: Oak wafers with G. H. Leland type of Rotary Solenoid.

## SLIDE



2-POSITION: Sliding type with floating slider.

Series 70



COMPLICATED SWITCHING: 2 to 4 positions; up to 20 poles; very thin.

Series 150

## ROTARY SLIDE



COMPACT—2 to 4 positions; max. switching in min. space.

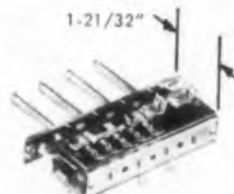
Series 160

## PUSHBUTTON



SINGLE BUTTON—1 to 4 poles; spring return and push-push.

Series 170, 175



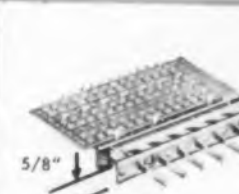
SIMPLER CIRCUITS: 3 to 12 buttons; very adaptable unit.

Series 80



COMPLICATED CIRCUITS: 1 to 18 buttons, up to 32 contacts each.

Series 130



ULTRATHIN: 1 to 12 buttons; up to 14 contacts per button.

Series 131

EACH SWITCH  
IS PRETOOLED  
IN NUMEROUS  
VARIATIONS.  
DETAILS  
ON ANY SERIES  
ARE AVAILABLE  
ON REQUEST

For Recommendations on Unusual Applications, send us a sketch and short description.

OAK MFG. CO.

MFG. CO.



1260 Clybourn Ave., Dept. D, Chicago 10, Illinois

Phone: MOhawk 4-2222



SWITCHES



ROTARY SOLENOIDS



CHOPPERS



VIBRATORS



SPECIAL ASSEMBLIES

CIRCLE 12 ON READER-SERVICE CARD

of Staff, Gen. Nathan Twining. The nation's top soldier hit at the Army for seeking too glamorous equipment to do an immediate job. The mobility concept was attacked. In this context Twining was directing his comments at "rapid and reliable communications, accurate acquisition, and simple supply procedures." "Every aspect of modern technology should be used to improve these areas," he said.

## Unnecessary Complexity

Twining went on to point out that "much of our equipment today is unnecessarily complicated. Are we making equipment so technical because it is supposed to be so today? I think we have introduced too many refinements and comforts into much of our equipment with resulting problems of maintenance under field conditions and training, not to mention the factor of cost . . ."

AUSA was shocked at this public rebuff, but could do little about it when its own people—Trudeau and Medaris—hit at the same areas. The R & D Chief called the requirements set by the military too high. He suggested that rather than seek perfection all the time, the services should be satisfied with, say, 90 per cent of the goal.

Trudeau also called for more decentralization of decision in light of rapid transportation and virtually immediate communications. He also advised that industry should be given greater authority over its projects. But, in being granted this authority, the companies must accept the responsibility of success and failure of the project.

This same kind of approach was reiterated by the Army's missile boss, Maj. Gen. J. B. Medaris. Furthermore, he thought that the military procedures for selecting contractors via open competition is too time consuming. Part of the long lead time between concept and operational capability can be attributed to this system.

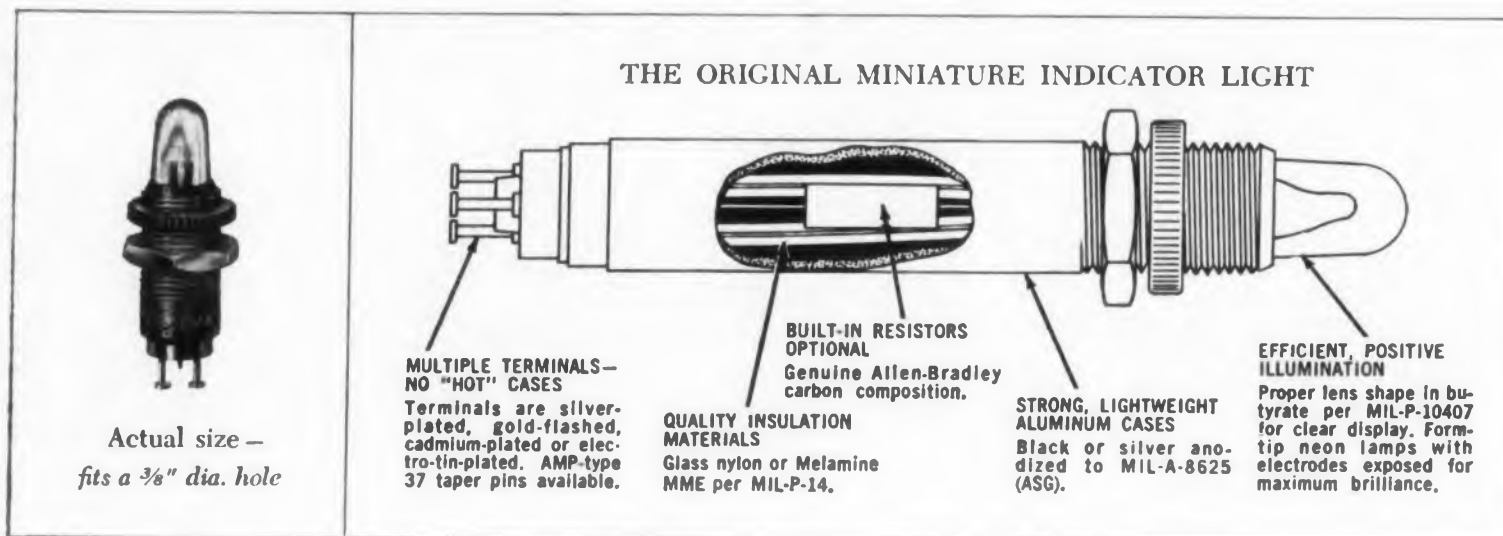
Medaris also felt that industry's red tape is more cumbersome than the military and is partly responsible for industry's inability to respond fast enough to the customer's changes in direction. He further chastised some elements of industry that have a "tendency to make a lifetime career out of a military project."

This same line was cast at industry by E. P. Oesada at a recent NSIA luncheon. Neither the new Federal Airways Agency director nor the AFMA chief gained many friends by these remarks. However, both have great influence on the kind and amount of work the electronics industry will be doing over the next few years. Oesada's FAA is expected to let many far-reaching contracts in air traffic control equip-



# BE SURE...BUY E-LITES

*engineered especially for computers, control systems, military applications*



You can mount almost any E-lite in a  $\frac{3}{8}$ " hole. These tiny units save precious space in computer data-processing systems, aircraft and industrial control systems, instruments, test equipment, telemetering systems—wherever long life and dependable operation are essential. They'll fit your system application *exactly* because

they're tailor-made for the job by system engineers. Choose from many replaceable-lamp or permanent-lamp types, with neon or incandescent lamps, with or without resistors, and in a variety of lens styles, colors and data readout capacities. 100% electrical and mechanical inspection assures you of full E-lite quality in every unit.

TWO-WEEK DELIVERY ON 1560  
STANDARD VARIATIONS  
*Special Prices On Volume Orders*



**REPLACEABLE-LAMP TYPES**  
Single-lamp holders for neon or incandescent lamps. Variety of lens types. Up to 3 digits available on flat lenses. 1DH holder shown.



**TRANSISTOR CIRCUIT NEON LIGHT**  
Has built-in diode-resistor network—no adapting needed. Fires on only 10 volts. Lamps are aged, selected for stability. Round or flat-face (readout) lens. Model 1AD shown.



**PERMANENT-LAMP ROUND-LENS INDICATORS**  
With neon or incandescent lamps. Model 1AG (neon) shown.



**LOW-COST INDICATORS**  
Neon and incandescent panel illumination, readout, etc. Round or flat lens. Lens marking available. Push-on retainer furnished. Models 1B (neon) and 1K (incandescent) shown.



**PERMANENT-LAMP READOUT TYPES**  
With permanent or changeable lenses, and lenses taking up to 3 digits. Neon or incandescent lamps. Model 1EG (neon) shown.



**DUAL LAMP HOLDER**  
Holds two lamps to provide double check on circuit operation. Monitors key circuitry in a variety of ways. Model 1FH.

MORE THAN 1500 SATISFIED USERS:

IBM    Burroughs    General Electric  
Electro-Data    Bendix    Hughes    Brush Instruments  
Magnavox    Ampex ... and others!

Write for 6-page bulletin with photos, descriptions, dimension drawings for the complete line. Sales representatives in principal cities. Submit your special problem for our engineered solution.



1805 Belcroft Avenue, El Monte, Calif.  
A subsidiary of Genisco, Incorporated

## WASHINGTON REPORT

ment happen. And Medaris' part in missile activities need not be elaborated on.

But their influence goes even deeper than these indicators. Deputy Defense Secretary Donald Quarles expects to request a \$42 billion budget for FY '60. In doing so, several large programs will have to be cancelled. Washington circles believe that missile and aircraft projects will be the hardest hit. And among these will be those conducted by companies giving every indication of making them "lifetime projects."

With all this great cry of an inadequate air defense, why is there such a delay in installing more missile masters for point defence typified by the Nike batteries? Rumors prevail that four such installations are now sitting in warehouses waiting for the Army and Air Force to decide who will have housekeeping responsibility and who will supply the bricks and mortar.

There should be quite a repercussion in the industry when—and if—ITT receives the award for the SAC global communications modernization program—456L. Although teamed with Hughes and Hoffman, ITT still carries a major share of the burden as well as having prime responsibility for SAC's command system, 465L. Many hundreds of millions of dollars are involved.

Without any illumination by publicity, it appears that the land-based Talos is slowly sinking into the ground. Pentagon Deputy Boss, Dr. Donald Quarles, admitted that there are now plans to discontinue its development—this, in spite of highly successful tests at White Sands.

Growth factor of Sperry Rand's Utah laboratories surprisingly high in light of recent recession. Officials claim the staff of Utah Engineering Laboratory will be more than 2000 by end of 1958. Big contract in laboratory is Sargeant solid-propellant guided rocket for the Army. Preliminary work on new antiballistic rocket, Vigilant, is also in progress. However, it is rumored that the work is only the first stage for a still highly classified follow-on missile of advanced design.

Complaints about too little applied R & D in electronics are refuted in EIA report that \$1.4 billion was spent in 1956. Estimate is based on National Science Foundation survey. However, the figures are a reflection of a total cost of \$6.4 billion for all basic research and applied R & D by all industries. According to former Defense R & D chief, Frank Newbury, about \$12 billion is actually spent on R & D. If true, electronics R & D should rise accordingly. Further, since figures are based on the 1956 survey, 1958 estimates should be considerably higher.

# EDITORIAL

## Seek Ye Not The Truth

"You are doing a disservice to the nation when you try to find out how good our weapons stock-up against the Russian's." So spake Maj. Gen. John B. Medaris last month at a NEC news conference. What the nation as a whole will know about our security will come from official communiques only. Official communiques in the past have been too often half-truths. Acting on incomplete facts, newspapers and magazines have often drawn erroneous conclusions, and we have editors confessing, "Why My Newspaper Lied" (*Saturday Review of Literature*, April 5, 1958). Engineers are often no better informed. Your source of information of our weapons' capabilities is often the newspaper or magazine. Despite your secret security classification, you often don't qualify as having a "need-to-know" requirement. As a consequence, few people know our real position. The rest of us apparently can do little more than have faith in those entrusted to decide what is good for us.

How you can get this faith is difficult to say. You usually know men not by their words but by their deeds. We see some deeds like Nike missiles and atomic submarines in sufficient quantities to impress us. Perhaps many of the words said impress us too until we remember words or symbols only and not the things they represent. Words are no good by themselves and as for the deeds of the military, we have no reference by which we can judge them. Do we then judge by the character of those who speak the words?

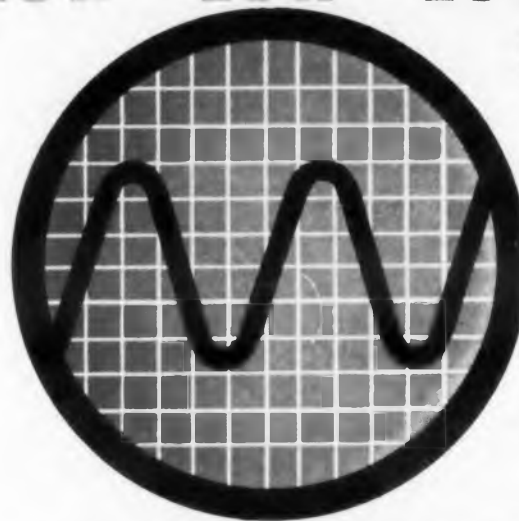
To judge a person's character is not easy. There are catalogs of virtues to be used: most of them suspect when one speculates on the possible motivations that drive a person. Motivations quite accidentally create results recognized as virtues. Vested interests are certainly motivations which raise havoc with a person's rationale.

Two virtues do stand out: selflessness and honesty. The selflessness of the kind shown by Heinrich Hertz who was too busy doing new things to bother to file patents for his own welfare is no doubt too much to expect in today's society. Scrupulous honesty would demand that we don't get any misleading information that either scares us too much or comforts us too much. This requires courage. And such courageous persons may easily expend their usefulness in official circles as did J. Robert Oppenheimer.

As most of us are thwarted in seeking the whole truth, let us ask that those with higher responsibility put truth above self-interest. Let's ask that skeptics be part of our top team as thinking starts with skepticism.

*James G. Kipp*

— — — — — **AC POWER** — — — — —  
**LOW LOW LOW LOW**  
**DISTORTION**



The Behlman  
**INVERTRON®**  
features low  
harmonic distortion.  
Sine wave distortion  
is held to less than 1%  
with .05% or better avail-  
able on special order.

The Behlman Invertron is a completely electronic A.C. Power Source widely used in research and development, production testing, test consoles, electronic systems or wherever A.C. Power other than that obtainable from the 60 cycle line is required.

## INVERTRON®

Models are available with single phase, two phase or three phase output and with either fixed and variable frequencies.

## INVERTRON®

A wide range of power ratings are available in standard models with other power ratings on special order.

## INVERTRON®

The Invertron features extreme frequency accuracy and stability, exceptional regulation against both line and load, and low harmonic distortion and noise.

## INVERTRON®

Specifications for all standard models include 1% maximum distortion, 1% regulation no load to full load, extremely low output impedance, and essentially zero response time.

Modular construction techniques employed to provide low cost custom as well as standard units.

For further information  
write or call

**BEHLMAN**  
ENGINEERING COMPANY  
ELECTRONICS • MECHANICS • OPTICS  
DESIGN • DEVELOPMENT • PRODUCTION  
2711 WINONA AVENUE  
BURBANK, CALIFORNIA

Representatives in all principal cities and Canada

CIRCLE 14 ON READER-SERVICE CARD



# Graphical Design of Transistor Bias Circuits

**G. V. Woodley**  
Raytheon Mfg. Co.  
Waltham, Mass.

**D**ESIGNING transistor bias circuits can be simplified by representing the following considerations graphically:

- the relative magnitudes of the resistors involved;
- the power consumed in the bias circuit;
- the stability of the chosen bias current for various conditions of temperature and for different transistors of the same kind.

Here is a method by which these three considerations can be represented graphically, making the design of the bias circuit easier. Two biasing schemes will be examined—one rather thoroughly. A design problem illustrates the method of determining the bias circuit of an ac transistor amplifier.

## Two Biasing Schemes

Two schemes of biasing are shown in Fig. 1. Here  $i_c$  is the desired collector bias current;  $i_t$  is the base current necessary to achieve this ( $i_c \cong \beta i_t$ ), and  $R_t$  is the input impedance of the transistor ( $R_t \cong \beta R_c$ ). Let us examine these two schemes one at a time.

## Common Method of Biasing

To determine the impedance level relationships which hold for any given bias current de-

sired, the transistor circuit of Fig. 1a is approximated by passive circuit of Fig. 2.

In this circuit

$$\left( i_t = \frac{R_b}{R_b + R_t} \right) \left( \frac{E}{R_f + R_b R_t} \right) \quad (1)$$

from which

$$\frac{R_f}{R_t} = \frac{K^2 \frac{R_b}{R_t}}{\frac{R_b}{R_t} + 1} \quad (2a)$$

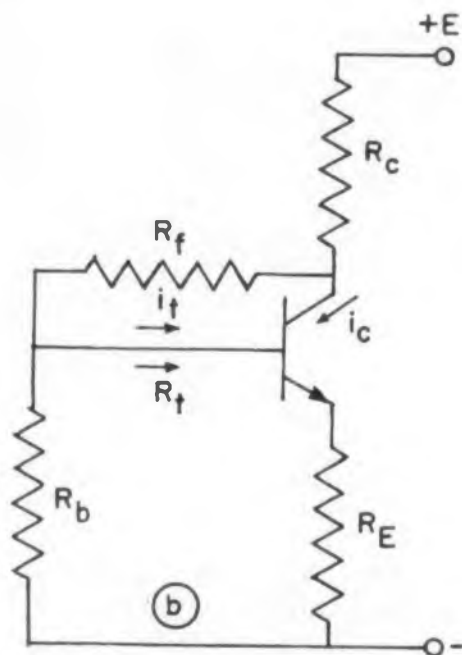
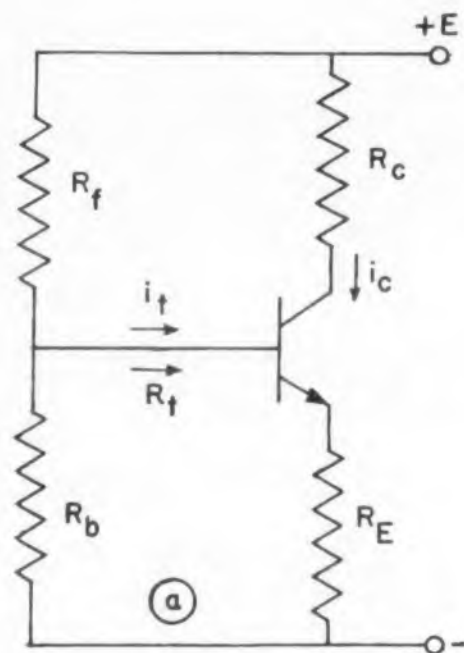
$$K^2 = \frac{E - i_t R_t}{R_t i_t} \quad (2b)$$

The stability consideration is as follows. Assume that the steady-state collector current is made up of two parts:

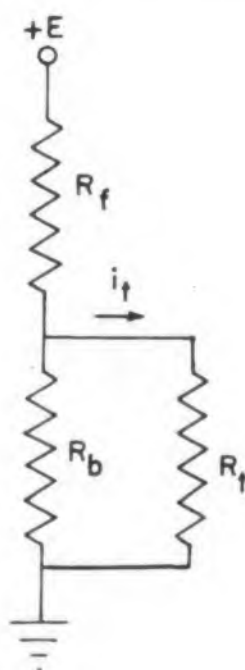
$$i_c = \beta i_t + (\beta + 1) I_{co} \quad (3)$$

Here  $I_{co}$  is defined as the common-base-circuit collector-cutoff-current. This is the standard definition, and hence the multiplier  $(\beta + 1)$ . Defining the stability factor  $S$  as,

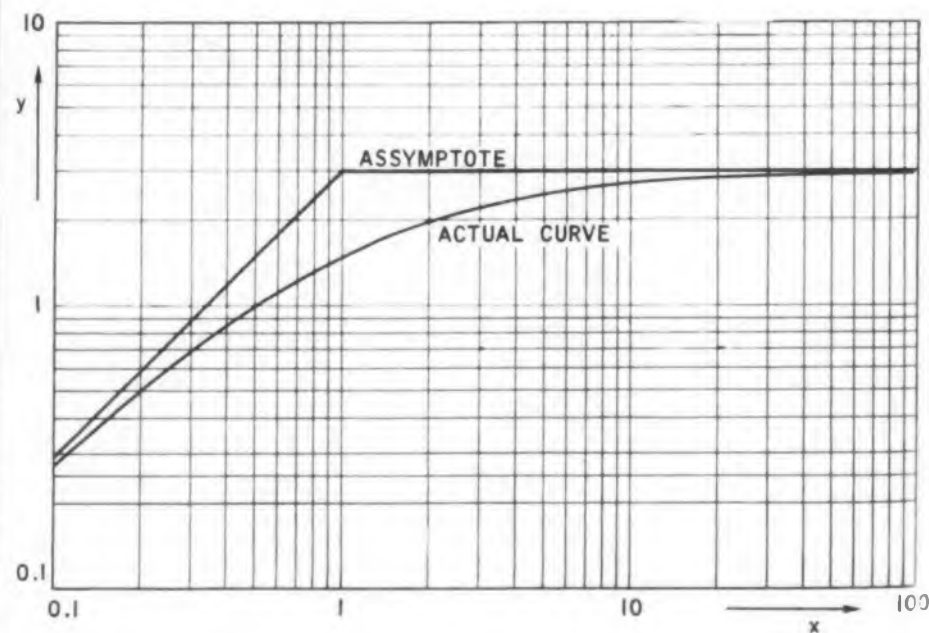
$$S = \left. \frac{\partial i_c}{\partial I_{co}} \right|_{V_c = \text{const.}} \quad (4)$$



**Fig. 1.** Two biasing circuits. Fig. 1a shows a common method of biasing transistors by the use of one battery. Fig. 1b shows a feedback method of biasing transistors by use of one battery.



**Fig. 2.** Passive approximation to the bias circuit of Fig. 1a.



**Fig. 3.** Asymptote and actual representation of the equation  $y = Kx/x+1$  for  $K = 3$ .

one as a figure which expresses the change in the collector current due to the change in the cut-off current. The larger this figure is, the more constant is the bias. Writing the necessary equations for Fig. 1a and solving them for  $i_o$  as expressed in Eq. (3), we differentiate the expression obtained with respect to  $I_{co}$  and obtain Eq. (5).

$$S = \frac{1 + \frac{R_e}{R_f} + \frac{R_e}{R_b}}{1 - \alpha + \frac{R_e}{R_f} + \frac{R_e}{R_b}} \quad (5)$$

Note that  $R_t/\beta$  is substituted for  $R_e$ , and  $1/\beta$  for  $(1-\alpha)$ .

Substituting Eq. (2a) into Eq. (5), we get

$$S = \frac{\frac{R_b}{R_t} \left( \frac{\beta K^1 + 1}{K^1 + 1} \right) + 1}{\frac{R_b}{R_t} + 1} \quad (6a)$$

$$S = \frac{\frac{R_b}{R_t} \left( \frac{\beta K^1}{K^1 + 1} \right) + 1}{\frac{R_b}{R_t} + 1} \quad (6b)$$

As an approximation Eq. (6b) is justified if  $\beta K^1 \gg 1$ , which is usually the case.

To determine the bias power, the approximation in Fig. 2 is used. From this,

$$P_b = \frac{E^2}{R_f + R_b R_t} \quad (7)$$

Again substituting Eq. (2a) into Eq. (7),

$$P_b = \frac{P^1}{K^1 + 1} \frac{\frac{R_b}{R_t} + 1}{\frac{R_b}{R_t}} \quad (8a)$$

$$P^1 = \frac{E^2}{R_t} \quad (8b)$$

Eqs. (2), (6), and (8) are the three important considerations of a bias circuit expressed as a function of the base resistor, nondimensionalized with respect to the input impedance of the transistor.

A graphical method of expressing these relationships can be found, if one examines these relationships and notices their similarity to frequency-domain representations of passive compensating networks. These expressions have asymptotes and correction factors, and can be drawn very easily by the use of a template. The equation and graph of such a template is given in Fig. 3. The template can be constructed out of cardboard or plastic from the graph.

(Continued on following page)



D. E.  
MAKEPEACE  
DIVISION

## FOR SLIP RING APPLICATIONS

**SLIP RINGS . . .** Diameter from  $\frac{1}{3}$ " to 48" and larger. Rings are plastic molded, electroplated, electroformed or fabricated. Annular or cylindrical rings are formed of both solid and laminated metals. **SLIP RING ASSEMBLIES . . .** All sizes 1 to 400 circuits. Performance closely approaches that of a uniform cable. Crosstalk between circuits similar to shielded cable; impedance match at video frequencies like matched coaxial cable; at radio frequencies sufficiently close for many applications. D. E. Makepeace Division, Attleboro, Mass.

CIRCLE 101 ON READER-SERVICE CARD



AMERSIL  
QUARTZ  
DIVISION

## FOR ULTRAVIOLET TRANSMISSION

**AMERSIL FUSED QUARTZ . . .** Ideal for use in high ultraviolet transmission applications and as laboratory ware, ranging from plain tubing to many intricate fabrications. Ingots and plates available in general commercial quality as well as in three special optical grades: **OPTOSIL®**, practically bubble-free—very slight granular structure; **HOMOSIL®**, completely free of bubbles—just the faintest traces of granular structure; and **ULTRASIL®**, completely homogenized—increased UV transmission.

Amersil Quartz Division, 685 Ramsey Avenue, Hillside, N. J.

CIRCLE 102 ON READER-SERVICE CARD



CHEMICAL  
DIVISION

## FOR PURIFYING AND PURIDRYING

**DEOXO® PURIFIER . . .** provides low-cost catalytic purification of hydrogen and other gases to the extent of less than one part oxygen per million. Requires no operating expense, no maintenance, no reactivation, no auxiliary heating, no water cooler. **DEOXO® DUAL PURIDRYER . . .** combines continuously-operating, dual tower, automatically-run drying unit with the features of Deoxo Purifier—catalytically produces pure, dry hydrogen, so pure it contains less than one part oxygen per million, so dry that it has a dew point of better than  $-100^\circ$  F.

Chemical Division, 113 Astor Street, Newark 2, N. J.

CIRCLE 103 ON READER-SERVICE CARD



ENGELHARD INDUSTRIES, INC.

113 ASTOR STREET  
NEWARK 2, NEW JERSEY



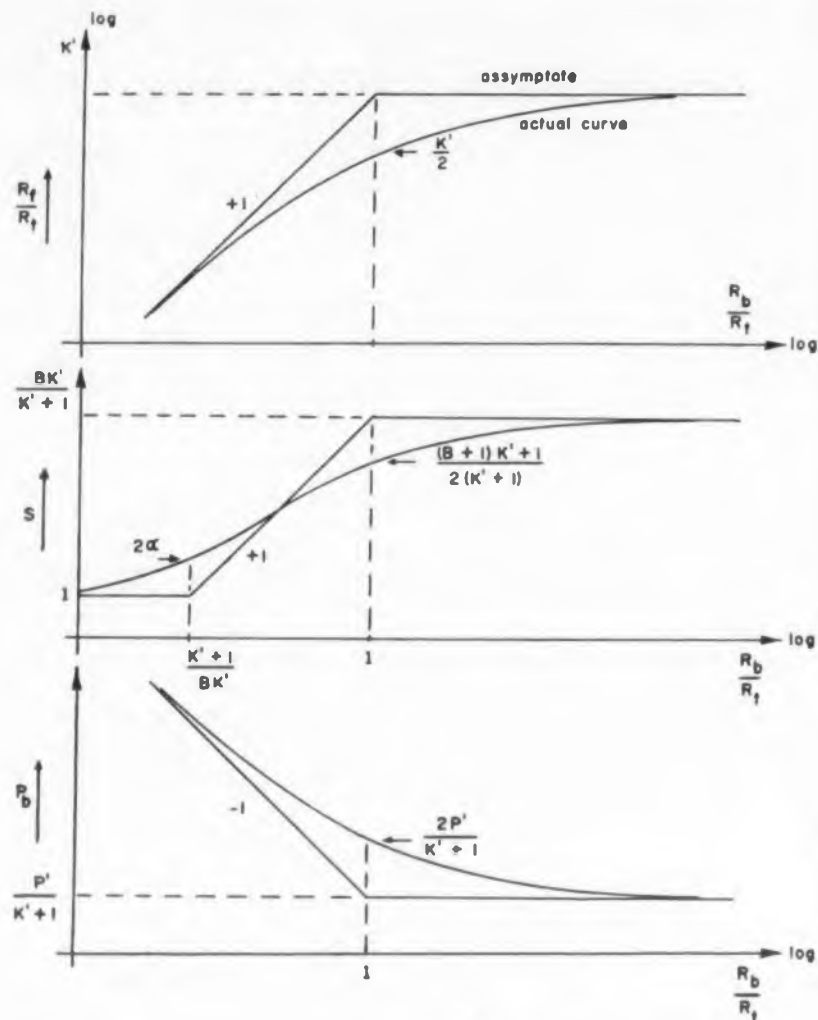


Fig. 4. (Above) Graphical representation of Eq (2), (6) and (8).

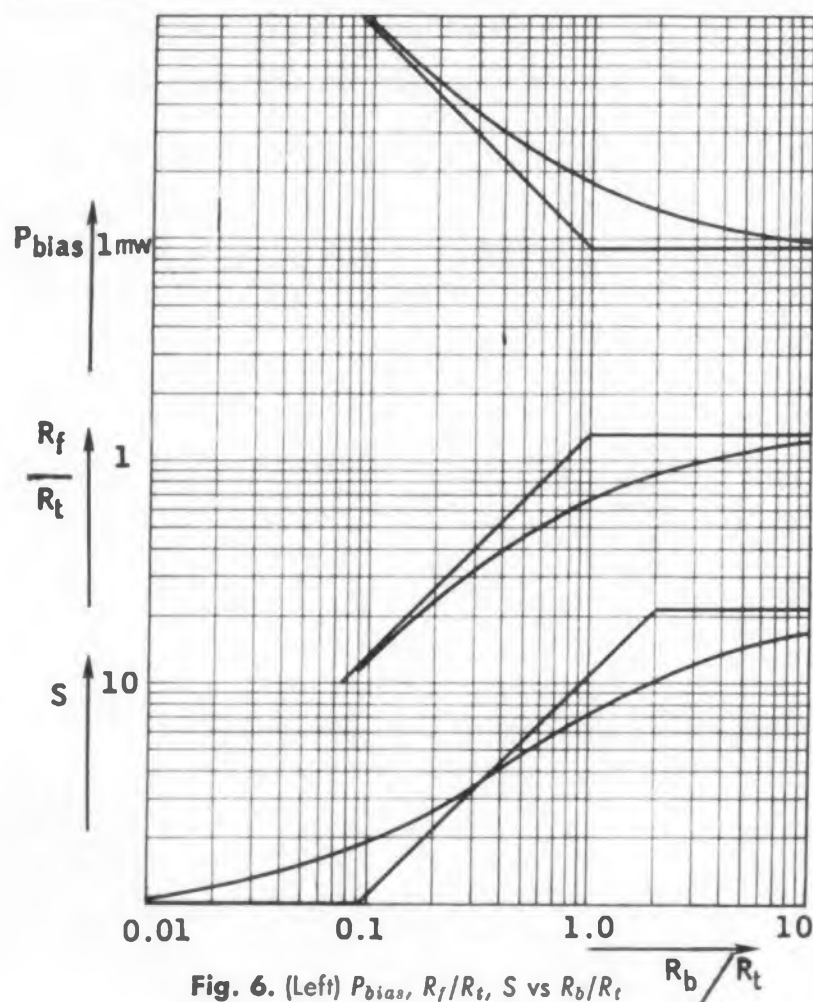


Fig. 6. (Left)  $P_{bias}$ ,  $R_f/R_t$ ,  $S$  vs  $R_b/R_t$  for circuit shown in Fig. 7.

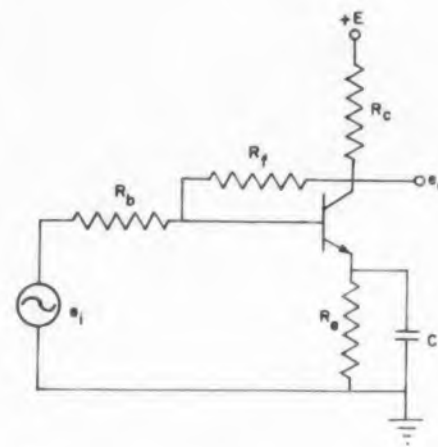


Fig. 5. (Above) Common emitter feedback amplifier.

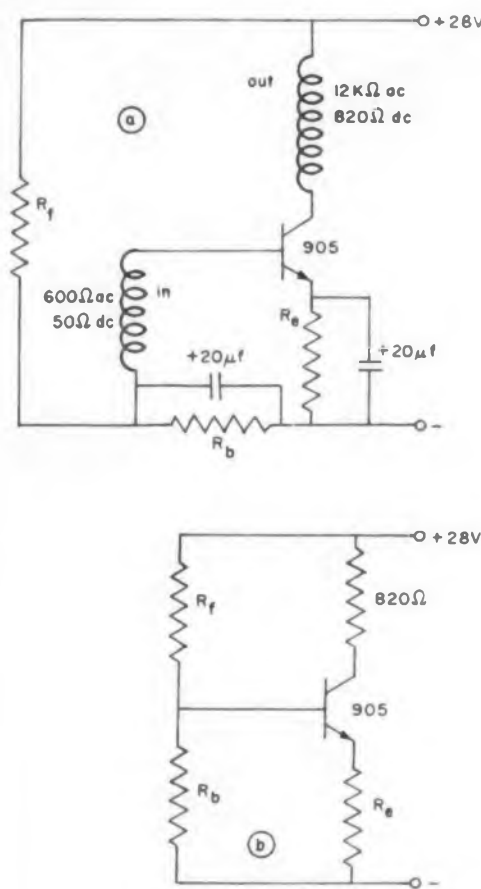


Fig. 7. (Above) Circuit of an ac amplifier. Fig. 7a shows the ac circuit and Fig. 7b shows the dc equivalent.

Eqs. (2), (6), and (8) are graphically represented in Fig. 4. Note that,

$$P' = \frac{E^2}{R_t} \quad K' = \frac{E - i_e R_t}{i_e R_t}$$

The representation of Fig. 4 can be drawn easily for any particular case with the help of template. Whenever one quantity is varied, the effect on any of the others can be determined at a glance. The illustrative example presented later, shows a typical procedure using Fig. 4.

#### Feedback Method of Biasing

Here the situation is more difficult. Some of the equations of interest have been derived, however, and are presented here.

In this case one additional consideration becomes important—that of gain. A common-emitter circuit is used as shown in Fig. 5. If  $C$  is large enough, then

$$\left. \frac{e_o}{e_i} \right|_{ac} \cong \frac{-R_c R_f}{R_b \left[ \frac{R_f}{\beta+1} + R_e \right]} \quad (9a)$$

The dc gain is:

$$\left. \frac{e_o}{e_i} \right|_{dc} = \frac{-R_c [(\beta+1) R_f - R_t]}{R_b R_f + R_t R_f + R_t R_b + R_c [(\beta+1) R_b + R_t]}$$

The bias current  $i_e$  is given by,

$$i_e = \frac{\alpha E / R_f}{1 - \alpha + \frac{R_e}{R_f} + \frac{R_e}{R_b} + \frac{R_c (R_e + R_b)}{R_b R_f}} \quad (10)$$

The stability factor is,

$$S = \frac{1 + \frac{R_e}{R_f} + \frac{R_e}{R_b} + \frac{R_c (R_e + R_b)}{R_b R_f}}{1 - \alpha + \frac{R_e}{R_f} + \frac{R_e}{R_b} + \frac{R_c (R_e + R_b)}{R_b R_f}} \quad (11)$$

Note that Eqs. (10) and (11) have the same denominator.

A point of interest is the similarity of Eqs. (5) and (11). In Eq. (11) the term  $\frac{R_c (R_e + R_b)}{R_b R_f}$  is added to both the numerator and denominator of Eq. (5). This term has the effect of increasing the stability of bias current.

An important special case of Eq. (11) exists when  $R_e = 0$ .

$$\text{If } R_e = 0, \quad S = \frac{1 + \frac{R_c}{R_f}}{1 - \alpha + \frac{R_c}{R_f}} \quad (12)$$

The stability is not a function of  $R_b$ , but the gain, Eq. (9a), is, making it possible to adjust

gain without affecting the stability. Eq. (12) can be adapted to graphical methods very easily. This sort of bias can be used most effectively in the last stage of an ac amplifier.

#### Illustrative Example

The methods of Fig. 4 will be used to determine the biasing circuit of an ac transistor amplifier.

The following is the synthesis procedure. Since the max voltage swing of the 905 is 30 v and the ac load is 12.0 K, we wish to bias the transistor in the middle of a 30 v - 12.0 K load-line, or at  $i_e = 1.25$  ma,  $v_e = 15$  v. The emitter voltage should be

$$V_e = 12 \text{ v} = 1.25 R_e$$

Assuming that  $i_e = i_c$ . From this,  $R_e = 10 \text{ k}$ . One measurement is necessary for the accurate determination of  $K^1$ . Opening  $R_6$  and substituting a decade resistor for  $R_f$ , this decade resistor is varied until the desired emitter current is obtained. In this case this produces an emitter voltage of 12 v with a 10 K emitter resistor. This value of  $R_f$ , which shall be referred to as  $R_{f\infty}$ , because it was measured with  $R_6/R_t = \infty$ , was 500 K in this case.

From the voltage divider relationship, assuming no drop between base and emitter,  $R_t = 375 \text{ K}$  and  $\beta = 37.5$ .

Since  $K^1 = \frac{R_{f\infty}}{R_t}$ ,  $K^1 = \frac{500}{375} = 1.33$ .

Also,  $P^1 = E^2/R_t = 2.1 \text{ mw}$ , and  $P^1 (K^1 + 1) = 0.9 \text{ mw}$ . The additional bit of information we need before drawing Fig. 4 for this case is that

$$\frac{K^1}{K^1 + 1} = 21.4$$

Using this information, Fig. 6 is constructed. A special template constructed for 2-1/4" x 2-1/4" cycle log-log paper was used.

In this case, the bias power is inconsequential.

Choosing  $S = 2$ , we read:  $\frac{R_b}{R_t} = 0.12$ ;  $\frac{R_f}{R_t} = 0.15$ ;

$P_{\text{bias}} = 8 \text{ mw}$ . From which  $R_b = 47 \text{ K}$ , using resistors in the 5 per cent rma values.

Summarizing then for the circuit in Fig. 7,

$$R_e = 10 \text{ K}_n$$

$$R_b = 47 \text{ K}_n$$

$$R_f = 56 \text{ K}_n$$

$$S = 2$$

$$P_b^* = 8 \text{ mw}$$

This network was constructed and checked experimentally. The emitter voltage for a group of six different 905 transistors varied from 12.2-12.6 v, against a calculated value of 12 v.

Now... from Clevite!



CLEVITE GOLD BONDED DIODES FOR

# MECHANICAL RELIABILITY

**New manufacturing techniques  
increase ruggedness for rough  
service applications.**

Designed to withstand severe conditions of shock and vibration, the new Clevite ruggedized diode offers, in addition to the well known electrical advantages of gold-bonded diodes, a new high in mechanical strength.

For installation with automatic assembly equipment, for missiles, or other applications in which high values of acceleration are encountered, for all your diode needs, specify Clevite

Clevite data on request.

A DIVISION OF

**CLEVITE**

OTHER CLEVITE DIVISIONS:  
Clevite Graphite Bronze • Brush Instruments • Clevite  
Electronic Components • Clevite Harris Products •  
Clevite Ltd. • Clevite Ordnance • Clevite Research Center  
Texas Division • Intermetall G.m.b.H.

**CLEVITE**

**TRANSISTOR PRODUCTS**

241 Crescent St., Waltham 54, Mass. TWInbrook 4-9330

CIRCLE 16 ON READER-SERVICE CARD

# Reflectionless Bead for Symmetrical Strip Transmission Line

K. S. Packard  
Airborne Instruments Lab.  
Mineola, N. Y.

The design of a reflectionless bead for supporting the center conductor of a strip transmission line is described. The design and fabrication are simple and the SWR is extremely low over the full useful frequency range of most practical symmetrical strip transmission lines.

IN ANY multiconductor transmission line some means for maintaining the spacing of the conductors is required. In the symmetrical strip transmission line, comprising a rectangular center conductor equally spaced between two parallel ground planes, one may usually use a continuous dielectric sheet to perform this function. There are applications, however, where it is desirable to use a bead-supported center conductor. In such cases one could use any of the common bead design techniques used for coaxial lines. But all the more practical ones suffer from some degree of frequency sensitivity.<sup>1</sup> Symmetrical strip transmission line has a property not possessed by coaxial line. It is the possibility of constructing a simple, series inductive-discontinuity. This property permits the design of a simple reflectionless bead.

## Designing the Bead

Consider the symmetrical strip transmission line shown in Fig. 1. The plan view shows an undercut in the strip width to compensate for the relative dielectric constant of the bead and maintain the characteristic impedance constant. The discontinuity reactance introduced by this undercut is pure series inductive.<sup>2</sup> If the bead is allowed to overlap the undercut, a pure shunt capacitive reactance will be introduced at this point. Providing that the extent of these discontinuities is small compared with a wavelength they will not be sensitive to frequency. Then by making the ratio of inductance to capacitance equal to the square of the characteristic impedance of the line, the bead will be reflectionless.

In any specific case the required overlap may be found as follows. For a given characteristic impedance,  $Z_0$ , and dielectric constant,  $\epsilon$ , the width,  $W'$ , of the undercut portion of line may be found from curves of the characteristic impedance.<sup>3</sup> The discontinuity inductance is given by,<sup>2</sup>

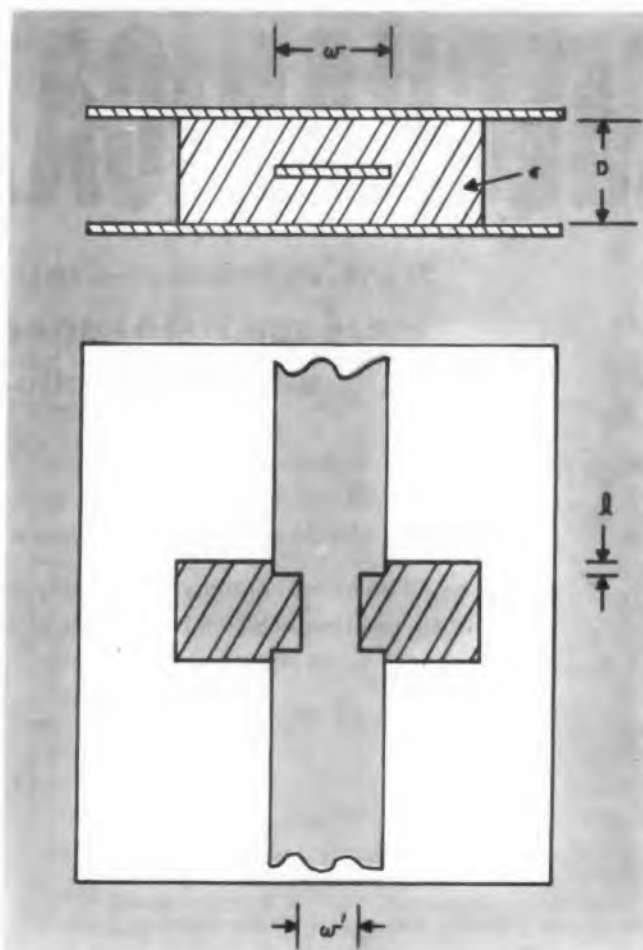


Fig. 1. Reflectionless bead for strip transmission line.

$$L = Z_0 \frac{2W}{\omega \lambda} \ln \csc \left( \frac{\pi W'}{2W} \right) \quad (1)$$

where

$$W' = D K(k)/K'(k), \quad k = \tanh \left( \frac{\pi w}{2D} \right)$$

$K$  and  $K'$  are complete elliptic integrals of the first kind. In most practical cases where  $w/d > 0.5$ , an adequate approximation is

$$W' = w + \frac{2D}{\pi} \ln 2.$$

The quantity  $W'$  is defined similarly. The discontinuity capacitance for small  $l$  is given by,

$$C = \frac{l(\epsilon - 1) \times 10^{-10}}{3 Z_0} \quad (2)$$

where  $l$  is measured in cm.

For no reflection, the characteristic impedance in the vicinity of these discontinuities, which are considered to be of infinitesimal extent, must be made equal to  $Z_0$ . Thus

$$L/C = \frac{6 Z_0^2 W \ln \csc \left( \frac{\pi W'}{2W} \right)}{(\epsilon - 1) l \omega \lambda \times 10^{-10}} = Z_0^2 \quad (3)$$

Noting that  $\omega \lambda = 2\pi c/\sqrt{\epsilon}$

where  $c = 3 \times 10^{10}$  cm per sec, we find that the required overlap is,

$$l = \frac{W \ln \csc \left( \frac{\pi W'}{2W} \right)}{\pi \frac{\epsilon - 1}{\sqrt{\epsilon}}} \text{ cm} \quad (4)$$

It remains to be shown that  $l$  is small compared to a wavelength.

In a practical transmission line of this type,  $D < \lambda/4$ , and for a dielectric constant of about



we will find that

$$\ln \csc \left( \frac{\pi W'}{2W} \right) \approx 0.2, \frac{\epsilon - 1}{\sqrt{\epsilon}} \approx 1$$

$$l \approx 0.07 W.$$

In the region of 50 ohms,  
 $W \approx 1.5 D$

so that  
 $l \approx 0.03 \lambda$

which is sufficiently small for the tangent of the electrical length to be approximated by the length to a 1 per cent accuracy. Even at the maximum usable frequency of the line, where  $D = \lambda/2$ ,

$$l \approx 0.06 \lambda$$

which is still sufficiently small for good compensation.

It should be noted that in the case of a thick strip, a truly infinitesimal capacitive discontinuity may be obtained by decreasing the thickness in the bead region.<sup>4</sup> The combined change in both thickness and width would, however, prove difficult to analyze.

#### Design Problem

To indicate the order of magnitudes involved, let us consider a 50 ohm line with a ground plane spacing of 0.5 in., a strip thickness of 0.025 in. and a polystyrene bead ( $\epsilon = 2.56$ ). We have then

$$w = 0.648 \text{ in.}, W = 0.868 \text{ in.} = 2.20 \text{ cm.}$$

$$w' = 0.318 \text{ in.}, W' = 0.538 \text{ in.}$$

and

$$l = \frac{2.2 \ln \csc \left( \frac{0.538 \pi}{1.296} \right)}{0.975 \pi}$$

$$l = 0.137 \text{ cm.} = 0.054 \text{ in.}$$

A line of these dimensions is normally used in the 10 cm wavelength region so that the electrical length of the overlap is only  $0.014 \lambda$ . The overlap is, however, of sufficient size so that it can be machined accurately.

It is quite likely that, in any practical application of this design technique, the chief source of residual reflection will be the fabrication tolerances.

#### References

1. Microwave Transmission Circuits, G. L. Ragan, McGraw-Hill, 1948.
2. Equivalent Circuits for Discontinuities in Balanced Strip Transmission Line, A. A. Oliner, *Trans. IRE*, Vol. MTT-3, pp. 134-143, March 1955.
3. The Characteristic Impedance of the Shielded Strip Line, R. H. T. Bates, *Trans. IRE*, Vol. MTT-4, pp. 28-33, January 1956.
4. Equivalent Circuits for Discontinuities in Transmission Lines, J. R. Whinnery and H. W. Jamieson, *Proc. IRE*, Vol. 32, pp. 98-114, February 1944.

# HONEYWELL

## MAGNETIC RECORDING-REPRODUCING HEADS



Standard and custom designs for computers, memory devices, card, tape or drum recording-readout

Honeywell supplies prototype or production quantities of custom or standard heads—to meet requirements of many original equipment makers. It stands ready to do the same for you.

Honeywell heads are manufactured in completely equipped, modern production facilities, staffed with experienced specialists. In addition, a complete design and application engineering service is at your call—to help in meeting special needs, or adapting standard heads to the design of your equipment.

Write for complete technical information and custom design service. For even faster service, call on your local Honeywell field engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, 10721 Hanna Street, Beltsville, Maryland.

Series	Track Data		Crosstalk (db)	Number of Tracks for Various Tape Widths							
	Width (Mils)	Spacing C to C (Mils)		¼	½	¾	1	1¼	1½	1¾	2
700	50	140	-60*	2	4	5	7	9	11	13	14
800	40	125	-60*	2	4	6	8	10	12	14	16
1000	40	100	-55*	3	5	8	10	13	15	18	20
1200	32	85	-50*	3	6	9	12	15	18	21	24
1300	26	78	-40**	3	6	10	13	16	19	23	26
1400	40	72	-40**	3	7	10	14	17	21	24	28
S1400	32	70	-40**	3	7	10	14	17	21	24	28
1600	32	62	-35**	4	8	12	16	20	24	28	32
2000	20	50	-35**	5	10	15	20	25	30	35	40

\*For Direct Recording, 1000cps  
 \*\*For Digital Pulse Recording

Condensed listing of standard magnetic heads

# Honeywell



*First in Control*

CIRCLE 17 ON READER-SERVICE CARD

# Simulated Doppler Effects For Radar System Testing

J. E. Toffler

Hughes Aircraft Co.  
Los Angeles 45, Calif.

**M**ANY types of conventional fire control and missile radar systems employ a gated receiver. A gated receiver is one which receives signals only during the time that the reflected signal pulse from the desired target is being received. This prevents random noise from saturating the receiver and also provides a method of selecting one target out of many. Due to the Doppler effect, the echo pulses and hence the receiver gating pulses will generally not be at the same frequency as the transmitted pulses, and may be varying in frequency. This article explains how to calculate the frequency shifts involved and suggests a method of simulating these shifts to test receiver tracking capability

(the ability to remain in synchronism with the echo pulses).

## Calculating Doppler Frequency Shift

The usual formula for calculating Doppler frequency shift is,

$$f_1 = f_o \left( 1 \pm \frac{v}{c} \right) \quad (1)$$

where

$f_1$  = observed frequency

$f_o$  = actual source frequency

$v$  = relative velocity between source and observer

$c$  = velocity of transmitted energy (980 ft. per  $\mu$ sec for light)

The above formula is exact only for the case of a stationary source of sound waves and a moving observer. In the case of light, unlike sound, it is immaterial whether the relative velocity is due to the source or to the observer. Neglecting second order effects, however, eq (1) is accurate enough for most purposes.<sup>1</sup>

To find the fractional change in frequency required, eq (1) can be written,

$$\frac{f_1 - f_o}{f_o} = \frac{\Delta f_o}{f_o} = \pm \frac{v}{c} \quad (2)$$

The rate of frequency shift due to a relative acceleration can be found by differentiating,

$$\frac{d}{dt} \left( \frac{f_o}{f_o} \right) = \pm \frac{1}{c} \frac{dv}{dt} = \pm \frac{a}{c} \quad (3)$$

where

$a$  = acceleration

In radar systems the source is usually a reflecting target. For the most general case, it is necessary to consider three-point Doppler theory involving a true source, a reflector, and an observer. Based on these considerations, a suitable apparent velocity and acceleration can be selected to use for  $v$  and  $a$  in eqs 2 and 3 to determine the required frequency shift.

An example, assume that test equipment is needed to test the tracking capability of a receiver for a simulated signal representing a maximum acceleration of 400 g, or 0.0129 ft/ $\mu$ sec/sec. Using eq 3, it is seen that the required rate of frequency shift is 13.1 parts per million (ppm) per sec.

It is difficult to design a precision crystal oscillator which will provide a constant rate of frequency shift and also difficult to check or calibrate the oscillator to verify that the frequency shift is correct. An alternate approach is to use a modulated time delay system. This method allows the designer freedom in the design of the precision oscillator, is relatively easy to design and test, and allows for "programs" of accelerations and decelerations or velocities of any magnitude.

If recurrent pulses are all delayed by a certain fixed time interval, the resultant pulse train will represent a condition of zero velocity and zero acceleration. By changing the time interval linearly, a constant velocity can be simulated; by changing in a "square-law" manner, a constant acceleration is simulated.

## Measuring Doppler Frequency Shift

The frequency shift can be readily measured with an oscilloscope having a time base calibrated in microseconds, due to the simple relation that the frequency shift in parts per million is numerically equal to the output pulse velocity across the face of the oscilloscope in microseconds per second; or the total displacement in microseconds equals the time integral of the frequency shift:

$$S = \int_{T_1}^{T_2} \frac{f_1 - f_o}{f_o} dt \quad (4)$$

where  $T_2 - T_1$  is the time interval over which the displacement is measured. The time modulation of the output pulse can be obtained with a monostable delay circuit, such as a phantatron or a cathode coupled multivibrator, in which the delay is very nearly proportional to an applied voltage.<sup>2</sup>

This system is illustrated as a block diagram in Fig. 1. To observe displacement of the output pulse, it is necessary to trigger the oscilloscope externally with the original undelayed pulse. An

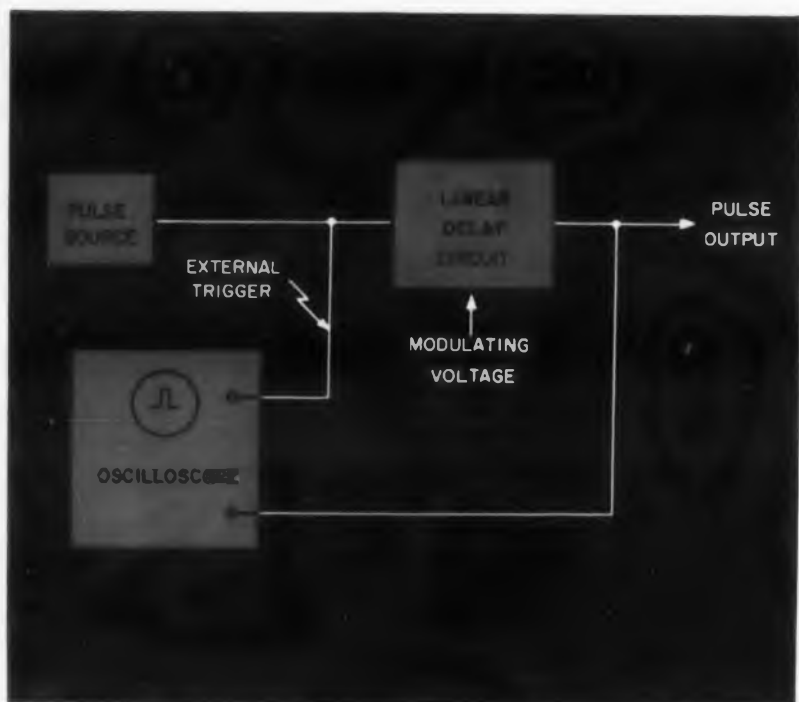


Fig. 1. Monostable delay circuit. The delay is almost proportional to the applied voltage.

# NOW-

## RAPID ACCURATE TESTING OF

**SILICON  
GERMANIUM  
SELENIUM**

## RECTIFIERS and DIODES



### WITH THE NEW *Cedco* METALLIC RECTIFIER ANALYZERS

#### FEATURING

## 5 STANDARD CIRCUIT TESTS

1. Visual dynamic voltage-current characteristic.
2. Dynamic reverse-current leakage.
3. Dynamic forward-voltage drop.
4. Static reverse-current leakage.
5. Static forward-voltage drop.

NOW . . . for the first time, production and laboratory users of power rectifiers and signal diodes may perform *five* standard circuit tests with *one* precision instrument . . . the CEDCO Metallic Rectifier Analyzer.

Versatile, accurate and rapid, the new CEDCO Analyzer exceeds the highest standards of engineering quality. Three Weston meters, accurate within 1%, AC Voltmeter (0 to 1500 V.), DC Voltmeter (0 to 1000 V.) and DC Milliammeter (0 to 10 AMP.) assure dependable performance.

**Model S-101**—Self-contained featuring complete set of plug-in adapters, accepting wide range of sizes.

**Model S-102**—Ideal for laboratory use. Adjustable test fixture for remote testing permits shelf mounting away from the working area.

Illustrated brochure, Bulletin R-250, is available upon request.

Eastern Regional Sales Office  
Wilson Building  
Camden, New Jersey

**Cedco** ELECTRONICS  
PHILADELPHIA, PENNSYLVANIA

DESIGNERS AND MANUFACTURERS OF PRECISION ELECTRONIC TEST EQUIPMENT

Expanded sweep is very helpful in making accurate measurements.

A simple plan is to choose a sinusoidally varying acceleration, causing velocity and displacement also to be sinusoidal. A sinusoidal voltage for modulation of the delay can be obtained from a low frequency oscillator, a function generating potentiometer, or a synchro.

#### Example

Assume that a sinusoidal acceleration is desired with peak amplitudes  $\pm 400$  g, and a period of 2 secs. As shown above, 400 g corresponds to a rate of frequency shift of 13.1 ppm/sec. Therefore the acceleration and rate of frequency shift are,

$$a \text{ (in g units)} = 400 \sin \frac{\pi}{2} t$$

$$\frac{d}{dt} \left( \frac{\Delta f_o}{f_o} \right) = 13.1 \sin \frac{\pi}{2} t$$

The frequency shift is obtained by integrating,

$$\begin{aligned} \frac{\Delta f_o}{f_o} &= \frac{f_1 - f_o}{f_o} = \int 13.1 \sin \frac{\pi}{2} t dt \\ &= \frac{-2}{\pi} \times 13.1 \cos \frac{\pi}{2} t \end{aligned}$$

Finally, the displacement observed on the oscilloscope is obtained by using eq (4).

$$\begin{aligned} S &= \int_1^3 -8.34 \cos \frac{\pi}{2} t dt \\ &= 10.6 \mu\text{secs} \end{aligned}$$

It is thus very easy to check or adjust the acceleration to 400 g merely by adjusting the total pulse displacement on the oscilloscope to 10.6  $\mu$ secs. The simulated velocity in this case can be found by integration of the acceleration. As mentioned previously, 400 g equals 0.0129 ft/ $\mu$ sec/sec. Therefore,

$$\begin{aligned} V &= \int a dt \\ &= 0.0129 \sin \frac{\pi}{2} t dt \\ &= -0.0082 \cos \frac{\pi}{2} t \end{aligned}$$

This represents a maximum apparent velocity of 0.0082 ft per  $\mu$ sec or 5,600 mph.

#### References

1. Fundamentals of Optics, Jenkins and White. McGraw-Hill Book Co., 1950, Pages 190-195.
2. Pulse and Digital Circuits, Millman and Taub. McGraw-Hill Book Co., 1956, Pages 193-194, 225-228.

CIRCLE 18 ON READER-SERVICE CARD



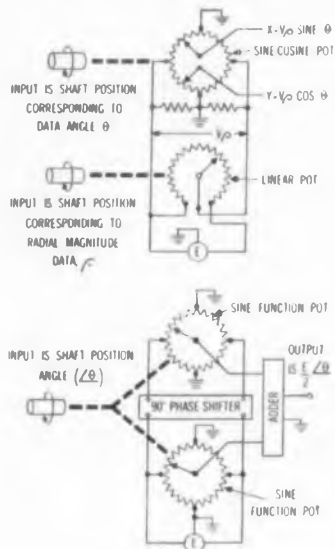


# SINE-COSINE *Precision* POTENTIOMETER-RESISTORS

For resolution of voltage into sine and cosine components in accordance with positions of shaft rotation.



## TYPICAL APPLICATIONS:



**ANGLE DATA TRANSMISSION** as used in automatic controls, directional and ranging systems, analog computers, and telemetry.

**PHASE DIVISION** as used in investigation of phase sensitive systems, delay measurements, and timing applications.

**DATA CONVERSION** as used in rotation of coordinates, or conversion from polar to rectangular coordinate form, for computers or data display applications.

Potentiometers having sinusoid functions are available in 3", 2", 1 7/8", 1 1/2", 1 1/4", and 7/8" diameters. These potentiometers are available with two sliders giving independent outputs, one proportional to the sine and the other to the cosine of the shaft angle. Multiple units may be ganged and phased for cosine function or for other applications such as rotation of coordinates.

Precision in potentiometer-resistors feature wide temperature range, excellent environmental stability, highly precise mechanical construction and electrical performance.

Technical reports on the use of these units, and complete data are available on request.

## TECHNOLOGY INSTRUMENT CORP

555 Main St., Acton, Mass. COlonial 3-7711  
P.O. Box 3941, No. Hollywood, Calif. POplar 5-8620

CIRCLE 19 ON READER-SERVICE CARD

## Comparing

# Illuminated In-Line Readouts

**D**IGITAL presentation of data has three advantages over the analog method. They are:

- Elimination of human estimating error.
- Speed in observing data.
- Reduced fatigue of human operator.

Most popular of the digital presentations are the illuminated digits arranged in a horizontal row: In-Line Readouts. They are currently available in many sizes and digit combinations. Five of the more common types of illuminated readouts are compared in the table appearing on the opposite page. These units represent a sampling of the market and include representatives of major design concepts.

### How Accurate?

Accuracy of the digital readouts are dependent on three factors. One is the ability of the instrument to reproduce exactly the data presented to it. Most readout designs are such that mistakes on the part of the display unit are next to impossible. This is because the actuating signals either directly activate the display digits, or are processed through decoding units which are highly

reliable. Another factor upon which accuracy depends is the nature of the display. It must not lead to faulty recognition of the digits. The third factor is the manner of forming the characters. Some displays form characters from bars, segments or dots of light. Failure of certain of these elements can sometimes cause characters to be misread.

### Visibility

Effective visibility of the digital display is an important aspect of performance. All units analyzed in the table depend on the contrast between the digit's own luminescence and that of the surroundings for effectiveness of visibility. In general, the poorer the ambient lighting conditions, the greater the visibility of the Readout.

### Maintenance

The major portion of Readout maintenance is centered in lamp replacement. Regardless of precautionary measures, lamps eventually burn out. Most Readouts examined have been constructed to permit replacement of the lamps easily and quickly.

### Five Illuminated In-Line Readouts Compared

Features Compared	Edge-Lighted Lucite Plates	Multi-Lens Projection	Glow Discharge Tube	High Intensity Lamps	Lighted Segments
<b>Character construction</b>	Characters are engraved on separate lucite plates which are arranged one behind the other.	Characters are photo engraved on concave surfaces of condensing lenses which are molded on one lucite plate.	Numerals stacked into gas-filled, cold cathode tube and act as glow discharge cathodes.	Many neon lamps placed directly behind the viewing screen to form characters.	Combinations of straight-line segments form the characters.
<b>Method of Illumination</b>	Each plate edgely lit with individual lamp. Light reaching engraving is reflected out.	Light passes through lens and is focused on a screen. There is one lamp per lens.	Cathode corresponding to desired numeral is energized. Glow results from ionization.	Lamps corresponding to points in a character's shape are energized and projected on screen.	Light from proper segments produce desired characters.
<b>Visibility</b>	1 in. high character on 2 in. sq plate visible to 40 ft within angle of 45 deg. (NLS).	100 per cent intensity viewing of all characters for 90 deg. included angle (IEE).	0.8 in. characters visible up to 40 ft (Burroughs HS).	2.25 in. numerals visible up to 200 ft viewing angles of 150 deg. included angle (CMC).	1.25 in. numerals provide visibility over 40 ft through viewing angles of 150 deg. included angle (Beckman).
<b>Other factors</b>	Characters can be changed by removing plates. Lamps are available over wide voltage range, are easily replaced. Each unit can hold 12 characters.	Data from two lenses may be projected on screen. Using colored lenses a character may be overlaid with a colored spot of light. This technique used with go-no-go gage readings.	Ten numerals, 0 to 9 available. Units are low in cost, consume little power.	A lamp failure does not lead to recognition error. At least 3 lamps must fail before error can occur.	As with some other units, there is no masking of characters by unused elements.
<b>Manufacturers</b>	Non-Linear Systems, Inc., Delmar, Calif., Millman Engineering Co., Los Angeles, Calif.	Industrial Electronic Engineers, North Hollywood, Calif.	Burroughs Corp., Plainfield, N.J.	Computer Measurements Corp., North Hollywood, Calif.	Beckman Instruments Inc., Berkeley Div., Richmond, Calif.



Fig. 1. This edge-lighted display is manufactured by Non-Linear Systems, Inc., Del Mar, Calif. Lighting both numeral and the decimal point simultaneously provides a combination of two symbols.



Fig. 2. Display units combining several projection systems in horizontal rows. Manufactured by Industrial Electronic Engineers, North Hollywood, Calif.



Fig. 3. This "Nixie" numerical indicator tube is produced by Burroughs Corp., Plainfield, N.J.

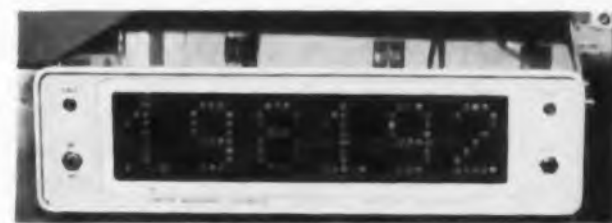


Fig. 4. High-intensity lamps form the characters in this Readout unit. Manufactured by Computer Measurements Corp., North Hollywood, Calif.



Fig. 5. Seven lighted characters form the numerals 0 through 9 in this unit, manufactured by Beckman Instruments Inc., Berkeley Div., Richmond, Calif.

# Quiggley's

## Breakfast

### Brainstorm



### ...or the case of the sub-miniature toroids

Major Quiggley, DC, AC, etc. banged his fist on the table and stared with fascination at the breakfast cereal before him. "Eureka! I've got it!" he bellowed with enthusiasm. "Sub-miniature toroids, just the size of these Cheerios\* to solve our limited space problems!"

The major beamed with satisfaction. "Great idea!" he purred.

"I'll call B & W and get them to develop it!"

Major Quiggley rushed to the office, put through a call to Barker & Williamson, and rapidly outlined his earth-shaking idea. "It will revolutionize the industry!" he concluded with final triumph.

Tactfully, the harassed sales manager explained that B & W had not only been manufacturing toroids the size of Cheerios for many years, but also have available a complete line of sub-miniature as well as larger types. He indicated that many of the toroids were so small that the center hole was only  $\frac{1}{16}$ " in diameter! Quiggley sputtered, "You should let a feller know, old chap! Send one of your sales engineers right over!"

