

AUGUST 14, 1959

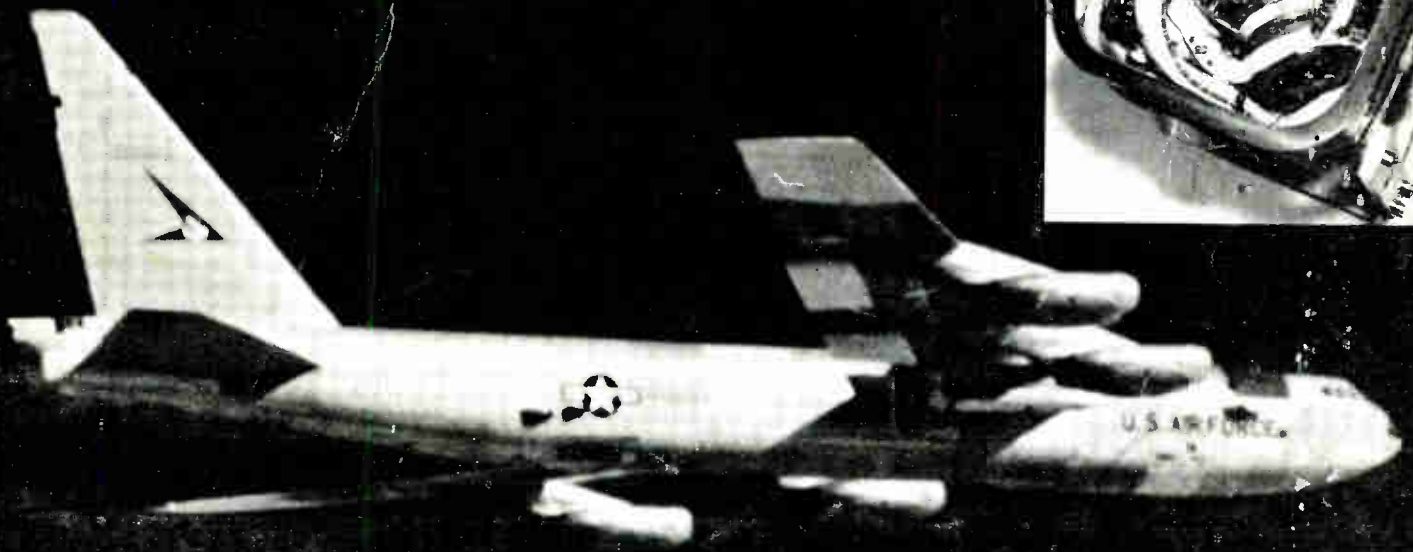
# electronics

A MCGRAW-HILL PUBLICATION

VOL. 32, No. 33

PRICE SEVENTY-FIVE CENTS

## Inertial Guidance for Manned Rocket



San Francisco Industry: 50

L E MC CRAW  
989 ECHLES ST  
MEMPHIS TENN 11



# For Your Special Applications

The bulk of UTC production is on special units designed to specific customers' needs. Illustrated below are some typical units and some unusual units as manufactured for special applications. We would be pleased to advise and quote to your special requirements.

## FILTERS

All types for frequencies from .1 cycle to 400 MC.



400 — telemetering, 3 db at  $\pm 7.5\%$ , 40 db at 230 and 700 —  $\frac{3}{4}$  x  $1\frac{1}{4}$  x 2"



15 — BP filter, 20 db at 30 — 45 db at 10G — phase angle at CF less than 3° from -40 to +100° C.



LP filter within 1 db to 49 KC, stable to .1 db from 0 to 85° C., 45 db at 55 KC.



LP filter less than .1 db 0 to 2.5 KC, 50 db beyond 3 KC.



Tuned DO-T servo amplifier transformer, 400 — .5% distortion.



Toroid for printed circuit, Q of 90 at 15 KC.



Dual toroid, Q of 75 at 10 KC, and Q of 120 at 5 KC.



HVC tapped variable inductor for 3 KC oscillator.

## HIGH Q COILS

Toroid, laminated, and cup structures from .1 cycle to 400 MC.

## SPECIALTIES

Saturable reactors, reference transformers, magnetic amplifiers, combined units.



RF saturable inductor for sweep from 17 MC to 21 MC.



Voltage reference transformer .05% accuracy.



Multi-control magnetic amplifier for airborne servo.



input, output, two tuned interstages, peaking network, and BP filter, all in one case.



Wound core unit 01 micro-second rise time.



Pulse current transformer 100 Amp.



Pulse output to magnetron, bifilar filament.



Precise wave shape pulse output, 2500 V. 3 Amps.

## PULSE TRANSFORMERS

From miniature blocking oscillator to 10 megawatt.

## POWER COMPONENTS

Standard and high temperature hermetic, molded, and encapsulated.



Multi-winding 140 VA, 6 KC power transformer  $1\frac{1}{4}$  x  $1\frac{1}{4}$  x 1"



200° C. power transformer, 400 —, 150 VA.



400 — scope transformer, 20 KV output.



60 — current limiting filament transformer, Sec. 25 Mmfd., 30 KV hipot.

# UNITED TRANSFORMER CORPORATION

150 Varick Street, New York 13, N. Y. • EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y.,  
CABLES: "ARLAB" PACIFIC MFG. DIVISION, 4008 W. Jefferson Blvd., Los Angeles, Cal.

## Issue at a Glance

A McGRAW-HILL PUBLICATION  
Vol. 32 No. 33

JAMES GIRDWOOD, *Publisher*

W. W. MacDONALD, *Editor*

JOHN M. CARROLL, *Managing Editor*

*Associate Editors:* Frank Leary, Michael F. Tomaino, Howard K. Janis, Sylvester P. Carter, Roland J. Charest, William P. O'Brien, George Sideris, John F. Mason, William E. Bushor, Thomas Emma, Samuel Weber, Sy Vogel, Leslie Solomon, M. M. Perugini.

*Pacific Coast Editor* (Los Angeles) Harold C. Hood; *Midwestern Editor* (Chicago) Harold Harris; *New England Editor* (Boston) Thomas Maguire.

*Art Director*, Harry Phillips, Roy Thompsen.

*Production Editor*, John C. Wright, Jr., Bernice Duffy.

*Market Research*, Edward DeJongh.

*Editorial Assistants*, Gloria J. Filippone, Arlene Schilp, Patricia Landers, Eleanor Schaefer, Carol Weaver.

**BRUCE A. WINNER**, *Advertising Sales Manager*. R. S. Quint, *Assistant Advertising Sales Manager and Buyers' Guide Manager*. Fred Stewart, *Promotion Manager*. Frank H. Ward, *Business Manager*. George E. Pomeroy, *Classified Manager*. Hugh J. Quinn, *Circulation Manager*.

*New York:* Donald H. Miller, Henry M. Shaw, William J. Boyle. *Boston:* Wm. S. Hodgkinson. *Philadelphia:* Warren H. Gardner. *Chicago:* Harvey W. Wernecke, Martin J. Gallay. *Cleveland:* P. T. Fegley. *San Francisco:* T. H. Carmody, R. C. Alcorn. *Los Angeles:* Carl W. Dysinger, D. A. McMillan. *Denver:* J. Patten. *Atlanta:* M. Miller. *Dallas:* Gordon L. Jones, Robert T. Wood. *London:* E. E. Schirmer. *Frankfurt:* Michael B. Zeynel.

### Business

San Francisco's 50-Year Story. How peninsula got that way.....	28
New Radar Tells Target's Sex. Systems for battlefield survey.....	33
What Role for Basic Research? Report on industry opinion.....	38
West's Growth Speeds Up. How coast areas compare.....	43
Tv Tape Goes Mobile. Van-borne systems up station flexibility.....	43
Shoptalk .....	4
Electronics Newsletter .....	11
Washington Outlook .....	14
Financial Roundup .....	21
25 Most Active Stocks.....	21
Market Research .....	24
Current Figures .....	24
Meetings Ahead .....	46

### Engineering

X-15 makes its first free flight. See p 49.....	COVER
Guidance Systems in Manned Space Flight. Inertial references for space navigation.....	By S. T. Cap and N. P. White 49
Feedback Design for Transistor Stages. Design method is useful for many applications.....	By T. R. Hoffman 52
Optimizing Antenna Switches and Phasers. Multiple airborne antennas are switched or phased for maximum performance.	By I. Dlugatch 55
Ferroelectric Crystals for Switching Applications. Materials used for information storage.....	By M. Prutton 58
Transistorized Horizontal Deflection for Television. Designing beam-deflection and high-voltage circuits.....	By M. Fischman 60
Computer Switching with Semiconductors and Relays. How to choose between two kinds of switches.	By G. L. LaPorte and R. A. Marcotte 64
Dynamic Testing of Computer Building Blocks. Mega-pulse generator can also be used as clocking system.	By R. W. Buchanan and B. Kautz 66
Generating Pulses with Solid-State Thyratrons. Replaces tubes and relays.....	By V. W. Goldie, R. G. Amicone and C. T. Davey 70

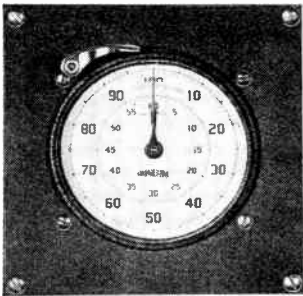
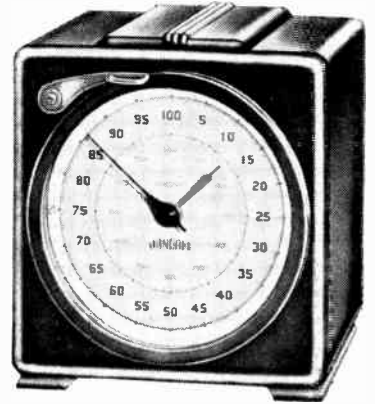
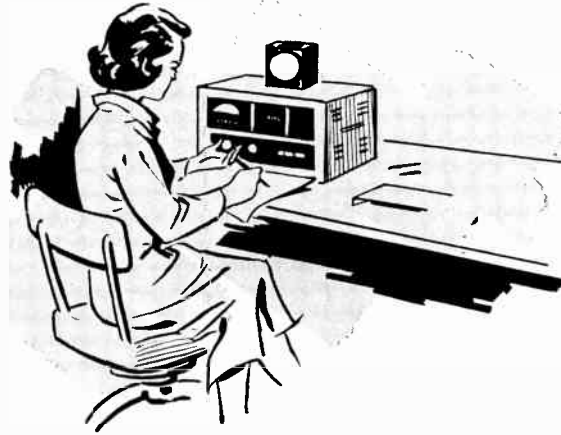
### Departments

Research and Development. Geomagnetic Effects of Nuclear Bombs..	72
Components and Materials. How Liquid-State Switch Controls A-C..	76
Production Techniques. Set Tests 18 Transistor Values.....	80
On the Market.....	84
Literature of the Week.....	104
Plants and People.....	106
News of Reps.....	109
Comment .....	110
Index to Advertisers.....	118



...SYNONYM for

# PRECISION in TIMING

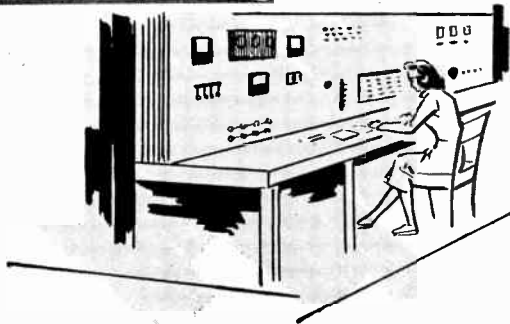


For timing requirements in research, testing or production . . . if the need for *precision* is paramount . . . the choice is STANDARD.

Recognized as THE criterion by which other timers are judged (and *calibrated*), STANDARD Elapsed Time Indicators are noted for their long life under continuous use.

Large enough to work with handily and read readily, STANDARD timers are electric clutch controlled by manual or automatic switch or by electric circuits or output of electronic tubes. Units are synchronous motor driven . . . available for flush panel mounting or portable use . . . equipped for manual or electric zero reset.

*For ultra precision timing with AC current, models available for 400 CPS operation. Also available: 400 CPS power supply operating from DC source.*



Request descriptive Catalog  
No. 198

MODEL	SCALE DIVISIONS	TOTALIZES	ACCURACY
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

**THE STANDARD ELECTRIC TIME COMPANY**

89 LOGAN STREET  
SPRINGFIELD, MASSACHUSETTS



Travelling Display—  
Watch for showing in  
your area. See  
complete STAND-  
ARD Systems in  
operation.

ALSO MANUFACTURERS OF:



Emergency  
Lighting Equipment



Laboratory  
Panels



Hospital Signalling  
Equipment

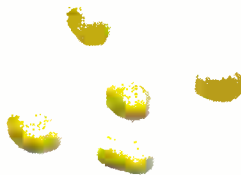


Analogue  
Computers



Precision  
Timers

**it's  
for  
the  
BIRDS\***



**THE KERNEL**

**... A New Microminiaturized Toroidal Inductor**

The new Burnell & Co. MT 34 and MT 35 microminiature Kernel toroidal inductors are made to order for the engineer who isn't content with outer husk solutions but gets right to the core of second generation missile communication problems.

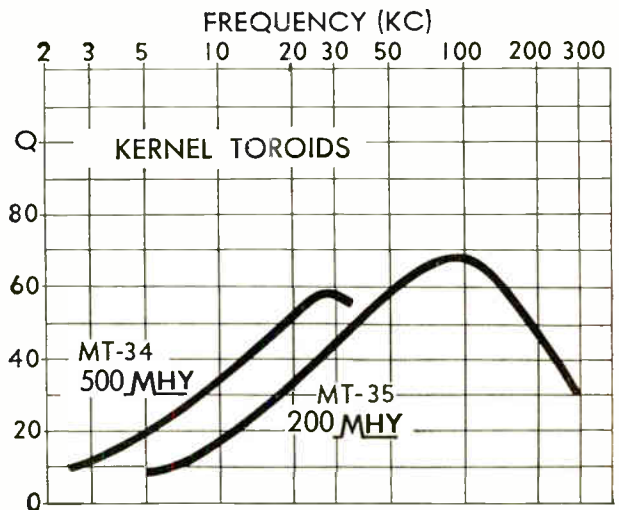
MT 34 microminiature Kernels can be supplied with inductances up to 500 mhys and the Kernel MT 35 is available in inductances up to 200 mhys. MT 34 Kernels are recommended for frequencies to 30 kes and the MT 35 is applicable to frequencies up to 200 kes depending on inductance values. Q for the MT 34 is greater than 55 at 25 ke and for the MT 35 more than 60 at 100 kes.

Size of the MT 34 and MT 35 is .417" OD x .215", spacing between leads .3" x 1" L with a weight of .06 ounces.

The new microminiature Burnell MT 34 and MT 35 Kernels provide maximum reliability as well as considerable economy in printed circuit use. Completely encapsulated, the Kernels will withstand unusually high acceleration, shock and vibration environments.

Write for special filter bulletin MTF to help solve your circuit problems.

\*missiles



**Make sure to see us at the  
Wescon Show—Booth 404**

*Burnell & Co., Inc.*

PIONEERS IN microminiaturization OF  
TOROIDS, FILTERS AND RELATED NETWORKS

EASTERN DIVISION  
Dept. E-22  
10 PELHAM PARKWAY  
PELHAM, N. Y.  
PELHAM 8-5000  
TELETYPE PELHAM 3633



PACIFIC DIVISION  
Dept. E-23  
720 MISSION ST.  
SOUTH PASADENA, CAL.  
RYAN 1-2841  
TELETYPE PASACAL 7578

## electronics

August 14, 1959 Vol. 32, No. 33

Published weekly, with an additional BUYERS' GUIDE and REFERENCE Issue in mid-June, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948) Founder.

Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y. Longacre 4-3000. Publication Office: 99-129 North Broadway, Albany 1, N. Y.

See panel below for directions regarding subscriptions or change of address. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice President; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary; Nelson L. Bond, President, Publications Division; Shelton Fisher, Senior Vice President; Ralph B. Smith, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

Single copies in the United States, U. S. possessions & Canada 75¢; \$1.50 for all other foreign countries. Buyers' Guide in the United States, U. S. possessions & Canada \$3.00; all other foreign \$10.00. Subscription rates—United States and possessions, \$6.00 a year; \$9.00 for two years; \$12.00 for three years. Canada, \$10.00 a year; \$16.00 for two years; \$20.00 for three years. All other countries, \$20.00 a year; \$30.00 for two years; \$40.00 for three years. Second class postage paid at Albany, N. Y. Printed in U.S.A. Copyright 1959 by McGraw-Hill Publishing Co., Inc.—All Rights Reserved. Title registered in U. S. Patent Office. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11; 68 Post Street, San Francisco 4; McGraw-Hill House, London E. C. 4; 85, Westendstrasse, Frankfurt/Main; National Press Bldg., Washington 4, D. C.; Six Penn Center Plaza, Philadelphia 3; 1111 Henry W. Oliver Bldg., Pittsburgh 22; 55 Public Square, Cleveland 13; 856 Penobscot Bldg., Detroit 26; 3615 Olive St., St. Louis 8; 350 Park Square Bldg., Boston 16; 1301 Rhodes-Haverty Bldg., Atlanta 3; 1125 West Sixth St., Los Angeles 17; 1740 Broadway, Denver 2; 901 Vaughn Bldg., Dallas 1. ELECTRONICS is indexed regularly in The Engineering Index.

Subscription: Address correspondence to: Fulfillment Manager, Electronics, 330 W. 42nd St., New York 36, N. Y. Allow one month for change of address, stating old as well as new address, including postal zone if any. Subscriptions are solicited only from persons engaged in theory, research, design, production, management, maintenance and use of electronics and industrial control components, parts and products. POSITION and COMPANY CONNECTION must be indicated on subscription orders.

Postmaster: please send form 3579 to Electronics, 330 W. 42nd St., New York 36, N. Y.



Member ABP and ABC

**HALF CENTURY OF PROGRESS.** Our lead business article on p 28 reveals some little known facts that led to the electronics industry's growth on the peninsula south of San Francisco. It provides a quick but fascinating briefing on local industry for readers attending Wescon next week.

We learned a lot from this story. For one thing; how deep go the roots of western electronics. Seems the ball started rolling, broadly speaking, before the beginning of this century. Development of electron devices, in a narrower sense, dates from 1912.

Author of this article is a man intimately associated with peninsula electronics, Emmet G. Cameron. Cameron graduated from University of California at Berkeley with a B.S.E.E. and an impressive list of honors.

He worked for several firms on the West Coast and elsewhere, progressively increasing his executive responsibility. He joined Varian in 1953 as works manager of the tube division and is now vice-president and general manager of the firm.

He is currently a director of Western Electronics Manufacturers Association. This week he writes as a historian about things electronic in and around Palo Alto.

**YOUR FUTURE.** Continuing growth both of our industry and this magazine has resulted in additional openings on our staff for engineering editors. Helping to write and edit ELECTRONICS magazine can be a deeply satisfying and rewarding experience. It can also be a man-killing job. It depends on what kind of a man you are.

Here's what it takes: A degree in electrical engineering with heavy concentration in electronics, a year or so of experience in our industry, a well-developed bump of curiosity about new circuits, components, systems and materials.

If you fill this bill and are able to write, edit and report technical developments, Editor MacDonald would like to talk to you about your future on our staff—especially if you live within commuting distance of New York City.

### Coming In Our August 21 Issue . . .

**LOW-NOISE SYSTEMS.** Progress in the development of low-noise amplifiers such as masers and paramps has reached the point where these devices are being incorporated into military microwave hardware.

According to New England Editor Maguire, virtually all new government contracts for missile acquisition radars, satellite tracking radars and tropo scatter communications systems now incorporate paramps. In addition, extensive study of diode paramps for tv tuners is reviving the hope once held for uhf-tv.

Maguire's article describes the progress being made in paramps and packaged tunable masers which are in great demand by radio astronomers. In addition you'll learn of other significant developments in the microwave field.

**TRANSISTOR MEASUREMENTS.** With high-frequency performance of transistors pushing to higher limits all the time, precise measurements of the maximum frequency of oscillation are required to predict the ultimate performance of these devices. J. Lindmayer and R. Zuleeg of Sprague Electric Co., in North Adams, Mass., have devised a technique for measuring this parameter using a coaxial structure. This method extends the range of measurement up to 1,000 mc.



# 2N393



2 x actual size

# 2N1122

## HIGH-SPEED, HIGH-GAIN MICRO-ALLOY TRANSISTORS for modern computer circuitry

Types 2N393 and 2N1122 Micro-Alloy Transistors combine high gain with excellent high frequency response to meet demands of high-speed computer switching applications in the megacycle range. Low saturation resistance, low hole storage, and exceptionally good life characteristics make these micro-alloy transistors top performers in general high frequency applications and computer circuits.



Made by electrochemical manufacturing techniques, Sprague Micro-Alloy Transistors are uniformly reliable, as well as reasonably priced for transistors with such excellent operating parameters.

All Sprague transistors—micro-alloy, micro-alloy diffused base, and surface barrier types—are now produced in Sprague's completely new spotless semiconductor facility.

For engineering data sheets on the types in which you are interested, write Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

*Sprague micro-alloy, micro-alloy diffused base, and surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type numbers are manufactured to the same specifications and are fully interchangeable. You have two sources of supply when you use micro-alloy and surface barrier transistors!*

### Other popular SPRAGUE transistors



**2N128**

SB MIL GENERAL PURPOSE  
(MIL-T-12679A)



**2N240/5B5122**  
FOR COMPUTER  
SWITCHING



**2N344/5B101**  
FOR MEDIUM GAIN  
AMPLIFIERS



**2N345/5B102**  
FOR HIGH GAIN  
AMPLIFIERS



**2N246/5B103**  
FOR HIGH FREQUENCY  
OSCILLATORS



**2N501**  
MADE FOR ULTRA-HIGH  
SPEED SWITCHING

#### SPRAGUE COMPONENTS:

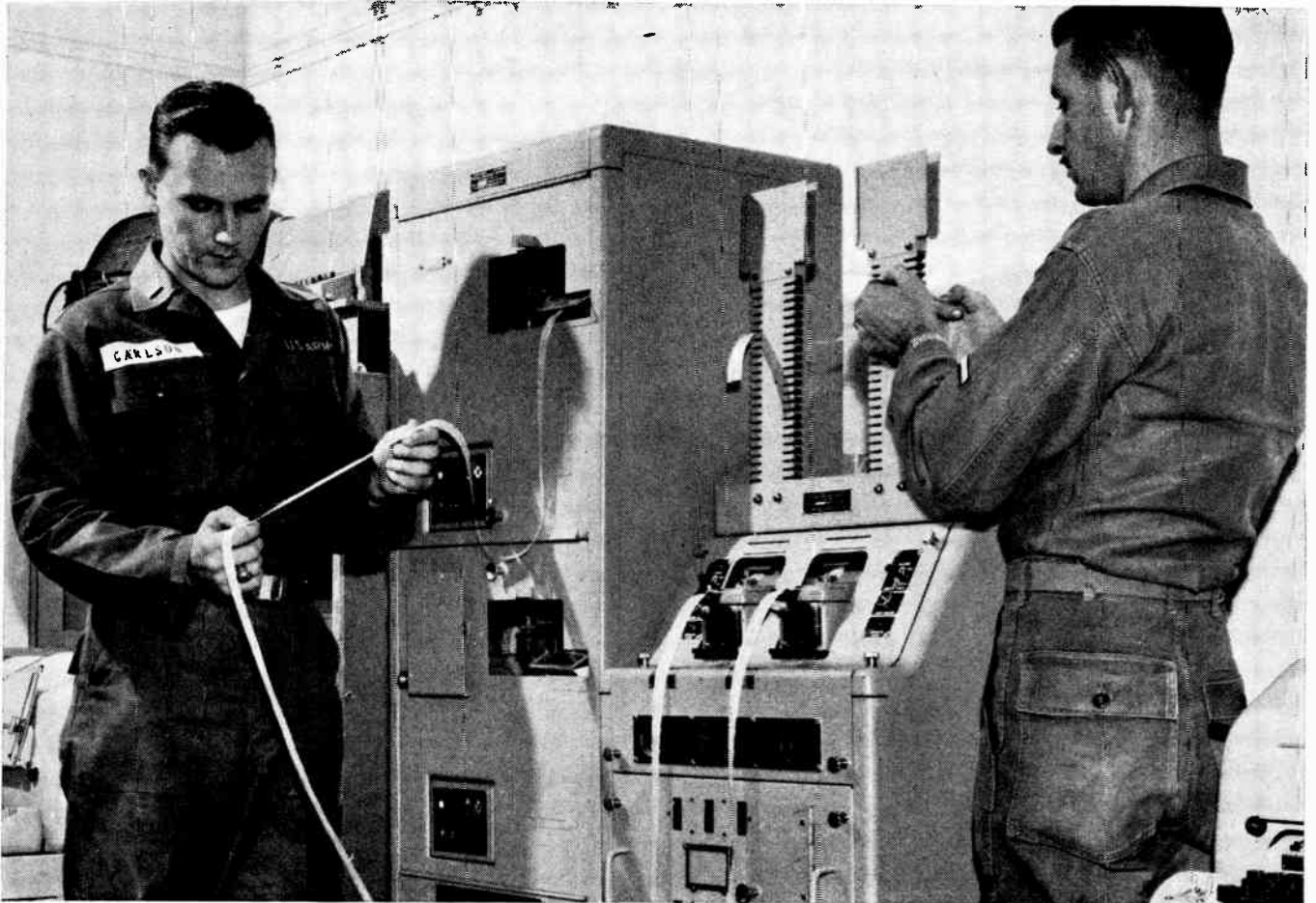
TRANSISTORS • RESISTORS • MAGNETIC COMPONENTS •  
CAPACITORS • INTERFERENCE FILTERS • PULSE NETWORKS  
• HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE  
PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

# SPRAGUE®

THE MARK OF RELIABILITY

# TOP LEVEL TALK

*relayed on teleprinted tape*



**At U.S. Army field communications centers, Kleinschmidt torn tape relay units send, receive, retransmit messages to widely-dispersed commands**

"Getting the word" from top command to outlying units in the field can create a communications traffic jam. This compact relay unit solves the problem. It quickly, accurately, automatically numbers and *prints* each message as it simultaneously *relays* another message to one or 100 receivers in the communications network! Developed

in cooperation with the U. S. Army Signal Corps, the unit's applications include telemetering, integrated data processing, torn tape communication. In recognition of Kleinschmidt's high standards of performance, equipment produced for the U. S. Army is manufactured under the Reduced Inspection Quality Assurance Plan.

# KLEINSCHMIDT



**DIVISION OF SMITH-CORONA MERCHANT INC., DEERFIELD, ILLINOIS**  
Pioneer in teleprinted communications systems and equipment since 1911

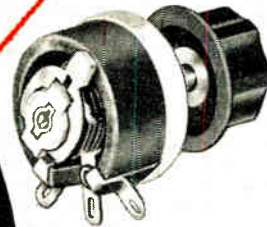


Newest addition  
to industry's  
most complete  
line of  
**Rheostats**

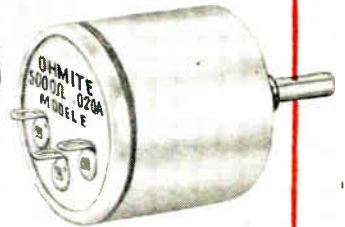
**12½-Watt**  
miniature

**OHMITE®**

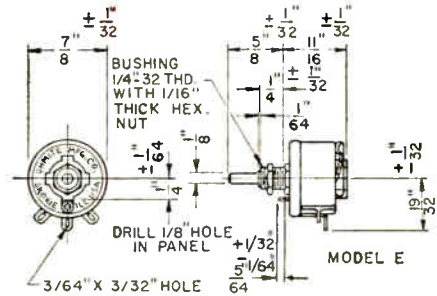
**Rheostat**  
In Enclosure



Without enclosure, only 7/8" diam. In enclosure, exclusive of shaft but including terminals, only 1 1/2" long by 1 3/4" diam.



Compact enclosure of Model E Rheostat consisting of lightweight, drawn aluminum housing is dusttight.



Even though Ohmite already has the most complete line of rheostats available to industry, Ohmite continues research and development to *improve and expand* this product line. Newest addition is the 12½-watt miniature Model E Rheostat in enclosure. Ohmite's Model E wire-wound power rheostat will dissipate 12½ watts.\* Yet, it is no larger than many 1- or 2-watt potentiometers. Such extraordinary power handling capability is characteristic of Ohmite's time-proven, all-ceramic and metal construction, and exclusive vitreous enamel coating. This tiny unit is designed to operate at a maximum hot spot temperature of 340°C. Derating is linear from full wattage at 40° C to zero watts at 340° C. With its small size, and because it can be used at high ambients, the Model E is applicable to *many military and aircraft uses*.

Special length shafts and bushings, screwdriver shafts, locking type bushing, tandem mountings, enclosures, etc., similar to the variations available on the larger rheostat, can be provided upon specific request.

\* Rating on metal panel

**Smaller** than many 1- or 2-watt potentiometers

**All-ceramic and metal**—vitreous enameled

**High dissipation for small size**—many military applications

**Tandem assemblies** consisting of two, three or more units can be supplied made to order.

**Resistance range:** Up to 5000 ohms with 23 stock values; higher values available with OHMICONE silicone-ceramic coating.

**Resistance Tolerance:** ± 10%

**Weight:** 0.52 ounce



**11 SIZES**  
**12½ to 1000 Watts**

Write on company letterhead for Catalog 58,

Be Right with

**OHMITE®**  
Quality Components

**Manufacturing Company**  
3610 Howard Street, Skokie, Illinois

rheostats tap switches resistors  
r.f. chokes relays variable transformers  
tantalum capacitors germanium diodes

Get several instruments in one! These



PRECISION

**hp 650A - FLAT WITHIN 1 DB, 10 CPS TO 10 MC!**



hp 650A TEST OSCILLATOR

**Many Uses** Testing TV amplifiers or wide-band systems, measuring filter transmission characteristics and tuned circuit response, determining receiver alignment, making telephone carrier and bridge measurements.

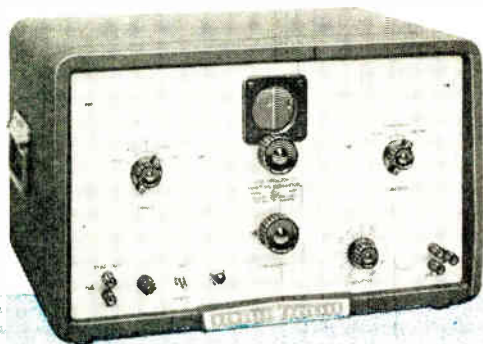
**Special Advantages** No zero set, extremely wide frequency range, no adjustments during operation, output voltage attenuator, self-contained VTVM, 2% to 3% stability, simplest operation.

**Specifications**

**Frequency Range:** 10 cps to 10 MC, 6 bands  
**Stability:**  $\pm 2\%$  to 100 KC,  $\pm 3\%$  above  
**Output:** 15 mw or 3 v into 600 ohms; 6 v open circuit  
**Voltage Range:** 0.00003 to 3 v  
**Frequency Response:** Flat within 1 db full range  
**Distortion:** Less than 1% to 100 KC, less than 2% to 1 MC, 5% at 10 MC

**Output Monitor:** VTVM monitors attenuator input in v or db  
**Output Attenuator:** 50 db attenuation in 10 db steps; output variable continuously from + 12 to - 50 dbm  
**Hum:** Less than 0.5% full scale  
**Price:** \$490.00 (cabinet) \$475.00 (rack mount)

**hp 202A - DOWN TO 0.008 CPS; TRANSIENT-FREE!**



hp 202A LOW FREQUENCY FUNCTION GENERATOR

**Many Uses** Electrical simulation of mechanical phenomena, vibration studies, servo research and testing, medical research, geophysical problems, subsonic and audio testing.

**Special Advantages** No transients, continuously variable 0.008 to 1,200 cps, electronically synthesized sine, square or triangular waves, 1% stability, 0.2 db response, less than 1% distortion on all but x 100 range.

**Specifications**

**Frequency Range:** 0.008 to 1,200 cps, 5 bands  
**Frequency Stability:** 1%, including warm-up  
**Output Waveforms:** Sine, square, triangular  
**Output Voltage:** 30 v peak-to-peak across 4,000 ohms, all waveforms  
**Internal Impedance:** Approx. 40 ohms full range  
**Sinewave Distortion:** Less than 1% except 2% on x 100 range

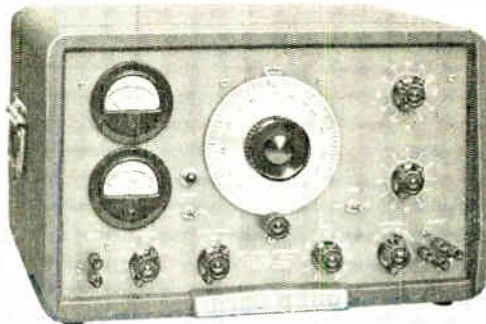
**Output System:** Floating; either side may be grounded  
**Frequency Response:** Constant within 0.2 db  
**Hum:** Less than 0.05% of max. output  
**Sync Pulse:** 10 v peak neg., less than 5  $\mu$ sec duration  
**Price:** \$525.00 (cabinet) \$510.00 (rack mount)

Call your rep for engineering help.

# OSCILLATORS

fill so many different needs!

## 205AG - SIX INSTRUMENTS IN ONE - 20 CPS TO 20 KC!



 205AG AUDIO SIGNAL GENERATOR

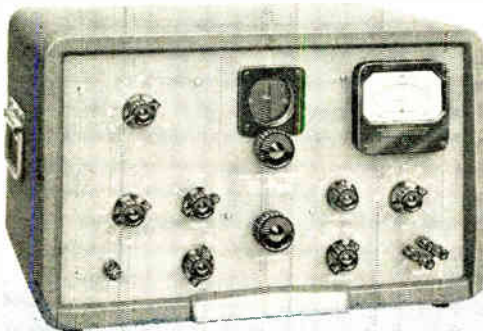
**Many Uses** Measure amplifier gain and network frequency response, measure broadcast transmitter audio and loudspeaker response, drive bridges, use in production testing or as precision source for voltages; many other laboratory applications.

**Special Advantages** Completely self-contained high power frequency response instrument. No auxiliary equipment needed. 5 watts output, less than 1% distortion, no zero setting. Supplies precisely known voltage, output meter calibrated in v and dbm, separate input meter for gain measurements, wide range of output impedances.

### Specifications

<b>Frequency Range:</b>	20 cps to 20 KC, 3 bands	<b>Distortion:</b>	Less than 1% above 30 cps
<b>Frequency Stability:</b>	Better than 2% long term	<b>Hum:</b>	60 db below output voltage or 90 db below zero level
<b>Output:</b>	5 watts into matched load	<b>Input, Output Meters:</b>	Read direct in v or dbm
<b>Frequency Response:</b>	$\pm 1$ db full range to $+ 30$ dbm; $\pm 1.5$ db above $- 30$ dbm	<b>Input Attenuator:</b>	Extends meter range to $+ 48$ dbm and 200 v rms, 5 db steps
<b>Output Impedances:</b>	50, 200, 600, 5,000 ohms; circuit is balanced and center-tapped; any terminal may be grounded	<b>Output Attenuator:</b>	110 db in 1 db steps
		<b>Price:</b>	\$500.00 (cabinet) \$485.00 (rack mount)

## 206A - LESS THAN 0.1% DISTORTION TO 20 KC



 206A AUDIO SIGNAL GENERATOR

**Many Uses** Precision, convenient audio voltage source, ideal for checking FM transmitter response and distortion; broadcast studio performance, high quality, high fidelity amplifier testing and transmission measurements.

**Special Advantages** Continuously variable audio frequency voltage, 0.2 db response. Represents the ultimate in voltage output accuracy and low distortion at any level. 2% frequency stability, less than 0.1% distortion. 111 db attenuator with 0.1 db steps.

### Specifications

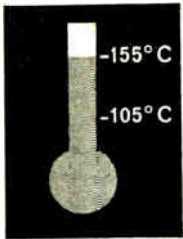
<b>Frequency Range:</b>	20 cps to 20 KC, 3 bands	<b>Frequency Response:</b>	Better than 0.2 db, 30 cps to 15 KC
<b>Calibration:</b>	Direct in cps, 20 to 200 cps	<b>Distortion:</b>	Less than 0.1% above 50 cps
<b>Frequency Stability:</b>	$\pm 2\%$ including warmup drift	<b>Hum:</b>	At least 75 db below output or 100 db below zero level
<b>Output:</b>	$\pm 15$ db into 50, 150 and 600 ohms	<b>Output Attenuators:</b>	111 db in 0.1 db steps
<b>Output Impedances:</b>	50, 150 and 600 ohms balanced; 600 ohms single ended	<b>Price:</b>	\$750.00 (cabinet) \$735.00 (rack mount)

## HEWLETT-PACKARD COMPANY

1008A PAGE MILL ROAD - PALO ALTO, CALIFORNIA, U. S. A. CABLE: "HEWPACK" • DAVENPORT 5-4451  
HEWLETT-PACKARD S. A., Rue de Vieux Billard No. 1, Geneva Cable "HEWPACKSA" • Telephone (022) 26.43.36

Field representatives in all principal areas

sales and service on  instruments



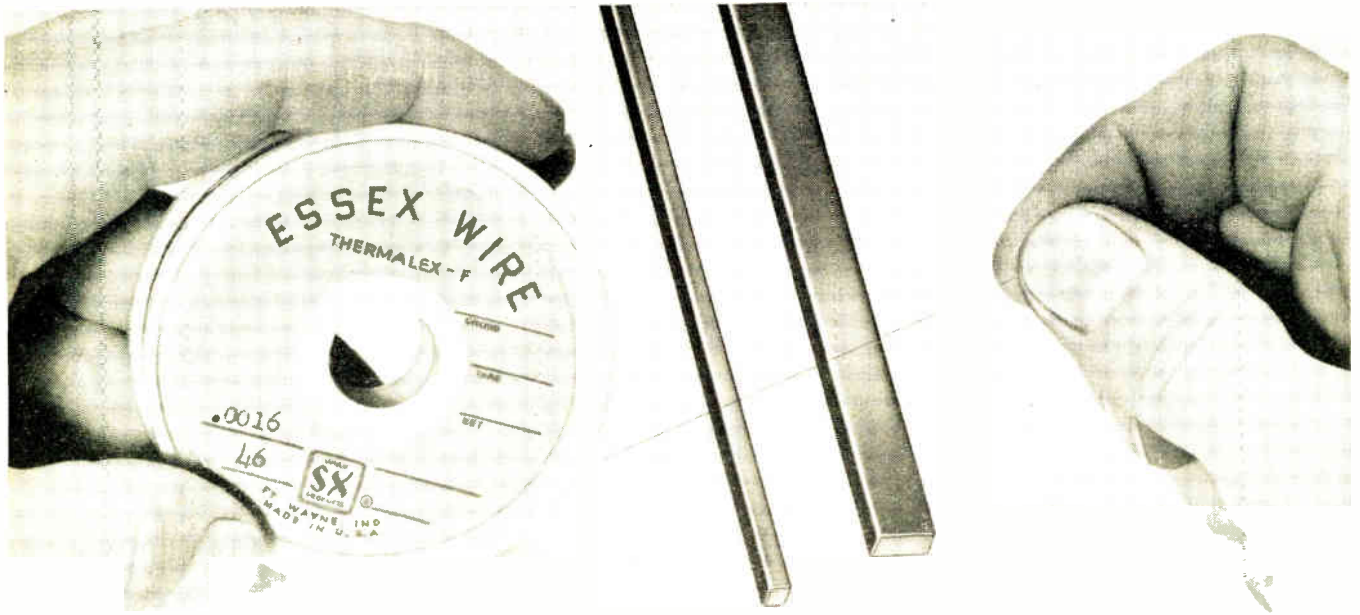
ESSEX

Now...all sizes and shapes  
of **SX Magnet Wire**  
for every "hot spot" application

# Thermalex F<sup>®</sup>

MAGNET WIRE

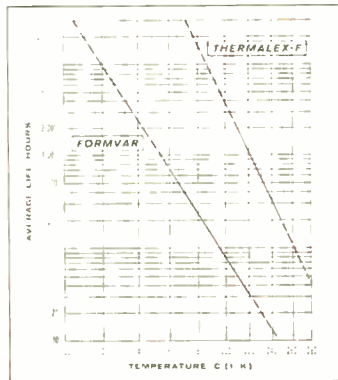
Class F (155°C)



**Rounds, squares and rectangulars also available  
with single and double glass coverings**



**VERSATILE GENERAL PURPOSE APPLICATION**  
Thermalex-F is not a special wire but has properties required for a general purpose application and can be used through the 105 C-155 C temperature range... Class A applications as well as Class F... eliminating the need for buying more than one type of magnet wire.



**OUTSTANDING THERMAL STABILITY**  
A.I.E.E. #57 "Procedure for Evaluation of the Thermal Stability of Enameled Wire" which is an accepted test, indicates a 30,000 hours life at 170°C for unvarnished specimens.

Thermalex-F, a Class F (155°C) magnet wire insulation developed by Essex, is now available in round wire from 11 to 50 AWG size and all Formvar sizes of square and rectangular. This full size range gives every manufacturer the versatility he needs in one insulation type for his exact application!



THE WIRE DESIGNED WITH THE FUTURE IN MIND

**Magnet Wire Division  
ESSEX WIRE CORPORATION**

Fort Wayne, Indiana

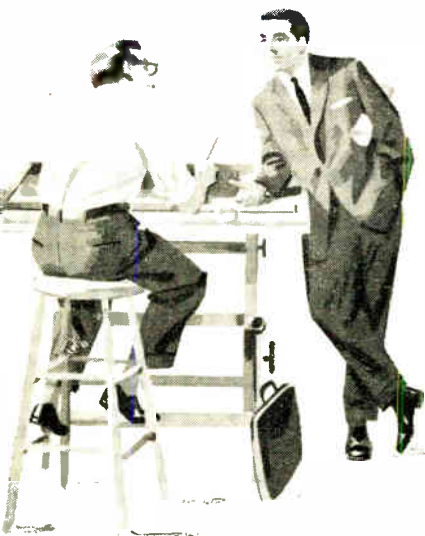
Manufacturing Plants: Birmingham, Ala.; Anaheim, Cal.;  
Fort Wayne, Ind.; Hillsdale, Mich.

*National network of Warehouses and Sales Offices  
... Call your local "Essex Man."*

# Skills + Experience --- Top Quality

**Benefit from the experience  
gained in building  
21,000,000 picture tubes...**

**specify **RCA!****



#### FIELD OFFICES

**EAST:** 744 Broad Street, Newark 2, N. J.  
HUmboldt 5-3900

**MIDWEST:** Suite 1154  
Merchandise Mart Plaza, Chicago 54, Ill.  
WHitehall 4-2900

**WEST:** 6355 E. Washington Blvd.  
Los Angeles 22, Calif.  
RAYmond 3-8361

In over a decade of experience, RCA has produced more than 21,000,000 picture tubes. What does this experience promise you?

First, it promises *quality*...high standards for checking every tube component every production step. It promises *improvements*...the constant research that has given you the latest developments in picture-tube design. Every improvement in technique, every new design is thoroughly proved-out before release. Further, this "know-how" promises the *dependability* and *availability* you need to meet tight production schedules. Why settle for less?

RCA offers you every active picture-tube type for black-and-white television...types with either low or high grid-No. 2 voltage, either short or long neck, either 90° or 110° deflection, as well as the very latest in color picture tubes. For details, get in touch with the RCA Field Representative at our office nearest you.



**RADIO CORPORATION OF AMERICA**  
Electron Tube Division

Harrison, N. J.



## COMPLETE LINE + FAST SERVICE = HIPERSIL CORES

Westinghouse stocks all types and sizes of Hipersil cores in three locations to serve you better

**COMPLETE LINE** includes the new EIA, RS-217 standard sizes.

- Type C: 12, 4, 2 and 1 mil sizes, in single- and 3-phase, from a fraction of an ounce to 300 pounds.
- Ring Cores: with new polyclad treatment—assure best magnetic performance of any Epoxy resin-coated core ready to receive windings.
- Special Cores: to any specification and shape requirement—rectangular, triangular and others.

**FAST SERVICE** is assured by complete stocks at Greenville, Pa.; Boston, Mass.; and Los Angeles, Calif.

Performance of Hipersil® cores in "iron-core" components is guaranteed to meet or exceed specifications.

For more facts, write for Price List 44-520 and Descriptive Bulletin 44-550 to Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa. J-70920

YOU CAN BE SURE... IF IT'S  
**Westinghouse**

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS"  
CBS TV MONDAYS

# WASHINGTON OUTLOOK

WASHINGTON—MORE MONEY for ICBM production and for defense against ballistic missiles and submarines. That sums up most major changes in individual electronics-related projects of the fiscal 1960 defense appropriation. The bill has come out of the congressional wringer in final shape after six months of debate, haggling and revision. The total sum is close to the administration's \$39.2-billion budget request, not counting an additional \$1.6 billion for military construction still in the mill.

ICBM production was jacked up \$172 million over the Pentagon's request. A \$137-million increase was voted for antisubmarine defense—with \$13.2 million extra for the Goodyear Aircraft-Librascope-Kearfott Subroc underwater missile. The Army got a \$238-million bonus for general hardware procurement—much of it to be spent on additional communications equipment and ground radar—and an increase of \$137 million to speed development of Western Electric's Nike Zeus anti-ICBM missile.

Offsetting the budget hikes were a series of cutbacks: \$50 million was knocked out for Air Force radar replacement; procurement funds for the Bomarc, Nike Hercules and Mace missiles were trimmed; the Navy received \$35 million to buy long lead-time components for a nuclear aircraft carrier in place of a proposed \$260-million conventionally powered vessel.

- **Military contracting officers** will be unable to commit the fiscal 1960 money—which includes some \$4.8 billion for electronics—for a couple of months.

Still to come is the Pentagon's apportionment procedure, conducted jointly with the Budget Bureau, during which individual projects are reviewed once more. The budget plans are still subject to change.

The military services will be allowed to spend most, if not all, the extra funds tacked on to some of the projects. No firm decision, however, has been made yet on the ICBM increase.

- **Military spending plans** will be even more difficult to anticipate in the future as the result of new congressional action which will require the armed services committees of both houses to okay an authorization bill on missile and aircraft procurement in addition to the money bills voted by the two appropriations committees. This double congressional check is now routine for foreign aid and military construction expenditures.

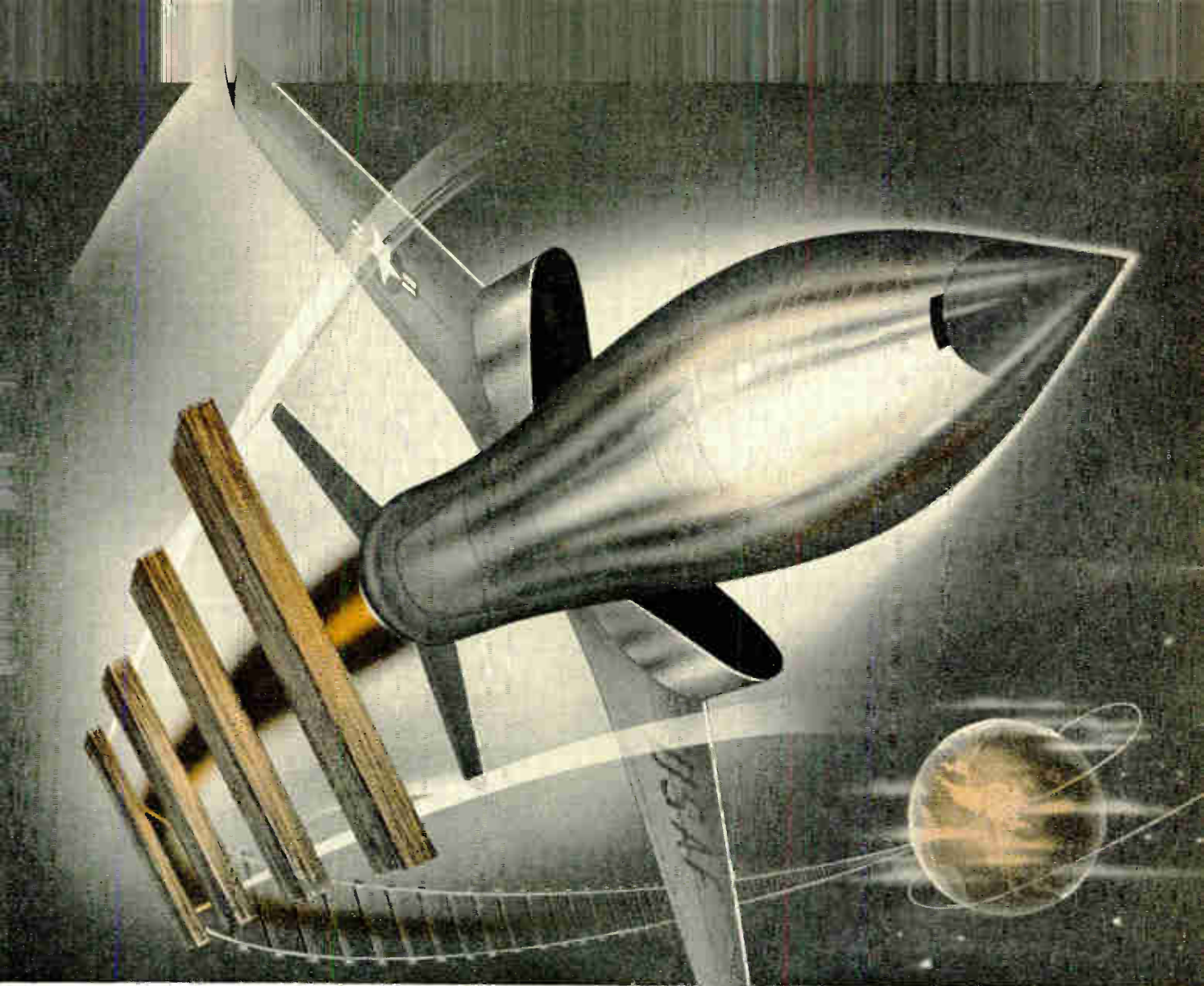
The new double-check reflects Congress' intent to have a greater voice in decisions related to specific weapon projects. On long-range planning for production runs, missile and aircraft contractors and subs will now have still another obstacle to sweat out.

- **Hearings may be held** this fall on the major current proposal dealing with control over the radio spectrum—the new bill by House Commerce Committee chairman Oren Harris (D., Ark.).

Rep. Harris feels there has been enough study. Now he wants a specific proposal. He views his bill not as the final answer but a departure point.

His bill would establish a frequency allocation board to divide the spectrum between government and nongovernment users. The board would consist of three members appointed by the President for nine years. They could be overruled only by the President acting in the interest of national security or foreign relations.

The FCC would continue to assign whatever frequencies are given over to civilian use. A government frequency administrator, personal assistant to the President, would be the czar over all government uses, assigning frequencies among the various agencies.



## *Express line to everywhere...*

Developing over 15,000 lbs. of thrust from its powerful jet engine . . . traveling at nearly twice the speed of sound in its surge through the uncharted vastness of the stratosphere . . . this is the formidable Republic F-105 "Thunderchief" . . . the newest fighter-bomber of the Tactical Air Command. And all the while, the sole occupant of this supersonic arsenal with wings is as sure of his position as the engineer of an express train running on carefully surveyed and mile-posted roadbed!

Thanks to the LFE Doppler Radar Navigator, which the Air Force chose for the F-105, the pilot knows instantly and automatically his course and distance to destination; ground speed and drift angle, over land or sea at all speeds from stationary to nearly Mach 2! The AN/APN-105 is fully automatic, self-contained, lightweight, and free from the effects of shock, vibration, and cloud reflections.

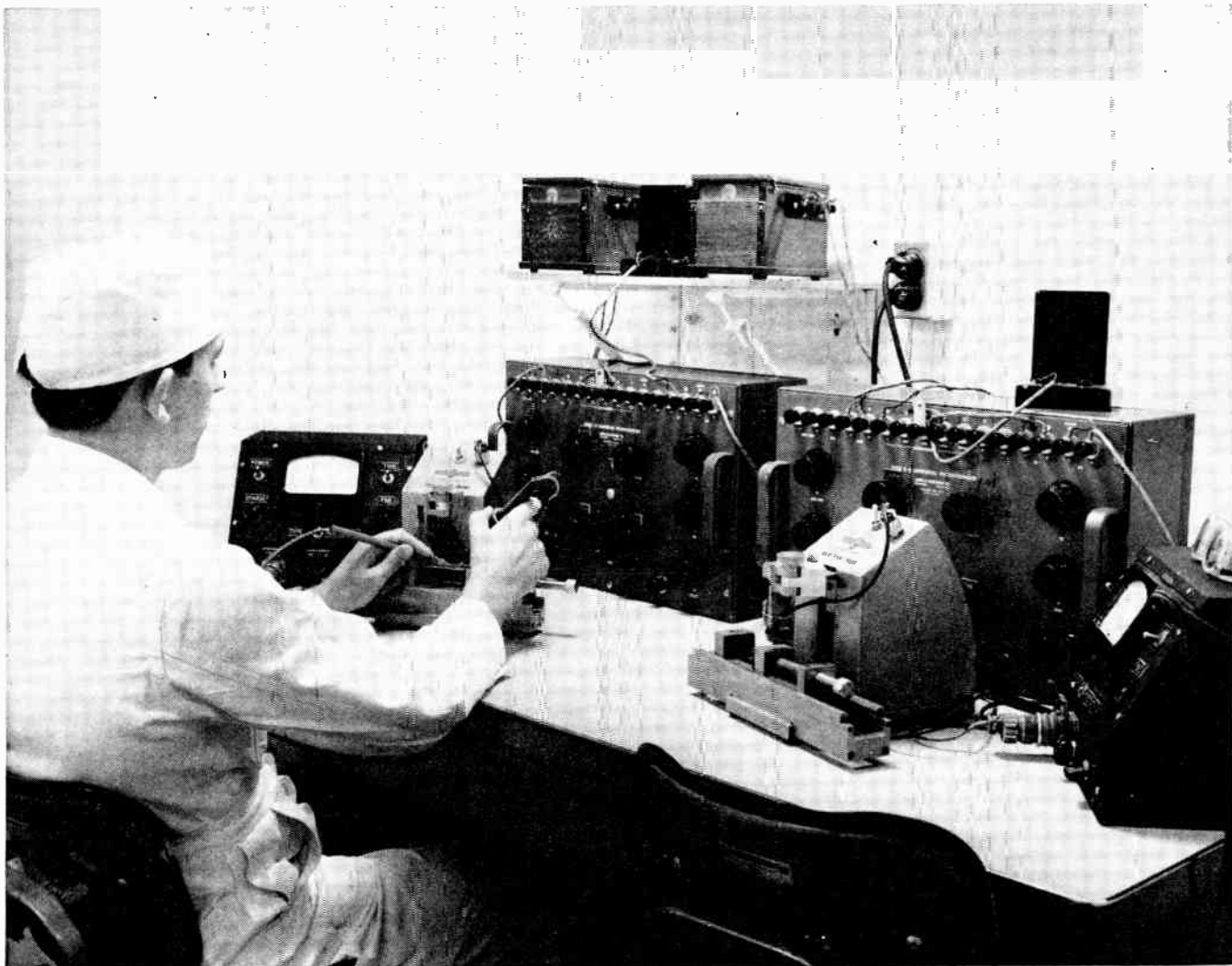
This latest in the LFE series of Radar Navigators is another example of the unparalleled experience in Doppler Radar which has earned LFE its reputation for *Leadership from Experience*.

**L**eadership *from* **E**xperience

**LABORATORY FOR ELECTRONICS, INC.** 1079 COMMONWEALTH AVENUE • BOSTON

**ENGINEERS:** LFE offers outstanding employment opportunities in Navigation, Radar and Surveillance, and Computer Systems and Components.





Operator making a routine quality control test of type and resistivity on silicon characterization crystal.

## Round-the-clock operations at new Du Pont plant assure you of ample supplies of Hyperpure Silicon

Du Pont's new Brevard, N. C., HYPERPURE Silicon plant—with a 70,000 lbs./yr. capacity—is now operating at high production rate to assure you of a prompt supply of high-purity silicon in the form, grade and quantity you need. Du Pont is uniquely qualified to serve you because of its experience as pioneer producer of semiconductor grades of silicon. This experience includes installing the first full-scale commercial silicon plant in the world and frequent expansion of productive facilities since then.

**Single crystals** of Du Pont HYPERPURE Silicon are now available in a wide range of resistivities, thanks to Du Pont's new research and manufacturing techniques. Each has a specially prepared "spec. sheet."

**Here's more news:** Du Pont recently completed a \$3,000,000 Technical Service Laboratory specifically

designed, equipped and staffed to handle customer problems. Here, highly trained Du Pont Technical Specialists are available to discuss any difficulties in crystal growing or manufacture you may encounter.

Du Pont HYPERPURE Silicon is also available in densified cut rods . . . and rods specially designed for float-zone refining in Grades 1, 2 and 3, with carefully controlled purity levels. As an additional service, Du Pont offers doping material at no additional cost.



**Free booklet is available upon request.** It describes the manufacture, properties and uses of HYPERPURE Silicon. E. I. du Pont de Nemours & Co. (Inc.), Pigments Dept., Silicon Development Group, Wilmington 98, Delaware.

**HYPERPURE SILICON**



BETTER THINGS FOR BETTER LIVING  
... THROUGH CHEMISTRY



from

# DALOHM

*better things in  
smaller packages*

# NEW

## Type MF METAL FILM RESISTORS

These new molded metal film resistors combine the advantages of DALOHM's unique molding techniques with advanced, high vacuum, evaporated metal film procedures to provide the best characteristics of wire wound resistors — including high resistance values — while retaining miniature size.

Inherently stable, DALOHM metal film resistors offer good high frequency characteristics; low noise levels; low and controllable temperature coefficients; and the *ability to withstand rigorous environmental conditions.*

### SPECIAL PROBLEMS?

You can depend on DALOHM for help in solving any special problem in the realm of development, engineering, design and production. Chances are you can find the answer in our standard line of precision resistors (wire wound, metal film and deposited carbon); trimmer potentiometers; resistor networks; collet-fitting knobs; and hysteresis motors. If not, just outline your specific situation.



## DALE PRODUCTS, INC.

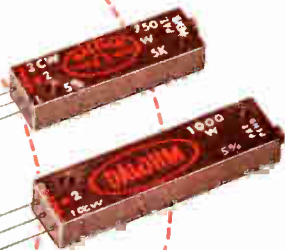
Box 136 Columbus, Nebraska

- Rated at 2, 1, 1/2, 1/4 or 1/8 watts, depending on size.
- Resistance range from 100 ohms to 4 Megohms, depending on size.
- Standard tolerance  $\pm 1\%$ .
- Temperature coefficient  $\pm 50$  and  $\pm 100$  P. P. M., depending on size.
- Completely insulated.
- Provides complete protection from moisture and salt spray
- Endures severe mechanical shock.
- High stability.
- Excellent high frequency characteristics.
- Allows high heat dissipation.
- Long, reliable load life.

*Write for Bulletin R-43*

from  
**DALOHM**

better things in  
smaller packages



**NEW**

750 and 1000  
T-POTS

These two new trimmer potentiometers, in standard and miniature sizes, mark another DALOHM advance in meeting the most stringent requirements. Both surpass the applicable paragraphs of MIL-R-19A, MIL-R-12934A, MIL-E-5272A and MIL-STD-202A.

Ruggedly constructed, with *completely sealed cases*, and inherently stable, DALOHM 750 and 1000 potentiometers perform reliably under extreme conditions of temperature and humidity, shock and vibration.

	<b>750</b>	<b>1000</b>
• Rated at:	2 watts*	2.5 watts*
• Resistance range:	10 ohms-30K ohms	10 ohms-50K ohms
• Standard tolerance:	± 5%	± 5%
• Size:	.180 x .300 x 1.000"	.180 x .300 x 1.25"
• Screw adjustment:	17 ± 2 revolutions	25 ± 2 revolutions
• Weight:	2 grams	2.5 grams
• Volume:	.054 cubic inch	.068 cubic inch

\*Mounted per MIL-R-19A

**COMPLETELY SEALED**

END RESISTANCE: 3% maximum on all values

NOMINAL RESOLUTION: 0.1% to 1.3%

LINEARITY: Below ± 3% on all values

NOISE DURING ADJUSTMENT: Per NAS-710 (100 ohms maximum equivalent noise resistance)

TEMPERATURE COEFFICIENT OF TRIMMER: 50 PPM/° C. maximum

WELDED CONSTRUCTION THROUGHOUT: Assures maximum reliability and precision

VIBRATION: Per MIL-STD-202A, Method 204, Condition B, 15 g. to 2000 cps.

LOAD LIFE: Per MIL-R-19A

SHOCK: Per MIL-STD-202A, Method 202A, 100 g.

ACCELERATION: Per MIL-E-5272A, Procedure II, 100 g.

HUMIDITY: Per MIL-STD-202A, Method 106A

Write for Bulletins R-41 and R-44



**DALE PRODUCTS, INC.**

Box 136 Columbus, Nebraska

Edward F. Aymond Company  
Dallas 19, Texas

Leroy W. Beier Company  
Chicago 35, Illinois

William V. Brainard Company  
Palo Alto, California

Buraw-Cowan  
Detroit 19, Michigan

Ray Deane  
Kansas City, Missouri

Maury Farber Associates  
Buffalo 2, New York  
Manlius, New York

Merrill Franklin Company  
Minneapolis, Minnesota

International Standard Electric Corp.  
Export Department  
New York 7, New York

J. K. DOOLEY Co.  
Seattle, Washington

Kaelber and Mack  
Manchester, L. I., New York  
Wakefield, Massachusetts

Rudy Mueller  
Denver, Colorado

William J. Reasor & Assoc.  
Atlanta, Georgia  
Tampa, Florida

Jake Rudisill Associates  
Charlottesville 3, North Carolina

Scott & Steffen, Inc.  
Cleveland 15, Ohio  
Dayton 2, Ohio  
Pittsburgh 22, Pa.  
Indianapolis, Ind.

Thomas L. Stevens Company  
Lawndale, California

Robert L. Wilkinson, Inc.  
Towson 4, Maryland  
Glenside, Pennsylvania

**DISTRIBUTORS**

**ARIZONA**

Radio Spec. & Appliance  
Phoenix, Arizona

Standard Radio Parts, Inc.  
Tucson, Arizona

**CALIFORNIA**

Kierulff Electric  
Los Angeles, California

Zack Radio Supply Company  
San Francisco, California

Cannex Corp.  
Oakland 14, California

Manley Electronic Supply  
Lancaster, California

Wholesale Electronic Supply  
Ventura, California

Shelley Radio Company  
Los Angeles, California

Shanks & Wright  
San Diego, California

**COLORADO**

Denver Electronic Supply  
Denver 4, Colorado

**DIST. OF COLUMBIA**

Electronic Wholesaler  
Washington, D. C.

**FLORIDA**

Goddard Distributors  
West Palm Beach, Florida  
Tampa, Florida

Hammond Electronics, Inc.  
Orlando, Florida

Thurrow Distributors  
Tampa, Florida  
Orlando, Florida  
Pensacola, Florida

**HAWAII**

Precision Radio  
Honolulu 14, Hawaii

**ILLINOIS**

Newark Electronic Company  
Chicago, Illinois

**INDIANA**

Brown Electronics, Inc.  
Fort Wayne, Indiana

Graham Electronic Supply  
Indianapolis, Indiana

Radio Distributing Company  
South Bend, Indiana

**KANSAS**

Interstate Electronic Supply  
Wichita, Kansas

**MARYLAND**

Kann-Ellert  
Baltimore 3, Maryland

D & H Distributing Co.  
Baltimore 30, Maryland

**MASSACHUSETTS**

A. W. Mayer Company  
Boston, Massachusetts

**MICHIGAN**

Radio Tube Merchandising  
Flint 2, Michigan

Electronic Supply Corp.  
Battle Creek, Michigan

Electronic Supply Corp.  
Kalamazoo, Michigan

Radio Electronic Supply  
Detroit, Michigan

**MINNESOTA**

Electronic Center, Inc.  
Minneapolis, Minnesota

Radio Electronic Supply Co.  
Minneapolis, Minnesota

Gopher Electronics  
St. Paul, Minnesota

**MISSOURI**

Electronic Components for  
Industry Co. St. Louis 17, Missouri

Jones Electronic Sales  
Kansas City 1, Missouri

**NEW JERSEY**

General Radio Supply  
Camden 2, New Jersey

Federated Purchaser  
Mountainside, New Jersey

**NEW YORK**

Federal Electronics  
Binghamton, New York

Radio Equipment Corporation  
Buffalo 3, New York

Electronic Center, Inc.  
New York 11, New York

Harrison Radio  
New York 7, New York

Stack Electronics, Inc.  
Binghamton, New York

Terminal Radio  
New York 7, New York

Higgins & Sheer  
Poughkeepsie, New York

Rochester Radio Supply  
Rochester, New York

Morris Distributing Company  
Syracuse, New York

Arrow Electronics  
Mineola, L. I., New York

Valley Electronics Labs  
Ulster, New York

Milo Electronics  
New York 7, N.Y.

E. E. Taylor  
Albany 6, N.Y.

**NEW MEXICO**

Radio Specialties, Inc.  
Alamogordo, New Mexico

**NORTH CAROLINA**

Dalton-Hege Radio Supply  
Winston-Salem, North Carolina

**OHIO**

Mytronic Company  
Cincinnati, Ohio

Pioneer Electronic Supply  
Cleveland, Ohio

Srepco, Inc.  
Dayton, Ohio

**HUGHES-PETERS, INC.**

Columbus, Ohio

**OKLAHOMA**

Radio Supply Company  
Oklahoma City, Oklahoma

Oil Capital Electronics  
Tulsa 1, Oklahoma

**OREGON**

Eoff Electric Co.  
Portland, Oregon

**PENNSYLVANIA**

Federated Purchaser  
Allentown, Pennsylvania

Albert Steinberg  
Philadelphia, Pennsylvania

Cameradio  
Pittsburgh, Pennsylvania

Electronic Distributors  
Philadelphia, Pennsylvania

**RHODE ISLAND**

William Dandrea & Co.  
Providence, Rhode Island

**TEXAS**

Adak Electric Co.  
Grand Prairie, Texas

Lenert Company  
Houston 1, Texas

Midland Specialties Co.  
El Paso, Texas

**UTAH**

Standard Supply Company  
Salt Lake City, Utah

**WASHINGTON**

Pacific Electronic Sales  
Seattle 1, Washington

Seattle Radio Supply  
Seattle 1, Washington

**WEST VIRGINIA**

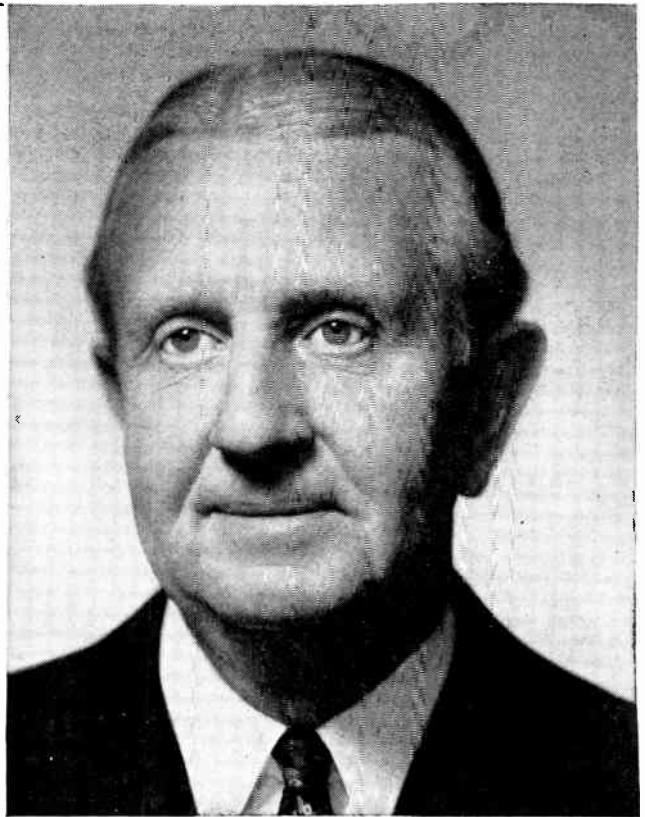
Chemcity Electronics Dist.  
Beckley, West Virginia

**WISCONSIN**

Taylor Electric Company  
Milwaukee 13, Wisconsin

*“...an investment  
that makes  
all other  
investments  
worthwhile”*

JOHN COLLYER  
Chairman of the Board  
The B. F. Goodrich Company



“For much of our nation’s progress, technologically, economically and socially, we must look to the excellence of our institutions of learning, whose students of today will be the scientists, the managers, the statesmen and the cultural and religious leaders of tomorrow.

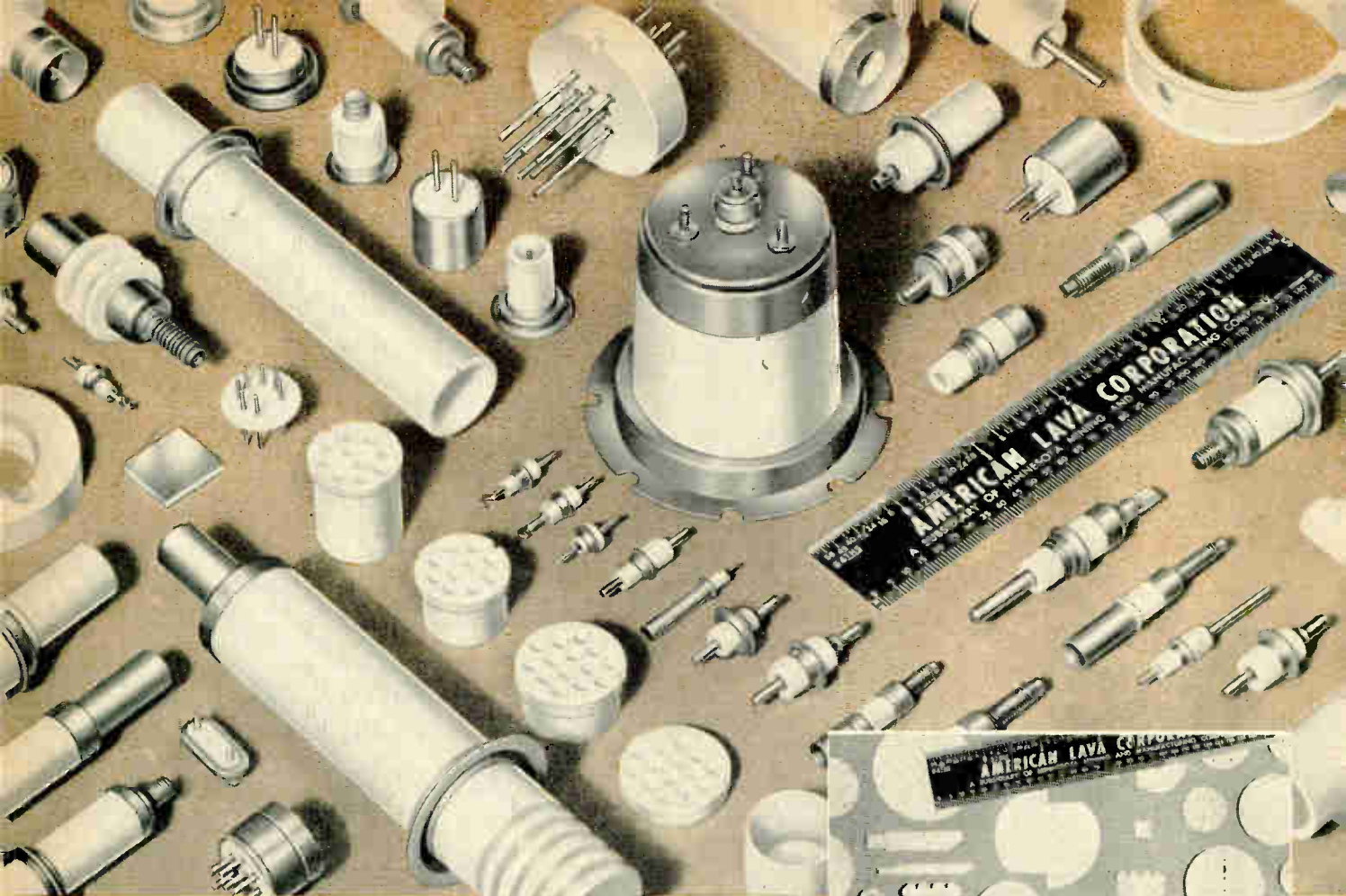
“It is the responsibility of the American people and American industry to provide the financial aid so urgently needed now by our colleges and universities.

“Join this important crusade. Contribute today to the university or college of your choice. You will be making *an investment that makes all other investments worthwhile.*”

If you want more information on the problems faced by higher education, write to:  
Council for Financial Aid to Education, Inc., 6 E. 45th Street, New York 17, N. Y.

*Sponsored as a public service, in cooperation with the  
Council for Financial Aid to Education*





AlSiMag pioneered micro-miniature ceramics . . . some as thin as 0.005". Relatively high strength, superior performance at high temperatures, high frequencies. Excellent record for withstanding fatigue, heat, shock, vibration.



The AlSiMag Ceramics in these multiple pin headers may be safely used up to 2800°F. The metal components are the limiting factors. These tantalum pins with nickel braze alloy operate around 1000° F. All materials are rugged. Strong hermetic seal. Low vapor pressure. High temperature bake-out is practical.

# RELIABILITY

## IS AN OUTSTANDING CHARACTERISTIC OF ALSiMAG<sup>®</sup> CERAMICS

AlSiMag Ceramics offer exceptional resistance to heat and erosion. They have marked electrical and physical stability at elevated temperatures and in varying environments. Chemically inert. Good strength. Can be accurately fabricated in micro-miniatures.

AlSiMag Ceramics include many special purpose ceramics, some especially adapted to hermetic sealing. Widest choice of materials, more than half a century of specialized experience. Send blue print and operating conditions.

A Subsidiary of  
Minnesota Mining and  
Manufacturing Company

**AMERICAN LAVA  
CORPORATION**

CHATTANOOGA 5, TENN.  
58TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Boston: Newton Center, Mass. • Chicago: Bedford Park, Ill. • Cleveland, O. • Dallas, Texas • Los Angeles, Cal. • New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle Wash. All other export: Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

# Plan Eight-Company Merger

LARGE-SCALE CONSOLIDATION and merger activities currently set in motion by **Consolidated Electronics Industries Corp.** and **Philips Industries Inc.** will establish one new company, one wholly-owned subsidiary and absorb eight smaller firms.

The new company will bear the same name as the older firm, **Consolidated Electronics Industries Corp.** In addition to its older namesake it will include: **Philips Industries Inc.**, **Central Public Utilities Corp.**, **St. Louis, Mo.**, and **Advance Transformer Corp.**

CEIC will establish a wholly-owned subsidiary, **Philips Electronics and Pharmaceuticals Inc.**, which will in turn own **Anchor Serum Co.**, **Philips Electronics Inc.**, **The Islands Gas & Electric Co.** and **Philips Roxane, Inc.**

Both the consolidations and the mergers are subject to the approval of stockholders of the various constituent companies. The present **Consolidated Electronics** common stock is listed on the New York stock exchange. Application for listing of the new firm will be made immediately upon completion of its formation. The company will begin operations with a net worth of approximately \$50 million.