#### Here's What Major Quiggley Learned About Toroids from the B & W Sales Engineer:

- **Sizes**—B & W manufactures a complete range of standard and special toroid coils and related networks.
- **Tolerances**—5% for standard types and as close as 1% for specials.
- **Finishes**—plain—waxed—tape wrapped—encapsulated, or hermetically sealed to MIL-T-27A Specs where required.
- **Delivery**—To meet your requirements in time and quantity.

\*Reg. Trademark—General Mills



## Barker & Williamson, Inc.

Canal St., Bristol, Pa.

Specialists in Designing and building equipment  
To operating specifications

A few other B&W products: I. F. TRANSFORMERS • COMMUNICATIONS EQUIPMENT • AUDIO PHASE SHIFT NETWORKS • TEST EQUIPMENT • and many types of standard and special electronic components and equipment.

CIRCLE 20 ON READER-SERVICE CARD

# Transistor Variable Gate with High Stability

Everett R. James

Motorola Inc. Research Lab.

Riverside, Calif.

WITH JUST a few minor changes the stability and accuracy of the basic gating circuit can be increased by a factor of ten. A simple feedback arrangement and the use of improved products such as the Sensoritor (a silicon resistor with a well defined temperature coefficient) make this improvement possible. Now many circuits that previously were put aside as unsatisfactory become acceptable.

Compensation of the voltage controlled monostable multivibrator circuit described in this article is only one example. The compensation scheme used to stabilize this circuit is certainly applicable to other forms of the multivibrator circuit. Investigation show that compensation is also possible in the bistable flip-flop circuit.

#### Design Requirements

A gating signal is required which could be varied from 10  $\mu$ sec to 120  $\mu$ sec by a dc analog voltage while holding an accuracy of 1 per cent

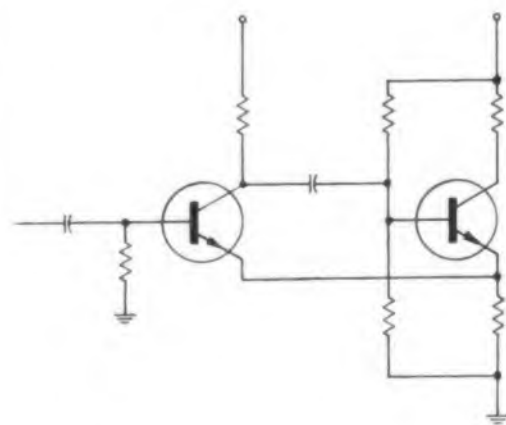


Fig. 1. (Above) Basic circuit.

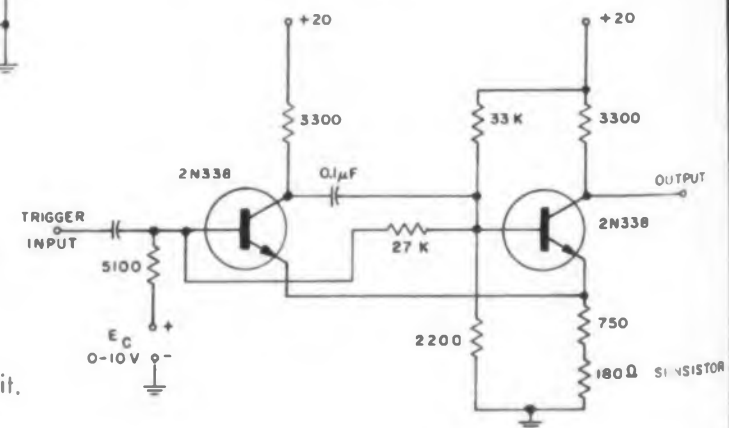


Fig. 2. (Right) Final circuit.



The 1 per cent accuracy must be maintained at an operating temperature of 75 C. The basic circuit selected to satisfy the first requirement is a monostable multivibrator. The multivibrator because of its sensitive trigger level is most adaptable to voltage control. The transistor version of this circuit has been thoroughly discussed in numerous publications.<sup>1,2</sup> Therefore, the design of the basic circuit will not be covered in this article.

It is of interest, however, to discuss the reason for selecting the particular configuration shown in Fig. 1. Because of the temperature performance of the circuit, it is desirable to use silicon transistors. The present state of silicon transistors restricted the circuit to a configuration using two npn transistors. The cathode coupled arrangement is selected to facilitate stability and temperature compensation.

#### Selecting The Proper Transistor

Once the basic configuration is established, it is necessary to select the transistors. The 2N338 is selected because of its low  $I_{CBO}$  and high speed response. The output waveform must have a 1  $\mu$ sec rise time in order to preserve 1 per cent tolerance limits. Standard design procedure was used to select the component values.<sup>1</sup> The best location for the control voltage was on the triggered base as better range was obtainable at this point. A positive control voltage was available from an analog computer and the operational voltage range was selected to be 1-10 v, although this value is arbitrary and may be varied by changing the resistance in the base lead. A significant improvement in performance was noted when high stability resistors were used for bias and collector load: a prototype of the basic circuit was constructed and complete performance checks were made to determine the degree of stabilization required.

#### Improving Linearity

The uncompensated circuit (Fig. 1) showed a control linearity of about 10 per cent at room temperature and drifts another 10 per cent in going from room temperature to 70 C. The first problem is to improve linearity at room temperature. To accomplish this, feedback is inserted first from collector to base and then from base to base. An improvement is noted in both cases, but only with base to base feedback is it possible to achieve 1 per cent accuracy. The next problem is to maintain this accuracy at elevated temperature.

Investigation of several temperature compensation schemes shows little promise that 1 per cent linearity could be maintained to 75 C. However, the development of the Sensistor



Used where clean high vacuums are required... processing vacuum tubes... evacuating accelerator sections and ionization chambers... laboratory and industrial applications.

**SIMPLICITY ITSELF—**  
The Vacjon high vacuum pump operates entirely electrically — no moving parts.

**NO OIL VAPOUR—**  
Cold traps or vapor traps are not necessary.

**ULTRA HIGH VACUUM—**  
Creates vacuum in excess of  $10^{-7}$  mm of Hg, one trillionth of an atmosphere. This small compact unit has a pumping speed of 20 liters/second at  $10^{-7}$  mm of Hg.

**LOW POWER CONSUMPTION—**  
At  $10^{-6}$  mm Hg power consumption is only 0.44 watts. No continuously running back-pump is required.

**LONG LIFE—** Operating life in excess of 10,000 hours at  $10^{-6}$  mm of Hg has been obtained. Life expectancy is almost unlimited at  $10^{-7}$  mm of Hg.

**MEASURES ITS OWN VACUUM—**  
The current indication on the power supply meter provides a practical measurement of pressure.

**SIMPLE INSTALLATION—**  
Complete unit consists of the Vacjon Pump, 24-1047 Magnet, 24-1048 Power Supply.

**ONLY FROM VARIAN—**  
The Vacjon high vacuum pump has no equal for simplicity, cleanliness, and performance. Get the complete story in the Vacjon High Vacuum Pump Engineering Bulletin — write for your copy today.

THE MARK OF LEADERSHIP

**VARIAN ASSOCIATES**  
PAID 4150 21, CALIFORNIA

Representatives throughout the world

TELEVISIONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, X-RAY SPECTROMETERS, MAGNETS, MACHINETOOLS, STALOG, DRUMS and PAPER, TYPING RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

CIRCLE 21 ON READER-SERVICE CARD



## resistance control for controllers

precision control of electrical resistance...that lets you design-in lower production costs

Before you specify a resistance alloy for *any* application, check these characteristics of low-cost Carpenter 1-JR against your needs.

No. 1-JR is a chrome-aluminum-iron alloy with high electrical resistance. It is available in two types, both ideal where a high specific resistance and low temperature coefficient of resistance are required. (Resistivities at room temperature, 720 and 680 ohms per cir. mil. ft. respectively.)

Carpenter 1-JR is less expensive than other resistance alloys offering comparable performance. In addition, it is easy to fabricate. Strip blanks cleanly, can be spot welded, or edge wound. Bar stock can be readily forged. This alloy also offers good scale resistance.

Order strip, wire or bars through the Carpenter representative who serves your company—or write directly to the mill, outlining your requirements. Be sure to ask for a copy of the new 64-page technical summary on Carpenter's advanced family of electronic, magnetic and electrical alloys. The Carpenter Steel Company, 145 W. Bern St., Reading, Pa.

# Carpenter STEEL

### The Carpenter Steel Company

Main Office and Mills, Reading, Pa.

Alloy Tube Division, Union, N. J.

Webb Wire Division, New Brunswick, N. J.

Carpenter Steel of New England, Inc., Bridgeport, Conn.

CIRCLE 22 ON READER-SERVICE CARD

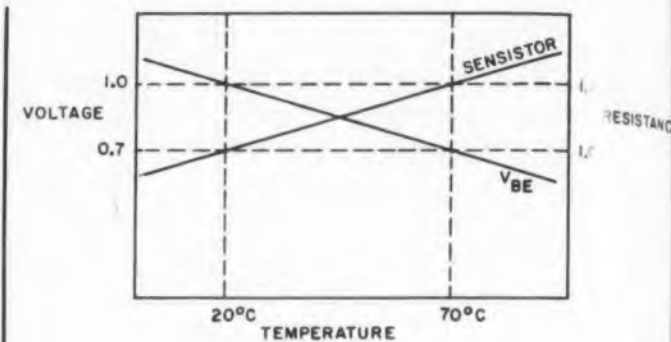


Fig. 3. Temperature characteristics.

opens a new possibility. The Sensistor (silicon resistor) produced by Texas Instruments is a temperature compensating device that has a temperature characteristic closely approximating the reciprocal of the  $V_{BE}$  curve of the transistor. Since the firing point of the multivibrator is directly a function of  $V_{BE}$ , Sensistor is a logical choice for temperature compensation. Fig. 3 shows the  $V_{BE}$  and Sensistor curves for comparison.

The curves are merely illustrative and do not have quantitative data since at the time of writing accurate data was not available. Experiments show that  $V_{BE}$  increases approximately 30 per cent in going from 20 C to 70 C. To better understand the effect of the Sensistor compensation, it is advantageous to study the total bias voltage in the configuration of Fig. 2. The composite voltage base to ground ( $V_B$ ) may be broken into three separate voltages:  $V_{BE}$  transistor threshold voltage,  $V_R$  drop across emitter resistor, and  $V_S$  drop across Sensistor. Therefore,  $V_B = V_{BE} + V_S$  where, for the purpose of our present analysis,  $V_B$  and  $V_R$  are constant. Solving the above equation for  $V_{BE}$ ,  $V_{BE} = V_B - (V_R + V_S)$  or  $V_{BE} = \text{Constant} - V_S$  for a constant value of  $I_{BE}$ . If the latter equation is to be satisfied as  $V_{BE}$  decreases with temperature  $V_S$  must increase. From the Sensistor data sheets it is possible to select the proper Sensistor value which will satisfy the equation within the limits desired. In the circuit shown in Fig. 2, a 220 ohm Sensistor was selected as the proper value but later temperature cycling showed 180 ohms to be more satisfactory.

### Obtaining High Stability

The final circuit with complete stabilization is shown in Fig. 2. Extensive tests were performed on the completed unit and are shown in the curves Fig. 4 and 5. Fig. 4 demonstrates the effect of feedback to improve linearity. Fig. 5 shows temperature drift for the uncompensated, overcompensated and properly compensated circuit. With the 180 ohm Sensistor it was possible to hold drift to 1 per cent over the operating temperature range. Temperature cycling

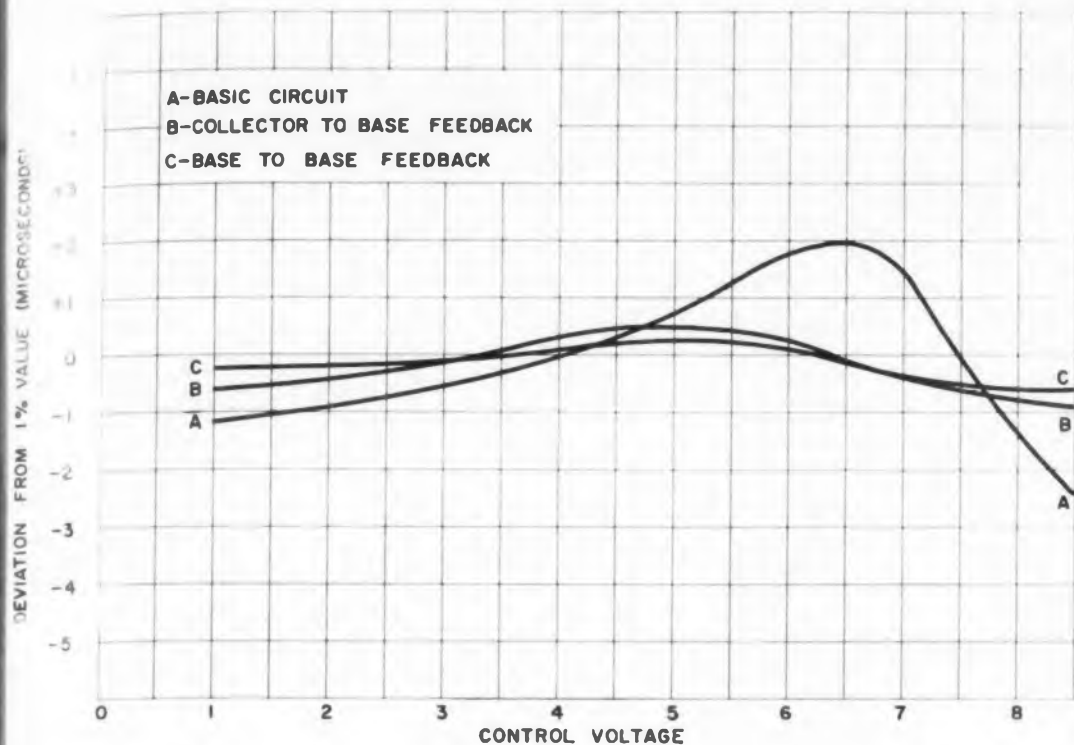


Fig. 4. Linearity.

is necessary to optimize the Sensistor value, for only by periodic measurement can the overall compensation be observed.

Temperature cycling discloses a slightly different value than did the calculations. The output waveform exhibits a rise time of 0.7  $\mu$ sec and a fall time of less than 2  $\mu$ sec.

#### References

1. Transistor Circuit Engineering, Shea et al.
2. Design of a Transistor Monostable Multivibrator, H. E. Schaurecker, *Electronic Equipment Engineering*, December 1957, page 40.

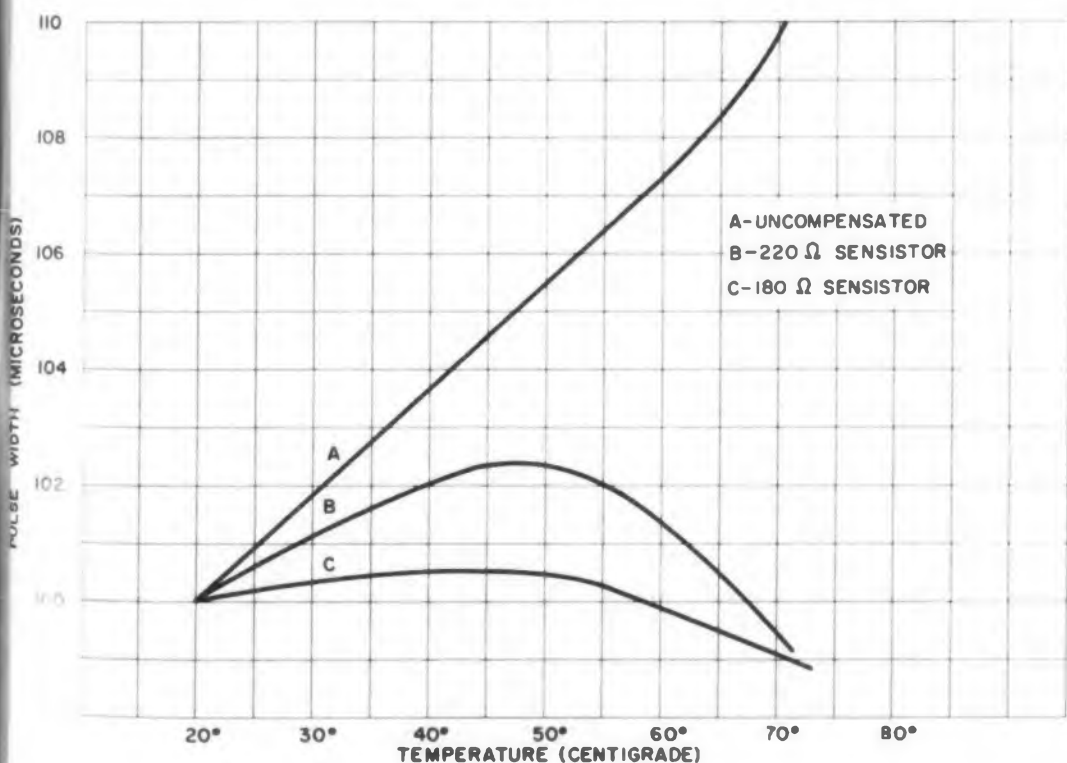


Fig. 5. Drift characteristics.

*if it's a capacitor...*

**C-D** *makes it...*

*and makes it better!*

### A Complete Line of Ceramics from a Single Source

C-D Ceramic Capacitors are produced under one roof, with full control over all operations, from start to finish. Whatever types of ceramic capacitors your designs call for, C-D has them... and C-D is your most dependable source.

- **DISC TYPES:** Temperature compensating, close tolerance, general purpose bypass, high voltage, A-C line bypass.
- **TUBULAR TYPES:** Temperature compensating, close tolerance, trimmer.
- **SLUG TYPES:** High voltage.
- **AUTOMATION:** Plug-in termination available in temperature compensating, stabilized capacity, general purpose bypass, close tolerance disc types.
- **SPECIAL DESIGN TYPES:** Feed-thru, standoff, miniaturized.

Engineering samples sent on request. For complete data on C-D Ceramics, write for Catalog No. 616 to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.



CONSISTENT HI-DEPENDABILITY  
**CORNELL-DUBILIER CAPACITORS**

SOUTH PLAINFIELD, NEW JERSEY, NEW BEDFORD & CAMBRIDGE, MASS., PROVIDENCE & HOPE VALLEY, R. I., INDIANAPOLIS, IND., SANFORD, FUGUAY SPRINGS & VARINA, N. C., VENICE, CALIF., & SUBSIDIARY, THE RADIART CORPORATION, CLEVELAND, OHIO; CORNELL-DUBILIER ELECTRIC INTERNATIONAL, N. Y.

CIRCLE 23 ON READER-SERVICE CARD



# Sealed-in Gas Shrinks Resistor's Size

**S**EALLED-IN gas reduces the size of these metal film resistors. The gas helps dissipate the heat produced inside the unit. Thus more watts can be handled in a smaller package. Given the same volume and ohmic value, the gas-filled metal film resistors can stand four times as many watts as its wirewound counterpart.

## The Inside Story

The resistive element of the unit is formed on the inside of a steatite tube. Take a look at Fig. 1 which shows a resistor sliced in half. A moisture dispersing epoxy coating is molded over the tube. Formerly, air was contained inside the resistor. But now, during manufacturing, air is removed and replaced with an inert gas. The inert gas (undisclosed by the maker) is better than air for two reasons. First, it prevents oxidation of the resistive element. Second, it conducts heat better. Heat produced within the unit is conveyed by the inert gas to the terminals where it is carried out.

Called the Vamistor Missile Line, the units are made by Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J.

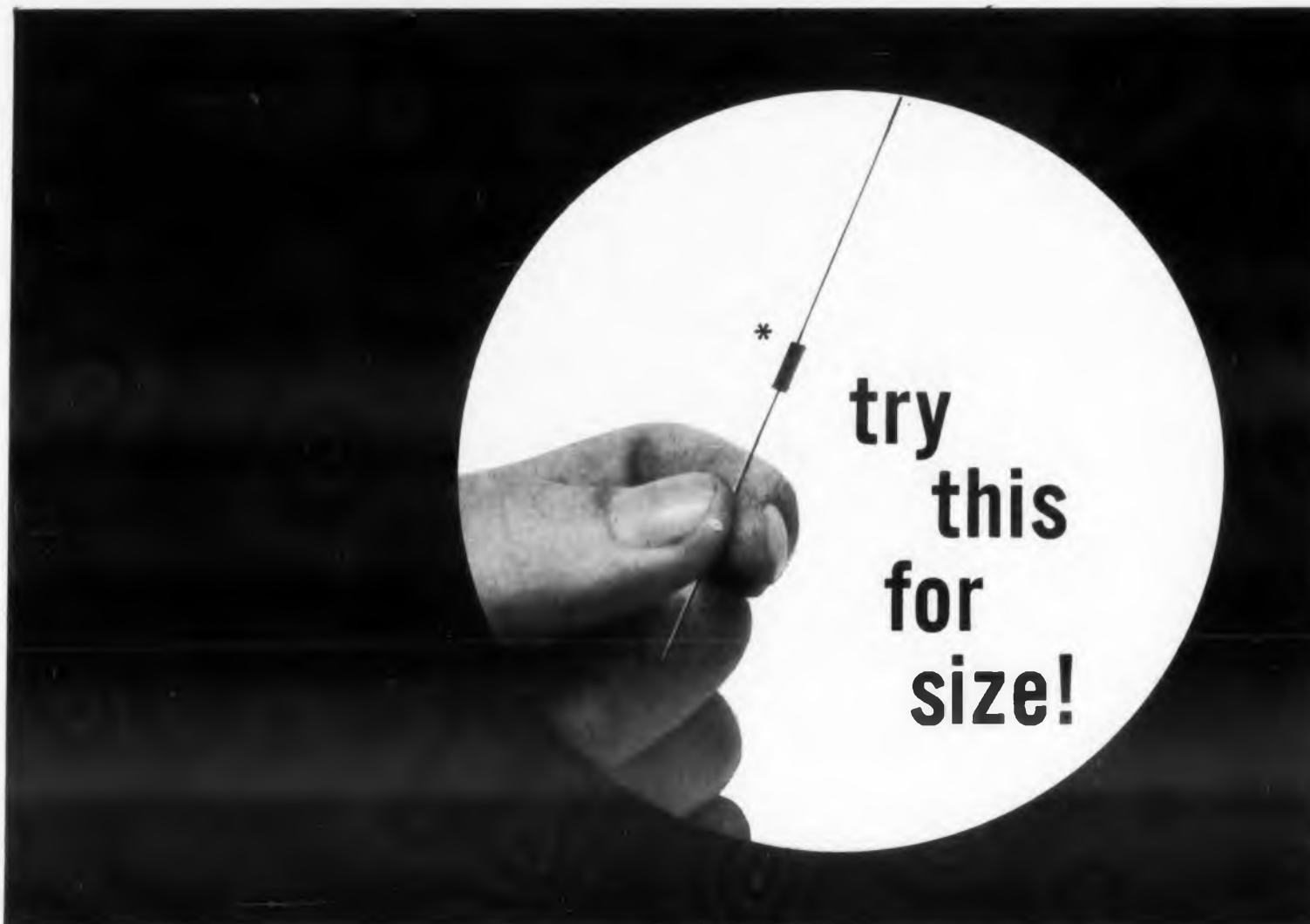
## Sizes Available

Two models of the Vamistor Missile Line are available. Model 9854 has ohmic values ranging from 100 ohms to 2 megohms. Wattage ratings are variable, depending on ambient temperatures. See Fig. 1. At 40 C they will handle 4 w and at 175 C the limit is 0.25 w. Length of the unit is 0.866 in., and the diameter is 0.312 in.

Resistance range for the model 9855-4 starts at 100 ohms and ends at 500 K. Again, wattage ratings depend on ambient temperatures. See Fig. 2. At 100 C they'll stand 1 w. But at 175 C they're derated to 1/8 w. Length of this model is 0.650 in., and the diameter is 0.235 in.

## Test Results

The gas filled Vamistor has been tested for thousands of hours. It has an estimated life of 10,000 hours. Noise of the unit is comparable to



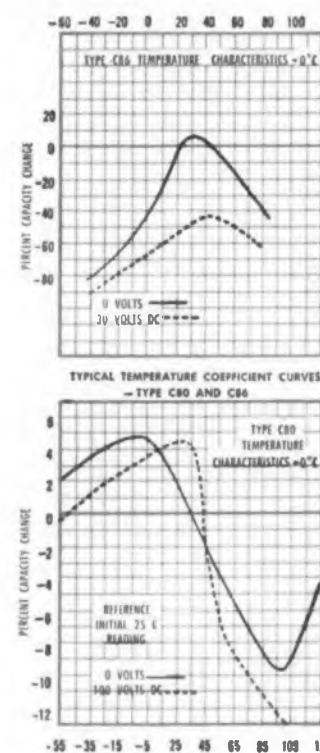
\* Actual size of a 1000 mmf. unit @ 100 vdc.

## Aerovox CERAFIL® Capacitors

**CERAFIL**... positively the smallest ceramic capacitors available anywhere. These remarkably ultra-miniature units are designed primarily for airborne and spaceborne equipment, transistorized circuit applications in hearing-aids and other critical applications where space and weight are at an absolute premium.

**CERAFIL**... provides completely new design and construction features in a ceramic capacitor. This unique construction makes it possible to obtain extremely high capacities per unit volume.

**CERAFIL**... units are rugged ceramic capacitors of proven reliability for operation at temperatures from  $-55^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ , and to  $125^{\circ}\text{C}$  when derated to 50 volts. Available in capacities from 10 mmf. to 100,000 mmf. in working voltages of 30 and 100 vdc. in axial or radial lead construction. They will meet or surpass all the requirements of MIL-C-11015A.



Write today for complete technical information on these ultra-miniature Cerafil Capacitors to...



OLEAN, NEW YORK

CIRCLE 24 ON READER-SERVICE CARD

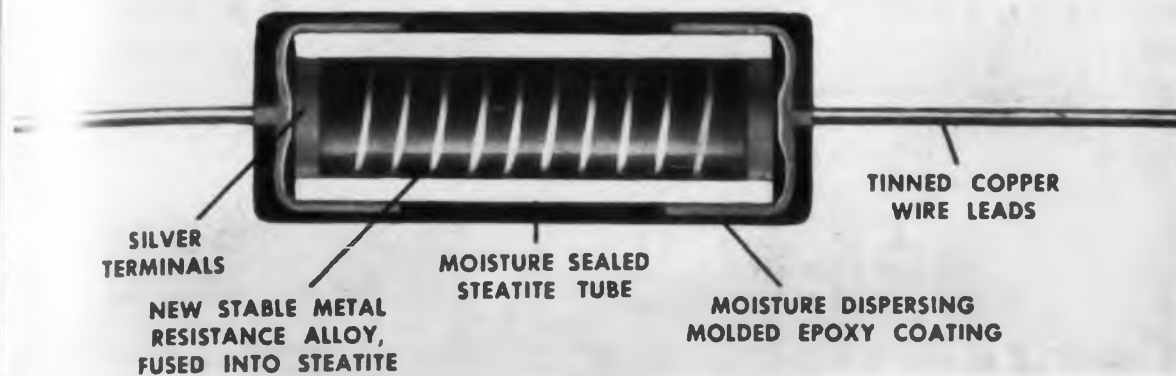


Fig. 1. Cross section of the Vamistor

wirewound units: -200 db. Its voltage coefficient is 1 ppm per volt. Temperature coefficient is 50 ppm per degree C. For 10 sec it will handle about 6.25 w with an average resistive value change of 0.01 per cent. Insulation is 10,000 megohms and dielectric strength is 900 v rms with 0 per cent change. The unit will in most cases do better than specified by MIL-STD-202.

For more information on this gas-filled Vamistor, turn to the Readers Service card and circle number 106.

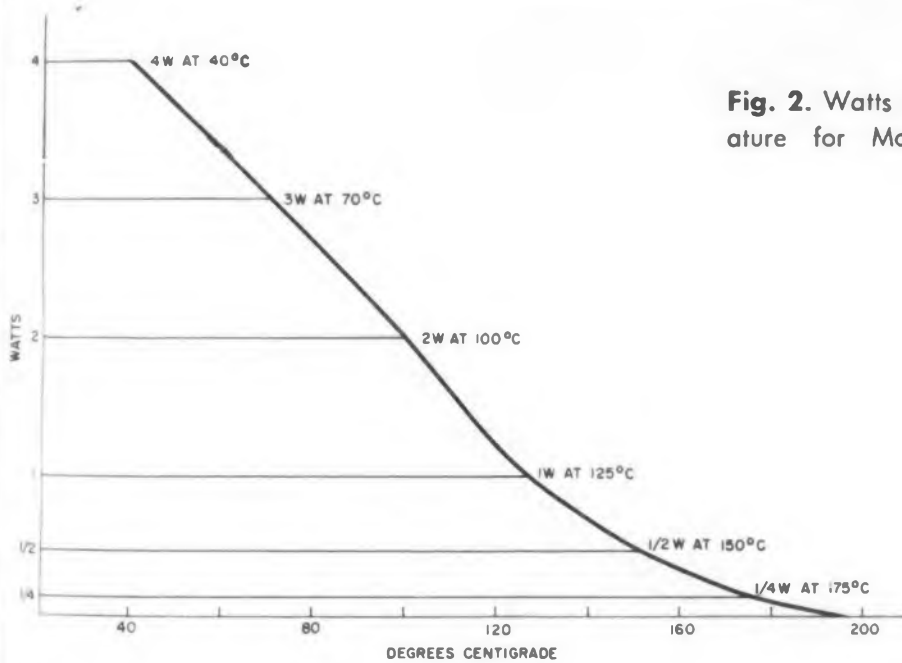


Fig. 2. Watts vs. temperature for Model 9854.

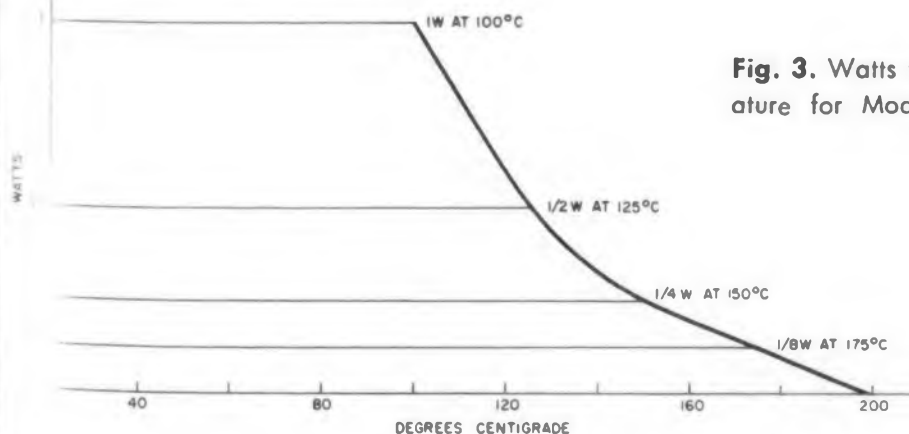


Fig. 3. Watts vs. temperature for Model 9855-4.

## Kennedy Introduces a new dual polarized feed with 2 waveguide inputs



### FEATURES:

- 2 inputs for maximum power transmission at both polarizations (10kw. on each).
- More than 30 db. decoupling.
- Same center of radiation.
- Presently installed and operating at these frequencies: 1700-2400 mc; 755-985 mc and 400-450 mc. Also available in other frequencies.

**T**HIS latest development in feed design greatly steps up versatility and flexibility in quadruple diversity tropospheric scatter systems.

For the most efficient use of your antenna, let Kennedy engineers design your feed system. Complete pattern data available for this dual polarized feed system applied to a 60-ft. dish.



ANTENNA EQUIPMENT

**D. S. KENNEDY & CO.**

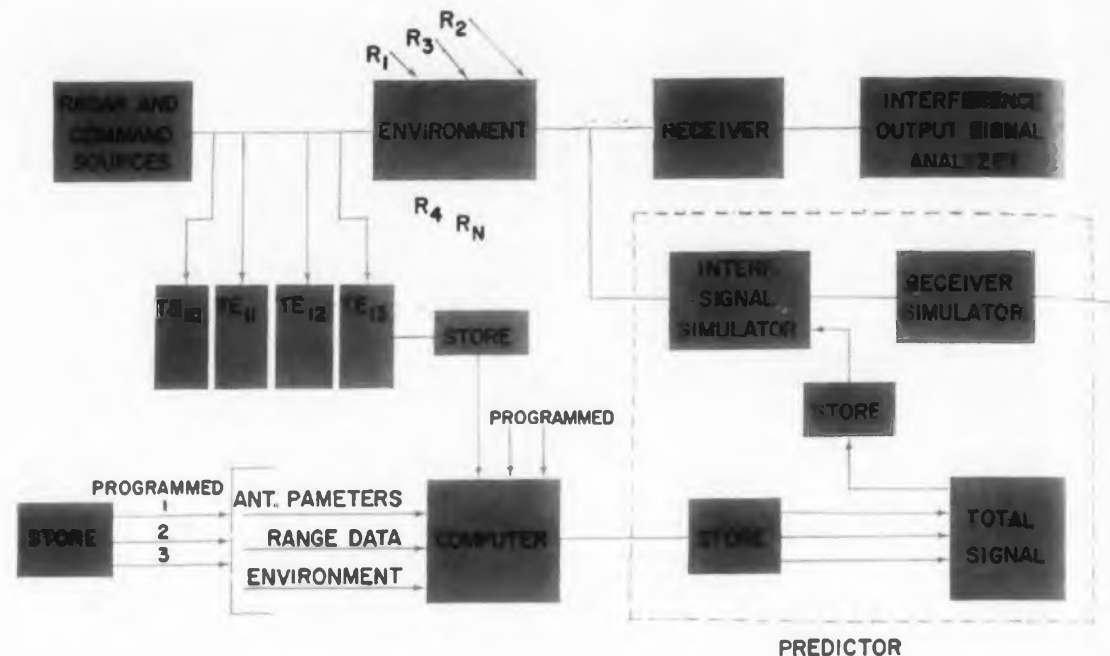
155 King Street, Cohasset, Mass.



CIRCLE 25 ON READER-SERVICE CARD

## MEETING REPORT

**Functional block diagram** of an interference prediction system described by Mr. Berliner. Necessary parameters shown at left can be retained in a storage device or programmed into a computer as required. Output of computer would then be fed to a storage device and then, to a simulator, shown on right in dotted rectangle. Computer output would be total signal environment or desired portion of total signal environment. Computer should also be capable of providing answers to factors which are causing interference and other answers to particular problems. These data, in proper form, would then be fed into interference simulator. Output of simulator would feed to receiver under test and then to interference output analyser.



## CONFEREES SAY

# Reduce RFI With Education

Ben Patrusky

Assistant Editor

**R**IDDING electronic equipment of interference sources by the "shotgun" technique has "got to go." Designers must consider the radio frequency interference (rfi) problem right from the foetal pencil-sketch stage to equipment baptism. More often they don't consider it at all. The result: brute force application of suppression devices after the equipment has been installed—a task that's uneconomical, not always effective, and often catastrophic.

That's the immediate problem most delegates at the Fourth Conference on Radio Interference Reduction and Electronic Compatibility were eager to see solved. Most advocate: make the designer aware of the rfi problem.

"Many designers are sorely lacking in any understanding of the rfi," C. W. North of the Martin Co. declared. "They just don't concern themselves with the fact that equipment may be placed in environments where there is concentrated electromagnetic radiation. Equipment

which proved operational at home may be incompatible with other equipment in an electronic complex like Cape Canaveral. They've got to be made aware of the fundamental importance of interference-free equipment."

### Missile "Buggings" Cited

To emphasize the validity of these observations, here are some recent results of ineffective interference suppression Mr. North cited in a conference address.

- Missiles have taken erroneous paths.
- Missiles have failed in later stages and were either destroyed or failed in flight.
- Missiles were blown up from internal signals while in flight. (It was discovered that in one case, relay transients produced a "dump" signal.)
- Missile flights were delayed for hours and frequently cancelled.
- Complete design changes had to be made before a successful launching could be attained.

Leonard Thomas of the Navy Bureau of Ships suggested a capsule initial solution.

"Before a hand is laid on the drawing board, the designers must consider all potential sources of rf energy. When these are determined they should investigate where this energy will be used. If locally, they must take all available steps to isolate the stuff."

Admittedly a large percentage of engineers have not been obliged to live with the rfi problem. "In fact they've consistently ignored it," one would-be educator commented. They are not entirely to blame, however.

Merely getting an operational piece of equipment can be a harrying task—especially when time limits are imposed. It is, therefore, understandable that engineers cannot devote themselves to rfi. And certainly in some areas the knowledge which many educators would like to bequeath to the designers just doesn't exist at some of the higher frequencies. Some radars are



working at 10 kmc. Others are being built for higher frequencies. "Many engineers know about basic propagation at 20 kmc; it's really brand new to many," Mr. Thomas stated. "We just don't know about the 'plumbing' requirements in that range," he said.

#### Need Vertical Education

Furthermore, as some delegates suggested, this educational renaissance must be of a vertical nature. Not only must the designer be educated. There has to be a re-orientation of administrative thinking in this area. "If the top guys make their business, it will surely rub off all the way down the line," one representative observed.

He along with several others, cited the fact that some companies have hired rfi consultants to work closely with the designers. He noted that the programs are generally meeting with excellent results. It is the way of thinking which has been adopted from manufacturers of nonelectronic interference equipment.

The nonintentional radiating devices—vehicles, internal-combustion engine, commutating devices, etc.—were until fairly recently the worst offenders. This broadband interference problem has for all intents and purposes been brought under control. How? The manufacturers took the initiative and obtained expert assistance from rfi specialists. The narrow-band rfi problem must now be licked.

#### Allergic To Aid

People working in electronics don't appear quite as receptive to hiring these people, was one criticism. "They're allergic to outside assistance; they believe bringing in outsiders is a snide criticism of their work." Another caustic observation went this way: "They feel as if someone is telling them how to make love to their wives."

But another conferee commented:

"Sure, there are rfi specialists. But it's expertise gained by cut-and-try. A number-knowledge of interference parameters is needed.

"Their [rfi specialists] guess is probably better than ours, as to how a piece of equipment will fare in some heavy electronic network. But they don't know either. The military wants high power and high gain antennas, highly sensitive receivers. All these equipments are placed close together. Then you have a vast number of modulation systems bugging each other. Result: chaos."

In his address, J. Berliner of Rome Air Development Center described RADC's projected plan and approach of analysis and control of electromagnetic interference.

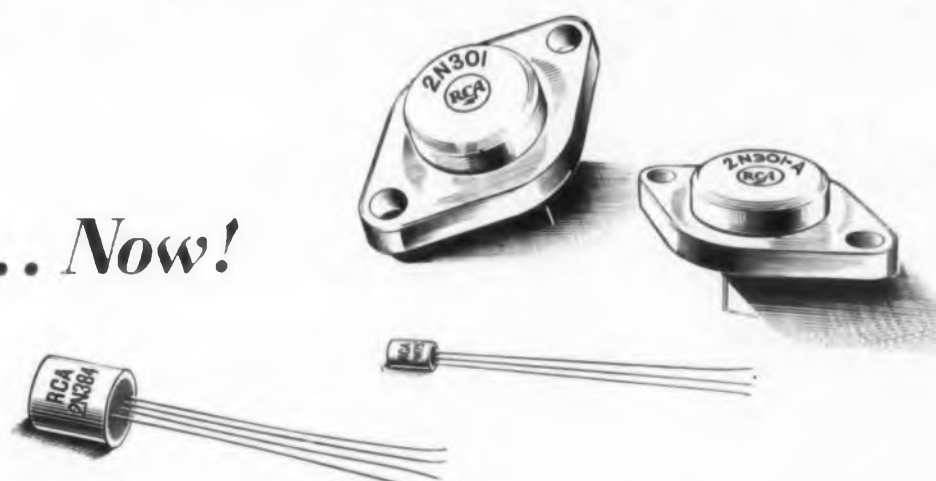
(Continued on page 34)



# RCA TRANSISTORS

**Where?...at your local RCA Distributor!**

**When?... Now!**



The complete RCA Transistor line—comprising entertainment, computer, power, and other outstanding RCA types for industrial and communications equipment, and including the famous "Drift" types—is now available to you locally. Your local RCA Distributor is in "high gear" and is now in a position to offer RCA transistors at factory prices (on quantities up to 100). When you want service, speed, and savings in transportation and in the handling of purchase orders, call your local distributor and specify "RCA Transistors"!



**RADIO CORPORATION OF AMERICA**

Semiconductor Products—Distributor Sales

Harrison, New Jersey



SANDERS FLEXPRINT <sup>®</sup> CABLES AND HARNESSES offer designers unlimited opportunities to take advantage of flat, flexible wiring in a wide variety of permanently bonded insulating plastics from low cost vinyls and polyethylenes to fluorocarbons.

# Flexible Printed Wiring in all lengths for all layouts

Reliability-proved Sanders development sharply reduces weight, bulk, and cost of electronic and electrical assemblies.

Sanders Flexprint Wiring brings to commercial and military applications a combination of field-tested advantages unmatched by conventional wiring and ordinary printed circuits.

**Check these features!** Flat copper is etched to the conductor length, pattern and current carrying capacity that fits your application. The conductors are bonded between thin sheets of flexible insulating plastics that meet your environmental requirements. The bond is permanent . . . insulation can't peel. The result: reliable, printed wiring that often weighs less than half as much as conventional wiring . . . can occupy less than 1/3 the space.

**Check these benefits!** Flexprint Wiring conforms to any housing shape or layout . . . withstands effects of vibration

and flexing . . . allows interconnected assemblies to move independently. Completely encapsulated conductors provide maximum environmental protection . . . increase equipment reliability. Flexprint Multi-Conductor Cable can be cut . . . stripped (with a simple stripping tool) . . . connected to printed circuit connectors or boards or to itself. Accurately reproduced Flexprint Wiring Harnesses speed up assembly . . . permit automatic production . . . eliminate error. The result: better wiring at lower cost.

**Check these options!** Flexprint Wiring can be designed and produced in straight cables or complex harnesses . . . in any length . . . in single or multiple layers or bonded to rigid materials as a replacement for printed

board . . . with or without a cover coat . . . with vinyls, polyethylenes, polyesters, silicones, Kel-F, Teflon, or other insulations.

**Check all the facts!** Write today for complete data about capabilities, prices and deliveries.

#### EXPERIMENTERS AND DESIGNERS

*Flexprint is available in the form of unetched copper-plastic laminate, without cover coat, together with complete instructions for etching your own circuits. Details on request.*

<sup>®</sup> TRADEMARK — SANDERS ASSOCIATES, INC.

SANDERS **FLEXPRINT** WIRING

Flat . . . Flawless . . . Flexible



**SANDERS ASSOCIATES, INC.**

NASHUA, NEW HAMPSHIRE • Dayton, Ohio • Inglewood, California • Washington, D. C.,

CIRCLE 27 ON READER-SERVICE CARD

"First we must obtain necessary and sufficient information and data on all parameters which contribute to the interference problem, e.g. transmitter spurious output, receiver vulnerability, environmental factors," Mr. Berliner explained.

Once this data is obtained, he said, corrective measures can be undertaken. Accumulation of this data, however, emphasizes the need for data reduction techniques and field intensity meters for frequencies beyond 10 kmc.

"We must begin evaluation of spurious outputs while in early design stages," Mr. Berliner asserted. He commented further that a means to determine what type of signals will be experienced by the equipment "prior to equipment installation" is needed.

The second phase of the program is interference prediction.

"Once various parameters which contribute to interference are obtained, it is then possible to apply this information to predict interference occurring with: (1) planned introduction of new equipment into operating environment, (2) planned establishment of a new site," he stated.

Mr. Berliner then described an interference prediction system which is illustrated here.

Specific problems uncovered by analysis techniques could then be eliminated or reduced during equipment research and design. Mr. Berliner explained.

"What cannot be accomplished through suppression techniques," he added.

And these are the techniques he listed: time sharing, shielding, spectrum conservation, frequency channelization, spurious control, antenna improvement, special circuit techniques, modulation techniques, receiver improvement.

#### Where The Specs Fail

Meanwhile, military specs also came in for some lashing. Though it is generally agreed that the specs governing rfi up to 10 kmc are "pretty good" when calling out radiation levels, there are many aspects which don't make the vendor's task any easier.

As Bill Jarva of the Filtron Co. put it in his address:

"The specs give a general estimate of undesirable radiation. But they do not provide information to solve practical physical problems. In fact, the information given is often misleading and measurements indicating intense interference emission may be obtained where none exists and vice versa. Numerous variables exist which cause large inconsistencies in measuring interference emission from a given source."

There have also been instances in which military enforcement of these specs have been lax and so contractors have just ignored them.

built some equipment without bothering to meet the spec," one company official reported. "The spec wasn't entirely sure enough when the equipment was first used at the test site it created a hell of a lot of interference. The equipment had to be shut off and a costly, time-consuming program of suppression had to be initiated. We piled junk upon more junk. And you can bet there still are times when the test site control board makes us shut down because of the rfi the equipment still generates. I'm sure much of our problem could have been eliminated way back in design."

#### "We'll Never Lick RFI"

"Many of the specs have been updated," Mr. Thomas commented. The levels prescribed are those which have been determined after careful consultation and are attainable. These levels, if they're not exceeded, should result in a satisfactory system.

"The drawback is that we have to work with off-the-shelf equipment which are often rfi offenders. Getting up field changes to render the field equipment usable makes for a great many problems."

He cited the example of one piece of equipment which required 40 field changes.

"It's just a matter of time. We must wait for equipment attrition," he said.

When asked if he thought the rfi problem would ever be licked, Mr. Thomas uttered an unqualified no.

"In fact we'll ultimately be forced into lower levels of interference tolerability," he stated.

The Armour Research Foundation, Chicago, Ill., is publishing the proceedings. They will be available shortly. All thirty-one technical papers will be included. These areas covered include: missile systems, communications and radar techniques, instrumentation techniques, radiating devices, interference control, nonlinear devices, and computer techniques. In addition, the various keynote and luncheon addresses will be reprinted.

#### This Interference is Poison

As if the rfi problem weren't complicated enough, another source of interference crawled into the picture recently at Cape Canaveral. It seems C. W. North of the Martin Co., explained, that while inspecting a test hangar whose floor was crawling with cables, he noted one wire doing just that—crawling. The crawling wire turned out to be a rattlesnake. Admittedly it was an electrifying find. *Note. Talk of snaking wires.*

This is the actual size of Heinemann's new sub-miniature circuit breaker, the SM3. Hermetic seal and all, it weighs no more than a bantam 2.1 ounces. It is magnetically actuated, therefore does not require de-rating for high ambient temperatures. In fact, under extensive environment-testing, the breaker has demonstrated excellent all-around operational stability. It will function properly on the tundra or in the tropics, will withstand the onslaughts of salt-sea atmosphere, sand, dust and high humidity. The SM3 is available to



ACTUAL SIZE

your specifications in any integral or fractional current rating from 0.050 to 10 amperes, at 110V, either 60 or 400 cycles AC, or 50V DC. And you have a choice of either fast or slow time delay, so that overload response can be matched closely to the operating characteristics of the protected equipment. If you have need of a rugged, compact circuit breaker "packaged" to go anywhere, you'd do well to give the SM3 some serious consideration. The facts and figures are presented for your review in Bulletin 3502. Write for a copy today.

**HEINEMANN ELECTRIC COMPANY, 156 PLUM ST. TRENTON 2, N.J.**

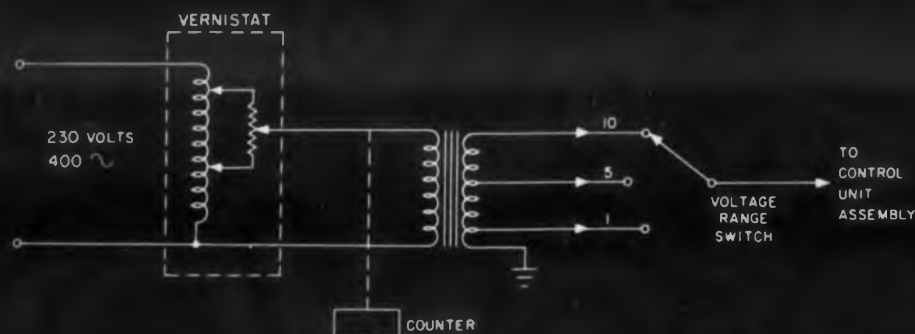


Eclipse-Pioneer  
designs test set  
for B-58 Hustler  
autopilot system...



An automatic flight control system that "thinks ahead" of the pilot is a "must" for the Air Force's Convair B 58 Hustler — world's fastest bomber. "Brain" of this system — developed by Eclipse Pioneer Division of Bendix Aviation Corporation — is a compact control unit assembly in which all flight factors are continuously and instantly translated into commands to control surfaces. To check out this assembly quickly and conveniently, a mobile test set has also been designed — and Vernistat is there as an accurate source of test voltages in simulating a number of signals and commands.

...and  
Vernistat\*  
is there!



Vernistat a.c. potentiometers were selected for several of the test panels because of their unique combination — in one component — of reliability, low output impedance, low phase shift, and high linearity. In the typical application above, a Vernistat is mechanically geared to a counter to provide an output voltage that can be accurately set to the required value. Low phase shift from input to output is maintained by the Vernistat's inherent design. And need for an isolation amplifier — with its added cost and disadvantages — is eliminated.

## Doesn't Vernistat thinking belong in your system design too?

In this application, Vernistat thinking by Eclipse-Pioneer engineers helped solve a design problem with reduced equipment cost, system complexity, and design time. Cost was only a quarter of that of an alternative method utilizing conventional potentiometer, isolation amplifier, and d.c. power. Use of fewer components reduced system complexity, increased accuracy and reliability, and saved valuable

design engineering man-hours.

In servo systems, analog computers, and similar uses, you too can obtain such results with Vernistat a.c. potentiometers. With this new concept in relating shaft position to voltage, you get low output impedance (as low as 45 ohms) with high input impedance (as high as 200,000 ohms), plus high resolution (to 0.004%), low phase shift (as low as 0.2 minutes), and high

linearity (to 0.01%).

In addition to precision a.c. potentiometers, Vernistat products include function generators (adjustable non-linear potentiometers), and variable ratio transformers. Military specifications are met by the wide selection of models available.

Write today for complete details and specifications on Vernistat precision products.

\*vernistat® — a new design concept that unites in one compact device the best of both the precision autotransformer and the multiturn potentiometer.

**Perkin-Elmer** Corporation



765 Main Avenue, Norwalk, Conn.

CIRCLE 29 ON READER-SERVICE CARD

## Transistorize

measures microwa

**P**ORTABILITY is the unique feature of this new microwave power bridge. Light in weight and as precise as most laboratory units, this battery-powered device is completely transistorized. It is suitable for making checks where larger, heavier units are too inconvenient to hook up.

Made by Airborne Instruments Laboratory, 1345 New York Ave., Huntington Station, L.I., N.Y., this Type 50 Power Bridge is self-balancing and permits direct reading of power in watts and dbm. Its frequency range is from 10-40,000 mc using a thermistor as the detector. Power ranges are 0-1 and 0-10 mw.

Power bridges using vacuum tubes are usually heavier, weighing as much as 25 lb. Type 50 weighs about 4 lb. Vacuum tube units require about 100 watts of ac power to operate 5 or 6 vacuum tubes. AIL's unit operates from two 9S v mercury cells.

Basic principle of operation is the substitution of audio for rf power. While this technique is not new, the major circuit feature is the design of the transistorized voltmeter circuit (Fig. 1).

Type 50 consists basically of an audio oscillator and a bridge in a closed-loop circuit. The amplitude of the audio signal is variable and is dependent upon and controlled by the condition of balance of the bridge. The balance of the bridge is in turn dependent upon the total power in a thermistor which, through the action of the closed loop, is maintained at a constant value. As rf power is applied to the thermistor, the bridge is unbalanced and the unbalanced voltage is impressed across the input of the audio oscillator. Audio power is thereby decreased until the cumulative power in the thermistor is restored again to its constant value.

At this point, the bridge is balanced and no further change occurs in the audio signal. The output of the audio oscillator, which is then a function of the rf power applied to the thermistor, is displayed on the meter.

Printed wiring is utilized in the bridge, along with commercial components to facilitate repairs if necessary. The case is watertight, but

ize bridge ...

power anywhere

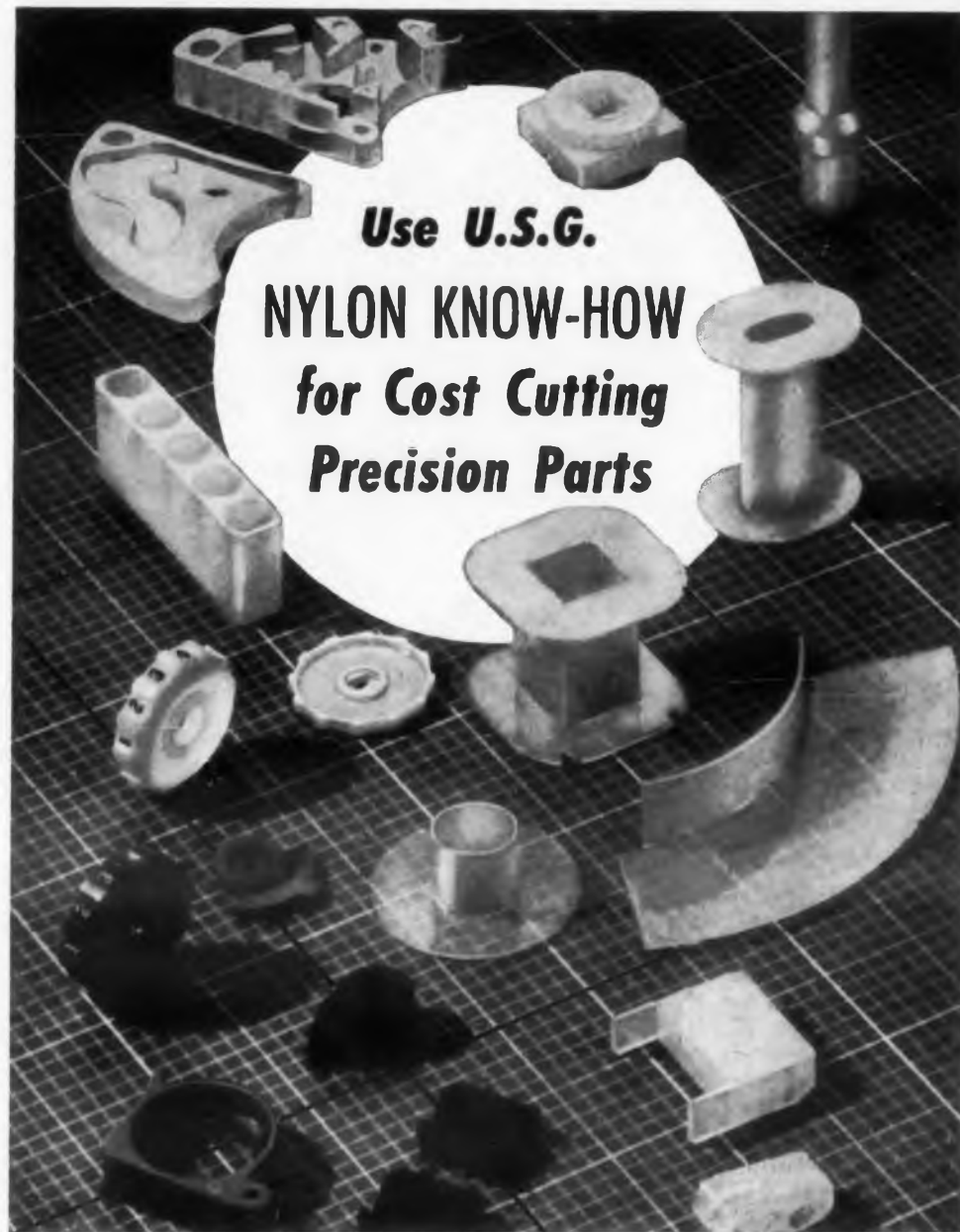
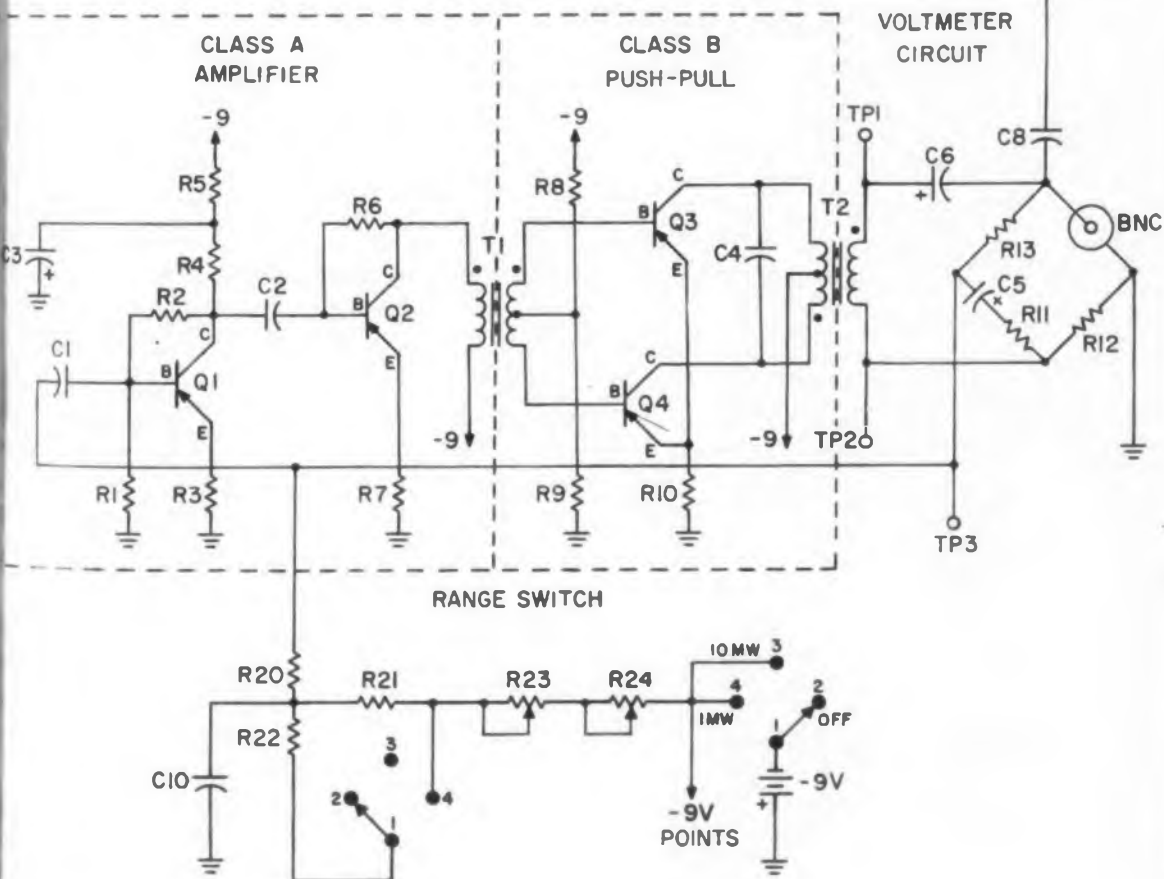
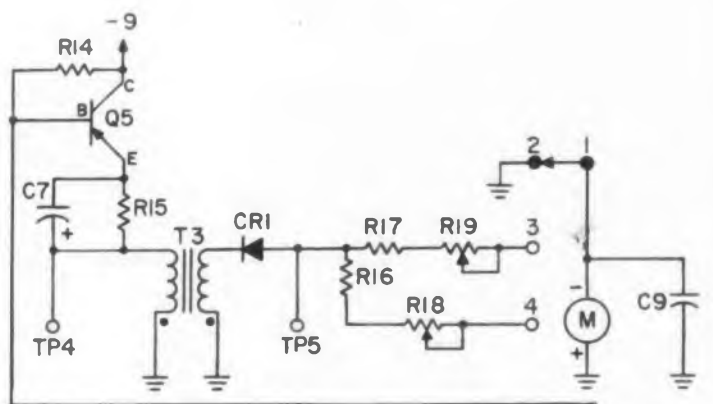


the instrument is easy to remove. Its design permits mounting the working portion in a panel if desired.

Quick readings at remote locations may be taken to check aircraft equipment, radar, TV, microwave links or rf leakage.

For more information on this transistorized microwave power bridge, turn to Readers Service Card and Circle 100.

Fig. 1. Schematic of portable transistorized power bridge.



For those mechanical and electro-mechanical parts that must be strong, durable, wear resistant, *design to use Chemiseal Nylon* (du Pont ZYTEL). It has the highest compressive strength, is the most rigid, has the best resistance to heat, abrasion, chemicals, solvents, oils and greases—and is the lowest priced of the standard nylon compositions.

U.S.G. Nylon service goes all the way, offering STOCK (sheets, tape, rod, tubing, special shapes), for manufacture of parts in your own plant; MACHINING (precision fabrication on high speed automatics) to your specifications; and INJECTION MOLDING (volume production to close tolerances at lowest cost).

To be sure you are securing your parts at the lowest cost, consistent with your requirement at every stage from prototype to plant scale production—*check your costs with U.S.G. "know-how"*.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

United States Gasket Company  
Camden 1, New Jersey

**United  
States  
Gasket**

Plastics Division of  
**GARLOCK**



CIRCLE 30 ON READER-SERVICE CARD



# Use Mil Components in Miniaturized Circuits

**Gustave Pellegrino, Jr.**

Belock Instrument Corp.  
Great Neck, N. Y.

**M**ANY Mil components are compatible with miniaturized circuitry. Using them has advantages often overlooked. One advantage is the elimination of detailed descriptions when ordering. For example, the design engineer specifying a 1/2 in. potentiometer must consider style, bushing, shaft length, resistance, tolerance, etc. In many cases the callout would vary for different component makers. But a 12 digit Mil-designation, such as RV6LAYS501B, completely specifies a particular 1/2 in. potentiometer from any manufacturer.

#### Saves Time and Money

In the design of operational military equipment the government usually requires that all nonstandard components be justified. This leads to additional cost in time and money for the equipment manufacturer using nonstandard components.

When considering smaller, nonstandard parts factors such as reliability and availability must be evaluated.

#### Reference Chart

The accompanying reference charts cover nine fixed and variable resistor Mil specifications. The styles represent only a small number of the total available. They are, however, the more commonly used units and easily procured. A subminiature rating was given those resistors whose largest dimension is about 1/2 in. or less. Components about 1 in. or less are called miniature. The rest are labeled standard.

## Specify Reliable Components from Telecomputing



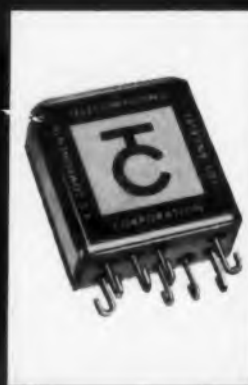
**HIGH TEMPERATURE  
CERAMIC CAPACITORS**

Featuring new ceramic dielectric and high capacity per unit area, TC Capacitors are designed for high temperature use, and subminiaturized for printed circuit mounting. Operating temperature  $-55^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$ ; Maximum capacity variation over entire temperature range  $\pm 10\%$ ; Voltage rating 200 WVDC; Proven Reliability; Conform to tentative MIL-C-11015B; Capacitance range 10mmf to .068mf.



**SUMMIT ELECTRONIC  
PRODUCTS**

Magnetic amplifiers, precision ratio transformers, and inductors are custom designed to your requirements or manufactured to your specifications. Summit products offer: precision, uniformity, rugged reliability, minimum lead time, test facilities to assure premium quality, packaging to your specification—encapsulated, potted, or taped for potting with your assemblies.



**MICRO MINIATURE  
RELAYS**

Designed for space and weight savings, hermetically sealed TC Relays conform to MIL-R5757C and MIL-R25018. Ambient temperatures  $-65^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ; standard units designed for 15 G's; special relays to 45 G's at 5 to 2000 cycles per second; coil resistance 30 to 10,000 ohms. Guaranteed life at 2 amp load, 100,000 cycles; at 5 amps, 12,000 cycles. Tests at  $125^{\circ}\text{C}$  ambient have produced 2 million operations at 2 amps, 60,000 at 5 amps.



**ROCKER SOLENOIDS**

For aircraft and missile applications, Rocker Solenoids are custom designed to all applicable specifications. Available movements: push, pull, push-pull, switching, locking, and latching; configurations: miniature, pressurized, and hermetically sealed. Low or high temperatures (to  $800^{\circ}\text{F}$ ); continuous or intermittent operation; motions from thousandths of an inch to  $+1$  inch; forces from 1 ounce to  $+100$  pounds. Newly designed units act in less than 15 milliseconds.



FOR COMPLETE INFORMATION, WRITE, WIRE, OR PHONE

National Sales  
Representatives Telco  
Electronic Sales Division  
**TELECOMPUTING CORPORATION**  
915 North Citrus Avenue  
Los Angeles 38, California  
Phone: HOLLYWOOD 4-0181

CIRCLE 31 ON READER-SERVICE CARD



Three Mil specifications covering fixed composition and film resistors.

Specification	MIL-R-11B				MIL-R-10683A				MIL-R-10509B			
Description	Fixed, Composition				Fixed, Composition Film				Fixed, Film			
Characteristic	Insulated				Very High Frequency				High-Stability			
Max. Ambient, Full Watts	70°C				40°C				70°C			
Shape	Tubular				Tubular				Tubular			
Stability	Poor				Good				Good			
Tolerance	± 5%				± 5%				± 1%			
High-Freq. Operation	Good				Excellent				Good			
Style	RC09	RC20	RC32	RC42	RF50	RF40	RF30	RN60	RN65	RN70	RN75	
Rating (Watts)	¼	½	1	2	¼	½	1	¼	¼	½	1	
Size	SM	SN	Min	Min	SM	Min	Std	SM	Min	Min	Std	
Leads	Axial	Axial	Axial	Axial	Axial	Tab	Tab	Axial	Axial	Axial	Axial	
Minimum Resistance	10Ω	10Ω	2.7Ω	10Ω	20Ω	20Ω	20Ω	10Ω	10Ω	10Ω	10Ω	
Maximum Resistance	22M	22M	22M	22M	1M	1M	1M	1M	2M	5M	10M	

Three Mil specifications covering fixed wirewound resistors.