• **AMP Inc. & Pamcor Inc.**, Harrisburg, Pa., reports highest net sales and income in the company's history for the first half of 1959. Net sales amounted to \$20,439,931, as compared with \$14,832,112 for the same period in 1958. New orders this year totaled \$21,920,000 and the backlog of unfilled orders stands at \$7,720,000.

• **Ampex Corp.**, Redwood City, Calif., announces plans to establish a subsidiary to be called **Ampex Military Products Co.** The new group will be devoted to major R&D activity for direct government projects as well as for prime contractors. Location of the new facilities is still under study.

• **Crosby Electronics**, Hicksville,

N. Y., has acquired rights to the **Madison Fielding** line of high-fidelity and stereophonic equipment. The acquisition marks the entrance of **Crosby Electronics** into the consumer manufacturing field. The product line includes receivers, tuners, amplifiers and preamplifiers. Crosby will continue its work in manufacturing electronic test equipment and specialized broadcast gear.

• **Controls Company of America**, Schiller Park, Ill., through a special stockholders meeting has voted to increase the firm's \$5 par value common stock from 1 million to 3 million shares. This action paved the way for a 50 percent stock distribution on August 10 to stockholders of record July 24.

## 25 MOST ACTIVE STOCKS

WEEK ENDING JULY 31

	SHARES (IN 100'S)	HIGH	LOW	CLOSE
Sperry Rand	2,093	27½	25½	26¼
Lear	908	17½	16¼	17
Emerson	835	17¾	15¾	17½
General Dynamics	757	54½	50¾	54½
Gen Tel & Tel	620	78	74½	75½
Intl Tel & Tel	573	39	37¼	37¾
Raytheon	561	53¼	51½	52¼
Elec & Mus Ind	548	7½	6½	7¾
Univ Control	519	18¾	17½	18½
Gen Elec	480	82¾	80¾	81¼
Philco	451	28¾	27½	28
Avco Corp	422	15½	14½	14½
Westinghouse	398	97	94½	95¼
Gen Instr	371	29¾	25¾	28¾
RCA	351	67¾	65¾	66¼
Burroughs	331	35½	33¾	35
Reeves Soundefft	315	10½	9½	9½
Admiral	312	23½	20¾	20½
Ampex	279	88¼	82¼	83
Zenith	250	122	116½	119¼
Amer Bosch Arm	239	33½	32½	32½
Beckman	226	67½	64	65¾
Cons Elect Ind	222	45¼	42½	42½
Robinson Tech Prod	209	22	14½	21½
Litton Ind	197	137¾	126¼	128

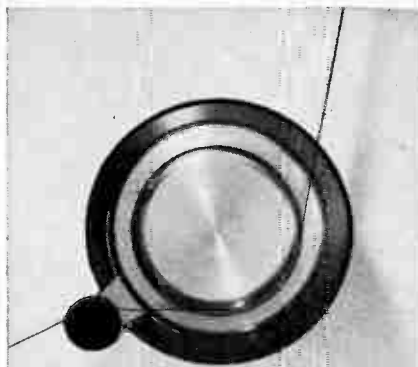
The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for **ELECTRONICS** by **Ira Haupt & Co.**

## NEW PUBLIC ISSUES

	No. of Shares
Wilcox Electronic Company	318,736
Cubic Corporation	100,000
Controls Company of America	191,703
Television Shares Management Corp.	206,500
Executone Incorporated	136,000

## STOCK PRICE AVERAGES

(Standard & Poor's)	July 29, 1959	July 1, 1959	Change From One Year Ago
Electronic mfrs.	98.56	100.02	+75.3%
Radio & tv mfrs.	116.42	115.26	+130.1%
Broadcasters	103.36	104.75	+66.2%



## AMPEX: turning point for tape

Magnetic recording has reached the point where a better tape, by itself, can significantly improve the performance of your equipment. Anticipating this, Ampex has developed its Instrumentation Tape to assure the highest capability that the state of the art requires.

Precision tape reliability comes principally from the properties of its coating. And Ampex combines oxide preparation and careful coating techniques with the exclusive Ferro-Sheen process to produce the smoothest, most cohesive, most uniform of precision tapes. The result is measurably higher signal-to-noise ratios, and much less tape wear.

This, with its squared-up hysteresis curve, makes Ampex Instrumentation Tape ideal for all recording systems: direct, FM-carrier, PDM, and NRZ-digital.

Ampex Instrumentation Tape is available on hubs, NAB-type or die-cast magnesium - alloy Precision Reels. Widths of ¼", ½" and 1" are standard on either Mylar\* or acetate base, in the following lengths, reel diameters, and base thicknesses:

### AMPEX STANDARD TAPE LENGTHS (feet)

REEL DIAMETER	BASE THICKNESS (mils)	
	1.0	1.5
7"	1800	1250
10½"	3600	2500
14"	7200	5000

\*DU PONT TRADEMARK

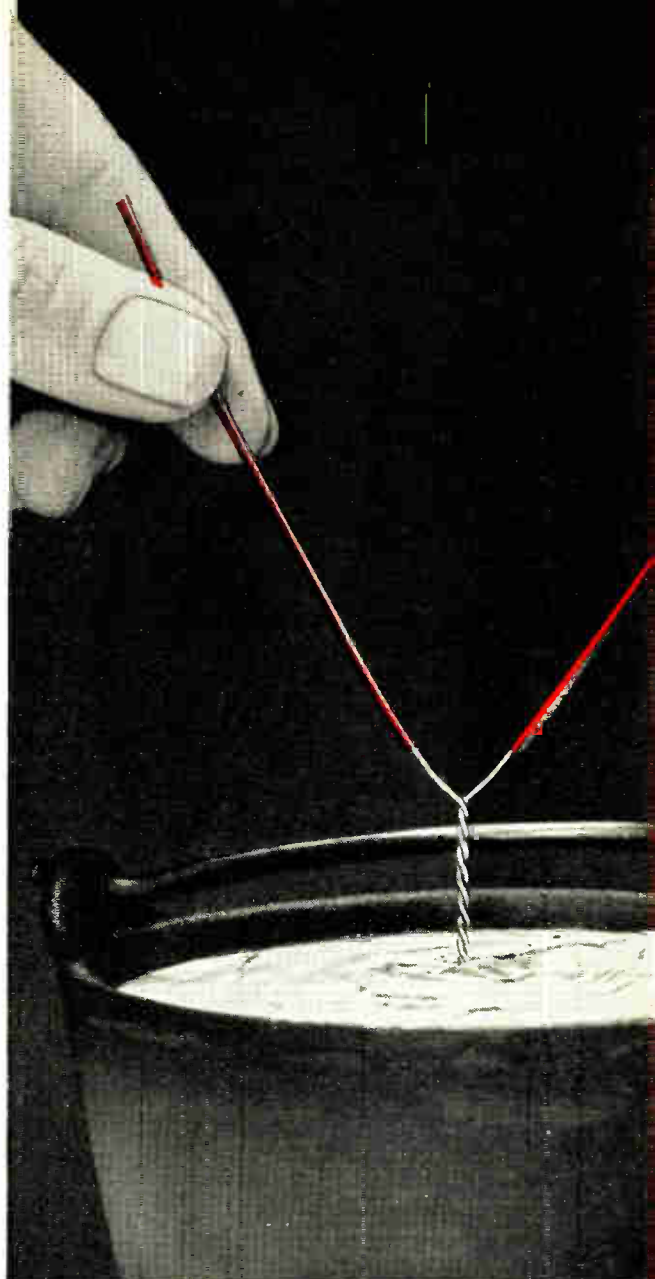
For complete specifications or additional tape literature, write

## AMPEX MAGNETIC TAPE

934 CHARTER STREET, REDWOOD CITY, CALIF.



**TWIST WIRES ...**



**DIP IN SOLDER ...**

# Anaconda

**ready to solder magnet wire...is saving time a**

A superior product is known by the companies that keep it. And many companies—from coast to coast—are doing just that with Anaconda Analac.

Here's why: Analac\* film-insulated, solderable magnet wire can be used similarly to Formvar or Plain Enamel—except that it is solderable without stripping!

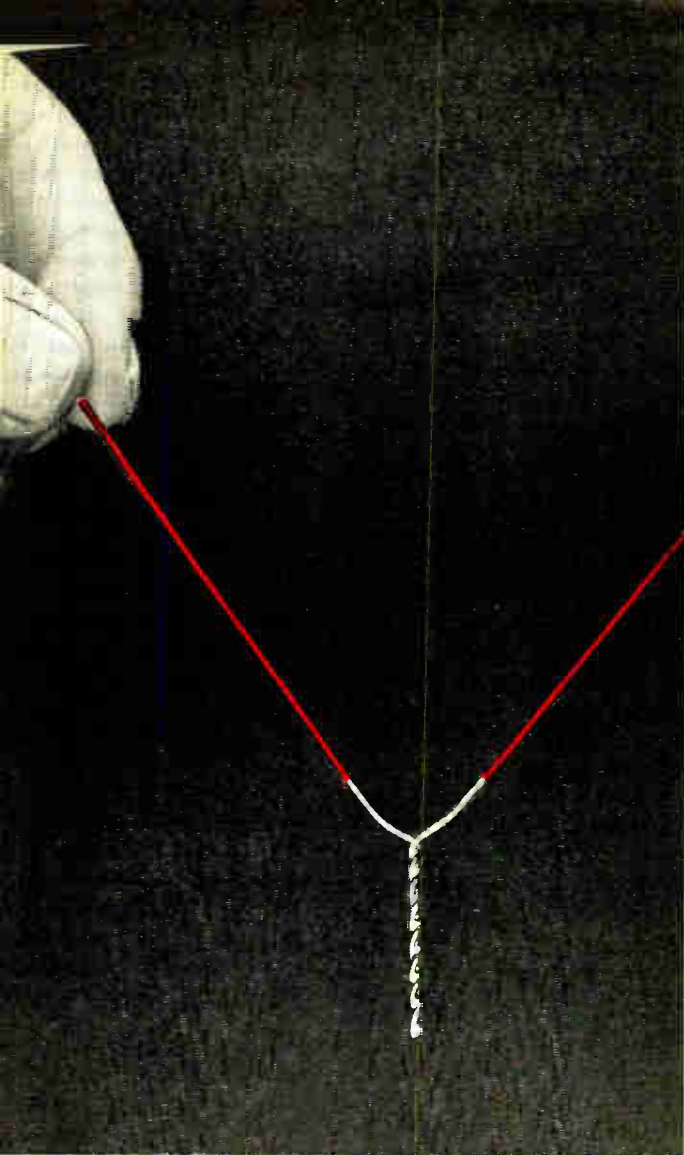
Soldering by dipping, iron or gun produces a perfect joint—in just one second in finer sizes—without removing the insulation. Analac reduces labor, saves time and money wherever many soldered connections are made, or where insulation removal is hazardous.

Not only this, Analac has the excellent abrasion resistance and other good mechanical properties of the

enamel wire you're now using. It handles readily, forms well in high-speed winding.

Analac is colored a bright red with stable dye many years for identical applications—making it highly visible even in finest sizes. This helps operators feel more secure, results in higher quality work. Distinctive color simplifies its identification, too, from nonsolderable wire.

Analac is available in an exceptionally large range of sizes. The Man from Anaconda will be glad to give you more information and help with a production run in your plant. See "Anaconda" in your phone book—in most principal cities—or write: Anaconda Wire & Cable Company, Magnet Wire Headquarters, Muskegon, Michigan.



**JOINT IS COMPLETED WITHOUT TRIPPING WIRE** with Analac wire dipped in 50-50 tin-lead solder at 360° C (680° F). The insulation is moved at the temperature of molten solder.

**Analac...**  
**costs for many industries**

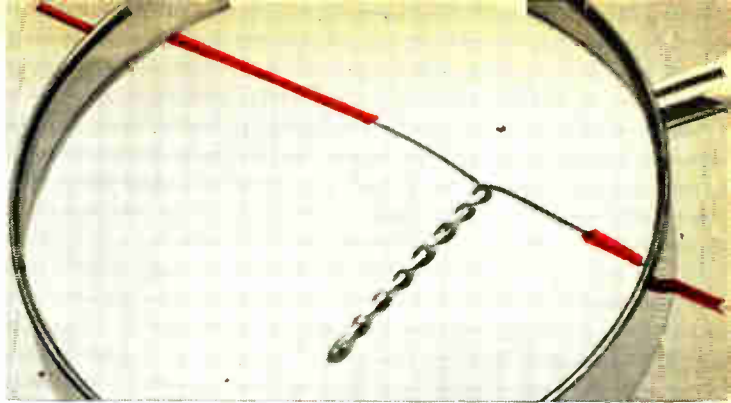
See the Man from

**ANACONDA®**

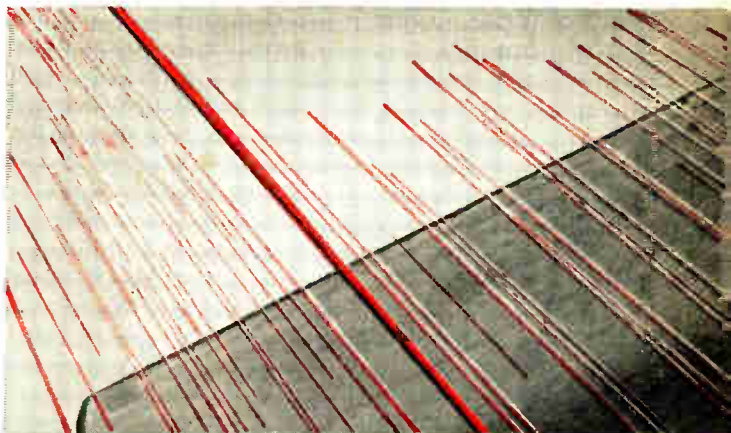
for ready-to-solder

**Analac**

magnet wire



**1. STRONG JOINTS**—as strong as the same joints made in bare copper wire—are produced. Here in laboratory test, joint holds under high stress.



**2. EXCELLENT ABRASION RESISTANCE** of Analac is shown in this test. It has the same high windability normally associated with Formvar, Plain Enamel.



**3. MOLDED-PLASTIC CASES** — designed and developed by Anaconda—protect spools of Analac from damage during shipping. Result: no breaks due to bent spools.



**NEW CATALOG ON ANALAC**

Yours for the asking.

Mail coupon  
 for your copy.

**ANACONDA WIRE & CABLE COMPANY**  
 Magnet Wire Headquarters,  
 Muskegon, Michigan.

Please send me catalog C-95A on  
 Analac ready-to-solder magnet wire.

NAME & TITLE.....

COMPANY.....

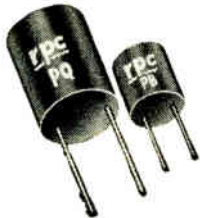
ADDRESS.....

CITY, ZONE, STATE.....

## PRECISION RESISTORS

Type P. wire wound, encapsulated, miniature single ended units for mounting on printed circuit with no support other than wire leads. Resistor element is insulated by Teflon from lead wire, increasing voltage breakdown. Can be operated in ambient temperatures up to 125°C. 7 sizes, from 1/4" to 3/8" diam. Rated from .1 to .4 watt. Resistance values to 2 meg. Tolerance from 1% to .05%. Meets requirements of MIL-9-93B.

Other PRECISION WIRE WOUND RESISTORS: Type L with radial lugs, radial or axial wire leads; Type S, hermetically sealed, with axial wire leads.



### RESISTANCE PRODUCTS COMPANY

914 S. 13 St.

Harrisburg, Pa.

Specialists in manufacturing quality resistors: Precision Wire Wound — High Voltage — High Megohm — High Frequency. Our test equipment and standards for checking and calibrating are matched only by leading laboratories. Write for more information.

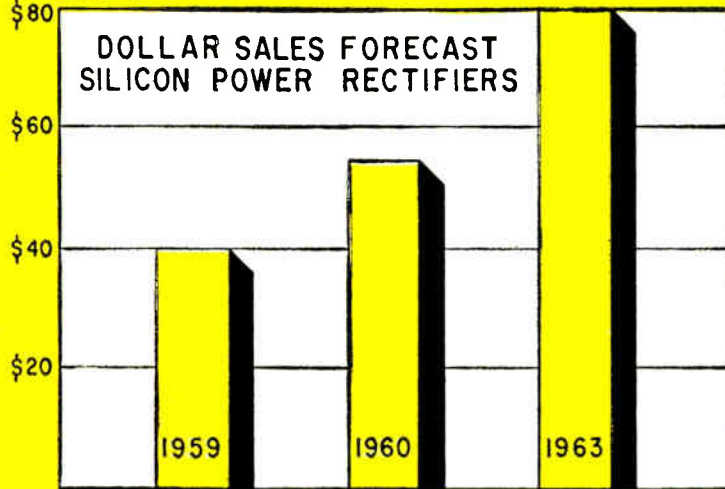
## METAL FILM RESISTORS



NEW! This precision low noise metal film resistor meets and exceeds requirements with temperature coefficient of plus or minus 50 ppm/°C independent of resistance value. Standard tolerance plus or minus 1 per cent. Type WHM-1, 125" long x .406" diam.—is equivalent to MIL Style RN 75, maximum voltage rating 500V. Type WFH-.781" long x .250" diam.—equivalent to MIL Style RN 70, maximum voltage rating 350V.

Enclosed in specially designed hermetically sealed plastic casing (patent pending) to protect precision resistor element.

MILLIONS OF DOLLARS



SOURCE: ITT

## Silicon Rectifier Sales Up 35%

SILICON POWER RECTIFIER sales this year should hit the \$40-million sales mark, a gain of 35 to 40 percent over sales of \$25 to \$26 million in 1958, says Paul Petrack, silicon products manager for ITT Components division.

In units, the volume forecast for 1959 is 15 million, which compares with sales of 8 to 10 million units in 1958.

Estimates include only silicon rectifiers with 100 milliamp ratings or higher. All glass diodes and zener diodes are excluded.

By 1960 dollar sales should rise to \$55 million, says Petrack. His rough estimate for 1963 is \$80 million. Unit estimates for these years are 25 million in 1960 and 35 million in 1963.

Above forecasts are based on investigations made by ITT. The investigations did not include the big market for silicon power rectifiers which is developing among automobile manufacturers.

It is expected the automobile industry, which has started to shift from d-c generators to alternator-rectifiers for power generation, will buy an additional \$3 to \$6 million worth of the rectifiers by 1961-1962.

Sales to industrial users take about 50 percent of the dollar mar-

ket at present, says Petrack. Remainder is divided between military product users—40 percent—and entertainment product users.

Industrial portion of the market should be still larger in next few years, Petrack says.

Growth in use of electric power by industry and greater industrial use of electronic equipment are general factors behind the optimistic industrial business outlook. Among the specific factors are the developments in the automobile industry and trends toward use of d-c motors and electronic machine tools.

Other factors behind Petrack's forecast for rapidly rising silicon power rectifier sales, include the general growth of the electronic industry and the electronic components business, expectation of greater use of the rectifiers by the military for radar and other military equipment, plus expansion of sales to manufacturers of tv and radio sets.

## FIGURES OF THE WEEK

### LATEST WEEKLY PRODUCTION FIGURES

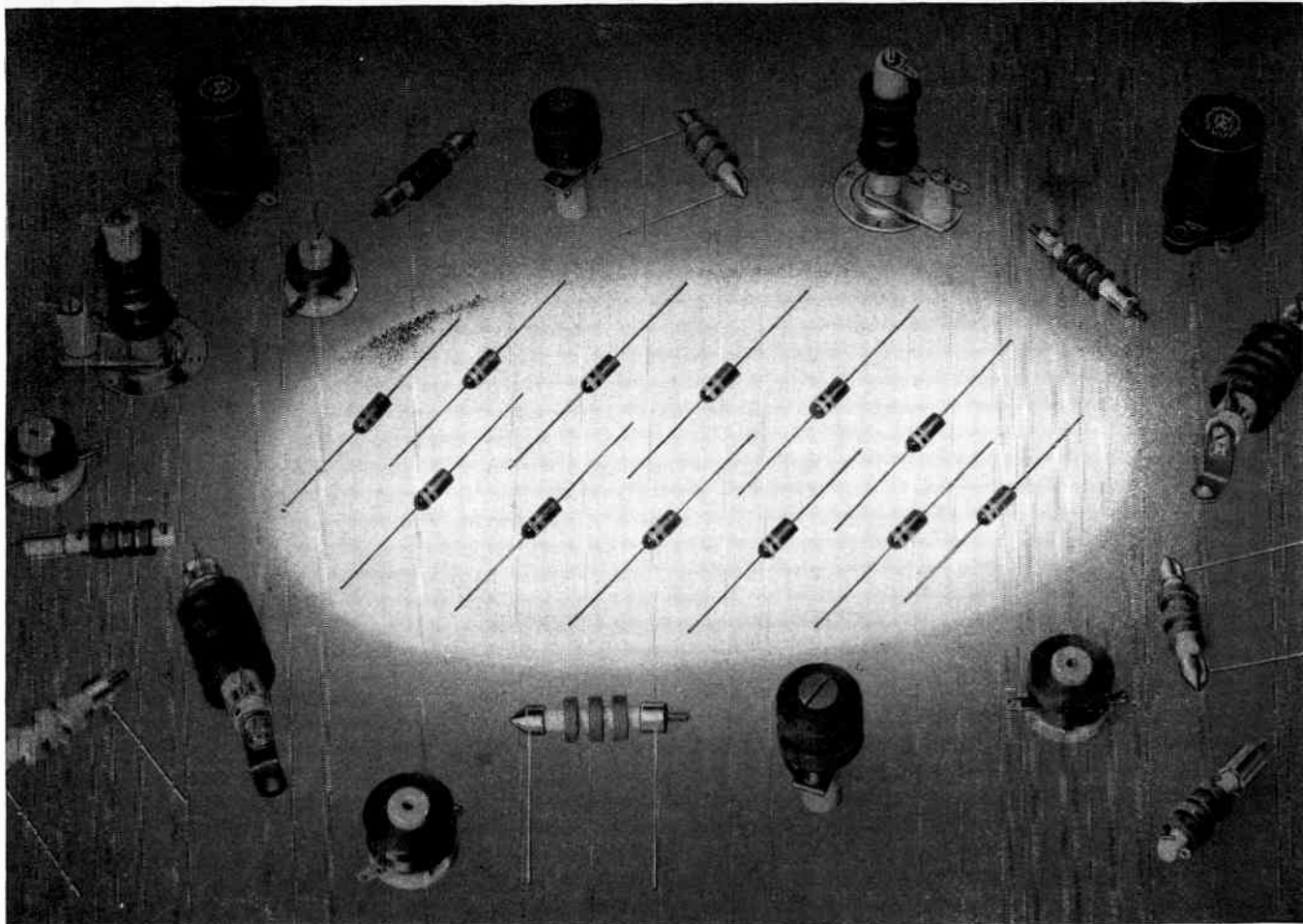
(Source: EIA)	July 24, 1959	June 26, 1959	Change From One Year Ago
Television sets	98,447	110,300	+63.6%
Radio sets, total	240,644	288,041	+39.0%
Auto sets	77,827	126,022	+42.4%





... and B.F. Goodrich is selling it... in the form of microwave absorbent. If you're in the business of space, this is the testing material for you. As you know, the specifications and details are complicated. So why not ask for *all* the information? Write for free booklet to The B.F. Goodrich Company, 586 Derby Place, Shelton, Connecticut.

# **B.F. Goodrich** *microwave absorbents*



## Encapsulated Inductances

Millen DESIGNED for APPLICATION encapsulated coils provide another advance in the r-f inductor field. Modern application requires miniature, heat and cold resistant, hermetically sealed, and abrasion resistant r-f inductor assemblies. The James Millen Manufacturing Company has pioneered many advances in the r-f inductor field, including the now standard 4 pi r-f choke, the axial lead r-f choke, and the miniature r-f choke. Developments have now made possible another advance, the No. 34301 and No. J301 encapsulated inductors—hermetically sealed—miniature size. Ambient temperature minus 55 degrees to plus 100 degrees C.

### NO. J301 MINIATURE ENCAPSULATED INDUCTANCES

DESIGNED for APPLICATION miniature inductances are: extremely small (see table at right)—hermetically sealed—wound on axial lead Carbonyl cores—color coded. Coils are available in RETMA standard values plus 25, 50, 150, 250, 350, 500, and 2500 microhenries. Coils are three layer solenoids up to 350 microhenries. From 360 to 2500 microhenries coils are pi-wound. Current rating 50 to 600 milliamperes depending on coil size. Inductance  $\pm 5\%$ . Special coils on order.

### NO. 34301 STANDARD ENCAPSULATED INDUCTANCES

Encapsulated DESIGNED for APPLICATION axial lead phenolic form r-f inductances. Hermetically sealed—heat resistant—abrasion proof—color coded. 1 to 350 microhenries available in RETMA standard values plus 25, 50, 150, 250, and 350 microhenries. Inductance  $\pm 5\%$ . Values available in same progression as J301 coils listed in the table at the right. Solenoid winding for 1 to 15 microhenries. Universal pi winding from 20 microhenries to 350 microhenries. Current rating 250 to 1500 milliamperes, depending on coil size. Ambient temperature range—minus 55 degrees to plus 100 degrees Centigrade. Size:  $\frac{3}{8}$  inches diameter  $\times$   $\frac{1}{2}$  inches long. Special coils on order.

COIL NUMBER	INDUCTANCE MICROHENRIES	DIAMETER INCHES	LENGTH INCHES
J301-25	25	$\frac{3}{16}$	$\frac{9}{16}$
J301-33	33	$\frac{3}{16}$	$\frac{9}{16}$
J301-47	47	$\frac{3}{16}$	$\frac{9}{16}$
J301-50	50	$\frac{3}{16}$	$\frac{9}{16}$
J301-82	82	$\frac{3}{16}$	$\frac{9}{16}$
J301-100	100	$\frac{3}{16}$	$\frac{9}{16}$
J301-120	120	$\frac{3}{16}$	$\frac{9}{16}$
J301-150	150	$\frac{3}{16}$	$\frac{9}{16}$
J301-200	200	$\frac{3}{16}$	$\frac{9}{16}$
J301-220	220	$\frac{3}{16}$	$\frac{9}{16}$
J301-250	250	$\frac{3}{16}$	$\frac{9}{16}$
J301-300	300	$\frac{3}{16}$	$\frac{9}{16}$
J301-330	330	$\frac{3}{16}$	$\frac{9}{16}$
J301-350	350	$\frac{3}{16}$	$\frac{9}{16}$
J301-360	360	$\frac{7}{32}$	$\frac{5}{8}$
J301-390	390	$\frac{7}{32}$	$\frac{5}{8}$
J301-430	430	$\frac{7}{32}$	$\frac{5}{8}$
J301-470	470	$\frac{1}{4}$	$\frac{11}{16}$
J301-500	500	$\frac{1}{4}$	$\frac{11}{16}$
J301-510	510	$\frac{1}{4}$	$\frac{11}{16}$
J301-560	560	$\frac{1}{4}$	$\frac{11}{16}$
J301-620	620	$\frac{1}{4}$	$\frac{11}{16}$
J301-680	680	$\frac{9}{32}$	$\frac{3}{4}$
J301-750	750	$\frac{9}{32}$	$\frac{3}{4}$
J301-820	820	$\frac{9}{32}$	$\frac{3}{4}$
J301-910	910	$\frac{9}{32}$	$\frac{3}{4}$
J301-1000	1000	$\frac{9}{32}$	$\frac{3}{4}$
J301-1200	1200	$\frac{5}{16}$	$\frac{13}{16}$
J301-1300	1300	$\frac{5}{16}$	$\frac{13}{16}$
J301-1500	1500	$\frac{5}{16}$	$\frac{13}{16}$
J301-1800	1800	$\frac{5}{16}$	$\frac{13}{16}$
J301-2000	2000	$\frac{3}{8}$	$\frac{7}{8}$
J301-2200	2200	$\frac{3}{8}$	$\frac{7}{8}$
J301-2400	2400	$\frac{3}{8}$	$\frac{7}{8}$
J301-2500	2500	$\frac{3}{8}$	$\frac{7}{8}$

JAMES MILLEN

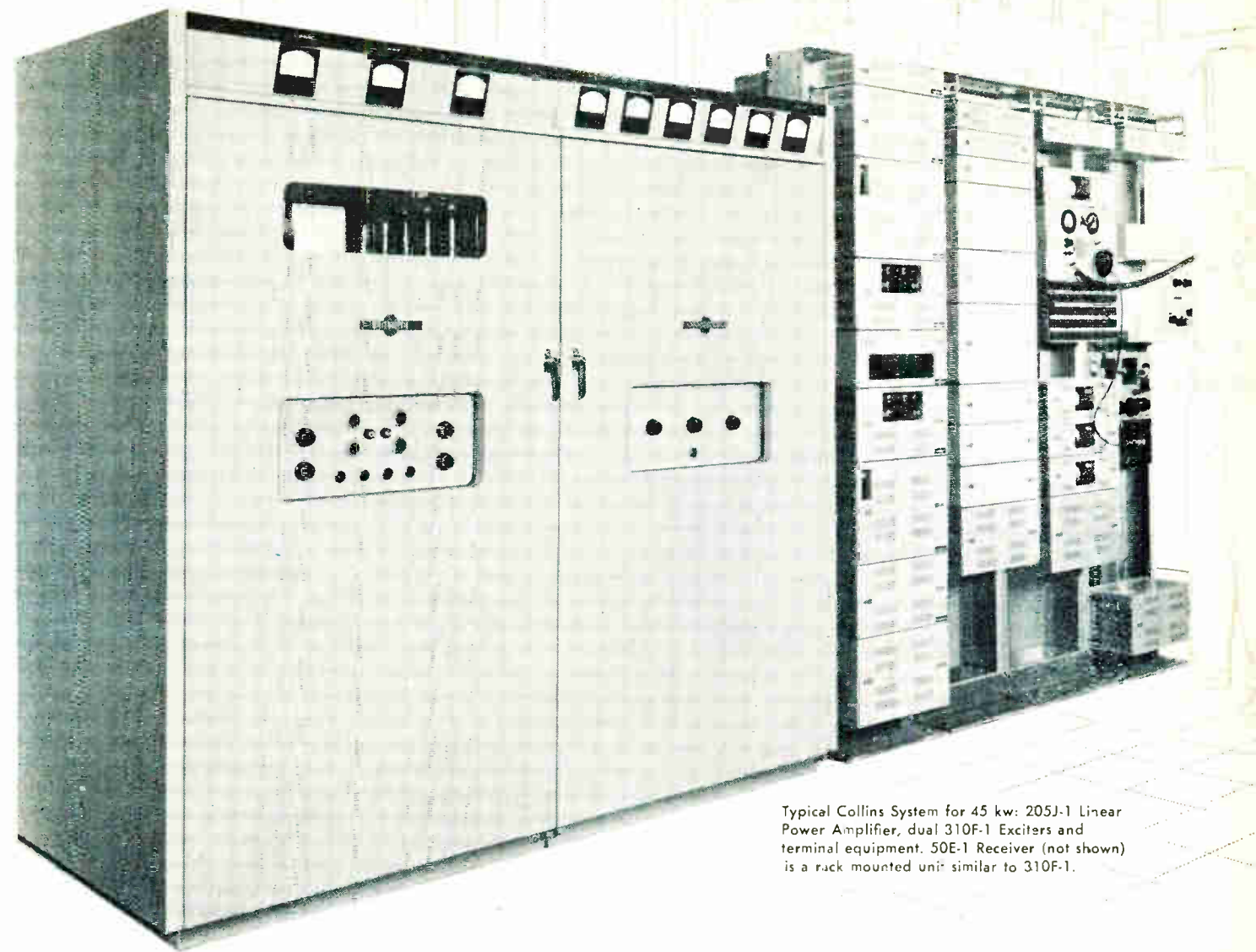


MFG. CO., INC.

MAIN OFFICE

AND FACTORY

MALDEN, MASSACHUSETTS, U. S. A.



Typical Collins System for 45 kw: 205J-1 Linear Power Amplifier, dual 310F-1 Exciters and terminal equipment. 50E-1 Receiver (not shown) is a rack mounted unit similar to 310F-1.

automatic tuning  
for 45 kw  
communication  
stations

# COLLINS SSB

Stemming from a common heritage of design concepts and engineering standards, Collins single sideband systems range in function from low power, fixed tuned facilities to this automatic 45 kw station. Any frequency in 1 kc steps in the 2 to 29,999 mc range may be selected on a direct reading counter dial. Switching matrices enable local or remote selection of antennas as well.

Nucleus for this station is the 205J-1, a fully automatic 45 kw PEP linear power amplifier. Tuning is completed automatically by servo systems actuated

by an error signal derived from phase comparison of input and output signals.

The automatically tuned 310F-1 Exciter generates the sideband signal with a balanced modulator and Mechanical Filter, heterodynes it to the operating frequency and amplifies it to the desired excitation level, using receiving type tubes throughout.

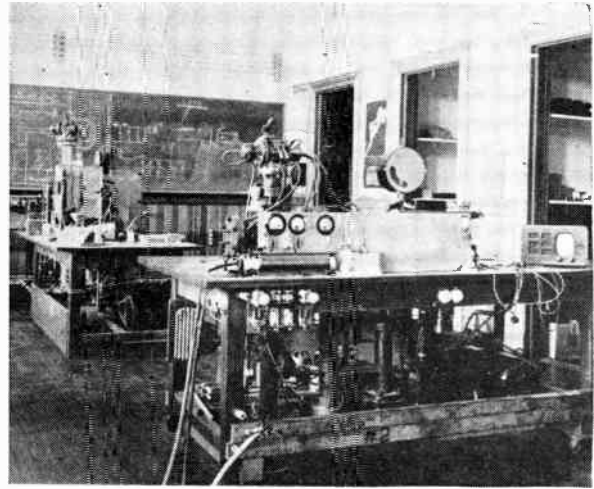
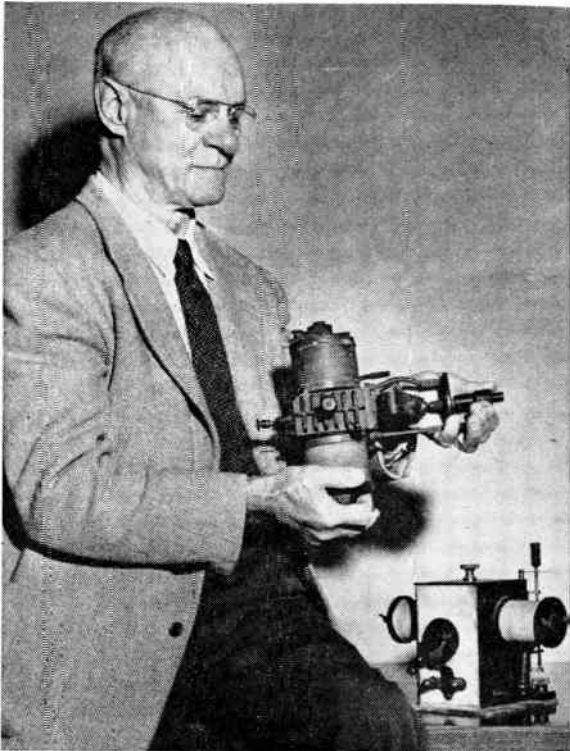
Closely related to the exciter is the 50E-1 Receiver. It uses a Mechanical Filter for narrow bandwidth and sharp skirt attenuation. Frequencies are synthesized by a stabilized master oscillator

which is phase locked to an internal frequency standard imparting a stability of 1 part in  $10^9$  per month. Frequency standards with a stability of 1 part in  $10^7$  per day are available.

The equipment described is part of the complete Collins line of SSB equipment and accessories. Other equipment can provide from 100 watts to 45 kilowatts output with manual or automatic servo tuning.

Write for literature or consult your Collins representative for additional technical information.





Cyril Elwell (left), called founder of electronics industry in San Francisco's peninsula area, holds Poulsen-arc converter he built in Palo Alto 50 years ago. On table: original converter he brought from Denmark in 1909. Photo above: Stanford University lab where Hansen, Ginzton, the Varians and others worked in late '30s

# San Francisco's 50-Year Story

By EMMET G. CAMERON, Vice President-General Manager, Varian Associates, Palo Alto, Calif.

FIFTY YEARS AGO the San Francisco Peninsula was a pleasant, sleepy area of farms and orchards. Today it is a humming interurban community of half a million people.

A single industry—electronics—forms the backbone of peninsula economics, and has wrought the change. The industry has over 100 manufacturing and research firms in the area, doing an annual business in the neighborhood of \$400-million, furnishing the livelihood for about 30,000 of the area's young families.

### Three Events

Of the many actions and events in San Francisco's story, three stand out because of their powerful impact.

The first occurred at Palo Alto on Oct. 1, 1891, when Stanford University installed its first president, David Starr Jordan. The policies of this great educator created the atmosphere in which electronics later grew.

Twenty years later, in the summer of 1912, three men named de Forest, Van Etten and Logwood leaned over a table in a house in Palo Alto watching a fly walk across a sheet of paper. They were listening to the fly's footsteps, tremendously amplified. It was the first time anywhere that a vacuum tube amplified a signal, and more than any other event this was the birth of electronics.

In July of 1937, also in Palo Alto, a young physicist named Russell Varian was classifying ideas for a tube to work at centimeter wave lengths. As he worked, the idea came to him for a control principle that fitted none of his categories—the principle of velocity modulation of electrons.

### World Leader

David S. Jordan brought to Stanford a group of outstanding teachers, many from Cornell. Among these was Harris Ryan, whose name lives in the Ryan High-Voltage Lab.

The presence of these men attracted outstanding students to Stanford. Their leadership inspired the young men to strike out on their own. Cyril Elwell, one of the early students, was destined to be the actual founder of the industry in the area.

Elwell, an American raised in Australia, came to Palo Alto in 1902 to study at Stanford. In 1908 he was persuaded by Ryan to work on a damped-wave radio system invented by Ignatius McCarty of San Francisco. After a year of work, Elwell saw that only c-w radio would provide adequate quality. He moved to acquire the U. S. rights to the Poulsen arc system, invented in Denmark by Valdemar Poulsen in 1903.

With these rights, Elwell founded the Poulsen Wireless Telephone & Telegraph Co., which became the Federal Telegraph Co., forerunner of Federal Telephone & Radio, now the American manufacturing arm of ITT.

Elwell's new company boomed. In 1912, Elwell hired a group of men almost all of whom are revered today as true pioneers of the industry. These included Lee de Forest, Charles Logwood, Herb Van Etten, Doug Perham, Leonard Fuller, Ed Pridham and Peter Jensen.

Pridham and Jensen left Federal Telegraph to invent the moving-coil loudspeaker and found the Magnavox Company. Later Jensen founded the loudspeaker company which bears his name.

In the early '20s the Stanford labs trained another generation of men destined for industry leadership. Four of these, among many of note, were Fred Terman, Ralph Heintz, Herbert Hoover, Jr., and Charles V. Litton.

**Radio Pioneers**

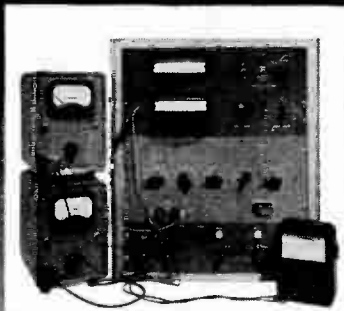
After graduation from Stanford, Ralph Heintz founded with Jack Kaufman, a University of California engineer, the firm of Heintz & Kaufman, Ltd., which for many years pioneered in short-wave radio developments. When World War II came he founded, with Bill Jack, the Jack & Heintz Company to manufacture electrical equipment for U. S. aircraft. Ralph Heintz now operates a private research laboratory in Los Gatos.

Heintz & Kaufman, Ltd. began the manufacture of large vacuum tubes for radio transmitters in 1931. Two of the men employed in this operation, Bill Eitel and Jack McCullough, left in 1936 to found (in a vacant butcher-shop) their own company. Eitel-McCullough, Inc. (or "Eimac") now has plants in San Bruno and Belmont.

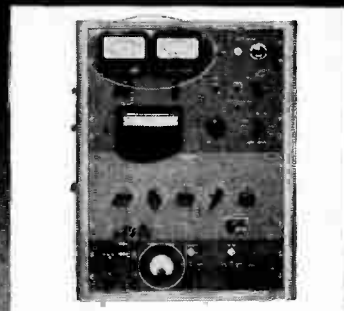
Charles Litton became the leader in the vacuum-tube activities of Federal Telegraph, designing and developing many tubes as well as basic tube-manufacturing processes and equipment which affected the entire industry. When in 1931 Federal Telegraph was moved from Palo Alto to New Jersey, Litton stayed on the Peninsula to found Litton Engineering Laboratories and later Litton Industries. Charles Litton still operates the Laboratories, now in Grass Valley, Calif., while through a series of mergers Litton Industries, now headed by Tex Thornton, has be-

(Continued on p 33)

*customize efficiency & accuracy  
with trio labs' BUILD-IN instruments*



**BEFORE** . . . 3 external instruments were used to measure AC and DC voltages . . . cluttered, tedious, wasteful, subject to error.



**AFTER** . . . 3 trio labs' miniature VTVMs integrally built-in now are always on hand to measure just the parameters you designate.

*the industry's  
pioneer & complete line of*

**MINIATURIZED ELECTRONIC INSTRUMENTS**

**MILITARY**  
for MIL-E-5400A & MIL-T-945A applications.



B Series ruggedized single-range AC VTVMs \$160.



D Series ruggedized multi-range AC VTVMs \$272.



G Series ruggedized single or multi-range DC VTVMs \$136.



J Series ruggedized low-level multi-range DC VTVMs \$450.

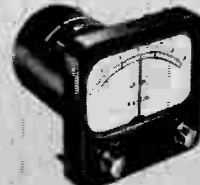
**COMMERCIAL**



E Series Single-range AC VTVMs \$99.50



Model 109-1 low-level multi-range AC VTVM \$199.



F Series single-range DC VTVMs \$84.50



Model 125-1 Null Meter \$125.

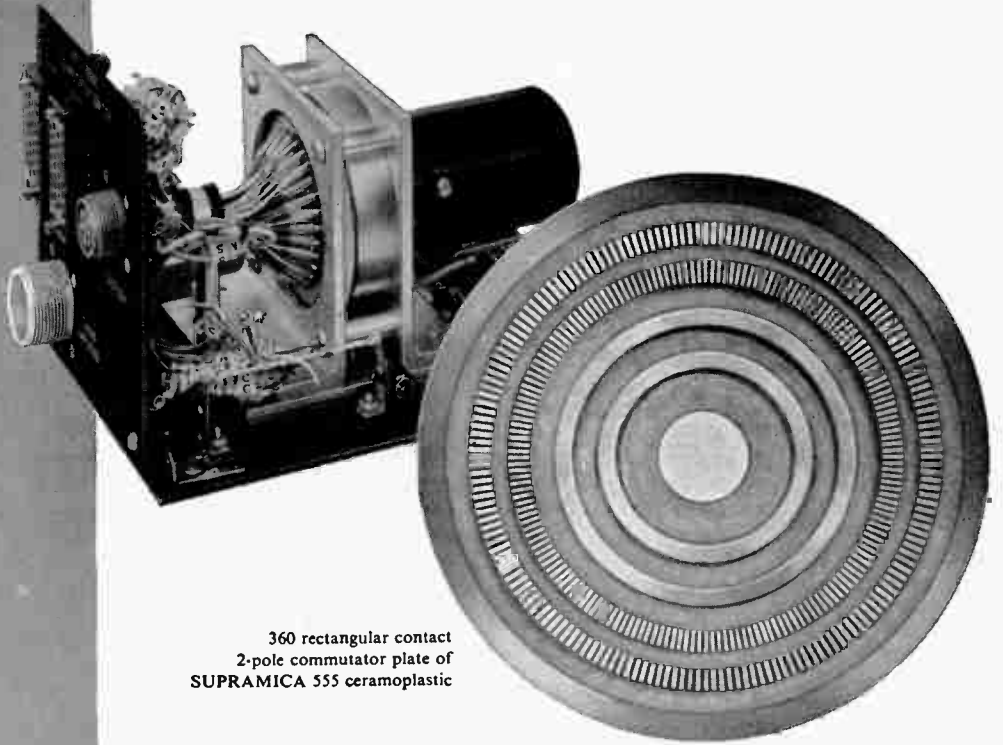
By building-in trio labs' panel-mounting instruments you . . . customize test systems, set-ups and instruments; save space (average model is 4" x 4" x 4"); save time with at-a-glance monitoring; save money; make monitoring foolproof ("go-no go"); improve system reliability; increase overall design freedom. Choose from many "standard" or "special" models — or consult us for new designs for your needs. Write for free "how to" Engineering Guide to Dept. E-3



Trio Laboratories, Inc. Plainview, Long Island, New York

See us at WESCON BOOTH 3728

# major advance in miniaturization: **SUPRAMICA® 555** commutator plates



360 rectangular contact  
2-pole commutator plate of  
SUPRAMICA 555 ceramoplastic

## on a 3 inch precision-molded plate ... up to 540 rectangular contacts!

Since 1948 . . . when Mycalex Electronics Corporation pioneered the first *precision-molded* MYCALEX® 410 glass-bonded mica, 180-contact commutator plate . . . MYCALEX switches have introduced a degree of accuracy and dependability never before approached in mechanical switching.

And now, Mycalex offers a *new* ceramoplastic commutator plate design destined to set *even higher* standards for long-life, low-noise-level multiplexing.

Typical of these new plates is the CP 427. Its specifications call for *precision-molded* SUPRAMICA 555 ceramoplastic which delivers total dimensional stability as well as superb thermal endurance (700°F.). The individual contacts of this plate have an exclusive *rectangular* form and embody tolerances within the .0005" range. They are permanently fixed in place.

An exclusive brush-holder design permits *lower pressures* on the wipers . . . gives *lower contact resistance* with a noise level of *less than 10 microvolts*. Brush bounce is eliminated and life greatly extended. MYCALEX switches using this type of design have been tested satisfactorily for over 1000 hours at 600 RPM without maintenance.

Information on complete MYCALEX switches or matched brush assemblies and plates is available.

General Offices and Plant: 120-A Clifton Blvd., Clifton, N. J.  
Executive Offices: 30 Rockefeller Plaza, New York 20, N. Y.

EXCLUSIVE LICENSEE OF MYCALEX CORPORATION OF AMERICA

SEE OUR NEWEST PRODUCTS BOOTH 1003-1005 WESCON '59



# POWER

handling capacity  
of the new  
Westinghouse  
Silicon



transistor!

**Greater than 99% efficiency** when used to handle 1.5 kw of power in a low-frequency DC switch! Power loss is only 10-15 watts when handling 1.5 kw. That's just one of the impressive specifications established by a remarkable new semiconductor device—the Westinghouse Silicon Power Transistor.

This Power Transistor is remarkable in other ways, too . . .

- It is the first power transistor available in voltage ranges above 100 volts.
- It has power dissipation capability of 150 watts made possible by the low thermal resistance of  $.7^{\circ}\text{C}/\text{watt}$ .
- It can operate at higher temperatures than germanium ( $150^{\circ}\text{C}$ ., compared to  $85^{\circ}\text{C}$ ).

- It has astonishingly low saturation resistance—less than  $.5$  ohms at 5 amperes and  $.75$  ohms at 2 amperes, an achievement made possible through extensive research and development of hyper-pure Siemens-Westinghouse Silicon.
- It is 100% power-tested under actual maximum rated specifications before leaving the plant.
- It is encapsulated in a rugged, all-welded case.

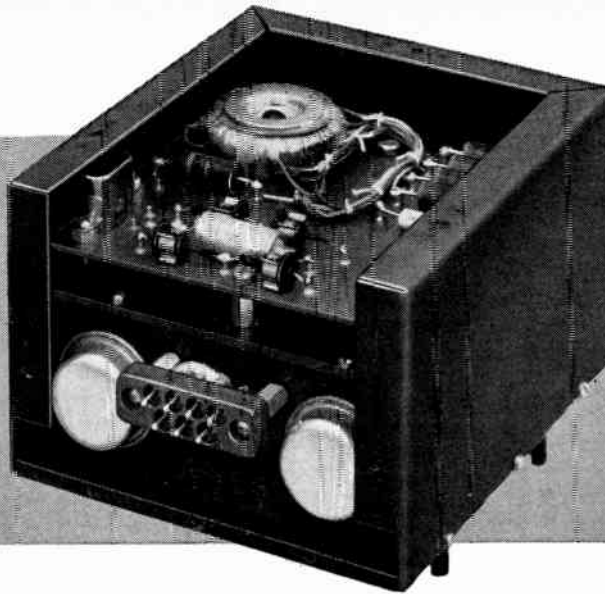
**HERE ARE A FEW OF THE APPLICATIONS . . .**

- Inverters and converters • Data processing circuits • Servo output circuits • Series regulated power supplies • As a low frequency switch • In class A amplifiers.

Available in 2 and 5 ampere collector ratings in production quantities now. For complete specifications and details, contact your local Westinghouse representative.

**YOU CAN BE SURE...IF IT'S** **Westinghouse**  
Westinghouse Electric Corporation, Semiconductor Department Youngwood, Pa.

**AMSTAT\***  
Wider in  
RANGE



**AMSTAT\***  
Broader in  
SCOPE

**\*AMSTAT—American Electronics' new line of Static Power Devices**

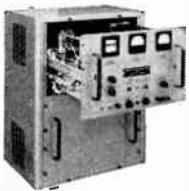
**WIDER IN RANGE**—offering units with the widest rating range available in the industry—10VA to 3000 VA—50C to 6KC—single and three phase.

**BROADER IN SCOPE**—opening new applications for the desirable features of static power devices with a complete line of Inverters, Frequency Changers and Converters in Transistor and Silicon Controlled Rectifier units.

American Electronics, Inc., through its Electric Machinery and Equipment Division, now offers one dependable source for a complete line of solid-state power converting devices. Their outstanding performance characteristics are unique in the industry, including operation to zero load... operation with leading and lagging power factor loads and with highly unbalanced loads.

Advanced design features such as spike suppression, inherent short-circuit proof circuitry, and greater tolerances to heat, assure longer unit life and unmatched reliability.

Only part of the AMSTAT story can be told in this limited space. For complete information on American Electronics' new line of Static Power Devices, please write:



Model 8254VR Silicon Controlled Rectifier Frequency Changer for Laboratory Use.



**AMERICAN ELECTRONICS, INC.**

ELECTRIC MACHINERY & EQUIPMENT DIVISION

2112 NORTH CHICO AVENUE, EL MONTE, CALIFORNIA • CUMBERLAND 3-7151

MODEL NO.	DESCRIPTION	OUTPUT			INPUT VOLTAGE		MAX. AMBIENT TEMP. (Operating)	REMARKS
		VA	VOLTS	Freq. CPS	Nom.	Range		
8251VT	Inverter, 1 ph	100	115 V	400	28 VDC	26-29 VDC	-54°C to 71°C	Square wave output. Frequency and voltage unregulated.
8252VT	Converter, 1 ph	100	6.3 VAC, 6 amps 400 VDC, 75 ma 150 VDC, 120 ma	1200 DC DC	28 VDC	25-31 VDC	-54°C to 71°C	Regulated and filtered DC outputs.
8253VT	Inverter, 1 ph	100	117 V	400	28 VDC	26-31 VDC	-54°C to 71°C	Sine wave output. Frequency and voltage regulated.
8254VR	Frequency Changer, 1 ph	500	105-125 V adj.	360 to 440 adj.	115 VAC	105-125 VAC	40°C	Sine wave output. Frequency and voltage regulated. Silicon controlled rectifier unit.
8255VT	Inverter, 3 ph	200	115/200 V	400	28 VDC	26-29 VDC	-54°C to 71°C	Stepped voltage wave output. Frequency regulated. Voltage not regulated.
8256V	Filter Pack, 3 ph	200	115/200 V	400	28 VDC	26-29 VDC	-54°C to 71°C	Sine wave output. Frequency, but not voltage regulated.
8257V	Regulator Pack, 3 ph	100	115/200 V	400	28 VDC	26-29 VDC	-54°C to 71°C	Frequency and voltage regulated.
8258VR	Inverter, 1 ph	500	115 V	400	28 VDC	26-29 VDC	65°C-500VA 85°C-300VA	Sine wave output. Voltage and frequency regulated. Silicon controlled rectifier unit.
8259VR	Inverter, 3 ph	1500	115/200 V	400	28 VDC	26-29 VDC	65°C-1500VA 85°C-1000VA	Sine wave output. Voltage and frequency regulated. Silicon controlled rectifier unit.
8260VR	Inverter, 3 ph	1000	115/200 V	400	28 VDC	26-29 VDC	85°C Max. MS 33543 Curve I	Sine wave output. Voltage and frequency regulated. Silicon controlled rectifier unit. Class H insulated magnetic components.
8261VR	Frequency Changer, 3 ph	3000	115/200 V	400	117 VAC	105-125 V 320 to 480 cps	65°C-3000VA 85°C-2000VA	Sine wave output. Voltage and frequency regulated. Silicon controlled rectifier unit.



(Continued from p 29)

come one of the larger electronics companies in the country.

Bill Hewlett and Dave Packard were two products of Stanford's "communications laboratory" in the attic above Dr. Ryan's office on the campus. Under Fred Terman this lab became a center of electronics developments, and one of the inventions accomplished here was Bill Hewlett's resistance-tuned oscillator. This instrument was the first product of the company which Hewlett and Packard founded in 1938.

### Gets World Fame

In the late thirties another of the real giants of the industry began his work in Stanford's Physics Laboratories. This was Dr. William Webster Hansen, who in his short lifetime was to collaborate in three major developments.

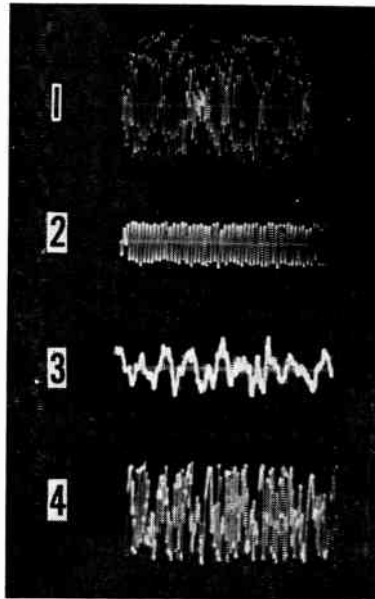
Dr. Hansen worked with the Varian brothers on the invention of the Klystron, was co-inventor with Dr. Felix Bloch of nuclear magnetic resonance apparatus, and in 1947 with Dr. Edward Ginzton developed the first of Stanford's linear accelerators. Peninsula electronics men continue to found new companies which combine technical accomplishment with economic success. In 1948 the Varian brothers founded Varian Associates, now a major area manufacturer.

Many of the electronics companies founded in the area are well-known all over the world. Ampex, famous for its videotape gear, was founded in 1944 by Alexander M. Poniatoff in San Carlos. Lenkurt was founded by Len Erickson and Kurt Apperson to develop and build radio systems for telephone communications, is now part of the General Telephone family. Dalmo-Victor, founded by T. J. Moseley, has become a major manufacturer of airborne antennas.

Besides home-grown companies, the Peninsula has in recent years begun to attract "outposts" from some of the giants of the electronics industry. These firms move West to tap the talent in the Bay area, stay to confirm its phenomenal success story.

# New Radar Tells Target's Sex

Army is buying 3 highly-sensitive combat surveillance radars for seeing and hearing at night



Video presentations of moving targets picked up by Hazeltine's new Army combat surveillance radar show (1) a train, (2) automobile, (3) walking man and (4) walking girl. Difference is caused by Doppler effect

RADAR THAT CAN distinguish between a man and a woman a mile away (by the shorter, quicker steps taken by a woman wearing a skirt) is one of three new combat surveillance radar systems soon going to the Army.

Consisting of short, medium and long range units, the three sets together can monitor a battle area up to a distance of 20,000 meters, during darkness or fog.

### Improved Version

The short-range, 5,000-meter unit is Sperry's AN/PPS-4, an improved version of the Army's "Silent Sentry." It is being produced for evaluation under a \$3.5-million follow-on contract.

Switching from tubes to transistors in the new version reduced by half the set's power requirements, making it possible to use a battery in place of a gasoline generator. The system has no moving parts and no fuel problems. No scope is used with the system. Returned signals are auditory only. Range, azimuth and elevation data

are accurate within 25 yards. A moving man can be detected at a half mile.

Army's medium-range, 10,000-meter radar, designated the AN/TPS-21, is under development by Hoffman. Originally developed under a Navy contract, the equipment is being bought by the Army. New sets will provide both video and audio presentations.

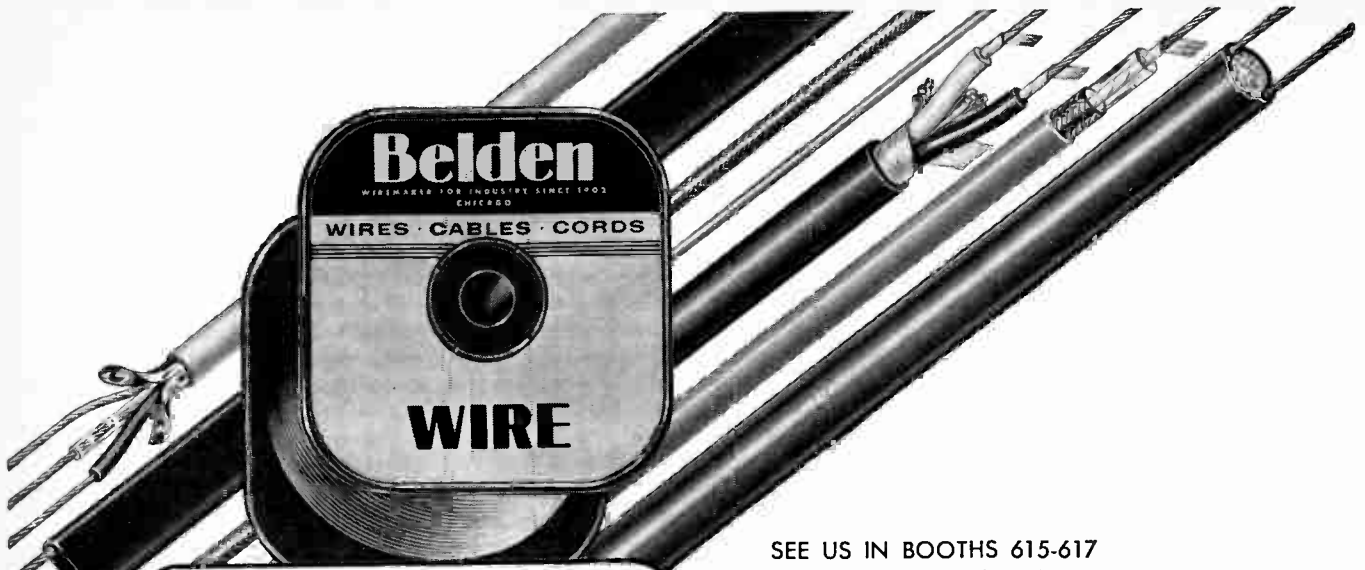
Long-range, 20,000-meter unit, designated the AN/TPS-25, is being produced by Hazeltine under a new \$2-million contract. Previous contracts for development and prototypes amounted to \$4 million. In addition to distinguishing between a man and a woman at one mile, the unit can make out the difference between a moving man and a moving vehicle at 10,000 meters, and can determine the speed and direction of moving vehicles at 20,000 meters.

Using pulsed radar, presentation of the returned signal is both audio and visual. Because of Doppler effect, the sounds heard through the set's loudspeaker reveal the nature of the target. The steady whining of a moving vehicle is different from the more erratic sound bounced back from the knees of a walking man.

### Starts Tracking

Antenna's azimuth during search is ten degrees. Once moving target is picked up, the azimuth is cut down to two degrees for tracking. If range of the object is determined to be 9,000 meters, the field of focus is gated for between 8,500 and 9,500 meters. All objects within this area (2-deg arc and 1,000-meter depth) return signals. Echoes from the moving object stand out against the stationary background clutter due to Doppler effect—there is a 30-cycle difference for every 1 mph of motion.

Sperry's PPS-4 and Hazeltine's TPS-25 were recently displayed for the first time at the Association of the U. S. Army's annual meeting in Washington.



SEE US IN BOOTHS 615-617  
AT WESCON SHOW

## THE WIRE YOU NEED

- for EVERY ELECTRONIC application
- Correctly Rated—Quality Controlled
  
- for positive performance
- for the most complete line for all electronic applications
- for most advanced construction designs, insulations, and shieldings correctly service-rated
- for dependable uniformity under strictest quality control
- for complete information in an easy-to-read catalog
- for fast service

*You Can Depend on Belden . . . Ask Your Belden Jobber*

One Wire Source for  
Everything Electrical & Electronic

**Belden**  
WIREMAKER FOR INDUSTRY  
SINCE 1902  
CHICAGO



Magnet Wire • Lead Wire • Power Supply Cords,  
Cord Sets and Portable Cord • Aircraft Wires  
Electrical Household Cords • Electronic Wires  
Welding Cable • Automotive Wire and Cable

8-2-8

THE NEW

# SLO-SYN

## SYNCHRONOUS MOTORS

### AUTOMATIC MACHINES AND APPARATUS

needing a simple, efficient, maintenance-free synchronous motor

### NUMERICAL CONTROL SYSTEMS

requiring continuous, constant-speed traverse and/or incremental stepping for positioning

### REMOTE CONTROL SYSTEMS

using either manually-operated or remote positioning control

### SERVOMECHANISMS

calling for instant starting, stopping and reversing characteristics without slip or chatter



**72 RPM**

*shaft speed*

**STARTS**

*instantly!*

**REVERSES**

*instantly!*

**STOPS**

*instantly!*

*can be used as a  
stepping motor!*



**THE  
SUPERIOR ELECTRIC  
COMPANY**

**Bristol, Connecticut, U.S.A.**

# SLO-SYN SYNCHRONOUS MOTORS

A SLO-SYN is an enclosed, permanent magnet type a-c motor with a slow basic shaft speed of 72 RPM. A single-pole, three-position switch can give complete forward, reverse and "off" control because the motor has three leads only. The SLO-SYN Motor will start or stop in less than 0.025 seconds or approximately 1.5 cycles. No need for electrical or mechanical braking because the motor will stop in less than 5° of shaft rotation. Maximum moment of inertia of a load rigidly attached to the shaft is 1.5 pound-inches<sup>2</sup>. Loads with higher inertia can be started by using a coupling method which allows 5° freedom. Types having specially-designed planetary gear assemblies are available to provide speeds of 3.323, 0.665, 0.133 or 0.027 RPM. Torque on all planetary gear types is 2500 ounce-inches.



TYPE SS150

## AS A D-C STEPPING MOTOR

The SLO-SYN Synchronous Motor can be adapted for use as an incremental stepping device by the use of a d-c power source and a suitable switching arrangement. When used as a control system stepping or "inching" motor, d-c electrical impulses are converted into either 200 or 400 precise increments of one revolution of the motor shaft. The motor will maintain its rated torque for any stepping position. Each step is made instantly without slip or clatter because no ratchets are used.



- ▼ Available with speed reducing planetary gears
- ▼ Available with enclosed capacitor and resistor
- ▼ Available with both enclosed capacitor and resistor and planetary gears

## RATINGS AND SPECIFICATIONS

INPUT ..... 120 volts, 40/70 cycles,  
1 phase

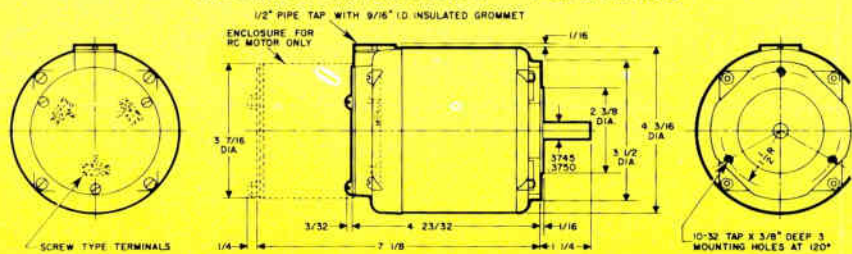
OUTPUT SPEED 72 RPM at 60 cycles

MAX. CURRENT 0.3 ampere at 60 cycles

TORQUE ..... 150 ounce-inches

WEIGHT ..... 6.5 pounds

## OUTLINE DIMENSIONS - TYPE SS150



THE SUPERIOR ELECTRIC COMPANY, Bristol, Connecticut

Please send SLO-SYN Synchronous Motor Bulletin

Please have your representative call.

Name \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

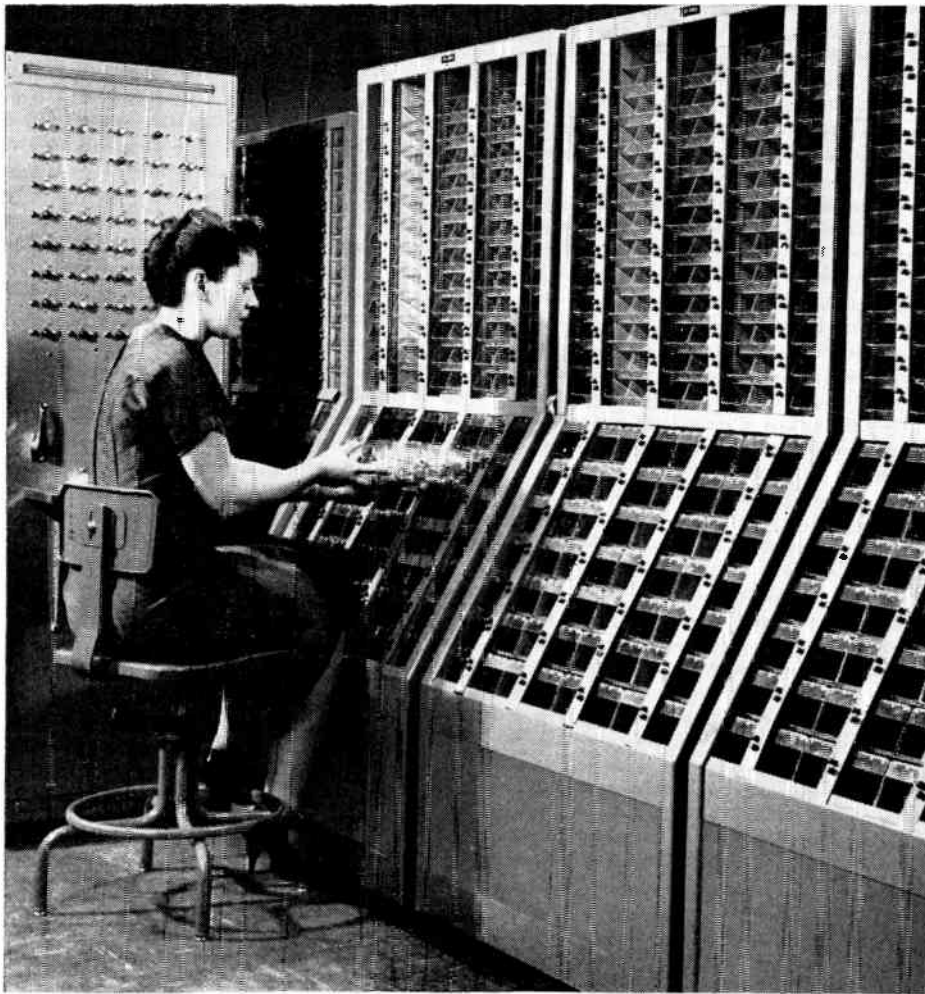
City \_\_\_\_\_ State \_\_\_\_\_

... FOR YOUR FILES

Request SLO-SYN Bulletin giving full technical information, ratings and specifications.



THE SUPERIOR ELECTRIC COMPANY  
Bristol, Connecticut, U.S.A.



*News from  
Raytheon's  
Semiconductor  
Division...*

**AUTOMATIC TESTING—**

The operator is testing Raytheon semiconductor products at one of the new automatic test sets. This equipment, designed by Raytheon engineers, checks and classifies transistors according to the several hundred possible combinations of test parameters—including emitter and collector current cutoff, frequency cutoff, a-c beta, d-c beta, breakdown voltages, input voltage, collector capacitance, extrinsic base resistance and gain.

**POSITIONS FOR MEN WHO ARE GROWING  
FASTER THAN THEIR ASSOCIATES**

If you have applicable experience in any of the following areas and want to learn more about Raytheon's semiconductor opportunities, please use the attached coupon.

**Device Design and Development**

**Process Engineering**

**Mechanization**

**Circuit Design**

**Application Engineering**

*The place for the man  
who is growing faster...*

**Semiconductor  
Division of**



*Excellence in Electronics*

Mail to:  
Mr. Joseph McGovern  
Semiconductor Division  
Raytheon Company  
150 California Street  
Newton 58, Massachusetts

Gentlemen:  
I would like further information about Raytheon's  
Semiconductor Division.

NAME \_\_\_\_\_

STREET \_\_\_\_\_

CITY \_\_\_\_\_ ZONE \_\_\_\_\_ STATE \_\_\_\_\_

DEGREE(S) \_\_\_\_\_ YRS. EXPERIENCE \_\_\_\_\_

PHONE NUMBER \_\_\_\_\_

(B)

When you want 'em ... you've got 'em!

**Good-All**

**CAPACITORS**

**AUTHORIZED  
INDUSTRIAL  
DISTRIBUTORS**

ARLINGTON, VIRGINIA  
Industry Services, Inc.  
Key Electronics Division

BALTIMORE, MARYLAND  
Kann-Elliott Electronics, Inc.

BATTLE CREEK, MICHIGAN  
Electronic Supply Corp.

BUFFALO, NEW YORK  
Radio Equipment Corp.

CAMBRIDGE, MASSACHUSETTS  
Electrical Supply Corp.

CAMDEN, NEW JERSEY  
General Radio Supply Co.

CHICAGO, ILLINOIS  
Lukka Sales Corporation  
Newark Electric Co.

CLEVELAND, OHIO  
Pioneer Electronics Supply Co.

CLIFTON, NEW JERSEY  
Eastern Radio Corporation

DALLAS, TEXAS  
Engineering Supply Co.

DAYTON, OHIO  
Sreco, Inc.

FT. WAYNE, INDIANA  
Ft. Wayne Electronics Supply, Inc.

HOUSTON, TEXAS  
Harrison Equipment Co., Inc.

INDIANAPOLIS, INDIANA  
Graham Electronics Supply, Inc.

KANSAS CITY, MISSOURI  
Burslein-Applebee Co.

LOS ANGELES, CALIFORNIA  
Radio Product Sales Corp.

MIAMI, FLORIDA  
Electronic Equipment Co., Inc.

MINEOLA, NEW YORK  
Arrow Electronics, Inc.

NEW YORK, NEW YORK  
Electronics Center, Inc.

PHILADELPHIA, PA.  
Philadelphia Electronics, Inc.

POUGHKEEPSIE  
Higgins & Sheer Electronic  
Distributors

SAN DIEGO  
Radio Parts

SAN FRANCISCO, CALIF.  
Fortune Electronics  
Television Radio Supply Co.

SCRANTON, PA.  
Fred P. Purcell Co.

SEATTLE, WASHINGTON  
C. and G. Radio Supply Co.

SOUTH BEND  
Radio Distributing Co.

SPRINGFIELD, MASSACHUSETTS  
T. F. Cushing, Inc.

ST. LOUIS, MISSOURI  
Interstate Supply Corp.

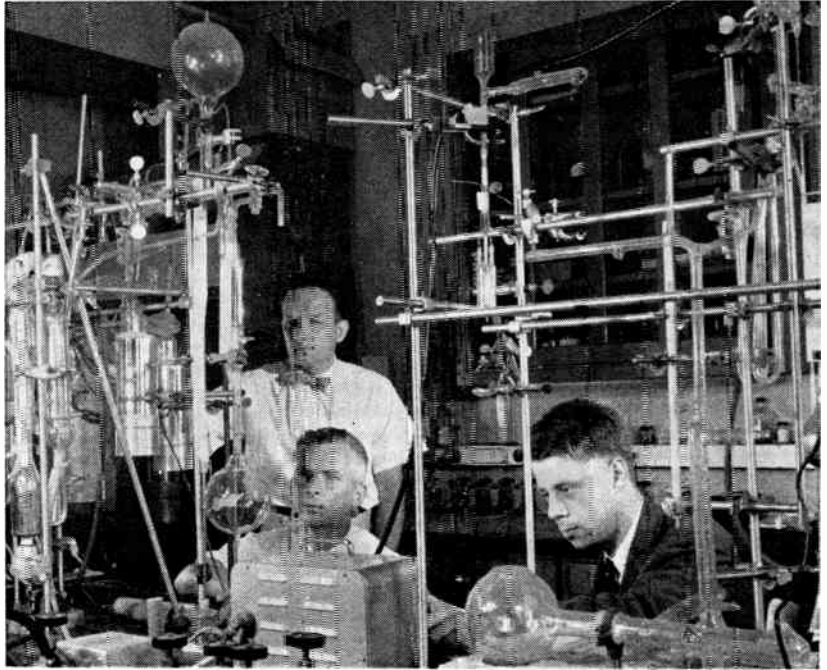
ST. PAUL, MINN.  
Northport Electronics, Inc.

TULSA, OKLAHOMA  
Oil Capital Electronics Corp.

WATERBURY, CONNECTICUT  
Bond Radio Supply Co., Inc.



**GOOD-ALL ELECTRIC MFG. CO.**  
Distributors' Div.  
26 Rittenhouse Pl. Ardmore, Pa.



Semiconductor research intrigues skilled men at Bell Telephone Laboratories

## What Role for Basic Research?

In our industry basic research need not involve a large program. It can have a limited objective

THE TRANSISTORS, masers and mavars of tomorrow will come out of today's basic research programs.

Who will cash in on these yet undiscovered products of tomorrow? Giant firms employ thousand-man staffs constantly on "fishing" expeditions. Does this cut the smaller firm out of new proprietary products?

Not so, say several industrial research directors. The smaller firm can run an effective basic research program with limited objectives.

The role of basic research among government, industry and university scientists and administrators was highlighted recently by the Symposium on Basic Research at the Rockefeller Institute.

### Who's Researching

It's generally conceded that basic research in physical science, as a continuing effort within the electronics industry, is carried on by only the oldest research laboratories associated with the largest corporate enterprises. The others

cannot afford to underwrite full-time research that is not clearly related to a practical end.

Peter C. Goldmark, president and director of research of CBS Laboratories, Stamford, Conn., tells ELECTRONICS that basic research today really works for industry in two ways: (1) The by-products of basic work in many government, university and industry labs help the whole industry. (2) A single company's broad objectives may be implemented by a program that includes basic research.

To some, a scientist is not a basic research man unless he is free to ask all of his own questions. But a more liberal definition is sometimes accepted by industry.

This is the concept of a limited objective assigned to a scientist in the form of a fundamental question about nature; the question seems worth asking the scientists on the chance that, if he can answer it, the knowledge can be applied to a broader objective.

In such a case, Goldmark says,

the basic researcher should be completely removed from the practical aspects of the program. The limited objective—to satisfy a curiosity—may involve a hope but not an expectation, of acquiring some knowledge that will be useful.

### One Example

Goldmark cites the research connected with the depositing of iron oxides on thin plastic film which culminated in today's magnetic tape. Although the technique was probably accomplished with an object in mind, there must have been more limited objectives that were previously assigned to physicists and chemists.