Specification	MIL-R-93A				JAN-R-184				MIL-R-26C		
Description	Fixed, Wirewound				Fixed, Wirewound				Fixed, Wirewound		
Characteristic	Accurate				Low-Power				Power		
Max. Ambient, Full Watts	85°C				40°C				25°C		
Shape	Tubular				Tubular				Tubular		
Stability	Excellent				Good				Good		
Tolerance	± .1%				± 5%				± 5%		
High-Freq. Operation	Poor				Poor				Poor		
Style	RB09	RB15	RB17	RB52	RU3	RU4	RU6	RW59	RW55	RW56	
Rating (Watts)	⅛	¼	½	¼	½	1	2	2.5	5	10	
Size	SM	Min	Min	Min	Min	Std	Std	SM	Std	Std	
Leads	Tab	Tab	Tab	Axial	Axial	Axial	Axial	Axial	Axial	Axial	
Minimum Resistance	.1Ω	.1Ω	.1Ω	.1Ω	.24Ω	.51Ω	1.0Ω	.1Ω	.1Ω	.1Ω	
Maximum Resistance	.185M	.225M	.75M	.12M	.47K	2.2K	3.3K	2K	9K	16K	

Three Mil specifications covering variable composition and wirewound resistors.

Specification	MIL-R-94B		MIL-R-19A				MIL-R-22A	
Description	Variable, Composition		Variable, Wirewound				Variable, Wirewound	
Characteristic			Low Operating Temp.				Power	
Max Ambient, Full Watts	70°C		40°C				25°C	
Shape	Circular		Circular				Circular	
Stability	Poor		Good				Good	
Tolerance	± 10%		± 5%				± 5%	
High-Freq. Operation	Good		Poor				Poor	
Style	RV6	RV4	RA10	RA20	RA30	RP10	RP15	
Rating (Watts)	⅓	2	1	2	4	25	50	
Size	SM	Min	Min	Min	Std	Std	Std	
Leads	Tab	Tab	Tab	Tab	Tab	Tab	Tab	
Minimum Resistance	100Ω	100Ω	15Ω	3Ω	3Ω	2.0Ω	2.0Ω	
Maximum Resistance	5M	5M	2.5K	15K	25K	5K	10K	

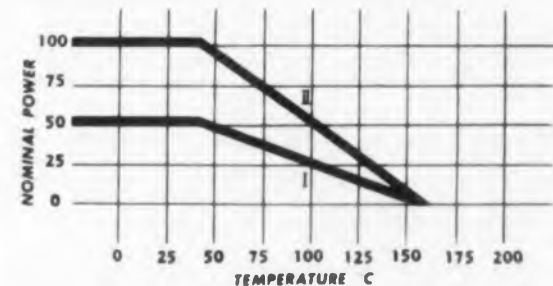


## DON'T X-RAY RESISTORS!

Eliminate This Production Cost With . . .

## PYRO-SEALED\* CARBON FILM RESISTORS

\*Pyro-Seal is an exclusive patented process that fuses shock resistant borosilicate glass to metal end caps. The result — complete sealing out of gases, solder flux and other contaminants that spell death to ordinary resistors. During production, quality control checks every resistor individually for a minimum of 18 hours at 350°C . . . a rugged test that solder sealed resistors can not endure, thus insuring ultimate perfection in seals. Other rigid quality control tests have shown that Pyrofilm Resistors stored at 500°C for 3 months change less than 1%. For a continuous in-use check, Pyro-Sealed resistors are visible and can be examined for color and conformity.



- Temperature Coefficients — Matched to .0001% °C
- Resistance Range — 10 ohms to 300 Megohms.
- Diameter — ⅜"
- Standard Tolerance — 1% to .1%
- Nominal Power Ratings — ½, 1 and 2 Watt

Write For Further Information On Pyrofilm's Complete Line of Pyro-Sealed Resistors.



**PYROFILM RESISTOR COMPANY, INC.**  
U. S. Highway #46 • Parsippany, New Jersey  
DEarfield 4-8282

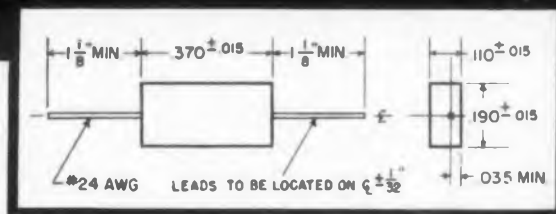
CIRCLE 32 ON READER-SERVICE CARD

**Smallest MOLDED\*  
MICA CAPACITOR**  
73% Smaller†  
**Micamold Missilmite**  
for 55°C to 125°C operation

MEETS AND EXCEEDS MIL-C-5A  
MEETS AND EXCEEDS MIL-C-11272A



\*Pat. Applied For  
†73% smaller than CM-15.



Micamold's Missilmite subminiature molded mica capacitors are the Smallest Molded Mica Capacitors Ever Produced...73% SMALLER! Due to radically new engineering design, new materials and assembly methods, Perfectly Symmetrical Missilmites MEET and EXCEED MIL-C-5A and MIL-C-11272A, Characteristics "C," "D" and "E." These subminiature molded mica capacitors will withstand operating temperatures of -55°C to +125°C (standard range is from -55°C to +85°C), and weigh only 1/2 gram.

Reliable and stable Missilmites permit greater design flexibility to the engineer, and are especially desirable in critical miniaturized assemblies. Recommended for use in missiles, delay lines, pulse networks, computers, transistorized assemblies...or wherever minimum size and weight, with stability, are required.



General Instrument Corporation  
also includes  
Automatic Manufacturing  
F. W. Sickles Division  
Radio Receptor Co., Inc.  
(subsidiary)

Send for Bulletin 114A to:

**MICAMOLD ELECTRONICS MANUFACTURING CORP.**

(Subsidiary of General Instrument Corp.)

1087 FLUSHING AVENUE, BROOKLYN 37, NEW YORK • HYacinth 7-5400

CIRCLE 33 ON READER-SERVICE CARD

# One Size Relay



It's not the small one this time. Babcock's BR-7 is somewhat larger than the crystal can relay shown in this photo, but has a capacity ranging from dry circuit to ten amperes.

A SINGLE subminiature can gives relay users the option of dry circuitry or a 10 amp contact load. Somewhat larger than a crystal can type, which many reliability engineers distrust, the new relay can be used throughout a piece of electronic gear.

One size fits all applications. While the contact assembly for switching vacuum tube grids, thermocouples or piezoelectric devices necessarily differs from the one used for output applications and switching control circuits, the remainder of the relay configuration stays the same.

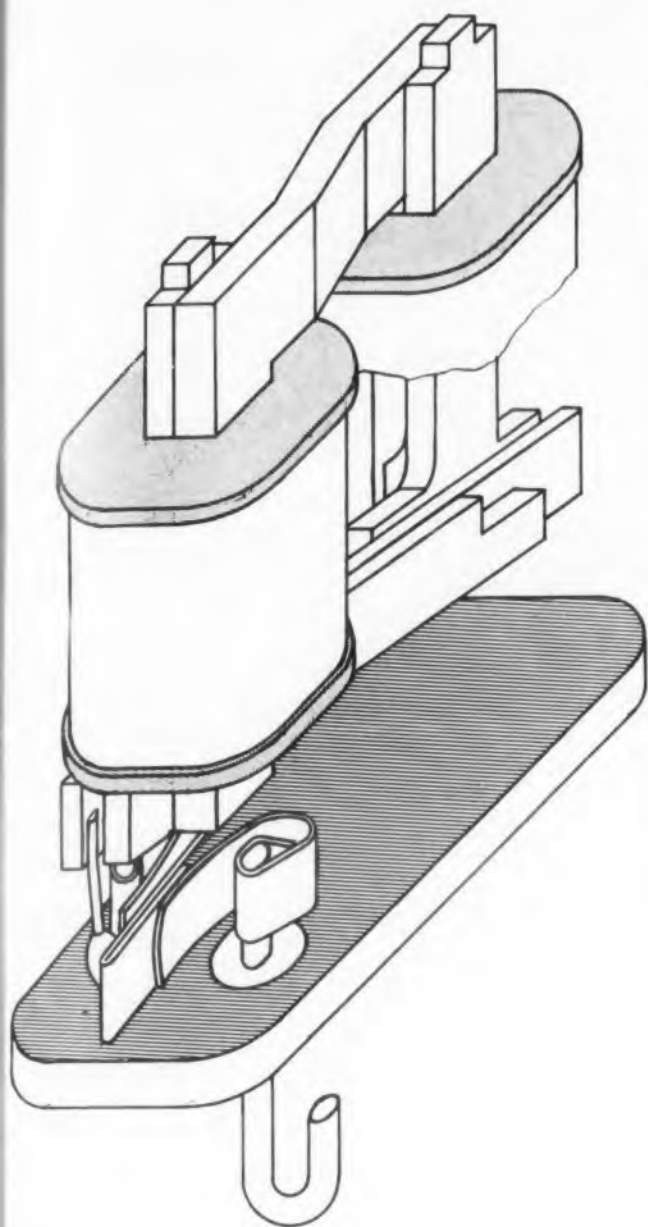
Babcock Relays, Inc., 1640 Monrovia Ave., Costa Mesa, Calif., conducted a survey aimed at learning what relay characteristics were most in demand by industry. They found the largest proportion of users specified contact loads under 10 amp, and conformance to MIL specs. They wanted sensitivity and reliability, too.

Babcock settled on a can size of 1.26 x 1.07 x 0.56 in. This permitted them to use a larger wire size and be reasonably assured of mechanical reliability in production; it is also well below the 1 x 2 x 2-1/2 in. size of telephone-type relays. The double coil design shown in Fig. 1, a torqued magnetic structure (for a straight armature, helpful in production) and optimum pole faces (with reluctance to match the reluctance of the magnetic circuit) are standard for all relays.

Dpdt contact configuration, shown in the drawing, is basically the same for high power as dry circuit work, the only difference being that the contact spacing for 10 amp is 0.025 in. (1.5 to 2 msec transfer time) while for dry circuit applications the spacing and pressure is less. The spring-like curve of the static contacts gives a longitudinal "wipe" to avoid arcing.

The BR-7—no model number differentiation is made for relay contact heads operating up to 5 amp and those operating from 5 to 10 amp—is rated for a life of 100,000 actuations minimum over a temperature range from -65 to 125 C.





**Fig. 1.** Relay construction. "Wipe" is caused by the slide-and-deflection of the dpdt contact assembly, as the glass bead shoves the contact over. Arcing is kept to a minimum. Use of a torqued frame for the double coil assembly permits a straight armature—good news for the production quality control department.

Pull-in power is 480 mw for 10 amp contacts; 80 mw for 2 amp contacts; lower for spdt and special adjustments.

Coil resistance is 20 K maximum; insulation resistance 1000 meg; dielectric strength 1500 v rms. The relay will withstand 0.4 in. double amplitude vibration over a 10 to 40 cps frequency range, 30 g from 40 to 2000 cps.

For use with printed circuits, the BR-7 has a standard 0.2 in. grid spacing header, though hooked headers are provided for applications above 5 amp: the 0.05 in. pin diameter is too large for available sockets.

For further information about this one-size relay turn to the Readers Service Card and circle 104.



## Handy & Harman Silver Powder and Flake for Electronic Applications



**Among the many forms of silver and silver alloys manufactured by Handy & Harman are:**

Fine silver (wire, strip and foil) • Silver anodes and grain for plating • Silver contact alloys • Silver powders • Silver flake, paints and paste • Silver brazing alloys • Silver electronic solders • Silver sintered metals • Solder-flushed silver alloys • Silver chloride and oxide • Coin silver (wire and strip) • Silver bi-metals

The increased acceptance of silver powder and flake in electronic circuitry and components has created a demand for a source that can supply these materials at a consistently high level of quality.

Handy & Harman manufactures silver powder and flake in all types and forms, for use in formulations on printed circuitry and wiring, resistors, condensers, thermistors, printed terminal strips on glass, ceramics or plastic laminates, etc.

If you are working on conductive or resistive coatings where you require excellent electrical conductivity, Handy & Harman will welcome the opportunity to assist you in the choice — or discussion of *any* silver product that may interest you. Write for Technical Bulletin A-4 on Silver Conductive Coatings and Bulletin A-5 on Silver Powder and Flake.

Our technical service and field application experience are at your disposal... we welcome inquiries on products and product problems involving any form of silver.

Your NO. **1** Source of Supply and Authority on Silver Alloys



**HANDY & HARMAN**

General Offices: 82 Fulton St., New York 38, N. Y.

DISTRIBUTORS IN PRINCIPAL CITIES

OFFICES AND PLANTS  
ATLANTA, GA.  
BRIDGEPORT, CONN.  
PROVIDENCE, R. I.  
CHICAGO, ILL.  
CLEVELAND, OHIO  
DETROIT, MICH.  
LOS ANGELES, CALIF.  
OAKLAND, CALIF.  
TORONTO, CANADA  
MONTREAL, CANADA

CIRCLE 34 ON READER-SERVICE CARD



# LORD electronic mounting systems

LORD designs and manufactures *complete*, assembled mounting systems in a wide range of standard and special designs. These provide excellent vibration and shock protection for airborne electronic equipment.

With recently expanded facilities, LORD offers outstanding service on all types of standard bases to meet all pertinent MIL specifications.

Extensive experience can be applied to the design of specialized systems to meet high-performance requirements or to withstand environmental extremes such as high temperatures, high frequencies, steady-state accelerations and transient shock conditions.

All materials and designs are selected to satisfy both performance and cost considerations. To initiate your mounting system project or obtain more information, contact your nearest LORD Field Engineer or the Home Office, Erie, Pa.

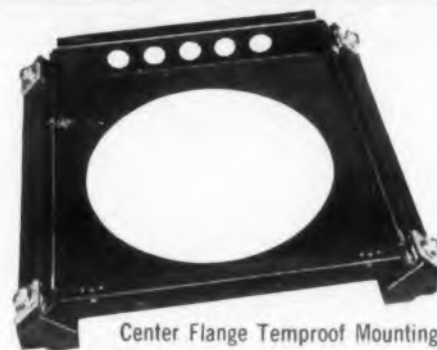


MS-91404-S1 mounting base assembly incorporates Temproof Mountings.



MT-1555/U base with miniature Temproof Mountings provides all-attitude protection for electronic unit.

Special all-attitude base with BTR (Broad Temperature Range) Mountings for gyro in jet-powered aircraft.



Center Flange Temproof Mountings are used in 39-pound mounting system for airborne antenna harmonizer.



Custom-designed rectilinear mounting system protects missile gyro against rotation from translational inputs.

High-performance mounting system for missile protects canister-type electronic units of modular design.



## FIELD ENGINEERING OFFICES

ATLANTA, GEORGIA - Cedar 7-9247  
BOSTON, MASS - Hancock 6-9135  
CHICAGO, ILL - Michigan 2-6010  
CLEVELAND, OHIO - Shadyside 9-3175  
DALLAS, TEXAS - Riverside 1-3392

DAYTON, OHIO - Baldwin 4-0351  
DETROIT, MICH - Diamond 1-4340  
KANSAS CITY, MO - Westport 1-0138  
LOS ANGELES, CAL - Hollywood 4-7593  
NEW YORK, N. Y. - Circle 7-3326

PHILADELPHIA, PA - Pennypacker 5-3559

"In Canada - Railway & Power Engineering Corporation Limited"

LORD MANUFACTURING COMPANY • ERIE, PA.

CIRCLE 35 ON READER-SERVICE CARD



Digital readout to 0.1 per cent accuracy from this

# Minified Millivoltmeter

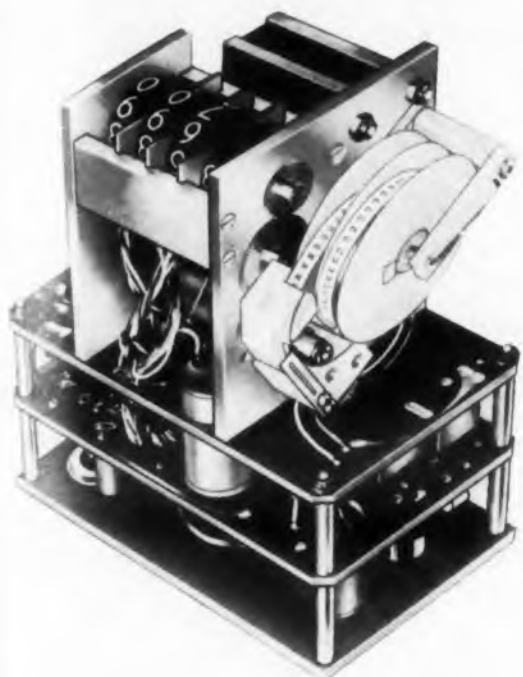
WHEN AN analog/digital converter packs a transistorized amplifier, a chopper, an input filter, a slidewire pot, a servo motor, a digital readout, and a zener reference in a small can, measuring only 3 x 5 x 5-3/8 in.—that takes a lot of packing. And when the converter weighs less than three pounds, provides 0.1 per cent accuracy, and 0.05 per cent conformity, with an infinite resolution potentiometer, it bears looking into.

In response to our "How come?", the B & H Instrument Co., Inc. of 3479 West Vickery Blvd., Fort Worth, Tex., explained it this way.

The heart of the instrument is a tape-slidewire, formed by bonding a resistance wire within the edge of a laminated Mylar tape.\* The tape, 12 feet long, is calibrated against a 60 foot long master tape. During calibration, digital values as specified, are automatically printed on the face of the tape for linear or nonlinear readout through a window in front of the case. This way, linear, parabolic, hyperbolic, or logarithmic functions can be presented in any scale.

If the printed readout is not desirable, a digital in-line counter is geared to the slidewire drive shaft. In this case, variations in resistance slope, up to 15 per cent, are accomplished by varying the sprocket hole spacing.

\*This novel potentiometer is shown in the New Products section of this issue. A larger and somewhat different version was featured in ED September 1955, p. 50.

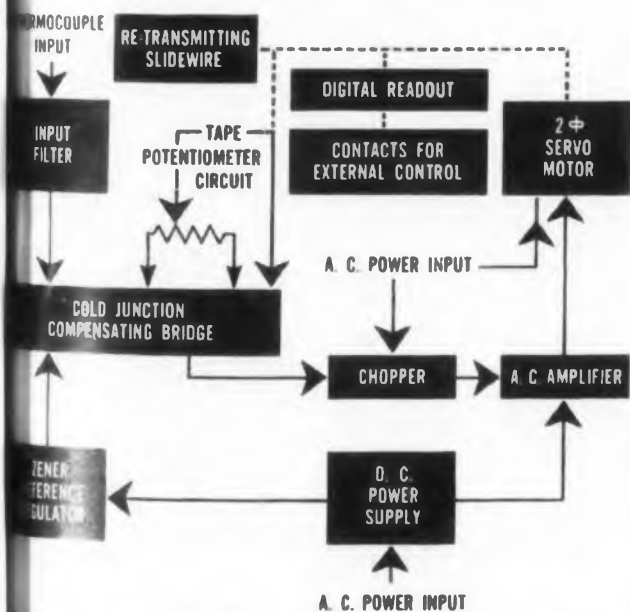


With room to spare, this very small A/D converter provides infinite resolution with a 12 foot long, servo-driven slidewire.

The slidewire, available with resistance from 100 ohms to 100 K, is driven between two concentric spools by the sprocket drive, which in turn, is driven by a null-balanced servo motor.

Available for 60 or 400 cycle operation, the entire instrument takes only 20 va from a 115 v line. The two models, one for temperature measurements, the other for rpm, can be equipped with 100 ma, 115 v contacts to provide a signal for programming and control. They even have space left for a retransmitting slidewire.

For more information on this very small A/D converter, turn to the Reader-Service Card and Circle 105.



Temperature indicating unit. The block diagram shows the components in the instrument. The dotted lines indicate optional features which can be built in.

the most  
reliable  
metallized  
capacitors  
made!



## DIFILM<sup>®</sup> METALLIZED CAPACITORS

Now improved and better than ever!!!

UNMATCHED for reliability in high temperature operation, Sprague's Type 118P DIFILM Metallized Capacitors have the highest insulation resistance of any metallized paper capacitors. Their unusual reliability is largely attributed to the dual dielectric, a unique combination of polyester film and metallized paper impregnated with a special high-temperature mineral wax. They're designed for operation at 125°C without voltage derating.

Life tests for Sprague's new Type 118P capacitors are the same as those for standard paper capacitors—140% of rated voltage for 250 hours at full rated temperature, 125°C. Dielectric tests, too, are the same as for comparable paper capacitors—twice the rated voltage.

Type 118P DIFILM capacitors may also be used at extremely low voltages. Capacitors in typical applications have been operated up to 5000 hours with only 2 volts applied without the non-clearable short circuits which have been typical of earlier metallized paper designs. The vibration and shock resistance of DIFILM

Metallized Capacitors make them well-suited to missile electronics and similar applications.

The improved quality of these capacitors is the result of advanced manufacturing techniques combined with the development of new and better materials... all under strict quality control. Sprague is the only commercial capacitor manufacturer to metallize its own condenser tissue... the only manufacturer to continuously inspect all plastic film used to see that it meets rigorous Sprague standards. No wonder Sprague is first in quality metallized paper capacitors!

Write for Engineering Bulletin 2211A to Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

For fast deliveries of popular ratings, call your local Sprague Industrial Distributor.

# SPRAGUE<sup>®</sup>

the mark of reliability

### SPRAGUE COMPONENTS:

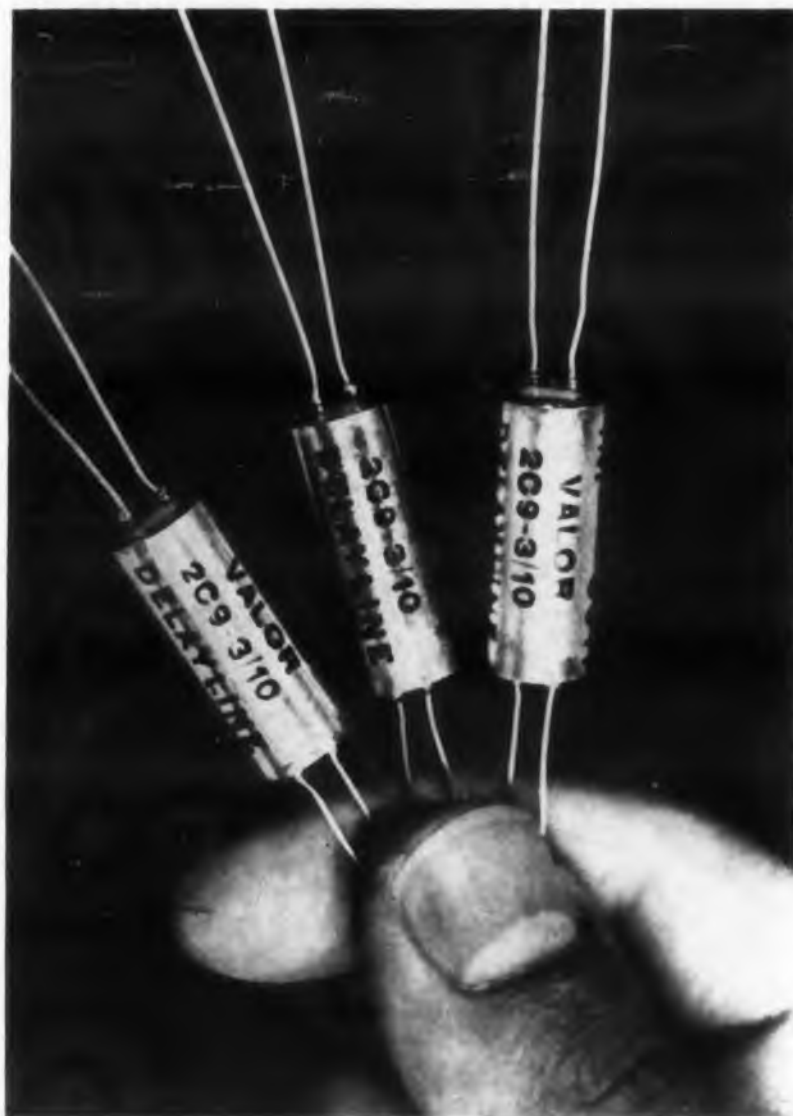
CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS  
CIRCLE 36 ON READER-SERVICE CARD

# NEW PRODUCTS

*Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.*

## SMALL STUFF

An old engineering dictum states that equipment must be designed so that it costs nothing, requires no maintenance, lasts forever, and occupies no space. Here are some of the latest items developed with the last requirement in mind.



## DELAY LINES

Designed for transistor and printed circuit applications, these lumped constant delay lines (left) are packaged in a 1 x 0.4 in. metal tube. The delay lines consist of powdered iron toroidal inductors and temperature compensating ceramic disk capacitors. The unit is phase and frequency compensated for best pulse response. There are seven units in the series. Characteristics range from 0.1  $\mu$ sec delay, 0.03  $\mu$ sec rise, and 500 ohm impedance (Type 1C9-3/5) to 0.7  $\mu$ sec delay, 0.23  $\mu$ sec rise, and 1600 ohm impedance (Type 7C91-3/16).

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

CIRCLE 37 ON READER-SERVICE CARD

## POINT-CONTACT DIODES

These miniature germanium point-contact diodes (right) are encapsulated in hermetically sealed glass cases. Eleven types are manufactured for both general purpose and computer applications. They have a maximum length of 0.265 in., and a maximum diameter of 0.105 in. Lead length is 1.25 in.

Erie Resistor Corp., Dept. ED, Erie, Pa.

CIRCLE 39 ON READER-SERVICE CARD

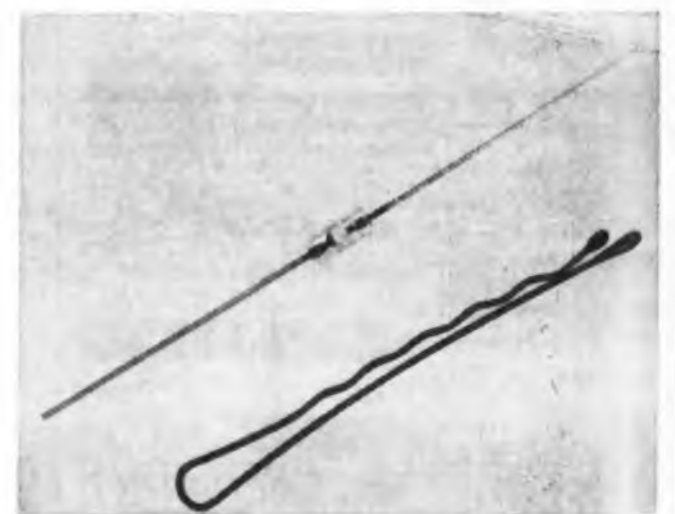


## TANTALUM CAPACITORS

Case size of these sintered anode electrolytic capacitors is less than 1/16 in. in diameter and a little over 1/8 in. in length. Designated type HAT, the units were developed for miniature transistorized devices. Dc leakage is less than 1  $\mu$ a. They are available in ratings from 1 to 10  $\mu$ f and 1 to 10 v.

P. R. Mallory & Co., Inc., Dept. ED, 3029 E. Washington St., Indianapolis 6, Ind.

CIRCLE 38 ON READER-SERVICE CARD







### SLIDEWIRE-TAPE POTENTIOMETER

A resistance wire bonded to a Mylar tape forms the heart of this unit. The wire is available in lengths of 120 in., and resistance ranges are from 100 ohms to 100 K. Labeled Ta'pot H5600, the calibration may be either linear or nonlinear. Conformity between true resistance and specified function is 0.05%. Resolution is better than 0.01%. Total resistance tolerance is 0.25%. Unit will handle 2 w at 25 C. Operating temperature range is -55 to +70 C. Two or more units may be ganged together. Case dimensions are 2 x 2.25 x 2.75 in.

The Howell Instrument Co., Dept. ED, 3101 Trinity St., Fort Worth 7, Tex.

CIRCLE 40 ON READER-SERVICE CARD



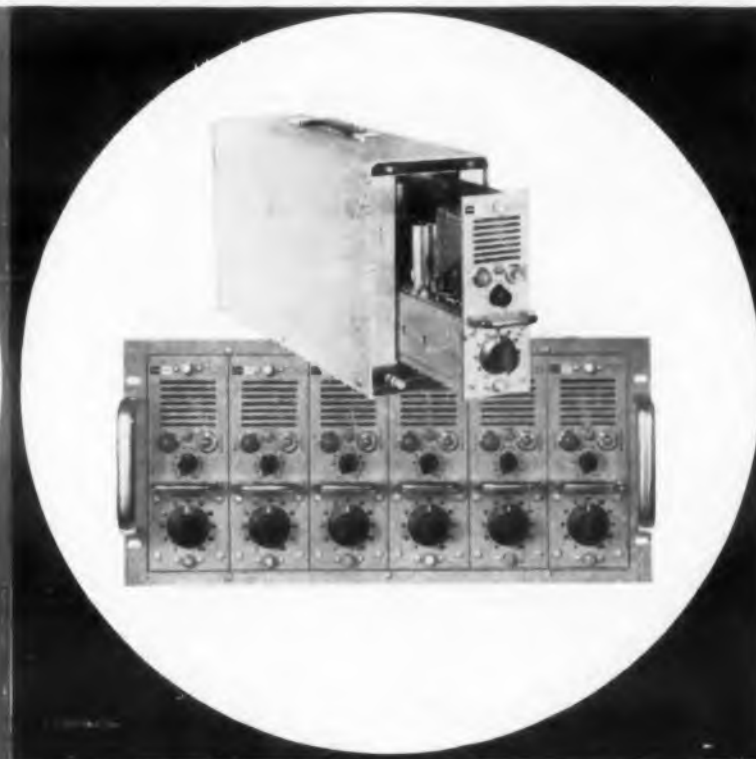
### MAGNISTOR

The Magnistor is a solid state magnetic component. Designated MPT-1, the unit is constructed of four coils: set, reset, interrogation, and signal output. Coils are on a ferrite core. With associated circuitry, the Magnistor can function as a differentiating detector with a permanent or erase storage capability. Sealed in an epoxy plastic, it operates over a wide frequency range. The unit has both data processing and industrial control applications.

Filter Instrument Co., Inc., Dept. ED, Sunnyside Blvd., Plainview, N.Y.

CIRCLE 41 ON READER-SERVICE CARD

## AMPLIFY MICROVOLTS WITH STABILITY... measure strain, temperature, other phenomena, to 0.1% with a KIN TEL DC amplifier



### NEW...TRUE DIFFERENTIAL DC AMPLIFIERS ELIMINATE GROUND LOOP PROBLEMS...RESCUE MICROVOLT SIGNALS FROM VOLTS OF NOISE

160 db DC, 120 db 60 cycle common mode rejection with balanced or unbalanced input ■ Input completely isolated from output ■ Input and output differential and floating ■ 5 microvolt stability for thousands of hours ■ 0.05% linearity, 0.1% gain stability ■ Gain of 10 to 1000 in five steps ■ >5 megohms input, <2 ohms output impedance ■ 10 volt at 10 ma output ■ 120 cycle bandwidth ■ Integral power supply

Ideal for thermocouple amplification, the Model 114A differential DC amplifier eliminates ground loops; allows the use of a common transducer power supply; drives grounded, ungrounded or balanced loads; permits longer cable runs; and can be used inverting or non-inverting. The 114A can be mounted in either single amplifier cabinets or six amplifier 19" rack adapter modules. Price: 114A - \$775; six amplifier module - \$200; single amplifier cabinet - \$125.

### WIDEBAND, SINGLE ENDED DC AMPLIFIERS AMPLIFY DATA SIGNALS FROM DC TO 40 KC WITH 2 MICROVOLT STABILITY

±2 microvolt stability ■ <5 microvolt noise ■ 40 kc bandwidth ■ 100 KΩ input, <1 ohm output impedance ■ Gain of 20 to 1000 in ten steps with continuous 1 to 2 times variation of each step ■ ±45 V, ±40 ma output ■ 1.0% gain accuracy ■ 0.1% gain stability and linearity ■ Integral power supply

Millions of cumulative hours of operation have proved KIN TEL Model 111 series DC amplifiers to be the basic component for all data transmission, allowing simple, reliable measurement of strain, temperature and other phenomena. DC instrumentation systems - with their inherently greater accuracy, simplicity, and reliability than AC or carrier systems - are made entirely practical by the excellent dynamic performance, stability, and accuracy of KIN TEL DC amplifiers. Price: 111BF - \$575; six amplifier module - \$200; single amplifier cabinet - \$125.

5725 Kearny Villa Road, San Diego 11, California



CIRCLE 42 ON READER-SERVICE CARD

## NEW PRODUCTS

### Silicon Solar Cells

Conversion efficiencies of 10%



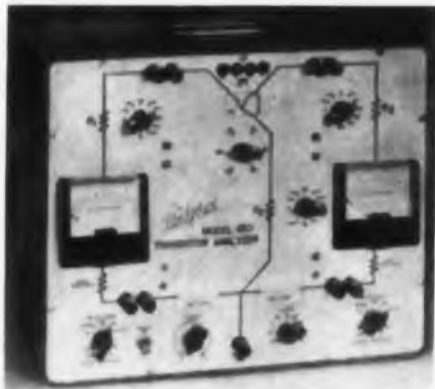
For both commercial and military use, these rugged silicon solar cells can convert 10% and more of the radiant energy falling on their surface. Rectangular in shape, they can provide an output of approximately 9 w per sq ft of active cell area in bright sunlight. Their efficiency is due in part to alloying techniques which permanently bond the contact to the silicon wafer. The contact is thus made an integral part of the cell itself, while still allowing individual cells to be soldered. Besides increasing efficiency, this bond minimizes series resistance. Individual cells are obtainable with or without color-coded pig-tail leads. They measure 0.5 x 1 cm, 0.5 x 2 cm, and 1 x 2 cm.

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

CIRCLE 43 ON READER-SERVICE CARD

### Transistor Analyzer

Has wide range of applied voltages



Accuracy of the 850 transistor analyzer is  $\pm 2$  per cent of full scale. The tester has a wide range of applied voltages available by substitution for breadboard configurations—common base, common emitter, and common collector.

The Hickok Electrical Instrument Co., Dept. ED, 10525 Dupont Ave., Cleveland 3, Ohio.

CIRCLE 44 ON READER-SERVICE CARD

## FOR THE FIRST TIME... ALL IN ONE WIRE!

WINDABILITY  
SOLDERABILITY  
VARNISHABILITY  
RELIABILITY...

# IT'S PHELPS

- BETTER WINDABILITY—"lays in" easier.
- LOW TEMPERATURE SOLDERABILITY—no damage to copper conductor.
- IMPROVED VARNISHABILITY—safer in hot varnish solvents.
- FIELD-TESTED RELIABILITY—uniquely balanced properties provide better thermal life.



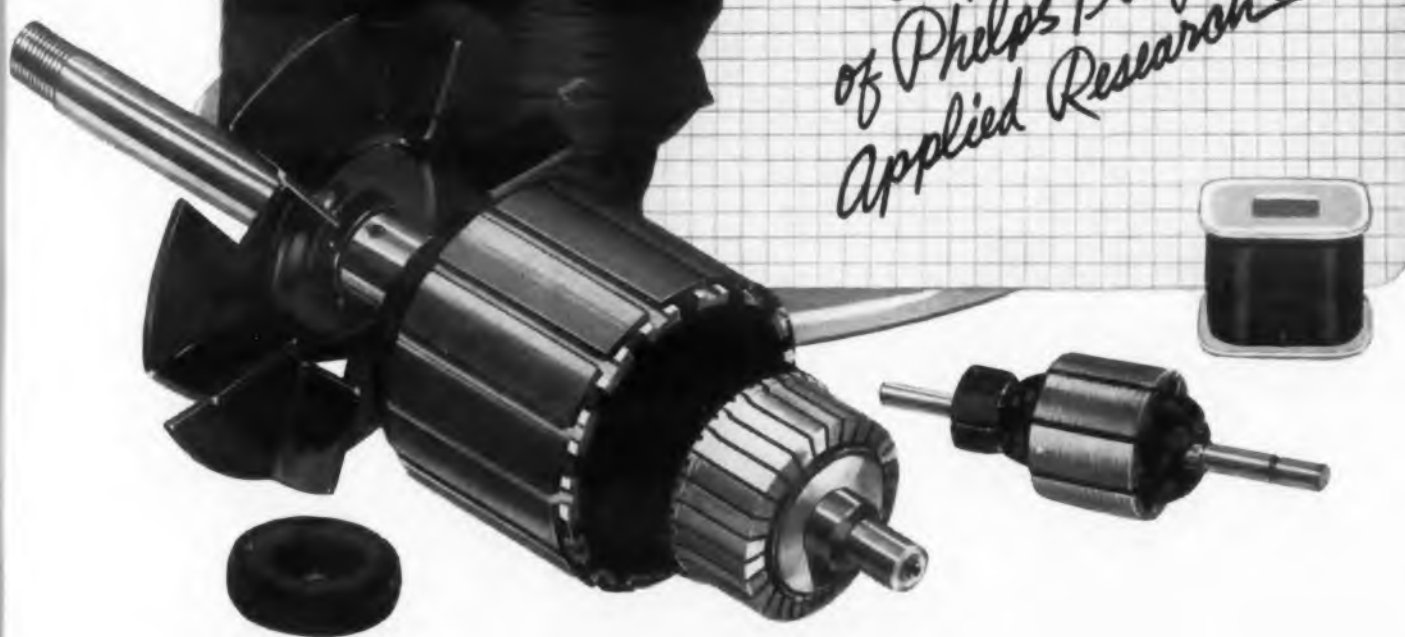
Phelps Dodge magnet wire is available in modern non-returnable spools, reels and "Pakeze" containers

Nyleze\* is another example of the advanced magnet wires developed by Phelps Dodge through its Applied Research. It is a new combination of materials with highly desirable properties for use in such applications as series armatures and fields, stators, potted coils, random wound coils, toroids and other difficult winding designs. These properties suggest possibilities for cost economies and improved designs that result in better operating performance of your equipment.

\*Nyleze is red in color

# S DODGE NYLEZE!

*A product  
of Phelps Dodge  
Applied Research!*



*Any time your problem is magnet wire, consult Phelps Dodge for the quickest, easiest answer!*

FIRST FOR  
LASTING QUALITY  
FROM MINE  
TO MARKET!



**PHELPS DODGE COPPER PRODUCTS**  
CORPORATION

**INCA MANUFACTURING DIVISION**  
FORT WAYNE, INDIANA

CIRCLE 45 ON READER-SERVICE CARD

## Tantalum Capacitors

Have sintered anodes



In tubular cases, type 109D tantalum capacitors have sintered anodes and can be furnished with insulating sleeves. They offer higher capacitances than shouldered cup units of the same size.

Sprague Electric Co., Dept. ED, 347 Marshall St., North Adams, Mass.

CIRCLE 46 ON READER-SERVICE CARD

## Aircraft Power Transformers

Withstand extreme shock



For aircraft and missiles, these power transformers withstand extreme acceleration and shock. Models are 1 or 3 phase in ratings from 10 va to 5 kva.

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

CIRCLE 47 ON READER-SERVICE CARD

## Accelerometers

40 mv per g sensitivity



Sensitivity of 40 mv per g is provided along with high resonant frequencies up to 30 kc in the A-380 and A-395 accelerometers. The units provide a flat response over temperatures ranging from  $-70$  to  $+250$  F, with an accuracy of  $\pm 5$  per cent. Both series are available in grounded or integrally ungrounded designs. The A-380 series has a range of 0.05 to 500 g, and a useful frequency range of 3 to 2500 cps. The A-395 series covers 0.1 to 800 g, useful within 3 to 9000 cps.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N.J.

CIRCLE 48 ON READER-SERVICE CARD



FILTON BROWN New York

NEW

FILTONS NEW MICRO-MINIATURE...THE MOST ADVANCED DESIGN



Filtors, the leading specialists in the development and manufacture of sub-miniature relays is proud to announce the addition of the new Powrmite micro-miniature relay to its existing line of traditionally outstanding relays.

In every field of achievement there is always one leader. In

Leading manufacturers of hermetically sealed micro and sub-miniature relays.

relays with highest available reliability the leader is Filtors, Incorporated. All of the experience and know how gained in attaining its position of leadership have gone into making Filtors new Powrmite micro-miniature relay *truly reliable*—again the leader in a field of many.

**FILTONS, INC.**

Main office and plant: Port Washington, N. Y., POrt Washington 7-8220  
West coast office: 13273 Ventura Blvd., Studio City, Cal., STanley 3-2770

VIBRATION UP TO 30 G's AT 2000 CPS.  
70 G's SHOCK • 2 AMP OR DRY CIRCUIT  
-65°C. TO +125°C.



## NEW PRODUCTS

### Precision Fine Wire

#### Temperature Stable

This precision fine wire maintains virtually constant resistance from -65 to +250 C. It is made of Molecuoy, a nonmagnetic 75/20 nickel chromium alloy modified with additions. Diameters range from 0.01 to 0.0004 in.

Molecu-Wire Corp., Dept. ED,  
Scobeyville, N.J.

CIRCLE 50 ON READER-SERVICE CARD

### Program Timer

#### Has glow transfer tubes

Originally developed for annealing turbine blades, this program timer operates from 115 v, 60 cps and comes in a standard relay rack housing. It produces a series of pulses which are initiated by a momentary contact closure. Any number of pulses from 1 to 30 may be selected by the controls. The duration of the pulses, as well as the spacing between, can be adjusted from 0.1 to 10 sec. Glow transfer tubes indicate the progress of the sequence.

G. C. Wilson & Co., Dept. ED,  
Huntington, W. Va.

CIRCLE 51 ON READER-SERVICE CARD

### Power Pentode

#### Low distortion

A 9-pin miniature power pentode, the 6/8BQ5 vacuum tube is designed for low-distortion TV and high fidelity use. As a class A amplifier, it delivers 5.7 w with a maximum of 10% distortion. In class AB push-pull operation, it will deliver 17 w with a maximum of 4% distortion. A relatively small signal produces high output. In class A operation with 4.3 v on one tube, it is possible to obtain 5.7 w. Rated plate dissipation is 12 w. A long bulb is used to provide the needed radiation area.

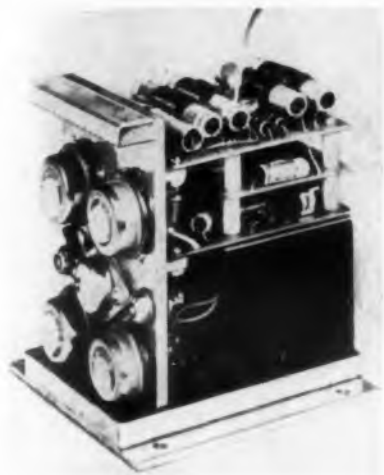
Westinghouse Electric Corp.,  
Electronic Tube Div., Dept. ED,  
Route 17, Elmira, N.Y.

CIRCLE 52 ON READER-SERVICE CARD

← CIRCLE 49 ON READER-SERVICE CARD

## Inverters

Ac or dc to dc or ac



Static Power sources, these transistorized converter-inverters may be used in aircraft radio, radar, missile instrumentation, and remote radio telephone and telegraph. Converting ac or dc to dc and ac, they offer up to 5 w cubic inch output. Efficiency is 80% for input voltages greater than 23 v dc. Series 760 units have 6.3 to 32 v dc input; 1 to 10 kv dc output; up to 1 kw output power; and 0.01% regulation. Series 770 units have 6.3 to 440 v ac inputs at 60 to 2000 cps; 1 v to 10 kv dc output; up to 1 kw output power; and 0.01% regulation. Series 780 units have 6.3 to 32 v dc input; 0 to 440 v ac output at 60 to 400 cps; up to 200 w output power; and 0.5% regulation. Series 790 units have 6.3 to 440 v ac input at 60 to 2000 cps; 1 to 10 kv ac output at 60 to 2000 cps; up to 1 kw output power; and 0.5% regulation.

Spectrol Electronics Corp., Dept. ED, 1704 S. Del Mar Ave., San Gabriel, Calif.

CIRCLE 53 ON READER-SERVICE CARD

## Solenoid

Stands high temperature

The SD-225 solenoid was designed for reactor control systems in atomic submarines. It withstands high internal pressures and high temperatures.

WSP Engineering Co., Dept. ED, 60 S. Walker Ave., Maywood, Calif.

CIRCLE 54 ON READER-SERVICE CARD

CIRCLE 55 ON READER-SERVICE CARD












Available now...from **PHILCO**



# World's First Complete Family of Instrument Transistors!

**Specially engineered Transistors to meet the specific needs of Control Circuitry . . . from Philco Transistor Center, U. S. A.**

System designers now have, at their fingertips, a full range of outstandingly reliable transistors to meet the specific requirements of counters, metering devices, amplifiers, logic elements, relay drivers, pulse modulators, pulse line drivers and many other instrumentation applications.

	<b>2N226</b> —250 mw high gain, low frequency PNP germanium junction transistor for medium power relay driver and signal output applications.		<b>2N535</b> —micro-miniature high gain, general purpose audio frequency germanium PNP junction transistor for use in metering decoders, signal amplifiers and telemetering applications where outstanding reliability is required in minimum space.
	<b>2N240</b> —general purpose, PNP germanium surface barrier high speed switching transistor for use in counters and logic circuits.		<b>2N598</b> —medium frequency, medium power, high current PNP alloy junction transistor for counters and logic circuits.
	<b>2N386</b> —60v. germanium power transistor for servo amplifiers, high power-high voltage audio circuits, servo amplifier output stages, dc.-to-dc. converters and high power relay drivers.		<b>2N600</b> —studded version of 2N598 for applications requiring higher power dissipation.
	<b>2N393</b> —high gain, high speed germanium micro alloy transistor, especially well suited to wide fan-in and fan-out logic systems.		<b>2N670</b> —very high peak current, high voltage, low frequency PNP germanium alloy junction transistor in JETEC-type package. The 2N670 is specifically engineered for pulse modulators and pulse line drivers.
	<b>2N496</b> —very low saturation resistance, high switching speed PNP Silicon surface alloy transistor for high temperature counters and logic elements.		<b>2N671</b> —specially studded version of 2N670 for applications where high average dissipation is encountered.
	<b>2N501</b> —high gain, super high frequency germanium micro alloy switching transistor for use in extra high frequency counters, logic circuits and wide-band video amplifiers.		
	<b>2N502</b> —very high frequency small signal amplifier micro alloy transistor for general purpose amplification at frequencies up to 400 m.c.		

Make Philco your prime source for all transistor information and prices. Write Dept. ED-1158

**PHILCO CORPORATION**  
**LANSDALE TUBE COMPANY DIVISION**  
**LANSDALE, PENNSYLVANIA**





## NEW PRODUCTS

### Volt-Ohmmeter

For explosive circuits



A high sensitivity, low energy unit, the Igniter volt-ohmmeter is for circuits where explosive or sensitive contacts and components are involved. It can measure continuity, resistance, and stray dc voltage. It is safe for testing explosive cartridges, missile and missile firing circuits, TNT detonators, and circuits with current sensitive components such as platinum contacts and conductive liquids. In a shock resistant plastic case, the unit has an encapsulated power supply and a 5-position selector switch. It has a resistance scale for accurate readings from 0 to 100 K. The voltage scale has two ranges: 0 to 50 and 0 to 500 mv. Maximum current and power available at the terminals are 0.5 ma and 170  $\mu$ w. Open circuit voltage is 1.35 v. Maximum power is delivered when a 2700 ohm load is applied across the terminals.

Borg-Warner Corp., Pesco Products Div., Dept. ED, Bedford, Ohio.

CIRCLE 56 ON READER-SERVICE CARD

### Integrator Drive Assembly

With changeable components



This integrator drive assembly can have its components varied to meet a wide range of design requirements. Motor-generator used operates on 115 v, 400 cycles. Stall torque rated at 0.63 oz in. and rotor inertia of 1.3 gm  $\text{cm}^2$ . Unit can be used where electrical output corresponding to shaft input is desired.

Helipot, Dept. ED, Newport Beach, Calif.

CIRCLE 57 ON READER-SERVICE CARD

3 completely new  
**GENISCO CENTRIFUGES**  
with 10 times greater accuracy,  
larger centrifugal capacities,  
maximum flexibility...*and*  
*priced lower than any other*  
*centrifuges now available!*





*The low-cost answer to fast,  
accurate testing of components under  
simulated operational g-forces  
as required by MIL-E-5272A.*

These new precision centrifuges feature a unique, high-torque ball-disc integrator drive system which provides accuracies you would expect only from a rate-of-turn table. Constancy of boom rotation, including wow and long-term drift, is better than .05% at any speed setting—approximately 10 times more accurate than currently available machines. Boom speed is infinitely variable and is measured by an electronic counter built into the console.

The building block design concept gives the new centrifuges exceptional flexibility. Machines are assembled from six basic off-the-shelf components; drive system, drive motor, boom, test compartment, console and accessories. You simply select components which provide features needed to meet your specific requirements. Interchangeability of the components permits easy modification as requirements change. Kits are available for modification by the customer.

This new design concept also results in manufacturing economies which are reflected in the cost of the machines. *The new machines are the lowest priced centrifuges now available—in spite of their greater accuracy, flexibility and capacity.* Ask your Genisco representative for complete information today.

There are more than 400 Genisco centrifuges now in operation.

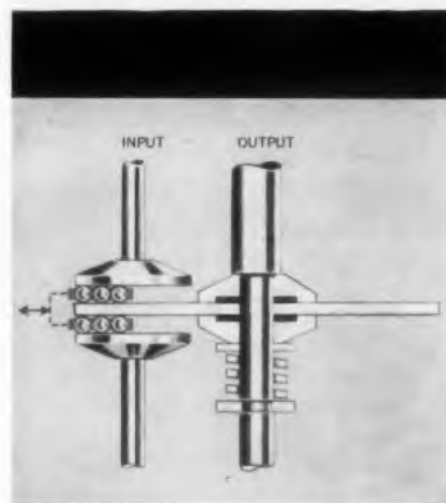


2233 Federal Avenue, Los Angeles 64, California

#### brief performance specifications

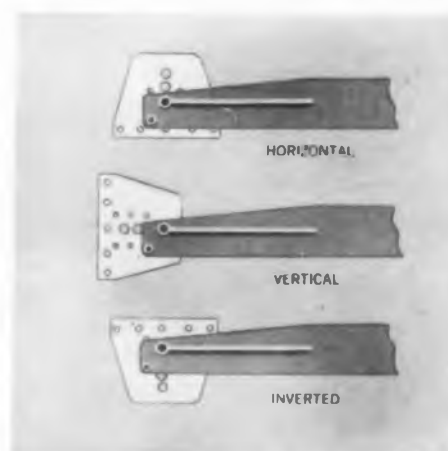
Model No.	Diameter	Test Object Weight	Capacity G-pounds	RPM Max.	G-Range Max.	Test Object Dimensions
A-1010	30" table	50 lbs. dead weight	2,500	800	.1 to 200 g's	
A-1020	60" arm	100 lb. dead weight	10,000	600	.1 to 250 g's	12" cube
A-1030	96" arm	100 lb. dead weight	10,000	400	.1 to 175 g's	18" cube

Large custom centrifuges: Genisco centrifuge experience includes the design, manufacture and installation of large custom built machines. We invite your inquiry.



**Entirely new, more efficient drive system**—An integral variable speed transmission based on the new *Rouverol* \*ball-galaxy principle achieves, for the first time in rotating machinery, high torque characteristics while maintaining the inherent accuracies of a hardened steel-to-steel ball-disc integrator. A novel choice of geometry among the drive elements results in a virtually linear handwheel vs rpm relationship, thus facilitating the presetting, programming and servo-controlling of output speeds. A built-in torque-limiter clutch protects the transmission from damage resulting from abuse or high inertia conditions.

\*Pat. Pending



**Basket-type mounting platforms**, available on Model A-1020 and A-1030, may be oriented from the horizontal to the vertical or to the inverted attitude for multiple-axis testing without demounting the test object. Baskets may be raised or lowered to achieve an optimum dynamic balance and minimum angular deflections when extreme accuracies are required. When the basket is inverted the outside surface of the platform may be used to mount bulky, lightweight packages.

**Available accessories** include additional slip rings, servo control, microwave joints, high pressure air and hydraulic systems, TV viewing systems. Any accessory can be added at any time by the user. The mounting base is standard equipment.

## Microwave Tester

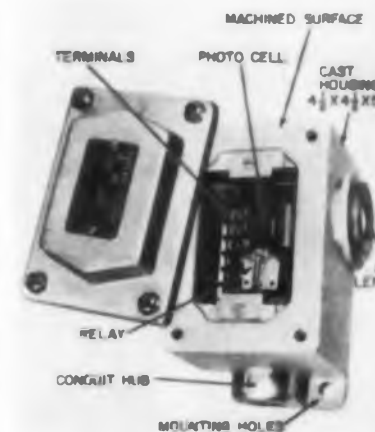
For radar systems



An X-band microwave radar test set, the MTG 100X provides a delayed target to a pulse radar at its microwave frequency. An afc loop locks the target pulse to the radar frequency. This unit and the company's RP 175 video target simulator form the RTS-100 microwave radar target simulator system, which offers target speeds to 500 ft per sec, accelerations to 30 g, and ranges to 30 nautical miles. The MTG 100X power output is adjustable from -10 to -80 dbm.

Remanco, Inc., Dept. ED, 1630 Euclid, Santa Monica, Calif.

CIRCLE 59 ON READER-SERVICE CARD



## Photorelay

Explosion proof

Housed in a cast explosion proof case, type RPF1 photorelay needs minimum maintenance. For machinery, production, and process applications, it is resistant to wetness, dirt, shock, vibration, and temperature extremes. Operation is from 100 to 130 v at 25 to 60 cps. The unit is controlled by the 8 ft-c type RPPFE115 light projector, also explosion proof, which can be placed up to 20 ft away. Factory speed tests are made at 1000 per min, and the maximum recommended counting rate is 600 per min. The contacts are rated at 5 amp spdt. The photorelay and projector are each 4.5 x 4.5 x 5.5 in.

Photobell Co., Inc., Dept. ED, 43 Vesey St., New York 7, N.Y.

CIRCLE 60 ON READER-SERVICE CARD

CIRCLE 58 ON READER-SERVICE CARD

## NEW PRODUCTS

### Digital Indicator

Has 1 in. characters



In response to four bit binary coded decimal input, this 1 in. character digital indicator displays through 9 and two blanks in sequence. The motor driven unit operates on an open circuit principle, checking code agreement of both binary ones and zeros to assure correct positioning. Operating time is 0.1 to 0.8 sec.

Union Switch & Signal, Div. of Westinghouse Air Brake Co., Dept. ED, Pittsburgh 18, Pa.

CIRCLE 61 ON READER-SERVICE CARD

### Linearity Testers

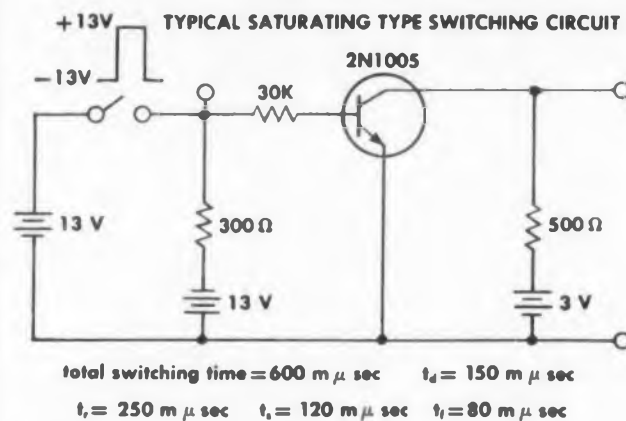
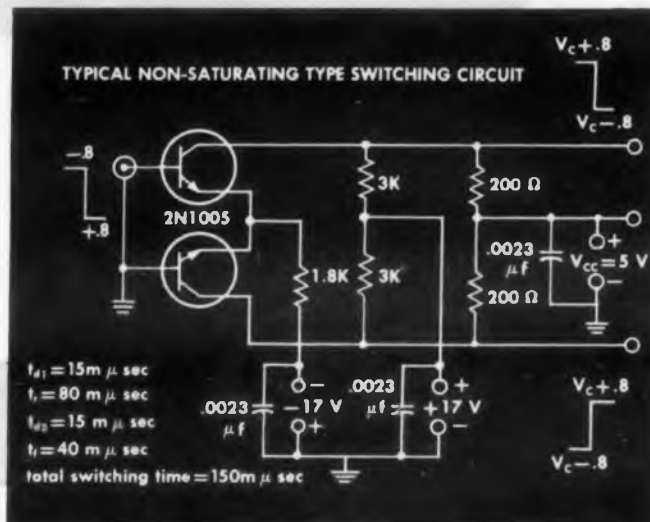
For potentiometers

As a production inspection gage, the LT-2 tester checks potentiometers for predetermined linearity tolerances. As an analytical tool, it can be used to evaluate the linearity characteristics of 1, 3, and 10 turn potentiometers in detail. It can also find the angular position between end terminals and taps. Once programmed and set, the tester will measure continuously and automatically, stopping when nonlinearity exceeds a preselected value. Percentage deviation from linearity is indicated directly on a panel meter. The unit includes power supply, test voltage supplies, dc amplifier, master potentiometer, and angular position scale. Connections are provided for auxiliary data recording. Power requirements: 105 or 125 v ac, 60 cps, 300 w. Boller & Chivens, Inc., Dept. ED, 3 Meridian Ave., South Pasadena, Calif.

CIRCLE 62 ON READER-SERVICE CARD

# NEW SILICON TRANSISTORS..

Actual Size



extremely high speed  
switching times as  
low as 150 μsec

NOW switching times as low as 150 μsec with NEW production-quantity TI 2N1005 and 2N1006 N-P-N silicon transistors!

The newest additions to the nation's widest transistor line are packaged in the industry preferred JETEC TO-5 package... and *guarantee* DC betas of 20-to-55 and 45-to-100. For the reliability your high speed switching circuits require, both units also *guarantee*  $h_{fe}$  greater than 1 at 50 mc, collector dissipation of 125 mW at 25°C, 60 ohms saturation resistance, and 0.1 μA collector cutoff current.

For reliability... plus production quantities delivered on time... select the silicon switchers most suited to your specific applications from the table shown below:

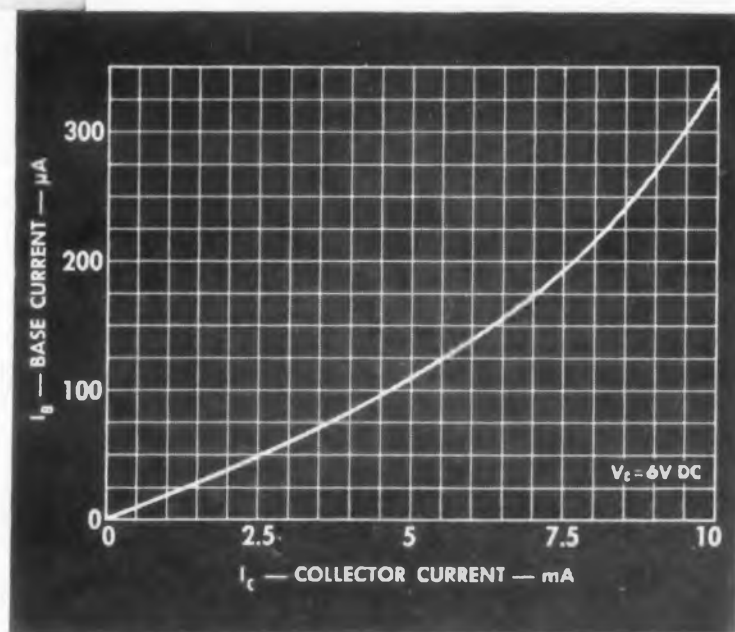
SAME-DAY DELIVERY

FROM YOUR NEARBY TI DISTRIBUTOR

IN 1-249 QUANTITIES

Type	Dissipation at 25°C W	Small Signal Current Transfer Ratio $h_{fe}$	Collector Current $I_c$ mA	DC Current Transfer Ratio $h_{FE}$	Collector Breakdown Voltage-V BV <sub>CEO</sub>	Saturation Resistance R <sub>CS</sub> Ohms	Alpha Cutoff Frequency $f_{cb}$ mc
		min max	max	min max	min	max	min
2N337	0.125	19	20	20 55	45	150	10
2N338	0.125	39	20	45 150	45	150	20
* 2N1005	0.125	1 @ 50MC		20 55	15	60	75 (typ)
* 2N1006	0.125	1 @ 50MC		45 150	15	60	75 (typ)

\* NEW TYPE ADDED TO PRODUCT LINE



IMMEDIATELY AVAILABLE IN PRODUCTION QUANTITIES



# TEXAS

WORLD'S LARGEST SEMICONDUCTOR PLANT

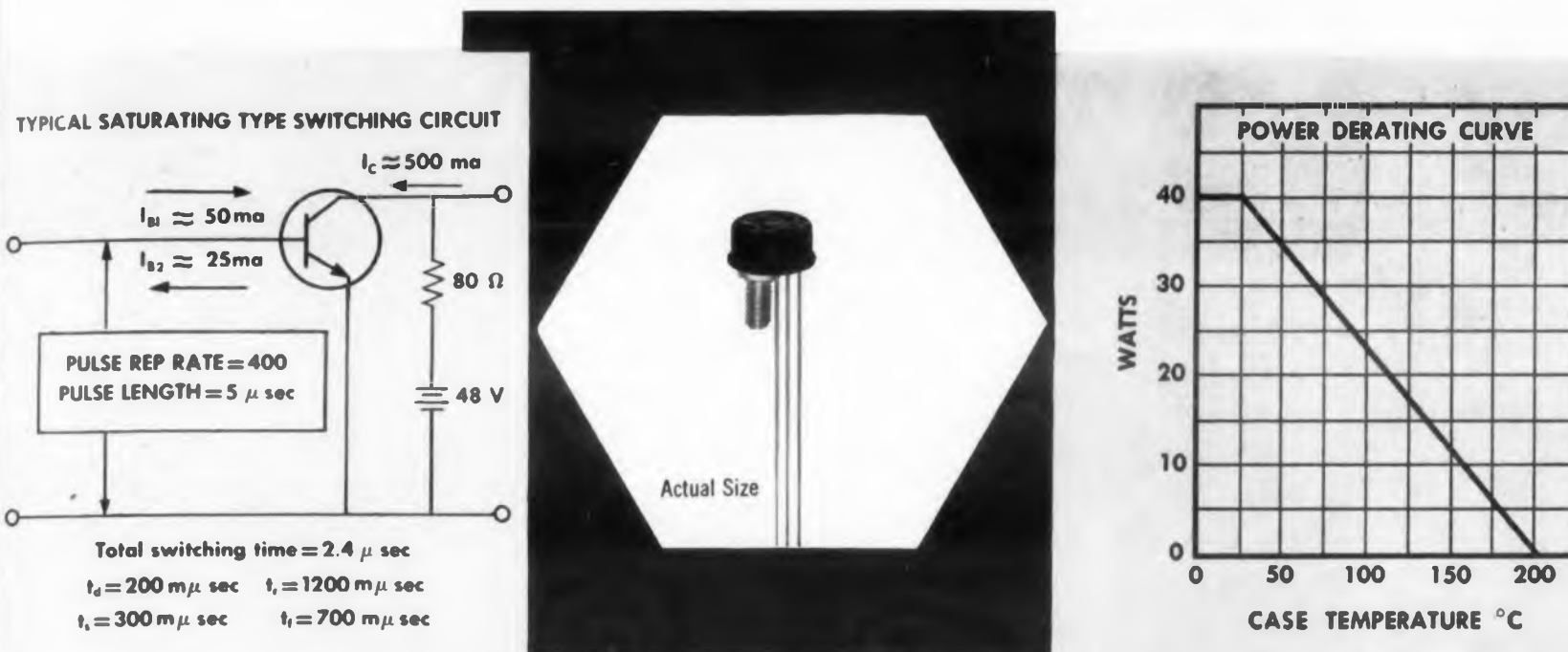


# FROM TEXAS INSTRUMENTS!

intermediate power transistors

80 and 120  $BV_{CEX}$  2.4  $\mu\text{sec}$  switching

20 W at 100°C operation to 200°C



NEW TI silicon intermediate power transistors have bridged the gap between high and medium power devices... TI 2N1047, 2N1048, 2N1049, and 2N1050 guarantee 20 watts at 100°C.

Ideal for your power switching applications, these newest gaseous diffused transistors provide a typical total switching time of 2.4  $\mu\text{sec}$ ! All four new units dissipate 40 watts at 25°C with an infinite heat sink

... the new TI design permits mounting of the semiconductor wafer directly onto the stud.

For your intermediate power and power switching applications, specify the 120-volt 2N1048 and 2N1050 or the 80-volt 2N1047 and 2N1049 with design flexibility and tight beta spreads of 12-to-36 or 30-to-90 that are guaranteed!