Even though they may follow the concept of a limited objective for a fundamental scientist many research directors do not think in terms of the label, "basic research." They see fundamental studies and applied research as too intermingled to sort out.

Radioastronomy is an example of a whole science that crossed over from basic to applied research, Goldmark points out. At one time men studied it with no earthly motives; now it's part of applied space research.

Another research director, commenting on the overlapping of basic and applied research in industry, says that applied research is sometimes underrated by both the public and by scientists. This, he attributes to an aura of glamor which has come to surround famous names in basic research.

### Critical Questions

He said that trying to understand nature by first asking a critical question of it, and then finding the answer, was essential to scientific progress, but that there are comparatively few scientists today who are mature enough to ask so critical a question that a great discovery will be produced. Of those that have such maturity, he said, there are few to go around in our industry or any other.

For this reason, he says, the electronics industry does not employ many researchers who stake out their own ends and regard practical possibilities as by-products or accidents.

**Good-All**

**CAPACITORS**

## Two SPACE SAVERS and a Classic

**SPACE SAVER**

**Good-All Type 663UW 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.....	Voltage Range...100-1000 VDC
Dielectric.....Mylar™ Film	I.R. at 25°C 100,000 Meg. x Mfd.
Case.....Plastic Wrap	Temp. Range -55°C to +125°C
End Fill,Thermo-Setting Plastic	Humidity Resistance . Superior

**SLIM LINE**

**601PE — Tailored for transistors**

Wafer-thin shape is ideal for upright mounting in tight spaces. An excellent replacement for ceramic discs where stability is important.

SPECIFICATIONS.....	Temp. Range..Full to+85°C..
Dielectric.....Mylar™ Film	Derate 50% at+125°C
Case.....Dipped Epoxy	I.R. at 25°C.....
Voltage Range..50 VDC only	.....75,000 Meg. x Mfd.
	Humidity Resistance Superior

**CLASSIC**

**METAL ENCLOSED Tubulars per MIL-C-25A and MIL-C-0025B (U.S.A.F.)**



These capacitors are well-known classics... from the standpoint of broad usage in military electronics. Good-All specializes in CP tubular styles CP04, CP05, CP08, CP09, CP10 and CP11. \*DuPont's trademark for polyester film.

A LEADING MANUFACTURER OF TUBULAR,  
CERAMIC DISC AND  
ELECTROLYTIC CAPACITORS



**GOOD-ALL ELECTRIC MFG. CO.**  
OGALLALA, NEBRASKA

®



**From Technical Breakthrough**

**to Reliable Production**



## **CARCINOTRONS<sup>\*®</sup>**

Backward Wave Oscillators have now attained the full cycle of the capability associated with all CSF products. This cycle, beginning with the pioneering research and development has led to the largest frequency coverage in Carcinotrons, is now completed with the reliable full scale production of these tubes.

Electronically tunable, the Carcinotron tube permits the largest range of uninterrupted tuning ever achieved by a single tube. Latest developments in CSF CW Carcinotrons include:

- ▶ milliwatts at 2 m/m wavelength
- ▶ watt at 4 m/m wavelength
- ▶ 10 watts at 8 m/m wavelength
- ▶ 5 kilowatts at 1 m wavelength

A partial listing is shown below of current CSF production of type "O" Carcinotrons, which have a complete coverage from 1 to 100 kMcs.

CO 515	980	— 2100 Mcs.
CO 521	8000	— 16,000 Mcs.
CO 2012 A	15,500	— 24,000 Mcs.
CO 1308 A	23,500	— 37,500 Mcs.

Current production of "M" type Carcinotrons between 1 and 10.5 kMcs includes:

CM 5200	1200 — 1500 Mcs	500 W Cw min
CM 440	2700 — 3400 Mcs	500 W Cw min
CM 7060A	3200 — 4000 Mcs	200 W Cw min
CM 730	8500 — 10,500 Mcs	80 W Cw min

American Radio welcomes inquiries about special development for particular needs.

\*U.S. Patent No. 2,880,355

# **AMERICAN RADIO CO., INC.**

445 PARK AVENUE, NEW YORK 22, NEW YORK

*Subsidiary of Compagnie Générale de T. S. F. (CSF) Paris, France*

CIRCLE NO. 40 READER SERVICE CARD



# Check *RMC* for your needs in ceramic capacitors

## *RMC* DISCAPS



RMC  
800

### Type JL

RMC Type JL DISCAPS are engineered for applications requiring a minimum of capacity change as temperature varies between  $-60^{\circ}\text{C}$  and  $+110^{\circ}\text{C}$ . Over this wide range the capacity change of type JL DISCAPS is only  $\pm 7.5\%$  of capacity at  $25^{\circ}\text{C}$ . Standard working voltage is 1000 V.D.C.



RMC  
0022

### Type B

Designed for by-passing, coupling or filtering applications, Type B DISCAPS meet and exceed all E.I.A. RS198 specifications for Z5U ceramic capacitors. Type B DISCAPS are manufactured in capacities between .00015 MFD and .04 MFD and one rated at 1000 working volts.



RMC  
JF  
.001

### Type JF

Type JF DISCAPS exhibit a frequency stability characteristic that is superior to similar types. These DISCAPS show a change of only  $\pm 7.5\%$  over the range between  $+10^{\circ}\text{C}$  and  $+85^{\circ}\text{C}$ . These DISCAPS extend the available capacity range of the E.I.A. Z5F ceramic capacitor between  $+10^{\circ}\text{C}$  and  $+85^{\circ}\text{C}$  and meet all Y5S specifications between  $-30^{\circ}\text{C}$  and  $+85^{\circ}\text{C}$ .



RMC  
100

### Type C

Specifications of E.I.A. RS198 are met or exceeded by these temperature compensating DISCAPS. Smaller sizes are well suited to designs where space is at a premium. Type C DISCAPS are rated at 1000 working volts providing a higher safety factor.



RMC  
.005

### Type SM

Where space is at a premium, Type SM DISCAPS can be specified with complete assurance of the quality, dependability, and electrical performance built in all RMC DISCAPS. SM DISCAPS show minimum capacity change between  $+10^{\circ}\text{C}$  and  $+65^{\circ}\text{C}$ .



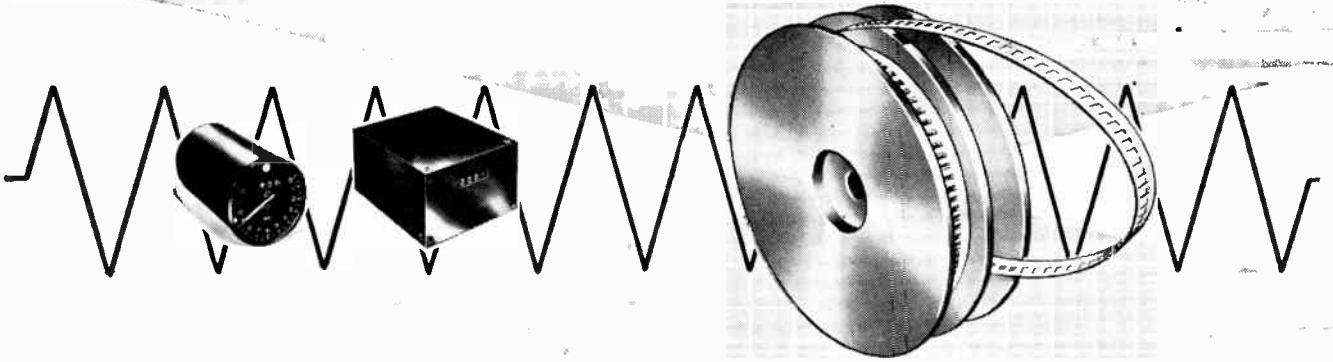
RMC  
Z5U  
005

### FIN-LOCK DISCAPS

Designed for holes from .040 to .052 "Fin-Lock" DISCAPS are automatically stopped in holes over .052 by the shoulder design of the leads. "Fin-Lock" leads permit either automatic or hand assembly. "Fin-Lock" leads are available on all DISCAPS of standard voltages, ratings and spacings at no increase in price.

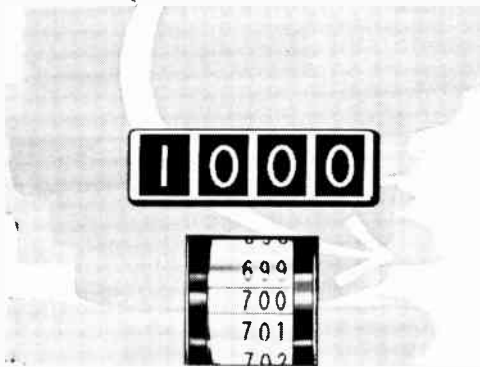
DISCAP CERAMIC CAPACITORS	<i>RMC</i>	<b>RADIO MATERIALS COMPANY</b>
		A DIVISION OF P. R. MALLORY & CO., INC. GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill. Two RMC Plants Devoted Exclusively to Ceramic Capacitors FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

...the instrument with the **TAPE-SLIDEWIRE!**



Why not have  
highest accuracy...

if it costs no more???



The basic accuracy of the Ta'Pot® results from its designed built-in correction for variations in wire diameter, structure or mechanical arrangement. Calibration is simply represented by punched holes in tape (for gearing to an in-line counter) or by printed scale markings on the tape. *B & H Instruments incorporating the Ta'Pot have a normal accuracy of 0.1% and higher accuracy is available.*

The TA'POT® is the fundamental component of these B & H Instruments:  
AUTOTEMP™, AUTOTAK™,  
MILLI-V-METER™,  
JETCAL Analyzer®, TEMPCAL®

For particulars write or telephone  
(EDison 6-7243)...

**NO MANUAL TAPPING or PADDING  
is PERFORMED or NECESSARY.**

**LOW COST and HIGH ACCURACY  
are the SIMPLE and  
NATURAL ATTRIBUTES of the DESIGN!**

**IT CANNOT BE MADE LESS ACCURATE!**

TA'POT is the registered trade mark of Howell Instrument Company



**B & H INSTRUMENT CO., INC.**

3479 West Vickery Blvd., Fort Worth 7, Texas

Sales-Engineering Offices: ATLANTA, GA., COMPTON, CAL., DAYTON, OHIO, VALLEY STREAM, L.I., N. Y., WICHITA, KAN., TORONTO, ONT. (George Kelk Ltd.), MITCHAM, SURREY, ENGLAND (Bryans Aeroequipment Ltd.)

Visit us at Booth #847—ISA Show—Chicago

# West's Growth Speeds Up

Centers sprout as east, west companies open branches in Arizona, Utah, Colorado, New Mexico

SAN FRANCISCO—Wescon won't be the only topic here next week.

Sure to be discussed plenty are four inland western states, Arizona, Utah, Colorado and New Mexico.

Five years ago electronics was almost nonexistent in them. Today it's spreading faster than sagebrush—and far more profitably.

Companies headquartered along the Pacific, and an increasing number of Eastern firms, are locating branch operations in Arizona, Utah, Colorado, and New Mexico.

Climate, living conditions, and recreation facilities have attracted many new firms and technical personnel to the West, as have electronic markets springing up in the West. The chance for association with universities and research

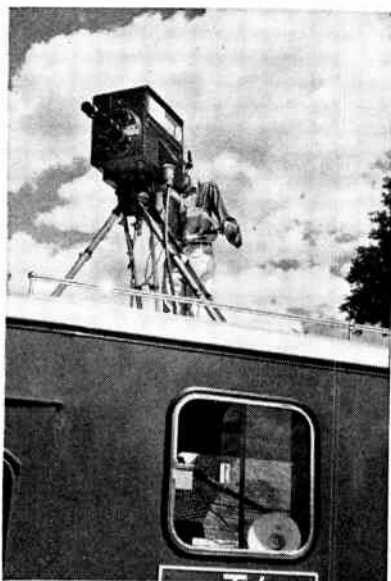
institutes is another attraction.

The Los Angeles-Orange County area continues to be the largest center of electronics in the West with a gross sales volume of \$1.157 billion estimated for 1959. By year's end it is predicted that 84,000 people will be employed.

Second largest center is the San Francisco Bay area with figures slightly less than half those of the southern complex, but with a higher growth rate.

This year's outlook for the Portland-Seattle area is approximately \$70 million in business. Tying for fourth place are the San Diego County and Phoenix-Tucson areas, with an estimated \$62 million each during '59. The greater Denver area is expected to do close to \$42 million.

## Tv Tape Goes Mobile



INDICATION of the growing impact of tv tape on station operations is evident in the attention being paid to mobile tape units.

In the photo, a unit belonging to Giantview Tv, Detroit, is shown. First placed in operation last month, the gear is designed for shooting taped commercials and

features on location. Expected customers include advertisers, tv stations and film producers.

The van-mounted equipment includes an Ampex recorder, four pickup cameras, camera chain equipment plus power supplies and auxiliary gear.

Earlier this year, Ampex equipped a mobile unit for company use containing two camera chains. The gear in this van can be operated while the vehicle is in motion as well as when it is parked. It can also be tied into tv studio facilities for interior recording. The 35-ft van is 10 ft high, 8 ft wide. It weighs about 10 tons loaded.

In the New York area, a double unit has been outfitted by RCA for Termini Video Tape Services. One van contains the recording gear, while a second holds the camera equipment.

Television station WFLA, Tampa, Fla., has expanded its facilities by purchase of a mobile tape unit. A second station, WPST, Miami, has also announced purchase of a unit.

  
**COLUMBUS  
ELECTRONICS  
CORP.**

**DOUBLE  
DIFFUSED  
SILICON  
RECTIFIERS**



Now . . . an extensive line of high performance, hermetically sealed, silicon power rectifiers UP TO 35 AMPS. JEDEC types exceeding MIL specifications.

**NEW**

SINGLE unit VERY HIGH VOLTAGE silicon rectifiers exhibiting these desirable characteristics . . .

**HIGH  
VOLTAGE**  
up to 2000 PIV

**LOW  
FORWARD DROP**  
1.5 Volts, DC

**EXTREMELY  
LOW LEAKAGE**  
1  $\mu$ A

**FORWARD  
CURRENT**  
up to 20 Amps.

**NEW**

INSULATED STUD silicon rectifiers offering these quality features . . .

- Simplify mounting
- Saves assembly parts & costs
- Obtain efficient heat transfer
- Give greater design flexibility

AVAILABLE UP TO 10 AMPS PER UNIT AND UP TO 2000 VOLTS PIV.

WRITE FOR FULL DETAILS

**COLUMBUS ELECTRONICS CORP.**

1010 SAW MILL RIVER RD., YONKERS, N. Y.  
YOnkers 8-1221 • TWX-Yonkers, NY-1369

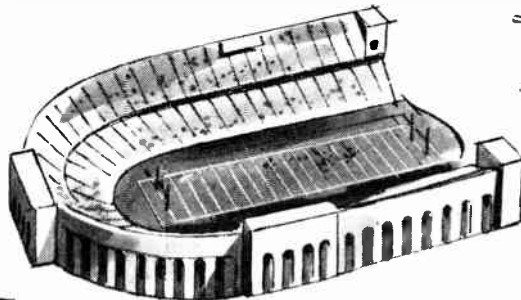
# Magnavox

a leading company



in a wonderful city

## Champaign-Urbana, Illinois



offers unlimited opportunity for  
**Design Engineers**

**Yes, Magnavox is a leading company . . .** not only in television and high fidelity but in the Government and Industrial Division too. Our new modern facilities in Champaign-Urbana, Illinois, represent a young but extremely productive organization. Within 3 months we are expanding over 100%. We can offer digital, communications and packaging design engineers unlimited opportunities with permanent positions on our growing staff.

*"Champaign-Urbana A Fine Place To Live and Work" say Magnavox Engineers . . .*

**Here's why . . .**

Excellent Public School System for Children and Teenagers • Home of the University of Illinois with its Highly Rated Electronics Engineering School, Big Ten Sporting Events, and fine Campus • Minimum Commuting Time from Home to the Office, Low Cost of Living • Magnavox Assistance Toward Advanced Education.

*If you are a Design Engineer in the Digital, Communications or Packaging Fields, please write Mr. D. M. Ormiston today. You'll be glad you did.*

**THE MAGNAVOX COMPANY • URBANA, ILLINOIS**

# A VITAL 100 MINUTES!

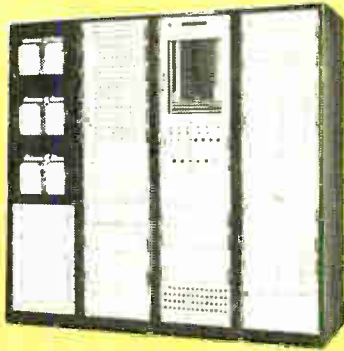
## *Firing Sequencer with 762 CLARE RELAYS gives automatic control*

Automatic control of the countdown at the Air Force's Cape Canaveral Missile Test Center—from X minus 90 minutes to 10 minutes after a missile is fired—is in the hands of a Milgo Model III Sequencer.

The Sequencer, built by Milgo Electronic Corporation, Miami, Fla., automatically controls the myriad operations which must be performed before any missile can be launched. It is preprogrammed to recognize the precise condition that must exist during each of the operations it controls. When any other condition is detected, it will automatically hold fire until the condition is corrected. In a recent instance, it saved a Titan prototype which developed a malfunction after firing but before actual takeoff.

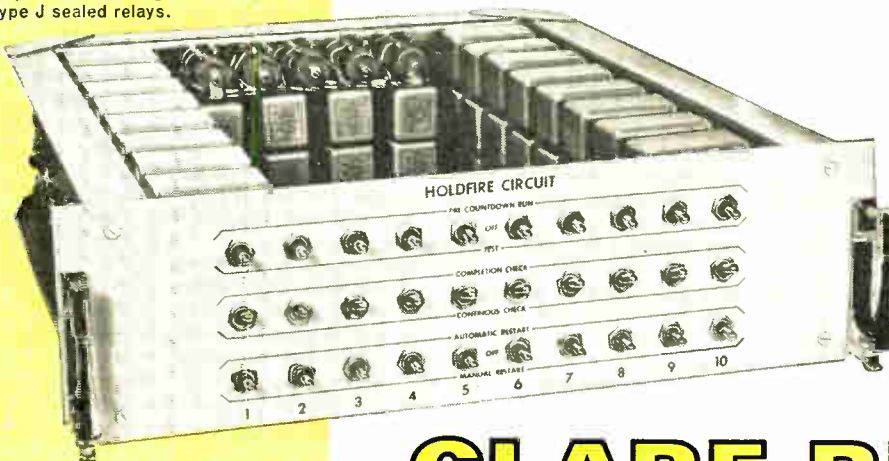
Another of these sequencers is being built by Milgo for installation at the Pacific Missile Range, Vandenberg Air Force Base, Calif.

Milgo engineers selected 762 Clare Type J and Type HG Relays for this supremely important device, and not one has ever malfunctioned. Here is convincing proof that, where the safety of personnel and of valuable equipment is at stake and the utmost accuracy is demanded, a designer who rides with Clare relays can rest assured that he has chosen wisely and well,—not necessarily the cheapest relays but certainly the very best.



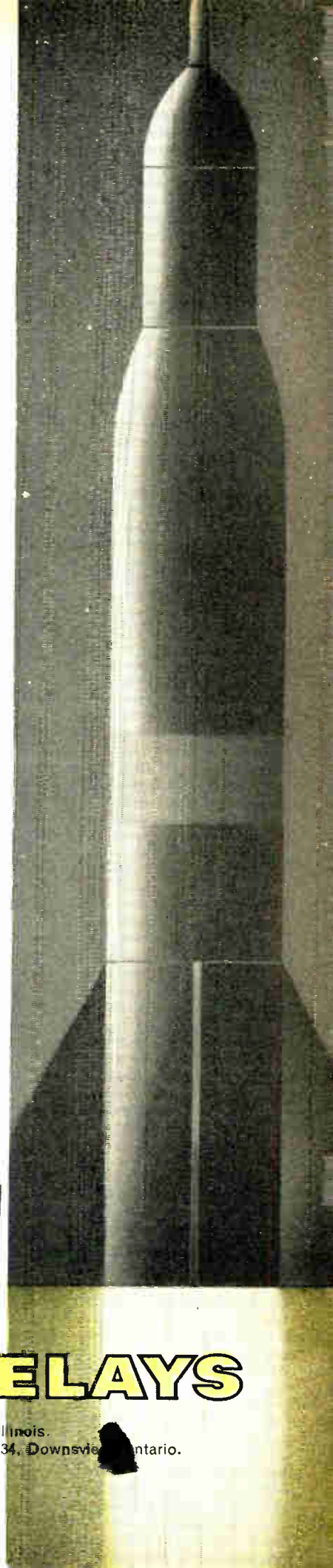
Front view of Model III Sequencer which uses 762 CLARE Type J Relays and 14 CLARE Type HG Relays. Made by Milgo Electronics Co., Miami, Fla.

View of control rack of Model III Sequencer showing 56 CLARE Type J sealed relays.



# CLARE RELAYS

C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois.  
In Canada: C. P. Clare Canada Ltd., P. O. Box 134, Downsview, Ontario.  
Cable Address: CLARELAY



# BIRD

## "Termaline" 50 ohm Coaxial Line LOAD RESISTORS

BIRD "Termaline" Load Resistors are designed to provide a constant impedance of 50 ohm from DC through the useful coaxial frequency range. Each Resistor is intended to simulate an infinite length of 50-ohm line, thus providing an almost reflectionless termination. Low VSWR and freedom from radiation makes the Bird Loads extremely useful during adjustment and testing. Measurements of power are also possible when these Resistors are used as terminations for the appropriate Bird "ThruLine" Directional Wattmeters. Accuracy in RF resistance, rugged ability to absorb power and absence of any need for adjustments has long characterized the Bird "Termaline" Load Resistors. For specifications on standard models see chart below. For other requirements please phone or write. Our long experience in this field may assist you in the solution of your problem.



**MODEL  
888**

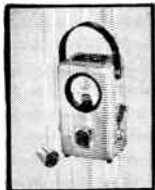
1200  
Watts  
Continuous  
Duty  
1500 Watts  
Intermittent Duty  
2 to 3 KW  
Continuous Duty with  
forced air cooling  
Input connections are  
available to terminate  
most coaxial lines.

Model	Max. Power	Freq. Range	Max. VSWR*	Input Connector
80-M	5 W	0-4 KMC	1.2	Type "N" male
80-F	5 W	0-4 KMC	1.2	Type "N" female
80-CM	5 W	0-4 KMC	1.2	Type "C" male
80-CF	5 W	0-4 KMC	1.2	Type "C" female
80-BNCM	5 W	0-4 KMC	1.2	Type BNC male
80-BNCF	5 W	0-4 KMC	1.2	Type BNC female
80-A	20 W	0-1000 MC	1.1	Type "N" female
81	50 W	0-4 KMC	1.2	Type "N" female
81-B	80 W	0-4 KMC	1.2	Type "N" female
82-A	500 W	0-3.3 KMC	1.2	Coplanar. Adapter to UG-21B/U supplied
82-AU	500 W	0-3.3 KMC	1.2	"LC" Jack mates with UG-154/U plug on RG-17/U cable
82-C	2500 W**	0-3.3 KMC	1.2	Coplanar. Fittings and cable assemblies for flexible and rigid coax lines available

\*VSWR on all models is 1.1 max. from DC to 1000 MC.

\*\*Water cooled

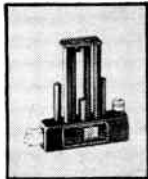
### Other Bird Instruments



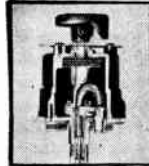
"ThruLine"  
Directional  
RF Wattmeters



"Termaline"  
RF Absorption  
Wattmeters



Coaxial  
RF Filters



Coaxial  
RF Switches



**BIRD ELECTRONIC CORP.**  
CHurchill 8-1200  
30303 Aurora Road, Solon, Ohio  
Western Representative:  
VAN GROOS COMPANY, Woodland Hills, Calif.

## MEETINGS AHEAD

Aug. 17: Ultrasonics, National Symposium, PGUE of IRE, Stanford Univ., Palo Alto, Calif.

Aug. 18-21: Western Electronics Show and Convention, WESCON, Cow Palace, San Francisco.

Aug. 23-26: Electrical Conf. of the Petroleum Industry, AIEE, Wilton Hotel, Long Beach, Calif.

Aug. 23-Sept. 5: British National Radio & Tv Exhibition, British Radio Industry Council, Earls Court, London.

Aug. 24-26: Gas Dynamics Symposium; Plasma Physics, Magnetogasdynamics; American Rocket Society, Northwestern Univ., Evanston, Ill.

Aug. 24-27: Ballistic Missile and Space Technology, USAF, Space Technology Labs, Inc., Los Angeles.

Aug. 31-Sept. 1: Elemental and Compound Semiconductors, Tech. Conf., AIME, Statler Hotel, Boston.

Aug. 31-Sept. 2: Army-Navy Instrumentation Program, Annual Symposium, Douglas Aircraft and Bell Helicopter, Statler-Hilton, Dallas.

Sept. 1-3: Association for Computing Machinery, National Conf., MIT, Cambridge, Mass.

Sept. 3-6: Air Force Association's National Convention, Exhibition Hall, Miami Beach, Fla.

Sept. 14-16: Quantum Electronics, Resonance Phenomenon, Office of Naval Research, Shawanga Lodge, Bloomingburg, N. Y.

Sept. 17-18: Engineering Writing and Speech, Dual National Symposia, PGEWS of IRE, Sheraton-Plaza, Boston and Ambassador, Los Angeles.

Sept. 21-25: Instrument-Automation Conf. & Exhibit, ISA, International Amphitheater, Chicago.

Oct. 12-15: National Electronics Conference, IRE, AIEE, EIA, SMPTE, Sherman Hotel, Chicago.

Mar. 21-24, 1960: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, N. Y. C.

There's more news in ON the MARKET, PLANTS and PEOPLE, and other departments beginning on p 84.

REAL TIME..  
UNIVERSAL BASIS FOR  
DATA CORRELATION

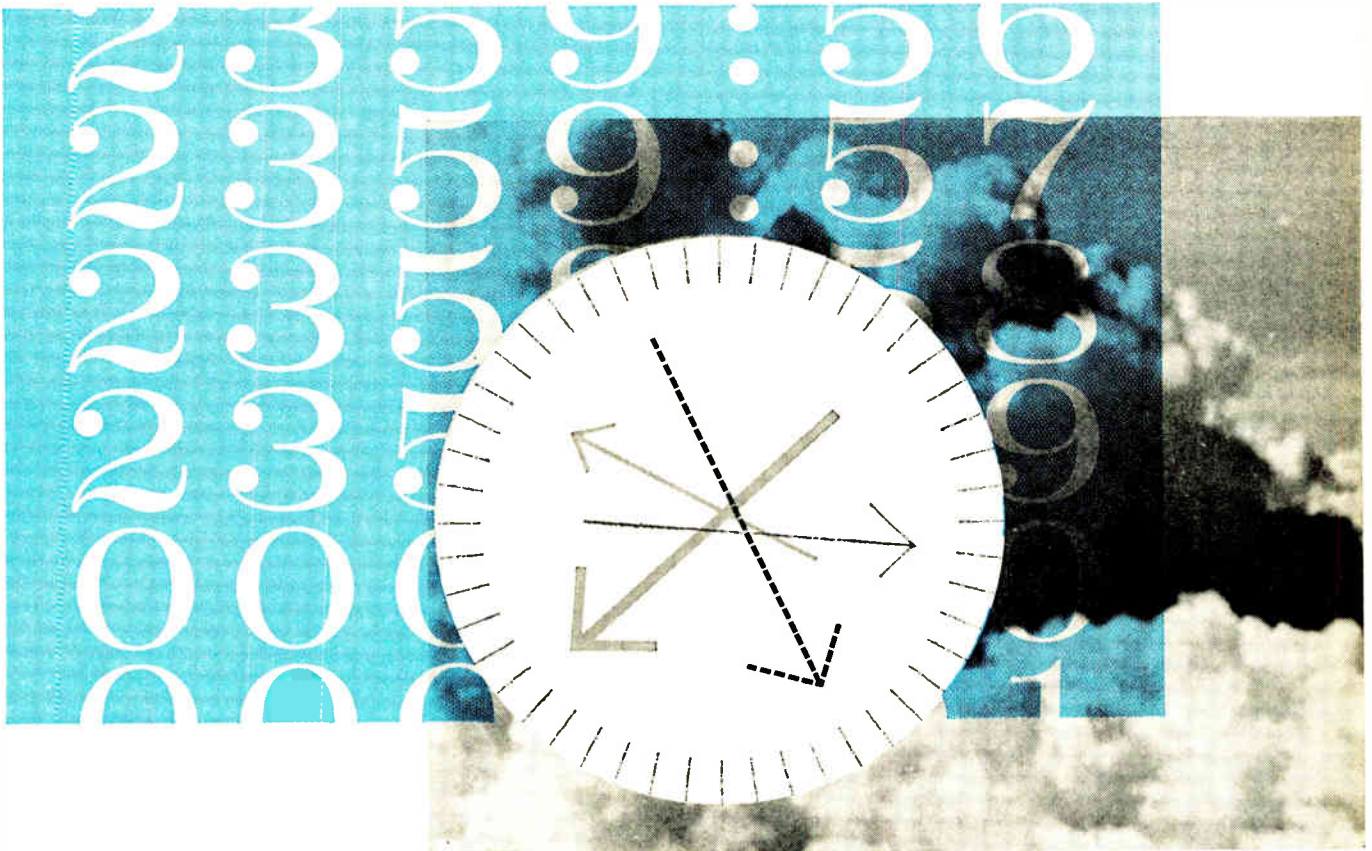
## DIGITAL TIMING SYSTEM

Temco's Digital Timing System is a compact, accurate, airborne device capable of generating real time information for visual display at up to 21 remote indicators, for magnetic tape and graphic recordings, and as a source of coded digital time for master time transmission.

The system will automatically synchronize to a transmitted master time signal and correct for propagation delay time, insuring exact time event relationship of all remote systems. The additional capability to decode a recorded or transmitted signal makes the system complete in itself.

One of Temco's many proprietary products, the Model G-1033 Digital Timing System was developed and manufactured by Temco's Overhaul and Aerosystems Division assisted by Temco Electronics and is now in use on classified military programs.

Many excellent engineering and scientific positions are now open in this and other Temco programs. We invite your inquiry.



TEMCO

OVERHAUL & AEROSYSTEMS

A Division of TEMCO AIRCRAFT CORPORATION • P. O. Box 1056 Greenville, Texas

ANOTHER FIRST FROM PHILCO



PHILCO MADT\*  
TRANSISTORS  
MAKE POSSIBLE THE  
WORLD'S FIRST  
BATTERY-POWERED  
PORTABLE TV



**High Frequency MADTs\***  
for tuner, video IF, sound IF



**Alloy Junction Units**  
for sweep, synchronizing and  
audio stages



**Special MADTs\***  
(with revolutionary Philco cathode ray tube) for display circuits

Television breaks free from the electrical outlet! Philco's sensational new Safari plays *anywhere* without plugging in... and only Philco Transistors make it possible.

Philco Micro Alloy Diffused-base Transistors (MADT\*) for the tuner and IF stages are products of Philco's famous FAT Lines (Fast Automatic Transfer) ... the first automatic transistor production lines in the world. They are the *only* transistors manufactured by mass production methods to meet the exacting standards of performance, uniformity and economy to make transistorized television a practical reality. Their excellent high frequency capabilities provide sensitivity and low noise performance comparable with conventional vacuum tube receivers.

This is another example of Philco's leadership in Transistor engineering and production. To meet *your* transistor requirements, consult Philco first. *For complete information, write Dept. E-859.*

\*Trademark Philco Corp. for Micro Alloy Diffused-base Transistor

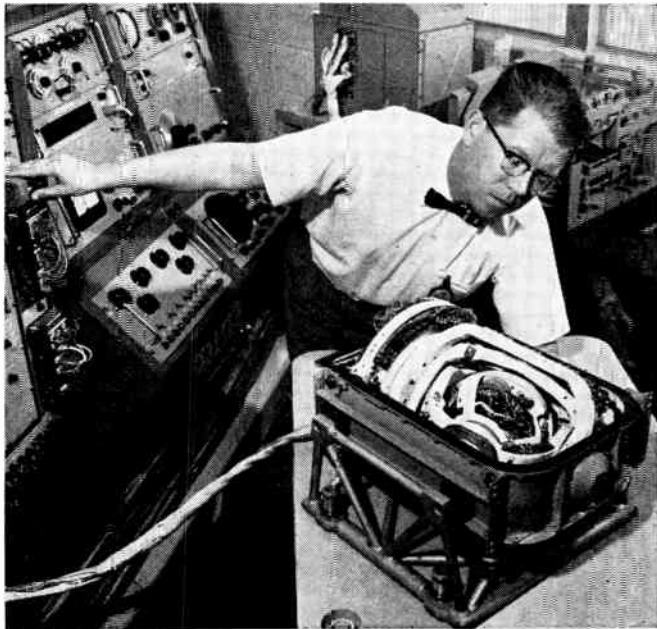


**PHILCO**

LANSDALE TUBE COMPANY DIVISION • LANSDALE, PENNSYLVANIA







X-15 instrument panel showing the inertial speed, rate-of-climb and altimeter indicators (grouped at top right of panel)

Checking out the central assembly of the stable platform

## Guidance Systems in Manned Space Flight

Conventional reference sensors are impractical at the altitudes and velocities of the planned X-15 flight path. The inertial reference system, including the transistorized integrator amplifier with a gain of a quarter of a million, is described.

By **S. T. CAP** and **N. P. WHITE**

Senior Engineer, Engineering Section Head, Sperry Gyroscope Company, Great Neck, N. Y.

MANNED SPACE FLIGHT poses a number of unusual electronics problems. The safe return of the pilot and the X-15 in many ways hinges on the accurate performance of the flight data references. At the altitudes and velocities of the X-15 flight path, conventional reference sensors such as doppler and height radars, machmeters and pressure altimeters are either inaccurate or impractical.

The inertial reference system to be described is completely self-contained requiring no external references or ground links. It consists of a stabilizer,

which incorporates a stable platform, a computer and inertial cockpit instrumentation of unique design.

The cockpit instruments include a total velocity indicator, a rate-of-climb indicator and an altitude indicator all giving inertially-derived information. Attitude information from the stabilizer is repeated on the new standard ball indicator of the Air Force integrated flight instrumentation system.

For flight performance evaluation, these data plus all velocity components are supplied to recorders. Information is recorded with a higher degree of ac-

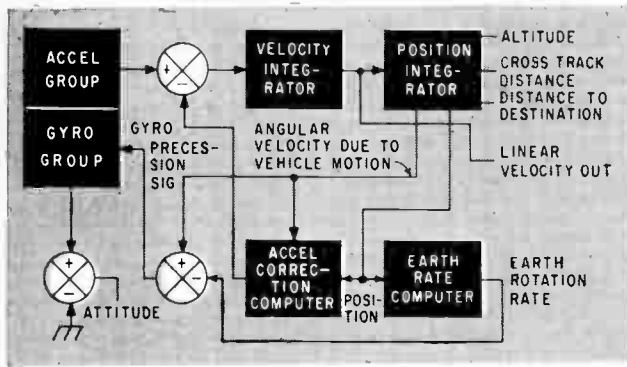


FIG. 1—X-15 inertial system uses two precision accelerometers and two gyroscopes interconnected with precision integrators in a Schuler loop. A third gyro supplies heading reference

curacy than that required for the pilot's display.

In the system shown in Fig. 1, the platform's two precision accelerometers and two gyroscopes are interconnected with precision integrators in a Schuler loop or 84-minute pendulum. This system maintains the vertical direction and provides aircraft velocity outputs. A third gyroscope maintains the heading reference and a third accelerometer provides vertical acceleration information.

**INTEGRATORS.** The integrators are directly involved in the computations of the output velocities and to a lesser extent in maintaining the vertical directional reference. The accuracy of the accelerometers (0.01 percent of reading) must be preserved by accurate integration.

The integrator shown in Fig. 2, consists of a precision d-c tachometer (.002 percent of reading linearity) driven by a 6-watt a-c servomotor which in turn is driven by the integrator amplifier. The amplifier accepts up to eight input signals through a

precision (0.005-percent ratio deviation) network and a low-noise chopper modulator.

All computing components have accuracies approaching that of laboratory standards. The integrator amplifier contributes less than 0.01-percent error to the computations.

The integrator amplifier uses ten silicon transistors and has a gain of a quarter of a million. The schematic of the amplifier is shown in Fig. 3. Emitter-follower isolation stage  $Q_1$  is followed by two grounded-emitter, emitter-follower pairs  $Q_2$  through  $Q_4$ . Gain stage  $Q_5$  and phase inverting driving stage  $Q_6$  and  $Q_7$  are transformer-coupled to power output transistors  $Q_8$  and  $Q_9$ . The output transistors are provided with heat sinks.

High amplifier gain produces some problems. For example, if a spurious signal of only microvolt level were picked up at the input, the amplifier would saturate and be rendered inoperative. To avoid such pickup, the input network is shielded by a Mu-metal can grounded to signal ground and an overall steel can grounded to the power ground. A low-noise

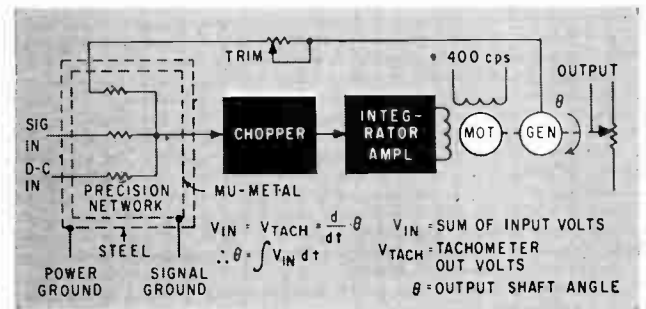


FIG. 2—Precision integrator uses d-c tachometer whose accuracy is 0.002-percent of reading driven by a 6-watt a-c servomotor powered by the integrator amplifier

### Schuler Loop

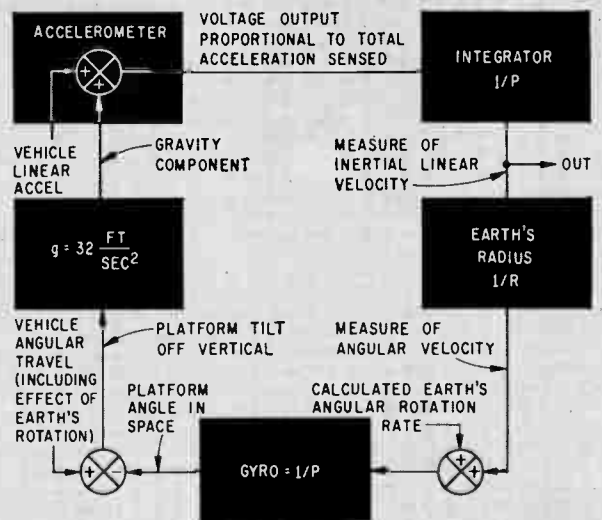
Schuler-tuned pendulum is a term used to describe a system which will maintain a vertical reference direction despite vehicle accelerations with respect to the earth's surface.

In the X-15 inertial reference system, this objective is carried out by precessing the gyros (which determine the platform vertical direction) at an angular rate specified by the integrated accelerometer output. As this rate equals the angular velocity of the vehicle around the earth, the platform vertical direction is thus kept aligned with the true vertical direction.

If an error exists in the pure inertial loop (for example, an erroneous vertical direction or velocity), the error recurs in a cyclic manner with an 84-minute period in the same fashion as a physical pendulum oscillates about the vertical. This gives rise to the name 84-minute pendulum.

The inertial system oscillates when an error is introduced because the gyro-accelerometer combination is a closed feedback loop with two integrations and no damping as illustrated in the attached figure.

The gyro determines the accelerometer angular position and thus contributes to its output since they are both mounted to the same structure. The accelerometer responds to both vehicle acceleration and any gravity acceleration component due to a tilt from the vertical direction.



The period is 84-minutes because the characteristic equation is  $p^2 + g/R = 0$  and the natural period is  $2\pi\sqrt{R/g}$  in seconds

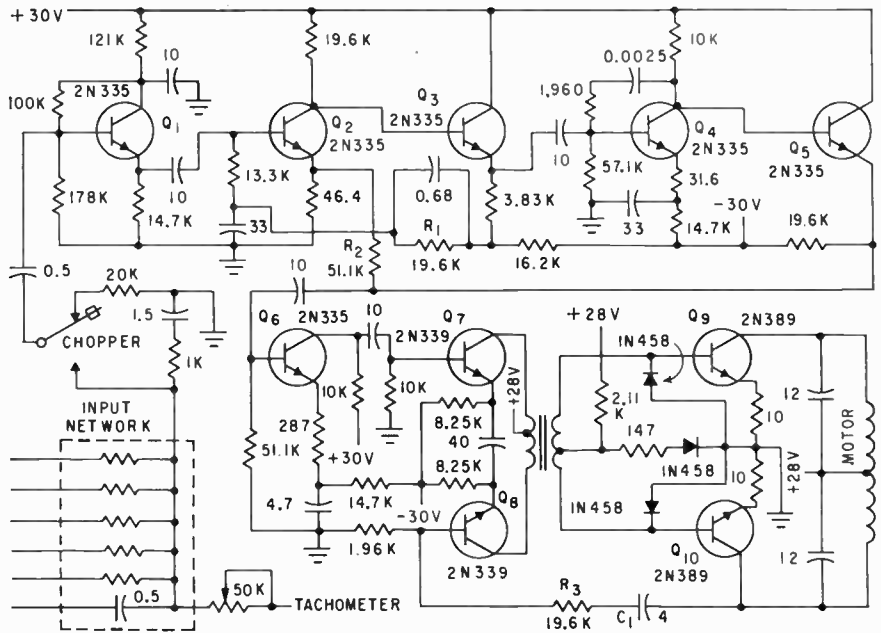


FIG. 3—Integrator amplifier has gain of 250,000 and uses ten silicon transistors in five voltage gain stages

power supply with a ripple of less than 0.01-percent is used.

Transistor bias stabilization is achieved by application of some form of d-c feedback to every

stage. All stages have relatively high-impedance emitter resistors bypassed where required. The gain of  $Q_2$  and  $Q_3$  is kept constant by feedback through  $R_1$ . The gain of  $Q_2$  through  $Q_3$  is stabilized by feedback from  $Q_5$  to  $Q_2$  through  $R_2$ . Feedback through  $R_3$  and  $C_1$  stabilizes the driver-output stage gain. All components are derated at least 2:1. The extremely high loop gain makes the integrator errors due to amplifier gain variation negligible.

**PACKAGING.** Components of the amplifier were the smallest available in the tolerances required. The final assembly containing three integrators is shown in Fig. 4. Although component density is high within the integrator, numerous test points are available.

Components are mounted vertically to conserve space and hand wiring is used throughout, resulting in an amplifier that is appreciably more compact than a printed circuit version. In the final assembly step, a special thermosetting resin was applied to the card assembly forming a high-strength coating that holds the wires and components firmly in place. The completed amplifier is then wired into place on the integrator mechanical assembly to produce the final unitized package.

The amplifiers are only a fraction of the size of the associated electromechanical package so unitized type packaging arrangement is used throughout the entire system. To utilize all available space, amplifiers are designed to fit within the mechanical assemblies. The need for separate space-consuming electronics racks is obviated. Interconnection wiring is at a minimum and many electrical connectors are eliminated. Electrical isolation of computing loops is another feature of this type of packaging.

The authors acknowledge the help of Paul Marcus, designer of the integrator amplifier.

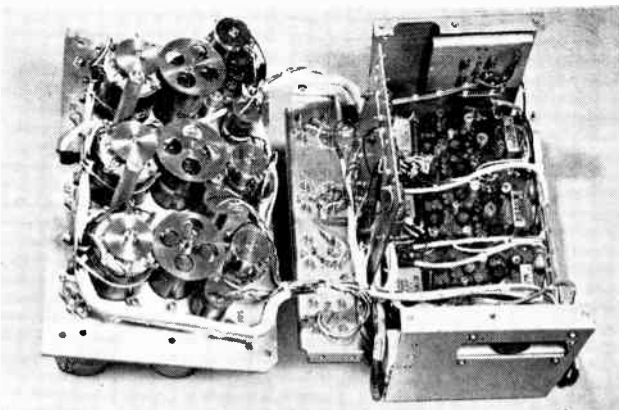
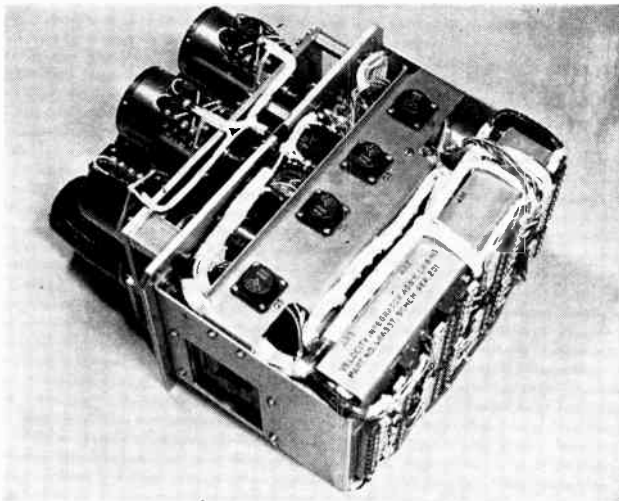


FIG. 4—Assembled integrator package showing wiring arrangement and transistor heat sinks. Three integrators are packaged together

# Feedback Design for

Negative feedback lessens the effects of temperature and transistor variations. For a specified current gain, the design method produces maximum available feedback. Alternatively, the equations and the approach may be used to obtain a specified input impedance

By **THOMAS R. HOFFMAN**, Professor of Electrical Engineering, Union College, Schenectady, New York

**N**EGATIVE FEEDBACK is known to contribute to amplifier stability and to lessen the effects of transistor variations. But the problem of considering all possible parameter variations over a given temperature range is complex and is best attacked with the aid of a fairly good-sized computer.

Since in many cases this procedure is not possible or economical, the usual design objective is to use as much negative feedback as possible and still obtain the re-

quired overall gain. The basic idea is to trade excess gain for stability.

Testing the completed circuit will reveal the extent to which the stability requirements have been met. If the maximum available amount of negative feedback has already been used, and further stability is required, another stage of amplification with feedback may be the solution.

All semiconductor devices, transistors included, are by nature temperature sensitive. Variations of

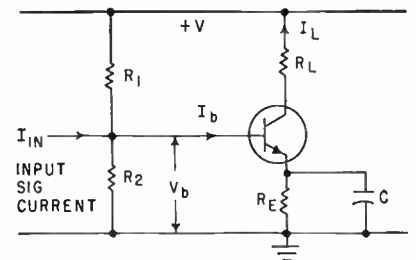


FIG. 1—Typical grounded emitter stage without feedback. The capacitor brings the emitter to a-c signal ground

the operating point also affect performance, often appreciably. The variation of parameters in production lot transistors is well known and again, negative feedback helps to minimize the effects of these variations.

Only the grounded emitter stage is considered here since it is the configuration with the highest gain and is the most often used. Negative feedback may be introduced into a grounded emitter stage by adding an unbypassed emitter resistor ( $R_E$ ) or a feedback resistor ( $R_F$ ) from collector to base. Although it might be thought that the results would be similar regardless of how the feedback was derived, the two cases produce greatly different input impedances. Thus the unbypassed emitter resistor makes possible a substantial increase in input impedance while the addition of feedback resistor  $R_F$  decreases the input impedance. The two cases will be considered separately.

Table I—Formulas for Feedback Amplifier Design

	Unbypassed $R_E$ (Fig. 2 and 3)	Collector to Base $R_F$ (Fig. 4 and 5)
Current Gain	$K_i = \frac{I_L}{I_b}$ $= \frac{R_E + r_e - r_m}{R_E + R_L + r_e + r_e(1 - a)}$ $= \frac{R_E - 2,310,000}{R_E + 197,500}$	$K_i = \frac{I_L}{I_1}$ $= \frac{-aR_F}{R_L + R_F(1 - a + R_L/r_e)}$ $= \frac{-0.925R_F}{0.079R_F + 10,000}$
Input Impedance	$R_i = \frac{V_b}{I_b}$ $= r_b + (r_e + R_E)(1 - K_i)$ $= 300 + (R_E + 20)(1 - K_i)$	$R_i = \frac{V_b}{I_1}$ $= [r_e + r_b(1 - a)](1 - K_i)$ $- \frac{R_L r_b}{r_e} K_i$ $= 12.5 - 43.7 K_i$
Overall Current Gain	$\left  \frac{I_L}{I_S} \right  = \left  K_i \left[ \frac{R_S R_B}{R_i(R_S + R_B) + R_S R_B} \right] \right $	
Overall Voltage Gain	$\left  K_V \right  = \frac{I_L R_L}{E_S} = \left  K_i \left[ \frac{R_L R_B}{R_i(R_S + R_B) + R_S R_B} \right] \right $	

# Transistor Amplifier Stages

Figure 1 shows a conventional arrangement for an *npn* grounded emitter amplifier without feedback. Resistors  $R_1$  and  $R_2$  are chosen in conjunction with  $R_E$  and  $V$  to give the desired d-c emitter current. Capacitor  $C$  bypasses  $R_E$  so that the emitter is grounded for a-c. The quantities of interest are current gain,  $K_i = I_L / I_b$ , and input resistance,  $R_i = V_b / I_{in}$ . Current  $I_b$  is the portion of the input signal current  $I_{in}$  that actually reaches the transistor. Note that the overall current gain  $I_L / I_{in}$  will depend on the division of  $I_{in}$  between the bias resistance ( $R_1$  and  $R_2$  in parallel) and the transistor base lead. If  $K_i$  and  $R_i$  are known, this ratio may be readily determined.

If  $C$  in Fig. 1 is omitted,  $R_E$  be-

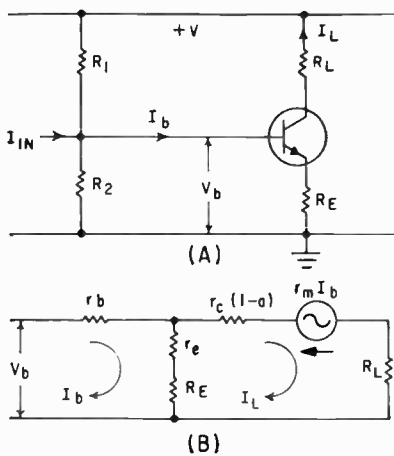


FIG. 2—Removing the emitter bypass capacitor produces negative feedback in transistor stage (A); equivalent circuit for small signals only (B)

comes a factor in the signal behavior of the circuit. This circuit and its a-c equivalent are shown in Fig. 2A and 2B.

The current gain  $K_i$  may be expressed in terms of the device parameters. Input resistance  $R_i$  can be concisely expressed in terms of  $K_i$ . The equations for these two quantities are given in Table I.

Evaluation of the expressions for  $K_i$  and  $R_i$  is generally difficult because of the large number of

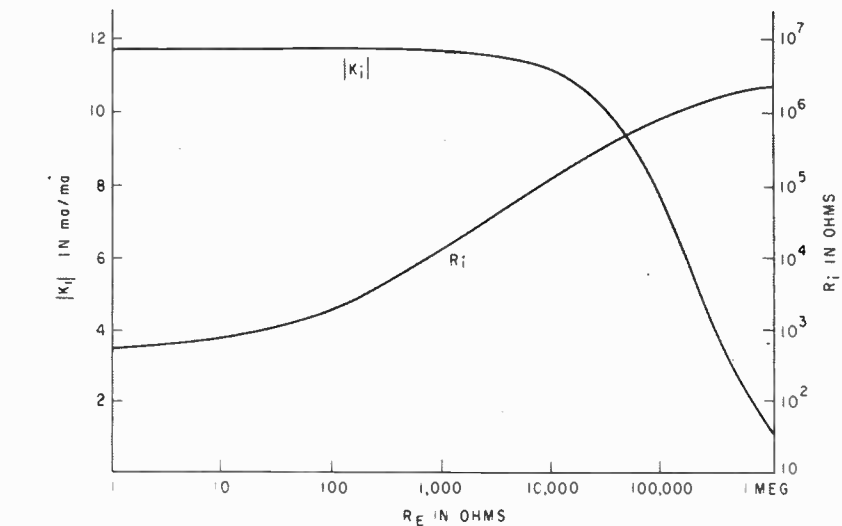


FIG. 3—Current gain  $K_i$  and input impedance  $R_i$  functions for feedback obtained from an unbypassed emitter resistor. Current gain is little affected until  $R_E$  exceeds 10,000 ohms. Curves are for small signals

parameters involved. At this point the designer must substitute average values of parameters for the transistor he plans to use. To illustrate, typical values for a low-level, silicon junction transistor have been chosen:

- $r_b = 300$  ohms
- $r_c = 20$  ohms
- $r_e = 2.5$  megohms
- $\alpha = 0.925$
- $r_m = \alpha r_e = 2.31$  megohms

In addition, it will be assumed that  $R_L$  is 10,000 ohms. This, too, will be a known quantity in a particular design. The expressions for  $K_i$  and  $R_i$  with the above values substituted are included in the table.

Figure 3 is a plot of current gain and input impedance as a function of unbypassed  $R_E$ . Note that  $R_i$  starts to increase almost immediately as  $R_E$  exceeds zero, while  $K_i$  is not affected appreciably until  $R_E$  exceeds 10,000 ohms. From a practical viewpoint, it may be concluded that variation of  $R_E$  over a range that would still permit proper biasing will have no noticeable effect on  $K_i$  but will increase  $R_i$  drastically. However, if the input signal source is anything other than an

ideal constant current generator, increased  $R_i$  will lower the overall current gain by reducing the amount of signal current that reaches the transistor base ter-

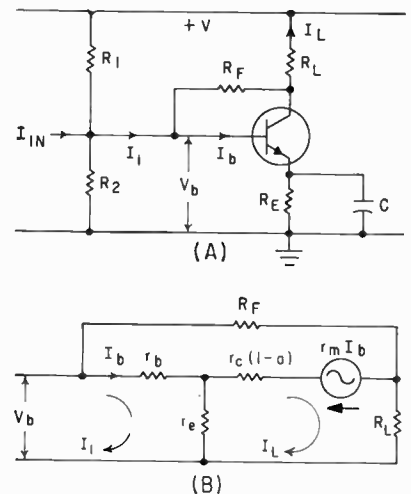


FIG. 4—Negative feedback from collector to base is obtained through resistor  $R_F$  (A). Bypassed  $R_E$  is not effective in small signal a-c equivalent circuit (B)

minimal.

For the transistor used, a 10,000-ohm load resistor is small with respect to  $r_e (1 - \alpha)$ . Current gain  $K_i$  and  $R_i$  are therefore relatively

insensitive to changes in  $R_L$ .

Figure 4A shows the circuit for collector to base feedback and Fig. 4B the equivalent circuit. With the approximation that  $r_e$  and  $r_b$  are much less than  $r_e(1 - a)$ , normally true for transistors of all types, equations for  $K_i$  and  $R_i$  are developed and listed in the table.

be readily obtained from the relationships just presented by including the effect of bias and source impedances. An equivalent circuit which would apply for either feedback arrangement is shown in Fig. 6. The source has been represented by a constant current generator  $I_s$  paralleled by the source impedance

is also obtainable. The source is represented by its Thevenin equivalent (a constant voltage generator  $E_s$  in series with the source impedance  $R_s$ ), and voltage gain can then be expressed in terms of  $R_i$ ,  $K_i$ ,  $R_s$  and  $R_B$  as follows:  $K_v = I_L R_L / E_s = K_i \{R_L R_B / [R_i (R_s + R_B) + R_s R_B]\}$ . Again, this is readily evaluated for any  $R_E$  or  $R_F$  with the aid of the curves.

### Design Examples

Use of the curves is best illustrated by examples. Assume a transistor with the average small-signal parameters of Figs. 3 and 5 is to be used in an application requiring an overall current gain of 8. The source impedance is 10 K, and the bias circuit impedance ( $R_i$  and  $R_B$  in parallel) is 20 K. Load resistance is 10 K.

For unbypassed  $R_E$  feedback, determine  $R_E$  to satisfy the requirement. The overall gain is:  $|I_L / I_s| = |K_i| \{10^4 (2 \times 10^4) / [30,000 R_i + 2 \times 10^4]\} = 8$ . From Fig. 3 it is evident that  $K_i$  is independent of  $R_E$  over a wide range. Thus, assuming  $K_i$  to be 11.7 (the no-feedback value), we may solve for  $R_i$  equal to 2,107 ohms. This requires an  $R_E$  of 122 ohms. (Note that if a d-c  $R_E$  larger than 122 ohms is desired for bias stability, the additional resistance can be bypassed by a capacitor. The 122 ohms represents the value of  $R_B$  that should be effective in the signal circuit.)

For  $R_F$  feedback, determine  $R_F$  to satisfy the requirement. The overall gain is:  $|I_L / I_s| = |K_i| \{2 \times 10^4 / [30,000 R_i + 2 \times 10^4]\} = 8$ . Using Fig. 5, a cut and try method is used. When  $R_F$  equals 400 K, the curve yields a  $K_i$  of 8.88 and an  $R_i$  of 430 ohms, which satisfies the above relationship.

For actual design work, the curves for  $K_i$  and  $R_i$  must be plotted accurately. Furthermore, it must be realized that the curves are for a particular type transistor and normally cannot be used in a design problem requiring other types. In many cases the same curves can be used, with little error, for several types of transistors.

Note that resistance, except for one case, is plotted to a log scale.

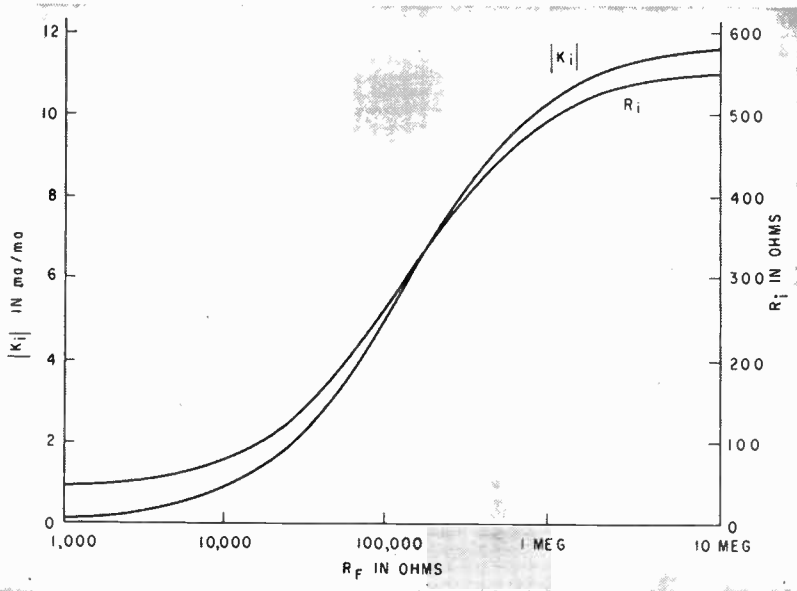


FIG. 5—Current gain  $K_i$  and input impedance  $R_i$  are shown for negative feedback from collector to base via resistor  $R_F$ . The gain and input impedance vary in nearly the same ratio. Curves are for small signals only and should not be extrapolated.

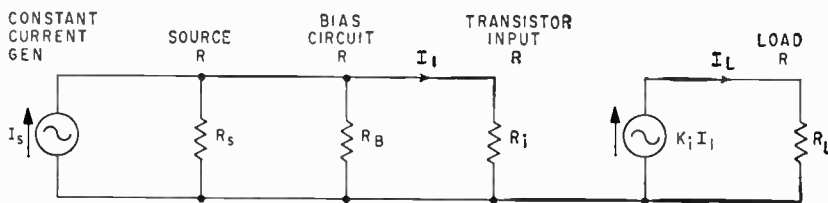


FIG. 6—Equivalent circuit for grounded emitter stage

Presentation of the results of these equations again requires specific values. Using the typical device parameters of the  $R_E$  case, the expressions for  $K_i$  and  $R_i$  are plotted in Fig. 5. Note that  $K_i$  and  $R_i$  vary together in much the same proportion as  $R_F$  decreases. For this case, the magnitude of the load resistance has a greater effect on gain than in the  $R_E$  case.

### Circuit Design

In a practical problem, the parameter of interest is usually the overall current gain. This may

$R_s$ . This representation is perfectly general since any source can be so shown by applying Norton's theorem.

Since  $R_i$  and  $K_i$  are known for any value of the feedback resistor ( $R_E$  or  $R_F$ ), overall current gain can be readily predicted with the help of the curves (Fig. 3 or Fig. 5). The relationship is:  $I_L / I_s = K_i \{R_s R_B / [R_i (R_s + R_B) + R_s R_B]\}$ . The factor in brackets is merely the current division ratio between  $R_i$  and the parallel combination of source and bias resistances.

If desired, overall voltage gain

# Optimizing Antenna Switches and Phasers

Multiple antenna systems for airborne communications equipment are automatically switched or phased for maximum performance rather than simply above a predetermined minimum. Techniques provide signal-to-noise enhancement and increased range without contributing switching transients

By **IRVING DLUGATCH\*** Hoffman Laboratories, Inc., Los Angeles, California

**M**ODERN AIRCRAFT seldom provide ideal single antenna locations. It is difficult to make arrangements in aircraft design specifically to fit requirements of communications antennas. Despite extensive research, development and measurement, it is not possible to provide omnidirectional properties.

The problem has been aggravated by using high frequencies (uhf and vhf). There are often nulls or shadows in some directions, sometimes requiring changes in course to maintain communications.

Two antennas on different parts of the aircraft improve omnidirectional characteristics. Directivity

patterns of the two antennas are chosen to be complementary. However, simple parallel connections would result in interferences, creating a null. Actually, multiple nulls occur so that with two antennas, uhf performance particularly may show little or no improvement. Hence, a means is required to combine signals received from two or more antennas so that signal addition results in the largest possible output signal.

## Phasing and Switching

Two general types of solutions are available—antenna phasing and antenna switching. With antenna phasing, an artificial delay is inserted in series with one antenna so that signal addition will occur. In one scheme, this is accomplished by continually and rapidly varying the phase of one antenna about a mean value to eliminate stationary nulls. In a second type phaser, delay is automatically adjusted until signal level exceeds a predetermined threshold for the equipment, at which point the phaser is locked.

Similarly, a switch may cycle continuously to reduce interference or may be stopped when one antenna provides the desired minimum signal.

These methods are compromises, since a much greater signal-to-noise level might be available if phasing or switching in the automatic types

could be pursued to their optimums. A chopper or wobbler does not eliminate nulls but merely reduces them and, at the same time, reduces average signal. Also, they introduce new interferences from switching transients and modulations. The technique to be described adds to the automatic phaser or switch a means of optimizing selection of switch position or degree of delay by locking equipment at maximum signal level.

In the basic receiving system in Fig. 1, A and B are either switching or phasing elements operated by the control unit. Essentially, this unit is a bistable multivibrator triggered by a clock that alternately turns on one antenna and turns off the other until receiver audio output reaches an amplitude large enough to turn off the clock. In some systems, where transmission is required, the transmitter is connected as shown by the dotted lines. The control unit remembers which antenna the receiver was using, and it switches that radiator to the transmitter.

## Phasing Control

In the phasing control part of the circuit in Fig. 2, output of the pulse generator triggers a stair generator with capacitor  $C_1$  being charged in small steps. Charging can continue as long as  $V_2$  is conducting. When the receiver thresh-

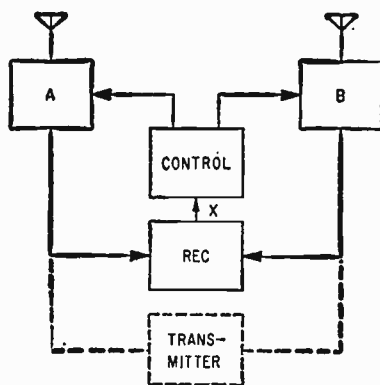


FIG. 1—Control unit switches between antennas or phasing elements until received signal reaches predetermined amplitude

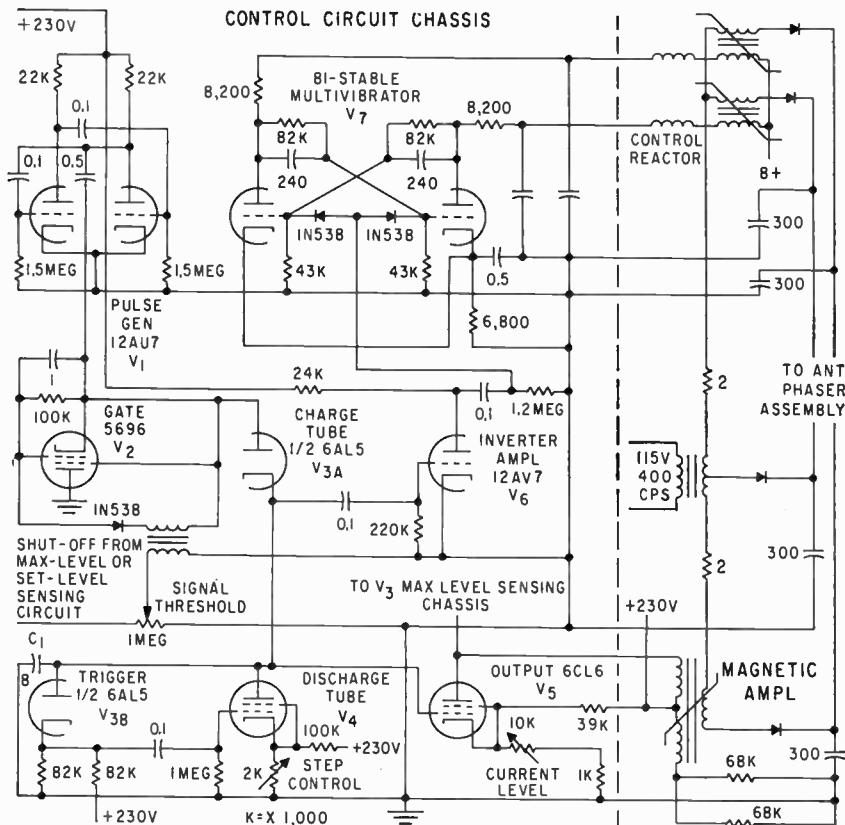


FIG. 2—In complete system, stair generator charges  $C_1$  in steps until receiver threshold cuts off  $V_2$ . Charge on  $C_1$  biases  $V_5$  to change magnetization of reactor and thus changes antenna phasing

hold is exceeded, a bias cuts off  $V_2$ , stopping the process.

Tubes  $V_{3B}$  and  $V_4$  limit the number of steps so that, if a satisfactory signal is not obtained, the count can be started again. At signals too low for reliable communications, the phasing control permits cycling. Capacitor  $C_1$  controls bias on  $V_5$ , which operates a saturable reactor to vary current in the coil used to change magnetization of the ferrite phasing element. When the combined signal from both antennas results in a predetermined minimum signal level, the cycle is stopped. The charge on  $C_1$  remains, resulting in constant output current.

### Sensing Device

A sensing device at point X in Fig. 1 is needed to determine whether phasing could be improved by going to the next increment before releasing the locking pulse, as in Fig. 3. Audio output is switched rapidly between two storage components. Switching is synchronized with the pulse generator

so that each storage is sampling the result of a succeeding increment of antenna phase change. Thus the level of each store is alternately increased toward the signal limit. Before saturation is reached, recycling must occur. While amplitudes are increasing, one storage level will either equal or exceed the other. Should the levels start to decrease, as would occur if the signal passed through a peak, the same storage level would become lower and/or equal to the other, as shown in Fig. 4.

If storage A is in the first switch position and incremental increases are equal, the plot indicates that A leads B during a rising amplitude and lags during the fall. This condition is further stressed by the curve for the difference between A and B.

The phase detector in Fig. 3 senses this change as an indication of a peak and permits the output signal to pass through the gate to the control circuit, where it turns off the control action.

It was assumed that reduction in

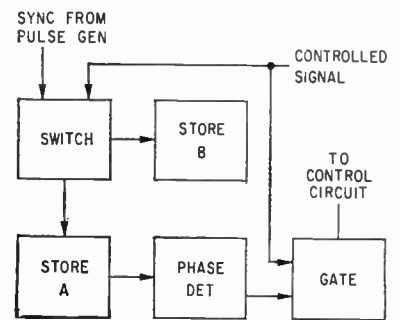


FIG. 3—Switching between two storage units is synchronized with pulse generator to sample result of antenna phase changes

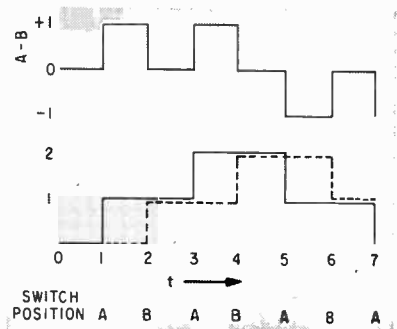


FIG. 4—Storage in A (solid line) and in B (dotted line) show how levels increase until a peak is passed

level would occur with storage A first, but the reverse could be true. For example, when  $t$  equals 4 in Fig. 4, the B level may drop to zero or to unity. In the first case,  $(A - B)$  will exceed the normal value and an amplitude-sensitive device can be added to stop control action.

In the second case, the unit would not detect the optimum position. However, the system can be arranged so that a limited number of steps are used before recycling occurs. If timing is based on an uncompensated, free-running pulse generator, it is unlikely that the effect of a specific step in one cycle would coincide with that of another, particularly since the received signal is varying at the same time. At worst, the phaser would be operating as a wobbler, but servo operation would be restored as quickly as conditions of transmission change.

### Circuit

The circuit in Fig. 5 incorporates this technique. Audio is rectified by  $V_1$ . Capacitor  $C_1$  provides a ref-



erence of average signal value. The d-c obtained alternately charges  $C_2$  and  $C_3$  at the grids of  $V_2$ . Switching is done by  $V_3$ , a bistable multivibrator, and is synchronized with the pulse generator so that each switch position corresponds to a change in antenna phasing.

As  $C_2$  and  $C_3$  are charged, plate currents of  $V_2$  increase following the pattern indicated by Fig. 4. Tube  $V_{1A}$  functions as a phase detector.

With rising signal amplitude, bias on  $V_{1A}$  will be either zero or positive. When the peak is passed and phase reversed, the grid of  $V_{1A}$  goes negative. The grid of  $V_{1B}$  is therefore made positive, closing relay  $K_1$  and permitting the control signal to pass to the control unit. Relay  $K_2$  opens whenever the difference in the potentials of  $C_2$  and  $C_3$  become excessive, forcing the system to either resume or initiate cycling.

A similar system designed for an antenna switch is shown in Fig. 6. An important difference in operation is that at each position of the switch a different antenna is being used. Otherwise, the phase detector

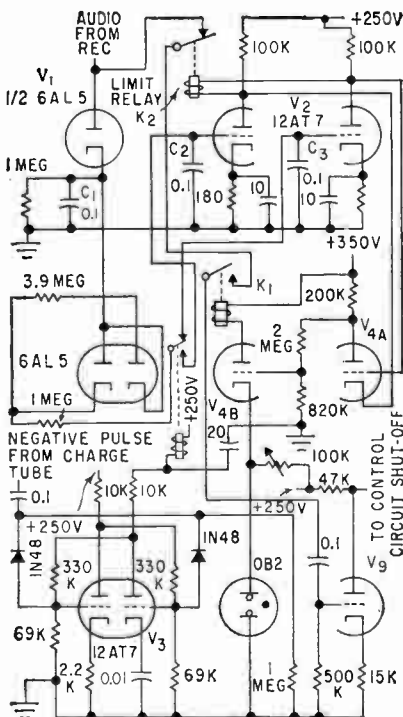


FIG. 5—Rectified audio provides reference voltage which is applied alternately to  $C_2$  and  $C_3$ . When peak is passed, relay  $K_1$  permits signal to pass to control unit

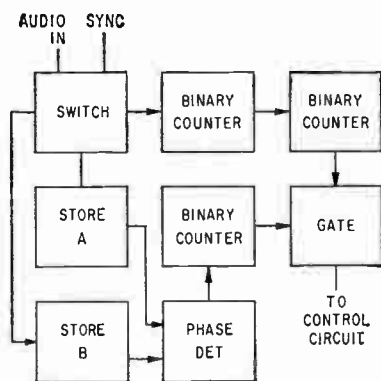


FIG. 6—Antenna switching is accomplished with an arrangement similar to that for antenna phasing

of the sensing unit is essentially the same as that for the phaser.

### Decoding

Details of the decoding method are shown in Fig. 7. When a substantial signal appears on one antenna, one phase detector delivers a pulse to its counter. Two such pulses to the same counter are required to release the control signal to lock the system.

Because each counter is responsive to triggers of one polarity only, it is necessary to have separate phase detectors and counters for each antenna. It is possible that sensing unit sensitivity may not detect a useful signal. To avoid this, the gate is opened on every fourth switch pulse, and, if the preset threshold is exceeded, the system would use antenna  $B$ .

### Performance

The significance of this technique in antenna installations is determined as follows: Assume that amplitudes of signals from each antenna are equal and that either signal alone exceeds the receiver threshold. The control unit without sensing will, in the case of the phaser, lock the system when the phase angle between the two antennas is 120 degrees. At that point, the resultant signal is exactly equal to that of a single antenna. Losses in the system can be ignored since they can be overcome by reducing the phase angle between antennas.

However, with the sensing device, it is possible by optimum phasing to achieve a signal power level twice that of one antenna. This is

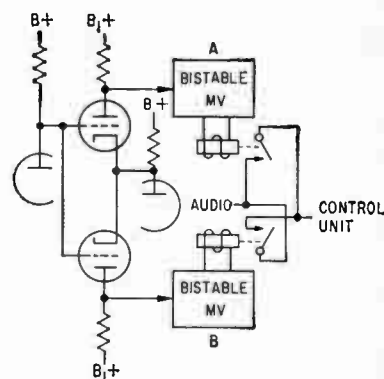


FIG. 7—When a large signal on one antenna sends two pulses to the same counter, a control signal locks the system

equivalent to a 3-db decrease in receiver noise figure or an increase in effective range by a factor of 1.41.

Further, insertion losses of the device for improving the antenna system are often such that it is essential to achieve optimum phasing for any improvement over a single antenna.

### Switch Advantage

The advantage of the sensing unit with an antenna switch is less obvious. An increase in signal will accrue but is less likely to be in the order of 3 db. The advantage lies in reducing the possibility of locking on a reflection or other undesirable signal. A direct, good-quality signal is more likely to be of greater amplitude than one damaged by propagation delays or distortions. In this sense, an immeasurable noise figure improvement is obtained. Also, switch insertion losses will be compensated by obtaining a larger signal.

Finally, the sensing unit permits replacement of choppers and wobblers in many systems. These types reduce signal power substantially, offsetting benefits of multiple antennas. In addition, they introduce modulations that interfere with signal intelligibility.

A disadvantage of the sensing circuit is its basically slow response. However, a switching time of one second was satisfactory with many types of navigation and communication equipments.

The work described was performed under contracts AF33 (616)-5122 and AF33(600)-32378 for WADC.