Ti Silicon—Medium Power—Intermediate Power—Power—Transistors

	Type	Dissipation at 25°C W	f <sub>oe</sub> Typical	I <sub>c</sub> mA max	h <sub>FE</sub>		BV <sub>CEO</sub> min	R <sub>CS</sub> Ohms max
					min	max		
medium power	2N497	4	9 @ 2MC	200	12	36	60	25
	2N498	4	9 @ 2MC	200	12	36	100	25
	2N656	4	6 @ 2MC	200	30	90	60	25
	2N657	4	6 @ 2MC	200	30	90	100	25
intermediate power	2N122	8.75		140	3		120	200
	* 2N1047	40	10 @ 1MC	500	12	36	80	15
	* 2N1048	40	10 @ 1MC	500	12	36	120	15
	* 2N1049	40	9 @ 1MC	500	30	90	80	15
	* 2N1050	40	9 @ 1MC	500	30	90	120	15
power	2N389	85 at 25°C 45 at 100°C	3.5 @ 1MC	2A	12	60	60	5
	2N424	85 at 25°C 45 at 100°C	6 @ 1MC	2A	12	60	80	10

NEW TYPE ADDED TO PRODUCT LINE

## INSTRUMENTS

INCORPORATED  
SEMICONDUCTOR - COMPONENTS DIVISION  
13500 N. CENTRAL EXPRESSWAY  
POST OFFICE BOX 312 • DALLAS, TEXAS

TEXAS INSTRUMENTS SALES OFFICES  
DALLAS • NEW YORK • CHICAGO • LOS ANGELES  
DAYTON • DENVER • DETROIT  
OTTAWA • PHILADELPHIA • SAN DIEGO • SAN FRANCISCO  
SYRACUSE • WALTHAM • WASHINGTON, D. C.

3-Inch Storage Tube  
2.6 in. diameter useful target



For use in computers, the WL-7225 is a rugged, 3-in. storage tube with a useful target 2.6 in. in diameter. The electron gun beam focuses to a fine spot. A coaxial connector for the output terminations permits compact mounting.

Westinghouse Electric Corp.,  
Electron Tube Div., Dept. ED,  
P.O. Box 284, Elmira, N.Y.

CIRCLE 63 ON READER-SERVICE CARD

### Insulated Printed Circuits

Imbedded in base material

Imbedded Circuitry is printed circuitry imbedded in the base material with an insulating cover. Locked in place, it is not disturbed by severe conditions. Extra thick, conductors and terminals can be narrow and close together.

Beck's Inc., Dept. ED, 300 E. Fifth St., St. Paul 1, Minn.

CIRCLE 64 ON READER-SERVICE CARD

### Linear Encoder Systems

Measure lengths of 0 to 100 ft

LE-100 encoder systems measure and automatically record linear lengths from 0 to 100 ft in 1/8, 1/16, or 1/1000 in. steps. Accuracy is  $\pm 1$  count of the least significant digit.

G. M. Giannini & Co., Inc., Datex Div., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 65 ON READER-SERVICE CARD

CIRCLE 66 ON READER-SERVICE CARD



## NEW PRODUCTS

### Capacitors

For energy storage



Stock ratings of these tubular capacitors range from 0.1  $\mu\text{f}$  at 150 kv with 0.1  $\mu\text{h}$  inductance to 0.25  $\mu\text{f}$  at 50 kv with 0.04  $\mu\text{h}$  inductance. Low-cost energy storage units, they are designed for fast discharge applications requiring high peak energy within a short time constant. They are also suited for blocking and bypass service, power supply filters, and similar uses. The precision rolled, aluminium foil electrodes are separated by polyester film dielectric and assembled in a hermetically sealed, liquid filled, phenolic case. The metal end caps have no. 1/2-13 x 11/16 in. threaded studs. The capacitors have minimum magnetic flux, low impedance, and high ringing frequency. Removable corona shields can be provided for either end.

Axel Bros., Axel Electronics Div., Dept. ED, 134-20 Jamaica Ave., Jamaica, N.Y.

CIRCLE 67 ON READER-SERVICE CARD

### Differential Transformer Accelerator

Infinite resolution



A differential transformer accelerator with infinite resolution model 7-34 features ultimate output ratio—to 60 v in a range from  $\pm 1$  g to  $\pm 50$  g. It is temperature compensated within 0.1 per cent of critical during damping. The unit is 3.3 x 1.9 x 1.6 in.

Edcliff Instruments, Dept. ED, P.O. Box 565, Monrovia, Calif.

CIRCLE 68 ON READER-SERVICE CARD

# CHECK YOUR PRECISION

WHEN YOU NEED  
A PRECISION  
POTENTIOMETER  
TO MEET THESE  
REQUIREMENTS...

Capable of independent  
phasing of resistance elements  
in relation to shaft position . . .

High performance in extra-  
small space, yet meeting  
precision tolerances . . .

DO YOU LOOK  
FOR THESE  
FEATURES?

- Elimination of clamping rings.
- Complete independence of each cup in ganged assembly for phasing operations.
- Superior performance and life.
- Maximum reliability and stability.
- Sturdy terminals molded in place.
- Thermally compatible.

## IF SO, YOUR PRECISION POTENTIOMETER

BECAUSE  
YOU JUST PICKED...

CLAROSTAT  
VARI/PHASE®  
PRECISION  
POTENTIOMETER

CLAROSTAT  
SERIES 57  
1/2" PRECISION  
POTENTIOMETER

THAT  
LOOKS LIKE  
THIS



AND  
WORKS LIKE  
THIS . . .

Designed to meet applicable specifications of military aircraft industry and general electronic equipment, the Clarostat Vari/Phase offers an exclusive design whereby phasing of individual units in ganged assemblies may be accomplished by a simple, single operation. Available in four series ranging from 7/8" to 3" in overall diameter, and from 2- to 6-watt ratings. Resistance range depending upon unit size, in standard units running up to 200K ohms.

New Hi-Load winding element in the Clarostat Series 57 1/2" dia. potentiometer, combined with an advanced rotor and brush assembly, meets "more performance in less space" requirements of the most critical user. Unit body is nickel-silver, with a thermally compatible cover in which terminals are molded in place. Rated at 1.5 watts, with resistance ranges up to 40K ohms. Linearity is plus/minus 2% standard; plus/minus 1% special.

*and  
furthermore*

Clarostat offers unparalleled design, testing and model-making facilities to meet your unusual precision potentiometer requirements. For extreme environmental conditions, Clarostat maintains the most complete precision resistance encapsulating facilities in the industry. Special shaft and bushing configurations, coupled with Clarostat encapsulation ("POTPOT"®) result in units that withstand the most adverse moisture, salt spray and dust conditions.

# POTENTIOMETER I. Q....

For controlling from 2 to 20 circuits simultaneously, also available with switch . . .

Multi-turn adjustment of resistance for greater accuracy in effect and readout . . .

Padding or trimming effect in minimum space, under adverse environmental conditions.

Life up to 2,000,000 cycles.

Choice of continuous or limited rotation.

Rugged construction electrically and mechanically.

● Greatest winding length in given outside diameter.

● Maximum immunity to environmental conditions.

● Rugged mechanical and electrical construction.

● Low-temperature coefficient wire.

● Positive clutching and de-clutching mechanism.

## POTENTIOMETER INTELLIGENCE QUOTIENT IS O. K.!

### CLAROSTAT SERIES 42 PRECISION POTENTIOMETER



A highly versatile precision potentiometer offering a choice of continuous or limited rotation. Individual units are encased in a high dielectric phenolic and ganged by means of threaded rods and metal end-plates. Electrical rotation is 291° plus/minus 5%. The Series 42 exceeds MIL-R-19 specifications where applicable. Watt power handling capacity, with linear resistance range of from 100K ohms, and a tapered range up to 350 ohms per degree of rotation. Resistance tolerance is plus/minus 5%.

### CLAROSTAT MULTI-TURN PRECISION POTENTIOMETER



A superior material, electrically and mechanically, is used for the housing, making possible a thinner shell which in turn provides up to 20% more winding length for given outside diameter. This means a greater overall resistance range and finer resistance resolution, size for size, than other comparable units. Available in three sizes from .875" to 2" dia., and from 3- to 6-watt ratings, with resistance ranges depending upon size selected. All units are 10-turn, with 5% resistance tolerance standard, 1% special.

### CLAROSTAT PADOHM® PRECISION POTENTIOMETER



A 25-turn rectangular precision potentiometer built to the highest standards of design and materials. A low-temperature coefficient wire is wound on a special ceramic core for maximum stability. Effective electrical travel is 98% minimum of mechanical travel. End resistance is 1% of maximum overall resistance. Available in two types: 1.25 watt and 0.25 watt, derated to "0" power linearly at 135° and 105° C. respectively. Resistance range of from 100 to 20K ohms employing plus/minus 20 ppm wire standard.

17 YEARS OF RESISTANCE LEADERSHIP

Experience you can buy only at CLAROSTAT

LITERATURE ON REQUEST



CLAROSTAT MFG. CO., INC.  
DOVER, NEW HAMPSHIRE

CIRCLE 69 ON READER-SERVICE CARD

### Pressure Transducer Variable reluctance diaphragm type



The S-90 temperature compensated, single coil, variable reluctance diaphragm type pressure transducer can be used as the variable inductor in inductance and reactance controlled fm/fm subcarrier oscillator systems. Differential, gage, and absolute models are offered with numerous pressure ranges from 0 to 10 through 0 to 5000 psi. The unit has low sensitivity to shock, vibration, and acceleration.

Ultradyn, Inc., Dept. ED, P.O. Box 3308, Albuquerque, N. Mex.

CIRCLE 70 ON READER-SERVICE CARD



### Phase Shifter Has two direct-reading scales

Phase shifter type Q-4 is a 400 cycle unit with two direct-reading scales. It provides any phase shift from 90 deg leading to 90 deg lagging in the testing of electronic equipment, control circuits, components, and instruments. Rated at 1000 va, continuous duty, the Q-4 has a 120/240 v input and 120 or 240 v, 3 phase output.

Knopp Inc., Dept. ED, 1307 66th St., Oakland 8, Calif.

CIRCLE 71 ON READER-SERVICE CARD

### Synchronous Timing Motor

Has internal solenoid

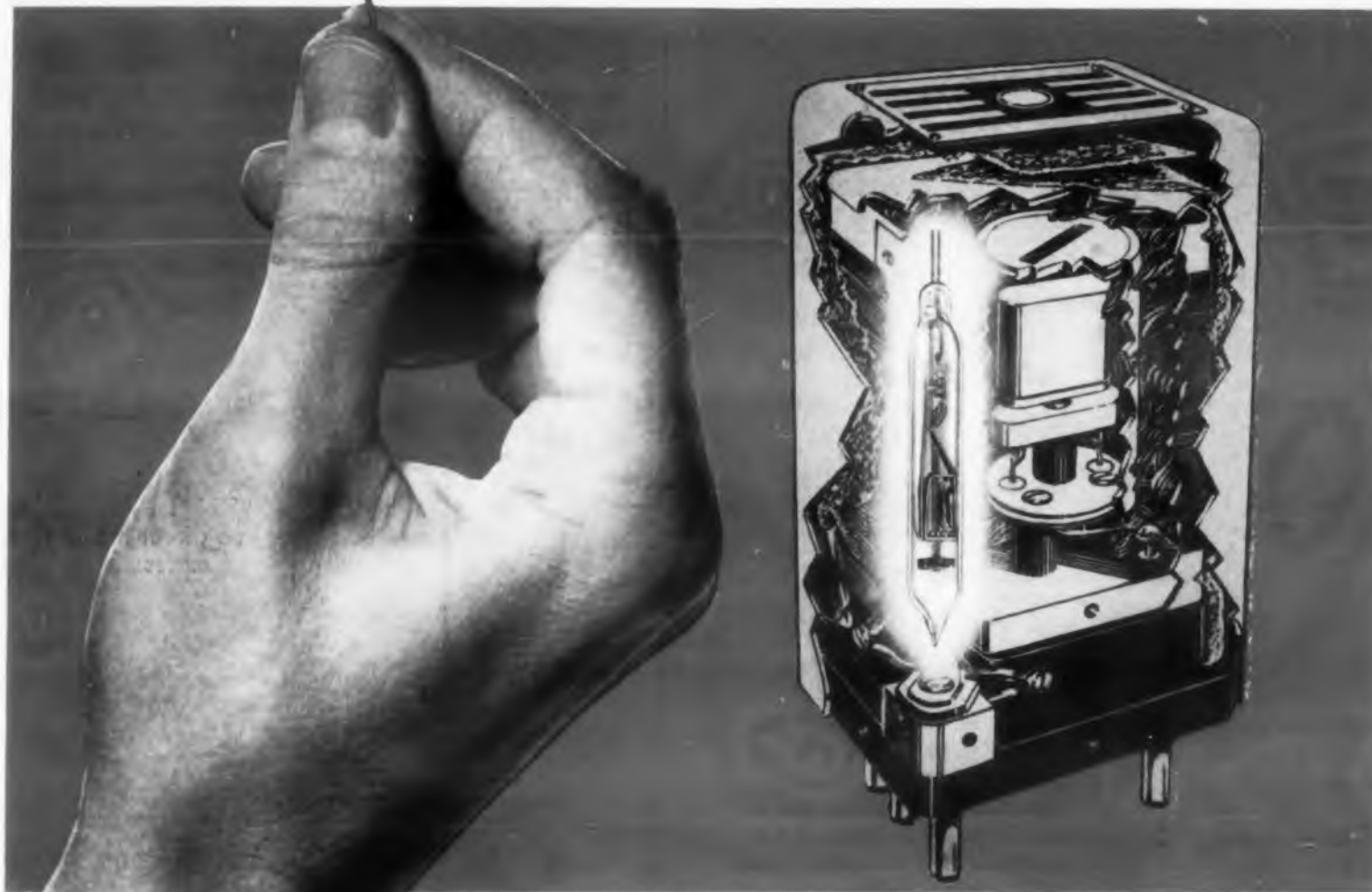
The 450 synchronous timing motor has an internal solenoid to assure instant starting and stopping. In speeds between 1 and 180 rpm, the unit is 2 in. in diameter and 1-21/64 in. deep. Output torque is 9 in.-oz at 1 rpm.

Bristol Motors, Dept. ED, Old Saybrook, Conn.

CIRCLE 72 ON READER-SERVICE CARD



THOMAS A.  
**EDISON**  
 sealed thermostats  
 feature close control,  
 lasting stability



Edison Sealed Thermostats are widely used in crystal ovens, electronic ovens and oscillator compartments—and many other electronic components adversely affected by temperature variations. Capable of maintaining temperatures within 0.2°C. Edison sealed thermostats offer these special features:

- Slow-make, slow-break principle, insures small temperature differential.
- Protective gas atmosphere minimizes effects of contact arcing under heavy loads, resulting in high stability.
- Radiant energy, and conducted or convected heat is rapidly transmitted to the bimetal by the highly conductive gas fill.
- Long bimetal arm is highly sensitive to temperature changes and assures accurate control, predictable performance.

For complete data on Edison Sealed Thermostats, write for Bulletin No. 3009B.

**Thomas A. Edison Industries**  
 INSTRUMENT DIVISION

55 LAKESIDE AVENUE, WEST ORANGE, N. J.  
 CIRCLE 73 ON READER-SERVICE CARD



**NEW PRODUCTS**

**Mercury Rectifier Tester**  
 Handles all types



All types of mercury vapor rectifiers can be tested with this one instrument. Self contained the tester reads ionization voltage for the determination of tube condition and life. Tubes are tested in their sockets.

Teletronix Engineering Co., Dept. ED, 408 Eagle Rock Blvd., Los Angeles 41, Calif.

CIRCLE 74 ON READER-SERVICE CARD

**DC Power Supply**  
 Transistorized



Model 7PVR20 transistorized power supply produces 100 v dc at 40 ma from an input of 115 v  $\pm 10\%$  at 400 cps. Output voltage variation  $\pm 0.5\%$ . The unit is 2.5 x 2.5 x 3 in. and weighs 17 oz. It operates from  $-40$  to  $+165$  F.

Western Gear Corp., Dept. ED, P.O. Box 158 Lynwood, Calif.

CIRCLE 75 ON READER-SERVICE CARD

**Function Generator**  
 Tests pneumatic components

Functionair model 100A is a function generator for testing pneumatic components and systems. It converts electrical signals into pneumatic pressure signals and responds to frequencies from 0 to 50 cps when used with volumetric loads up to 20 cu in.

Palisades Engineering Co., Inc., Dept. ED, P.O. Box 22, Pacific Palisades, Calif.

CIRCLE 76 ON READER-SERVICE CARD

CIRCLE 77 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1958



# Electron Tube News

## —from SYLVANIA

Anticipating the circuit designer's needs—everywhere in electronics

### TELEVISION . . .

#### New Tripotential Electron gun takes another 2-inch slice off picture tube length

Sylvania, pioneer in 110° picture tube development, introduces another basic design innovation in cathode ray tubes—the short tripotential focus electron gun. It reduces picture tube length up to 2 1/8 inches, yet permits use of standard design centering magnets, yokes and other associated components.

Voltages required to operate tripotential focus picture tubes are available in ordinary TV receiver circuit designs.

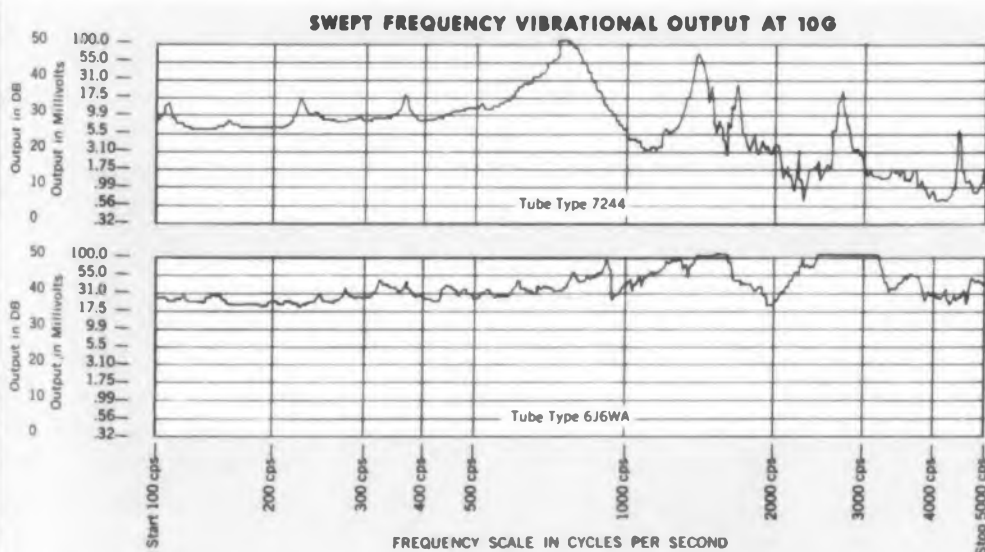
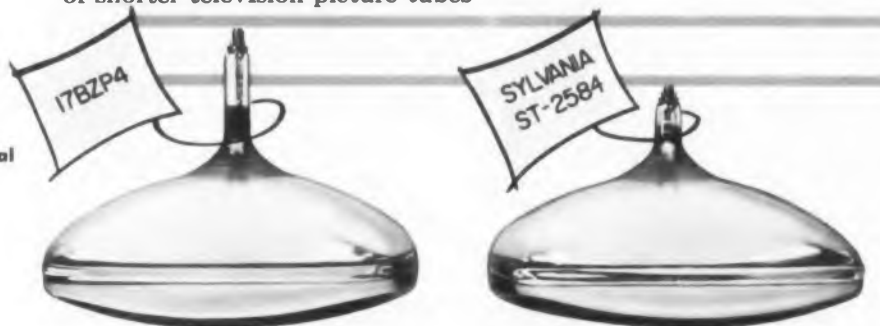
The new gun is much less complicated than conventional types. Its simplicity of design not only makes the gun inherently more rugged but allows for greater uniformity in manufacturing and assembling. This means less arcing, fewer shorts and better over-all performance throughout life.



Tripotential Electron gun is a major advance in the evolution of shorter television picture tubes

#### Mechanical Dimensions Comparison Chart Over-all Dimensions (Inches)

Screen 110° types, 1 1/8" neck dia.	Conventional Tubes	Sylvania Tripotential
17"	12 9/16	10 7/16
21"	14 11/16	12 9/16
24"	15 7/8	13 3/4



Over a frequency range of 100 to 5,000 cps at a 10 G level the type 7244 produced a vibrational output in the range of 6 millivolts average while the 6J6WA averaged 60 mv or higher

### RELIABILITY . . .

Stacked tubes in glass set new standards for reliability in shock and vibration tests

Production of Sylvania's new stacked tubes in glass, types 7244 and 7245, is being stepped up to meet the increasing demands of military and industrial customers. Fast growing acceptance is based on the inherent reliability of the stacked mount structure:

#### Reliability

Actual vibrational test data of the stacked structure compared with a conventional tube indicates as much as 2 to 1 improvement in vibrational output at 6 times the G level.

# New dual-pentode for STEREO



Sylvania Framelok construction is adapted for greater circuit flexibility, better performance and new economy

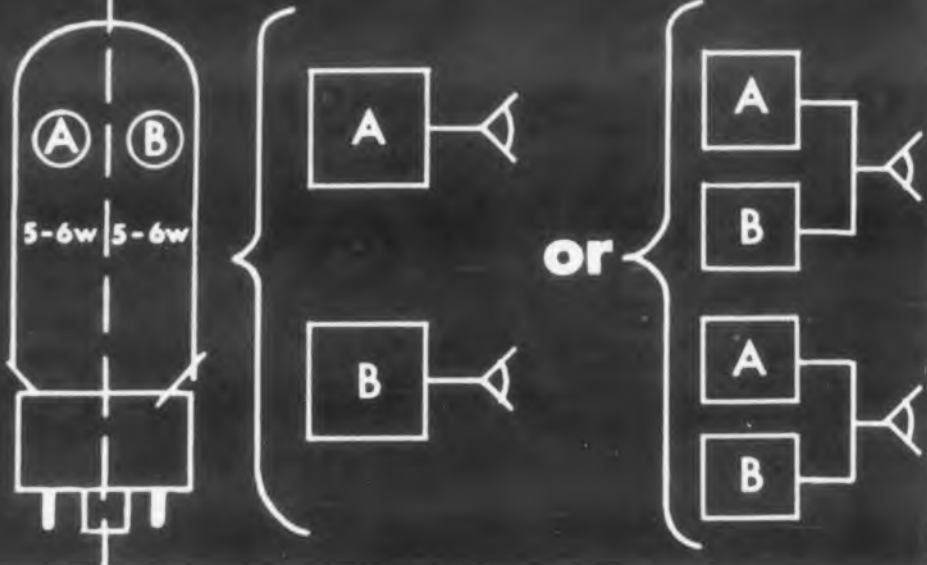
A new tube design which takes advantage of the symmetry of the Sylvania Framelok tube construction is being developed specifically for application for the output stages of stereophonic sound circuits. Because it incorporates two identical pentodes in one envelope this new Framelok tube provides design flexibility and can introduce substantial circuit economies.

This new design concept now makes possible the use of a single Framelok tube—common cathode

and screen grid—that will supply 5 to 6 watts usable audio output in each channel. Its unusual flexibility also permits application in push-pull in each stereo channel or two tubes push-pull, parallel in high power monaural systems.

In addition to its potential cost advantages there are the many benefits inherent only in the Framelok design: • Greater uniformity of electrical characteristics in tube after tube • Greater stability of electrical characteristics during tube life • Less change in electrical characteristics due to element temperatures at high dissipation levels • Better control of cutoff • Less chance for shorts, microphonism and noise • Better plate-to-screen current ratios • Less arcing.

New Framelok dual pentode type designed for stereo can supply 5 to 6 watts audio output single ended at the voice coil for each channel. High flexibility allows one tube to provide push-pull operation for each channel



## RELIABILITY (Continued)

	Type 7244	Type 6J6WA
Frequency	40 cps	25 cps
G Level	15 G's	2.5 G's
Vibrational Output	15 MV	25 MV

### Stability and Uniformity

The planar structure of the stacked tube in which all elements are arranged in parallel planes insures optimum stability of operation and uniformity of characteristics.

Fewer dimensions need to be controlled, providing a major simplification and reduction in the number of critical tolerances in parts fabrication.

### Increased Mechanical Life

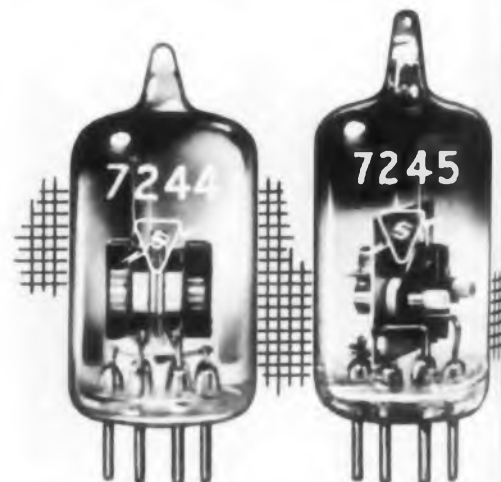
The ceramic mount structure is solidly integrated and relative mo-

tion between elements is negligible. The entire mount is displaced with shock and vibration as one solid entity, and parts or elements will not react independently. In fact, ceramic stacked mount tubes in glass have survived several hundreds of hours on 15 G, 40 cycle vibration fatigue with no significant change—a test which usually destroys conventional tube types in less than a hundred hours.

### Lower Costs for Customers

The stacked tube in glass means less equipment maintenance. In-plant tube selection can be eliminated or reduced. Missile flights and other military operations have

a higher probability of success with the rugged stacked tube. No major circuit redesign is necessary since the types are basically retrofits. The 7244 and 7245 can go in present equipment where 6J6WA and 6J4WA types are used with only slight compensations.



Better chief a standa "slump 9.2 per wats V deliver at 4.16

As a superio Throug have b the sar Desig a cente cathod

Ne Wherev 7025 w coil hea triode averag

Sylvan cutoff p The tri possibi Folds electric noise, le audio sy

Double now ava tubes. I

RATINGS ( Peak inverse D. C. output Peak plate Peak voltage heater (cat respect to Transformer Total effective supply resi per plate.

SY

## AUDIO

### Beam power audio pentode for quality amplifiers

Better power output and less distortion than comparable types are the chief attributes of the new 6BQ5. It maintains initial peak performance standards throughout life. Throughout life tests the tube exhibits no "slumping" due to excessive screen dissipation. It delivers 5.6 watts at 9.2 percent distortion single ended under 4.30 v. signal input and 5.95 watts with a 4.70 v. signal. In push-pull at 250 v. plate & screen, the 6BQ5 delivers 10.65 w. at 3.4 percent distortion; at 300 v. plate & screen, 16.5 w. at 4.16 percent distortion.

### Improved high-mu twin triode serves as audio amplifier or phase inverter

As a result of Sylvania's continuing tube improvement program, a superior 12AX7 is now available with sharply reduced hum and noise. Through improved aging and processing schedules Sylvania engineers have been able to maintain the output advantages of the tube while at the same time minimizing the hum and noise characteristics.

Designed primarily for quality audio circuits, the improved 12AX7 has a center tapped heater for operation at 12.6 or 6.3 volts. It has separate cathodes and is packaged in a T-6½ envelope.

### New double triode for extremely critical audio applications

Wherever extreme limits on hum and noise must be met, Sylvania's new 7025 will fill the requirements. Its special design incorporates a folded coil heater that improves over-all performance. The new high mu twin triode has an equivalent noise and hum voltage of 1.8 microvolts rms average and 7 microvolts rms maximum.

### Low hum-low noise triode-pentode for hi-fi

Sylvania's new 7199 is a 9-pin miniature medium mu triode and sharp cutoff pentode designed particularly for high-quality audio applications. The triode is normally used as a phase inverter, although many other possibilities exist, while the pentode is used as a high-gain audio amplifier.

Folded coil heaters, separate cathodes and an internal shield to reduce electrical coupling combine to provide a pre-amplifier tube with low noise, low micro and high reliability, as required in high-performance audio systems.

### New rectifier for hi-fi audio equipment

Double anode, indirectly heated, common cathode rectifier type 6CA4 is now available from Sylvania. The new tube can handle two 6BQ5 output tubes. It delivers 150 ma. maximum DC output current.

#### RATINGS (Design Center Values)

Peak inverse plate voltage.....	1000 volts max.
D. C. output current.....	150 ma. max.
Peak plate current per plate.....	450 ma. max.
Peak voltage between cathode and heater (cathode positive with respect to heater).....	500 volts max.
Transformer voltage	2x250 2x300 2x350 volts, rms.
Total effective plate supply resistance per plate.....	150 200 240 ohms min.



# SYLVANIA



## BUSINESS REPLY CARD

First Class Permit No. 2833 Sec. 34.9 P.L.&R., Buffalo 9, N.Y.

SYLVANIA ELECTRIC PRODUCTS INC.  
1100 Main St.  
Buffalo 9, N.Y.





## MOBILE COMMUNICATIONS...

**Sylvania introduces four new receiving tubes designed to meet the specialized requirement of mobile radio equipment**

Now manufacturers of commercial and industrial mobile transceivers can select from a new line of rugged Sylvania receiving tubes designed with the special conditions of mobile radio in mind. The new tubes, types 7054, 7056, 7059 and Sylvania original type 7258, operate from B supply voltages ranging from 100 to 250 volts. The heater voltages of the line are centered at 13.5 volts—the midpoint of heater voltage range for vehicular equipments. This allows a full 3.52 volt safety margin for the tubes to take care of the fluctuating power supply that may occur in such mobile equipment.

In the Sylvania original type 7258, the pentode section may be used as an RF or IF tube. The triode section can serve as a low frequency oscillator or general purpose amplifier.

Type 7054—a 9 pin sharp cutoff pentode  
 Type 7056—a 7 pin sharp cutoff pentode  
 Type 7059—a 9 pin medium mu triode, sharp cutoff pentode  
 Type 7258—a 9 pin medium mu triode, sharp cutoff pentode

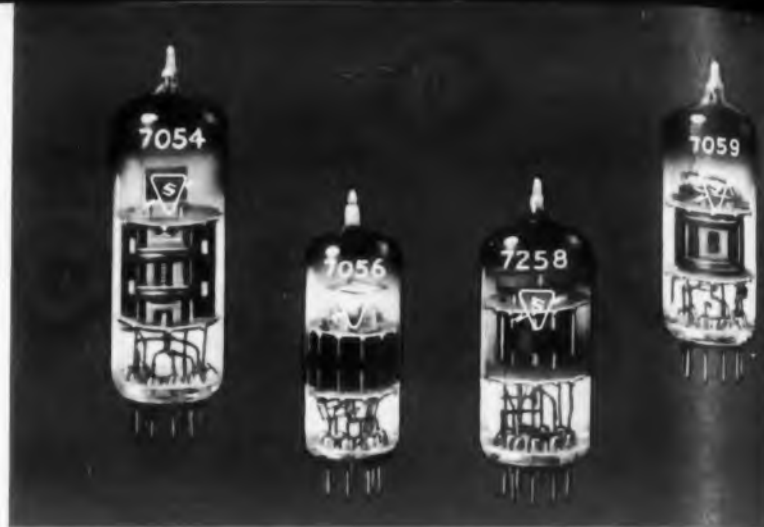
Characteristics and typical operation for Sylvania original type 7258

	Triode Section	Pentode Section
Plate Voltage	150	125 Volts
Grid No. 2 Voltage		125 Volts
Grid No. 1 Voltage	-3	0 Volts
Cathode Bias Resistor		56 Ohms
Plate Current	15	12 Ma
Grid No. 2 Current		3.8 Ma
Transconductance	4500	7800 umhos
Amplification Factor	21	
Plate Resistance (Approx.)	4700	170,000 Ohms
Grid No. 1 Voltage for $I_b=20 \mu a$ (approx.)	-17	-6 Volts
Plate Current at $E_c1 = -3 V R_k = 0$		1.6 Ma

## INDUSTRIAL & MILITARY C-R TUBES

**Sylvania introduces a brand-new special purpose 12" CRT designed particularly for radar and medical applications**

Now, an economical 12" 'scope tube, type SC2558, with fast response time, high impedance input and post deflection acceleration is available from Sylvania. The



new tube, which will sell for approximately  $\frac{1}{2}$  as much as comparable types, incorporates both electrostatic deflection and focus. Its lower operating voltage eliminates the need for an elaborate power supply. With post deflection acceleration, greater deflection sensitivity is possible with increased brightness.

The large screen size of type SC2558 is especially convenient for group viewing of medical and radar displays. The new tube incorporates an aluminized screen, standard base and is available in any phosphor coating specified.

Typical Operating Conditions

Anode No. 3 Voltage	10,000 Volts D.C.
Anode No. 2 Voltage	5,000 Volts D.C.
Deflection factor	
Deflecting Plates 1-2	105 to 145 v/in.
Deflecting Plates 3-4	80 to 115 v/in.



# SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.  
 1740 Broadway, New York 19, N. Y.  
 In Canada: Sylvania Electric (Canada) Ltd.  
 P. O. Box 1190, Station "O," Montreal 9.

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY

Please send additional information on the items checked below:

New tripotential gun

Stacked tubes in glass:

Type 7244

Type 7245

Industrial & Military

Cathode Ray Tubes:

Type SC2558

Audio Tubes:

New Framelok tube for stereo

Type 6BQ5

Type 12AX7

Type 7025

Type 6CA4

Type 7199

Mobile Radio Tubes:

Type 7054

Type 7056

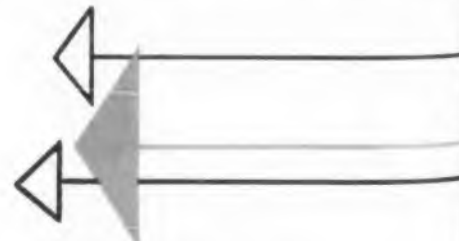
Type 7059

Type 7258

Name \_\_\_\_\_

Address \_\_\_\_\_

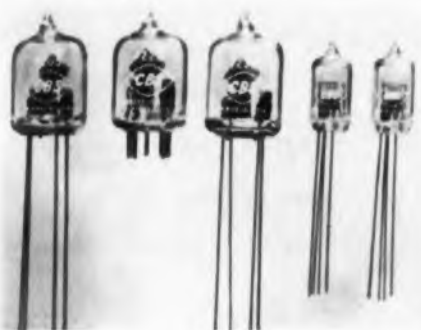
Company \_\_\_\_\_



**Use this handy business reply card to request additional information on these important new Sylvania developments**

## Trigger Tubes

1.6 to 4  $\mu$ sec anode delay times



Krytrons are accurate, fast switching cold-cathode trigger tubes which replace relays, thyratrons, and other devices in simplified circuits. Types 7205 and 7229 through 7232 control up to 500 amp with input currents of less than 20  $\mu$ a. The miniature units operate from  $-55$  to  $+85$  C and under extreme shock and vibration. Anode delay times are from 1.6 to 4  $\mu$ sec.

CBS-Hytron, Dept. ED, Danvers, Mass.

CIRCLE 78 ON READER-SERVICE CARD

## Voltage Stabilizers

1/30 sec response

These redesigned constant voltage stabilizers correct fluctuations in 1/30 of a second and operate within  $\pm 1\%$  of nominal output voltage. Inputs are 95 to 130 v and 190 to 260 v. Outputs are 6.3, 120, and 240 v.

Acme Electric Corp., Dept. ED, Cuba, N.Y.

CIRCLE 79 ON READER-SERVICE CARD

## Sweep Generator

Measures to 0.01 db



The entire sweep of model 1099 is level to 0.1 db. Its lower limit is locked to 100 kc; the upper limit is variable to 20 mc. Input and output probes allow a differential method of measurement and eliminate errors due to frequency/level changes.

Micro Instruments, Dept. ED, 111 Cedar Lane, Englewood, N.J.

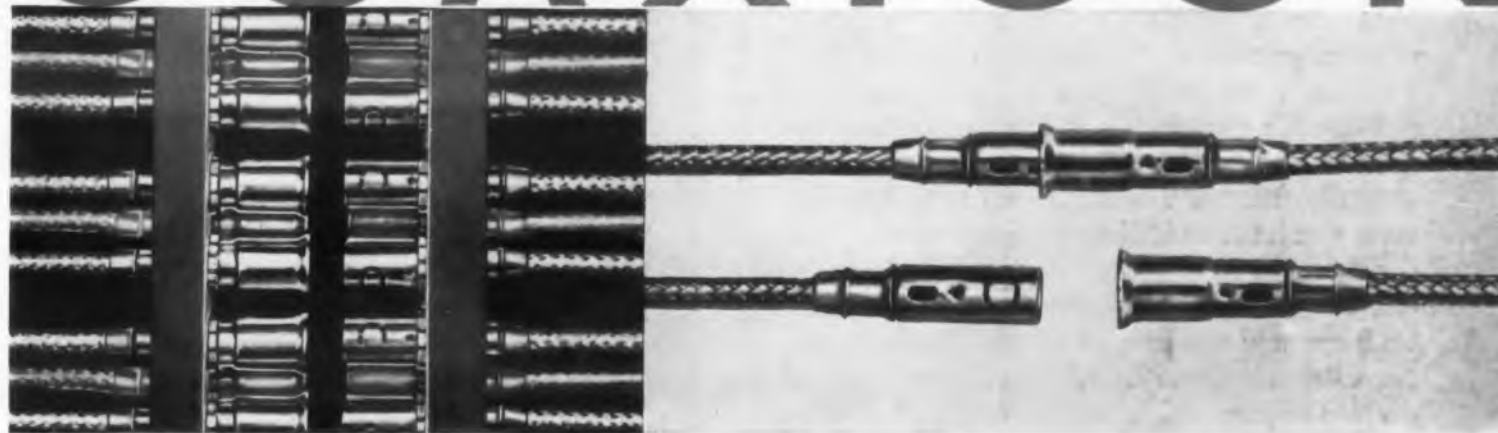
CIRCLE 80 ON READER-SERVICE CARD

CIRCLE 77 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1958

# THE NEW CONCEPT IN COAXIAL DISCONNECT SPLICING...

# COAXICON



Here is a totally new method for attaching disconnect splices to coaxial cables that will create new standards of performance... on chassis connections, computers, test equipment—in fact, anywhere that two coaxial cables need fast and reliable disconnect splicing.

Easily attached to coaxial cables by AMP's modern compression method, the all new A-MP COAXICON assures you of uniformity, absolute reliability and new low cost—in either free-hanging or through-panel units. In addition, the COAXICON supports cable shielding against vibration while offering fully insulated positive electrical performance.

Production rates easily exceed any method you're now using. With a simplified wire stripping method, it takes just one stroke of the matching A-MP tool to permanently crimp COAXICON to your coaxial cable.

Think of it—no more burned or melted insulation, no doubtful, sloppy connections, no time consuming, high-cost assembly methods. Once you've seen the all new COAXICON, you won't settle for less.

*Send for a sample and complete product information today.*

# AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan

CIRCLE 81 ON READER-SERVICE CARD

## NEW PRODUCTS



**Oscilloscope**  
Up to 24 channels

Using a persistent cathode ray tube 17 in. long, the RM-24 oscilloscope displays up to 24 channels of information at once. The instrument can be used to study time and motion, stress, strain and vibration, pressures, analog functions, and biological phenomena. It has individual plug-in channel amplifiers with individual control for Y position, beam intensity, gain, and balance. A position for switching a high gain channel amplifier for external X input is incorporated on the time rate switch. The calibrated time base features recurrent as well as triggered sweep. Time is calibrated from 100  $\mu$ sec per cm to 1 sec per cm. The unit has a frequency response from dc to 3500 cps and requires 26.25 in. of panel space. An external power supply with regulated dc sources is provided for external mounting or internal mounting in a console.

Railway Communications, Inc., Rycom Instruments Div., Dept. ED, 9351 E. 59th St., Raytown 33, Mo.

CIRCLE 82 ON READER-SERVICE CARD

### Subcarrier Discriminator

In all standard IRIG frequencies



Available in any standard IRIG frequency, the 951 subcarrier discriminator provides single ended output from  $\pm 1$  to  $\pm 10$  v for full bandwidth deviation at currents to  $\pm 200$  ma. Output noise is under 0.1% for full deviation. Power consumed is 180 w. Special units with frequencies to 250 kc and outputs to 25 kc may be ordered.

Midwestern Instruments, Dept. ED, 41st and Sheridan, Tulsa, Okla.

CIRCLE 83 ON READER-SERVICE CARD

# Sharpening





# g the Falcon's claw

**Faster flying, higher climbing, farther reaching**  
...the new supersonic Falcon air-to-air guided missile. Conceived, developed, and manufactured by Hughes Engineers, it is today's best performing air-to-air missile.

The Super Falcon GAR-3, newest in the family of Falcon missiles, is powered by a new and longer-lived solid propellant rocket engine. It can climb far beyond the altitude capabilities of the interceptor and destroy an enemy H-bomber in any kind of weather.

Hughes Research & Development Engineers, always moving forward, are also developing the GAR-9, a new atomic air-to-air missile which will be used with the F-108, a fantastically swift long range interceptor being built for the Air Defense Command.

The new atomic missile will be able to reach out over extremely long distances and destroy enemy bombers long before they reach their U.S. and Canadian targets.

Advanced Research & Development at Hughes is not confined to just guided missiles. Investigations presently underway at the Hughes R&D Laboratories include Space Vehicles, Advanced Airborne Systems, Nuclear Electronics, and Subsurface Electronics... just to name a few. At Hughes in Fullerton engineers are engaged in the Research, Development and Manufacture of advanced three-dimensional radar systems. At Hughes Products, the commercial activity of Hughes, advanced Research & Development is being performed on automatic control systems, microwave tubes, and new semiconductor devices.

The challenging nature and diversity of Hughes projects makes Hughes an ideal firm for the Engineer or Physicist interested in advancing his professional status.

*Photo at left shows Convair F-102 firing salvo of Falcon GAR-1 air-to-air guided missiles.*

*An immediate need now exists for engineers in the following areas:*

Computer Engineering	Systems Analysis
Field Engineering	Microwaves
Semiconductors	Circuit Design
Technical Training	Communications
Microwave Tubes	Radar

*Write in confidence, to Mr. Phil N. Scheid,  
Hughes General Offices, Bldg. 6-V-1, Culver City, California.*

1958. HUGHES AIRCRAFT COMPANY



**Sophisticated Hughes Electronic Armament Systems** control high-speed jet interceptors from take-off to touch down, and during all stages of the attack.



**Ground Systems** being developed at Hughes in Fullerton provide mobile three-dimensional radar protection and high-speed data handling.

*Creating a new world with ELECTRONICS*

## HUGHES

HUGHES AIRCRAFT COMPANY  
Culver City, El Segundo,  
Fullerton and Los Angeles, California  
Tucson, Arizona

## Vibration Meter

Portable



The T-1 vibration meter is a light, portable, battery-operated unit designed for use with the company's TD-series vibration pickups. Accurate measurements of acceleration, velocity, and displacement are selected from the function switch and read directly. Four transducers may be connected at once.

Southwestern Industrial Electronics Co., Dept. ED, 2831 Post Oak Rd., Houston 19, Tex.

CIRCLE 84 ON READER-SERVICE CARD

## Computer Module

Static flip-flop



A digital computer module, the T-Pac model FS-10 static flip-flop contains two dc coupled Eccles-Jordan flip-flop circuits using surface barrier transistors. To permit its use as a standard logical element, the unit has diode gated inputs to set and reset the flip-flop. It can drive sensitive relays requiring up to 10 ma, and, in shift register applications, it can shift at rates up to 1.5 mc. The output has an inherent 0.5  $\mu$ sec delay. The inputs accept normal T-Pac assertion and negation signals, and each output can be connected to 30 gates. Output levels switch between  $-0.1$  and  $-16$  v. The etched circuit layout is designed so that simple wiring changes can readily be made to modify the gating structures.

Computer Control Co., Inc., Dept. ED, 92 Broad St., Wellesley, Mass.

CIRCLE 85 ON READER-SERVICE CARD

CIRCLE 554 ON READER-SERVICE CARD

# NEW Power Ferrite for Flyback Transformers offers



- Higher Flux Density
- Lower Core Losses
- Higher Curie Point

Now, with Allen-Bradley's new Class W-04 ferrite, you can design smaller flyback transformers with smaller cores. This saves space... saves weight... saves copper... and you have a saving in over-all cost!

Specify Allen-Bradley's new W-04 ferrite for your flyback transformers. The table below compares its superior properties with Allen-Bradley's "premium quality" W-03 ferrite. Write for complete data, today!

Class	Temp. °C	B <sub>max</sub> * in Gauss at 10 Oe	Core Loss P <sub>h</sub> in $\mu$ Watts cm <sup>3</sup> cps				$\mu_{max}$ *	$\mu_0$ at Room Temp.	B <sub>u</sub> **	$\mu$ at B <sub>u</sub> †	Curie Temp °C
			B=1350 Gauss		B=1800 Gauss						
			16 Kcps	60 Kcps	16 Kcps	60 Kcps					
W-04	25	4900 ± 10%	3.8 ± 20%	5.3 ± 20%	6.4 ± 20%	9.0 ± 20%	7000 ± 30%	2000	2700 ± 15%	6000 ± 25%	225
	115	3700 ± 10%	3.8 ± 20%	5.3 ± 20%	6.4 ± 20%	9.0 ± 20%	7000 ± 30%				
W-03	25	4200 ± 10%	4.1 ± 20%	5.5 ± 20%	6.9 ± 20%	9.1 ± 20%	6000 ± 30%	2000	2100 ± 15%	5600 ± 25%	180
	115	2800 ± 10%	4.2 ± 20%	6.5 ± 20%	6.9 ± 20%	10.0 ± 20%	6000 ± 30%				

\*B<sub>max</sub> and  $\mu_{max}$ , Frequency—16 Kcps.

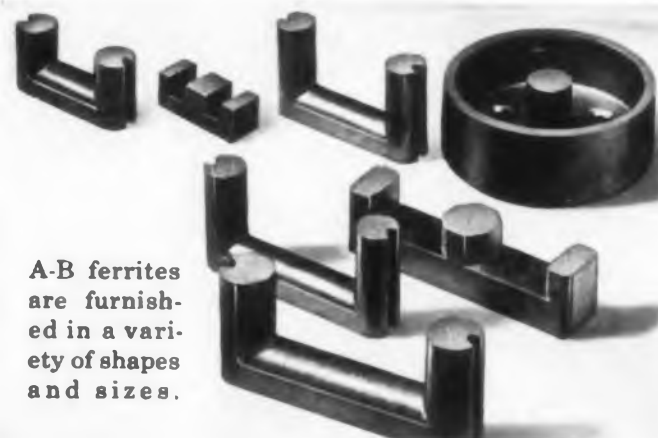
\*\*Usable flux density—flux density at which the 115°C permeability is equal to 1/2 of the 25°C permeability.

†Permeability of the core at 25°C at B<sub>u</sub>.

Allen-Bradley has also developed new square-loop power ferrites (R-03), and ferrites for transistorized medium frequency inverters (W-07). Our engineers will be glad to assist you with your ferrite problems.



Allen-Bradley Co., 1344 S. Second St., Milwaukee 4, Wis.  
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.



A-B ferrites are furnished in a variety of shapes and sizes.

CIRCLE 86 ON READER-SERVICE CARD

## NEW PRODUCTS

### Transistorized Power Supply Has 0.01% regulation



Without switching, the SC-32-2.5 transistorized power supply delivers a continuously variable output of 0 to 32 v at 0 to 2.5 amp. Stability for 8 hours and regulation for line or load are both 0.01% or 0.002 v, whichever is greater. Ripple is less than 1 mv rms. The unit has a recovery time of less than 50  $\mu$ sec, an output impedance under 0.01 ohm, and a temperature coefficient of less than 0.01% per degree C. Power requirements are 105 to 125 v, 50 to 65 cps.

Kepeco Labs, Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 87 ON READER-SERVICE CARD

### RF Power Resistors

For severe environments

Noninductive NH resistors are miniature, wire-wound power units for severe environments. In 10, 25, 50, and 250 w sizes, they operate from -55 to +275 C. Tolerances range from  $\pm 0.05\%$  to  $\pm 3\%$ ; resistances, from 1 ohm to 37 K.

Dale Products, Inc., Dept. ED, Columbus, Nebr.

CIRCLE 88 ON READER-SERVICE CARD

### Insulation Tester

For uhf dielectric measurements



Type 874-LM dielectric measuring line tests solid insulation over the 200 to 5000 mc range. It measures dielectric constants from 1 to 10 within  $\pm 2\%$ , and dissipation factors from 0.0001 to 0.05 within  $\pm (5\% + 0.0001)$ .

General Radio Co., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 89 ON READER-SERVICE CARD

## Miniature Servomechanisms

In kit or assembled form



Supplied assembled or as kits, model 20-200 servomechanisms are versatile sets of parts which can be put together as pre-engineered 1-7/8 in. components. They fit into standard MS cases 2 in. in diameter. The parts may be made into aircraft instruments, panel indicators, control mechanisms, actuators, computer elements, or a variety of electromechanical components. Seven shafts operating in ball bearings are available for gearing, and as many as three servo loops can be accommodated in a single unit. Up to six size 8 rotating components may be installed, or two size 8 and two size 10. Length varies according to application. Outputs may consist of electrical synchros or potentiometers, torque shafts, dials and pointers, counters, or combinations. Antibacklash gears, clutches, and integrally lighted dial assemblies are also available.

Servo Development Corp., Dept. ED, 567 Main St., Westbury, N.Y.

CIRCLE 90 ON READER-SERVICE CARD

## Power Supply

High voltage



Transistorized model 59 power supply operates from 6 v dc. Its output can be adjusted from 1000 to 1500 v dc. The unit is suited for use with photomultiplier tubes, geiger tubes, and other gas filled detectors.

Components Corp., Dept. ED, Denville, N.J.

CIRCLE 91 ON READER-SERVICE CARD

## Is one of these FOUR DUPLEXER TECHNIQUES right for you...

To secure optimum performance and reliability in your duplexer system you now have a choice of five basic techniques.

Microwave Associates is in a position to give you completely unbiased recommendations because we design and manufacture all types of gas tube and ferrite devices for duplexer applications.

If you have a current problem in this field our application engineering service is at your disposal.

## ... OR do you need OUR NEW FERRITE DUPLEXER?

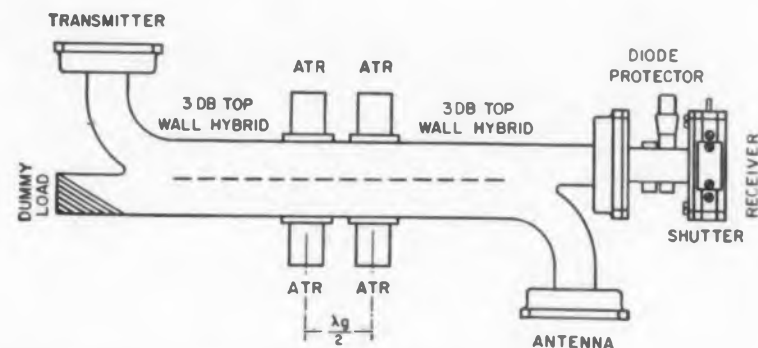
Write or call...



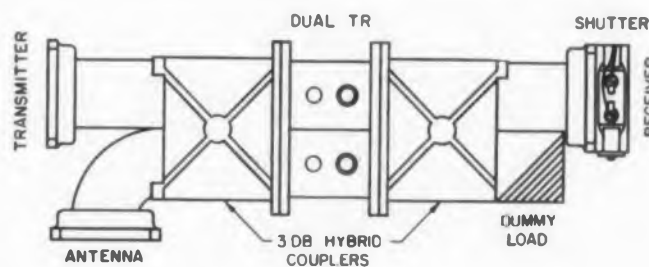
MICROWAVE ASSOCIATES, INC.

BURLINGTON, MASSACHUSETTS TELEPHONE BROWNING 2-3000

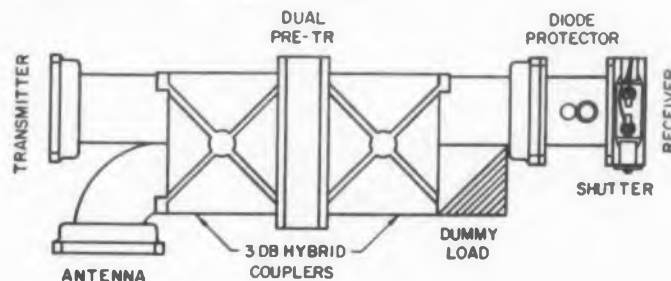
CIRCLE 92 ON READER-SERVICE CARD



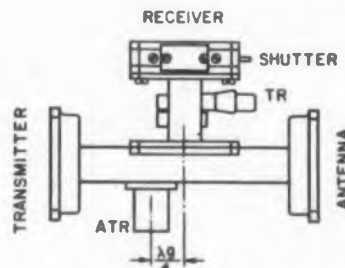
1 BALANCED DUPLEXER: 4 ATR's, DIODE PROTECTOR, SHUTTER



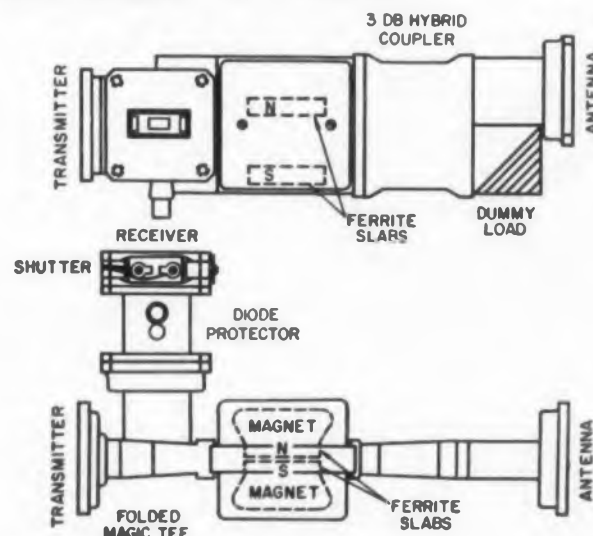
2 BALANCED DUPLEXER: DUAL TR, SHUTTER



3 BALANCED DUPLEXER: DUAL PRE-TR, DIODE PROTECTOR, SHUTTER



4 BRANCHED DUPLEXER: ATR, TR, SHUTTER



5 FERRITE DUPLEXER: DIODE PROTECTOR, SHUTTER



new!...

# RUGGEDIZED Continental Connectors

NOW RUGGEDIZED TO WITHSTAND SHOCK AND VIBRATION EXTREMES



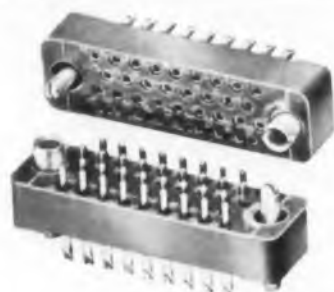
7 Contacts MM7-22



14 Contacts MM14-22



20 Contacts MM20-22



34 Contacts MM34-22

ACTUAL SIZE

- ★ Smallest size without sacrifice of performance
- ★ Available in 5, 7, 9, 11, 14, 20, 26, 29, 34, and 44 contacts
- ★ Positive polarization reversed guide pin and guide socket
- ★ Melamine . . . Plaskon . . . Diallyl Phthalate Molding Compounds
- ★ Available with hoods, screwlocks and protective shells

#### ELECTRICAL AND MECHANICAL RATINGS

Voltage Breakdown:	
At Sea Level	1800 Volts RMS
At 60,000 Ft.	450 Volts RMS
Current Rating	3 Amps.
Solder Cup (MM-22)	#22 AWG Wire
Minimum Creepage Path Between Contacts	1/8"
Minimum Air Space Between Contacts	3/64"
Contacts, Center-to-Center	3/32"
Pin Diameter (MM-22)	.030"

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

You're  
always  
sure  
with

# DeJUR

electronic  
components

exclusive sales agent  
DeJUR-AMSCO CORPORATION  
45-01 northern boulevard  
long island city 1, n. y.

CIRCLE 93 ON READER-SERVICE CARD

## NEW PRODUCTS

### Linear Amplifier

Gain of 50 to 1600



For amplifying small pulses to measurable or visual levels, model LA-100 linear amplifier can be used with proportional or scintillation counters, with ionization chambers, and for checking radioactive isotopes. It has a unique circuitry that completely does away with any cps effects from the pulsations being analyzed. Fine gain with its inherent instability is eliminated. Temperature stability is good. The unit has gains of 50 to 1600 in six switchable positions. Resolving time at 100 times overload is 10  $\mu$ sec; usable signal is 200  $\mu$ v to 1 mv; linearity is 0.5%; and input impedance is 4 K. Output from a cathode follower. The minimum discriminator height is 600 mv and the maximum pulse height is 100 v.

Gyra Electronics Corp., Dept. ED, 518 Spring Ave., La Grange Park, Ill.

CIRCLE 94 ON READER-SERVICE CARD

### Double Pulse Generator

10  $\mu$ sec rise time



Optimum rise time of pulse in the Nag type 5002 is 10  $\mu$ sec and independent of pulse width. Square wave output ranges from 0.25 to 2.5 x 10<sup>7</sup> cps. Dial calibration is accurate within 5%. External trigger signals can be as low as 0.5 v and have frequencies up to 2.5 x 10<sup>7</sup> cps. Pulse delay: variable from 0.2  $\mu$ sec to 2 sec. Amplitude of main pulse: 20 mv to 50 v, positive or negative.

Jackson Edwards Co., Dept. ED, 4101 Lankershim Blvd., North Hollywood, Calif.

CIRCLE 95 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

# AiResearch centralized air data computing system...



## on Navy's new McDonnell F4H-1

...supplying the following major airplane subsystems: Autopilot, Air Induction, Armament Control, Navigation, Surface Controls, Cockpit Indication and Pneumatic Static Pressure Correction.

The AiResearch centralized air data computing system integrates pneumatic, electronic, electrical and mechanical components on one of the Navy's fastest jets. It senses, measures, and automatically corrects all air parameters affecting flight. It supplies air data information to the pilot and all major airplane subsystems.

This centralized combination of transducers, computers and indicators is the

most complete air data computing system ever devised. It enables aircraft to operate at maximum efficiency continuously.

Eliminating duplication of components, the AiResearch centralized air data computing system cuts down space and weight requirements over decentralized systems by many times. Its principal functions: angle of attack, true static pressure (electrical and pneumatic), true air speed,

true Mach, altitude, rate of climb, total temperature, dynamic pressure and altitude and Mach error.

AiResearch has been the leader in the development of centralized computing systems. The F4H-1 installation is the first, single package air data computer possessing completely interchangeable, modular construction.

Your inquiries are invited.

**THE GARRETT CORPORATION**

ENGINEERING REPRESENTATIVES: AIRSUPPLY AND AERO ENGINEERING, OFFICES IN MAJOR CITIES

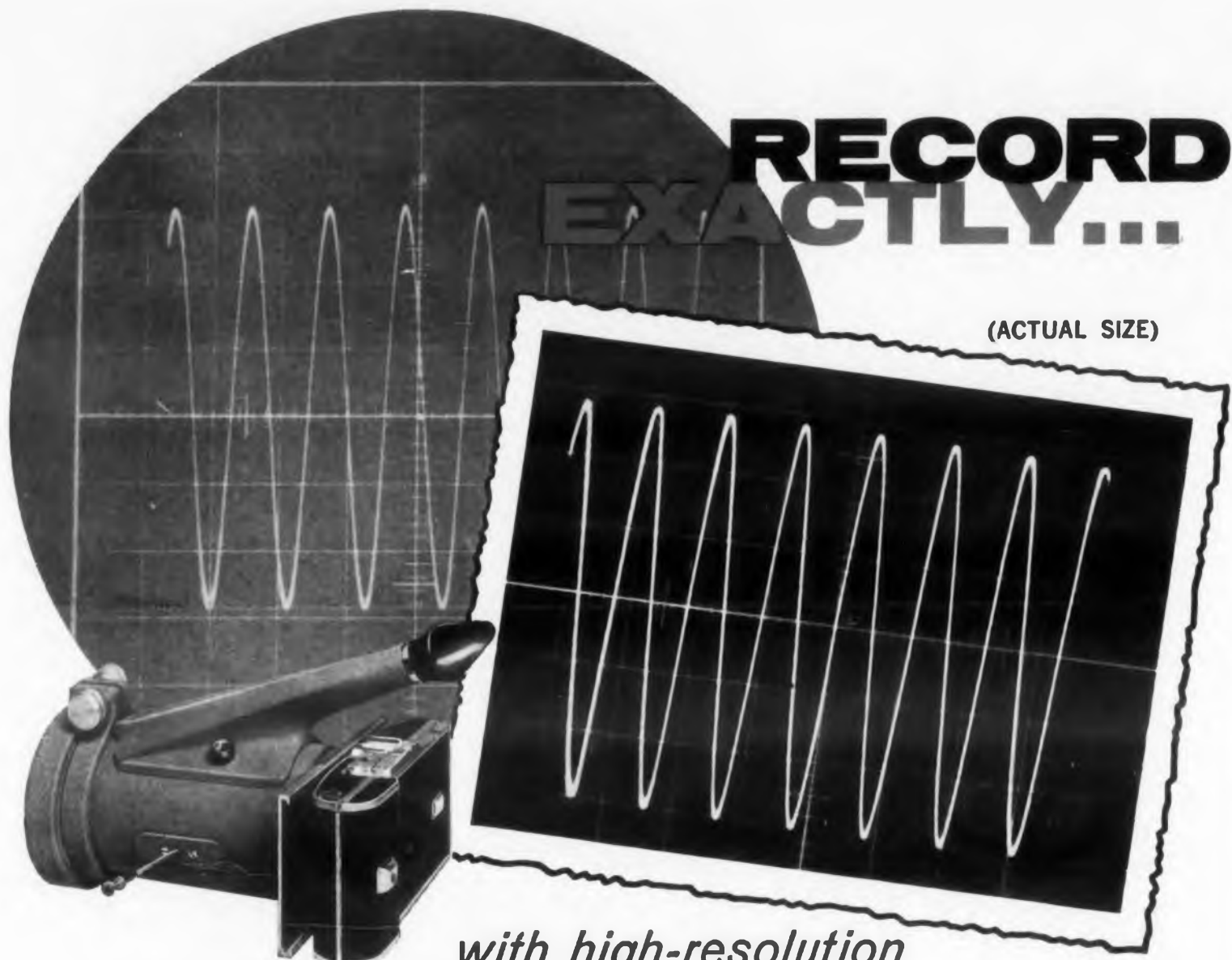
**AiResearch Manufacturing Divisions**

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS  
CIRCLE 96 ON READER-SERVICE CARD

CIRCLE 550 ON READER-SERVICE CARD





with high-resolution

# ACTUAL-SIZE, 60-SECOND PRINTS DU MONT® 353 record camera



**TYPE 299**  
General-purpose recorder for 5" scopes. Wide variety of backs available.  
f/1.9 \$369.00 f/2.8 \$292.00



**TYPE 302**  
Polaroid-Land camera makes 60-second prints on opaque or transparent films.  
f/1.9 \$391.00 f/2.8 \$314.00



**TYPE 339**  
Polaroid-Land camera for recordings from 3-inch scopes. 1:1 object-to-image ratio.  
f/2.8 \$246.00



**TYPE 352**  
For extremely fast writing rate photography — up to 75 in/usec — on 35 mm film. Automatic operating features enable up to 6 photographs per second.  
f/1.5 \$648.00



**TYPE 321-A**  
Continuous, or single exposures. Perforated or unperforated 35 mm film. Film speeds to 10,800 in/min.  
f/1.5 \$1,295.00 f/2.8 \$1,145.00

In just 60 seconds you can have exact, ready-to-use reproductions of the pattern on the scope screen, exactly the same size, non-reversed, on any standard-type Polaroid Land film\*

The new Du Mont 353 Record Camera offers every feature for ease of operation and versatility, such as: 1:1 object-to-image ratio; choice of f/1.9 or f/2.8 lens; sliding detent back for multiple exposures on a single frame; rotatable barrel permitting use of either long or short film dimension; available accessories for use of cut, pack or roll film; easy, fast access to lens and shutter; screen viewing while recording; direct viewing of trace during lens adjustment, to name a few of the many outstanding features.

Price: f/1.9 **\$350<sup>00</sup>**  
f/2.8 **295<sup>00</sup>**

\*Including Types 46 and 46L positive-transparency negatives.  
NOTE: All prices F.O.B., Clifton, N.J., U.S.A.

WRITE FOR COMPLETE CAMERA CATALOG

INSTRUMENT DIVISION, ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J., U. S. A.  
CIRCLE 97 ON READER-SERVICE CARD

## NEW PRODUCTS



**Ribbon Cable**  
Up to 3 in. wide

This improved Tempbraid cable comes in widths from 0.25 to 3 in. It consists of Teflon lead wires woven with Teflon and other yarns into a flat, flexible ribbon. The cable has many advantages where motion is involved. It can be pulled over rollers, coiled on drums, and placed between chassis and panel doors. With the yarns impregnated, the ribbon can be slit to make small inexpensive harnesses. The harness construction is square or rectangular, permitting more conductors to be placed in square or rectangular channels.

Hitemp Wires, Inc., Dept. ED, 1200 Sharn Dr., Westbury, N.Y.

CIRCLE 98 ON READER-SERVICE CARD

### Transistorized Indicator For linear displacement



Portable and battery powered, the Micro type 170 transistorized indicator is an electronic gaging unit. It is suitable for surface plate height gage work, checking setups, runout, alignments of parts and machines. The unit has two full scale sensitivity ranges: 0.006 in. with 770X magnification, and 0.0006 in. with 7700X magnification. There is a single zero adjustment for both ranges. Graduations on the 4.6 inch high-magnification scale are 10 millionths of an inch.

Airborne Instruments Lab, Dept. ED, 160 Old Country Rd., Mineola, N.Y.