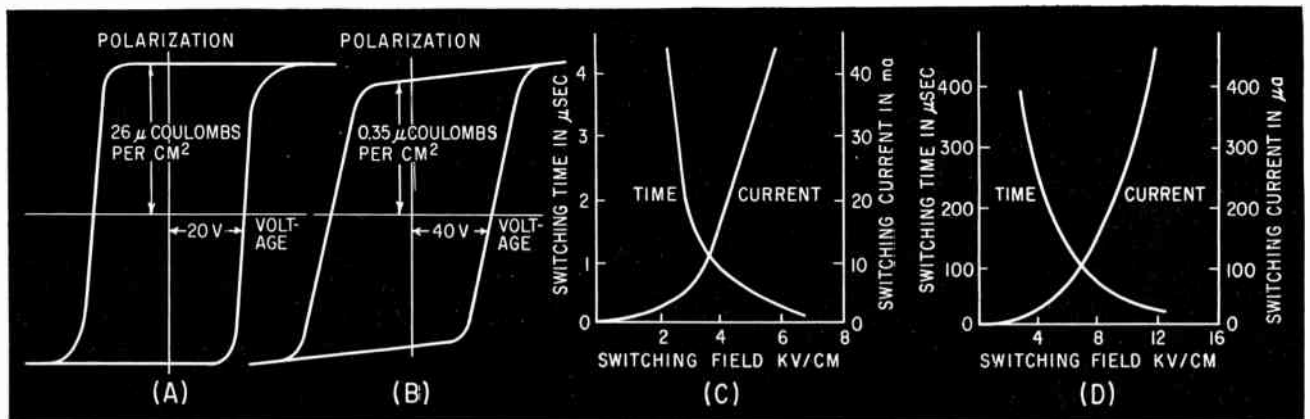


FIG. 1—Charts show hysteresis loops of 0.2-mm thick crystals of barium titanate (A) and guanidine aluminum sulphate hexahydrate (B). Graphs (C) and (D) respectively indicate switching current and switching time for single crystals of each

# Ferroelectric Crystals for Switching Applications

Characteristics of nonlinear ferroelectric single crystals indicate they may be used for information storage devices of small size and low power consumption as well as for transducers and phonograph pickups

By **M. PRUTTON**, Research and Design Division, Electronics Branch, International Computers and Tabulators, Ltd., Stevenage, England

**FERROELECTRIC SINGLE CRYSTALS** show a hysteresis between their polarization and the electric field strength applied to them, analogous to ferromagnetic materials. They can be polarized completely in one direction and then reversed by a pulse of suitable length. Generally, they possess square hysteresis loops.

**COMPUTER USES**—Their nonlinear behavior and sometimes high dielectric constants have already led to some applications as high permittivity materials.

Anderson describes a shifting register constructed with barium titanate crystals which can operate at rates up to 2,000 pulses per second with 12-volt output pulses. Such a system may be attractive because of its very small size and low power consumption. However, speeds over 100,000 pulses per second are not likely to be obtained with presently known materials.

Barium titanate is also used in its ceramic form for transducers. Rochelle salt is widely used in crystal phonograph pickups.

**CRYSTAL PROPERTIES**—Physical properties of single crystals of some ferroelectric materials are given in Table I. Coercivity and switching speed are functions of crystal thickness and applied field strength as noted. The values tabulated are approximate and are intended only as a guide. The hysteresis loops of two well-known crystals, barium titanate and guanidine aluminum sulphate hexahydrate are shown in Fig. 1A and 1B, respectively.

**SWITCHING PROCESS**—The switching process in all of these materials is given by an exponential relation between switching time  $t_s$ , peak current  $i_s$ , and applied pulse field  $E$ . Thus,  $i_s = i_0 e^{-a/E}$  and  $t_s = t_0 e^{a/E}$ .

In these equations,  $e$  is the exponential of mathematics. The quantities  $i_0$  and  $t_0$  express the switching current and time for an infinitely large field  $E$ . The quantity  $a$  is called the activation field.

There is not sufficient data available to tabulate  $i_0$ ,  $t_0$ , and  $a$ . Crystal material, its thickness and electrode area determine the magnitude of  $i_0$  and  $t_0$ . Typical values for crystals 0.2 mm thick are: guanidine aluminum sulphate hexahydrate,  $i_0$  of 15 ma/cm<sup>2</sup> and  $t_0$  of 10  $\mu$ sec; barium titanate,  $i_0$  of 2 amp/cm<sup>2</sup> and  $t_0$  of 0.4  $\mu$ sec. Generally,  $a$  is of the order of thousands of volts per centimeter.

Plots of the exponential reversal characteristic are shown for typical crystals of these materials in Fig. 1C and 1D.

The exponential switching behavior renders the crystals unsuitable for the direct use of half-voltage matrix selection techniques for digital computer storage. It means that there is no threshold field below which the crystals will not switch.

**PRODUCTION**—All of these materials are soluble in water except for barium titanate, which is soluble

in hydrochloric acid. They can be grown in large single crystal plates or bars weighing from a quarter-pound to four pounds. Barium titanate is grown from a melt, usually as triangular plates about one cm on a side and one mm thick.

The production problems associated with such materials are not severe, as demonstrated by the techniques already well-established for manufacturing Rochelle salt piezoelectric phonograph pickups.

#### BIBLIOGRAPHY

- W. Kanzig, *Ferroelectrics and Antiferroelectrics*, "Solid State Physics," 4, Academic Press Inc., New York, 1957.  
 P. Forsbergh, Jr., *Ferroelectrics*, "Das Handbuch der Physik," 18, Julius Springer, Berlin, 1956.  
 M. Prutton, *Ferroelectrics and Computer Storage* *J Brit IRE*, 19, p 93, 1959.  
 C. F. Pulvari, *Ferroelectrics and Their Memory Applications*, *IRE Trans Comp Parts*, CP-3 p 3, 1956.  
 J. R. Anderson, *A New Type of Ferroelectric Shift Register*, *IRE Trans Electronic Computers*, p 184, Dec., 1956.  
 A. N. Holden, W. J. Merz, J. P. Remeika and J. P. Matthias, *The Properties of Guanidine Aluminum Sulphate Hexahydrate and Its Isomorphs*, *Phys Rev*, 101, p 962, 1956.  
 B. Matthias, J. Miller and J. P. Remeika, *The Ferroelectricity of Glycine Sulphate*, *Phys Rev*, 104, p 849, 1956.

**Table I—Nine Ferroelectric Crystals and Some of Their Physical Properties**

Material	Chemical Formula	Crystal Group	Refractive Indices	Curie Temp (deg K)	$P_{sat}^a$ (microcoulombs/cm)	$H_c^b$ @ 50 cps (kv/cm)	Switching Speed <sup>b</sup> ( $\mu$ sec)	Dielectric Constant <sup>c</sup>
Rochelle Salt	NaKC <sub>4</sub> H <sub>4</sub> O <sub>6</sub> • 4H <sub>2</sub> O	monoclinic	1.49	255 296	0.25 (0 C)	0.1	100	500
Barium Titanate	BaTiO <sub>3</sub>	tetragonal	about 2.4	393	26	1	1	5,000
Guanidine Aluminum Sulphate Hexahydrate	CNH(NH <sub>2</sub> ) <sub>2</sub> AlH(SO <sub>4</sub> ) <sub>2</sub> • 6H <sub>2</sub> O	trigonal	1.45 1.54	about 573	0.35	2	40	6
Guanidine Gallium Sulphate Hexahydrate	CNH(NH <sub>2</sub> ) <sub>2</sub> GaH(SO <sub>4</sub> ) <sub>2</sub> • 6H <sub>2</sub> O	trigonal	.....	about 573	0.36	4	60	6
Potassium Dihydrogen Phosphate	KH <sub>2</sub> PO <sub>4</sub>	orthorhombic	1.47 1.51	123	4.5 (110 K)	6	.....	1,500 (75 K)
Potassium Dihydrogen Arsenate	KH <sub>2</sub> AsO <sub>4</sub>	orthorhombic	1.52 1.57	92	5 (80 K)	about 2.5	.....	...
Triglycine Sulphate	(CH <sub>2</sub> NH <sub>2</sub> COOH) <sub>3</sub> •H <sub>2</sub> SO <sub>4</sub>	monoclinic	.....	320	2.2	0.22	5	...
Lithium Ammonium Tartrate	LiNH <sub>4</sub> C <sub>4</sub> H <sub>4</sub> O <sub>6</sub> •H <sub>2</sub> O	monoclinic	.....	95	0.22 (80 K)	.....	.....	8
Potassium Niobate	KNbO <sub>3</sub>	tetragonal	.....	693	about 26	.....	.....	700

(a) Saturation polarization, taken at room temperature if Curie temperature is well above room temperature. Other temperatures used are indicated (b) Coercivity and switching speed ( $t_s$ ) given are approximate values for crystals 0.2 mm thick and fields of 10 kc/cm (c) Highest value of the dielectric constant is quoted

# Transistorized Horizontal

New horizontal-deflection and high-voltage circuits are designed around only two transistors. Circuits are stable and efficient

By **MARTIN FISCHMAN**, Sylvania Research Laboratories, Bayside, New York

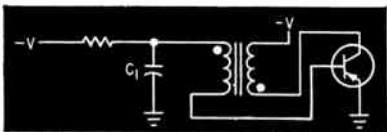


FIG. 1—Conventional transistor blocking oscillator

**E**FFICIENT AND STABLE, the 90-deg horizontal-deflection circuit and high-voltage generator that will be described uses only two transistors and a diode.

## Blocking Oscillator

Before getting into the actual circuit design, a brief description of the operation of conventional transistor blocking oscillators will be given. Figure 1 shows that the blocking oscillator transformer provides regenerative feedback from the collector to the base of the transistor as soon as current starts to flow. The gain and feedback of the circuit cause the current to build up so that the transistor operates in the saturation region of its characteristic. In this region the collector current is substantially independent of the base current. Due to the absence of gain in the circuit under these operating conditions the transistor voltages remain practically in an equilibrium state for a period of time. This voltage-equilibrium state corresponds to the turned-on period or pulse width of the blocking oscillator. The equilibrium condition continues until the transistor operating point moves out of the saturation region into a nonsaturation region. A regenerative process then begins which rapidly turns off the transistor. Termination of the equi-

librium condition may come about as a result of an increasing collector current, a decreasing base current or a combination of both; the cause depends on the relative values of capacitor  $C_1$ , transformer inductance and external resistive loading—if any exists. In this type of operation the pulse width is influenced by transistor characteristics, circuit loading, transformer characteristics and operating voltages.

An improved blocking oscillator circuit in which the pulse duration is accurately controlled by the transient response of a series  $L$ - $C$  circuit is shown in Fig. 2A. Figure

2B shows the transient current and voltage waveforms of a series  $L$ - $C$  circuit driven from a step voltage source. Current through the circuit is a damped sine wave oscillating about the zero current axis. Voltage across the capacitor is a damped cosine wave oscillating about the value of the step input voltage. The duration of the first half cycle of the sine wave is to a first approximation dependent solely on the  $L$ - $C$  values.

The base circuit of Fig. 2A has a similar oscillatory response for the first half cycle. A step voltage provided by the base winding of the

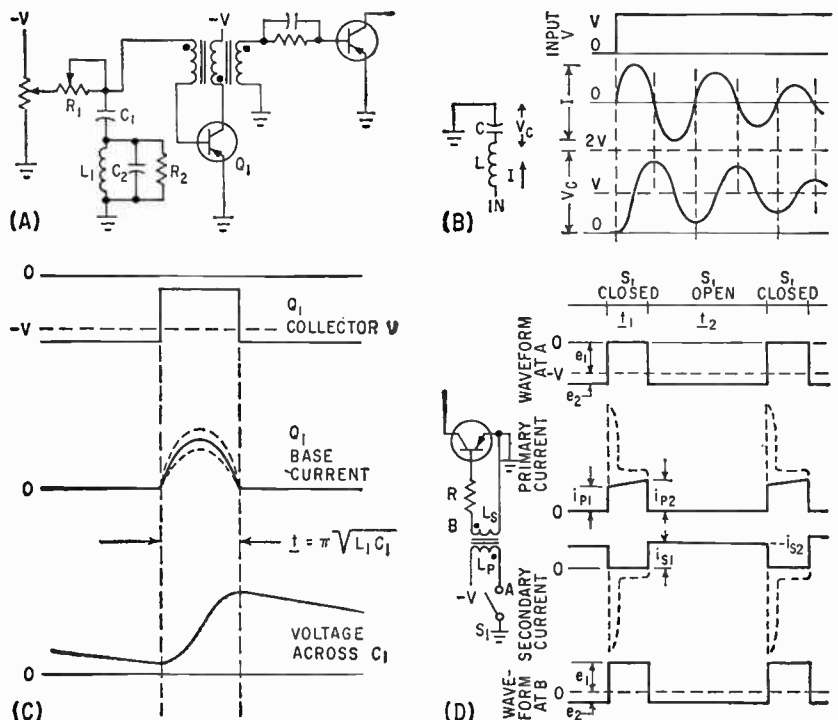


FIG. 2—Basic improved blocking-oscillator and driver (A). Equivalent series  $L$ - $C$  circuit and its transient response to step input (B). Blocking-oscillator waveforms (C). Idealized waveforms of driver (D)

# Deflection for Television

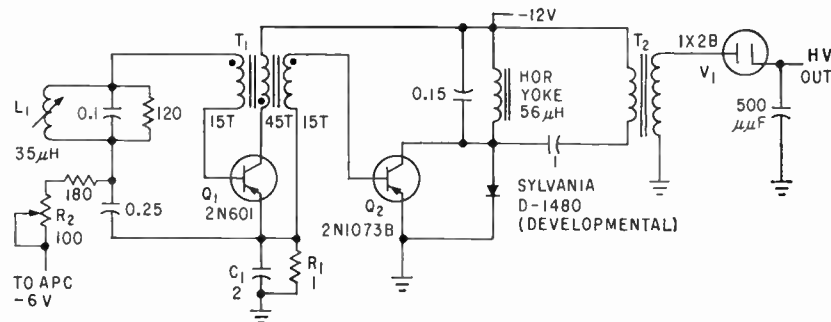
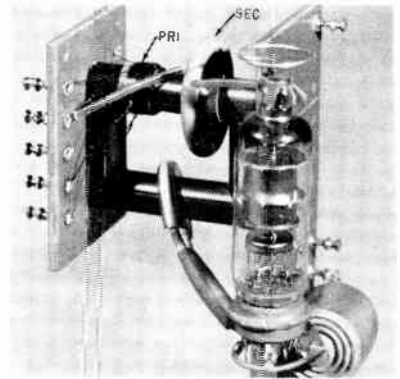


FIG. 3—Horizontal-deflection and high-voltage circuits. In typical operation, oscillator current is 0.12 amp, output-stage current 0.72 amp and p-p yoke current is 11 amp



Spacing between the high-voltage-transformer primary and secondary is about  $\frac{1}{4}$  in.

transformer drives the series circuit consisting of  $L_1, C_1$  and the low base resistance of the forward-biased base-emitter diode. During the first half cycle of oscillation the transistor is operated in the saturation region; thus the collector current is independent of the base current drive for practically all of the base-current waveform. When the base current goes through zero after the first half cycle of oscillation, the transistor falls out of saturation and a regenerative turn-off process begins.

The base-emitter diode is now reverse biased and oscillation of the  $L-C$  circuit terminates. Capacitor  $C_1$  remains charged with the proper polarity to maintain the transistor cut-off. Idealized waveforms at various points in the circuit of Fig. 2A are shown in Fig. 2C. The base-current waveform of Fig. 2C shows that the critical crossing of the zero current intercept in the base circuit occurs after a time,  $t$ , equal to  $\pi\sqrt{L_1C_1}$ , and is practically independent of the peak current amplitude. Due to storage effects a reverse current flows for a short interval before the transistor is turned off.

The frequency, or repetition rate, of the oscillator is determined mainly by the time constant  $C_1R_1$  and the voltage to which  $R_1$  is connected. Capacitor  $C_2$  provides a high frequency by-pass across  $L_1$ , thereby increasing the initial rate

of rise of base current during the edges or regenerative intervals of the pulse. Resistor  $R_2$  provides damping of the  $L_1, C_2$  parallel-resonant circuit.

## Driver Operation

The base-emitter diode of the output stage requires forward-current drive during the scan interval and reverse drive during the retrace interval. A simplified diagram of the circuit that accomplishes this is shown in Fig. 2D. Switch  $S_1$  is closed during the retrace interval,  $t_1$ , and open during the scan interval  $t_2$ . After steady-state conditions have been established the waveforms across the similar windings  $L_p$  and  $L_s$  have zero average values over a complete cycle; thus  $e_1t_1 \approx e_2t_2$ .

During interval  $t_2$ , forward-drive current approximately equal to  $e_2/R$  flows in the base of the output stage. Resistor  $R$  represents the total series resistance in the base circuit. Time constant  $L_s/R$  is assumed to be large in comparison to  $t_2$ . During interval  $t_2$ , energy is dissipated in the resistive elements. This energy of approximately  $e_2I_2t_2$  is replaced during retrace interval  $t_1$  by energy from the power supply equal to  $e_1I_1t_1$ ;  $I_1$  and  $I_2$  are average values of the currents during the intervals  $t_1$  and  $t_2$  respectively. The energy replaced by the power supply during  $t_1$  is stored in inductance  $L_p$ . The energy level at

the beginning of the interval  $t_1$ ,  $L_p(i_{p1})^2/2$ , is increased to  $L_p(i_{p2})^2/2$  at the end of  $t_1$ . Upon opening switch  $S_1$ , the energy is transferred from the primary to the secondary circuit. During the next scan interval,  $t_2$ , energy level  $L_s(i_{s1})^2/2$  is reduced a small amount to  $L_s(i_{s2})^2/2$ . The energy reduction is equal to the energy dissipated in the resistive elements in the secondary circuit during  $t_2$ .

Efficient output-stage operation requires rapid turn-off of the transistor at the end of the forward-drive interval. In order to accomplish this the ratio of reverse to forward drive current must be large. The ratio of reverse voltage to forward voltage across  $L_s$  is equal to  $t_2/t_1$ . If it is assumed that the forward and reverse base resistances are equal, the ratio of initial reverse base current to forward base current will be approximately equal to  $t_2/t_1$ . It is desirable for this ratio to be larger and means for increasing it will be discussed below. Secondary and primary currents flow simultaneously during the reverse-drive interval, during the reverse-drive interval, in which secondary and primary currents flow alternately. The dashed lines of Fig. 2D show idealized waveforms of the relatively large-amplitude, short-duration drive pulses that flow in the circuits during the initial part of the retrace interval. Throughout the

**Table 1—Transformer Design Data**

Blocking-Osc Transformer		
Winding	Turns	Inductance in millihenries
Collector	45	4.5
Output	15	0.5
Base	15	0.5

Wire: No. 30 Formvar  
Core: Allen-Bradley No. 1,620-160A Ferrite WO-3

High-V Transformer		
Pri.: 20 t No. 28 Formvar; single layer, close wound		
Sec.: 2,200 t No. 38 Bondeze-2, pie-wound		

Core: Allen-Bradley No. 1,620-160B, Ferrite WO-3

above discussion a transformer ratio of 1 to 1 has been assumed. In the actual circuit a different ratio is used in order to match the driver and output-base circuits.

To obtain an efficient, fast turn-off of the output transistor the forward base drive at the end of the scan interval should be just enough to maintain the transistor in saturation. This operating condition produces a minimum of stored base charge and reduces the reverse base-driving power requirement.

As previously mentioned, it is desirable to provide a high ratio of reverse to forward base drive. In Fig. 3, which shows the actual circuits developed, the circuit of  $R_1C_1$  helps to accomplish this condition. This  $RC$  circuit also tends to reduce the steady reverse base-emitter current of  $Q_2$  that normally flows when operating the emitter junction of  $Q_2$  in the breakdown region. This current reduction decreases blocking-oscillator input power since less average power flows during reverse drive. Breakdown current is reduced because of the voltage drop across  $R_1$  produced by the oscillator's collector current. Capacitor  $C_1$  provides by-pass action during the initial interval of reverse base current flow when the stored base charge is swept out.

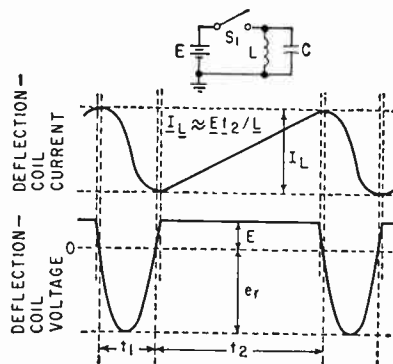
Blocking-oscillator transformers usually require damping after turn-off to prevent a large oscillatory voltage from appearing across the windings and retriggering the oscillator after a half cycle of

the output wave. An efficient method of damping may be effected by a diode and series resistor placed across one of the transformer windings. In the circuit of Fig. 3 the emitter diode of transistor  $Q_2$  damps the transformer when it is driven in the forward direction. If the blocking oscillator is to operate properly the emitter diode of the output stage must always be connected.

Automatic phase control of the oscillator may be obtained by connecting a control voltage to variable resistor  $R_2$ . The frequency sensitivity at this point is approximately one kc/v.

### Deflection System

A basic energy-recovery deflection circuit is shown in Fig. 4. This circuit consists of a voltage source  $E$ , a low-loss bi-directional switch and a deflection inductor shunted by a capacitor. Switch  $S_1$  is periodically closed during the scanning interval and opened during the retrace interval. During the scanning interval the deflection current



**FIG. 4—Waveforms for equivalent deflection circuit indicate energy-recovery process**

builds up at a rate  $di/dt \approx E/L$ . The switch opens during retrace interval  $t_1$  ( $t_1 = \pi\sqrt{LC}$ ) and the inductor current starting at its maximum value oscillates as a cosine wave for a half cycle, thus reversing its original polarity. In the low-loss case the reversed current that flows back into the power supply approaches the value of the previous forward current with the result that the net power taken from the supply approaches zero. Inductor voltage and current wave-

forms shown in Fig. 4 are for ideal conditions.

### Peak Transistor Voltage

For a given retrace time and waveform, the peak collector voltage is determined solely by the power supply voltage. In the simplified circuit of Fig. 4 the average value of the voltage across the pure inductance  $L$  is zero over the cycle. It follows that the product  $E \times t_2$  is approximately equal to the product of the average voltage during  $t_1$  multiplied by  $t_1$ . Since the average value of the sine-wave retrace voltage over the interval  $t_1$  is  $e_r \times 2/\pi$  the ratio of peak retrace voltage to supply voltage is

$$e_r \approx \frac{t_2}{t_1} \times \frac{\pi}{2}$$

Supply voltage  $E$  appears across the transistor in addition to the retrace voltage. The ratio of peak collector-emitter voltage to supply voltage is therefore

$$\frac{e_r + E}{E} \approx \frac{t_2}{t_1} \times \frac{\pi}{2} + 1$$

For a given supply voltage the retrace interval is adjusted to be of long enough duration to limit the transistor collector voltage to its maximum safe value.

Additional factors to be considered in determining the retrace time are:

1. The ratio of peak retrace voltage to supply voltage may be reduced in the case of non-sinusoidal retrace voltage waveforms. The harmonic waveforms introduced by a combined high voltage and scanner arrangement may reduce the above ratio by about 20 percent.

2. Allowance should be made for the reverse base voltage pulse during retrace. The peak reverse collector-to-base voltage depends on the type of drive circuit employed.

3. Some allowance is required for possible low-frequency operation during oscillator frequency adjustments and for out-of-sync operation due to other causes. A reasonable estimate for increased collector voltage due to low-frequency operation might be about 5 to 10 percent.

4. Power-supply variations above the nominal voltage result in pro-

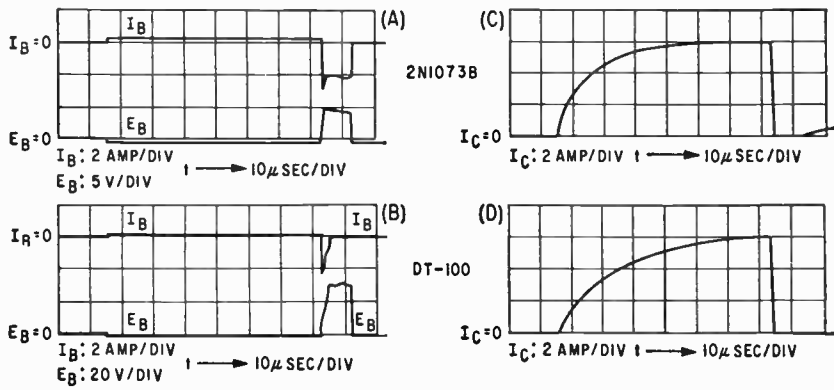


FIG. 5—Reverse base current in the 2N1073B flows during a positive pulse into its base (A) but in the DT-100, reverse current stops shortly after a positive base pulse appears

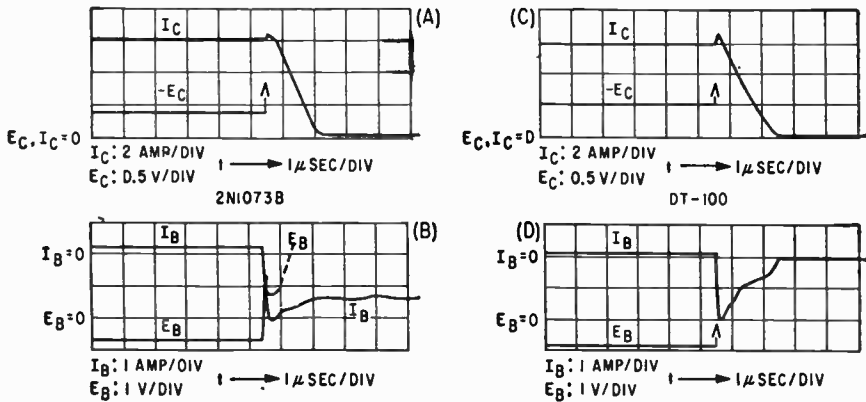


FIG. 6—For the 2N1073B, a reverse base current of 2 amp turns off a collector current of 6 amp in about 1.5  $\mu$ sec. Waveshapes obtained with test circuits, as were waves of Fig. 5

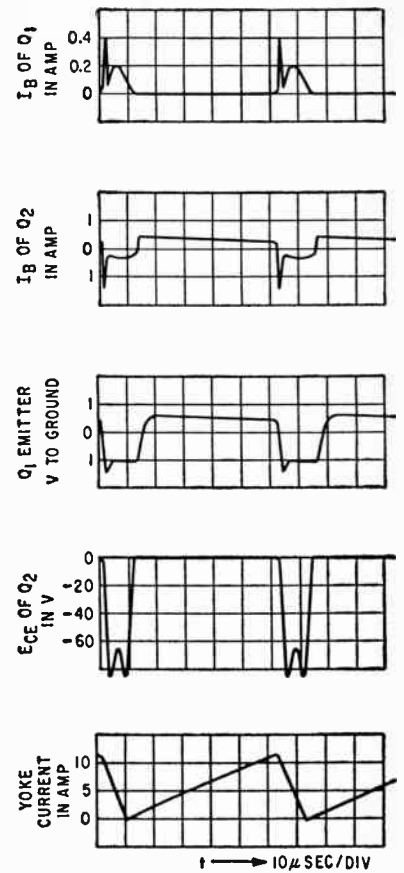


FIG. 7—These operating waveforms for the circuit of Fig. 3 are drawn to a common time scale

portionate increases in peak collector voltage.

The above considerations lead to a retrace time of not less than 12  $\mu$ sec for a single transistor output stage having a maximum collector rating of 120 v and using a nominal 12-v supply.

### Deflection and High Voltage

As mentioned previously, efficient operation of the output stage requires fast turn-off of collector current. This can be accomplished with alloy power transistors such as the DT-100 by providing large peak reverse drive current. However, as the voltage drop across the emitter junction during sweep-out of the base charge is considerable, large peak power is required from the driver stage. The diffused-alloy power transistor 2N1073B has the advantage of a much smaller voltage drop across the emitter junction during reverse current flow. Therefore, the required peak driving power is much reduced. To achieve the desired collector cur-

rent cut-off time the 2N1073B is driven into the region of emitter-junction breakdown.

Some test-circuit comparisons (with resistive load) of the 2N1073B and DT-100 power transistors are shown in Fig. 5 and 6. Fig. 5A and B show the difference in emitter junction voltage drop for similar reverse current between the two transistors. As indicated by Fig. 5C and 5D, forward-base drive performances are similar. Figure 6 compares transistor responses during reverse drive.

Waveforms at various points in the oscillator-driver and output circuit are shown in Fig. 7 for typical operating conditions.

The deflection yoke is a Sickles

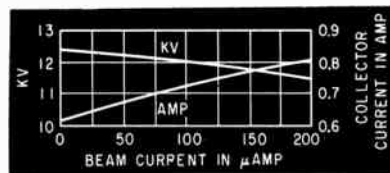


FIG. 8—Regulation of high-voltage output

17496-11 90-deg model with an inductance of 56  $\mu$ h. The yoke drives a ST2587A (Sylvania) 9/8-in.-neck tube. A step-up transformer with a turns ratio of 110 to 1 is driven from the deflection circuit and provides sufficient fly-back voltage for tube  $V_1$  of Fig. 3. Leakage inductance of the secondary of transformer  $T_2$  is adjusted by varying the lateral spacing between primary and secondary. This adjustment, which is normally about  $\frac{1}{4}$  in, increases secondary voltage peaking, reduces peak collector and yoke voltages. Transformer data is given in Table 1.

Figure 8 shows the high-voltage rectifier output as a function of beam current.

Future improvements of reduced retrace time and less input power may be expected when power transistors having higher voltage-breakdown ratings and improved switching characteristics become available.

### REFERENCE

- (1) A. D. Blumlein, U. S. Patent No. 2,063,025, Dec. 8, 1936.

# Computer Switching With

Here are the general considerations that influence computer designers in their choice of electromechanical or electronic types of switches

By **G. L. LaPORTE** and **R. A. MARCOTTE**,

Product Engineers, International Business Machines Corp., Essex Junction, Vermont

**SEMICONDUCTOR DEVICES** are not direct replacements for relays. They require supporting components in the logic package or switch. Economic justification for a point-by-point replacement of relays can only be found in such system requirements as speed, capacity and size.

In the low-and medium-power ranges, the normal applications of electronic and electromechanical switches overlap as shown in Table I, giving the designer a choice. Some of the considerations which influence the computer designer are generalized in Table II.

Examples of transistor logic circuits and a conventional relay OR circuit are given in Fig. 1. Each input of the complementary transistor resistor logic circuit (CTRL) or the complementary transistor diode logic circuit (CTDL) could be a relay point. But this is expensive because each leg requires a control device, losing the benefit of multipoint relays. Each input could be controlled by a transistor. However, the CTRL or CTDL make possible multiple input circuits utilizing either resistors or diodes and only one transistor.

Figure 2 is a transistor bilateral transfer circuit,

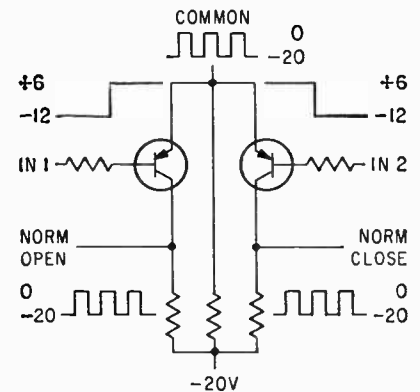
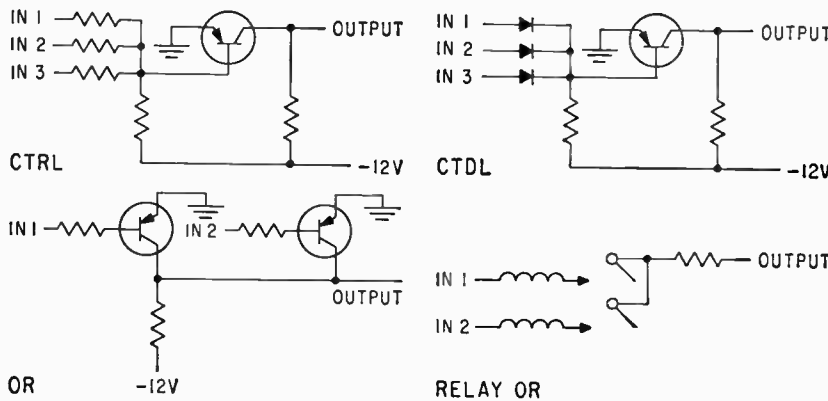


FIG. 1—Examples of basic building blocks for computer logic systems

FIG. 2—Transistor bilateral transfer circuit

Table I—Normal Applications of Electronic and Electromechanical Switches

Vacuum Tubes	Crystal Diodes	Transistors					Photo Diode	Heavy-Duty Diode
		Point Contact	Diffused Junction	Alloy Junction	Photo	Thyratron		
Electronic								
High Frequency Pulse Control	Low Level Switching	Intermediate Switching Low Power	Intermediate Switching Medium Power	Intermediate Switching Low Power	Intermediate Switching Medium Power	Low Frequency High Power Control		
Electromechanical								
Special-Purpose Relay	Polarized Relay	Photo Switch	Thermal Switch	General-Purpose Relay	Heavy-Duty Relay	Contactors		



# Semiconductors and Relays

performing the same function as a relay transfer contact. Its two bilateral transistors have comparable majority carrier efficiencies at either junction. The circuit is shown at 0 to -20 v levels, but can operate between any levels within the rating of the transistor.

Complementary inputs are required for the two transistors, therefore a bistable device such as a

trigger or inverter is required for this circuit. A single bistable device could drive as many as 25 sets of transfer circuits. Not considering the actuating device, about 20  $\frac{1}{2}$ -w resistors and eight bilateral transistors would be required to replace a four-position transfer relay. The relay actuating device would have fewer components than the transistor actuator.

**Table II—Desirable Computer Switch Characteristics and Characteristics of Semiconductors and Relays**

Characteristic	Semiconductor Devices	Electromechanical Relays
Bistability	bistable <i>on-off</i> device	bistable <i>on-off</i> device
Low resistance in either ON state	few ohms for transistors, around 10 kilohms for photoconductors	short circuit (1 ohm or less)
Infinite resistance in OFF states	many megohms for transistors, around 100 kilohms for photoconductors	infinite
Bidirectional for flexible polarity	unidirectional (bidirectional operation requires 2 or more in circuit)	inherently bidirectional
Flexible in speed of operation	10 milliseconds to a few millimicroseconds, higher speeds are feasible	250 <sup>+</sup> microseconds or slower
Low input power	low power required	reasonable power, adds appreciable inductance to circuit
Long life, reliability	unit life over 10,000 hr including shelf life, 1-1.5 failures per 10 <sup>7</sup> hr operation (total units in system)	average life 10 <sup>4</sup> to 3×10 <sup>8</sup> contact operations, indefinite storage life, 1 failure in 4×10 <sup>9</sup> contact operations
Resistance to environments	performance affected by temperature and radiation	contacts may bounce due to shock, reasonably independent of heat and radiation
Design flexibility and restrictions	adds circuit flexibility, amplification, volume; single point, complicates power source, limited reverse voltage, transients may cause damage, needs more supporting components	single point or single control of multiple points, variety of configurations available, actuating coil introduces transients
Control versatility	control may be electrical pulse, magnetic field, thermal, light	control may be pulse, magnetic field, thermal; operation visible in some types
Range of current and load breaking capacities	relatively limited except in association with higher power devices, capacity affects operate time, excellent at low levels of current and load	can carry and break moderate and large loads, large loads restrict speed, contact materials and pressures restrict use in dry circuit (very low level) operation
No contact bounce or chatter	no contacts to bounce, but internal noise must be considered in some applications	bounce or chatter inherent in most types, especially during shock and vibration
Easy to mount	mounts in any position, suited to automatic assembly, may require heat dissipation, precaution during soldering	printed circuit, chassis and frame-mounting styles (depending on size), some require upright mounting
Small size	very small size, but size partially offset by added circuit complexity	small per point in multipoint relays, but relatively large in low-point numbers
Low cost	relatively high per point, cost must be justified by design requirements	low cost, multipoint relays can be made for 15¢ to 30¢ per point
Availability	standard types readily available, but many still in development	readily available, manufacturing experience in general longer than for semiconductors

# Dynamic Testing of

Development of high-speed digital computer building blocks requires pulse sources that closely approximate the desired input to the units. The pulse source must be variable in frequency to remain useful as the search for higher operating speed progresses

By **ROSS W. BUCHANAN** and **BRUCE KAUTZ**, Staff Research Engineers, Denver Research Institute, University of Denver, Denver, Colo.

**D**YNAMIC TESTING of multiinput AND gates is expedited using the mega-pulse generator shown in the photograph. This device provides up to 18-mc pulses and can be used as a clocking system. A novel blocking oscillator allows synchronizing the generator with a HP212A pulse generator, or its equivalent, to obtain gating functions.

The generator was developed to provide a pulse source for testing the design of high-speed adders and gating circuits of various types. The gating provided at the generator's output allows testing circuits for 1st and  $n$ th pulse response as well as 50-percent duty cycle.

## General Technique

This gated mega-pulse generator is based on a technique of overdriving a cathode follower with a sinusoidal signal and using grid cutoff for base clipping and diodes for peak clipping. The usable frequency range of the pulser is up to 18 mc.

The unit generates only positive pulses at each of its four outputs. These outputs are developed by four identical cathode followers. Output pulse amplitude is continuously variable between 0 and 20 v. A gating system incorporated in each of the four channels gives up to a 10- $\mu$ sec burst of pulses or a 0- to 10- $\mu$ sec blank in a string of pulses when gated by the HP212A pulse generator.

Direct synchronization with the external pulse source is secured from the mega-pulser control oscil-

lator by use of a novel blocking oscillator technique.