CIRCLE 99 ON READER-SERVICE CARD



## Data Recorders

Automatic typewriter readout



With these data loggers, analog signals from temperature, strain, flow, pressure, level, vibration, and other transducers are converted to typewritten data. The systems incorporate a strip chart potentiometer recorder where data may be scanned and printed versus time. Two models are available: the 166 with a 48 point scanning system and a single range typewriter readout; and the 167, which has circuitry for multirange selection.

Gilmore Industries, Inc., Dept. ED, 13015 Woodland Ave., Cleveland 20, Ohio.

CIRCLE 107 ON READER-SERVICE CARD

## Cable Connector

1.15 to 1 vswr



Type 2075 captive pin connectors are approved for use with RG-117/U cable. They have captivated center conductors and dimensionally stable Teflon dielectrics. A slip nut feature allows complete mechanical insertion and good electrical contact prior to engaging the threads so that the nut may be easily rolled on and fitted into position. Capable of handling 500 w, the units have a frequency range of 350 to 5000 mc. vswr 1.15 to 1; insertion loss, 0.1 db maximum. These T male connectors are 1-3/4 x 3-5/8 in. They are qualified according to MIL-E-5272.

Tan Electronics, Inc., Dept. ED, Box 1217, Culver City, Calif.

CIRCLE 108 ON READER-SERVICE CARD

When you want 'em ... you've got 'em!



**NOW AVAILABLE AT  
LOCAL  
DISTRIBUTORS**

**ARLINGTON, VIRGINIA**  
Industry Services, Inc.  
Key Electronics Division

**BALTIMORE, MARYLAND**  
Kann-Ellert Electronics, Inc.

**BATTLE CREEK, MICHIGAN**  
Electronic Supply Corp.

**CAMBRIDGE, MASSACHUSETTS**  
Electrical Supply Corp.

**CAMDEN, NEW JERSEY**  
General Radio Supply Co.

**CHICAGO, ILLINOIS**  
Lukko Sales Corporation  
Newark Electric Co.

**CLEVELAND, OHIO**  
Pioneer Electronic Supply Co.

**CLIFTON, NEW JERSEY**  
Eastern Radio Corporation

**DALLAS, TEXAS**  
Engineering Supply Co.

**DAYTON, OHIO**  
Srecco, Inc.

**FOR WAYNE, INDIANA**  
Fr. Wayne Electronics Supply, Inc.

**HOUSTON, TEXAS**  
Harrison Equipment Co., Inc.

**INDIANAPOLIS, INDIANA**  
Graham Electronics Supply, Inc.

**KANSAS CITY, MISSOURI**  
Burststein-Applebee Co.

**LAFAYETTE, INDIANA**  
Lafayette Radio Supply, Inc.

**MIAMI, FLORIDA**  
Electronic Equipment Co., Inc.

**MINEOLA, NEW YORK**  
Arrow Electronics, Inc.

**MUNCIE, INDIANA**  
Muncie Electronics Supply, Inc.

**NEW YORK, NEW YORK**  
Arrow Electronics, Inc.  
Electronics Center, Inc.

**SAN DIEGO, CALIFORNIA**  
Shanks and Wright

**ST. LOUIS, MISSOURI**  
Interstate Supply Corp.

**SPRINGFIELD, MASSACHUSETTS**  
T. F. Cushing, Inc.

**TULSA, OKLAHOMA**  
Oil Capital Electronics Corp.

**WATERBURY, CONNECTICUT**  
Bond Radio Supply Co., Inc.

**GOOD-ALL ELECTRIC MFG. CO.**

Distributors' Div.  
26 Riffenhouse Pl. Ardmore, Pa.

CIRCLE 109 ON READER-SERVICE CARD

Good-All

CAPACITORS

**Two thoroughbreds  
and a workhorse!**

6600-1

**Good-All Type 663 UW SPACE-SAVING  
Sub-Miniature with a SKIN-TIGHT Case**

Type 663UW is an ideal choice for miniaturized and transistorized products. The space-saving possibilities are amazing.

**SPECIFICATIONS**  
Dielectric: Mylar Film  
Case: Plastic Wrap  
End Fill: Thermo-Setting Plastic

**Voltage Range** 100-600 VDC  
**Temp. Range** -55° to +125°C  
**IR at 25°C** 100,000 Meg. x MFD  
**Humidity Resistance** Superior

6000-RL

**GOOD-ALL Types 616 G and 617 G  
Sub-Miniature Metal Enclosed Mylar Designs**

Designed to provide EXTENDED LIFE at high temperatures. Rugged, military construction throughout. These lines include a 50-volt series for transistor applications.

**SPECIFICATIONS**  
Dielectric: Mylar Film  
Case: Hermetically Sealed  
Winding: Extended Foil

**Temp. Range** Full rating to 125°C  
50% derating at 150°C  
**D.C. Voltage Rating** 50, 150, 400 and 800

6000-ALL

**METAL ENCLOSED Tubulars per MIL-C-25A**

The "workhorse" of military electronics. Good-All specializes in Types CP04, CP05, CP08, CP09, CP10 and CP11. Approvals are listed by ASES in the current issue of the QPL.

\* DuPont's trademark for polyester film.

A LEADING MANUFACTURER OF TUBULAR,  
CERAMIC DISC AND  
ELECTROLYTIC CAPACITORS



**GOOD-ALL ELECTRIC MFG. CO.**  
OGALLALA, NEBRASKA

CIRCLE 110 ON READER-SERVICE CARD



# Curtiss-Wright RECTILINEAR STRIP CHART RECORDERS

offer you  
**12 BIG  
ADVANTAGES**



**1 MOVING-COIL AND DYNAMOMETER MOVEMENTS**—No choppers, tubes, motors, slidewires, mirrors . . . provides utmost reliability. AC, DC, and Power movements.

**2 UP TO 6 CHANNELS AVAILABLE** — Curtiss-Wright Double Size Models are the only Rectilinear Strip Chart Recorders to offer up to 6 channels. Curtiss-Wright recorders provide simultaneous recording of two to six variables on a single chart in any combination of different types of movements.

**3 SENSITIVITY DOWN TO 250 UA FOR DC** . . . can be extended beyond 250 ua by DC amplifier (optional).

**4 ACCURACY 1% FOR MOVING-COIL RECORDERS**—Conservatively rated as  $\pm 1\%$  of full scale for DC movements. Unusually low friction of pen against chart.

Curtiss-Wright . . . a new name in rectilinear strip chart recorders . . . offers you time proven advantages in precision operation. Made under licensing agreements with Metrawatt AG . . . a leading West German manufacturer of fine instruments for over 50 years . . . Curtiss-Wright recorders combine advanced design with highest quality workmanship. Moderate in price, these fine precision instruments are rugged and reliable . . . simple to operate. Write for complete information.

ELECTRONICS DIVISION  
**CURTISS-WRIGHT**  
CORPORATION • CARLSTADT, N. J.

CIRCLE 111 ON READER-SERVICE CARD

**5 INKLESS AND INK RECORDING** — Inkless recording is standard equipment on all but Miniature Models, on which it is optional. Cleanest, easiest method . . . a fine metal stylus "burns" the record into zinc coated chart paper. Instantly converted to ink recording.

**6 RECTILINEAR RECORDING** — A patented mechanical linkage changes angular motion of the needle into a straight line, giving an undistorted picture of the signal. Avoids errors and saves time.

**7 THREE-SPEED TRANSMISSION** plus 60:1 speed change from hours to minutes provides six interchangeable speeds in all.

**8 MOTOR AND SPRING DRIVES** — Sync motor, hand-wound short drive or electrically wound spring motors. Automatic chart rewind.

**9 LIGHT AND COMPACT DESIGN** — Small size and advanced design engineering of movement allows space and weight savings.

**10 DUST-PROOF AND SPLASH-PROOF CASES**—Steel cases decrease effect of stray magnetic fields.

**11 SHOCK-PROOF MOVEMENT** — Extra reliability when used in portable applications.

**12 OUTSTANDING WORKMANSHIP** — Improved design and meticulous attention to detail assure highest quality precision performance. All Curtiss-Wright recorders carry a one-year guarantee.

#### ILLUSTRATED ABOVE

**A — MINIATURE SLIM MODELS 86 (portable) and 87 (flush).** Weigh 9 lbs.  $3\frac{3}{4}$ " x  $7\frac{1}{8}$ " x  $8\frac{3}{4}$ ". \$295.00 and up

**B — STANDARD MODELS 81 (portable) and 82 (flush).** Weigh 19 lbs.  $7\frac{1}{2}$ " x  $9\frac{7}{8}$ " x  $8\frac{1}{2}$ ". \$445.00

**C — MINIATURE SQUARE MODEL (85)** Weighs 16 lbs.  $5\frac{5}{8}$ " square,  $12\frac{3}{4}$ " deep. \$330.00 and up

**D — DOUBLE SIZE MODEL 83 (portable) and 84 (flush).** Weigh 26 lbs.  $12\frac{3}{4}$ " x  $9\text{-}13/16$ " x  $8\frac{3}{4}$ ". \$860.00 and up

## NEW PRODUCTS

### Coaxial Double Slug Tuners

Cover 300 to 5000 mc



For mounting in a 50 ohm transmission line type SF coaxial double slug tuners cover the frequency range from 300 to 5000 mc. The two slugs may be adjusted from contact to a quarter wavelength apart and locked in position. The tuners are available for standing wave ratios of less than 2 to 1 and less than 10 to 1. They are 10.7 or 19.1 in. long and have a power rating of 100 w. The units have type N male and female connectors.

Microlab, Dept. ED, 71 Okner Parkway, Livingston, N.J.

CIRCLE 112 ON READER-SERVICE CARD

### Standard Frequency Multipliers

Generate 1 to 1000 mc signals



With crystal-controlled standards, type 1112 multipliers provide accurate measurements of microwave frequencies. The multiplier chain consists of two units. The first provides 20 mw at 1, 10, and 100 mc from three phase-locked quartz-controlled oscillators. The second provides 50 mw at 1000 mc from a phase-locked klystron oscillator. Input to the first unit, type 1112-A, is normally 100 kc, but alternatively 2.5, or 5 mc can be used. The second unit, type 1112-B, is driven from the 100 mc output of the first. The multipliers have low noise and are almost completely free from submultiple-frequency spurious signals.

General Radio Co., Dept. ED, West Concord, Mass.

CIRCLE 113 ON READER-SERVICE CARD



## Coaxial Cable Switch

Under 1.5 vswr



A small, dependable 115 v ac actuator, model C6N2DB coaxial switch will operate from 60, 400, 1600, and 2400 cps power sources. It meets airborne specifications and features low insertion loss and high crosstalk. At 10,750 mc, vswr is less than 1.5.

Thompson Products, Inc., Tapco Group, Dept. ED, 23555 Euclid Ave., Cleveland 17, Ohio.

CIRCLE 114 ON READER-SERVICE CARD

## Electrical Insulation Tape

Class H

Unsupported silicone rubber, tape X-1070 is class H and inorganic. Pressure-sensitive, it has 700 v per mil dielectric strength, and 1 million meg insulation resistance.

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

CIRCLE 115 ON READER-SERVICE CARD

## Magnetron Test Kit

For X and C band units

To be used in the field or on the production line, this portable kit tests X and C band 100 and 400 w magnetrons. It comes with or without a power meter and spectrum analyzer.

Bosma Labs, Inc., Dept. ED, 1 Salem Rd., Beverly, Mass.

CIRCLE 116 ON READER-SERVICE CARD

CIRCLE 117 ON READER-SERVICE CARD



## MINIATURIZED SEALED RELAYS



# HOT . . . but still in service!

We don't see many hot-skillet applications for sealed relays these days. But, if there were, General Electric miniaturized sealed relays could do the job—even in scorching bacon grease!

The best of laboratory equipment is used to check the continuous operation of all G-E sealed relays at ambient temperatures of *plus 125 C*. And, special forms are now available for use at ambients up to *200 C*! Inherent temperature-resistant characteristics qualify *all* General Electric sealed relays for use on

any job where extreme heat is a serious environmental problem.

Extreme high-temperature operation is just one of the many "plus" features—such as high-shock resistance, high-vibration resistance, low-temperature operation, and rugged construction—you get with all Miniature, Sub-miniature, and Micro-miniature G-E sealed relays. Today, General Electric sealed relays are proving their reliability on a wide variety of military and industrial electronics applications.

What's more, all G-E relays are avail-

able for dry-circuit jobs. Special manufacturing processes—plus a monitored run-in of each relay—provide reliable service in low-level circuitry.

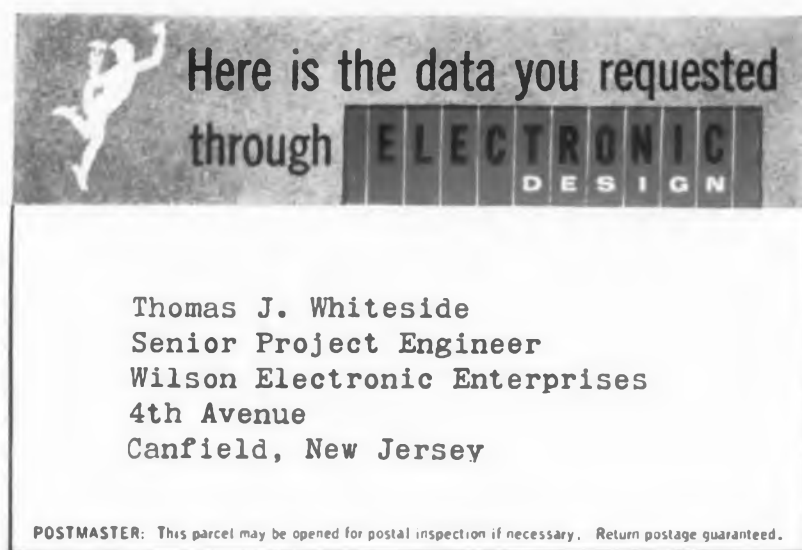
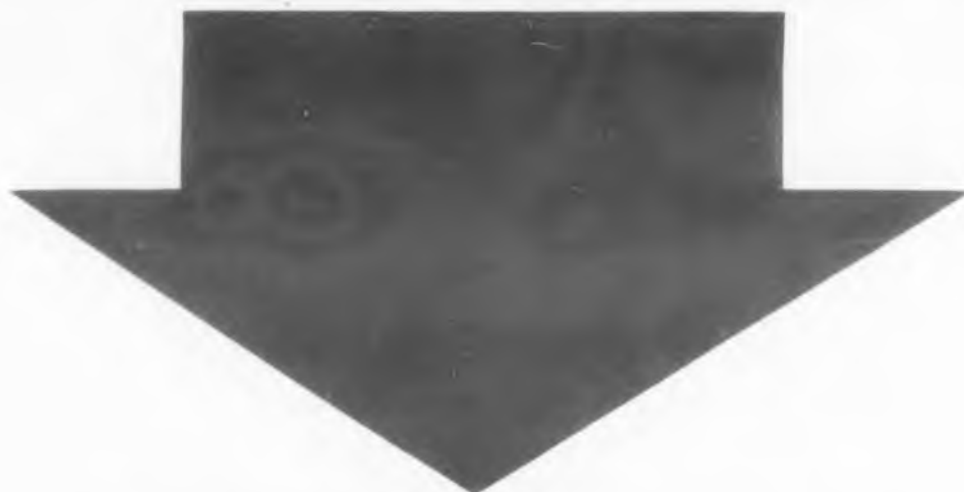
For further information, contact your G-E Apparatus Sales Office—or—write to General Electric Co., Section 792-9, Schenectady 5, N. Y., for your copy of the brand new G-E sealed relay catalog. *Specialty Control Dept., Waynesboro, Va.*

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**



# WATCH FOR THIS LABEL



## A NEW, FASTER, ONE DAY SERVICE TO SPEED THE INFORMATION YOU REQUEST

Look for this label on your incoming mail . . . it signals the material you have inquired about . . . and helps to bring it to you faster.

Recently, *Electronic Design* adopted a completely new system to speed and simplify communication between reader and advertiser.

When you make an inquiry on your reader service card, your name and address is typed directly on this label (a separate label for each item you have inquired about). As a result we are now able to process your card within one day of receipt. Your inquiries will be separated, recorded, labels typed, and on

their way to each manufacturer by AIR MAIL (1st. class within one day delivery zone) within twenty-four hours. No delay for batch mailing or complicated tabulation.

Although the new system involves considerable extra clerical effort and expense for *Electronic Design*, it means that there is less work for the advertiser, saves typing and the cost of a transmittal letter, enables him to answer your request quickly and easily.

New faster reader inquiry handling is one more step in *Electronic Design's* continuous program to improve its services for both reader and advertiser.

ANOTHER SERVICE . . . ONLY IN ELECTRONIC DESIGN

a HAYDEN publication, 830 THIRD AVE., NEW YORK 22, N. Y. • PLaza 1-5530

## NEW PRODUCTS

**AUTOMATIC TUBE TESTER.**—Model 1128 for large-scale vacuum tube testing. Performs complete dynamic tests on up to 25 tubes at once at rates of 7 to 10 sec per tube. Handles pentodes, triodes, diodes, and neon regulators.

Jackson Electronic & Mfg. Co., Dept. 1 D, 655 Johnston St., Akron, Ohio.

CIRCLE 118 ON READER-SERVICE CARD

**ELECTRONIC TEMPERATURE CONTROL.** Responsive to thermocouple output fluctuations of 1  $\mu$ v. Applicable to laboratory test ovens and glass fiber drawing dies. Three ranges: 0 to 800, 800 to 1800, and 1800 to 2800 F.

Hagan Chemicals & Controls, Inc., Controls Division, Dept. ED, Box 1346, Pittsburgh 30, Pa.

CIRCLE 119 ON READER-SERVICE CARD

**HEAVY DUTY SLIDE.**—A pair of series 80 slides handles 500 lb with wide safety factor. In any length from 6 to 60 in. Variety of locking mechanisms and mounting hole patterns. Meets all military specifications.

Jonathan Mfg. Co., Dept. ED, 720 E. Walnut Ave., Fullerton, Calif.

CIRCLE 120 ON READER-SERVICE CARD

**TRANSISTOR TRANSFORMERS.** — Transistor driver and output transformers hermetically sealed to MIL-T-27A specifications. Molded construction. Tabs, inserts, or studs on special order.

Microtran Co., Inc., Dept. ED, 145 E. Mine Ave., Valley Stream, N. Y.

CIRCLE 121 ON READER-SERVICE CARD

**BERYLLIUM COPPER SEAMLESS TUBING.** Complete line of seamless tubing from no. 25 all sizes. OD's range from 0.1 to 0.625 in. Wall thicknesses from 0.042 to 0.001 in.

Uniform Tubes, Inc., Dept. ED, Colleagueville, Pa.

CIRCLE 122 ON READER-SERVICE CARD

**CHASSIS SLIDES.**—Thinline ball bearing slides under 1/2 in. wide, handle 150 lb per pair. In any length from 6 to 36 in.

Jonathan Mfg. Co., Dept. ED, 720 E. Walnut Ave., Fullerton, Calif.

CIRCLE 123 ON READER-SERVICE CARD

**ENCLOSURES.**—Pressurized aluminum cases custom-built for missile and aircraft electronic equipment. Cooled by built-in blowers.

Northeastern Engineering, Inc., Dept. ED, P.O. Box 150, Manchester, N. H.

CIRCLE 124 ON READER-SERVICE CARD

**ALARM SYSTEMS.**—Series ST Annunciators—completely self-contained static switching circuit. Variety of models and sizes.

Seam Instrument Corp., Dept. ED, 1811 Irving Park Rd., Chicago 13, Ill.

CIRCLE 125 ON READER-SERVICE CARD

CIRCLE 126 ON READER-SERVICE CARD

Just  
off the press:

**NEW**

# GENERAL ELECTRIC TRANSISTOR MANUAL

*Greatly expanded 3rd edition contains  
latest applications, circuit diagrams  
and specifications*



Never before has so much vital information about transistors — facts you'll use every day in your work — been gathered between the covers of one book!

Whether you're looking for basic information like how to interpret parameter symbols, or are about to design a complex switching circuit, you'll find what you need in General Electric's big new Transistor Manual.

Throughout its more than 160 pages are described the very latest advances in the art of transistors and rectifiers. There are 50% more pages . . . expanded applications sections including new Unijunction Transistor circuits and transistor switches, including Flip-Flop Design Procedures . . . all the latest G-E transistor specifications . . . a list

of over 175 new Registered JETEC specs with interchangeability information . . . many new circuits, . . . and a new circuit index to make them easy to find. There's a chapter on General Electric's revolutionary new silicon controlled rectifier, a device which opens up whole new fields of application for semiconductors, but is still so new you won't find it in any other reference.

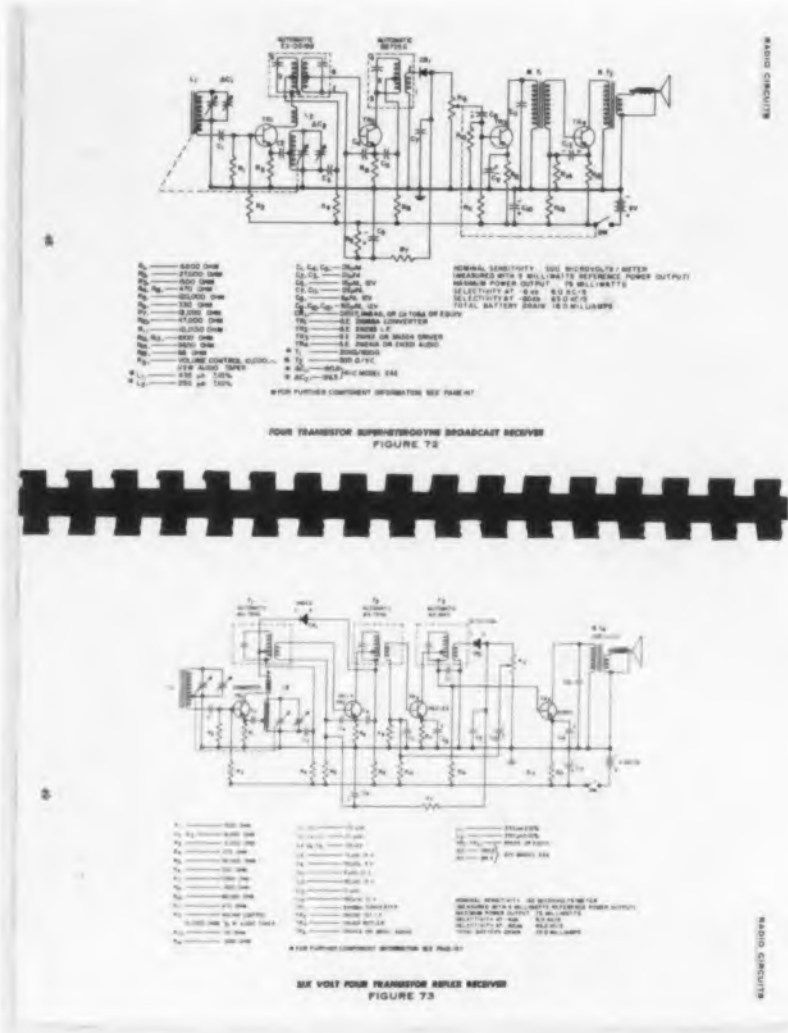
The General Electric Transistor Manual is already the most widely used book in the transistor field. You won't want to miss this tremendously improved new 3rd edition. Your G-E Tube Distributor has copies now, or mail the coupon on the reverse side with one dollar.

Get your copy from your G-E Tube Distributor, or mail coupon on back.

**MAIL COUPON TODAY!** —————→

*It's all here!*

# THEORY • CIRCUITS LOGIC • SPECS



In the fabulous field of semiconductors, with new products coming onto the market almost every day, there is an urgent and continuing need for sound, basic information. As part of OPERATION UPTURN, we offer the expanded new 3rd edition of the Transistor Manual in the hope it will increase understanding and use of transistors and help build sales and jobs in '58.

# GENERAL ELECTRIC



General Electric Company  
Semiconductor Products Dept.  
Section S23118  
Electronics Park, Syracuse, N. Y.

NAME \_\_\_\_\_

Rush me the new enlarged 3rd edition of G. E.'s Transistor Manual. I enclose \$1.00. (No stamps, please.)

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ ZONE \_\_\_\_\_ STATE \_\_\_\_\_

## TABLE OF CONTENTS

- BASIC SEMICONDUCTOR THEORY**
- TRANSISTOR CONSTRUCTION TECHNIQUES**
  - Major Parameters
  - Rectifier Construction
- BIASING**
- BASIC AMPLIFIERS**
  - Single Stage Audio Amplifier
  - Two Stage R-C Coupled Amplifier
  - Class B Push-Pull Output Stages
  - Class A Output Stages
  - Class A Driver Stages
  - Design Charts
  - Amplifier Circuit Diagrams
- HI-FI CIRCUITS**
  - Preamplifiers
  - Hybrid Preamplifier
  - Tone Controls
  - Power Amplifiers
  - Stereophonic Tape System
  - Hi-Fi Circuit Diagrams
- RADIO CIRCUITS**
  - Autodyne Converters
  - IF Amplifiers
  - Automatic Volume Controls
  - Reflex Circuits
  - Complete Radio Circuit Diagrams
- UNIUNCTION TRANSISTOR CIRCUITS**
  - Theory of Operation
  - Parameters — Definition and Measurement
  - Relaxation Oscillator
  - Sawtooth Wave Generator
  - Multivibrator
  - Hybrid Multivibrator
  - Relay Delay
- TRANSISTOR SWITCHES**
  - Temperature Effects on Switching Circuits
  - Power Dissipation
  - Saturation
  - Transient Response Time
  - Flip-Flop Design Procedures
  - Triggering
- LOGIC**
  - Binary Arithmetic
- TETRODE TRANSISTORS**
- SILICON CONTROLLED RECTIFIER**
- POWER SUPPLIES**
  - Circuits
- TRANSISTOR SPECIFICATIONS**
  - How to Read a Specification Sheet
  - Explanation of Parameter Symbols
  - G-E Transistor Summary
  - G-E Transistor Specifications
  - Registered JETEC Transistor Types with Interchangeability Information
  - G-E Outline Drawings
- CIRCUIT DIAGRAM INDEX**
  - Notes on the Circuit Diagrams
- READING LIST**

TEL  
Con  
acco  
stan  
Rolu  
Ked  
  
CAMEL  
timer-ac  
K-100 c  
strap m  
these r  
sec.  
Meter  
Union S  
  
DRAFT  
and tol  
symbols  
standar  
the sym  
Rapid  
bank, C  
  
EPOXY  
the enc  
for molc  
epoxy re  
lation.  
Resde  
  
GERMA  
alloy-jun  
service.  
factor of  
Radio  
Material:  
  
TRITIA  
of tritiat  
num. Sur  
ducer in  
and vacu  
Radiat  
First Ave  
  
TEMPER  
tapes on  
control. I  
Thermal  
range of  
ular surfa  
Yanco  
Ave. N.,  
  
ELE TRC



**TELEPHONE JACKS.**—In two long frame designs. Contacts of silver or palladium. Military types in accordance with MIL-J-641 specifications. Meet all standard circuit requirements.

Richards Electrocraft, Inc., Dept. ED, 4432 N. Kedzie Ave., Chicago, Ill.

CIRCLE 127 ON READER-SERVICE CARD

**CAMERA INTERVAL TIMER.**—Battery powered timer-actuator for use with the Eastman Kodak K-100 camera. Attaches to camera through carrying strap mounting holes. Provides any interval within these ranges: 0.5 to 40, 50 to 70, and 110 to 130 sec.

Meteorology Research, Inc., Dept. ED, 939 E. Union St., Pasadena, Calif.

CIRCLE 128 ON READER-SERVICE CARD

**DRAFTING TEMPLATE.**—No. 52 dimensioning and tolerancing template. Contains cut-outs for symbols recommended by MIL-STD-8A. Includes standard sizes of rectangles and circles for use with the symbols.

Rapidesign, Inc., Dept. ED, P. O. Box 429, Burbank, Calif.

CIRCLE 129 ON READER-SERVICE CARD

**EPOXY TUBING.**—For containers and coil forms in the encapsulation of components. Eliminates need for molds. In OD's from 0.2 to 2 in. Made of same epoxy resin or compound as that used for encapsulation.

Resdel Corp., Dept. ED, Wildwood, N. J.

CIRCLE 130 ON READER-SERVICE CARD

**GERMANIUM TRANSISTOR.**—Type 2N331 pnp alloy-junction unit for audio-frequency amplifier service. Typical power gain of 44 db; typical noise factor of 9 db. Hermetically sealed.

Radio Corporation of America, Semiconductor and Materials Div., Dept. ED, Somerville, N. J.

CIRCLE 470 ON READER-SERVICE CARD

**TRITIATED TITANIUM TARGETS.**—Thin films of tritiated titanium on stainless steel or molybdenum. Suitable as a neutron source or as an ion producer in static eliminators, current regulating tubes, and vacuum gauges.

Radiation Research Corp., Dept. ED, 1114 First Ave., New York 21, N. Y.

CIRCLE 131 ON READER-SERVICE CARD

**TEMPERATURE SENSOR.**—Thermal-Ribbon in tape-on or self-adhering types. For monitoring or control. Resistance of 676 ohms per deg C at 25 C. Thermal time constant of 0.5 sec. Temperature range of -60 to +160 C. Thin and flexible for irregular surfaces; 3/8 x 2 x 0.02 in.

Minco Products, Inc., Dept. ED, 740 Washington Ave. N., Minneapolis 1, Minn.

CIRCLE 132 ON READER-SERVICE CARD

CIRCLE 126 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1958



Another new miniature from Corning ...

## 1 to 8 uufd direct traverse trimmer capacitor

Small but still precise, this new Corning direct traverse type trimmer capacitor meets military as well as civilian requirements.

Other features besides its size:

**Silver plated hardware** takes the noise out of tuning and protects the unit from corrosion even under extreme environments.

**Mechanical stops** at both ends of capacitance adjustment, with self-contained adjusting shaft.

**Linear tuning** with fine resolution. About 0.50 uufd capacitance change per turn.

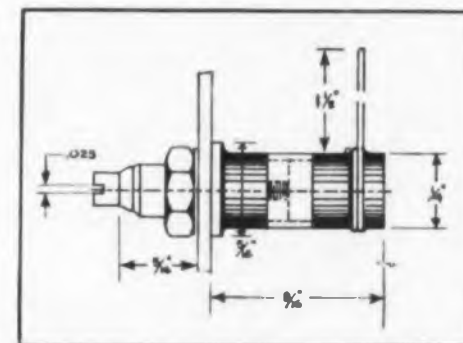
**No capacitance reversals.**

**Glass-Invar construction.**

Bushing and shaft assembly is coaxial for low inductance, high frequency applications.

**Shock, vibration, and thermal shock** resistance all excellent.

If you'd like more information, write for our new data sheet.



Corning means research in Glass



**CORNING GLASS WORKS, Bradford, Pennsylvania**

Electronic Components Department

CIRCLE 133 ON READER-SERVICE CARD

## NEW PRODUCTS

**HELIX MONITORS.**—T-shaped units for monitoring helix interception current in, or applying modulation to, traveling wave tubes. Cover octave frequency ranges from 250 to 12,000 mc.

T.E.M., Inc., Dept. ED, 71 Okner Parkway, Livingston, N.J.

CIRCLE 134 ON READER-SERVICE CARD

**REVOLUTION COUNTER.**—Model 1523 quick-reset, geared counter accepts speeds up to 6000 rpm or 8000 counts per minute. Unit is 5 x 2-5/8 x 2-13/16 in.

Veeder-Root Inc., Dept. ED, Hartford 2, Conn.

CIRCLE 135 ON READER-SERVICE CARD

**GALVANOMETER TESTER.**—Model GA-201 for complete check of mirror type galvanometers as used in recording type oscillographs. Tests units of any impedance.

North Atlantic Industries, Inc., Dept. ED, 603 Main St., Westbury, N.Y.

CIRCLE 136 ON READER-SERVICE CARD

**FORCED AIR DUCT HEATERS.**—For heated air blasts, ovens, and dryers. Parallel rows of finned strip elements mounted in steel frame. Two models with either three or six rows of heaters. Range of lengths from 7-3/8 to 38-7/8 in. Optional thermal controls for 60 to 250 or 100 to 550 F.

Vulcan Electric Co., Dept. ED, 88 Holten St., Danvers, Mass.

CIRCLE 137 ON READER-SERVICE CARD

**MACHINE SAFETY CONTROL.**—"Missing Parts Detector" shuts off a power press when stamped part fails to eject. With the company's Circuit Master Mark III, the control also provides overload protection, buckling control, end of material shutoff, and misfeed control. Self-adjusting.

Wintriss, Inc., Dept. ED, 20 Vandam St., New York 13, N. Y.

CIRCLE 138 ON READER-SERVICE CARD

**PERMANENT MAGNET SPEAKERS.**—High fidelity three-way units. KN-812 12 in. model has 30 cps to 20 kc frequency response and 35 w power capacity. KN-815 15 in. model has 25 cps to 20 kc response and handles 50 w.

Allied Radio Corp., Dept. ED, 100 N. Western Ave., Chicago 80, Ill.

CIRCLE 139 ON READER-SERVICE CARD

**FLAME-RETARDANT LAMINATES.**—Grade FR-1 paper-base laminate has maximum constant operating temperature of 275 F. NEMA flammability test: ignition time 120 sec and burning time, 30 sec. Standard sheet sizes: 36 x 36 and 36 x 72 in.

Synthane Corp., Dept. ED, Oaks, Pa.

CIRCLE 140 ON READER-SERVICE CARD

A giant step has been taken in the U.S. military development program with contracts for the creation of an unprecedented primary strategic weapon system. It is the Air Force DYNA-SOAR, now in Phase-I design stage by a six-company project team under Martin direction.

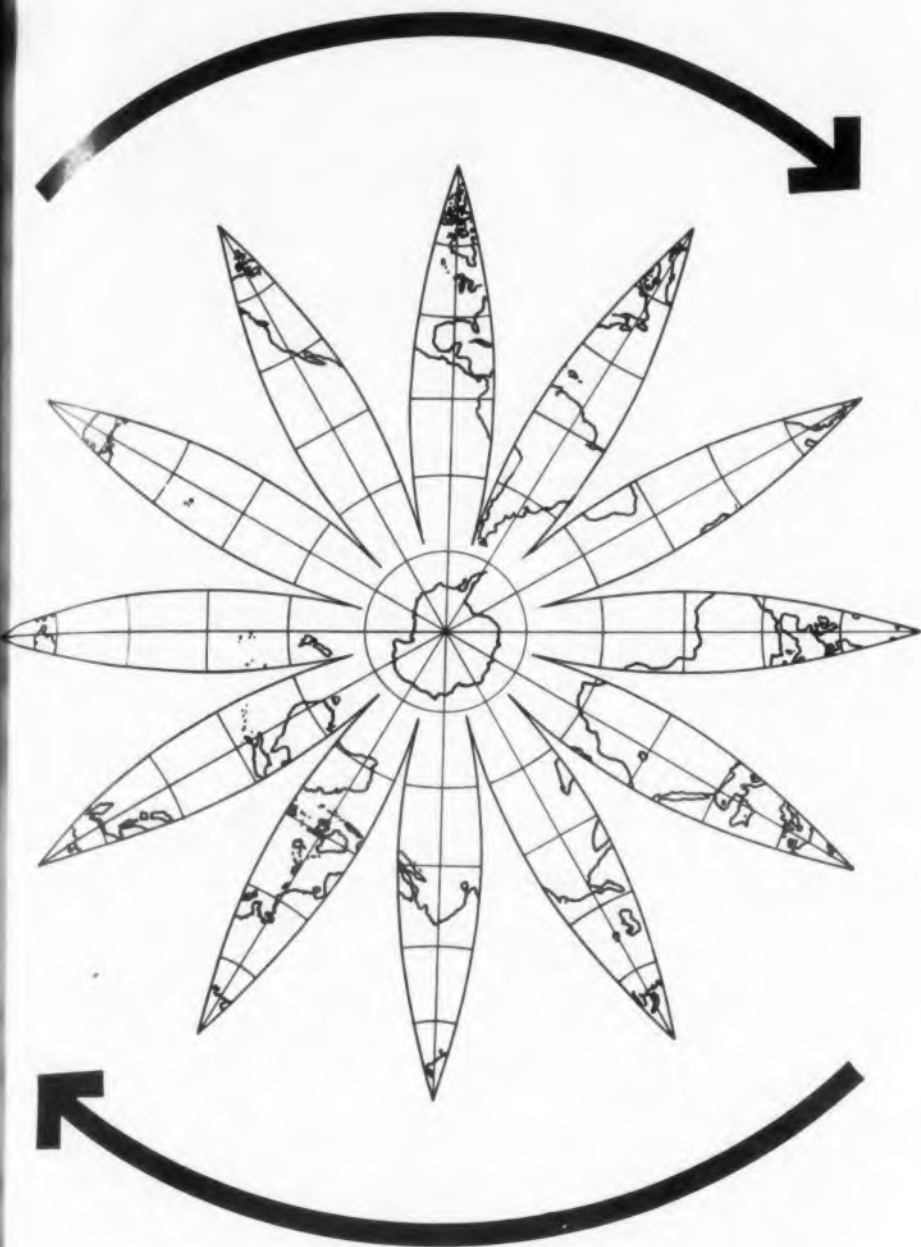
DYNA-SOAR—the most advanced military weapon system now in development—is a pilot-controlled bomber-reconnaissance space vehicle, its mission being to circle the earth at orbital velocity, with controlled aircraft landing capabilities. It will be propelled by several stages of rocket boosters, enabling it to operate from ground level to the ionosphere at hypersonic speeds.

In an entirely new and advanced concept of integrated industry coordination, the six companies teamed in this No. 1 military program constitute top capabilities in the basic areas of airframe, propulsion and radar guidance system development.

Bell, a pioneer in the boost-glide field, will design and build the airframe of the vehicle... Bendix will develop communication, telemetry, hydraulic and electrical power conversion systems... Goodyear will produce the crew-escape capsule and the radar system... Minneapolis-Honeywell will be responsible for guidance and navigation to keep DYNA-SOAR on course and supply position and velocity information to the crew... American Machine & Foundry's responsibility is an advanced system of ground handling and launching equipment... And Martin will establish the configuration and design of the rocket boosters, carry out an experimental aerodynamic program for the complete vehicle, and assemble a full-scale mockup of the system.

Because of the challenging technical problems involved, the presidents of the six companies—aggregating assets of over \$2 billion—comprise an active advisory panel with their top engineering teams participating.

Never before in military history has so formidable a task force of specialized industrial capabilities been applied against such an advanced concept.



**MICROWAVE TESTER.**—Expanded range of model TSA-W is 10 to 44,000 mc. Unit permits visual analysis of 0.1 usec pulses and provides frequency dispersion to 70 mc. Provides narrower display bandwidth with 7 kc resolution for wide pulse analysis.

Polarad Electronics Corp., Dept. ED, 43-20 34th St., Long Island City 1, N.Y.

CIRCLE 142 ON READER-SERVICE CARD

**MINIATURE WELDING HEAD.**—Model 1032 for resistance welders. Makes exactly repeatable welds at electrode pressures of 4 oz. Electrode pressure is continuously adjustable from 4 oz to 15 lb. Unit weighs 4 lb.

Unitek Corp., Weldmatic Div., Dept. ED, 380 N. Halstead Ave., Pasadena, Calif.

CIRCLE 143 ON READER-SERVICE CARD

**SELF-LOCKING INSERTS.**—One piece, all metal inserts press into drilled holes. Have resilient segments that provide a spring grip. With threaded or plain bore. Shock and vibration resistant.

J. B. Plevyak Mfg. Co., Dept. ED, 19 Jefferson St., Newton, N.J.

CIRCLE 144 ON READER-SERVICE CARD

**MEMORY SYSTEM.**—Type 1092-BQ8A digital buffer storage unit synchronizes systems of differing speeds. Stores up 1092 characters of 8 bits each. Operates at 100 kc rate.

Telemeter Magnetics, Inc., Dept. ED, 2245 Pontius Ave., Los Angeles 64, Calif.

CIRCLE 145 ON READER-SERVICE CARD

**BOBBINS.**—Glass silicone for Class H; glass melamine for Class B; glass phenolic for Class A. All can be run from one set of low cost tooling.

Stevens Products Inc., Dept. ED, 86-88 Main St., East Orange, N.J.

CIRCLE 146 ON READER-SERVICE CARD

**AUTOMATIC TV CAMERA.**—Model 63A accommodates light range of 120 to 1 with 50% change in video output level. Self-adjusts beam, target, and electrical focus circuits to optimum values. Weighs 10 lb.

Thompson Products, Inc., Dage Television Div., Dept. ED, Michigan City, Ind.

CIRCLE 147 ON READER-SERVICE CARD

**SHIELDED RADIATION COUNTER.**—Model NC-2 neutron monitor. Neutron sensitivity is 560 cpm per nv for a PoBe neutron flux. Ratio of front to side sensitivity is about 2 to 1 for 4.5. Counting rate meter has full scale ranges from 20 cps to 10 kc in 8 steps.

Tullamore Electronics Lab, Dept. ED, 6055 S. Ashland Ave., Chicago 36, Ill.

CIRCLE 148 ON READER-SERVICE CARD

on  
the shelf!



Ford Instrument

10-watt servo  
motors

**features**

- Available in high- and low-voltage types, 60 or 400 cycle
- Linear torque-speed characteristic
- Torque directly proportional to control voltage
- High torque-to-inertia ratio
- Ability to withstand continuous stalling
- Rapid response
- Freedom from cogging
- Maximum flexibility in mounting

**applications include**

Servo systems requiring sensitive, continuous control of load with high-torque and highest reliability. Models for use with output transformer. Models to operate from plates of vacuum tubes.

**FREE!** For complete technical data on the 10-watt servo motor, send coupon below.

ED

Component Sales Division  
**FORD INSTRUMENT CO.**  
 Division of Sperry Rand Corp.  
 31-10 Thomson Ave., L. I. C. 1, N. Y.

Please send me FREE literature.  
 Please send me prices on the following:

Low-voltage units  
 60 cps                       400 cps

High-voltage units  
 60 cps                       400 cps

Name \_\_\_\_\_  
 Position \_\_\_\_\_  
 Company \_\_\_\_\_  
 Address \_\_\_\_\_  
 City \_\_\_\_\_ State \_\_\_\_\_

8 56

CIRCLE 149 ON READER-SERVICE CARD

**MARTIN**  
BALTIMORE · DENVER · ORLANDO





EVERYTHING  
UNDER CONTROL

*Off the Shelf*

AT YOUR NEARBY **GUARDIAN**  
FRANCHISED DISTRIBUTOR



EAST

**Cramer Electronics Inc.**  
811 Boylston, Boston 16, Mass.  
**Rechester Radio Supply Co.**  
600 E. Main, Rochester 5, N.Y.  
**Arrow Electronics Inc.**  
525 Jericho Turnpike  
Mineola, L. I., New York  
**Federated Purchaser**  
1021 U. S. Rte. 22  
Mountainside, New Jersey  
**Electronic Ind'l. Sales Inc.**  
2345 Sherman N.W., Wash. 1, D.C.  
**Herbach & Rademan Inc.**  
1204 Arch, Philadelphia 7, Pa.  
**Cemeradio Company**  
1121 Penn, Pittsburgh 22, Pa.

SOUTH

**Dalton-Hege Radio Supply Co.**  
912 W. 4th, Winston-Salem, N.C.  
**Specialty Distributing Co.**  
763 Juniper, Atlanta 8, Ga.  
**Thuraw Distributors**  
121 S. Water, Tampa, Florida

MIDWEST

**Pioneer Elect. Supply Co.**  
2115 Prospect, Cleveland 15, O.  
**Mytronic Company**  
2145 Florence, Cincinnati 6, O.  
**Radio Specialties Inc.**  
456 Charlotte, Detroit, Mich.  
**Graham Elect. Supply, Inc.**  
122 S. Senate, Indianapolis, Ind.  
**Newark Electric Company**  
223 W. Madison, Chicago 6, Ill.  
**N.W. Radio & Elect. Supply Co.**  
52 S. 12th, Minneapolis, Minn.  
**Interstate Supply Co.**  
4445 Gustine, St. Louis 16, Mo.  
**Burstein-Applebee Company**  
1012 McGee St., Kansas City, Mo.

SOUTHWEST

**Busacker Elect. Equip. Co.**  
1216 W. Clay, Houston 19, Texas  
**Contact Electronics**  
2403 Farrington Dallas 7, Texas  
**Radio, Inc.**  
1000 S. Main, Tulsa 19, Okla.

**GUARDIAN ELECTRIC**

MANUFACTURING COMPANY  
1622-M W WALNUT STREET CHICAGO 12 ILLINOIS

CIRCLE 150 ON READER-SERVICE CARD

**GUARDIAN**  
the popular "buy word" for relays,  
steppers, switches and solenoids.  
All types with all physical and  
electrical characteristics are  
immediately available from stock  
at your nearby  
Guardian Franchised Distributor.



Micro-Minature  
IR-1005 RELAY



M.E.R. STEPPER



NO. 16 SOLENOID



2200-U RELAY



IR-1210 RELAY



IR 1410  
POWERLOID

FAR WEST

**Newark Electric Company**  
4747 W. Century Blvd.  
Inglewood, California  
**Andrews Hardware**  
334 South Main Street  
Los Angeles 13, Calif.  
**Pacific Wholesalers**  
1850 Mission Street  
San Francisco, Calif.

CANADA

**A. C. Simmonds & Sons**  
100 Merton Street  
Toronto, Ontario, Canada

## NEW PRODUCTS

**SCINTILLATION DETECTOR.**—Model DS8 probe for counting fast or slow neutrons, gammas, and betas. Has 10 stage, 3/4 in. photomultiplier tube and transistorized circuit. Weight, 5 oz; diameter, 1 in.

Nuclear-Chicago Corp., Dept. ED, 229 W. Erie St., Chicago 10, Ill.

CIRCLE 151 ON READER-SERVICE CARD

**SERVO MILLIVOLTMETER.**—SBI-200 self balancing indicator is a miniature panel mounted dc positioning servo. Provides a direct reading proportional to input ratio or millivolts.

North Atlantic Industries, Inc., Dept. ED, 603 Main St., Westbury, N.Y.

CIRCLE 152 ON READER-SERVICE CARD

**HEAVY-DUTY FASTENER.**—Type U securely retains parts on plain round shafts, rods, and axles. No notches or grooves required. Replaces cotter pins and drilling of holes. Removal resistance of 1000 lb.

The Palnut Co., Dept. ED, Glen Rd., Mountain-side, N.J.

CIRCLE 153 ON READER-SERVICE CARD

**SELF-LOCKING NUT.**—All-metal unit for sheet metal fastening. Has a clinching ring which, when squeezed, causes the sheet metal to flow around a back-tapered shank, locking the fastener in the sheet

Penn Engineering and Mfg. Corp., Dept. ED, Doylestown, Pa.

CIRCLE 154 ON READER-SERVICE CARD

**GYRO TESTER.**—Model T 856 control panel for measurement of critical gyro parameters. Incorporates all basic switches and meters for control of gyro inputs.

Sterling Precision Corp., Instrument Div., Dept. ED, 17 Matinecock Ave., Port Washington, N.Y.

CIRCLE 155 ON READER-SERVICE CARD

**STROBOSCOPE.**—Model WE-1-D high intensity stroboscopic light for analyzing high speed mechanical motion or vibration. Flashing rate may be manually varied from 10 to 400 cps in three ranges. Frequency is read on 4-in. meter which also serves as a vtvm.

Westport Electric, Dept. ED, 149 Lomita St., El Segundo, Calif.

CIRCLE 156 ON READER-SERVICE CARD

**RATIO COMPUTER.**—Scintillation detector of 4 pi geometry. Determines energy level of radiation, identifies the radioactive isotope, and measures the amount. Counting time of 100 sec per subject obtains a sensitivity of  $5 \times 10^{-10}$  curies for 1.5 Mev gamma rays.

Radiation Counter Labs, Inc., Dept. ED, Skokie, Ill.

CIRCLE 157 ON READER-SERVICE CARD

## first and only Complete Line of synthetic Lacing Cords

by Alpha Wire

COMPLETE INVENTORY  
IMMEDIATE DELIVERY

- Fungus-proof
- Strong
- Ties easily, fast, tight
- Knots don't slip
- Both round and flat-braided types
- Materials used are nylon, dacron, fiberglass
- Round types have diameters of .017" to .050" and tensile strength of 10 to 70 lbs
- Flat-braided types have diameters of 1/16" to 1/4", tensile strength of 30 to 250 lbs.
- Finishes available are: micro-crystalline wax (MW); synthetic rubber (SR); teflon (T); thermoplastic synthetic resin (AM); and synthetic rubber-like resin (GE)
- Conforms to Spec MIL-T-713A
- There's an Alpha Lacing Cord for your every need
- Manufactured to highest standards by THE HEMINWAY & BARTLETT MFG. CO.

Write for  
Free  
Catalog

ALPHA  
WIRE  
CORP.  
200 Varick  
Street  
N. Y. 14,  
N. Y.



CIRCLE 158 ON READER-SERVICE CARD



Producers of  
Guidance Slip Rings  
for

**BOMARC\***  
**POLARIS**  
**THOR**



\* 60-RING  
BOMARC  
SLIP RING

Experience on Projects such as:

- JUPITER "C"
- JUPITER
- REDSTONE
- ATLAS
- NIKE
- CORPORAL
- NAVAHOE
- AND OTHERS

Write for illustrated brochure

SLIP RING COMPANY OF AMERICA  
3612 WEST JEFFERSON BLVD., Dept. ED  
LOS ANGELES 16, CALIF.


Sales Engineers throughout the U.S. & Canada

CIRCLE 159 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 195

INSULATION

# NEWS

FROM ALPHA  WIRE

## NEW DESIGN FREEDOM FOR YOU WITH COMPLETE LINE OF ALPHLEX® TUBING AND SLEEVING

all cut and marked to your specifications

### PLASTIC TUBING

**PVC-105:** the universal insulating tubing for all electronic needs — conforms to spec MIL-I-631C, approved by Underwriters' Laboratories for 105°C. Displays high resistance to heat, oil, chemicals, corrosion, fungi, abrasion — with no loss in tensile strength, non-flammability or flexibility.

**PVC-80:** withstands temperatures to 80°C. Slightly more flexible than PVC-105.

**PVC-60:** low temperature flexibility to -50°C.

**PLE-70:** for UHF and extra high dielectric uses; also excellent for channeling chemical solutions.

**PVC-744:** meets Spec MIL-I-7444A. For aircraft applications to -67°C.

**PLASTIC ZIPPER TUBING:** Versatility unlimited. Zip to close or open. Or permanent seal. Choose from 5 types, any sizes.

**SILICONE RUBBER FIBERGLASS TUBING, SRF-200:** the finest class H insulation. Excellent shock & fungus resistance, flexibility, freedom from cracking and crazing, from -90°F to +400°F. Conforms to Spec MIL-I-3190.

**SILICONE IMPREGNATED FIBERGLASS SLEEVING, SFS-400:** a quality class H insulation retaining its flexibility and dielectric properties to +400°F. Meets Spec MIL-I-3190.

**PLASTIC IMPREGNATED FIBERGLASS SLEEVING, PIF-130:** excellent class B insulation sleeving for continuous operation to 130°C. Meets Spec MIL-I-3190.

**VARNISH IMPREGNATED TUBING & SLEEVING, VTS-135:** general-application insulation. 4 grades, all meet Spec MIL-I-3190.

**HIGH TEMPERATURE FIBERGLASS SLEEVING, HTF-100:** tightly braided class H 100% fiberglass sleeving for applications as high as 1200°F.

**TEFLON TUBING, TFT-250:** tough & flexible, -90°C to +250°C. Chemically inert. No moisture absorption. Non-flammable. Fungus-resistant.

**SPECIAL PROBLEM?** Consult with us at no obligation.

**ALPHLEX**  **TUBING**

Write for free catalog to ALPHLEX® TUBING Division Alpha Wire Corporation, 100 Varick Street, New York 14, N. Y.

CIRCLE 160 ON READER-SERVICE CARD

**TITANIUM WIRE CLOTH.**—From 4 to 120 mesh with wire diameters from 0.08 to 0.001 in.

Newark Wire Cloth Co., Dept. ED, 351 Verona Ave., Newark 4, N.J.

CIRCLE 161 ON READER-SERVICE CARD

**MULTIPLIER PHOTOTUBE.**—Model 6342-A for use in scintillation counters. Supersedes model 6342. Minimum cathode-luminous sensitivity, 50 µa per lumen; spectral response, 3000 to 6500 angstroms.

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

CIRCLE 471 ON READER-SERVICE CARD

**ADJUSTABLE-SPEED DRIVES.**—"Precision" series drives have 0.5% regulation and can operate continuously at full torque. In various horsepower up to 3/4 hp.

Servo-Tek Products Co., Dept. ED, 1086 Goffle Rd., Hawthorne, N.J.

CIRCLE 162 ON READER-SERVICE CARD

**ADHESIVES.**—R-81001, 81002, and 81114 synthetic rubber, phenolic resin base adhesives. At 600 F, shear strength is 495 psi. For rubber-to-metal, plastics-to-metal, metal-to-metal, and friction materials bonding.

Raybestos-Manhattan, Inc., Dept. ED, Bridgeport 2, Conn.

CIRCLE 163 ON READER-SERVICE CARD

**HEAVY-DUTY ANTENNA TOWER.**—Self-supporting to height of 130 ft. Modular construction. Suited for microwave, radio, and other communication use.

Rohn Mfg. Co., Dept. ED, 116 Limestone, Bellevue, Peoria, Ill.

CIRCLE 164 ON READER-SERVICE CARD

**PLASTIC INSULATION.**—Plastisol for plating, patching, or protective maintenance. Applied by spraying, painting, or dipping, it forms an adherent insulation surface on any metal or coating.

Sel-Rex Corp., Dept. ED, 75 River Rd., Nutley 10, N.J.

CIRCLE 165 ON READER-SERVICE CARD

**POWER TETRODE.**—The 12DS7 for use in hybrid automobile receivers where tube and transistor electrode voltages are obtained directly from a 12 v storage battery. Miniature 9-pin unit has two diodes and a high-perveance power tetrode in one envelope.

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

CIRCLE 472 ON READER-SERVICE CARD

**PULSE DELAY GENERATOR.**—Model 10-K provides a positive pulse delay variable in 0.1 µsec steps over 1 to 10,000 µsec range. Accuracy, 0.01%; jitter, 0.005 µsec.

Orbitran Co., Inc., Dept. ED, Lakeside, Calif.

CIRCLE 166 ON READER-SERVICE CARD

**potter**

MINIATURIZED

*Metallized Mylar\**  
**capacitors**

IDENTICAL CAPACITY  
AND VOLTAGE  
ONE-FIFTH  
THE  
SIZE

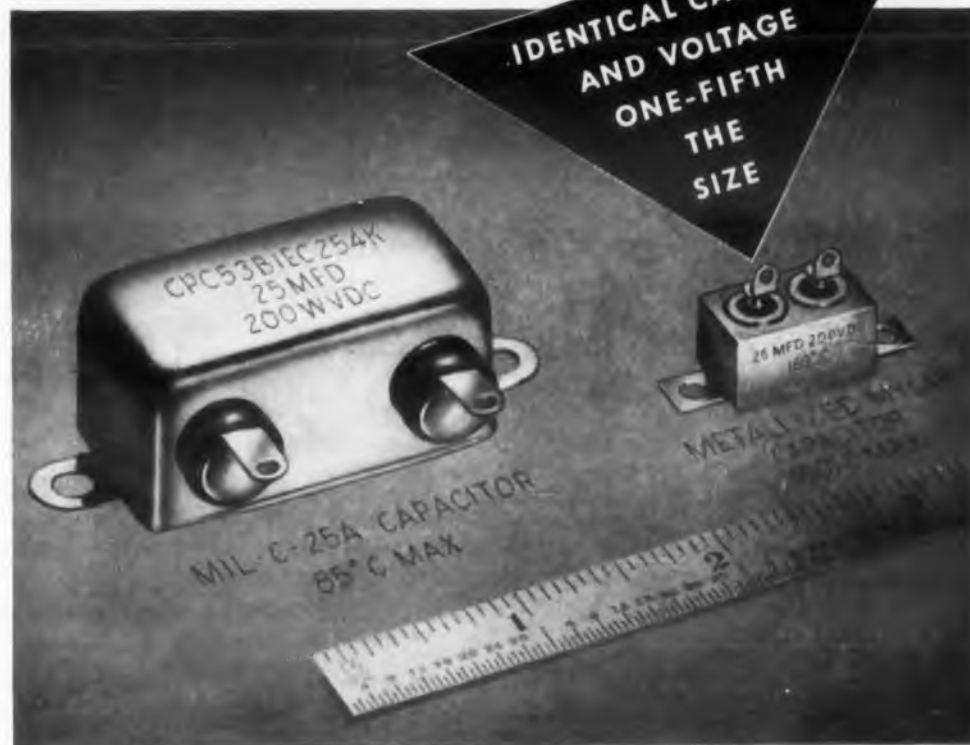


Photo above illustrates space saving potential with new Potter metallized construction.

**100 to 600 VDC  
CAPACITORS**

**FOR TEMPERATURES OF 125°C and 150°C**

\*"Mylar" is a registered DuPont trademark for its brand of polyester film

THE **potter COMPANY**

Specialists in Layer Wound Capacitors Since 1925  
1950 SHERIDAN ROAD, NORTH CHICAGO, ILL.

CIRCLE 167 ON READER-SERVICE CARD



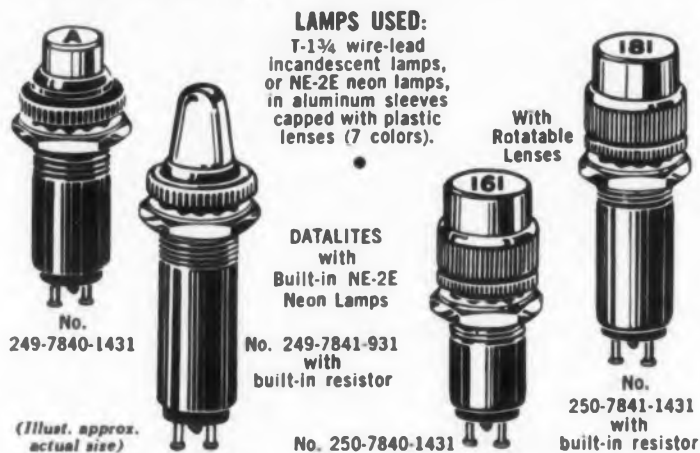


In this brochure—complete facts on DIALCO's

## DATALITES

For the Computer-Automation Industries

DATALITES by DIALCO are ultra-miniature Indicator Lights specially designed to meet the critical requirements of the computer-automation fields. Made in 2 basic styles: **Lamp Holders with DIALCO's own replaceable Lamp Cartridges** (see above); or **integrated DATALITES with Built-in Neon Lamps** which are **not replaceable** (see below). Ultra-compact, single units mount in  $\frac{3}{8}$ " clearance hole; the twin-lamp assembly mounts in  $\frac{3}{4}$ " clearance hole.



DATALITES have fully insulated terminals and conform to all applicable military specifications. Integrated units are available *with or without built-in resistors*. The cylindrical lenses can be hot-stamped with digits, letters, etc. Complete details in *Brochure L-160*. Send for it now.

**SAMPLES ON REQUEST—AT ONCE—NO CHARGE**



Foremost Manufacturer of Pilot Lights

### DIALIGHT CORPORATION

46 STEWART AVE., BROOKLYN 37, N. Y. • HYacinth 7-7600  
CIRCLE 168 ON READER-SERVICE CARD

## NEW LITERATURE

### Transformers 169

Four-page brochure describes transformers and related magnetic components designed for airborne electronics applications. Minitran Corp., 5 Oliver St., Newark 2, N.J.

### Configuration, Voltage Chart 170

This chart simplifies the identification, selection, and ordering of the correct types of plug caps and electrical receptacles for specific amperage and voltage requirements. Diagramming the approved and standardized receptacle openings and plug blade arrangements of 28 different types of polarized, non-polarized, and grounding devices for 2-, 3-, and 4-wire installations, these charts are offered in 17 x 22 in. wall size and 8-1/2 x 11 in. catalog page size. Arrow Hart & Hegeman Electric Co., Hartford, Conn.

### Aircraft, Missile Switches 171

Ten switches for aircraft and missile application are described and illustrated in the 2-color, 6-page brochure. Results of environmental tests conducted for resistance to severe vibration, shock, temperature extremes, long periods of dormancy, etc. are reported. Photographs are supplemented by schematic drawings and specifications. Airtron, Inc., 1096 W. Elizabeth Ave., Linden, N.J.

### 25-Year Batteries 172

Bulletin CP-540 covers the use, design, and construction of the firm's line of lead-calcium grid batteries. These batteries have a life-expectancy of 25 years in control, switchgear, auxiliary power, and other stationary battery applications. Included is complete cell data on the line from 40 to 1650 amp hour ratings, curves on discharge characteristics, rack data, and accessory details. C & D Batteries, Inc., Washington & Cherry Sts., Conshohocken, Pa.

### Transistor Circuits 173

Subject of Radio Brochure G-120. This booklet provides circuit diagrams and technical specifications on transistors for radios. Also included are specifications and circuitry for a new line of drift transistors for very high frequency, small signal applications. General Transistor Corp., 91-27 138th Pl., Jamaica, N.Y.



## New 20-ampere Variac Autotransformers

NEW portable model, cased, 3-wire output receptacle, ON-OFF switch, overload circuit breaker heavy-duty 3-wire line cord and plug.

The new Type W20 Variacs have all of the design features of the previous W units. Wrought metallic parts for better heat transfer between coil and base and between brush and radiator, ball-bearing models for special applications, exclusive DURATRACK contact surfaces for long, trouble-free life with low maintenance. Available in single, ganged, open or cased models and in the NEW Portable Types W20MT3 (115-V) and W20HMT3 (230-V).

Write for Complete Information

### GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

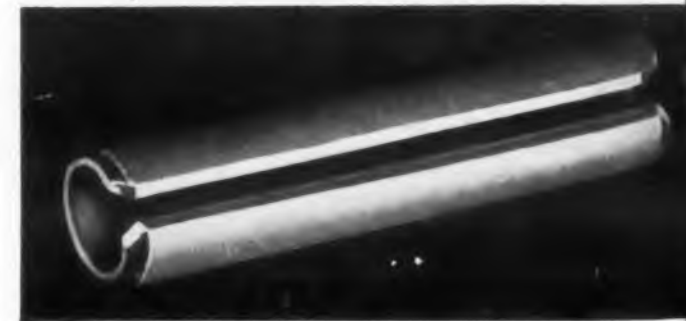
Broad Avenue at Linden, Ridgely, N. J. NEW YORK AREA 1000 N. Seward St. LOS ANGELES 2

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 174 ON READER-SERVICE CARD



## Versatile Rollpin

simplifies design, speeds production

ROLLPIN can be used in place of taper pins, solid straight pins, set screws, hinge pins, dowels, clevis pins . . . and in some cases as a rivet.

ROLLPIN is a slotted, cylindrical spring pin deliberately oversized in relation to standard production drilled holes . . . compressive forces lock it in place. Reaming or secondary safety operations such as peening are eliminated.

ROLLPIN is easy to install, easy to drive out with a drift pin punch, yet will "stay put" indefinitely.

ROLLPIN is available for immediate off-the-shelf delivery. Comes in sizes from .062" diameter to .500" in carbon steel, stainless steel or beryllium copper.

For a free bulletin detailing Rollpin applications and installation methods, write to Dept. R54-1157.



### ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, New Jersey

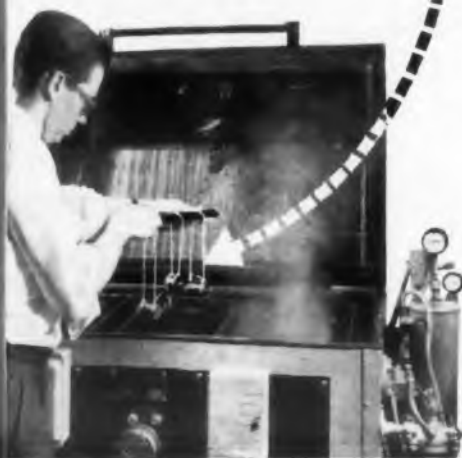
CIRCLE 175 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1956





## STIFF DOSE OF SALT



Exposure . . . to the equivalent of a stiff sea spray . . . on a hot, humid day—*one more* test the G-M Servos take in stride.

Not just a promise—but a tested fact.

G-M Servo Motors are built to deliver the ultimate in performance. The salt spray test shown above is just one of a battery of tortures designed to prove G-M Servos under all extremes of humidity, temperature, altitude, vibration and salt spray.

At G-M "Designed to Meet Mil. Environmental Specifications" is backed by production testing that does just that!

### 4 GOOD REASONS WHY G-M SERVO MOTORS SERVE YOU BEST!

- 1 G-M Servo Motors are available in standard sizes.
- 2 Standard G-M Servo Motors can also be modified to meet specific requirements.
- 3 Creative engineering in designing special servo motors with special characteristics.
- 4 Fast production—better service.

Write Now for information, or send for complete G-M charts and specifications. No obligation, of course.



### Magnetic Laminations

177

This lamination catalog includes variations of standard designs and several new shapes. Also included is a design and performance section. It is 140 pages long and written to simplify lamination procurement. Webcor, Inc., Lamination Div., 3912 W. McLean Ave., Chicago 47, Ill.

### Thermocouple Tables

178

Ten-page spiral-bound booklet of thermocouple tables has two "front covers" and no "back cover" (is turned over for changing from "mv to deg" to "deg to mv") and is indexed for further convenience. Tables are based on 150 F reference temperature. Pace Engineering Co., 6914 Beck Ave., N. Hollywood, Calif.

### Insertion Loss Tester

179

Application Notes No. 4 describes a dual channel insertion loss test set and emphasizes the development of a differential null detector. This device, when used with the recommended accessories, permits measurements to 20 db. Arranged in tabular form are additional instruments involved in the test set. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

### Mammoth Waveguide

180

A giant waveguide rotary joint—three times larger than the previous largest joint—is described in this 4-page bulletin. It furnishes details and specifications on the 6-ft high, 4-ft diameter joint produced for a new high-power low frequency Air Force radar. I-T-E Circuit Breaker Co., Special Products Div., Philadelphia 30, Pa.

### Digital Processing

181

Bulletin No. 3017 provides information on the operation, construction, and features of the 210 Data Processing System. Six pages long, the bulletin contains illustrations, typical applications, and brief theory. Beckman Instruments, Systems Div., 325 N. Muller Ave., Anaheim, Calif.

### Environmental Testing

182

This brochure describes and illustrates the facilities of environmental testing at the manufacturer's plant. The tests include temperature extremes, sand and dust, humidity, fungus, salt spray, shock, vibration, altitude, explosion, and others. Bowser-Morner Testing Labs, Inc., 141 Bruen St., Dayton 1, Ohio.

**NORTHAM**  
ELECTRONICS, INC.  
**NOW MERGED**

## A New Building Block Is Added at BJ ELECTRONICS

BORG-WARNER CORPORATION

Northam miniature magnetic tape recorders and recording systems, variable reluctance transducers, miniature accelerometers, airborne carrier systems, ground playback data reduction systems and special meteorological instrumentation are now available from BJ Electronics, Borg-Warner Corporation.

The Northam merger complements and extends the important group of products and services presently offered by BJ Electronics. Work backlog now transferred includes a USAF contract for high atmospheric wind sounding rockets, and further expansion of Northam multi-channel FM magnetic tape recording systems for missile nose cone flight test data acquisition.

*Complete technical literature and the services of field engineering personnel are immediately available upon request.*

Now—one source for all BJ Electronics and Northam products

BJ Vibrotron® Digital Transducers

BJ Radio-Frequency Test Instrumentation

BJ Data Measurement—Processing Systems

BJ Nuclear Instrumentation

Northam Miniature Magnetic Tape Recorders and Recording Systems

Northam Variable Reluctance Transducers and Miniature Accelerometers

Northam Meteorological Instrumentation

Performance and Environmental Testing



## BJ ELECTRONICS

BORG-WARNER CORPORATION

*Reliability you can count upon*

3300 NEWPORT BOULEVARD, P. O. BOX 1679, SANTA ANA, CALIFORNIA  
EXPORT SALES: BORG-WARNER INTERNATIONAL CORP., CHICAGO, ILLINOIS  
CIRCLE 183 ON READER-SERVICE CARD

CIRCLE 176 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1958

# most complete

- Design Forum
- Product Features
- Ideas for Design
- Engineering Review
- Standards and Specs
- Russian Translations
- Background for Design



More and more electronic engineers report: "I read *Electronic Design* first. It's complete, timely, easier to read, and I can depend upon getting all the new product information."

*Electronic Design's* 8 full time editors, plus staff of assistants, contributors, and correspondents scan the electronic horizons to bring you the complete design picture.

With reading time at a premium, *ED's* every-other-week frequency assures the prompt delivery of topical material; keeps up with this rapidly moving industry.

## ELECTRONIC DESIGN

a HAYDEN publication  
830 Third Ave., New York 22, N. Y.  
PLaza 1-5530

## NEW LITERATURE

### Digital Indicators 185

Principles and applications of servo null-balance digital indicating instruments are discussed in Bulletin No. 1758. The literature describes the common types of transducer pickups used with this type of indicator and illustrates applications. Illustrations include measurement of compression, tension, torque, pressure, flow, and temperature. Performance Measurements Co., 15301 W. McNichols, Detroit, Mich.

### Pressure Measurements 186

Technical brochure on gage, absolute and differential pressure measurements, describes the performance, application, mechanical and electrical specifications, compatibility in installations, and instructions for ordering the instruments. Also included are circuit diagrams, a typical installation, and a basic explanation of the operation of the equipment. Gulton Industries, Inc., Instrumentation Div., 212 Durham Ave., Metuchen, N.J.

### MIL Test Procedures 187

Brochure describes the system of test procedures and reporting methods for tests including vibration, shock, life, electrical measurements, etc. It includes test circuit diagrams, drawings of test fixtures, photographs of test setups, and other media which contribute to obtaining results. A cross reference between the procedures and applicable MIL specifications is included to aid the user in interpretation of military requirements. System of Procedure Specifications, 11916 W. Washington Blvd., Los Angeles 66, Calif.

### Absorption Analyzers 188

This 12-page catalog of test equipment provides descriptions of three models of absorption analyzers and accessory equipment available for use with these instruments. It also discusses the equipment incorporating electrostatic pickup for wave form analysis in electronic circuits having periodic wave forms between 3 and 240 mc. Kingston Electronic Corp., Medfield, Mass.

### Precision Resistors 189

Bulletin GR-20 catalogs bobbinless precision wire wound resistors, containing technical specifications of company's components, and basic engineering theory on precision bobbinless resistors. General Transistor Corp., 91-27 138th Place, Jamaica 35, N.Y.



## RMS to DC CONVERTER

Now, for the first time, laboratory standard accuracy readings of AC voltages (from 20 millivolts to 300 volts) are achieved without sluggishness, excessive loading, and non-linear scales. Model 1240 provides a precision DC output directly proportional to the TRUE RMS of an applied AC voltage regardless of the waveform of the input. Linear DC output has low impedance for meter, analog recorder, data processing system. Combined with DC digital voltmeter operates as precision AC digital voltmeter.

Price \$1,150.00

Model 1240

- True RMS regardless of waveform
- $\pm 0.1\%$  (of Reading) Accuracy
- Linear DC output
- 50 CPS to 10,000 CPS frequency response
- 0.5 second time response
- Low output impedance
- High input impedance

F.O.B. Concord



950 GALINDO STREET

CONCORD, CALIFORNIA

REPRESENTATIVES IN PRINCIPAL CITIES

CIRCLE 190 ON READER-SERVICE CARD



Typical  
**FAR-AIR**  
filters  
now in use by  
major  
electronic  
manufacturers



WRITE OR WIRE  
FOR TECHNICAL  
INFORMATION OR  
THE SERVICES OF  
YOUR NEARBY  
FAR-AIR®  
FIELD ENGINEER

HOW MUCH AIR?  
WHAT PRESSURE LOSS?  
WHAT TYPE OF FILTER?  
WHAT SIZE FILTER?  
HOW MANY FILTERS?

How Are You Going To Solve  
Your Electronic Equipment  
Ventilation Problems?

Smaller components, critical heat effects and effective dirt removal make proper ventilation of electronic equipment most important. FARR COMPANY offers a new line of air filters for electronic components that can be specially designed to meet your needs in any size, shape, material or capacity.

More Important, Farr Engineers who are among the country's leading authorities on air filtration, offer you expert assistance in your ventilation design problems.

**FARR**  
COMPANY

LOS ANGELES • NEW YORK • CHICAGO • NEW ORLEANS

Representing Locations: San Francisco, New York, Montreal, Canada; The Clyde Engineering Co. Pty. Ltd., Sydney, Australia; Montreal, Quebec, Canada; Birmingham, England

Originators of FAR-AIR Certified Filter Service

CIRCLE 191 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1955



**TOUGH**  
and tiny

Save SPACE  
and WEIGHT with

The  
**A. W. HAYDON COMPANY'S**  
Unique Line

of  
**RELIABLE SUB-MINIATURE  
TIME DELAY RELAYS**

**TINY!**  
1 x 2 inch cross section  
7 1/2 ounce basic weight

**TOUGH!**  
Temperature: 54 C. to 85 C  
Vibration: 500 CPS, 10g  
Shock: 30g  
Hermetically Sealed Housings!  
Direct Current or 400 Cycle Operation!  
Standard or Reverse Clutching!  
Custom Designed to Meet Military Specifications!  
Write for Bulletin AWH-TD-502.



**A.W. HAYDON Company**

NORTH ELM STREET, WATERBURY 20, CONNECTICUT  
Design and Manufacture of Electro-Mechanical Timing Devices

CIRCLE 192 ON READER-SERVICE CARD

## Lead Sulfide Detectors

194

This 8-page report is to provide industry with a description of performance characteristics of a range of lead sulfide detectors. The study further shows how the detectors can be produced with long wavelength response and with close control of such meters as resistance, time constant, responsivity, S/N, and NEP. Infrared Industries, Inc., 163 Highland Ave., Needham Heights 94, Mass.

## Transient Filters

195

Catalog sheet covers descriptive material on new line of transistor transient filters, including technical description, specifications, model numbers, and prices. These filters are connected at the dc input of transistorized inverters-converters, frequency changers and switching circuitry and eliminate line conducted transients to the circuits and spurious noise transmission to the line. ERA Electrical Corp., 67 East Centre St., Nutley, N.J.

## Oscillographs and Amplifiers

196

New 8-page bulletin provides detailed engineering specifications, electrical characteristics, and construction of the wide variety of direct-writing oscillographs and associated amplifiers. Rectilinear and curvilinear recording oscillographs using ink-writing pens, electric stylus and heat sensitive stylus are described in Bulletin 210. Photron Instrument Co., 6516 Detroit Ave., Cleveland 2, Ohio.

## Batteries

197

Use, design and construction of PlastiCell lead-antimony grid batteries for telephone, carrier and microwave service, are detailed in a 16-page bulletin. Complete cell data on the entire line from 10 to 1680 ampere hour ratings, curves on discharge characteristics, rack data, accessory details, and sales and service offices of company, are compiled in Bulletin T-533. C & D Batteries, Inc., Conshohocken, Pa.

## Folded Hybrid T's

198

Up-to-date guide for the selection of precision cast and fabrication E Plane and H Plane Folded Hybrid T's included chart of physical and electrical characteristics. Catalog No. 850 available from Microwave Development Laboratories, Inc., 92 Broad St., Babson Park 57, Wellesley, Mass.



*announces a new*  
**MINIATURE DISPLAY  
FOR ANNUNCIATORS**



Three lines of data available simultaneously! Twelve positions provide wide selection. Up to 3 lines may be used - individually or in combination.

**TEMP  
TEST  
STOP**

- One-plane presentation
- Data uniform in size
- Faster and easier to read
- Quickly seen from any angle of viewing
- Modular type construction
- Size: 1-9/16" wide, 2-5/8" high, 5-1/8" deep
- Data of your choice - For Example: PITCH, ALT, BANK, TSTR CHK, END-END, PT-PT, COMPLT, MALFNCT, IN PROG, etc.

Viewing Screen  
And Data Shown  
Actual Size.

Here's a new type miniature display for annunciators that offers greater flexibility, convenience, and savings in time, money, and labor. Small in size and light in weight, it is designed for those annunciator applications where simultaneous data is required in a fast, easy-to-read method. Twelve positions per unit provide wide selection of desired data. Available as a single unit, the IEE miniature display may be assembled in groups ready for panel mounting.

**HOW THE  
DISPLAY  
OPERATES**



The miniature display utilizes 12 miniature rear-projected images. When the lamp (A) at rear of the unit is lighted, it projects the corresponding data on the condensing lens (B) through a projection lens (C) onto the viewing screen (D) at the front of the display.

**WRITE TODAY FOR PRICES AND COMPLETE DETAILED SPECIFICATIONS**  
Representatives in principal cities



**INDUSTRIAL ELECTRONIC ENGINEERS**

Engineers and Manufacturers  
of Fully Automatic Systems and Machines  
3973 Lankershim Blvd., North Hollywood, Calif.

CIRCLE 199 ON READER-SERVICE CARD

## How KPR\* simplifies etched circuit production

\*Kodak Photo Resist

KPR helps you set up efficient coating and etching routines... because it is extremely stable (allows you to coat circuit boards months in advance, then store them as needed)... because it is durable... because your operators can learn to use effectively with a minimum of training. All this helps reduce make-overs and rejects, too. The basic steps in producing circuits with this all-plastic, presensitized, liquid coating are outlined below:

- (1) Clean metal; use power brush for speed.
- (2) Quick acid rinse insures good adhesion of KPR.
- (3) Coat plates by spraying, whirling, dipping; then store till needed.
- (4) Expose briefly to high-intensity arcs; exposure time never varies because of heat, humidity, or long storage.
- (5) Develop; vapor-spray degreaser is fastest.
- (6) Etch circuits, using standard techniques. KPR protects circuit image during assembly of components, strips off clean when panel is "skated" in tin-lead solder.

There's full information in a new booklet called "Industrial Uses of Kodak Photo Resist"—yours 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 patent: now or hereafter in existence.

**Eastman Kodak Company**

Rochester 4, N. Y.

**Kodak**

CIRCLE 193 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1958





### EXCELLENT HIGH FREQUENCY CHARACTERISTICS

#### Davohm Series 850 Hermetically Sealed Metal Film Resistors...

Used wherever the high frequency characteristics of resistors are important because:

- They have a very low reactive impedance component.
- There are no "insulating" plastics or varnishes on the film to add dielectric losses.
- The film is purely metallic without any "semi-conductor" effect.
- Values below 500 ohm can be furnished in unspiralled design as solid films or straight lines.

Send for our hi-frequency data on these— or test them in your circuit.

Now carried in stock by your local distributor.

THE **DAVEN** CO.  
LIVINGSTON, NEW JERSEY

World's Largest Manufacturer of Attenuators

CIRCLE 200 ON READER-SERVICE CARD

## NEW MINIATURE AGASTAT® time delay relay

for missile, aircraft and  
electronic applications



INSTANTANEOUS RECYCLING . . . reset time—less than .020 seconds  
UNAFFECTED BY VOLTAGE VARIATIONS . . . time delay remains constant from 18 to 30 volts DC  
ADJUSTABLE . . . time delays from .030 to 120 seconds  
CHOICE OF OPERATION . . . for either energizing or de-energizing  
SMALL . . . height—4 5/8" . . . width—1 3/4" . . . depth—1 1/2"  
LIGHT . . . maximum weight—15 ounces  
MEETS ENVIRONMENTAL REQUIREMENTS OF MIL-E-5272A

This new AGASTAT time delay relay is an externally adjustable, double-pole, double-throw unit. It incorporates the basic AGASTAT timing principle, proved by a half-century of reliable operation on automatic aids to navigation, in a space-saving miniature unit built to withstand the rugged environmental conditions of missile and aircraft applications.

For specific information on the new AGASTAT relay for your application, write to Dept. A-30-1124

AGA ELASTIC STOP NUT CORPORATION OF AMERICA

1027 Newark Avenue, Elizabeth, New Jersey  
Pioneers in pneumatic timing

CIRCLE 201 ON READER-SERVICE CARD

## NEW LITERATURE

### Air Moving Units 202

A 16-page, two-color brochure (Bulletin 5412) describes line of special purpose air moving units for original equipment manufacturers. More than 50 designs are illustrated and described including packaged centrifugal blowers, vaneaxial fans, tubeaxial fans, propeller fans, pressure blowers and fluid coolers. Specifications given include capacity range, operating speed, construction features and typical applications of each unit. American Standard, American Blower Div., Detroit 32, Mich.

### Indicator Lights 203

Catalog A-58 details complete line of subminiature incandescent indicating lights and accessories. 55 different body and type configurations (including receptacle for low voltage, low current series 344 bulbs) are available for all panel illumination applications. Product now being used by aircraft, missile test stand, laboratory and production line equipment manufacturers because of low cost and versatility. The Sloan Co., 4101 Burbank Blvd., Burbank, Calif.

### Transmitting Tubes 204

Recommended types and selection chart of all electron tubes currently available for transmitting and allied applications listed in comprehensive guide. Publication lists lighthouse and planar types, magnetrons, television camera tubes, Klystrons, triodes, tetrodes, diodes, reference cavities, and gas discharge devices. Data for all tubes includes frequency, plate power output, ratings and operating conditions in Bulletin PT-24. General Electric Co., Schenectady 5, N.Y.

### Electronic Clocks 205

Graphs for computing cumulative errors in electronic clocks are available in a 4-page brochure, which discusses theory and provides 2 examples on the use of the graphs. Timing equipment is also included. Hycon Eastern, Inc., 75 Cambridge Pkwy., Cambridge, Mass.

### Transistor Diode 206

Data for circuit designers interested in computers, telephony, control and pulse circuitry is provided in a new technical bulletin describing four-layer bistable transistor diode. Circuit properties, action of the four-layer diode, switching times, characteristics and test circuits are described in this "file-type" publication. Shockley Transistor Corp., 1117 California Ave., Palo Alto, Calif.



Unusually compact slide for light duty applications, the Jonathan No. 54 slide easily handles 50 lbs. per pair, with wide safety margin.

Optional pivot and locking mechanisms for 45°, 90° or 135°; 6" to 30" length; special attachment for any mounting application. Meets all applicable military specifications. Stainless steel ball bearings; construction of high strength aluminum alloy with stainless steel hardware. Delivery Prototype—10 days; production—2 to 3 weeks.

# J

Write or phone for information.

## JONATHAN MFG. CO.

720 E. Walnut Ave., Fullerton, Calif.  
New York Offices: 51 Chambers Street, N. Y. 1, N. Y.

CIRCLE 207 ON READER-SERVICE CARD



**SMALLEST IN THE INDUSTRY!**  
(patent applied for)  
TRANS-ELEC

## MINI-LITE

New Miniature transistorized control panel  
light that mounts in just 30 seconds!

Simply insert this indicator light in a 3/4" panel-hole, tighten the collar nut and plug in the taper pins. It's completely mounted and hooked up in 30 seconds . . . no soldering needed! Enclosed transistor and 3 resistors can control the NE-2E neon lamp with a 3.0 volt signal. This brand new self-contained display light unit is available in a variety of circuits for computers, data processors, signal systems and transistorized automatic control devices. Body only 1/2" in diameter and 1 1/4" long. For complete data on the Mini-Lite and other control panel components, write or phone WEst 9-6754.



TRANSISTOR ELECTRONIC  
CORPORATION  
3359 Republic Ave. Minneapolis 26, Minn.

CIRCLE 208 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1954

## Flow Switches 209

Devices which respond to the flow of liquid in a pipeline to make or break an electrical circuit are discussed in Bulletin FS-1. Typical application of these flow switches are listed, and their use in an air conditioning system is shown in detail. The bulletin introduces the new FS4 series flow switches, suitable for pressures up to 100 lb., and also covers the E-2 series flow switches, designed for heavy duty pressures up to 50 lb. McDonnell & Miller, Inc., 3500 S. Spaulding Ave., Chicago 18, Ill.

## Servo Valves

Catalog 210 contains a series of curves and schematics which highlight the design and performance characteristics of low flow servo valves for military, industrial and research applications. The 3 color, 6-1/2 page brochure features a detailed glossary of servo valve terms, as well as a cutaway photograph of a typical valve in this series. For a copy of this catalog, write on company letterhead to Moog Valve Co., Inc., East Aurora, N. Y.

## Sealants and Moldings 210

Technical data chart features polyurethane, Thiokol and silicone base electronic sealants and molding compounds. These materials, according to the chart, have good electrical properties, high temperature, fuel and cold flow resistance. Coast Pro-Seal & Mfg. Co., 2235 Beverly Blvd., Los Angeles 57, Calif.

## Crystal Filters 211

The 4 pages of Bulletin CF 10.7 discuss the 10.7 mc family of crystal filters. Vacuum tube and transistor circuitry is shown, in addition to pulse and impulse response photographs, attenuation vs. frequency curves, and block diagrams. Hycon Eastern, Inc. 75 Cambridge Pkwy., Cambridge, Mass.

## Electro-Mechanical Glossary 212

Electro-mechanical actuation and control terminology listed in glossary. Eight pages of definitions are included. Hoover Electric Co., 2100 S. Stoner Ave., Los Angeles 25, Calif.

## A Unique COAXIAL ATTENUATOR ..... from 0-1000 MCS.

Only Applied Research Inc. offers the fixed-pad attenuator with BNC connectors as stock items. Thus, you can directly integrate it with existing equipment without the need for special adaptors.



PAT. PEND.



## COAXIAL TERMINATIONS From 0-1000 MCS.

ARI terminations have been designed to be used either separately or with the attenuators or impedance transformers.

### CHARACTERISTICS

	Attenuators		Impedance Transformers		Coaxial Terminations	
	HFA-50	HFA-75	HFAM		HFT-50	HFT-75
Input Impedance (ohms)	52.5	75	50	75	52.5	75
Output Impedance (ohms)	52.5	75	75, 93, 200, 250 or 300	50, 93, 250 or 300	—	—
*Nominal Attenuation (db)	2, 3, 6, 10 or 20	3, 6, 10 or 20	minimum loss		0	0
Freq. Range (mcs)	0-1000		0-1000		0-1000	
Max VSWR (1000 mcs)	1.2		—		1.2	
Connectors	UG-88/U UG-89/U	UG-260/U UG-261/U	BNC		UG-88/U	UG-260/U

\*non-standard values to order.

# Applied Research inc.

76 South Bayles Avenue, Port Washington, N. Y.

CIRCLE 213 ON READER-SERVICE CARD

## ILLINOIS SUB-MINIATURE ELECTROLYTIC CAPACITORS



Time Tested Quality



2 PRONG UPRIGHT



TUBULAR



3 PRONG UPRIGHT

Here is a complete line of sub-miniature electrolytics which are especially desirable for low voltage D.C. circuits.

Advantages include: patented construction; hermetically-sealed; immersion proof; excellent life characteristics; low leakage currents; shock and vibration-resistant; plus many others.

Available in tubular and upright types, as illustrated, ILLINOIS SUB-MINIATURE CONDENSERS are ideal for applications requiring minimum size and weight.

Write for new, illustrated SMT catalog.

**ILLINOIS CONDENSER COMPANY**

1616 N. Throop Street Chicago 22, Illinois

Telephone: EVerglade 4-1300

CIRCLE 214 ON READER-SERVICE CARD



4101H-10



4101L-11

## TEMPERATURE TRANSDUCERS



2101H-15

response:

# 200 MSEC

**Other Specifications:**  
**Calibration accuracy:**  
 0.1-1.0%, depending on temperature range  
**Repeatability and hysteresis:**  
 within calibration accuracy  
**Resistance at 32 F:**  
 100 ± 5 ohms  
**Nominal temperature-resistance coefficient:**  
 0.0018/°C  
**Output:**  
 0-5 vdc, when Arnoux 100-ohm TME is used.

The newest line of Arnoux temperature transducers — 100-ohm resistance, 200-millisecond response — permits accurate measurement of transient temperatures such as those in missile and aircraft applications. The output signal is 0-5 vdc for as small a span as 180 F, when Arnoux transistorized TME-1 or TME-2 systems or similar equipment is used.

The fluid-immersion transducer (4101L-11), for static or moving fluid, is LOX compatible and available in two calibration ranges: —302 F to —285 F, —320 F to +500 F.

The air transducer (4101H-10) is for static to high-velocity gases.

The surface transducer (2101H-15) is for materials of limited area and thickness, and has great mounting versatility.

Both air and surface types are available in two calibration ranges: —100 F to +500 F, —100 F to +1200 F.

**ARNOUX**

## ARNOUX CORPORATION

11924 WEST WASHINGTON BLVD., LOS ANGELES 66, CALIF.  
 Sales Offices: Beverly Hills, Calif. • Dallas • Great Neck, N.Y. • Seattle • Bryn Mawr, Pa.

CIRCLE 215 ON READER-SERVICE CARD



THE MARK OF QUALITY



## d-c small motors

full size



quick solution to space problems

# NEW

## 1-1/4" diameter permanent magnet motor



With but slightly more than the diameter of a half dollar, this new space-saving, weight-saving d-c motor fits neatly into problem spaces. Explosion-proof cylindrical envelope. Designed to MIL-M-8609 specifications. Write for technical bulletins.

Let this compact, new Barber-Colman FYLM d-c motor help you answer design problems calling for limited motor area. Only 1.25" diameter . . . length 1.77" to 2.40". Capable of operating in ambient temperatures from -65°F. to +200°F, a typical continuous-duty 26-volt motor rated 15 millihorsepower at 9700 rpm, requires 0.6 ampere, and weighs 0.33 lb.

- Patented symmetrical progressive lap winding.
- Double shielded ball bearings.
- Output shafts up to 3/16" may be specified.
- Dynamic braking can be utilized.



**THE WIDE LINE OF BARBER-COLMAN ELECTRICAL COMPONENTS** includes: D-C Motors for industrial equipment and aircraft control applications. Output up to 1/10 hp . . . permanent magnet and split series types . . . various mountings and speeds . . . also available with gearheads or blowers. Tach Generators for accurate speed indication and servo rate control applications. Choppers that require extremely low driving power. Resonant Relays characterized by low operating power, narrow band width. Ultra-Sensitive Polarized Relays operating on input powers as low as 40 microwatts. 400 Cycle A-C Motors for aircraft and missile applications.

**TECHNICAL BULLETIN SERVICE** on all Barber-Colman electrical components. Detailed specifications, performance data, circuitry drawings. Write for bulletins on any or all products.



## BARBER-COLMAN COMPANY

Dept. K. 1883 Rock Street, Rockford, Illinois

Electrical Components • Small Motors • Automatic Controls • Industrial Instruments  
Aircraft Controls • Air Distribution Products • Overdoors and Operators  
Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

CIRCLE 216 ON READER-SERVICE CARD

# PATENTS

### Microwave Transmission Line

Patent No. 2,810,892. Daniel Blitz (Assigned to Sanders Associates, Inc.)

In the transmission line of this invention, the lamination sections commonly used in association with hf electronic devices are each composed of an outer conductor, an insulating panel, and an inner conductor. When used as a unitary, composite, transmission line, the two sections are assembled with the inner conductors connected together. By constructing a sandwich transmission line in this manner the inner-conductor-to-outer-conductor spacings are preserved and maintained constant, regardless of limited relative motion between the inner conductors and, hence, between lamination sections.

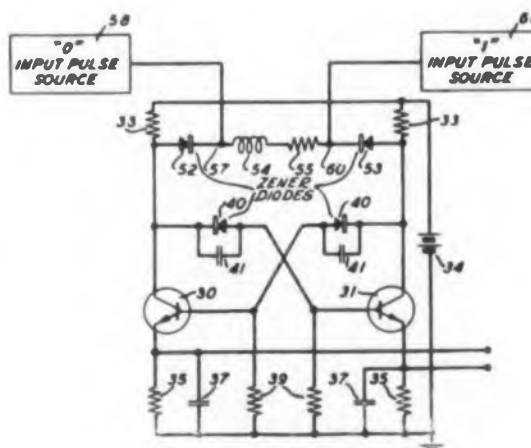
### Nonsaturating Transistor Circuits

Patent No. 2,840,728. George Haugk and Kenneth K. Kennedy (Assigned to Bell Telephone Labs. Inc.)

Back-to-back zener diodes in series with an inductance connected between collectors prevent saturation of either transistor in a bistable transistor multivibrator. Response time to control triggers is thereby reduced. Transistors switch rapidly from "on" to "off" when the current is less than saturation because the magnitude of minority carrier current is decreased.

Transistors 30 and 31 are shown in a bistable circuit. Zener diodes 52 and 53 with inductance 54 are tied in series to the collector electrodes.

Assume transistor 30 conducts minimum current. Then transistor 31 carries



maximum current-less than saturation current-fixed by the breakdown of diode 53. A trigger from the "0" pulse source is isolated from transistor 31 by inductance 54. The multivibrator flips and transistor 30 conducts at a level determined by the clamping effect of diode 52.

Transistor 31 carries a minimum current. A trigger from the "1" input source will cause the circuit to flip over to its original state where transistor 31 again carries maximum current.

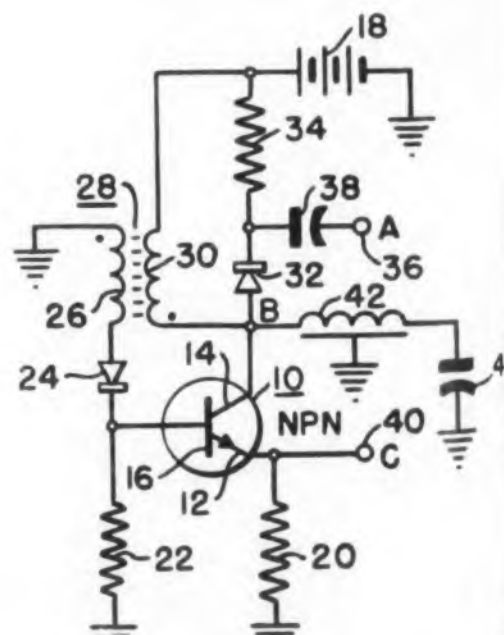
### Transistor Blocking Oscillator

Patent No. 2,848,613. Elherson D. Green and Martin G. Woolfson (Assigned to Westinghouse Electric Corp.)

This patent consists of a blocking oscillator which is locked to the frequency of the trigger source. Pulse width is fixed by a delay line.

In a very simple form of the circuit the transistor is cut off in the quiescent state since the base-emitter voltage is zero. A negative impulse coupled through capacitor 38 makes the collector negative. The transformer reverses the polarity causing the transistor to conduct its saturation current.

The negative impulse travels down transmission line 42. The short circuit effect created by capacitor 44 reflects back a positive pulse which switches the circuit back to the quiescent state.



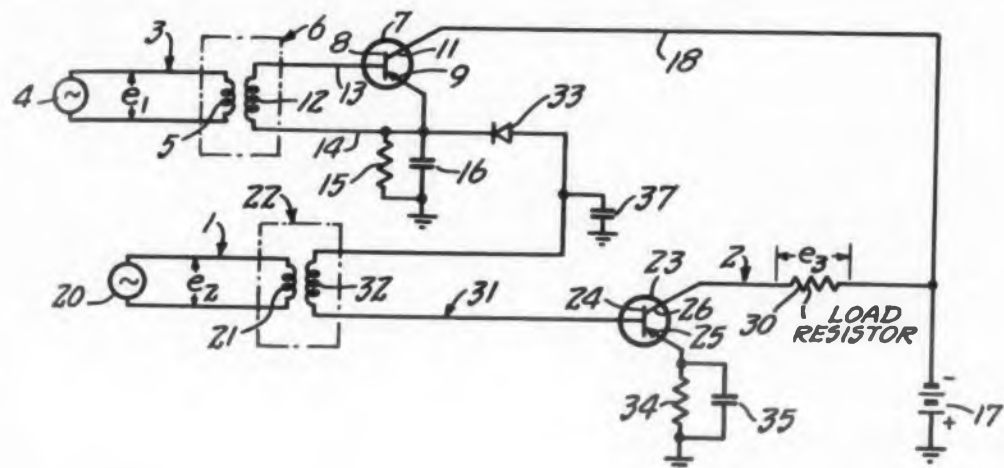


### Proportional Gate Circuit

Patent No. 2,837,740. Robert L. Riddle. (Assigned to Haller, Raymond and Brown, Inc.)

Provision is made for effecting by means of auxiliary signals, a substantially linear gating and amplifying control of the primary signal between a source and receiving circuit.

The auxiliary signal from source 4 is amplified by transistor 7 and rectified by diode 33 to set the emitter-base bias volt-



age on transistor 23. The current passed by transistor 33 to load resistor 30 through the emitter-collector path of transistor 23 is determined by the instantaneous bias developed by the auxiliary signal source.

In the auto-call portable receiver, a communication channel is established only when two modulated carriers are simultaneously transmitted to produce sufficient auxiliary signal output and are tuned to the frequency of the primary signal channel.

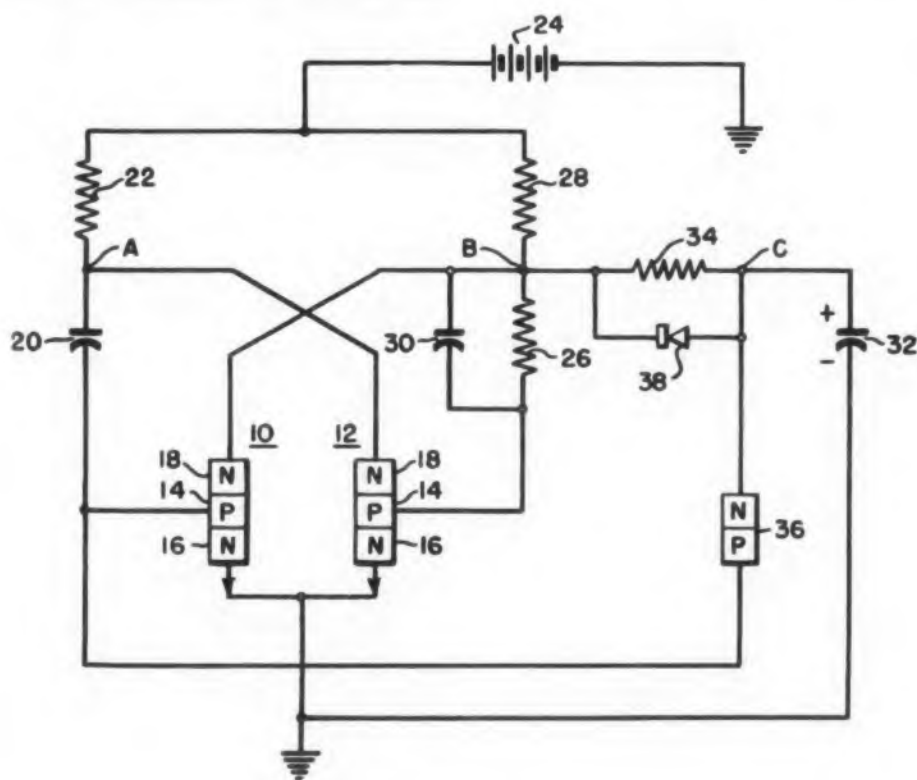
### Transistor Sweep Generator

Patent No. 2,841,712. Henri R. Hoge and Douglas L. Spotten (Assigned to Westinghouse Electric Corp.)

A monostable transistor and a diode comprise the essential elements of this rugged sweep generator.

Initially, the slight negative emitter-base voltage causes transistor 12 to saturate and hold transistor 10 at cut off.

Capacitor 32 charges linearly until zener diode 36 breaks down. Sufficient positive voltage is then coupled to the base of transistor 10 and transistor 12 cuts off. Transistor 10 conducts. This state is maintained until capacitor 32 discharges through transistor 10 and the voltage on capacitor 20 is insufficient to maintain conduction. Transistor 10 cuts off and the circuit flips back to the initial state.



## a-c small motors

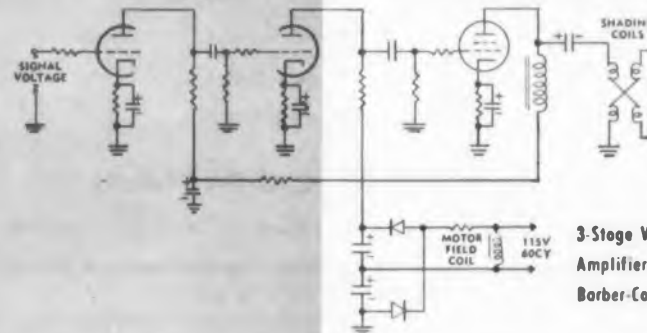
high quality...at low cost



for servo-mechanisms,  
remote switching and  
positioning devices,  
recording instruments,  
and voltage regulators

reversible  
up to 1/25 hp

Barber-Colman shaded pole reversible motors are adaptable to a variety of control circuits and power requirements. They meet the specifications of many applications requiring a compact, powerful, fast-reversing motor.



3-Stage Vacuum Tube  
Amplifier for Controlling  
Barber-Colman Reversible Motors

### geared

double plate—open  
single plate—open  
enclosed

Barber-Colman shaded pole motors are available with both enclosed and open gear trains. Wide choice of models with wide range of gear ratios.

"plus" features of Barber-Colman shaded pole motors

High starting torque . . . low inertia rotors . . . porous bronze or ball bearings . . . hardened and ground stainless steel shafts . . . long-life rugged construction.

### FREE CATALOG HELPS SELECT MOTOR NEEDED

Get the helpful condensed catalog of Barber-Colman shaded pole small motors. Contains complete descriptions of above motors, shows typical specifications performance characteristics, control circuit diagrams. Write for your copy



## BARBER-COLMAN COMPANY

Dept. K, 1283 Rock Street, Rockford, Illinois

Small Motors • Automatic Controls • Industrial Instruments • Aircraft Controls  
Electrical Components • Air Distribution Products • Overdoors and Operators  
Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

CIRCLE 217 ON READER-SERVICE CARD



**NEW**

## **KAY** *Vari-Sweep*

**MODEL 400**  
Cat. No. 867-A

### **WIDER RANGE, ALL-ELECTRONIC SWEEPING OSCILLATOR, OR (with sweep off) CONTINUOUSLY TUNED CW SIGNAL SOURCE**

The new Kay Vari-Sweep Model 400 is a highly versatile laboratory sweeping oscillator and signal source. Its wider range of continuous frequency coverage is combined with accuracy and performance standards previously associated with limited, fixed-frequency-band sweeping oscillators. The high RF output is held constant over the range by a fast acting AGC circuit. A variable sweep rate down to 10 cps permits checking of high-Q circuits.

#### **SPECIFICATIONS**

**Freq Range (CW or Sweeping):** Fundamental frequency, 15-470 mc, cont. variable in 10 switched overlapping bands. Direct-reading frequency dial.  
**Sweep Width:** 60% of center freq to 50 mc; at least 30 mc max 50-400 mc; approx. 20 mc max above 400 mc.  
**Sweep Rate:** Cont. variable, 10-40 cps; lacks to line freq.  
**RF Output:** 1.0 V rms (metered) into nom 70 ohms (50 ohms on request) to 220 mc; 0.5 V rms to 470 mc. AGC'd constant over

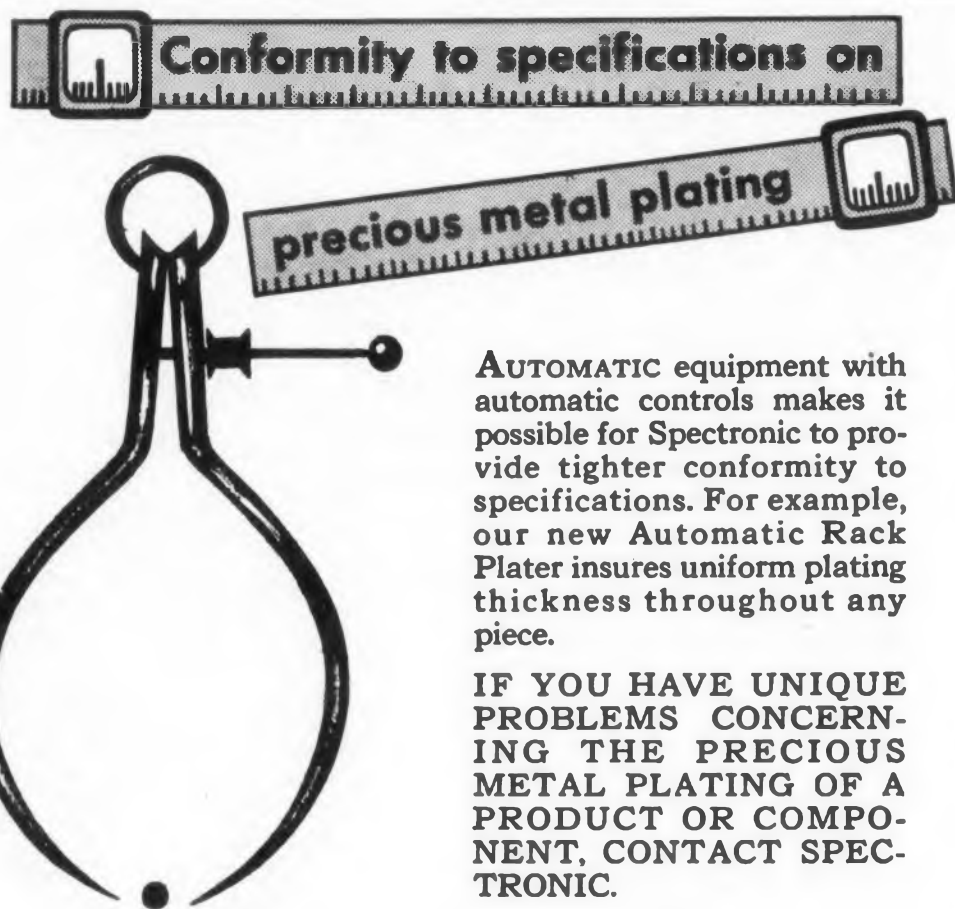
widest sweep and entire range to  $\pm 0.5$  db.  
**Attenuators:** Switched 20, 20, 10, 6 & 3 db plus cont. variable 6 db.  
**Sweep Output:** Reg. sawtooth in sync with oscillator. Amplitude 7.0 V approx.  
**Power Supply:** Input approx. 100 watts, 117-V ( $\pm 10\%$ ) 50-60 cps ac. B+ electronically regulated.  
**Dimensions:** 9 1/2" x 19 1/2" x 13".  
**Weight:** 34 lbs.  
**Price:** \$795.00 f.o.b. factory.

Write for new Kay Catalog

### **KAY ELECTRIC COMPANY**

Dept. ED-11      Maple Avenue      Pine Brook, N. J.      CApital 6-4000

CIRCLE 218 ON READER-SERVICE CARD



**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 219 ON READER-SERVICE CARD



## **BOOKS**

**Table for the Solution of Cubic Equations**  
*Herbert E. Salzer, Charles H. Richards, and Isabelle Arsham, McGraw-Hill Book Company, 327 West 41st St., New York 36, N.Y. 161 pp, \$7.50.*

This new book presents a table for the numerical solution of cubic equations having real coefficients, superseding other tables in number of decimal places, range, interval, required labor finding all three roots, and convenience in use.

From it the reader can obtain all three roots of any equation in a few minutes time, using nothing more complicated than a desk calculator. Here the interval of 0.001 is fine enough for linear or quadratic interpolation, and the 7 decimal accuracy is greater than in other tables. There are completely adequate facilities for interpolation (first and second differences alongside function), and the range of argument covers every possible set of real coefficients.

The presentation provides an introduction explaining the use of the table, interpolation, and comparison with other tables.

#### **Automatic Process Control**

*Donald P. Eckman, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 368 pp, \$9.00.*

This book treats the important principles of automatic control, emphasizing block diagrams and frequency techniques in process control. It begins with process analysis and continues into the generalized behavior of closed-loop systems. The author incorporates numerous problems with answers and nine detailed experiments, including the analog computer. Special topics covered include: new electronic controllers; control elements and actuators; non-linear elements often encountered in process control; Nyquist and Bode diagrams; fluid and thermal process control; computer optimizing control; and direct comparison of control actions.

**How To Become A Professional Engineer**  
*John Constance, McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y. 288 pp, \$5.50.*

This book may serve as a guide for both unlicensed engineers-in-practice and young graduates on how to obtain a professional engineer's license. Every step of the process is covered: the seven basic requirements for licensure are clarified; various state registration laws are summarized; examples are used to show how examining boards evaluate the experience of the candidate.

The book also explains how to prepare an application; gives pointers on selecting the qualifying experience and writing it up; shows how to prepare for written and oral examinations; points out what to look for—including pitfalls—in refresher courses; and tells how to achieve multiple-state registration.

#### **Principles and Applications of Random Noise Theory**

*Julius S. Bendat, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 431 pp, \$11.00.*

The book develops fundamental topics explaining the basic ideas of random noise analysis and optimum filtering techniques. Physical meanings and mathematical restrictions are emphasized. The author shows how to formulate noise problems, derive their solutions, and obtain proper physical designs and interpretations.

The presentation includes discussion on probability theory, random noise analysis, random processes, engineering systems, correlation functions, power spectral density functions, and optimum filters. Other material is relative to power spectra, optimum prediction and filter theory, analog computer techniques, detailed statistical error analysis for correlation measurements, advanced optimum time-variable designs, and the zero-crossing problem.



### Electronic Engineers Master Catalog

*Electronic Engineers Master*, 60 Madison Avenue, Hempstead, N.Y., \$7.50.

The 1958 edition of the master catalog and buying directory of electronic equipment, components and materials sold direct to original equipment manufacturers and other end users is a 1000-page volume containing product information of more than 300 manufacturers. A comprehensive index directs the reader to specific catalog information. Over 4000 manufacturers and service organizations (with addresses and telephone numbers) are listed alphabetically with their respective sales representatives and/or sales offices. A Special Trade Name Directory is another aid for locating information rapidly.

Regular supplements to EEM keep this annual catalog up-to-date throughout the year.

EEM is available to qualified purchasing agents and engineers who specify, design or buy electronic equipment, components or materials.

### Elementary Statistical Physics

C. Kittel, *John Wiley & Sons, Inc.*, 440 Fourth Avenue, New York 16, N. Y. 228 pp, \$8.00

In its fundamental treatment of a wide range of important applications of statistical physics, the book considers kinetic methods, the principles of detailed balance, the Boltzmann transport equation, thermal noise, and the thermo-dynamics of irreversible processes and fluctuations. Mention is also made of negative temperature, magnetic energy, density matrix methods, and the Kramers-Kronig causality relations.

Problems and examples are given which are applicable to many scientific fields—nuclear physics, electrical engineering, solid state physics, metallurgy, and chemistry.

### Wave Propagation and Antennas

George B. Welch, *D. Van Nostrand Company, Inc.*, 120 Alexander Street, Princeton, New Jersey. 257 pp, \$5.75.

This book presents a background of electromagnetic wave propagation and an analysis of fundamental principles of antennas. Developments in radar, forward scatter, and radio astronomy are

treated. Major emphasis is placed upon the basic principles. Similarities between optical and radio waves are constantly stressed. Graphical methods for obtaining radiation patterns are based on the single principle of interference.

### Techniques for Application of Electronic Component Parts in Military Equipment, Vol. II

Edited by Keith Henney and Craig Walsh, *McGraw-Hill Book Co., Inc.*, 330 West 42nd St., New York 36, N.Y. 357 pp.

The book is a working manual for designers of military electronic equipment and provides essential data on component parts so that they may select the parts for end equipment with the greatest reliability.

The volume covers power sources and converters including selenium germanium, and silicon rectifiers, vibrators, dynamotors, transistorized power supplies and batteries; fuses and circuit breakers; electrical indicating instruments; printed wiring boards; solder and fluxes; choppers; blowers; and transmission lines and waveguides. Most of the emphasis is on component types for which military specifications exist.

### Basics of Digital Computers

John S. Murphy, *John F. Rider Publisher, Inc.*, 116 West 14th Street, New York 11, N.Y., 416 pp, \$2.50 per volume, \$6.95 all three volumes, \$7.95 for single cloth binding.

This latest three-volume "picture-book" course offers a very simple treatment of electronic digital computers. Volume One reviews the development of computers, and explains the basic theory of computer arithmetic, data representation, the program, AND and OR circuitry, and control. Volume Two discusses the logical elements, circuits, typical types of signals, and magnetic cores, which are then combined to show a few units such as encoders, decoders, counters, and adders that are typical of computers. Volume Three handles the large system aspects of computers with separate discussions of types of memory, control system, and input-output equipment. Timing is also given extended treatment.



Don't worry, Mac, the Oscillator is built to take it!

### NEW AUDIO FREQUENCY OSCILLATOR HAS $\pm .002\%$ STABILITY AT 100 G's

Reeves-Hoffman's new audio frequency oscillator provides exceptionally reliable performance under high shock and vibration. Rugged construction and highly dependable oven control enables it to withstand as much as 100 G's while maintaining frequency stability of  $\pm .002\%$  over a temperature range of from  $-55^\circ$  to  $+85^\circ\text{C}$ . Equally reliable operation is assured under vibration of 2000 cycles at 10 G's! This new, hermetically sealed oscillator has a frequency range of 400 to 2000 cps, is compact, low in weight and meets applicable portions of specifications MIL-E-5272A. Available in transistor or tube types. Write for Bulletin TCO/300-OC.



DIVISION OF DYNAMICS CORPORATION OF AMERICA  
CARLISLE, PENNSYLVANIA

CIRCLE 220 ON READER-SERVICE CARD

for maximum reliability

### KEEP TRANSISTORS COOL

Keep transistors at or below maximum operating temperatures with these new Birtcher Transistor Radiators. Provides the transistor with its own heat sink and a greatly increased radiating surface. Easy to install in new or existing equipment. Modifications to fit hundreds of popularly used transistors.

FOR MOST JETEC 30 TRANSISTORS  
(Jetec Outline TO-9)

with NEW  
BIRTCHER  
TRANSISTOR  
RADIATORS

B

THE BIRTCHER CORPORATION  
industrial division

4371 Valley Blvd. Los Angeles 32, California

Sales engineering representatives in principal cities.

CIRCLE 221 ON READER-SERVICE CARD



## Testing Magnets with an Oscilloscope

IT IS well known that magnetic fields deflect the electron beam in cathode ray oscilloscopes. Most people who work with scopes have proved this phenomenon, as some time, by playing with a magnet close to the tube screen.

In contrast, another useful application of the phenomenon seems to be quite unknown. An oscilloscope can serve for production test of permanent magnets, as well as of soft steel parts. Fig. 1 to 3 show practical examples of these applications.

In the arrangements of Figs. 1 and 2, the oscilloscope is placed with the screen in the horizontal plane for convenience. A thin translucent layer of plastic material (Plexiglass or celluloid, preferably not thicker than 1/32 in., or simply Scotch tape), may be attached to the glass surface, to serve three purposes:

- To save the crt from breaking by accidentally dropped objects.
- To mark a scale, or tolerance limits for the trace.
- Stop blocks can be cemented on the translucent layer, to allow magnets of the same shape

to be placed always in exactly the same position.

### Testing Bar Magnets

Fig. 1 shows the normal arrangement for production tests of bar magnets. A linear light trace is produced on the oscilloscope and adjusted to a marked base line. By placing a magnet on the tube face, the trace is deflected from its original position. The amount of deflection is proportional to the strength of magnetic flux around the magnet. The indication can be used for numerically comparing the strength of magnets having the same physical shape. Calibration of an absolute scale, or marking tolerance limits can be done by measuring samples of the same shape with a fluxmeter.

After calibration, the method proves superior to the usual fluxmeter method. Placing pieces and reading is faster, polarity is checked at the same time, and accuracy is even better. Though the nominal accuracy of fluxmeters is usually  $\pm 5$  per cent the positioning of pieces under test with respect to the probe often introduces larger errors, especially in production test.

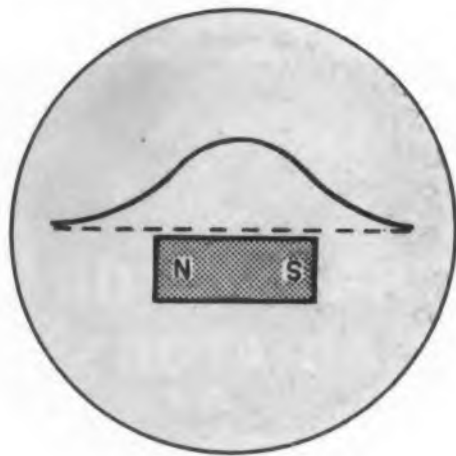


Fig. 1. Testing a bar magnet with a crt. The dotted line shows the normal trace. The solid line shows the trace deflected by a bar magnet.

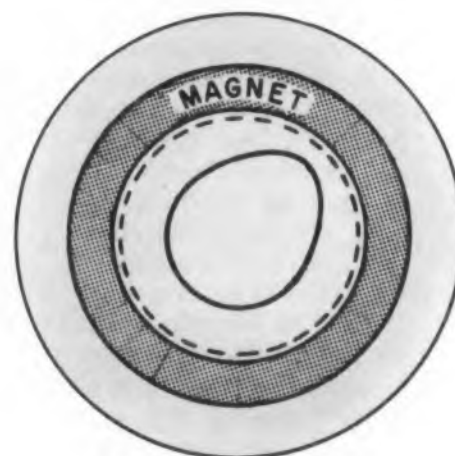


Fig. 2. A circular trace (dotted) is used for testing ring magnets. The solid line shows the trace produced by an unsymmetrically magnetized ring magnet.

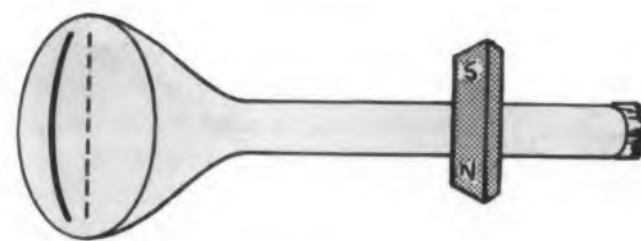


Fig. 3. Testing a mild steel bar for residual magnetism. Test piece is applied to neck of crt for higher sensitivity.

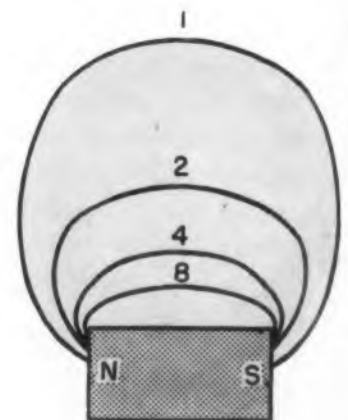


Fig. 4. Lines of gaged flux density around a bar magnet, point-by-point plotted (or photographed) on "Magnetoscope." Figures indicate relative flux density.

### Testing Ring Magnets

Fig. 2 shows a special application in testing ring magnets for symmetry. A circular light trace produced by applying sinusoidal ac in proper phase relation to horizontal and vertical input of the oscilloscope. Placing a ring magnet concentrically with the original circular trace will compress or expand the circle, depending on the polarity facing the tube screen. An unsymmetrical picture indicates unsymmetrical magnetization.

### Comparative Tests

Fig. 3 shows how comparative tests can be carried out on weak magnets. For higher sensitivity, the test piece is placed on the neck of the tube. In this way, very small amounts of residual magnetism can be detected. The method can replace elaborate instrumentation in testing soft parts for undesirable remanent magnetism.

### Gaging Flux Density

Lines of gaged flux around a bar magnet are shown in Fig. 4. These lines can be plotted point-point, or even directly photographed by using a special mask over the face of the crt. A patent application has been filed for this method.

### Use A Sensitive Scope

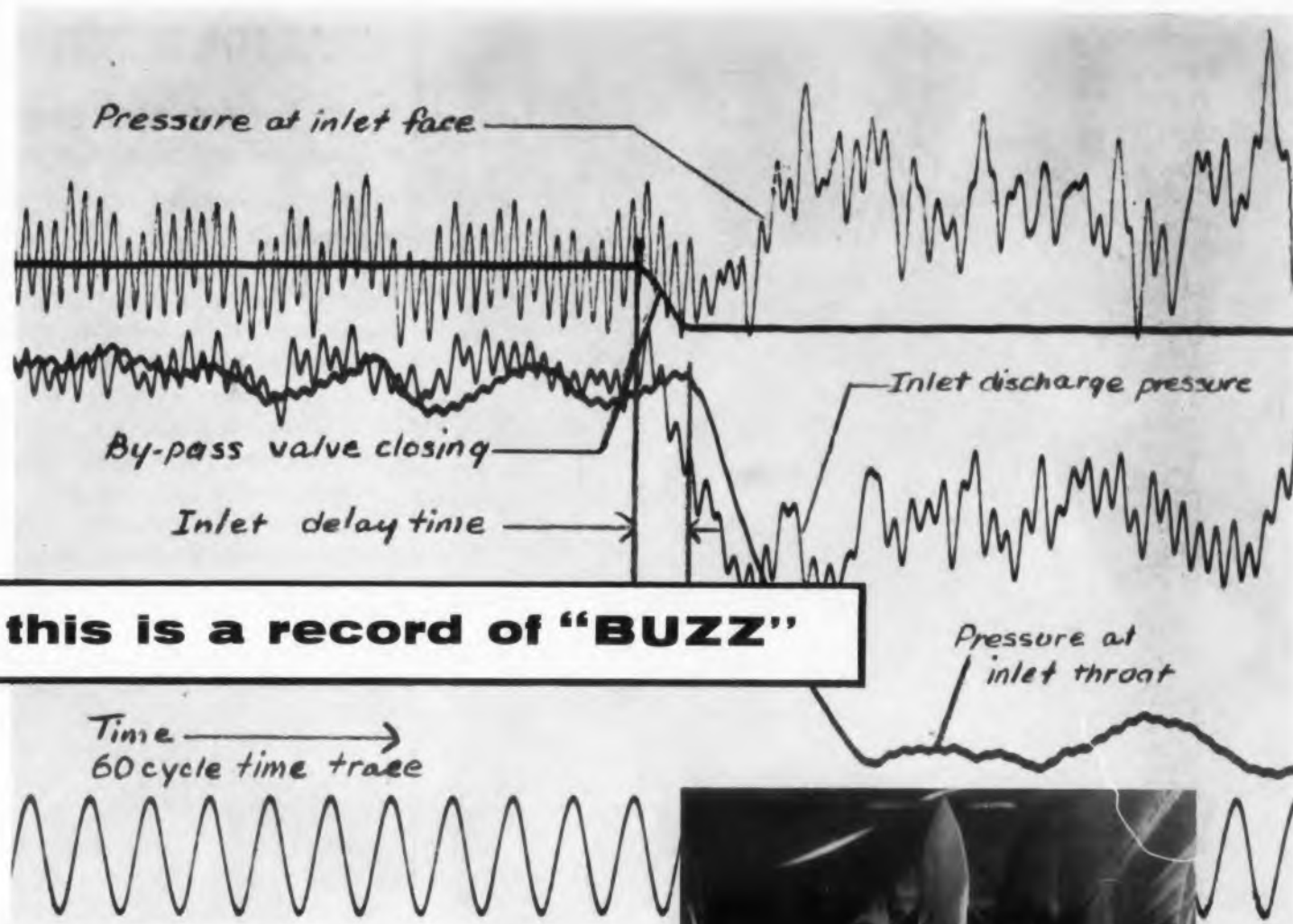
It is essential to have an oscilloscope of sufficient sensitivity for magnetic deflection. By a simple experiment, one can check whether or not an oscilloscope is suitable to test a certain type magnet.

Magnetic field deflection of the cathode ray is inversely proportional to the square root of the accelerating voltage. Earlier models of oscilloscopes usually employing lower accelerating voltages than modern types can often be used without change. By decreasing the high voltage applied to the crt, the deflection sensitivity can be further increased in most cases to about two or three times the original value.

For building up new "Magnetoscopes," only a dc supply are needed as major components. If the instrument is intended for testing ring magnets only, the tube may be a 3AP1 (3A). A dc supply of 250 v at 1 ma is sufficient to produce highest deflection sensitivity (in the order of 100 gauss per centimeter). With the tube and a supply of 2000 v at 1 ma, a sensitivity range of 3 to 1 can be covered by dial switch positions.

The only further electrical function required is to deflect the beam in a linear trace. This can be done by applying 60 cycle line voltage to one of the deflection plates.

W. J. Busch, Electronics Engineer, Strom-Carlson Co., Rochester, N.Y.



### The Visicorder charts pressure fluctuations in a supersonic inlet

A Model 906 Honeywell Visicorder wrote this record of pressure fluctuations . . . "buzz" . . . for the National Advisory Committee for Aeronautics at the Lewis Flight Propulsion Laboratory in Cleveland. Buzz is the term used to describe unsteady variation in pressure and airflow characteristics of a supersonic aircraft or missile inlet.

The purpose of these Visicorder studies is to define the buzz-free operating limits of the inlet, and to provide the designer with structural load information in case the inlet is inadvertently caused to operate on buzz during flight. This is particularly important because inlet buzz can result in fluctuating structural loads of the order of 1000 psf. Depending on the inlet design, this could cause structural failure of the inlet and loss of the airplane.

High response pressure transducers are used to measure these fluctuating pressures and the resulting electrical signal is fed into the Visicorder. Records such as this are also necessary in the determination of the inlet dynamics such as delay time. This information is then used to design inlet control systems.



The HONEYWELL VISICORDER is the first high-frequency, high-sensitivity direct recording oscillograph. In laboratories and in the field everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

# Honeywell

**H** Heiland Division

Reference Data: Write for Visicorder Bulletin

Minneapolis-Honeywell Regulator Co., Industrial Products Group, Heiland Division, 5200 E. Evans Ave., Denver 22, Colorado

CIRCLE 222 ON READER-SERVICE CARD





## ...and now for the sealing test!

If the pots you need *must* function in a dust or sand environment, you could build 'em yourself to make sure they stay clean! But before you move heaven and earth while testing your creation, exactly what have you planned, to give you a tight seal, yet low torque? And if that isn't enough of a problem, how do you keep foreign matter out of the bearings?

But why move heaven and earth, mostly earth, to test your own dirt-free pot, when Ace has the pots with the dust-free features? Special O-rings seal sand, dust and other foreign matter eliminating abrasion damage. Our wound nylon packing delivers excellent sealing with lowest torque. Also, a special silicone-type grease, located in shaft pockets, captures foreign particles before they ever get a chance to do any damage. So if grit's a problem for you, come to Ace for the answer. See your ACErep!



This 3" AIA Acepot (shown 1/3-scale), meeting all MIL spec's on sealing, incorporates these exclusive anti-dirt and dirt-trapping features. Mandrels are also fungicide-varnished, to insure long life.

**ACE** ELECTRONICS ASSOCIATES, INC.  
99 Dover Street, Somerville 44, Mass.  
SOMerset 6-5130 TXM SMVL 181 West. Union WUX

Acepot® Acotrim® Acoset® Aceohm® \*Reg. Appl. for  
CIRCLE 223 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

### Stopwatch Measures Tantalum Capacitors

Tantalum capacitors often have their markings removed in use. They're normally hard to measure since most bridges have internal signals greater than the peak voltage ratings of these capacitors. It's inconvenient to use an external dc power supply for polarizing the capacitors.

The unknown capacitor can usually be identified as to manufacturer. Knowing this, and the physical size, the possible range of capacity and voltage can be narrowed down.

An easy approximation of the capacity (above 4  $\mu$ fd) can be obtained with an ohmmeter and a watch. The unknown capacitor is discharged, then charged by the ohmmeter in the R x 10,000 position. The time from the initial connection to the time when the capacitor discharges to 100 on the scale is used to indicate the capacity.

A table can be made up with known capacitors. For each brand of capacitor, it should indicate the average time for the ohmmeter to read 100 (on the R x 10,000 scale).

The method doesn't work too well with capacities less than 4  $\mu$ fd, since the discharge rate is too fast. The discharge time can be increased somewhat by timing the discharge to a reading greater than 100 x 10,000. This value is small enough to keep the leakage of large capacitors from giving incorrect discharge times.

James R. Zoerner, Design Engineer, Crosley Div. of Avco, Cincinnati, Ohio.

### Free Running Blocking Oscillator With Equal Off-On Times

We needed a free running blocking oscillator, whose off-time was approximately equal to the on-time. With conventional techniques, the off-time is approximately two to three times the on-time.

The reason for this can be seen in Fig. 1. Capacitor C charges during a pulse, and must leak through R during the interpulse period. The transformer must also return to a non-saturated

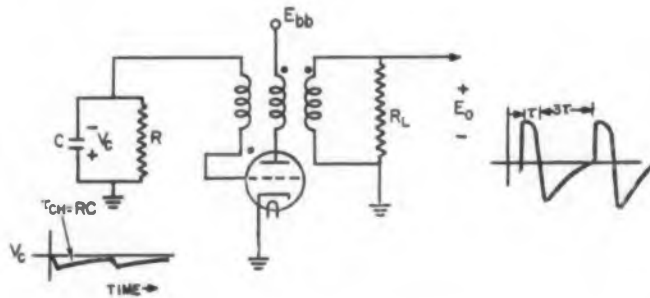


Fig. 1. Conventional blocking oscillator has an off-time about three times as long as the on-time.

## LINEAR ACCELEROMETER

RELIABILITY  
AND ACCURACY AT  
-65° F  
TO +200° F



The remarkable gas-damping feature of the Model A501 answers critical missile and aircraft testing demands for an accelerometer of accurate, reliable operation over a wide temperature range without the use of a heater jacket. Model A501 produces flat up to 100 cycles per second—reliable signals rapidly changing acceleration.



Range:  $\pm 5$  to  $\pm 50$  g  
Excitation: 5 volts DC or AC (rms)  
Output:  $\pm 20$  millivolts  
Non-linearity and Hysteresis:  
Not more than  $\pm 1\%$  full scale  
Weight: 6½ ounces

For detailed technical data to answer your questions, write for Bulletin A501TC.

**Statham**  
INSTRUMENTS, INC.

accuracy / integrity / reliability

12401 W. Olympic Blvd., Los Angeles, Calif.

CIRCLE 224 ON READER-SERVICE CARD



# PRODUCT-DESIGN MEMOS

FROM DUREZ

Electrical-grade phenolic

Fire-retardant prepreg

Large Inserts no problem

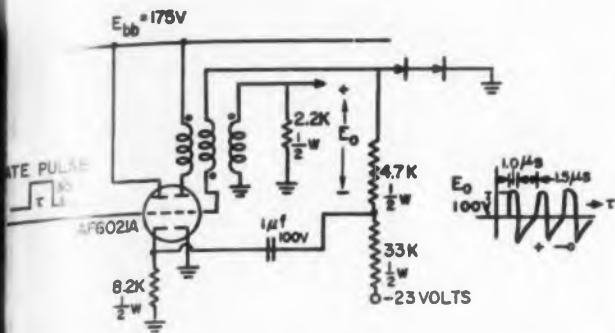


Fig. 2. In this blocking oscillator, the on-time can be made almost equal to the off-time. The transformer has a 1:1 ratio and uses a ferrite core.

condition, if retriggering is to yield an output. Of the two delays in recovery, the RC delay is usually more severe. This can be eliminated by placing zener diodes in place of, or in parallel with C. This prevents the capacitor from charging; therefore, the only recovery time is that of the transformer.

The circuit of Fig. 2 yields powerful pulse groups, with a short time duty cycle of 40 per cent and a long time duty factor of 0.01 at a short time rate of 400 kc. The zener dissipation may be monitored with a 1 ohm resistor in series to determine its current ( $I$ ). Its voltage ( $E$ ) may be monitored with a scope.  $P_{average} = n\tau/T EI$  where  $n$  is number of pulses in a pulse group and  $\tau/T$  is the width of a sub-pulse divided by inter-pulse-group period. Much faster repetition rates may be accomplished with short-pulse transformers (0.05 to 0.5  $\mu$ s). There should be no problem in obtaining 1 to 2 mc pulse repetition rates, and 5 mc rates may be possible.

Two or three zeners may be used in series to minimize the junction capacitance, if necessary. Some zeners work better than others in this respect. Two TI 653C's in series performed nicely in the circuit shown.

Jean A. Develet, Jr., *The Ramo-Wooldridge Corp., Penetration Systems Dept., Los Angeles 5, Calif.*

## Easy Color Coding

In a lab breadboard it is often difficult to correlate leads and test points with the circuit diagram unless effort is taken to label points and maintain a large supply of color coded wire. A good method is to keep a set of cheap water color paints and a small paint brush handy. When you can color code any available leads in a jiffy for easy identification with a minimum effort. Test points can be numbered and identified by small color dabs. Best of all, the paint takes easily to most surfaces.

Richard S. Muller, *Hughes Aircraft Co., Culver City, Calif.*



## Brain cells for a bird

Chill fog swirls in around the slim white missiles poised on their launchers. From clouds massing above, snow begins to spiral faster and faster.

For these silent sentinels on 24-hour watch, weather can be an enemy. Within the missile, and in the incredibly complex electronic brain that guides it, thousands of parts and connections must be ready to function perfectly in the few vital seconds of the rocket's flight.

This is one of the basic reasons why many thousands of mechanical and electrical missile components are made with Durez 16274 Natural, a mineral-filled phenolic with highly stable electrical characteristics.



Molded by standard compression or transfer methods, 16274 has excellent surface finish and can be machined with tung-

sten carbide tools. It is designed to meet the requirements of Mil-P-14D, Type MFE.

If these properties suggest a place for 16274 in a current project, check the coupon for a special 4-page bulletin detailing properties and molding and finishing procedures. For an evaluation sample, write us on your business letterhead.

## Fire-retardant prepreg

Now you can meet the most exacting requirements for reinforced plastic parts that must be strong, tough, and flame-retardant.

You get these properties in a new prepreg, made with Hetron<sup>®</sup> polyester, that eliminates weighing, mixing, and pouring of resin in your plant.

This material provides exceptionally high tensile, flexural, and impact strengths; smooth glossy surface; and excellent wet-strength retention. It is self-extinguishing without the use of additives.

The drapable sheet conforms to complex curvatures, facilitating layup. It is supplied in rolls up to 60 yards long, which have

shelf life of six months or more under normal storage conditions.

For a list of manufacturers of prepreg materials, write us. For data on the Hetron resins with which they are made, check the coupon.



The Black & Decker Mfg. Co.

## Big Inserts no problem

Do you hesitate to specify large molded-in-phenolic inserts for fear the phenolic will crack?

Your molder can now allay your apprehensions—with Durez 18001 Black.

Developed specifically for use with large metal inserts, as in this brush-holder cap for an electric hammer or saw, 18001 is highly crack-resistant. It combines many other qualities: high dielectric strength, excellent dimensional stability; arc resistance of 180 seconds by ASTM D495—and low cost.

For a more complete rundown on 18001, check the coupon and we'll send you technical data.



For more information on Durez materials mentioned above, check here:

- Electrical-grade molding compound, Durez 16274
- Hetron polyester resins (technical data file)
- Phenolic molding compound, Durez 18001

Clip and mail to us with your name, title, company address. (When requesting samples, please use business letterhead.)



PLASTICS DIVISION

HOOKER CHEMICAL CORPORATION

2211 Walck Road, North Tonawanda, N. Y.

CIRCLE 225 ON READER-SERVICE CARD



# SHIELDED CABLES

*designed for*



These low capacity cables are especially designed for use as leads between amplifiers, speakers and record changers of Stereo HI-FI units. Standard Two Conductor and Single Conductor cables are available and, where required, modifications of these cables can be developed to satisfy specific requirements.



## LOW CAPACITY RECORD CHANGER TO AMPLIFIER EXTENSION CABLE

Two Stranded Conductors with clear polyethylene insulation extruded in parallel with a spiral wrapped tinned copper shield and a black extruded plastic jacket. Two styles available, with .030" wall insulation, 24 uuf per foot shield to conductor capacity and .017" wall insulation, 39 uuf per foot shield to conductor capacity.

## LOW CAPACITY HI-FI AMPLIFIER INTERNAL SIGNAL CABLE

Two Solid Conductors in parallel with red and clear polyethylene insulation and spiral wrapped tinned copper shield with black extruded plastic jacket with 24 uuf per foot shield to conductor capacity.



## STEREO RECORD CHANGER TO SPEAKER CO-AXIAL SINGLE CONDUCTOR LOW CAPACITY CABLE

For complete specifications for these and other Lenz Wires and Cables write today for the new Lenz Catalog.

Single Stranded Copper Conductors with polyethylene insulation, tinned copper full coverage shield and black or gray plastic insulation. Three styles available with shield to conductor capacities of 28, 31 and 33 uuf per foot respectively.



WIRES

and

CABLES

In Business Since 1904

**LENZ ELECTRIC MANUFACTURING CO.**

1753 No. Western Ave., Chicago 47, Ill.

CIRCLE 226 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

### Current Measuring Adapter

In large consoles, it's not always easy to get to the right points to measure currents. In one piece of equipment, current could best be measured at the fuse holder, since the various assemblies were separately fused. But the problem remains—how to get into the fuse holder.

The gadget in the photograph solved the problem neatly. It's necessary to drill holes through the ends of a fuse and clean out the fuse. At one end, the hole must be large enough to clear the insulation on a wire which is to be inserted. At the other end, a stripped piece of wire goes through the fuse, and through a small hole and is soldered to the metal.

A hole large enough to clear two wires is drilled in the fuse holder end cap. The wires are threaded through this cap. Then the assembly replaces the regular fuse while current measurements are made. The ammeter goes at the end of the pair of wires.

*James A. Fred, Dev. Engr., P. R. Mallory & Co., Inc., Frankfort, Indiana.*



Adapter for measuring fused currents.

### Mechanical Modulation Of Microwaves

At least two means of mechanically modulating a microwave may be conceived:

1. Amplitude modulation by a rotating resistance card attenuator in the waveguide transmission line, and
2. Phase modulation by a rotating phase shifter in the waveguide transmission line.

Both methods can prove useful in telemetry applications where amplitude modulation or phase modulation of microwave signals is desirable. High modulation frequencies cannot be used because of the mechanical nature of the systems. Certain advantages can be realized through the use of these systems.

- With a continuously transmitting magnetron,

VITREOUS-ENAMELED RESISTORS



## "SNIP OR CLIP" TAB TERMINALS

Snip the lead, or clip the tab... the exact terminal type you... Save space and eliminate the... to stock two types of resistors... unique feature is on General Ele... 5-, 10-, and 20-watt resistors... your vitreous-enameled resistor... follow reader service instructions... General Electric Co., Roanoke, Va...

Progress Is Our Most Important Product

**GENERAL ELECTRIC**

CIRCLE 227 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1955



AMELE  
ORS



## FREQUENCY STANDARDS

Provide stable Square Wave source for missile requirements  
Light weight—small size  
Ruggedized for missile service

The TFS-SQ-400-28 Secondary Frequency Standard is a completely transistorized unit consisting of a crystal controlled oscillator, six binary count down stages, and an emitter follower output stage. This design provides a highly reliable source of reference frequency in a small package size.

Potted in high stability epoxy resins, the circuit complex exhibits high resistance to environmental stresses and immunity to moisture, pressure variations and normally destructive contaminants.

The crystal is mounted in a ruggedized holder to permit high acceleration; shock and vibration. Silicon resistors are used throughout and thermal coefficient components are used to insure reliability and stability over a wide temperature range.

### TYPICAL CHARACTERISTICS

Type TFS-SQ-400-28B

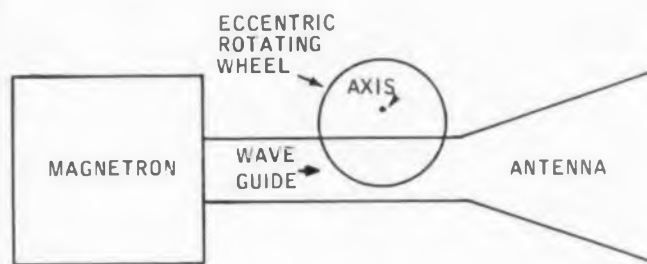
Frequency . . . 400 cps  
Frequency Accuracy  
20°C . . . . . ± .003%  
Frequency Stability . . . ± .05%  
Operating Conditions:  
Temperature . . . . . -55°C to +85°C  
Voltage Variation . . . 25 to 30 vdc  
Frequency Variation . . . 0 to 2000 cps @ 15 G  
Voltage . . . . . @ 28 vdc input  
20v P to P Min.  
Impedance . . . 1200 ohms  
Voltage . . . . . 28 vdc  
Power . . . . . 1 watt  
Wave Form . . . Square  
Dimensions . . . . . 3 1/2" long x 1 1/2" dia.  
Weight . . . . . 6 ounces

For data sheet or information on your requirements.

**Designers for Industry**  
Incorporated 1935  
Full Service Parkway • Cleveland 9, O.

Circle 229 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1958



**Microwave modulation** by an eccentric rotating wheel.

amplitude modulation is normally difficult to achieve without undesirable side effects, such as the shifting of the magnetron frequency. The figure shows the concept of an eccentric resistance card attenuator. The frequency of the amplitude modulation is determined by the speed of the rotating wheel. The modulation amplitude is determined by the depth of insertion of the wheel into the waveguide.

Some fixed-frequency magnetrons are useful only with pulse modulation. The use of the rotating phase shifter permits phase modulation of the magnetron's output. Thus phase modulation may be similarly accomplished through an eccentric wheel phase shifter. The modulation frequency is determined by the speed of rotation of the wheel, while the modulation amplitude is determined by the depth of insertion of the wheel into the waveguide. The figure is also applicable for this method, except that a phase shifter rather than a resistance card will be used as the eccentric wheel.

R. S. Duggan, Jr., Lockheed Aircraft Corp., Georgia Div., Marietta, Ga.

## Temporary Chassis Full of Holes

When constructing a temporary chassis for electronic equipment, a great deal of time is spent drilling and punching holes in aluminum. Often this chassis is short-lived and the effort put into the test setup is thus excessive.

A very convenient and inexpensive material for use as a test chassis, with "pre-punched holes," is heavy wire mesh. It can be obtained with any grade wire and with a specified number of wires per inch.

By folding the sides of a sheet of the mesh, a chassis can be formed. Small components can be located anywhere on the top or bottom of the mesh by securing them with screws through the mesh—and without the necessity of drilling holes. Large holes can easily be cut with tin cutters.

Aside from the simplicity of fabrication, the chassis also provides shielding and cooling.

Guenther K. Machol, IBM, San Jose, California.



## SHORT CIRCUIT PROBLEMS?

### ERA's TRANSISTOR CIRCUIT PROTECTOR Over-Voltage, Over-Current Electronic Limit Relay

Model RV30

For Transistor Power Supply and Load Circuit Protection

#### APPLICATIONS

- Transistorized Over-Voltage and Current Relay
- Connects Between Load and Power Supply
- Maintains Load Voltage Below Present Value
- Prevents Short-Circuit or Over Current Damage

#### SPECIFICATIONS:

Input 5-50 VDC, over-voltage adjustment range 5-50 VDC. Maximum pass current 1 ampere. Voltage drop approximately 0.4 V maximum. Current limit range 100 ma-1 ampere. Response time approx. 25 microseconds. AC turn off rating 115 VAC, 5 amps. Unit is self contained in a 6 7/8" x 3 1/2" x 5" miniaturized relay rack housing.  
Model RV30 Price \$95.00  
With AC Turn Off Magnetic Relay Add \$35.00  
FOB Cedar Grove.

The RV30 is interposed between the load circuit and power supply and effectively disconnects the circuit in the event of either an over-voltage or excessive current condition. The unit incorporates a transistor switch which normally provides an extremely low resistance path between connected equipment. Under abnormal operating conditions, a high resistance path is presented within a response time in the order of microseconds. In the event abnormal conditions are maintained an electromechanical relay is activated which removes the AC input power from the supply source.

The model RV30 contains both voltage and current sensing circuitry and over-voltage and current limits may be set by means of front panel controls.

Facilities for AC input switching of connected equipment are provided for in the rear of the unit.

#### Pioneers in Semi-Conductor and Transistorized Products.

First Miniaturized Power Packs.  
First Transistorized Power Supplies.  
First Automatic Transistor Test Equipment.  
First Dual Output Tubeless Supplies.  
First Packaged Transistor Circuits.

First Transistor Application Power Supplies.  
First Constant Current Generators.  
First High Current Semi-Conductor Regulated Supplies.  
First "E" Core Transistorized Converters/Inverters.  
First High Power Semi-Conductor Frequency Changers.



**ELECTRONIC RESEARCH ASSOCIATES Inc.**

67 Factory Place, Cedar Grove, N. J.

Center 9-3000

SUBSIDIARIES

ERA PACIFIC INCORPORATED • SANTA MONICA, CALIFORNIA  
ERA ELECTRIC CORPORATION • NUTLEY, NEW JERSEY

CIRCLE 229 ON READER-SERVICE CARD





## A new Signal Conditioning System by MRC

*Versatile... Dependable... Adaptable*

Now, Magnetic Research Corporation introduces a new Signal Conditioning System, originally designed for missile telemetering applications. In addition, the system performs to maximum efficiency in Research and Development of engines... in wind tunnels... aircraft... and on any additional applications where stability—simplicity—universality—light weight are most important. These outstanding features have been achieved through unique modular construction which also enables complete interchangeability and electrical isolation of any of the various modules. Power input required consists of D-C. The Signal Conditioning System is available in complete packaging of as many modular channels as required. The following modules presently available:

- POWER SUPPLY REGULATOR
- VIBRATION AMPLIFIER
- CARRIER AMPLIFIER
- D-C AMPLIFIER (0 to 2 cps band)
- D-C AMPLIFIER (0 to 100 cps band)



*Pacing the industry in astro-magnetics*

**MAGNETIC RESEARCH CORPORATION**  
3160 W. El Segundo Blvd., Hawthorne, California

CIRCLE 230 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

### Modify Power Supply To Save Transistors

In case of power failure, the output voltage of most vacuum tube dc power supplies increases momentarily to a high value. In most transistor work this sudden change in voltage is enough to damage the transistors.

A single pole normally open ac relay may be used to break one side of the supply at the output terminal. The coil of the relay is energized by the line voltage (after the power switch). If the power fails or the main switch is turned off by mistake, the relay opens and disconnects the terminal from the high voltage. To increase the life of the relay an arc suppression network, or a double pole relay may be used.

*J. Farzan, Burroughs Corp., Electro Data Div., Pasadena, Calif.*

### Rapid Frequency Deviation Measurement

The measurement of frequency deviation of fm signal generators or transmitters is usually fairly bothersome and time consuming, especially when several frequencies are involved, as in telemetering or inspection of test equipment.

Here is a method for the rapid and accurate measurement of frequency deviation.

In Fig. 1, the output of the fm source under test is mixed with the rf output of a swept frequency signal generator. The sweep generator center frequency is set to match the test unit carrier frequency, and the sweep width adjusted for approximately twice the expected frequency deviation.

When the combination frequencies are detected and filtered (the low impedance bandpass detector and low pass filter normally used with the sweep generator may be used), a normal oscilloscope presentation will show a "band of birdies" corresponding to the frequency deviation of the fm source under test.

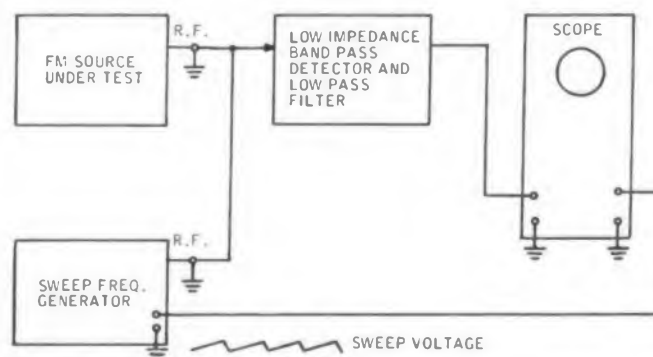


Fig. 1. Instrumentation for rapid measurement of frequency deviation.

17 light-years late for dinner...



As everybody knows, space travel by cutting magnetic lines of force... and a supply of good permanent magnets is a "must" you're going to make with  $E=mc^2$  in outer space. (Technical details on this are not yet ready for release.)

This wandering spaceman from Planet Plexippedes was making a routine flight over California and forgot to watch flux density indicator. Sudden—no power... and he had limp home on his auxiliaries, face an irate wife.

Too bad nobody told him about Thomas & Skinner's complete line of magnetic materials—permanent magnets, wound cores, laminations and SiFeM tapes. T & S magnetic materials have proved ideal in literally thousands of industrial applications. No reason why they wouldn't be ideal for space installations, too.

### SPECIALISTS IN MAGNETIC MATERIALS

Permanent Magnets • Magnetic Tapes  
Laminations • and Wound Cores

**Thomas & Skinner, Inc.**

1157 E. 23rd St., Indianapolis 7, Indiana  
CIRCLE 231 ON READER-SERVICE CARD

# NOW

## Beird-Atomic transistor test sets WITH EXTENDED RANGES!



### KP-2 series

with Semiconductor Regulated Power Supplies for Ease of Operation.  
New Ranges Available

Model	Current Range	Collector Voltage Range
KP-2	up to 1 amp	100 volts
KP-2SB	up to 1 amp	200 volts
KP-2SC	up to 2 amp	100 volts
KP-2SD	up to 2 amp	200 volts

Maximum Power 75 Watts

### Plus these added features:

- Common Base or Common Emitter
- Frequency Range — 100 cps to 200 kc
- Direct measurement of  $h$  parameters plus  $\alpha$  and  $\beta$  cutoff
- Meter indication of DC parameters,  $I_{co}$ ,  $I_{e0}$ ,  $V_{ce0}$ ,  $V_{ebf}$

All models available with built in VTVM and oscillator at extra cost.

The KP-2 Transistor Test Sets are versatile, precision instruments added to B-A's other transistor testing equipment: Model GP-4 for  $h$  parameters — 100 cps to 1 mc; KT-1 Portable for measuring Beta,  $h_{ie}$  and  $I_{e0}$ .

Write for complete information Instrumentation for Better Analysis



Beird-Atomic, Inc.

UNIVERSITY RD. CAMBRIDGE 38, MASS.  
Experienced Pulse Circuit and Communications Engineers — write to Technical Personnel Director.

CIRCLE 232 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1958

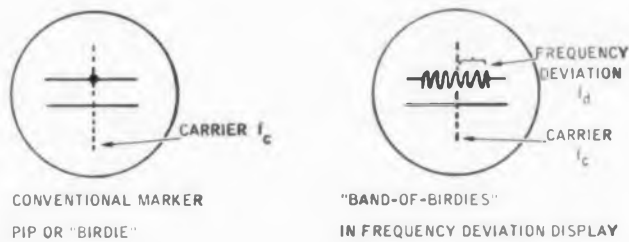


Fig. 2. Oscilloscope waveforms for the conventional marker pip or "birdie" (l), and for the "band of birdies" in the frequency deviation display (r).

The process involved is essentially that of producing a marker "birdie" as commonly used in bandpass alignment work. In this case however, "birdies" are produced at each instantaneous frequency correspondence between the two fm signals. Fig. 2 shows the scope presentations.

This method is faster, simpler and much less subject to ambiguities than trying to find the carrier "zeros" with a heterodyne frequency meter or calibrated receiver. The accuracy is that of the calibration of either the test source or the sweep generator, whichever is more accurate. The display is visual so rapid production testing is possible.

Michael L. Wolfe, Republic Aviation Corp., Guided Missiles Div., Mineola, N.Y.

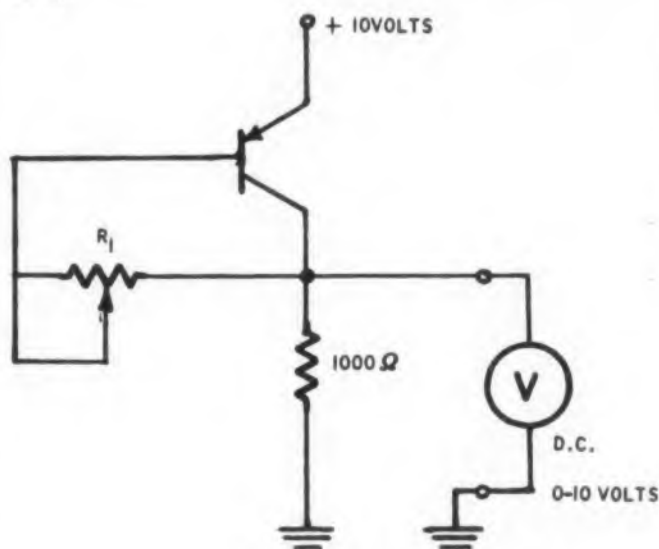
### Simple Beta Tester For Small PNP's

This tester gives a value of dc beta based on the ratio of collector to base current. This is a very good measure of the ac beta also, since it is taken at a current level of 5 ma.

The procedure is simple.

1. Adjust  $R_1$  for collector potential of 5 v.
2. The value of  $R_1$  will then be beta times 1000 ohms.  $R_1$  can be calibrated directly in beta.

J. M. Tewksbury, Bendix Radio, Baltimore 4, Md.



Simple beta tester for small pnp transistors.

# IMPULSE

## A DIGEST OF NEW DEVELOPMENTS IN ELECTRONICS AND AUTOMATION

PUBLISHED BY ROME CABLE CORPORATION, ROME, N. Y.  
PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

**JUST AROUND THE TURN IN ELECTRONIC DRIVING**—We mentioned in one of our previous issues an accessory that might tempt automobile buyers. This was an electronic navigational computer system being developed for the Army. Now we see in the *Wall Street Journal* where the boys from Detroit have unveiled the "General Motors Firebird III." This futuristic gas turbine-powered auto incorporates a new control system which was introduced by General Motors earlier this year. Electronic equipment in the car receives signals from a cable embedded in the highway and automatically directs the car on course along the highway. Another device on this auto of the future, says *WSJ*, provides automatic speed control. The old steering wheel and brake pedal have been eliminated and in their place is a single-stick steering device which is situated between the two passenger seats. A GM engineer said that the car has almost six times more cable and electric wiring than a conventional car of today.

**\$10 MILLION PER DAY!**—According to the Electronic Industries Assn., defense electronic spending for fiscal year 1958 will reach about \$10 million per day! EIA estimates expenditures of between \$3.5 billion and \$3.9 billion for the entire 1958 fiscal year, as compared to only \$2.5 billion for the same period of 1957. More and more extensive use of instrumentation might be the reason price tags for defense missiles are so high.

**IDEAS WANTED; \$10 MILLION REWARD**—Up to 80% of a \$5 million contract is available for subcontracting to anyone in the industry with a good idea or a good product that can lead to the development of Micro-Modules for the U.S. Army Signal Corps. Army wants to make military electronic equipment 10 times smaller without sacrificing quality and reliability, and do it at less cost. Ideas, anyone?

**IDEA HELPER**—One way to get ideas that solve tough cable problems is to call in a cable specialist. You'll find a complete group of them at Rome Cable Corp.—men experienced in the design and manufacture of conventional and special wires and cables. One can help solve your tough wire and cable problems—just call your nearest Rome representative, or write Rome Cable Corp., Dept. 431-D, Rome, New York. Our phone number is Rome 3000.

**TRENDS IN TELEMETRY**—As missiles become more complex, more information is needed from each firing. This is putting special demands on telemetry equipment. Trend is to electronic commutation, statistical telemetry, and pulse code modulation. Major headaches in the industry today: obsolete standards, limited frequency spectrum, lack of coordination.

**CABLEMAN'S CORNER**—As mentioned in one of the paragraphs above, one of the bugaboos in the procurement of electronic equipment is the lack of up-to-date standards. In order for a major contractor to properly evaluate his suppliers' quotations, a definite set of regulatory standards must be established and adhered to by the suppliers themselves.

Up-to-date standards are equally as important when evaluating test procedures. A reliable wire and cable manufacturer (such as Rome Cable Corporation) will have a series of standard checks and tests in force on every product that is produced in the plant. When special quality control is necessary, this manufacturer is prepared to do the job with a minimum of additional effort.

The rapidly expanding electronics field is constantly pressuring the individual manufacturer to produce special equipment. Not too much thought is given to the minimum quality requirements of this equipment except for that well-known phrase: "It's got to work!" Phooey! Unless the contractor realizes that making this equipment work involves adherence to proper testing and quality checks, chances are we'll still have exploding busts instead of rocketing successes.

Some of us may be inclined to be penny-wise and pound-foolish. Doesn't it make more sense to spend a few dollars on the order line to make sure that all is dependable on the firing line?

CIRCLE 233 ON READER-SERVICE CARD



## Improve Your Memory



### with a standard multiple purpose off-the-shelf drum

The 512-A Bryant general purpose magnetic storage drum meets the exacting requirements of a production component, yet has the versatility necessary for laboratory work. This standard 5" dia. x 12" long drum is stocked for immediate shipment, complete with standard components such as general storage brackets, recirculating register brackets and magnetic read/record heads. Its low price reflects the benefits of Bryant's 25 years' experience in the efficient design and production of high speed precision spindles.

#### Features:

- Guaranteed accuracy of drum run-out, .00010" T. I. R. or less
- Integral drive - Bryant precision motor (1200 to 12,000 R. P. M.)
- Capacities to 625,000 bits
- Accommodates up to 240 magnetic read/record heads
- High density ground magnetic oxide coating
- Super-precision ball bearing suspension
- Vertical mounting for trouble free operation

Special Models: If your storage requirements cannot be handled by standard units, Bryant will assist you in the design and manufacture of custom-made drums. Speeds from 60 to 120,000 R. P. M. can be attained, with frequencies from 20 C. P. S. to 5 M. C. Sizes can range from 2" to 20" diameter, with storage up to 6,000,000 bits. Units include Bryant-built integral motors with ball or air bearings. Write for Model 512-A booklet, or for special information.



Remember . . . you can't beat a Bryant drum!

**BRYANT COMPUTER PRODUCTS DIVISION**  
BRYANT CHUCKING GRINDER CO.

P. O. Box 620-M, Springfield, Vermont, U.S.A.

CIRCLE 234 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

### Diode Protects Tube During Grid Bias Changes

A cathode ray light source tube (DuMont K1388P16) was to be used in conventional circuitry. But the grid bias was to be varied to determine the operating characteristics. To prevent operating the tube with a positive grid, a TI 1N647 silicon diode was placed between grid 1 and the cathode.

The extremely high back resistance of the diode does not interfere with the normal negative voltage operation of the tube, while the low forward resistance limits positive grid excursions to very low voltages.

Neil Wotherspoon, AEC Computing and Applied Mathematics Center, New York University, New York, N. Y.

### Simple Continuous No-Loss Phase Shifter

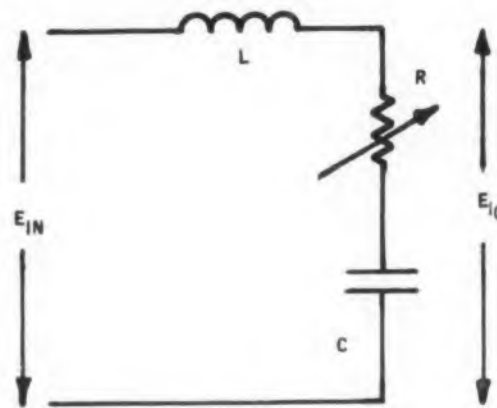
Here's a simple phase shifter whose phase can be varied continuously at a given frequency with no attenuation.

If, at any given frequency,  $L$  and  $C$  are properly chosen,  $e_o$  may be varied in phase over most of the range 0 to 180 lagging by simply adjusting  $R$ .  $E_o$  will remain equal to  $E_{in}$  for all values of  $R$ .

The important values are as follows  $L = 2/\omega^2 C$ , and the phase shift angle is twice the angle whose tangent is  $1/\omega CR$ .

The magnitude of  $R$  is inversely proportional to phase shift. If phase angles appreciably greater than 90 deg are required, a low impedance driving source should be used to prevent excessive loading.

David Perlman, Eastman Kodak Co., Rochester 4, N. Y.



Unity Transmission Phase Shifter



# AVION

**"S" - BAND**

**pulse oscillator  
model no. 306**

- offering superior stability for both vibration and temperature under extreme environmental conditions . . .
- small-size and light-weight

**TUNING RANGE** 300 MC (Nominal)  
**POWER OUTPUT** 1.5 KW peak minimum at .001 duty cycle, 1  $\mu$ sec pulsewidth, 1000 pps  
**TUBE** GE 6442 triode  
**OPERATING CONDITIONS** 3000 V at 2.5 amp peak (Nominal) Heater 6.3 V ac or dc (5%)  
**VIBRATION** 20 g . . . 20-2000 cps (FM 2 MC max.)  
**SHOCK** 70 g while operating (frequency shift 1 MC max.)  
**Temperature** -50 C to 100 C (4 MC max.)  
**FIXED CATHODE** Plate tuned (only tuning adjustment)  
**TUNING LOCKING DEVICE** Output connector (type N, TNC, or BNC, nominally 50 ohms)  
**OVERALL DIMENSIONS** Length 6-1/4"; Width 2"; Height 1-7/8" excluding connector  
**WEIGHT** 20 oz.  
**MOUNTINGS** Integral parts of the oscillator — included in the dimensions and weight, above  
**OTHER MICROWAVE COMPONENTS** S, C, and X — bands available.

SEND FOR LITERATURE

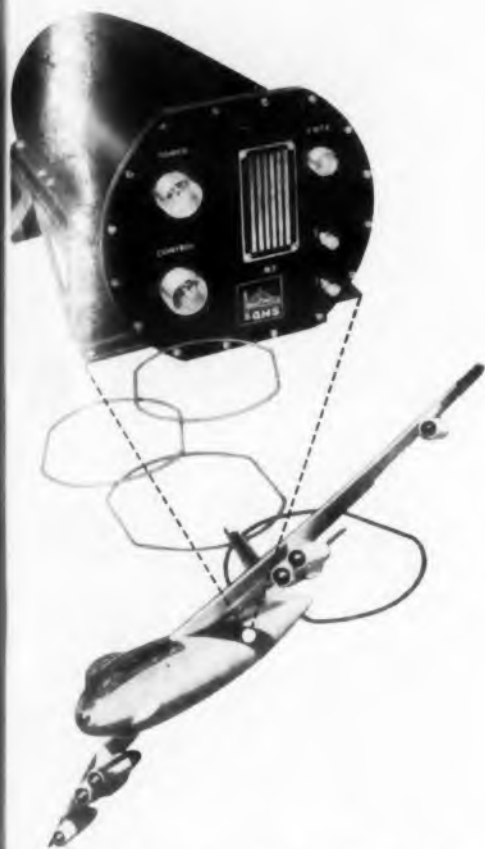
**AVION**  
AVION  
DIVISION

11 Park Place, Paramus, N. J.

CIRCLE 235 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1958





## GASEAL\* does the improbable NOW!

Before Gaseal, repair time on this Antenna Coupler was more than eight hours. With Gaseal, repair time is less than 15 minutes!

Gaseal is a resilient metal pressurized (1000 psi) seal, re-usable. It hermetically seals components, subsystems and complete systems against gases and liquids over a wide range of temperatures and environmental conditions.

Installation and service require no heat, special tools or skills.

Gaseal is available in many sizes and configurations for Aircraft, Missiles, Electronics, Chemical Processes and Military Applications.

WRITE FOR BULLETIN GHS 258.

GASEAL—Trademark of Hermetronics, Inc.  
(A Division of General Hermetic Sealing Corp.)

Photograph of B-47 Stratojet Courtesy  
U.S. Air Force

**GENERAL  
HERMETIC  
SEALING**  
ELECTRONICS FOR  
LAND, SEA AND SPACE CORPORATION  
Valley Stream, N. Y. • VALLEY Stream 5-6363

CIRCLE 236 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1958

## A DC Controlled Servo System

Certain control problems require the use of a servo system with a dc input signal. Generally, a vacuum tube or chopper is used for converting the input and a potentiometer is driven to obtain the proper null. The use of these components, which may be undesirable under certain conditions, can be avoided. A basic control loop is shown in the figure.

An input signal impressed on the saturable reactor produces a corresponding ac signal. The difference between the signal voltage and the induced voltage from the linear transformer (LT) provides the input signal to the transistor amplifier. When a signal is present, the motor is driven and in turn drives the LT until no signal exists at the input to the amplifier.

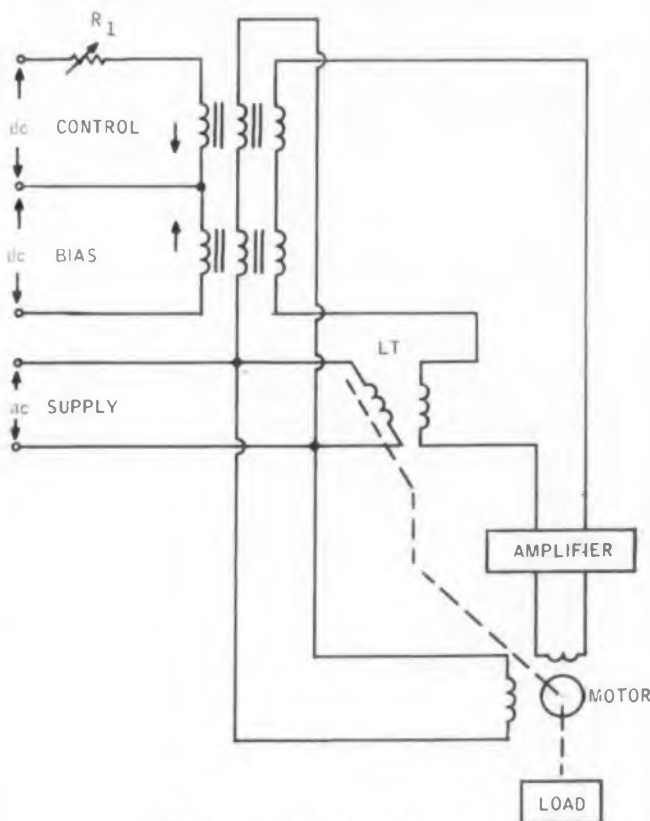
By properly matching the impedance at the input to the transistor amplifier, a reasonably sharp null may be obtained.

Sensitivity to small signals, limitation of drift and reversibility are achieved by applying a fixed voltage across the control coil and an equivalent voltage in opposition to this across a bias coil.

Linearity is roughly determined by varying the resistance  $R_1$  in the control coil circuit. The system proves to be very linear.

The circuit appears suitable for control systems involving step type inputs and may be adaptable for use in recording type meters. The components are such that they could be packaged in a small, rugged and virtually trouble-free unit.

M. Snyder, G. Shoemaker, Aeronautical Instruments Laboratory, Johnsville, Pa.



Servo loop with dc input.



## THE NRG-200 SERIES OF LOW-INDUCTANCE THERMONUCLEAR ENERGY-STORAGE CAPACITORS

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  
CIRCLE 237 ON READER-SERVICE CARD

**RELIABLE AND RUGGED**  
shock and vibration resistant



**HG-4SL**

**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**  
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

**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 263 ON READER-SERVICE CARD



**Linearity ±3% and Power Rated 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 238 ON READER-SERVICE CARD

**REPORT BRIEFS**

**Diffused Semiconductor Devices**

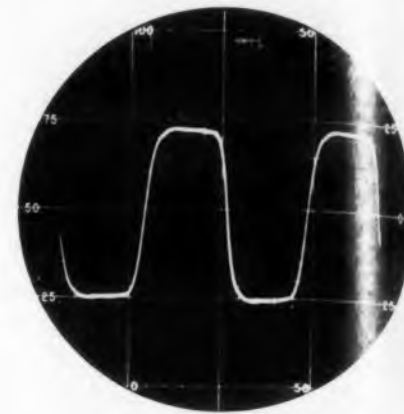
The essential processes of blank preparation, diffusion, electrochemical machining, and micro-alloying which are utilized in the fabrication of the graded base switching transistor have been successfully demonstrated in the laboratory. The results of the study indicate that it is possible to further develop the techniques and equipment discussed in this report in order to adapt these techniques and equipment to the requirements of large-scale production methods. *Industrial Preparedness Study on Diffused Semiconductor Devices*, J. D. McCotter and C. G. Thornton, Philco Corp., Philadelphia, Pa. March 1957, 64 pp, microfilm \$3.90, photocopy \$10.80. Order PB127428 from Library of Congress, Washington 25, D. C.

**Eliminating Radar Ground Return**

Clutter cancellation indication is a simple method for eliminating radar ground return. In most applications, it is a reasonable substitute for MTI, without the system restrictions inherent in MTI. An antenna beam established slightly lower in elevation than the main radar beam delivers information to an auxiliary receiver. Fed into a difference amplifier, this information is compared with that from the main receiver to \$4.80. Order PB127036 from Library of Congress, Washington 25, D. C.

**Amplitude and Phase Difference Fluctuations**

This report presents data on 8.6 mm wavelength of phase difference fluctuations on a 10-mile path in Colorado between Pikes Peak and the Garden of the Gods and of amplitude fluctuations on this path and on a 60-mile path between Pikes Peak and Mount Evans. The mm data are compared with similar data taken using a wavelength of 3.2 centimeters. *Amplitude and Phase Difference Fluctuations of 8.6 mm and 3.2 cm Radio Waves on Line-of-Sight Paths*, C. W. Tolbert, B. M. Fannin and A. W. Straiton, Electrical Engineering Research Laboratory, Austin, Tex. March 1956, 17pp, microfilm \$2.40. Order PB 125571 from Library of Congress, Washington 25, D. C.



AC Input to Rectifier from Special Sola Constant Voltage Transformer

**EFFICIENT regulated DC power supply**

Can you use a ±1% regulated dc power supply that has no filter choke drops... that has an unusually low ratio of size and weight to power output? If so, consider a Sola Regulated DC Power Supply.

This unique power supply combines: 1) a special Sola Constant Voltage Transformer, 2) a semiconductor rectifier, and 3) a high-capacitance filter without choke.

The output of this special Sola transformer (illustrated above) is virtually a square wave, form factor approx. 1.05. It not only minimizes ripple, but limits peak voltage to rectifier.

The current-limiting action of the Sola transformer permits the use of enormous capacitance for filtering, by controlling capacitor charging, thereby protecting it, and the rectifier junctions.

This dc source will give you exceptional performance on intermittent, pulse, and variable loads. The Sola-regulated dc supply is very reliable, simple, and compact. It's moderately priced.



Available from stock, or as a custom designed unit.

Write for Bulletin 31K-DC-235  
Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill.  
A Division of Basic Production Corporation



CIRCLE 239 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • November 26, 1958



When **ONE THOUSAND**



weigh no more than **ONE...**



that's **MINIATURIZATION!**

We produce precision turned nuts for all types of "miniaturized" equipment. For example . . .

the nuts shown above are identical in type and accuracy. The miniature size, measuring 1/8 x 3/64", weighs only 0.11 lbs. per thousand. The conventional nut is 1-1/16 x 21/32" and weighs 110 lbs. per M. This 1000-to-1 ratio is typical of our versatility.

When your fastening problems involve small nuts . . . or if you're looking for better price, quality and delivery . . . let Fischer quote your next order.

**FOR PRECISION BRASS AND ALUMINUM NUTS**

... **STANDARD, SPECIAL OR MINIATURE**  
... **SPECIFY FISCHER!**

there's no premium for precision at

**Fischer**  
**SPECIAL MFG. CO.**



FISCHER SPECIAL MFG. CO.  
42 Morgau St., Cincinnati 6, Ohio  
Please send your new 20-page CATALOG FS-1000 containing complete specifications on brass and aluminum nuts.

Name \_\_\_\_\_ Title \_\_\_\_\_  
Company \_\_\_\_\_  
Street \_\_\_\_\_  
City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_  
8148-FS

CIRCLE 240 ON READER-SERVICE CARD  
**ELECTRONIC DESIGN • November 26, 1958**

### Measurement of Ferrite Parameters

Part 1. The question is considered of measuring the magnetic permeability  $\mu$  and the dielectric permeability  $\epsilon$  tensors of ferrites by using an electromagnetic cavity resonator. The principle of perturbing the resonator is generalized to gyrotropic media and the problems of ferrite bodies of various shapes, placed in the resonant cavity, are solved by using a quasi-stationary approximation. Different vibrations are proposed of measuring  $\mu$  and  $\epsilon$  of ferrites by using a cylindrical resonator and certain experimental results are cited. Translated from Radiotekhnika i Elektronika, AN USSR, I, 447-468, 1956.

Part 2. The use of a rectangular resonator to measure the  $\mu$  and  $\epsilon$  ferrite parameters in samples of various shapes is considered. The perturbation theory developed by the author in Part 1 underlies the computations. Cited are experimental results of comparable measurements of ferrite parameters using a cylindrical and a rectangular resonator. Translated from Radiotekhnika i Elektronika, AN USSR, I, 638-646, 1956. *Measurement of Ferrite Parameters at Microwave Frequencies, V. V. Nikol'skii, Translated by Morris D. Friedman, Part 1, December 1956, 38pp, microfilm \$3.00. Order PB 127203 from Library of Congress, Washington 25, D.C. Part 2, October 1956, 18pp, microfilm \$2.40. Order PB 127202 from Library of Congress, Washington 25, D.C.*

### Backward Wave Oscillator

Two backward-wave oscillators have been developed which tune over the frequency ranges 35-50 kmc and 47-74 kmc, delivering power of the order of mw. Ceramic guns, stems, and output windows have been developed for use with these tubes. The tubes operate at collector currents of 3 to 5 ma, and require a focusing magnetic field of 1200 gauss. Helix voltage is varied from 800 to 3500 v to cover the complete frequency range of oscillation. Design features are calculated and observed performance curves for these tubes are shown. In addition to the development of the tape helix tubes, theoretical and experimental investigations were made of the properties of a coiled ridged waveguide and an interdigitally loaded waveguide as slow wave circuits for use in millimeter backward-wave oscillators. Design data and calculated performance for these circuits are given. *Development of Millimeter Backward Wave Oscillator, Donald J. Blattner and Fred Sterzer, Radio Corporation of America, RCA Laboratories, Microwave Advanced Development, Princeton, N. J. February, 1958, 72 pp, \$2.00. Order PB131765 from OTS, Washington 25, D. C.*

# Measurement Standards



NEW  
MODEL 1207

**4 Models**  
measure  
**Quartz Crystals**  
directly

## RFL Crystal Impedance Meters

Developed under U. S. Signal Corps technical requirements for the national crystal testing standardization program. They measure resonance and anti-resonance resistance of quartz crystals, including those covered by MIL-C-3098B, for determination of capacitance, inductance and performance index (PI).



MODEL 531



MODEL 541A



MODEL 459A

**MODEL 1207 (AN/TSM-15)** covers range of 75-200 mc for 10-125 ohm crystals. Crystal voltage at series resonance is measured within 10%, effective resistance within  $\pm 5$  ohms, and the power calculated. 18  $C_0$  cancellation inductances and 6 variable resistors supplied; operates from 115/230v, 50-1000 cps line. Price \$1245.

**MODEL 531 (TS-683/TSM)** Crystal Impedance Meter covers range of 10-140 mc. for 10-150 ohm crystals. Twelve fixed calibrating resistors of 10, 22, 30, 40, 51, 60, 68, 82, 91, 100, 120 and 150 ohms, plus a 100-ohm var. resistor for determining crystal resistance. Anti-resonance adapter also provided. Operates from 115/230v, 50-1000 cps source. Price \$590.

**MODEL 541A (TS-710/TSM)** for 10-1100 kc range crystals with resistances from 200 ohms to 0.5 megohms. An internal load capacitance is calibrated from 15 to 105 mmf with accuracy better than  $\pm 0.5$  mmf. Power dissipated in crystal measured by built-in VTVM and ohmmeter. For 115/230v, 50-1000 cps operation. Price \$860.

**MODEL 459A (Improved TS-330/TSM)** covers 800 kc to 15 mc range; employs new  $\pm 0.1$   $\mu\text{mf}$  load capacitors for testing 0.002% crystals; four resistance decades cover range of 0-9900 ohms. Operates from 115/230v, 500-1000 cps. Price \$1125.

Performance of all models is rigidly guaranteed. Prices are net f.o.b. Boonton, N.J. and subject to change without notice.

**SEND FOR TECH. DATA**  
For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.



**Radio Frequency LABORATORIES, INC.**  
Boonton, New Jersey, U. S. A.

CIRCLE 241 ON READER-SERVICE CARD

Here, in Part 6, we continue our translation of Professor Kharkevich's book with the beginning of his Section 9, Chapter 1. This section deals with detection.

# Nonlinear and Parametric Phenomena in Radio Engineering

Part 6

A. A. Kharkevich

(Translated by J. George Adashko)

Chapter 1

## Nonlinear Circuits and Fundamental Nonlinear Processes

### 9. Detection

The aim of detection is to extract the signal, i.e., the low frequency modulating oscillations, from a modulated oscillation. In this section we shall consider only the detection of amplitude modulated oscillations.

#### Detection and Rectification

The detection of am oscillations has much in common with rectification; the difference lies principally in the nature of the rectified signal and in the desired results. The simplest detector circuit contains a nonlinear element having the same characteristic as that of the rectifier shown in Fig. 15.

Let us first qualitatively analyze the phenomena that occur in detection. Let an am voltage act on a circuit with a nonlinear element having the broken characteristic shown in Fig. 21.

The current in the detector circuit comprises high frequency pulses. The envelope of these pulses is a replica of the envelope of the modulated oscillation. The current contains the carrier frequency and its harmonics, and a dc component in which we are usually not interested. Finally, the current contains the low frequency component, which we wish to separate.

ponent in which we are usually not interested. Finally, the current contains the low frequency component, which we wish to separate.

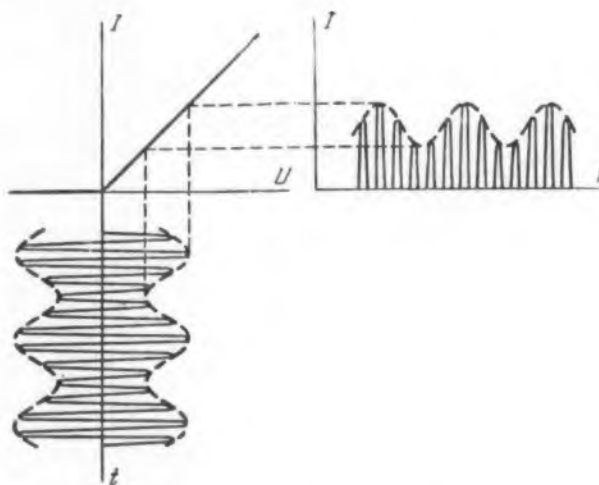


Fig. 21. An idealized detector characteristic.

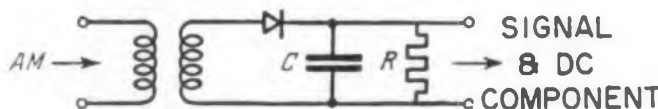


Fig. 22. A basic am detector circuit.

It must be emphasized that the modulated oscillation does not contain a low frequency component. We know, for example, that in the case of sinusoidal modulation, the modulated oscillation contains three sinusoidal components: the carrier, and the two sidebands which also have high frequencies.

To separate the low frequency component, which appears as a result of detection, it is necessary to filter out the high frequencies, and the dc component. The latter usually eliminates itself, since it will not pass through an amplifier channel containing transformers and coupling capacitances. As to the high frequencies, they can be filtered out with a simple RC element.

The detector then assumes the form shown in Fig. 22. It differs little in appearance from the rectifier circuit of Fig. 20. But the circuit of Fig. 22 performs still another task—it separates the low frequency of the signal, while the rectifier eliminates the ac component and produces a direct current.

This difference dictates the difference in requirements that must be satisfied by the filters. The filtering element in the detector circuit of Fig. 22 must eliminate the high frequency but retain a low frequency.

For this, it is essential that the resistance  $R$  be much greater than the capacitive reactance at the high (carrier) frequency  $\omega_0$ , and much less than the capacitive reactance at the low signal frequency  $\Omega$ . This condition is expressed by the inequality

$$\frac{1}{\omega_0 C} \ll R \ll \frac{1}{\Omega C}$$

One can arrive at this conclusion in a somewhat different manner. The RC network can be considered as an integrating circuit the purpose of which is to average the current. However, the circuit must average the high frequencies rather than the low frequencies, for averaging the latter would produce only a dc output.

The effect of integrating or averaging is determined by the time constant of the element or, more accurately, by the relation between the time constant

$$\tau = RC$$

and the period of the current. Averaging takes place only when the time constant is considerably greater than the period. If, to the contrary, the time constant is considerably less than the period, no averaging takes place, and the output voltage follows the input voltage.

With these considerations in mind, we can write the following condition for correct operation of an RC element:

$$T_0 \ll \tau \ll T_1$$



where  $T_0$  and  $T_1$  are respectively the periods of the carrier and signal frequencies. But this inequality is the same as one written above, if we recall that

$$T_0 = \frac{2\pi}{\omega_0}, \quad T_1 = \frac{2\pi}{\Omega}$$

Frequent use is made of full wave detection. Here, the carrier frequency is subjected to full wave rectification. The frequency is then doubled and can be more readily separated.

#### Full Wave Detection

Let us now analyze the detection process. Assume that full wave detection is used and that the characteristic of the detector can be written in the form  $I = k|U|$  as in Fig. 23. In the case of a carrier frequency  $\omega_0$  modulated by a sinusoidal voltage of frequency  $\Omega$ , we have the following expression for the modulated voltage:

$$U = U_m (1 + m \sin \Omega t) \sin \omega_0 t$$

To determine the current in the detector circuit we must take the modulus (absolute value) of this expression. It is necessary to obtain the modulus of each of the factors, since the modulus of a product equals a product of the moduli of the individual factors.

Note that the modulation coefficient  $m$  is a positive quantity that does not exceed unity. Therefore the factor  $[(1 + m \sin \Omega t)]$  cannot be less than 0, so we need find only the modulus of the last factor. Thus

$$I = k U_m (1 + m \sin \Omega t) |\sin \omega_0 t|$$

But  $\sin \omega_0 t$  is the result of full wave rectification of a sinusoid. We know the Fourier series expansion of this function

$$|\sin \omega_0 t| = \frac{2}{\pi} \left( 1 - 2 \sum_{k=1}^{\infty} \frac{\cos 2k\omega_0 t}{4k^2 - 1} \right)$$



Fig. 23. Detector characteristics in the form  $I = k|U|$ .

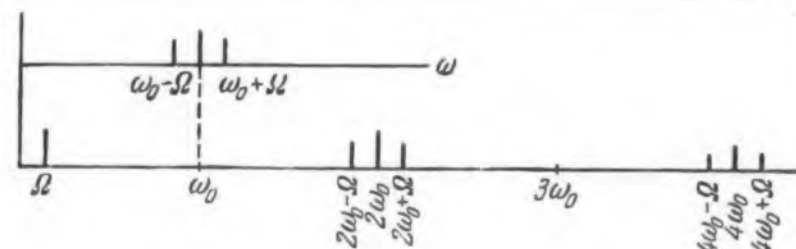


Fig. 24. Frequency spectra of modulated oscillation before and after detection.

Thus

$$I = \frac{2}{\pi} k U_m (1 + m \sin \Omega t) \left( 1 - 2 \sum_{k=1}^{\infty} \frac{\cos 2k\omega_0 t}{4k^2 - 1} \right) = \frac{2}{\pi} k U_m \left( (1 + m \sin \Omega t) - 2 \sum_{k=1}^{\infty} \frac{\cos 2k\omega_0 t}{4k^2 - 1} - 2m \sum_{k=1}^{\infty} \frac{\sin \Omega t \cos 2k\omega_0 t}{4k^2 - 1} \right)$$

We see that the purpose of detection has been accomplished: we obtain a current with a component  $(1 + m \sin \Omega t)$ , i.e., containing the modulating signal. In addition, the current contains many higher harmonics: even harmonics of the carrier with frequencies  $2k\omega_0$  (first sum) and sidebands with frequencies  $2k\omega_0 \pm \Omega$  (second sum). The spectra of the modulated oscillation before and after detection are shown in Fig. 24.

#### Linear Detection

We have considered detection involving a detector characteristic in the form of a broken line (Figs. 21 or 23). A detector with a characteristic of this kind is called "linear." It is naturally understood that the term "linear" refers not to the characteristic of the detector as a whole, but only to the form of the branch of the characteristic on one side (Fig. 21) or on both sides (Fig. 23) of the break in the line.

Examining Fig. 21, we see that only a "linear" detector leaves the form of the envelope undistorted. To show how the form of the detector characteristics influences the result of detection, let us consider the detection of an am signal by a square-law detector.

Section 9 will be continued in the Dec. 10 issue of ELECTRONIC DESIGN.

**MINIATURE 13-DIGIT ENCODER** for airborne or other limited space applications. Detailed specifications in Bulletin 0858. **SIZE:** 2 3/16" dia. x 3 3/4" long; 1/4" dia. shaft, 7/8" long. **WEIGHT:** 1 1/4 lbs. **OVERALL ACCURACY:** ± 1 1/4 quanta in 8192. **READOUT RATE:** Model A, nominally 10KC (50 microsecond pulse), max. of 100KC (5 microsecond pulse). Model B, max. of 200KC for element, 10KC for sequence. **MAXIMUM ANGULAR SPEED OF ROTATION AT FULL ACCURACY:** 2 rpm (6 rpm at 12-digit accuracy). 10 rpm with temperature control.



Model A2.6SS13 (Parallel readout)  
Model B2.6SS13 (Sequential readout)

**4" DIA. 13-DIGIT ENCODER** for general purpose applications. Detailed specifications in Bulletin 0958. **SIZE:** 4" OD with protrusions on one side x 7" long; 1/4" dia. shaft, 0.67" long. **WEIGHT:** 9 1/4 lbs. **OVERALL ACCURACY:** ± 1 quanta in 8192. **READOUT RATE:** 100 cps, max. **MAXIMUM ANGULAR SPEED OF ROTATION AT FULL ACCURACY:** 720 rpm; maximum rotation rate, 600 rpm.



Model A4DP13

**6" DIA. 13-DIGIT ENCODER** for general purpose applications. Specifications in Bulletin 1058. **SIZE:** 6 3/16" dia. with protrusions x 7 3/4" long; 1/2" dia. shaft, 1" long. **WEIGHT:** 1 1/2 lbs. **OVERALL ACCURACY:** ± 1 quanta in 8192. **READOUT RATE:** 100 cps, max. **MAXIMUM ANGULAR SPEED OF ROTATION AT FULL ACCURACY:** 720 rpm (10 microsecond pulse).



Model A6DP13

Now from

# Baldwin®

precision shaft angle analog-to-digital encoders in 5 standard models:

13, 16 and 18 digit /  
photoelectric readout / reflected binary code\*.

**9" DIA. 16-DIGIT ENCODER** precision unit for radar applications. Detailed specifications in Bulletin 1158. **SIZE:** 9 1/16" dia. with protrusions x 4 3/8" high; 1/2" dia. shaft, 1 1/4" long. **WEIGHT:** 17 1/2 lbs. **OVERALL ACCURACY:** ± 1 quanta in 65,536. **READOUT RATE:** 100 cps, max. **MAXIMUM ANGULAR SPEED OF ROTATION AT FULL ACCURACY:** 90 rpm (10 microsecond pulse)



Model A9SP16

**HIGH PRECISION 18-DIGIT ENCODER** for radar or theodolite applications. Detailed specifications in Bulletin 1258. **SIZE:** 21" max. dia. x 8 1/16" high. **WEIGHT:** 169 lbs. **OVERALL ACCURACY:** ± 1 quanta in 262,144. **READOUT RATE:** 100 cps, max. **MAXIMUM ANGULAR SPEED OF ROTATION AT FULL ACCURACY:** 25 rpm (10 microsecond pulse).



Model A21SP18

\*Encoders with decimal, trigonometric functions and other nonlinear codes are also available. All disks are made on a special divided circle machine designed and built by Baldwin. Write for descriptive bulletins.

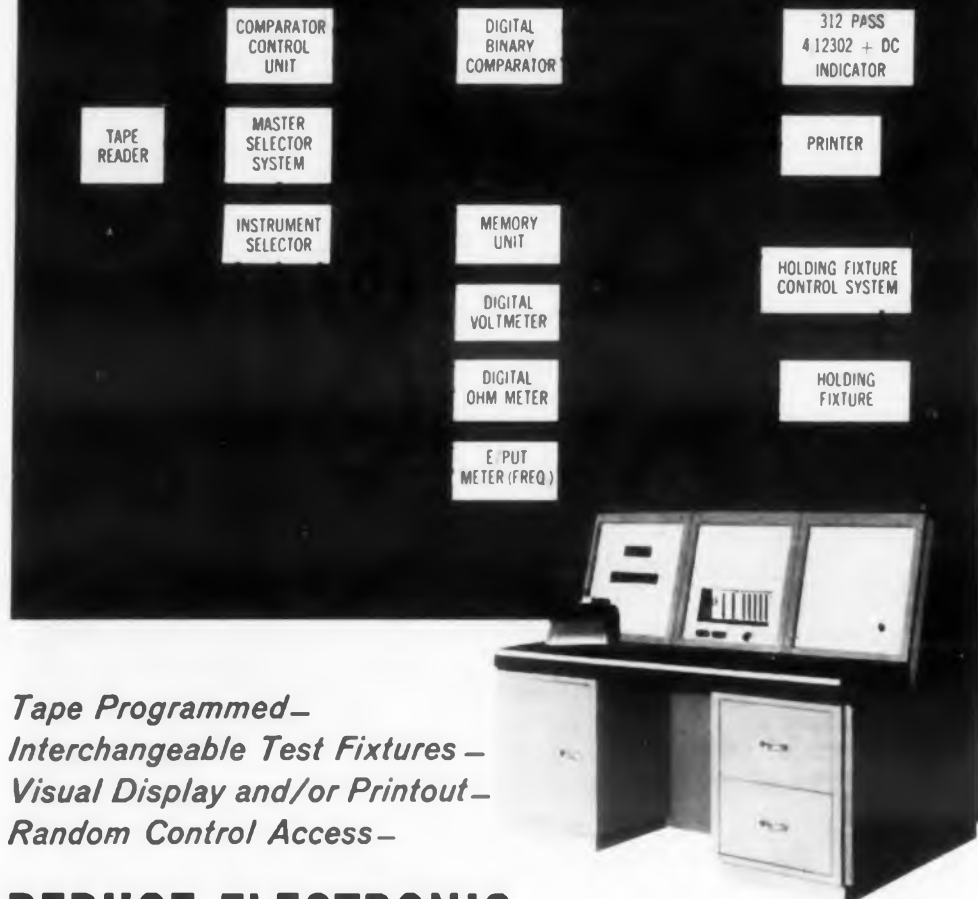
Industrial Products Division

**THE BALDWIN PIANO COMPANY**

1804 Gilbert Avenue, Cincinnati 2, Ohio

CIRCLE 242 ON READER-SERVICE CARD

## PROGRAMMED AUTOMATIC CHECKOUT SYSTEM



Tape Programmed—  
Interchangeable Test Fixtures—  
Visual Display and/or Printout—  
Random Control Access—

## REDUCE ELECTRONIC CHECKOUT TIME— INCREASE RELIABILITY

The Robertshaw 500 System

The new Robertshaw 500 System shortens electronic instrumentation test time while assuring reliable checkout using semi-skilled personnel.

More than one million test combinations may be sequenced to cover virtually all checkout combinations. The test instrument is simply placed in the holding fixture and the "Start" button depressed. The ensuing operations are completely automatic and continue until test completion or an unacceptable test measurement is encountered.

As the test cycle commences, a tape reader distributes instructions from a punched tape to operational control elements, which 1) control instrumentation, 2) set stimulation, 3) set high and low limits into the digital comparator, and 4) establish special holding fixture operations. Comparison of test measurements with programmed tolerances is performed by the digital comparator and the results presented in a visual GO, NO-GO display form. A printed numerical record of test results is also provided as a permanent log of system operation. Test versatility is afforded through use of various tapes and holding fixtures. Full technical information will be gladly provided upon request.

Field offices and sales representatives in principal cities.

AERONAUTICAL AND INSTRUMENT DIVISION  
**Robertshaw-Fulton** CONTROLS COMPANY  
SANTA ANA FREEWAY AT EUCLID AVENUE • ANAHEIM, CALIFORNIA  
CIRCLE 243 ON READER-SERVICE CARD

## RUSSIAN TRANSLATIONS



# What the Russians Are Writing

J. George Adashko

### CIRCUITS

**Interaction Between Signal and Noise in an Exponential Detector by A. D. Knyazev. EC 3/58, pp 11-20, 8 figs.**

The author investigates the detection conditions, under which the interaction between two signals may be accompanied by the weaker signal, becoming reinforced in the presence of a strong unmodulated or modulated noise. As a result, an improvement would be produced in the signal to noise ratio at the detector output. It is shown that for this purpose the amplitude characteristics of the detector must be a sharply rising one (for example, exponentially). Results of experiments are cited.

**Increase in Useful Power of a Tuned Semiconductor Amplifier by Increasing Its Efficiency, Part II by L. S. Berman. RE 3/58, pp 71-73, 5 figs., 1 table.**

The first part of the article was published in the November 1957 issue of *Radiotekhnika*. It was shown there that

by using an additional tank circuit, tuned to the third harmonic, it is possible to increase the efficiency of a semiconductor tuned amplifier from 74-75 per cent to 85-87 per cent, and to increase the useful power by a factor of 2.1-2.2 (for equal dissipation power).

In this article it is shown that the use of the second harmonic instead of the third harmonic gives somewhat better results, and increases the efficiency to 90-92 per cent. This is explained by the broader "valley" of the collector voltage during the time that the collector current flows, and also by the higher coefficient of utilization of the collector voltage. On the other hand, the maximum voltage in the collector is higher when the second harmonic is used, compared with the use of the third harmonic.

**Analytic Formulation of the Problem of Synthesis of Corrective Networks and Linear Systems by V. G. Segalin. A 2/58, pp 148-161, 1 fig.**

In spite of great progress made in the

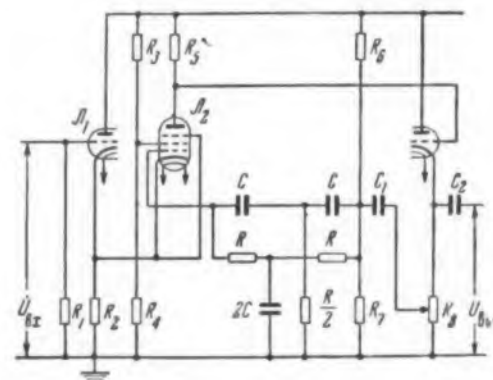


Fig. 1. Diagram of selective amplifier. It represents essentially a modification of a double-triode amplifier with cathode follower.

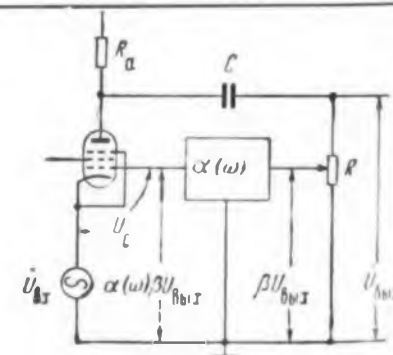
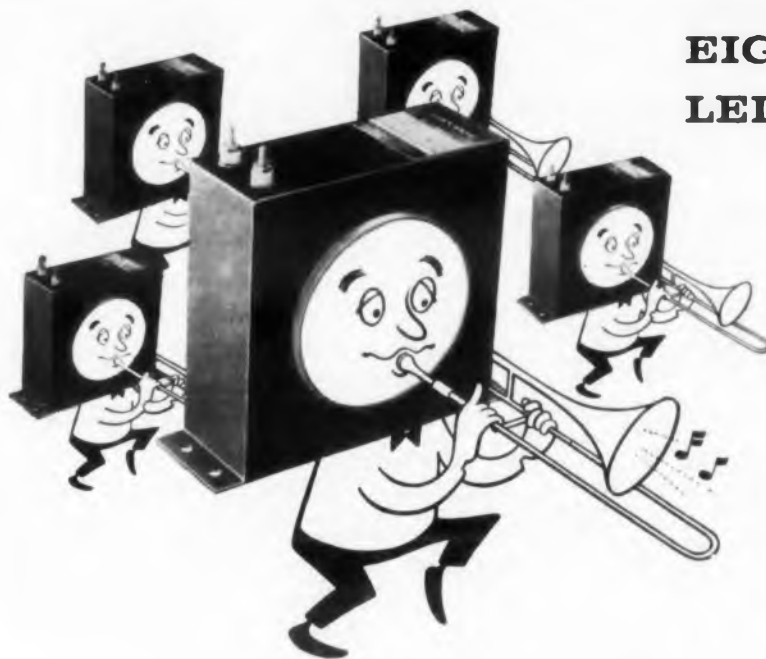


Fig. 2. Simplified equivalent circuit of Fig. 1. It is assumed that the gain of each cathode follower is unity, the cathode coupling of the tubes is negligible, and the double T network does not load the amplifier stage.



# JOURNAL OF APPLIED CONTROL DEVICES THAT NEVER WEAR OUT

For Control Engineers Who Are Wearing Out Before Their Time

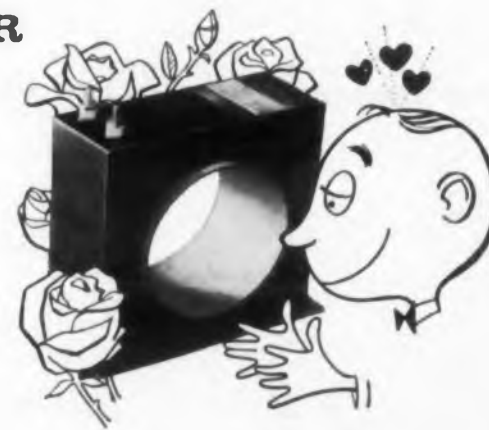


## EIGHTEEN TRANSDUCTORS LED THE BIG PARADE!

Some strip-plating friends of ours had to control currents flowing to eighteen anodes. To regulate the plating thickness, they had to sum the individual large (up to 7500 amperes d-c) currents, without interfering with the accurate metering of each one individually. Were they ever pleased to find that each of their eighteen CONTROL transducers (which never wear out) would eliminate special metering, and would also drive a heavy duty overload relay . . . contribute its share of power to an a-c totalizing transformer . . . and permit instrumentation currents to be carried great distances to switchboard panels with proper safety isolation and no loss of accuracy. *They said we could tell you, if you wanted more information, that they did away with shunts, too! Need more details?*

## A TRANSDUCTOR IS A TRANSDUCTOR IS A TRANSDUCTOR

Truth is there are people who think we are saying "transducers" when we are saying "transducers." 'Tisn't so. Our CONTROL transducers are simple saturable reactors which (oh, joy!) never need maintenance. We connect two Orthonol cores in series opposition, and run the bus bar, whose current we want to measure, through them (giving us, essentially, a one-turn control winding). Don't even have to make a direct electrical connection—and we wind up with enough output for instrumentation, and plenty left over for feedback control. *Try that on a transducer sometime. Or a shunt-millivoltmeter, for that matter. Whatever you want to try it on, you can try us for full information first.*



## WE HAVE TROUBLE WITH LIFE TESTS

One of the fine technical magazines in which this Journal appears recently did a survey on reliability. They wrote us and asked how long our CONTROL transducers would last under certain conditions. It was sort of embarrassing. How can you run a life test on something that won't wear out? You see, our transducers have no moving parts, no filaments to burn out, nothing to replace or maintain. Bury them in the ground or install them in the corrosive atmosphere of a chlorine plant—it makes no difference. We told the editor what our problem was, and he said, "Hmmm, I see." Now we're waiting to see what he's going to say about this remarkable step forward in reliability. *If you have to measure or record from 200 to 10,000 amperes with isolated meters, there's a world of information awaiting your inquiry. And it may give your maintenance man a break, too!*

Reliability begins with **CONTROL**

A DIVISION OF MAGNETICS, INC

Dept. ED-52, BUTLER, PENNSYLVANIA

CIRCLE 244 ON READER-SERVICE CARD

ynthesis of linear electric networks with lumped constants and linear automatic control systems, the problem of the synthesis of correcting networks has not yet been fully developed. What is still to be done at the present time is:

An analytic formulation of the synthesis problem for correcting networks; a procedure for obtaining the optimum transfer function of the correcting system and its generalized analytic expression;

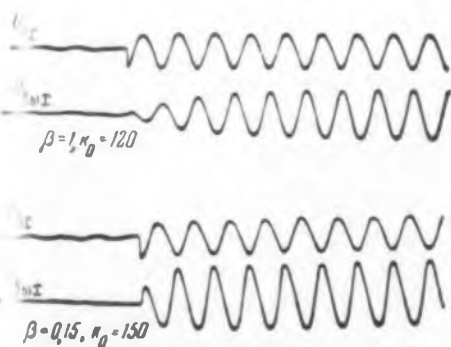
formulation of recommendations on the choice of various correcting networks, with allowance for the features of the uncorrected portion of the system under actual applications;

formulation of recommendations on the advisability of using active correcting networks, also with allowance for the actual application conditions.

**Selective Resistance Coupled Low Frequency Amplifier as an Element of a Control System** by Yu. G. Kochinev. AT 1/58, pp 355-359, 4 figs.

The dynamic properties of a selective RC amplifier with double T network are analyzed. The double T network is preferable over the Wien bridge circuit because less difficulty is involved in the summation of the input and feedback signals.

To obtain high selectivity, it is necessary that the open-loop gain of the amplifier be high and that the nonlinear and frequency distortions be relatively low. On the other hand, the input and output impedances of the feedback loop must be matched with the amplifier parameters. See Figs. 1-3.



Oscillograms of the input and output signals for two values of depth of feedback.



## MOLDED SUB-MINIATURE TOROIDS



STOCKED for immediate delivery

ARE NOW AVAILABLE FROM

Magnetic amplifiers, filters, transformers, transistorized power supply, all to customers' specifications.



# TOROTEL

PROMPT DELIVERY



MOLDED TOROIDS Ind—5MH to 36H STOCKED for immediate delivery



UNCASED Q values > 260 Size: 1/4" ID OD unlimited

MOST ENGINEERING SAMPLES FURNISHED IN ONE WEEK

PRINTED CIRCUIT TOROIDS

Size .662 OD .312 H Larger sizes available



PROMPT QUOTATIONS on stocked or special items; address—

# TOROTEL, INC.

11505 Belmont, Kansas City 34, Mo. Phone: S0uth 1-6314

REPRESENTATIVES IN MANY CITIES

CIRCLE 245 ON READER-SERVICE CARD

## New **LOW LOSS** Solid Ultrasonic Delay Lines by **BLILEY**



**Bliley**

**BLILEY ELECTRIC COMPANY**

UNION STATION BUILDING • ERIE, PENNSYLVANIA

This new series of solid ultrasonic delay lines, in range 2 to 50 microseconds, employs special barium titanate transducers to reduce loss level. Loss levels, into 100 ohm terminations, range from 6 to 10 db compared to 35 db for conventional types.

TYPICAL CHARACTERISTICS OF A 2 USEC. BLILEY LOW LOSS LINE:

- Delay time: 2 usec.
- Type: double ended absorber
- Center frequency: 30 mc.
- Termination: 500 ohms
- Capacity: 385 mmf.
- Insertion loss to first reflected pulse: 5 db.
- Third time signal: down 30 db
- Delay time variation from —20 to +60 C.: ±.01 usec.

Request Bulletin #513 for details

CIRCLE 246 ON READER-SERVICE CARD

## RUSSIAN TRANSLATIONS

### AUTOMATIC CONTROL

Concerning One Type of AC Bridge with Automatic Balancing by Two Parameters by V. Yu. Kneller. AT 2/58, pp 162-173, 7 figs.

AC bridges with automatic balancing of two parameters of a single arm are frequently used in automatic control. There are various versions of such bridges. The one discussed by the author is a bridge where the unbalanced voltage is resolved into two components by means of two phase-sensitive null indicators. Its outputs are amplified and control servomotors balance automatically the bridge. The effect of coupling between the balancing networks and the effect of nonlinearity of the static characteristics of the bridge circuit on the stability of the system are analyzed. A bridge circuit is developed, for which it is possible to decouple the balancing circuits over a wide range of measured quantities.

Statistical Analysis of Nonstationary Processes in Linear Systems by Using Inverse Simulating Devices by A. V. Solodov. AT 4/58, pp 312-324, 8 figs.

The minimization of the least square error in a servo system, when the input signal is random and the system itself is nonstationary, involves considerable analytical difficulties. Simulation affords the best approach to the subject, since a simulator can be coupled with an actual regulator. The application of this method of attack to

### 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.

- AJ Acoustic Journal (*Akusticheskiy Zhurnal*)
- AT Automation and Telemechanics (*Avtomatika i Telemekhanika*)
- CJ Communications Journal (*Vestnik Svyazi*)
- EC Electrical Communications (*Elektrosvyaz*)
- IET Instruments and Experimental Techniques (*Pribori i Tekhnika Eksperimenta*)
- JTP Journal of Technical Physics (*Zhurnal Tekhnicheskoy Fiziki*)
- ME Measurement Engineering (*Izmeritel'naya Tekhnika*)
- R Radio
- RE Radio Engineering (*Radiotekhnika*)
- REE Radio Engineering and Electronics (*Radiotekhnika i Elektronika*)



## Krohn-Hite POWER AMPLIFIER



MODEL UF-101

### FEATURING

- LESS THAN 0.005% DISTORTION AT 50 WATTS
- 110 DB DYNAMIC RANGE
- 50 WATTS OUTPUT FROM 15 CPS TO 30 KC

### SPECIFICATIONS

POWER OUTPUT.....	50 watts from 15 cps to 30 kc
FEEDBACK.....	80 db
FREQUENCY RESPONSE	±0.5 db from 0.5 cps to 30 kc ±3 db from 0.03 cps to 70 kc
DYNAMIC RANGE.....	110 db
OUTPUT IMPEDANCE.....	2, 4, 8, 16 and 450 ohms
VOLTAGE GAIN.....	14 db or 30 db to 16 ohm output
PRICE.....	\$425.00

Typical harmonic distortion at 1,000 cps is 0.003% in voltage at 50 watts.

Available for rack mounting at \$5.00 additional.

For further information on:

- Filters
- Power Supplies
- Oscillators
- Power Amplifiers

write for our free catalog D

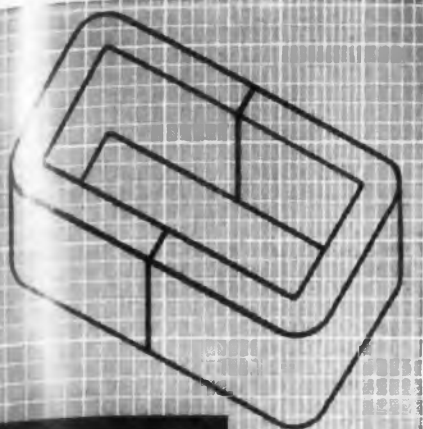


## Krohn-Hite CORPORATION

580 MASSACHUSETTS AVENUE  
CAMBRIDGE 39, MASS., U. S. A.

CIRCLE 247 ON READER-SERVICE CARD





## wound cores

Thomas & Skinner's Orthosil® Wound Cores are ideal for special applications and can be specially tested to customer requirements prior to shipment.

These T&S Wound Cores meet and exceed customer requirements in respect to all magnetic characteristics.

Besides complete assurance of quality and specification conformity, T&S offers its highly qualified engineering assistance—based on more than 50 years of experience in the magnetic materials industry—to help you select the core best suited for any given application.

T&S's entire organization prides itself in anticipating a customer's problems in advance and providing the correct engineering recommendations to prevent such problems from materializing.

### SPECIALISTS IN MAGNETIC MATERIALS

Permanent Magnets Magnetic Tapes   
Laminations and Wound Cores

**Thomas & Skinner, Inc.**

115 E. 23rd St., Indianapolis 7, Indiana  
CIRCLE 248 ON READER-SERVICE CARD

statistical problems has been somewhat limited in the past to special cases. Special circuits, called inverse circuits, are developed for a general analysis of such problems.

### Analysis of Quality and Synthesis of Automatic Control Systems with Time Lag by Fan-Chun-Wui. AT 3/58, pp 198-207, 18 figs.

The method of synthesis of correcting networks for servomechanisms, developed by Solodovnikov, is extended to include systems with time delay. Curves are developed for the synthesis of systems with time delay and for the analysis of their response. Several diagrams are plotted for the distortion function of the real frequency characteristic at various values of time delay.

### Determination of the Parameters of a System from Experimental (Specified) Frequency Characteristics by A. A. Kardashov and L. V. Karnyushin. AT 4/58, pp 334-345, 5 figs.

A method is proposed for determining the parameters of linear elements in automatic control systems. It is based on approximating these elements by means of experimental amplitude-phase characteristics. Tentative values of the coefficients of the analytic expression for the amplitude-phase characteristics are obtained by interpolation, and are subsequently refined by the least-squares method. The method proposed is applicable for all types of polynomials in the numerator and denominator of the transfer function. It gives sufficiently good results at slight-rule accuracy. Illustrative examples are given.

### MEASUREMENTS

### Prototype of a Diode Compensation Voltmeter by B. M. Rabinovich and A. M. Fedorov. ME 2/58, pp 74-76, 5 figs, 1 table.

The voltmeter is intended to measure between 25 mv and 100 v at frequencies from 30 cps to 300 mc. It requires no calibration against stand-

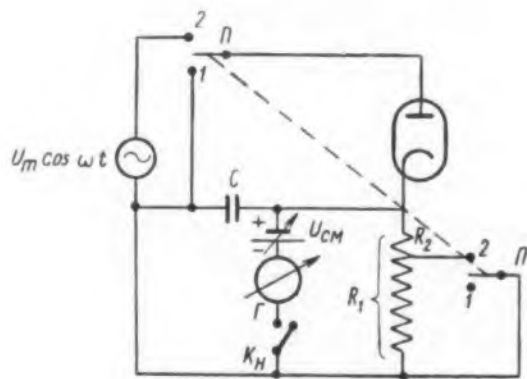
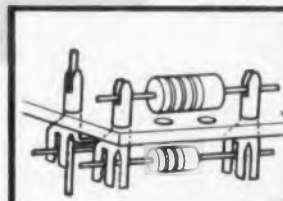
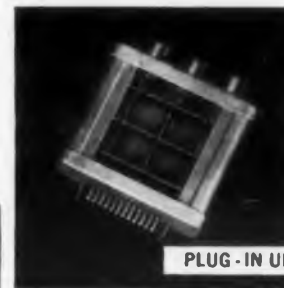


Fig. 4. Illustrating the operating principle of the vacuum tube voltmeter.

## Vector STRUCTURES FOR CIRCUITRY



TERMINALS AND TERMINAL BOARDS



PLUG-IN UNITS



SOCKET TURRETS,  
TERMINAL TURRETS,  
TRANSISTOR TURRETS.



SOCKET TEST ADAPTOR,  
CHANGE ADAPTORS,  
EXTENDERS, ROTOPROBES  
AND TUBE BASE PLUGS.

Write for catalog to:

**VECTOR ELECTRONIC COMPANY**  
1100 FLOWER STREET, GLENDALE 1, CALIFORNIA  
TELEPHONE: CHAPMAN 5-1076

CIRCLE 249 ON READER-SERVICE CARD

## IF IT'S DELAY LINES YOU NEED ...

CONSULT DIGITRONICS CORP., designers and manufacturers of high reliability, minimum volume DYKOR® Lumped-Constant and Continuously Variable Delay Lines . . . custom-crafted, quality units at the lowest possible price. Offering delays of from milli-microseconds to multi-milliseconds, precision-engineered DYKOR Delay Lines deliver proven long life and peak performance even under the most adverse conditions. Available in delays, shapes, sizes and terminal arrangements to suit your requirements.

### DYKOR LUMPED-CONSTANT DELAY LINES

#### FEATURING—

- HERMETICALLY SEALED, EPOXY-MOLDED OR OPEN CONSTRUCTION
- HIGHEST DELAY-TO-RISE TIME RATIO
- EXTREME ACCURACY
- WIDE TEMPERATURE RANGE
- LOWEST TEMPERATURE COEFFICIENT
- MEET ALL APPLICABLE MIL SPECIFICATIONS

### DYKOR CONTINUOUSLY VARIABLE DELAY LINES

#### FEATURING—

- INFINITE RESOLUTION
- NO SLIDING CONTACTS
- LOWEST TEMPERATURE COEFFICIENT
- HIGHEST DELAY-TO-RISE TIME RATIO
- EXTREME ACCURACY
- GREATER VERSATILITY IN USE

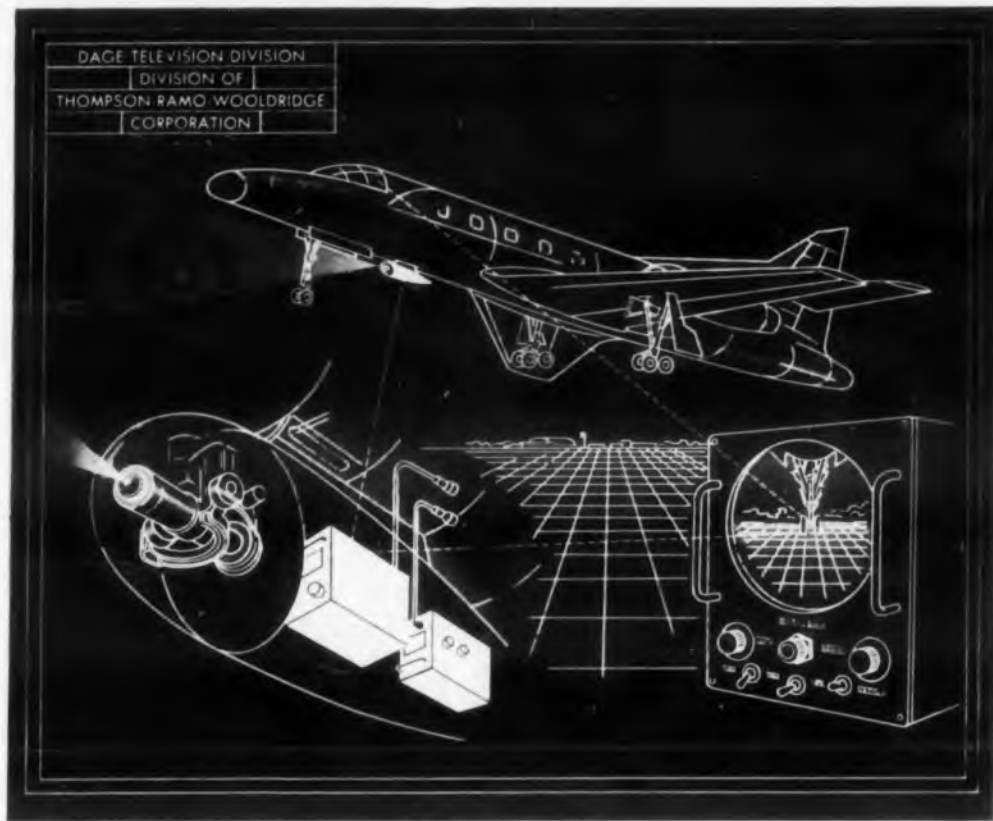
IT'S DIGITRONICS, TOO, FOR DIGITAL HANDLING AND CONTROL SYSTEM DESIGN AND ENGINEERING!

\*TRADE MARK

**DIGITRONICS CORPORATION**  
Albertson Avenue, Albertson, L. I., N. Y. • PL 7-3090

CIRCLE 250 ON READER-SERVICE CARD

Write for  
Quotation  
and new  
DYKOR  
Catalog



**DAGE** relies on new  
*Proto-Circuits Division*  
for printed wiring prototypes

Dage Television needed printed wiring prototypes—in a hurry. The project: the 1st Airborne Transistorized MIL Qualified TV System, for automatic, fully stabilized control of Photo Reconnaissance Cameras.


*Dage's choice:* PROTO-CIRCUITS Division of PHOTOCIRCUITS.

Only PHOTOCIRCUITS offers you such a complete, separate prototype facility. PROTO-CIRCUITS' streamlined organization—from design through tooling—cuts paperwork and overhead to the bare minimum. You get *fast service at low cost*, whether you're next door or across the country.

You get *better* prototypes, because PROTO-CIRCUITS uses the same highly refined production techniques utilized by PHOTOCIRCUITS.

The transition from prototype to production is a smooth one, free from awkward, costly mistakes and misunderstandings. PHOTOCIRCUITS' unique and unequalled production capacity assures a steady, on-time flow of boards, regardless of quantity.

Dage made the logical choice—based on high quality, low cost, fast service. For the same reasons, you too should contact PROTO-CIRCUITS for your prototype needs. Write or call Department 1135 for full information today.



## Photocircuits

CORPORATION

GLEN COVE, NEW YORK

PHONES: GLEN COVE 4-8000 FLUSHING 7-8100

CABLE: PHOCIRCO

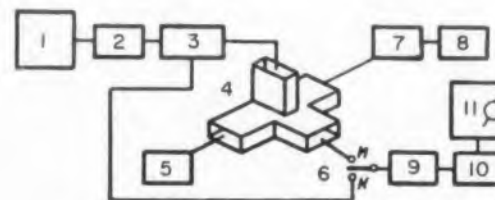
CIRCLE 251 ON READER-SERVICE CARD

## RUSSIAN TRANSLATIONS

ard ac instruments. Its accuracy depends on the accuracy of the standard cell employed and on the resistances in dc circuits. See Fig. 4.

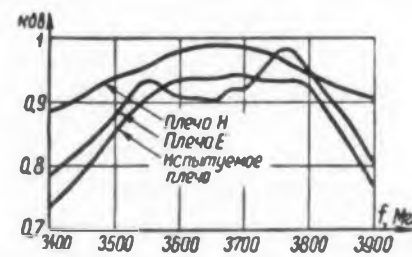
**Measurement of Small Reflection Co-efficients over a Wide Frequency Range with the Aid of a T-Bridge by V. K. Paramonov, A. A. Metrikin, and N. A. Fel'd. EC 5/58, 7 figs, 1 table.**

Description of a waveguide T-bridge, intended for the measurement of small reflection coefficients (less than 1 to 1.5 per cent) at frequencies from 3400 to 3900 mc. The asymmetry of the double T-bridge and the turning off the standard terminal resistance of the bridge is carried out during each change in frequency. The fundamental elements of the bridge, the procedure of their adjustment, and the procedure of measurement with the bridge are described. See Figs. 5-7.

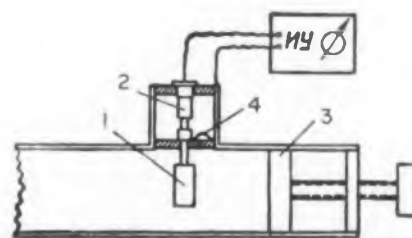


**Fig. 5.** Block diagram of the measuring bridge. 1—signal generator, 2—decoupling attenuator, 3—directional coupler, 4—double T, 5—variable terminal load, 6—waveguide switch, 7—measured element, 8—standard terminal load, 9—calibrating attenuators, 10—detector head, 11—measuring amplifier with indicator.

**Fig. 6.** The matching of the H arm, E arm, and the tested arms of the T over the tested frequency range. Abscissas—frequency mc, ordinates—SWR.



**Fig. 7.** Detector head. 1—vibrator, 2—detector, 3—short circuiting plunger, 4—jumper. It is used to complete the dc circuit of the detector and to adjust the Q of the resonant circuit and the form of the resonant curve.



## NOW...1 to 80 polaroid exposures in ONE loading with the newest BEATTIE OSCILLOTRON!



*LABORATORY recording of oscilloscope traces is far more efficient with this new camera.*

Key to the versatility of the new Beattie Oscilloscope camera with a polaroid back is the feather-touch Multiple Exposure Positioning Bar. Now you can get one-to-one presentation or up to 10 exposures on a single frame—by a simple adjustment. Other features: f/1.9 lens, shutter speeds from 1 sec. to 1/100 sec., time, and bulb.

This new Oscilloscope camera fits the same periscope to which all other Beattie Oscilloscope cameras are attached.



Multiple Exposure Positioning Bar

for more information write to

**B BEATTIE-**  
**C COLEMAN inc.**

1000 N. Olive St., Anaheim, California  
CIRCLE 252 ON READER-SERVICE CARD





**pick the  
best pilot light  
for your application  
in seconds!**

**Johnson pilot lights  
immediately available  
for original equipment  
or in-the-field replacement!**

Choose your next group of panel indicators from E. F. Johnson's "preferred" line—over 47 separate assemblies carefully selected from Johnson's standard line by many of the nation's top design and development engineers. Available in a wide variety of types, these "preferred" units may be obtained from stock at parts distributors throughout the country for original equipment or in-the-field replacement. Write for your free copy of Johnson's newest pilot light specification catalog—see how easy it is to select the *right* pilot light . . . fast!

**Select the right  
pilot light...fast!**

Complete pilot light catalog 750a contains detailed specifications, prices, and technical data . . . everything you need to select the best unit for your particular application. Write for your free copy of Catalog 750a today.

Available types include: continuous indication neon types; models for high and low voltage incandescent bulbs; standard or wide angle glass; and lucite jewels in clear, red, green, amber, blue, or opal. Specials, including those meeting military specifications, also available in production quantities.



**E. F. Johnson Company**

2011 Second Ave. S.W. • Waseca, Minnesota

Circle 253 on Reader-Service Card

**ANTENNAS**

**Choice of Most Suitable Dimensions and Design of Ferrite Antennas by B. I. Ryazanov. EC 2/58, pp 25-28, 4 figs, 1 table.**

Formulas and graphs are given for the calculation of the effective height and the inductance of ferrite antennas with round cores. The effect of various quantities on the parameters of the antenna, including the effective height for a constant inductance, are considered.

**In-Phase Band Short-Wave Antenna with Aperiodic Reflector by G. Z. Ayzenberg, V. D. Kuznetsov, and L. K. Olfin. EC 3/58, pp 21-28, 7 figs.**

This is a continuation of a general article on the same type of antenna published by the authors in the January 1958 issue of *Elektrosvyaz*. They give here the theoretical and experimental results, which make it possible to choose the dimensions of the aperiodic reflector. The directivity patterns of the antenna in the horizontal and vertical planes were examined theoretically and experimentally. Computation curves are given for the dependence of the directivity coefficient and the gain of the antenna on the wavelength. The results of an experimental investigation of the matching of the antenna with the supply feeder, using a model, are given for a broad frequency band. Certain information on specific antennas is also given.

**MAGNETIC AMPLIFIERS**

**Dynamic Character of Rectangular Static Hysteresis Loops (Influence of Eddy Currents) by M. A. Rozenblat. AT 1/58, pp 75-84, 7 figs, 3 tables.**

The author examines the influence of eddy currents on the form of the dynamic hysteresis loop, on the value of the differential permeability and on the value of the dynamic coercive forces of cores with rectangular static hysteresis loops. Analytic expressions are derived for the dynamic hysteresis loop under sinusoidal variation of the conduction, under sinusoidal variation of the magnetic field intensity, and under reversal of magnetization of the core by dc. Experimental data confirming the results of the calculations are also cited.

**Concerning a Magnetic Amplifier with Inductive Load, Connected through a Rectifier by L. V. Safiris. AT 3/58, pp 228-238, 18 figs, 2 tables.**

It has already been established that the duration of a transient in a magnetic amplifier feeding an inductive load through a rectifier is determined by the time constant of the load, regardless of the signal amplitude. This article provides an analysis for nonideal circuits.

# TANTALUM Sheet

## FROM STOCK

"As fast . . . as dependable as requisitioning from our own stock room." That's what hundreds of firms say about the Fansteel Tantalum Sheet Stocking Service.

Delivery of Fansteel Tantalum Sheet from stock has helped many customers to accelerate research and development programs . . . speed up prototype work and pilot runs . . . and to get into production without delay.

**FANSTEEL SERVICE SAVES TIME AND MONEY**

If you're now working on new projects using tantalum or are stepping up production schedules, let this Fansteel Service help save you time and money by giving you the flexibility of quick deliveries and lower inventory costs.

MOLYBDENUM USERS get the same benefits from the Fansteel Molybdenum Sheet stock program.

IMMEDIATE  
DELIVERY  
ON THESE  
FIVE  
MOST USED  
SIZES OF  
TANTALUM  
SHEET

.002"  
.003"  
.005"  
.007"  
.010"

**WE'LL RUSH YOU PRICE BULLETIN**

Call, wire or write for new price bulletin just released. Contains complete prices for both tantalum stock items and special mill runs.



K588A

# FANSTEEL®

**FANSTEEL METALLURGICAL CORPORATION**

NORTH CHICAGO, ILLINOIS, U. S. A.

Circle 254 on Reader-Service Card

## Design of Quartz Crystal Oscillators

IF CERTAIN, physically reasonable assumptions are made, exact solutions for the behavior of three-pole quartz crystal oscillators can be deduced easily. In the general three pole circuit shown in Fig. 1 it is assumed that the feedback factor,  $Z_1/(Z_1+Z_3)$  is large compared to the reciprocal of the tube amplification factor. The condition for oscillation is then given by

$$g_m Z_1 Z_2 + Z_1 + Z_2 + Z_3 = 0$$

It is further assumed that in addition to the tube, the only energy dissipation takes place in the crystal which is used as one of the three impedances. Linear operation and absence of transit time and other hf effects are also assumed.

The quartz crystal has its electrical properties represented by the equivalent circuit shown in Fig. 2. In this circuit the impedance  $Z_s$  is taken as

$$Z_s = R_s + j2\Delta\omega L_s$$

where  $\Delta\omega$  is the difference between the frequency of oscillations and the series resonant frequency of the crystal.

If either  $Z_1$  or  $Z_2$  represents the quartz crystal then the Pierce-Miller oscillator results. If the crystal is represented by  $Z_3$  and if  $Z_1$  and  $Z_2$  are capacitances then the circuit is the Pierce-Colpitts circuit.

Choosing the quartz crystal as the impedance  $Z_1$ , and letting  $Z_2$  be an inductance whose reactance is  $X_2$ , then  $Z_3$  is a capacitance with reactance  $-X_3$ . Defining a parameter  $A$  through

$$2A = \frac{X_p(X_3 - X_2)}{X_p + X_3 - X_2}$$

the frequency difference  $\Delta\omega$  is given by

$$2L_s = A \pm (A^2 - R_s^2)^{1/2}$$

Transconductance is given by

$$g_m X_2 / (X_3 - X_2) = R_s / (4A\Delta\omega L_s)$$

If  $Z_1$  and  $Z_2$  are interchanged then the formulas given above apply if  $X_1$  is replaced by  $X_2$  and vice-versa.

When the Colpitts circuit is used and the capacitive reactances in the arms 1 and 2 are denoted by  $-X_1$  and  $-X_2$  respectively then a

parameter  $B$  is defined where

$$2B = X_p^2 / (X_p + X_1 + X_2)$$

The frequency is given by

$$2\Delta\omega L_s = X_p - (B \pm B^2 - R_s^2)$$

and

$$g_m X_1 X_2 = \frac{X_p^2 R_s}{2B(B \pm B^2 - R_s^2)}$$

As indicated above, each of the expressions involves a choice of sign. Since generally the oscillator will stabilize at the condition which requires the smaller value of  $g_m$ , the plus sign is used.

In the original article both power dissipation in the quartz crystal and frequency stability of the oscillator with respect to parameter variation are considered. It is concluded that except at high frequencies (above 40 mc) the Colpitts circuit is most useful.

*Abstracted from an article by F. Rockstuhl, Telefunken Zeitung, Vol. 31, No. 119, April 1958, pp 50-58.*

## Errors In Binary Transmission

Table 1 Parameter Values

Keying Method	Demodulation Method	a	b	c	Valid if the error in R is less than 0.5 db for:
Frequency Shift	Envelope	2	0	2	all values of R
	Synchronous	2.5	1/2	2	$R \geq 5\text{db}; p \leq 0.04$
Phase Reversal	Synchronous	3.55	1/2	1	$R \geq 2\text{db}; p \leq 0.04$
Amplitude	Envelope, Threshold Value $k = 1/2$	2	0	2	$R \geq 2\text{db}; p \leq 0.25$
	Envelope, Threshold Value opt. $[F(R)]$	1.9	1/4	2	$R \geq 3\text{db}; p \leq 0.15$
	Synchronous	2.5	1/2	2	$R \geq 5\text{db}; p \leq 0.04$

IN BINARY transmission the probability,  $p$ , that a signal will be received erroneously (i.e. a 1 as a 0 or vice versa) depends both on the signal to noise ratio and the methods of keying and demodulation. It can be shown that phaseshift keying is the optimum binary transmission method.

One general formula can be used to approximate the various curves which give  $p$  as a function of signal to noise ratio,  $R$ , under the assumption of white noise and of equal probability for each binary element ( $p(0) = p(1) = 1/2$ ). The formula has the form

$$p \approx \frac{1}{aR^b} e^{-R/c}$$

The values of  $a$ ,  $b$  and  $c$  depend on the transmission and detection scheme and can be taken



as the constants shown in Table 1 within the limits indicated. Laboratory experiments confirm the validity of the formula.  
 Abstracted from an article by H. J. Held, Nachrichtentechnische Zeitschrift, Vol. 11, No. 6, June 1958, pp 286-292.

## Operating Temperature of Transistors

**O**PTIMUM design of transistor amplifier stages with high transistor lifetime requires that the internal temperature be limited. Although almost all transistor parameters are temperature dependent (and can therefore be used to determine operating temperature) the simplest relationship involves the residual currents at a pn junction which have the temperature dependence  $I_o = A \exp(-qV_o/kT)$ . Since the values of  $A$  and  $V_o$  differ from sample to sample, constant calibration at known temperatures is necessary if this relationship is to be used directly. This method also requires that elaborate mechanical switching arrangements be used.

If in place of the residual base-collector current (with open emitter) the collector current with shorted emitter is used as shown, the sensitivity of the measurement is increased and a direct reading (i.e. in deg C) circuit can be devised. The accuracy of 0.5 C can be reached.

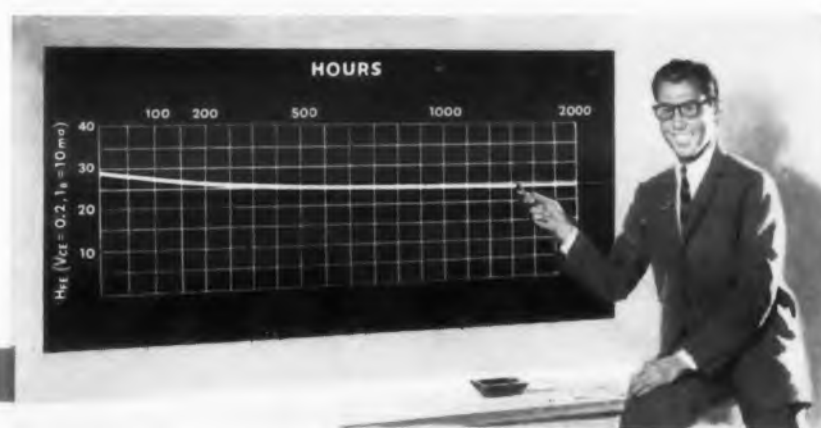
If  $V_1/V_T$  ( $V_T = kT/q$ ) is small then the collector current in the figure is related to the open circuit value by

$$I_2 = I_{co} \frac{V_T + R_B I_{co}}{V_T + R_B I_{co} (1 - \alpha_e)}$$

By making a portion of  $R_B$  adjustable it is possible to match the temperature dependence of  $I_2$  for various samples (approximately). It is then only necessary to calibrate at a given temperature and vary  $R_B$  to match the constant  $A$  in the expression for residual current.

Abstracted from an article by H. Beneking, Archiv der Elektrischen Uebertragung, Vol. 11, No. 12, December 1957, pp 504-508.

# Now PNP SWITCHING TRANSISTORS from Sylvania



designed to give you this same reliability you've come to expect from Sylvania's full line of NPN types

**H**ERE IS an important line of PNP switching transistors to complement Sylvania's line of NPN types. Manufacturing techniques developed for producing high-temperature stability in NPN types have been incorporated in these new PNP switching transistors. For designers this means the high reliability and stability synonymous with Sylvania NPN types, and permits circuit designs which take full advantage of the complementary aspects of NPN and PNP.

These transistors feature a new hermetically sealed inverted base TO-5 package which offers better heat dissipation to easily provide up to 150 mw at 25°C.

Electrical, mechanical, and environmental tests applied to these PNP transistors are in accordance with MIL-T-19500A.

### TECHNICAL DATA

Type	V <sub>CB</sub> Volts	V <sub>EB</sub> Volts	V <sub>CE</sub> Volts	f <sub>ob</sub> min mc	h <sub>FE</sub> Typical	Max. Dissipa- tion in MW
2N404	-25	-12	-24	4.0	50	120
2N425	-30	-20	-20	2.5	30	150
2N426	-30	-20	-18	3.0	40	150
2N427	-30	-20	-15	5.0	55	150
2N428	-30	-20	-12	10.0	80	150

Temperature range -65° C to +85° C

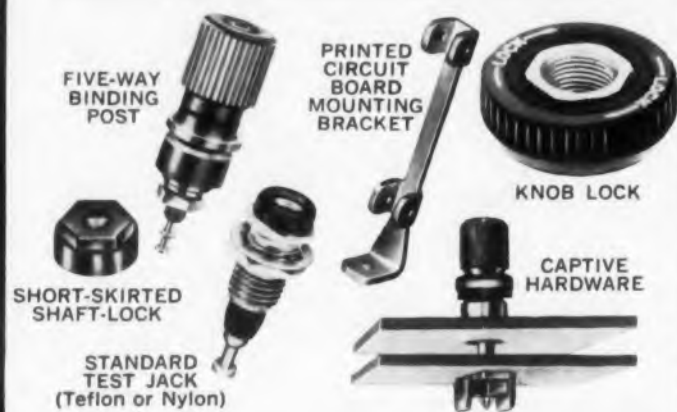


# SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.  
 1740 Broadway, New York 19, N.Y.  
 In Canada: P.O. Box 1190, Station "O"  
 Montreal 9

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY  
 CIRCLE 255 ON READER-SERVICE CARD

## MODERN PANEL COMPONENTS



## FREE DATA SHEETS

You'll make good use of these specs and mounting details on Raytheon's advanced line of precision-engineered mechanical components. Please write:

RAYTHEON Dept. 6120  
Commercial Equip. Div.  
Waltham 54, Mass.



CIRCLE 256 ON READER-SERVICE CARD

# MEETINGS

## Calendar of Events



- 1-5 Annual Meeting, American Rocket Society, New York, N.Y.
- 1-5 ASME Annual Meeting, New York, N.Y.
- 2-4 3rd EIA Conference on Reliable Electrical Connections, Dallas, Tex.\*
- 3-5 Eastern Joint Computer Conference, Philadelphia, Pa.\*
- 3-5 2nd National Symposium on Global Communications, St. Petersburg Beach, Fla.\*
- 3-5 American Inst. of Electrical Engineers, St. Petersburg, Fla.
- 4-5 Annual Conference Professional Group on Vehicular Communications (IRE), Chicago, Ill.\*
- 7-10 Annual Meeting American Inst. of Chemical Engineers, Cincinnati, Ohio
- 8-10 American Nuclear Society Meeting, Detroit, Mich.\*
- 9-10 Conference on Learning Effectiveness, Philadelphia, Pa.
- 9-11 Tenth Annual Technical Conference IRE Kansas City Section, Kansas City, Mo.
- 18-20 American Physical Soc., Los Angeles, Calif.
- 26-31 Annual Meeting American Assoc. for Advancement of Science, Washington, D. C.

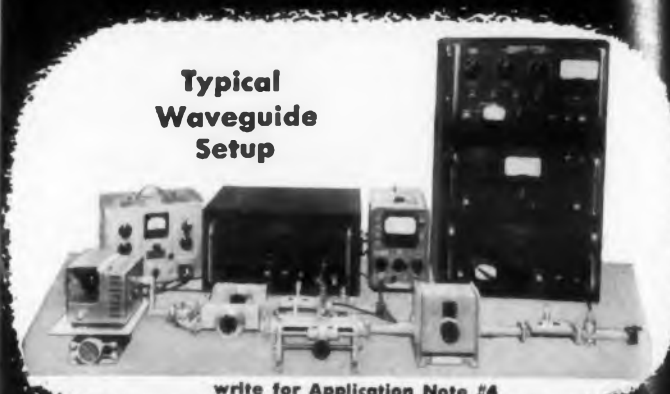
\*Indicates meetings described below.

### 3rd EIA Conference on Reliable Electrical Connections, Dec. 2-4

Statler-Hilton Hotel, Dallas, Tex. Manufacturing point-of-view as well as Government and Military aspects will be covered. All types of electrical connections will be considered including: (a) those which are out-of-sight and within (internal) component parts, such as connections inside capacitors, and (b) those which are exposed (external) and parts of an electrical or electronic system.

One full day will be devoted to each of three general subjects: (1) Fixed connections (wrapped, soldered, crimped, and welded); (2) sliding and

## WEINSCHEL dual channel INSERTION LOSS TEST SET with .01 db precision



Typical Waveguide Setup

write for Application Note #4

- \* attenuation range: 20 db
- \* with partial r-f substitution, range can be extended to 40 db if source can deliver output of 200 milliwatts.
- \* absolute accuracy: .02 db/10db
- \* frequency range: 20 to 90,000 mcs (limited by commercially available bolometer mounts)

where less accuracy is needed  
Single Channel Insertion Loss Test Set  
write for Application Notes #1

### Weinschel Engineering

10503 Metropolitan Avenue, Kensington, Maryland

CIRCLE 258 ON READER-SERVICE CARD



FREE

CHART LISTS THE CHARACTERISTICS FOR 34 STANDARD GRADES OF

**FARLITE** HIGH PRESSURE PLASTIC LAMINATES

This handy chart lists the grades, mechanical and electrical properties, and suggested uses for Farlite standard paper and fabric base laminates. If your requirements demand special grades, Farlite engineers will be happy to work with you to develop laminates to suit your individual needs.

PLASTICS DIVISION  
FARLEY LOETSCHER MFG. CO.  
DUBUQUE, IOWA

WRITE for your copy of this Farlite catalog containing the handy reference chart. It's FREE!

CIRCLE 259 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1958

Kester Solderforms will give you today's demanded economy plus end product quality greater than ever before.

Write For Complete Information

**KESTER SOLDER COMPANY**

4266 Wrightwood Ave. • Chicago 39, Ill.  
Newark 5, N. J. • Brantford, Can.

CIRCLE 257 ON READER-SERVICE CARD



wiping connections (such as encountered in potentiometers, rheostats, switches, and the like); and (3) connect-disconnect connections (plugs and jacks).

An attempt will be made to cover all the facets of the foregoing subjects, such as (1) choice of materials being joined together; (2) methods and equipment used to join them; (3) materials and processes used to protect the connections; (4) effects of usage or environments of the finished parts or systems on the electrical connections, and (5) servicing or maintenance aspects of the parts or systems.

For information, write W. O. Richards, 224 Cedar St., Syracuse 3, N.Y.

#### Eastern Joint Computer Conference, Dec. 3-5

Bellevue-Stratford Hotel, Philadelphia, Pa. Sessions to be presented: Reliability and components; Computer technology (Part 1—Present research, Part 2—Speculation on future); Organization and processing information; Design techniques; New computers.

#### 2nd National Symposium on Global Communications, Dec. 3-5

Colonial Inn and the Desert Ranch, St. Petersburg Beach, Fla. Jointly sponsored by IRE Prof. Group on Communications Systems and AIEE, Communications Div. Technical program to include 60 papers covering latest advances in radio and wire communications; data link systems; spectrum utilization, conservation, and administration; system reliability; application and utilization of military and civil systems. Fifty-four leading manufacturers of communications equipment will exhibit their latest problems. Further information may be obtained from Mr. Thomas F. Thompson, Jr., Chairman Registration Committee, Florida Power Corp., P.O. Box 4042, St. Petersburg, Fla.

#### Annual Conference Professional Group on Vehicular Communications, Dec. 4-5

Hotel Sherman, Chicago, Ill. Fifteen papers to be presented and nearly 20 leading manufacturers of two-way radio and accessory equipment will be exhibiting.

#### American Nuclear Society Meeting, Dec. 8-10

Sheraton-Cadillac Hotel. Leading nuclear scientists and engineers to discuss the most recent atomic energy concepts—including a package reactor for use in outer space.

## NEW BENDIX MS-R ENVIRONMENT RESISTING ELECTRICAL CONNECTOR



Now available and approved in complete conformance with MIL-C-5015D.

This new connector answers the demand from the aircraft industry for a shorter, lighter and more reliable environment resisting connector. This connector will inactivate practically all other MS types and the Military has assigned a new class letter R to insure incorporation of this better connector in all new designs.

An important reliability feature of the new MS-R connector is an "O" ring at the main coupling joint which provides for the best possible sealing and more positive inter-facial compression and assures complete performance compatibility among all approved MS-R connectors. Establishment of the MS-R connector as the "universal" military connector is testimony to the record of previous MS environmental resistant connectors using resilient inserts as pioneered by this Division. In the Bendix\* connector, wire sealing is accomplished by an exclusive slippery rubber grommet which permits convenient wire threading and grommet travel over wire bundles.

Write for more complete information on this latest addition to the ever-growing family of Bendix electrical connectors.

\*TRADEMARK



SCINTILLA DIVISION  
SIDNEY, NEW YORK



Export Sales and Service: Bendix International Division, 205 East 42nd St., New York 17, N.Y.

Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec.

FACTORY BRANCH OFFICES:

117 E. Providencia Ave., Burbank, Calif. • Paterson Building, 18038 Mack Ave., Detroit 24, Mich. • 545 Cedar Lane, Teaneck, N. J. • 5906 North Port Washington Rd., Milwaukee 17, Wisc. • Hulman Building, 120 W. Second St., Dayton 2, Ohio • 2608 Inwood Road, Dallas 19, Texas • 8425 First Ave., South, Seattle 8, Washington • 1701 "K" Street, N.W., Washington 6, D. C.

CIRCLE 260 ON READER-SERVICE CARD



**HAVE A SPECIAL PROBLEM?  
TALK WITH TABER ENGINEERS.**

*Taber* **TRANSISTOR  
AMPLIFIERS**

**MODEL 208G Transistor Hydraulic Valve Drive.** Ambient Temperature  $-50^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ , power output 150 mw, input signal 5V rms, input impedance 3000 ohms, output 10V DC, load impedance 2000 ohms CT., power supply  $+12\text{V}$  @ 20 ma,  $-12\text{V}$  @ 20 ma, switching input 6.3V rms @ 10 ma, 40 G's @ 60 cps.

**MODEL 198S for High Temperatures,** 90 db open loop gain plug-in amplifier, 3 db to 60 db closed loop gain,  $-60^{\circ}\text{C}$  to  $+125^{\circ}\text{C} \pm 1\%$  gain stability ( $\pm 5\%$  @  $+150^{\circ}\text{C}$ ) 1 meg input impedance, output 5.0V rms across 50 K ohms, 40 G's at 60 cps,  $7/8" \times 7/8" \times 2 1/2"$ , weight 1.8 ozs.

**MODEL 214G, A.C. Error Amplifier for Printed Circuit Resolvers,** up to 120 db closed loop gain, open loop gain over  $10^{11}$ , noise under 0.1 microvolts at 2 ohms, 5V rms output, for carriers 50 cps to 20 KC,  $1 1/2" \times 3 1/2" \times 7"$ , weight 15 ozs.

... Write for Literature and Prices ...



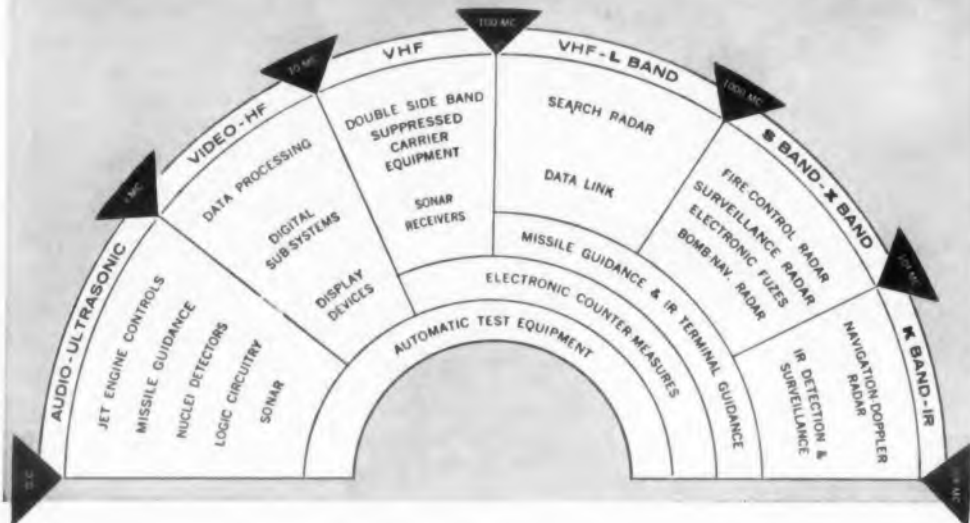
**TABER INSTRUMENT CORPORATION**  
Section 161 107 Goundry St. North Tonawanda, N. Y.  
Telephone: LUDlow 8900 TWX - TON 277

CIRCLE 261 ON READER-SERVICE CARD

Engineers-EE, ME, Physicists

# PROFESSIONAL CHALLENGE AWAITS YOU AT ANY POINT ALONG THE RF SPECTRUM

At General Electric's Light Military Electronics Department



By designing across the entire electromagnetic spectrum, Light Military displays diversification that is unique in the industry.

It takes a versatile engineer to answer the challenge projected by this type of diversity—one who can move freely across his discipline, exposing himself to unfamiliar problems and exploring new ideas with colleagues in the advanced

areas of electronics.

But equally important, Light Military's diversity demonstrates a characteristic of high significance to engineers seeking long-term futures—*stability*.

A unique combination of these two factors—*diversity and stability*—provides the formula for unusually rewarding careers at Light Military Electronics Department.

*We are particularly interested in talking to people capable of circuit design and systems analysis in the following fields:*

**POLARIS MISSILE GUIDANCE — ELECTRONIC COUNTERMEASURES PROGRAMS — SURVEILLANCE & FIRE CONTROL RADAR — DIGITAL TECHNIQUES — DISPLAY DEVICES — NAVIGATION EQUIPMENTS — MICROWAVE DEVICES — TRANSISTOR TECHNIQUES — RELIABILITY**

*Also Mechanical Engineers interested in the following fields:*

**ELECTRONIC PACKAGING — SHOCK & VIBRATION — EQUIPMENT CONFIGURATION — HEAT TRANSFER — MECHANISMS**

*Also openings in* ADMINISTRATIVE ENGINEERING — TECHNICAL WRITING



**GENERAL ELECTRIC**

Forward your resume in confidence, or simply fill out and mail this coupon.

Mr. Richard C. Kimm  
General Electric Company  
Light Military Electronics Department  
French Road, Utica, N. Y.

I am interested in professional career opportunities at Light Military.

Name \_\_\_\_\_

Home Address \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

Phone \_\_\_\_\_ Degree (s) \_\_\_\_\_

Year (s) Received \_\_\_\_\_ I am particularly interested in the following

technical areas: \_\_\_\_\_

(U. S. citizenship required)

66-SU



**TRANSISTOR  
CIRCUIT  
DESIGNERS...**

## WHAT IS YOUR GOAL??

**IF . . .** you would like to work on new commercial projects, as well as military, involving semi-conductor, transistor and related circuitry . . .

**IF . . .** you're looking for a forward-looking management that are engineers themselves—and a real opportunity to learn because you have access to all phases of design . . .

**IF . . .** you want to get in on the ground floor with a growing leader of transistorized and semi-conductor products where management positions are within easy reach . . .

**IF . . .** you want to work for a company offering all fringe benefits including insurance, paid holidays, vacations . . .

**IF . . .** you want to be sure of job security and settle in a country area with quick access to New York City facilities . . .

**IF . . .** you want to work in a modern plant, with streamlined facilities for research, design and development . . .

*U.S. citizenship preferred not required.*

**CONTACT MR. MOSKOWITZ  
ELECTRONIC RESEARCH  
ASSOCIATES, INC.**

67 FACTORY PLACE • CEDAR GROVE, N. J.  
Center 9-3000

Plants: Nutley, N. J. — Cedar Grove, N. J.  
Santa Monica, Cal.

CIRCLE 552 ON READER-SERVICE CARD

**ESC**  
WILL  
SHARE ITS  
PROFITS  
with

**ENGINEERS...**  
*Experienced  
Computer  
Components*

ESC Corporation, one of America's fastest growing engineer-managed electronics manufacturers, offers both a challenging position in design and development and a chance to share in its growing profit-sharing plan. You can work under supervision or assume responsibility for these vital ESC projects:

**Audio and Video Filters  
Delay Lines  
Core Matrices  
Magnetic Shift Registers**

A minimum of 3 years general experience is required with 1 year of pulse techniques preferred. In addition to an excellent salary commensurate with ability, you'll receive all company-paid benefits. Write or telephone in confidence to—

MR. RAY GRASSI



**ESC CORPORATION**

534 BERGEN BOULEVARD  
PALISADES PARK, N. J.  
Windsor 7-0400

CIRCLE 555 ON READER-SERVICE CARD



Research and Development ENGINEERS



**NEW**  
**career**  
**opportunities**  
**with**  
**MOTOROLA**  
**in Chicago**

Here is opportunity *unlimited* for men who like challenges and the rewards that go with accomplishment. Grow right along with dynamic 2-way radio communications, or work on important assignments from the armed forces.

You'll enjoy working at Motorola in well-instrumented laboratories, with men of the highest technical competence. Many liberal employee benefits, including an attractive profit sharing plan.

Living in one of Chicago's beautiful suburbs, you can choose from endless social, cultural and educational activities the year round.

**MILITARY**  
**POSITIONS OPEN**

- Radar transmitters and receivers
- Radar circuit design
- Antenna design
- Electronic countermeasure systems
- Military communications equipment design
- Pulse circuit design
- IF strip design
- Device using klystron, traveling wave tube and backward wave oscillator
- Display and storage devices

**CIVILIAN**  
**POSITIONS OPEN**

**2-WAY RADIO COMMUNICATIONS**

- VHF & UHF Receiver • Transmitter design & development • Power supply
- Systems Engineering • Selective Signaling • Transistor Applications • Crystal Engineering • Sales Engineers

**PORTABLE COMMUNICATIONS**

- Design of VHF & UHF FM Communications in portable or subminiature development.

**MICROWAVE FIELD ENGINEERS**

Positions also available in:

**Phoenix-Ariz.**

**Riverside, Calif.**

write

Mr. L. B. Wrenn Dept. J  
**MOTOROLA, INC.**  
 4501 Augusta Blvd., Chicago 51, Ill.



**MOTOROLA**

**ENGINEERING**  
**UNLIMITED**

AT ONE OF THE WORLD'S MOST  
 SUCCESSFUL CORPORATIONS

Select Openings at *National's*  
**NEW Engineering-Research Center**  
**at Dayton, Ohio**  
**Long-range non-military projects**  
**with exceptional stability**

**COMPUTER ENGINEERS**

**Senior Systems Analysts**—Require Senior Systems Analysts with strong theoretical and design knowledge in the electronic engineering field including familiarity with electronic and electro-mechanical digital machines. Should possess minimum of 3 years' experience with commercial application digital data processing equipment, however, would consider experience with scientific or defense application systems. Operational experience with a large data processing system is a distinct asset. Will be required to analyse and direct product improvement on large general purpose computer or small special purpose desk computer series. Advanced degree desired.

**Senior Circuit Designers**—Experienced in the design, development and analysis of transistorized computer circuits. Familiar with the application of magnetic cores to computer high-speed memory design. Growth opportunities involving decision making, concerning reliability, cost and component selection are offered. Advanced degree desired.

**Senior Circuit and Logical Designers**—Similar experience and duties as noted for Senior Circuit Designer, plus evaluation and de-bugging arithmetic and control areas of computer systems. Advanced degree desired.

**DATA PROCESSING ENGINEERS**

**Senior Electronic Design Engineers**—Experienced in development of logical design using standard computer elements, must also evaluate and design transistorized circuits including voltage regulated power supplies and circuitry related to decimal to binary coding. This data processing system is concerned with bank automation.

**SEND RESUMÉ TO:**

Mr. K. K. Ross  
 Professional Personnel Section C,  
 The National Cash Register Co.  
 Dayton 9, Ohio



CIRCLE 551 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 26, 1958

CIRCLE 553 ON READER-SERVICE CARD

## ADVERTISERS' INDEX

November 26, 1958

Advertiser	Page
AGA Div., Elastic Stop Nut Corp.	78
AMP, Inc.	57
Ace Electronics Associates	86
Aerovox Corp.	30
Allen-Bradley Co.	60
Alpha Wire Corp.	72, 73
Applied Research, Inc.	79
Arnoux Corp.	79
Avion Div., ACF Industries, Inc.	92
B-J Electronics, Borg-Warner Corp.	75
Baird-Atomic, Inc.	91
Baldwin Piano Co.	97
Barber-Colman Co.	80, 81
Barker & Williamson, Inc.	26
Beattie-Colman, Inc.	102
Behlman Engineering Co.	15
Bendix Aviation Corp., Scintilla Div.	107
Birtcher Corp.	83
Bliley Electric Co.	100
Bryant Chucking Grinder Co.	92
Burnell & Co., Inc.	9
Carpenter Steel Co.	28
Cedco Electronics	23
Clarostat Mfg. Co.	54-55
Clevite Transistor Products	19
Cornell-Dubilier Electric Corp.	29
Corning Glass Works	69
Curtiss-Wright Corp.	66
Daven Co., The	78
DeJur Amsco Corp.	62
Designers for Industry	89
Dialight Corp.	74
Digitronics Corp.	101
DuMont, Allen B. Laboratories	64
ESC Corp.	108
Eastman Kodak Co.	77
Edison, Thomas A., Inc.	56
Elastic Stop Nut Corp.	74
Eldema Corp.	14
Electronic Research Associates, Inc.	89, 108
Englehard Industries, Inc.	17
Fansteel Metallurgical Corp.	103
Farley & Loetscher Plastics Div.	106
Farr Co.	76
Filtors, Inc.	48
Fischer Special Mfg. Co.	95
Ford Instrument Co., Inc.	71
G-M Laboratories, Inc.	75
Gamewell Co.	94
Garrett Corp.	63
General Electric Co., Resistors	88
General Electric Co., Industrial Equipment	67
General Electric Co., Apparatus Sales	10
General Electric Co., Receiving Tubes	8-9
General Electric Co., Semiconductor Div.	68-69
General Electric Co., Light Military Div.	108
General Hermetic Sealing Corp.	93
General Radio Co.	74
Genisco, Inc.	50-51
Good-All Electric Mfg. Co.	65
Guardian Electric	72
Handy & Harmon Co.	41
Haydon, A. W. Co., Inc.	77
Heiland Div., Minneapolis-Honeywell	85
Heinemann Electric Co.	35
Hewlett-Packard Co.	110-111
Hi-G, Inc.	94
Hooker Chemical Corp.	87
Hughes Aircraft Co.	7, 58-59

Read directly

# 1 $\mu\mu a$

and

# 1 $\mu v$

with 10 times previous accuracy!

Drift less than  $\pm 2 \mu v$ ; noise less than  $0.2 \mu v$ !

**New -hp- 425A Microvolt-Ammeter**  
now makes these difficult measurements quickly and easily!

### ENGINEERING

Minute dc potentials, difference voltages, nulls

Resistances from milliohms to 10 megmegohms\*

Use with Esterline-Angus, other recorders

### PHYSICS, CHEMISTRY

Grid, photomultiplier currents

Ionization levels in vacuum

Thermocouple potentials

Voltaic currents in chemicals

### MEDICINE, BIOLOGY

Voltages in living cells

Nerve voltages

Voltages in plants, seeds

\*with external dc source.



is announcing more than 30





The all-new *-hp-* 425A Microvolt-Ammeter will provide engineers, physicists, chemists and physiological scientists with one compact, direct-reading instrument measuring minute voltages and currents with speed, simplicity and 10 times the sensitivity of the complex equipment arrays previously required.

Very careful engineering, including heavy filtering against ac signals and substitution of a unique photoelectric chopper for the conventional mechanical vibrator, has resulted in performance heretofore unobtainable. The long-term drift of the 425A is less than  $2\mu\text{v}$  and internal noise is less than  $0.2\mu\text{v}$ .

Conservative electrically, Model 425A includes every conceivable assurance of safety, accuracy and dependability. For example, momentary overloads of 1,000 volts cause no damage; and the new pickup probe is specially designed to minimize thermocouple and triboelectric effects. The meter provides constant polarity indication.

The new *-hp-* 425A also may be used to measure a wide range of resistances. Milliohms may be measured by using a battery and series resistor as a constant current source. Higher resistances may be measured with higher voltages; a 100 volt supply allows the 425A to measure accurately up to 10 megmegohms.

Call your *-hp-* representative now for demonstration on your bench; or, write for details.

### HEWLETT-PACKARD COMPANY

4882 K PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.

Cable "HEWPACK" • DAVenport 5-4451

FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

## SPECIFICATIONS

### MICROVOLT-AMMETER

**Voltage Range:** Positive and negative voltages from  $10\mu\text{v}$  full scale to 1 v full scale in an eleven step, 1, 3, 10 sequence.

**Current Range:** Positive and negative currents from  $10\mu\text{a}$  full scale to 3 ma full scale in an eighteen step, 1-3-10 sequence.

**Input Impedance:** Voltage Ranges: 1 megohm  $\pm 5\%$ .  
Current Ranges: Depends on range, 1 megohm to 0.33 ohm.

**Accuracy:** Within  $\pm 3\%$  of full scale.

### AMPLIFIER

**Frequency Range:** dc to 0.2 cps.

**Gain:** 100,000 maximum.

**Output:** 0 to-1 v for full scale reading, adjustable.

**Output Impedance:** 10 ohms, shunted by 1000 ohm potentiometer.

**Noise:** Less than  $0.2\mu\text{v}$  rms referred to input.

**Drift:** After 15 minute warm-up, less than  $\pm 2\mu\text{v}$  per hour referred to the input.

**Power:** 115 v  $\pm 10$  v, 230  $\pm 20$  v, 60 cps, 40 watts.

**Dimensions:** Cabinet Mount:  $7\frac{1}{2}$ " wide,  $11\frac{1}{4}$ " high, 14" deep.

**Weight:** Net 20 lbs.

**Price:** \$500.00.

*-hp-* 425AR (rack mount) \$505.00.

*-hp-* 425A (cabinet) \$500.00.

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

Advertiser	Page
I T & T, Components Div.	11
Illinois Condenser Co.	79
Industrial Electronic Engineers	77
International Resistance Co.	2
Johnson, E. F. Co.	103
Jonathan Mfg. Co.	78
Kay Electric Co.	82
Kennedy & Co., D. S.	31
Kester Solder Co.	106
Kin Tel	45
Kroh-Hite Corp.	100
Leach Corp.	8
Lenz Electrical Mfg. Co.	88
Lord Mfg. Co.	42
Magnetic Research Corp.	90
Magnetics, Inc.	99
Martin Co.	70, 71
Micamold Electronics Mfg. Corp.	40
Microwave Associates, Inc.	61
Minneapolis-Honeywell	21
Motorola, Inc.	109
National Cash Register Co.	109
Oak Mfg. Co.	13
Phelps Dodge Copper Products	46-47
Philco Corp., Lansdale Tube Div.	49
Photocircuits Corp.	102
Potter Co.	73
Potter Instrument Co.	8
Pyrofilm Resistor Co., Inc.	39
Radio Corp. of America	112
Radio Corp. of America, Semiconductor & Materials Div.	33
Radio Frequency Laboratories, Inc.	95
Raytheon Mfg. Co., Semiconductor Div.	4
Raytheon Mfg. Co., Mechanical Components	106
Reeves-Hoffman	83
Robertshaw-Fulton Controls Co.	98
Rome Cable Corp.	91
Sanders Associates, Inc.	34
Simpson Electric Co.	12
Slip Ring Co. of America	72
Sola Electric Co.	94
Spectronic Plating Co., Inc.	82
Sprague Electric Co.	43
Statham Instruments, Inc.	86
Sylvania Electric Products, Electronic Div.	105
Sylvania Electric Products, Equipment Div. (Inc.)	56-57
Systron Corp.	76
Taber Instrument Corp.	107
Technology Instrument Corp.	24
Telecomputing Corp.	38
Texas Instruments, Inc.	6, 52-53
Thomas & Skinner, Inc.	90, 101
Tobe Deutschmann Corp.	93
Torotel, Inc.	100
Transistor Electronics Corp.	78
U. S. Gasket Co.	37
Varian Associates	27
Vector Electronic Co.	101
Vernistat Div., Perkin-Elmer Corp.	36
Weinschel Engineering & Mfg. Corp.	106

30 basic new instruments in 1958

CIRCLE 262 ON READER-SERVICE CARD

*Slim...trim...*

and silver bright!



*...give your TV set designs the new look!*

Women's tastes favor the "slim...trim" look. And manufacturers of TV sets who never underestimate the power of the American woman are designing for lighter-weight, slimmer TV cabinets. They're doing it by specifying RCA 110° picture tubes—commercially available in 17"-, 21"-, and 24"-types.

RCA's "straight" electron-gun is designed to minimize deflection distortion—and eliminates the need for an ion-trap magnet. Inches shorter in length than 90°-deflection types having the same size faceplate, RCA 110°-deflection picture tubes with super-aluminizing produce bright, high-contrast pictures.

RCA 110° picture tubes are available in quantity to meet your production schedule. RCA can also supply you with the horizontal and vertical deflection tubes for 110°-deflection systems. For further information, call your RCA Field Representative.

**RCA FIELD OFFICES**

**East:** 744 Broad Street  
Newark 2, New Jersey  
HUmboldt 5-3900

**Midwest:** Suite 1154  
Merchandise Mart Plaza  
Chicago 54, Illinois  
WHitehall 4-2900

**West:** 6355 E. Washington Blvd.  
Los Angeles 22, Calif.  
RAYmond 3-8361



**RADIO CORPORATION OF AMERICA**

*Electron Tube Division*

*Harrison, N. J.*

DESIGN

HAYDEN PUBLISHING COMPANY, INC.  
830 Third Avenue, New York 22, N. Y.