## Control Oscillator

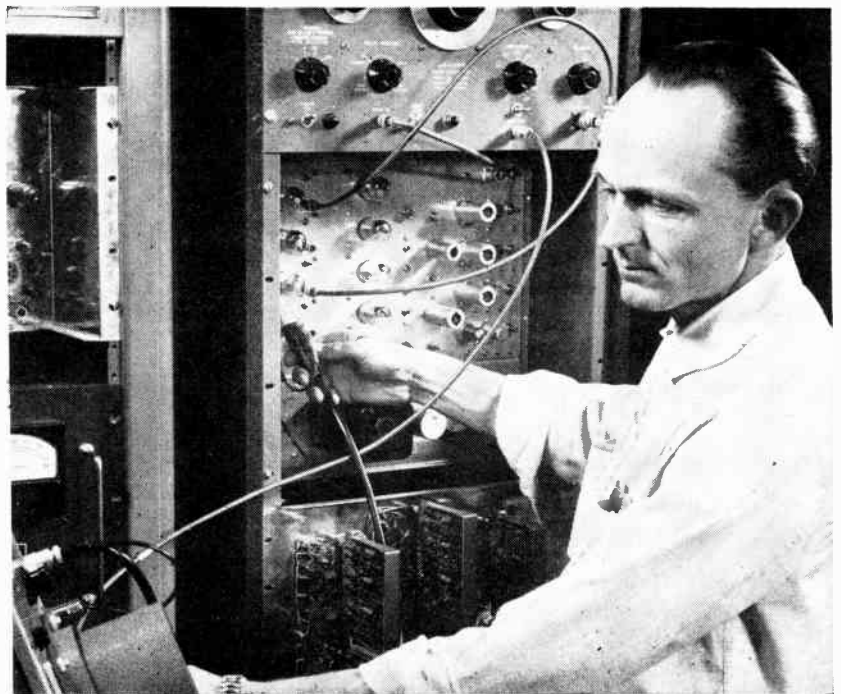
The pulser control oscillator is a basic self-biased Hartley type as shown in Fig. 1. Plug-in coils,  $L_1$ , are used for major frequency changes while minor adjustments are made with  $C_1$ . The amplitude of the oscillator is controlled by varying  $R_2$  to adjust the plate voltage of  $V_1$ . Pulse width is controlled by  $R_3$  which sets the bias level on the cathode-follower drivers.

By adjusting  $R_2$  in combination

with  $R_3$ , it is possible to adequately control the output pulse width and rise time. The rise time is a function of the oscillator since the system is degenerative from that point on.

Separate drivers are used for each of the four channels to prevent any coupling between channels. Resistors  $R_4$ ,  $R_5$ ,  $R_6$ , and  $R_7$  prevent h-f oscillation in the cathode-follower stages. The output of cathode-follower driver  $V_7$  is developed across  $R_8$ . This cathode must, in addition, drive pulldown resistor  $R_9$ .

Diodes  $D_1$  and  $D_2$  prevent the



One of the authors uses mega-pulse generator to test 10-mc dynamic logic units

# Computer Building Blocks

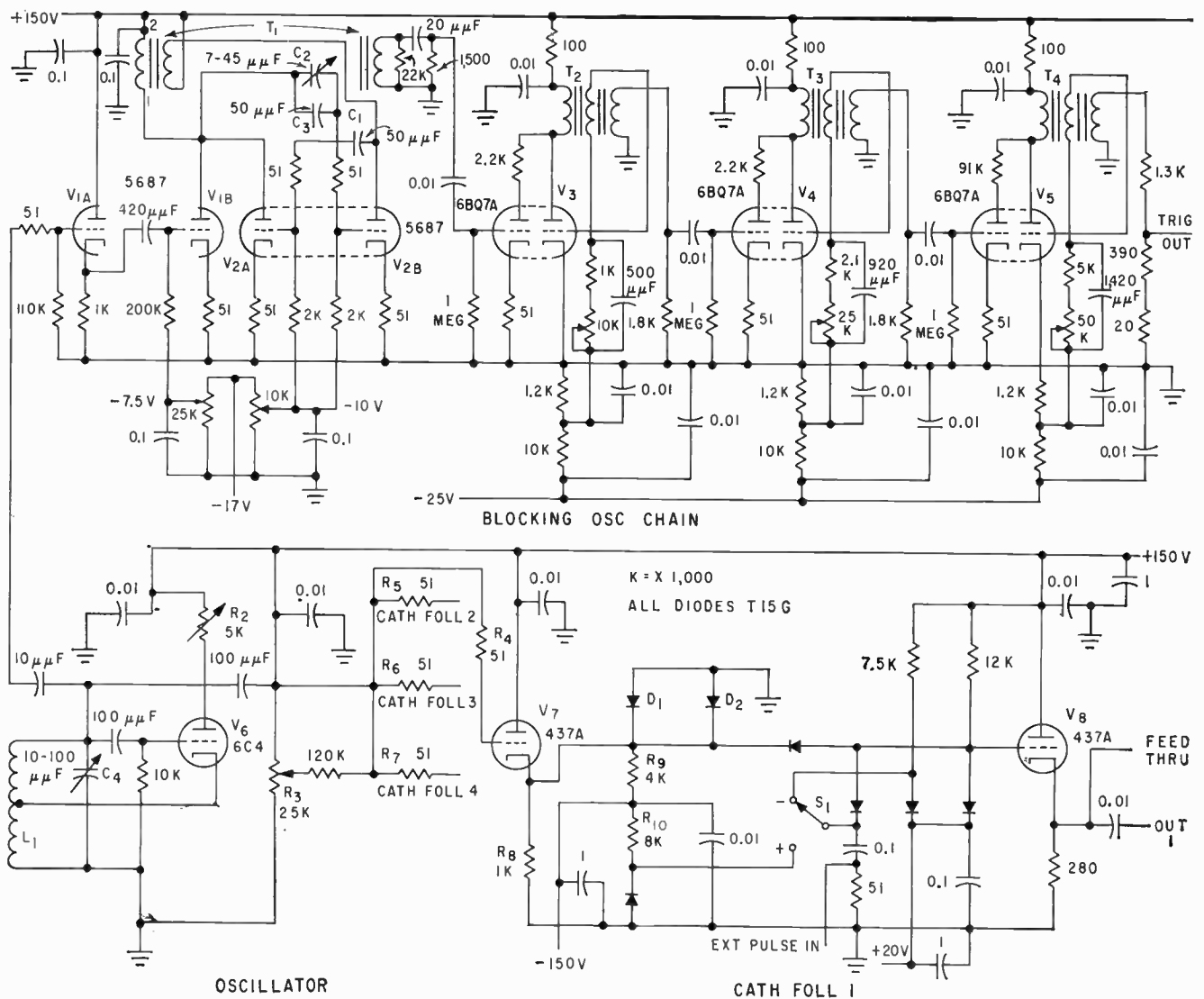


FIG. 1—Use of separate channel drivers prevents amplitude modulation of channels by eliminating coupling between channels

cathode of  $V_7$  from being pulled below ground. This technique is used to discharge the capacitance at the output of  $V_7$ .

## Switching

Cathode follower  $V_7$  drives one input of a two-input AND gate directly. The other input is driven by the external pulser. Switch  $S_1$  is used to secure either a 50-percent duty cycle or no output of the AND gate. When  $S_1$  is in the minus position, 50-percent duty cycle is obtained. At the same time, if a negative pulse is applied to the gate by the external pulser, the external

pulse turns off the gate and a blank interval, determined by the external pulse width, occurs in the string of output pulses.

When  $S_1$  is in the plus position, the AND gate is held down by  $R_{10}$  and there is no output pulse. The output of the AND gate drives the output cathode follower  $V_8$ . Pulse amplitude is controlled by varying the voltage to which the grid of  $V_8$  pulls up (shown as 20 v in Fig. 1). The output is varied from a single pulse to a 10 microsecond string of pulses by varying the width of a positive external input pulse.

The final output is available for

a-c drive into a coaxial line or directly out on a feed through. Output impedance is 21 ohms and the output stage has a gain of 0.9.

## Blocking Oscillator

The blocking oscillator chain is used to provide a synchronizing pulse for the external pulser. With no input to  $V_{1A}$ , the circuit would be free running.

The oscillator output is fed through cathode follower  $V_{1A}$  to the grid of  $V_{1B}$ , which is normally cut-off. The plate load of  $V_{1B}$ , winding 1-2 of  $T_1$ , is shared with  $V_{2A}$ .

When the signal on the grid of

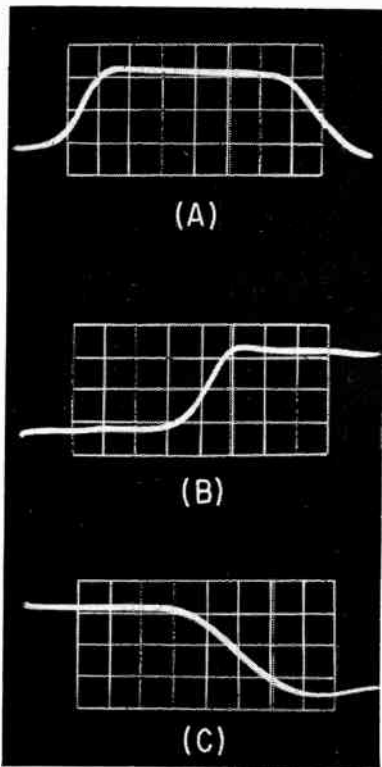


FIG. 2—Scope trace shows pulse (A), pulse rise (B) and pulse decay (C)

$V_{1b}$  causes  $V_{1b}$  to conduct a negative signal is applied to the plate of  $V_{2a}$ . Also, by virtue of transformer coupling, a positive signal is applied to the plate of  $V_{2b}$ . When  $V_{2a}$  is cut-off and  $V_{2b}$  is conducting, the application of the negative signal to the plate of  $V_{2b}$  causes them to reverse their states.

This action is compounded by the coupling capacitors between the grids and plates of  $V_{2a}$  and  $V_{2b}$ . At the instant  $V_{2a}$  starts to conduct the voltage at the plate of  $V_{2b}$  goes positive. During this interval the coupling capacitors are charged by the plate action. Since  $C_1$  is smaller than the parallel combination of  $C_2$  and  $C_3$ , the grid of  $V_{2a}$  is driven to cutoff before  $V_{2b}$  can turn on. Tube  $V_{2b}$  is finally turned on by the positive going voltage at the plate of  $V_{2a}$ .

The signal across the output of  $T_1$  is an asymmetrical wave with high-amplitude narrow positive portion and a low-amplitude wide negative swing. This output is differentiated to produce a narrow positive triggering pulse. The circuit reliably divides an 18-mc input by six.

#### Pulsar Output

Figure 2 shows the pulser output at 10-mc. and no load. The rise time

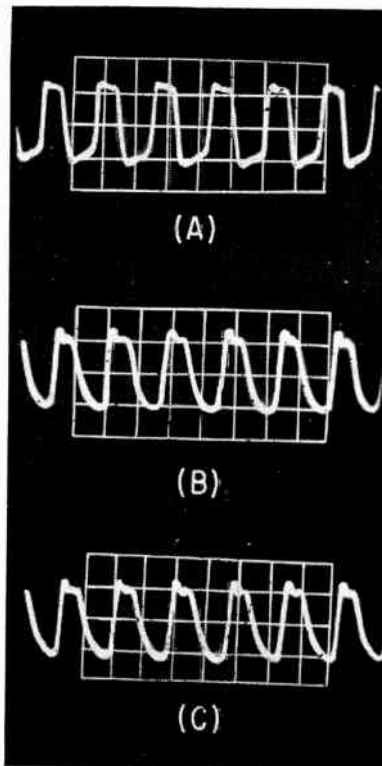


FIG. 3—Pulsar output with no load (A), 50  $\mu\text{f}$  load (B) and 70  $\mu\text{f}$  load (C)

is 7 millimicroseconds, the limit of the scope used. The decay time is 10 to 12 millimicroseconds. The effect of load on an output pulse of 10-mc is shown in Fig. 3. The 70  $\mu\text{f}$  load is greater than normal load requirements.

Figure 4 shows the output pulses being gated OFF and ON.

The pulser is especially useful for

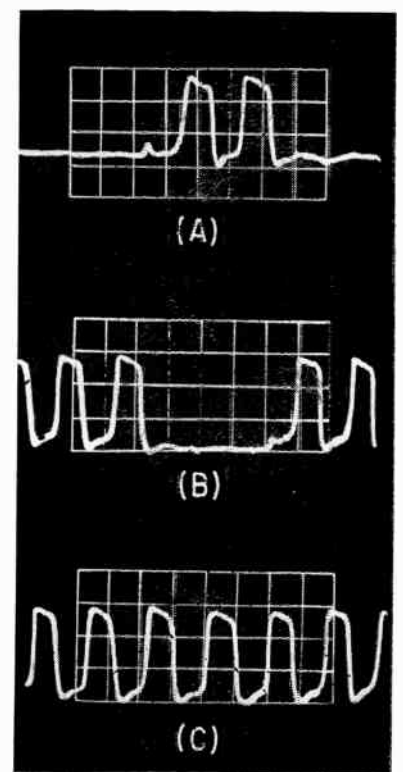


FIG. 4—Two pulses gated ON (A) and OFF (B) and ungated pulse (C)

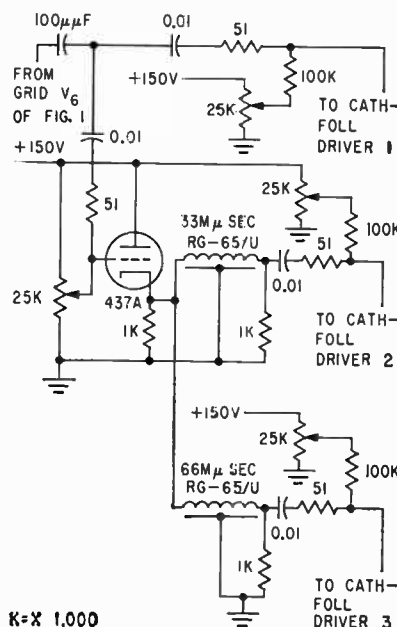
the dynamic testing of multiinput AND gates. Driving power is sufficient to drive several gate inputs in parallel. Thus, various combinations of input coincidence may be obtained by varying phasing and pulse width of the external gating pulses of only two channels. The variable output amplitude control provides a simple method of testing gate transient response as a function of input amplitude. These two features are used to thoroughly test gate designs before using them in prototype systems.

#### Clocking System

In addition to using the pulse generator for circuit testing, it is used to provide three- and four-phase 10-mc clocking for experiments where recirculation of pulses and pulse regeneration and reshaping are required. A three-phase clock system is shown in Fig. 5.

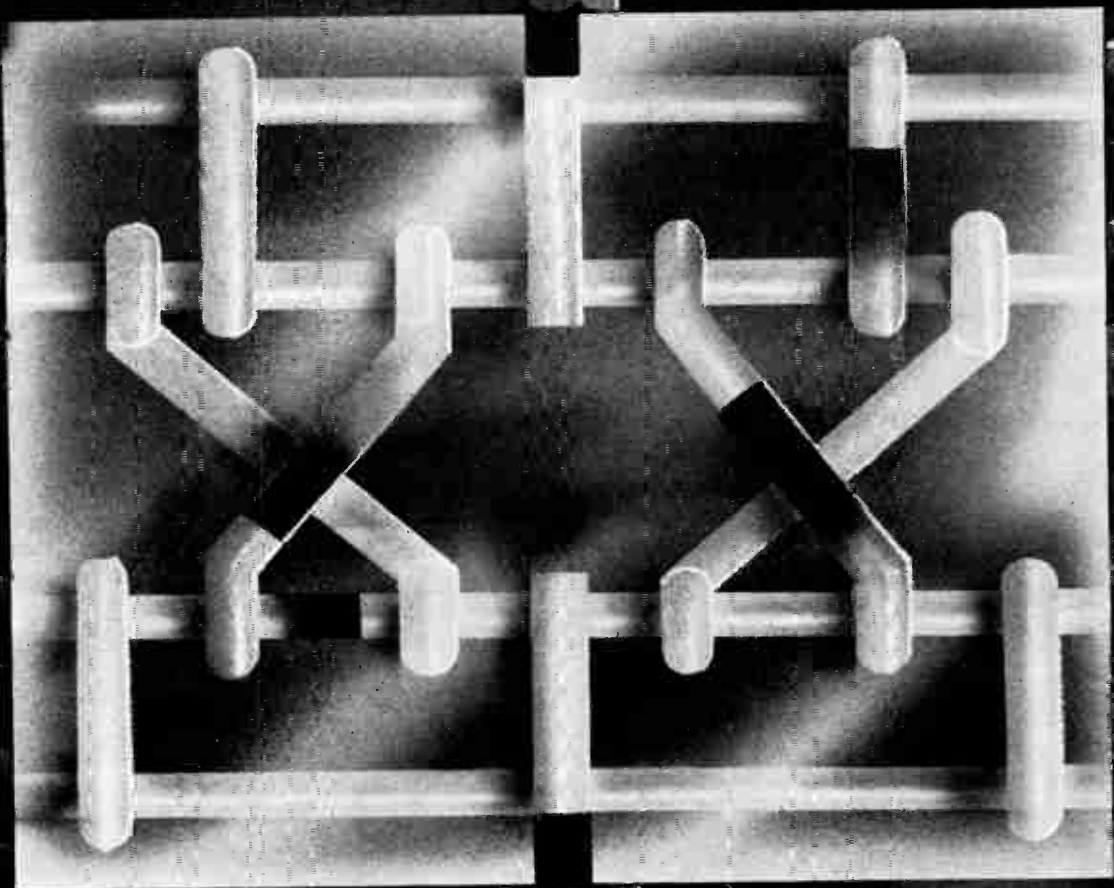
The delay line in the driver is necessary to secure proper impedance matching; otherwise, the circuit is the same as shown in Fig. 1.

The authors are indebted to the Department of Defense for sponsorship of this work and to Robert Bair, now with Colorado Research Corporation, for his aid in developing the blocking oscillator.



K $\times$  1,000

FIG. 5—Delay line is used to obtain impedance match



Report from IBM



Yorktown Research Center, New York

## PROBING THE PRINCIPLES OF HYDRAULIC LOGIC

How can hydraulic forces, driven by purely mechanical means, be harnessed to run at three milliseconds response time in a simple logic device? This is the question under study by a group of IBM scientists at Zurich, Switzerland—one of the laboratories coordinated from the IBM Yorktown Research Center.

Any logic unit requires an interchange of signals. In transmitting the signals hydraulically, complex flow phenomena are brought into play. The study of hydraulic logic has led to extensive theoretical investigations into turbulence, re-

sponse time, inertia and cavitation in a moving fluid. Hydraulic "multivibrators" have been constructed in which one valve sets a second, and motion of the second resets the first. This creates an oscillator in which flow transients may be observed by stroboscopic means. Measurement of flow characteristics is yielding important data on the speed, logical flexibility and optimum size of possible hydraulic logic devices.

Pursuit of hydraulic logic is shedding new light on fundamentals of liquid flow. Eventually it may lead to new applications in computer systems.

# IBM® RESEARCH

*Investigate the many career opportunities available in exciting new fields at IBM.  
International Business Machines Corporation, Dept. 659H, 590 Madison Avenue, New York 22, New York*

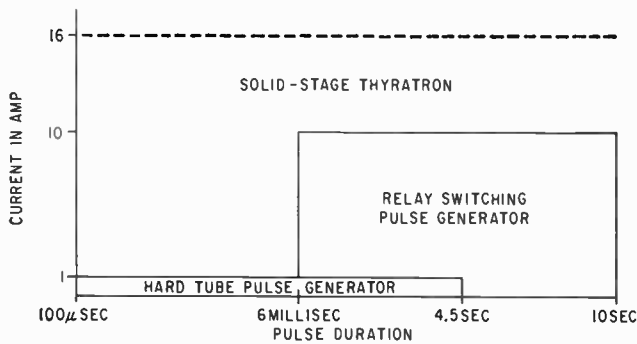


FIG. 1—Capabilities of solid-state thyratrons cover wide range

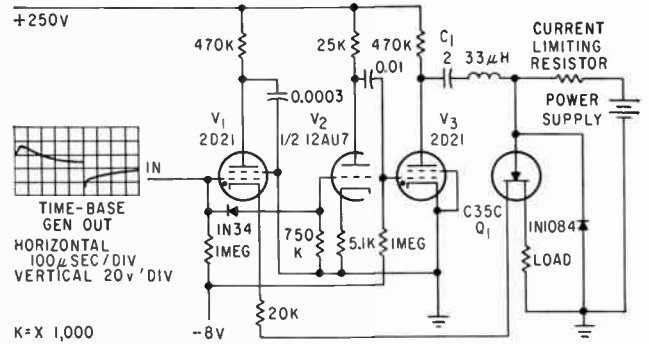


FIG. 2—A similar generator may switch currents of 100 amp

# Generating Pulses With Solid-State Thyratrons

Single-pulse generator uses combination of electron tubes and solid-state device. Practical applications include testing of detonators, primers, squibs and explosive switches

By V. W. GOLDIE, R. G. AMICONE and C. T. DAVEY,

Franklin Institute Laboratories for Research and Development, Philadelphia, Pa.

**S**OLID-STATE THYRATRONS can be used to replace hard-tube and relay-switching pulse generators with a considerable saving in space, cost and power input. One application where the ability of these devices to switch average currents as high as 150 amp, for pulse durations up to 8 milliseconds, proves useful is in sensitivity investigations of very insensitive electro-explosive devices. Figure 1 compares the current capabilities of equipment used to evaluate electro-explosive components.

These electro-explosive devices propagate a chemical reaction when activated by an electric stimulus. Under actual working conditions the electric stimulus may be a battery, capacitor discharge or any configuration of electrical pulse.

An electro-explosive device is initiated by passing an electric pulse through a resistive element incorporated in the device. Initiation occurs when enough heat is ab-

sorbed by the explosive to cause a self-sustaining reaction. Two commonly used means of transducing electrical pulses into heat are small resistance wires and carbon films. In both cases the explosive is in contact with the element being heated. The d-c resistance may be as low as 0.1 to 10 ohms for the wire element and as high as 750 to 15,000 ohms for the carbon spot.

To minimize percent deviation in pulse width, pulse widths of 100  $\mu$ sec or greater are used in the switching circuit shown in Fig. 2.

The input to the pulse generator is the differentiated output of a phantatron circuit. The leading positive spike of this pulse is used to trigger thyatron  $V_1$ , which closes the gate of solid-state thyatron  $Q_1$  and starts it conducting.

At some predetermined time later, the trailing negative spike of the input is inverted and used to trigger thyatron  $V_3$ . This action causes  $C_1$  to discharge, which in

turn reverses the polarity of the applied voltage across  $Q_1$  to stop conduction. The time lapse between the start and stop of conduction of  $Q_1$  defines the pulse width. Satisfactory results have been obtained with this circuit and square wave pulses from 100  $\mu$ sec to many seconds have been produced.

Currents varying from 50 ma to 16 amp and voltages from 100 mv to 100 v have been kept constant across electro-explosive devices ranging in resistance from 2 to 10,000 ohms. The rise time of the output pulse is less than 10  $\mu$ sec, while the trailing edge falls to zero in less than 1  $\mu$ sec.

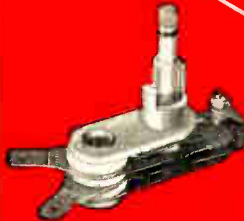
The authors acknowledge the advice of R. F. Wood. This work was carried on under the sponsorship of Picatinny Arsenal (Contract DA-36-034-501-ORD-62).

## REFERENCE

- (1) T. P. Sylvan, Solid-State Thyratrons Available Today, *ELECTRONICS*, p 50, Mar. 6, 1959.

# STEMCO THERMOSTATS

for precise, sensitive temperature control



1, 2, TYPE C† semi-enclosed (1), hermetically sealed (2). Small positive acting with electrically independent bimetal strip for operation from  $-10^{\circ}$  to  $300^{\circ}\text{F}$ . Rated at approximately 3 amps, depending on application. Hermetically sealed type can be furnished as double thermostat "alarm" type. Various terminals and mountings. Bulletin 5000.

3, 4, TYPE M\*† semi-enclosed (3), hermetically sealed (4). Snap acting bimetal disc type for appliance and electronic applications from  $-20^{\circ}$  to  $300^{\circ}\text{F}$ . Rated: 3 to 10 amps at 115 VAC and 28 VAC/DC. Available with a variety of mounting brackets, type of terminals and/or wire leads. Bulletin 6000.

5, 6, TYPE MX† semi-enclosed (5), hermetically sealed (6). Snap acting miniature units to open on temperature rise for missile, avionic, electronic and similar uses. Temperature  $10^{\circ}$  to  $260^{\circ}\text{F}$ ,  $2^{\circ}$  to  $6^{\circ}\text{F}$  differential. Depending on duty cycle, rated: 1 to 3 amps, 115 VAC and 28 VAC/DC. Also available in ceramic bases and hermetically sealed HC-6/U cans, with various mounting brackets. Bulletin 6100.

7, 8, TYPE S\*† adjustable (7), non-adjustable (8). Positive acting with single stud or nozzle mounting. Operation to  $600^{\circ}\text{F}$ . Rated at 15 amps at 115 VAC, 7 amps at 230 VAC. Spade, screw or formed terminals, various adjusting stems, etc. Bulletin 1000.

9, TYPE SA\*† adjustable (9), or non-adjustable. Snap acting with electrically independent bimetal. Also single-pole, double throw. Single stud or nozzle mounting. Rated at 1650 watts at 115-230 VAC only. Spade or screw terminals. Bulletin 2000.

10, TYPE SM\*† manual reset. Electrically same as Type SA (above) except for manual reset feature. Bulletin 2000.

11, TYPE B adjustable (11) or non-adjustable. For uses where heat generated by passage of current through bimetal strip is desirable. Various terminals, single stud or nozzle mounting. Operation to  $400^{\circ}\text{F}$ . Average rating  $5\frac{1}{2}$  amps, 115 VAC. Bulletin 9000.

12, 13, 14 TYPE A\*† semi-enclosed (12, 13), hermetically sealed (14). Insulated, electrically independent bimetal disc gives fast response and quick, snap action control for appliance and electronic applications from  $-20^{\circ}$  to  $300^{\circ}\text{F}$ . Lower or higher temperatures special. Depending on duty, rated: 4 to 13.3 amperes, 115 VAC and 28 VAC/DC. Various terminals and mounting brackets available. Bulletin 3000.

15, TYPE R\*† sealed adjustable (15), sealed non-adjustable. Positive acting for operation to  $600^{\circ}\text{F}$ . Rated at 15 amps at 115 VAC, 4 amps at 230 VAC. Screw terminals. Bulletin 7000.

16, TYPE W\*† adjustable (16), or non-adjustable. Snap action bimetal strip type for operation to  $300^{\circ}\text{F}$ . Depending on duty, rated: 5 to 10 amps, 115 or 230 VAC. Screw or nozzle mountings, spade or screw terminals. Bulletin 4000.

17, TYPE H† adjustable. Positive acting for fry pans, skillets, sauce pans, etc. Fail-safe, open in low to  $500^{\circ}\text{F}$  in high. Rated at 1650 watts at 115 VAC. Bulletin 10,000.

18, TYPE D\* automatic (18), or manual reset. For laundry dryers or other surface and warm air applications. Snap acting disc type for operation to  $350^{\circ}\text{F}$ . Open or enclosed. Rated: 25 to 40 amps at 120-240 VAC. Screw or spade terminals. Bulletin 8000.

Illustrations, for general information only, do not necessarily show size comparisons. Fully dimensioned and certified prints on request. Manufacturer reserves right to alter specifications without notice.

\*Refer to Guide 400 EO for UL or CSA approved ratings.  
†These thermostats covered by patents issued or applied for.

STEVENS manufacturing company, inc.  
P. O. Box 1007, Mansfield, Ohio

STEMCO

THERMOSTATS

CIRCLE NO. 71 READER SERVICE CARD

# Geomagnetic Effects of Nuclear Bombs

ANALYSIS of changes that occurred in the earth's magnetic field when two nuclear bombs were exploded by this country at high altitudes is being carried out by the National Bureau of Standards. Results indicate the night-time explosions ionized the upper atmosphere at a distance of 2,000 kilometers to nearly daytime intensity, resulting in electric currents that temporarily altered the geomagnetic field.

The effects were recorded at regular magnetic observatories. Up to about 2,500 kilometers from Johnston Island, the firing point, magnetic field changes are ascribed to primary and secondary gamma radiation from the explosions.

## Distant Effects

Effects at a site 3,400 kilometers away are attributed to charged particles from the detonations traveling along the lines of the earth's magnetic field toward the magnetic conjugate point, where artificial aurora were sighted on both occasions. Stations 4,000 kilometers or more from the explosions exhibited no distinguishable effect.

Analysis of rapid-run magneto-

graph results permits calculation of probable height of the lower explosion at between 35 and 50 kilometers and the other at about 20 kilometers or more higher.

## Tidal Oscillation

Tests confirm geomagnetic theories dealing with quiet diurnal variations and magnetic storms. The Stewart-Schuster theory of diurnal variations in terrestrial magnetism assumes existence of two electromotive-force systems in the atmosphere. They result from tidal oscillation of the atmosphere across lines of force of the earth's permanent magnetic field—one system occurs in the daylight hemisphere and the other in the dark hemisphere. Because of ionizing action of the sun, electric currents flow in the daylight hemisphere but are virtually nonexistent at night.

Explosion of the weapons produced artificial ionization permitting currents to be driven by electromotive forces already present. The pattern of the resulting current system, which produced the magnetic effects, closely resembles the pattern of the current system regularly flowing during daylight.

These artificially produced currents persisted for a little over half an hour after the explosion. The magnetic effects 2,000 kilometers away were nearly as large as if the lower layers of the ionosphere had been temporarily ionized to daytime intensity.

## Field Changes

The magnetic field changes observed 3,400 kilometers away do not fit into this current system, but are due to local effects at the magnetic conjugate point. These effects persisted for well over an hour. The field changes exhibit erratic fluctuations commonly experienced by stations in high latitudes where auroral particles impinge on the atmosphere.

Electromotive forces generating currents about 3,400 kilometers away may have had two possible causes. One is the atmospheric turbulence resulting from heating the influx of charged particles. The other is that a magnetic field was propagated from the explosion along the earth's magnetic lines of force to the conjugate point of explosion on the opposite side of the geomagnetic equator.

## Wide-Angle Tv Monitor



Closed-circuit tv at Atlantic City, N. J. airfield provides 7 by 3 aspect ratio picture. Developed by Grimson Color, Inc., monitor presents almost twice the information displayed by standard 4 by 3 aspect ratio screens

## Low-Cost Particle Acceleration

EXTRAORDINARY effects of high-energy radiation have been known to laboratory research scientists for years. Crude latex was cold-vulcanized in seconds, chemical changes and reactions of many kinds were accelerated and fresh meats, fish, vegetables and fruits when irradiated became capable of remaining fresh, palatable and safe at room temperature for many months.

Scientists predicted that the whole world would some day enjoy the benefits of this discovery. But the cost of generating and using high-energy radiation prohibited its commercial use.

After four years of research and development, the Dynamitron is now being produced by Radiation



*This month's news from Raytheon . . .*

# RAYTHEON ANNOUNCES NINE NEW SUBMINIATURE TRANSISTORS



**Raytheon  
Distributors  
Serving  
Key Markets  
Include:**

## Raytheon Distributors offer you broadest line of Submins

**WHATEVER YOUR REQUIREMENTS**—Raytheon offers 22 types of subminiature transistors for use in computers, general purpose audio, IF and RF for radio receivers and general purpose RF circuits. This broad Raytheon line now lets you select subminiature transistors to meet your exact requirements.

**TOP PERFORMANCE AND RELIABILITY**—Every Raytheon transistor features rigid processing control that insures reliability and stability of electrical characteristics. This rigid control lets you select any of these types with complete confidence in their performance.

**FAST, EFFICIENT SERVICE**—Raytheon Industrial Electronic Distributors offer these transistors and products to fill all your electronic needs from complete local stocks. You get faster, more efficient service and at no penalty in price.

**SINGLE SOURCE, ONE STOP BUYING**—Whatever your electronic needs, your local Raytheon Industrial Products Distributor offers you a complete line of industrial tubes including a new line of industrial control tubes, electronic hardware and now the broadest line of subminiature transistors available.

### About Industrial Distributors

by John Hickey,  
Raytheon Industrial Products Manager

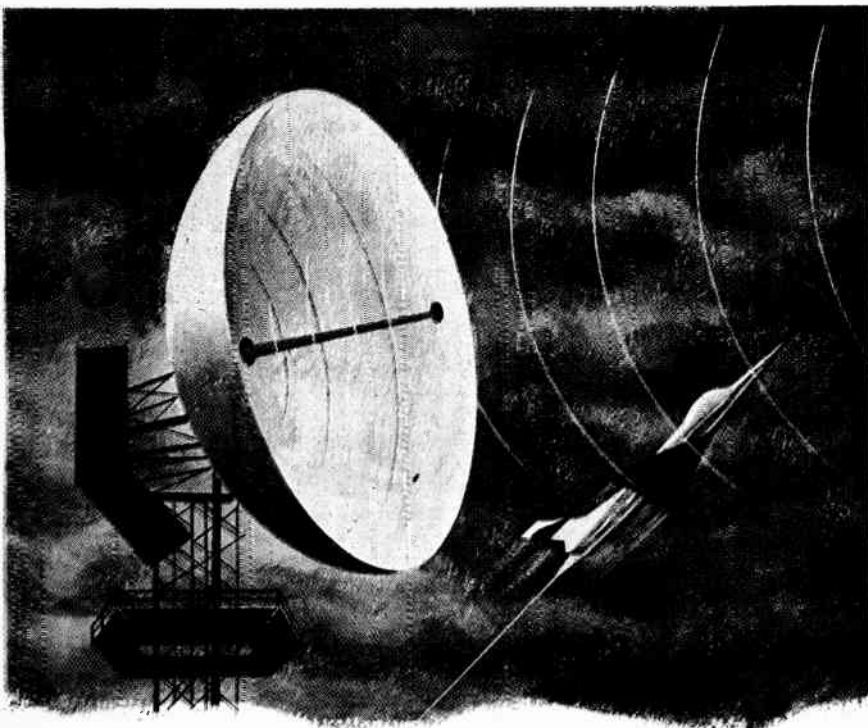
Every industrial distributor must have you, the customer, in mind at all times. To do this he must offer at all times, the best of service—fast and efficient, complete knowledge of your electronic needs, full, one-stop coverage of all your electronic requirements, and the best in prices. Every Raytheon Industrial Distributor satisfies all these requirements. If you don't know your nearest Raytheon Industrial Electronics Distributor, write me direct and I'll be glad to give him your name or have him call you.



RAYTHEON COMPANY • DISTRIBUTOR PRODUCTS DIVISION

- Baltimore, Md.  
Wholesale Radio Parts Company
- Birmingham, Ala.  
Forbes Distributing Company
- Boston, Mass.  
DeMambro Radio Supply Company
- Burbank, Cal.  
Valley Electronic Supply Company
- Chicago, Ill.  
Newark Electric Company
- Cleveland, Ohio  
Main Line Cleveland, Inc.  
Pioneer Electronic Supply Corporation
- Dayton, Ohio  
Srepc, Inc.
- Denver, Colo.  
Ward Terry & Company
- Detroit, Mich.  
Ferguson Electronic Supply Company
- Inglewood, Cal.  
Newark Electric Company
- Kansas City, Mo.  
Burststein-Applebee Company
- Knoxville, Tenn.  
Bondurant Bros. Company
- Los Angeles, Cal.  
Kierulff Electronics Corporation
- Milwaukee, Wis.  
Electronic Expeditors, Inc.
- Mobile, Ala.  
Forbes Electronic Distributors, Inc.
- New York City  
Arrow Electronics, Inc.  
H. L. Dalis, Inc.  
Milo Electronics Corporation
- Oakland, Cal.  
Elmar Electronics
- Philadelphia, Pa.  
Almo Radio Company
- Phoenix, Ariz.  
Radio Specialties & Appliance Corporation
- Portland, Ore.  
Lou Johnson Company
- Tampa, Fla.  
Thurow Distributors
- Tulsa, Okla.  
S & S Radio Supply
- Washington, D. C.  
Electronic Wholesalers, Inc.

This is a partial listing only. Names of other Raytheon Industrial Distributors on request from John Hickey, Raytheon Distributor Products Division, 55 Chapel St., Newton 58, Mass.



do you have

## RF INTERFERENCE PROBLEMS?

*—within a system... between systems... on new or in-service equipment—call INTERNATIONAL*

You'll find us highly experienced on interference reduction and control. We can help you design interference-free equipment, plan compatible systems, and eliminate interference at existing facilities—quickly, and at feasible cost.

**Working with you** at the design stage, for example, we avoid the need for elaborate suppression techniques or corrective measures. We cut down the size and weight of your equipment, and increase its efficiency. We insure compliance with interference specs.

**Fully equipped for the work.** International's facilities include every required type of environmental and test equipment, plus the latest techniques for measuring lower and lower levels of interference. Our engineers have extensive knowledge of solutions to interference problems. The company has successfully completed hundreds of interference projects for the military and industry. We're ready to help you.

*Ask for a technical representative to call. Booklet 202 on request.*

# IEMC



**INTERNATIONAL  
ELECTRONICS  
MANUFACTURING  
COMPANY**

OFFICES: 1000 Connecticut Ave., N.W., Washington 6, D.C., REpublic 7-6660  
PLANTS: Washington, D.C. and Annapolis, Md.

### INTERNATIONAL offers R & D in

- Antenna Development
- Antenna Multicouplers
- Antenna Tuners
- Waveguide Filters
- Frequency Preselection Networks
- Special Power Supplies

Dynamics, Inc. The new accelerator uses a new concept in high-voltage generator design to convert large amounts of electrical power into kinetic energy of a beam of high-velocity atomic particles. Constant, well-regulated voltage and substantial output current is achieved in a compact, economical device. It produces an electron beam or X-rays.

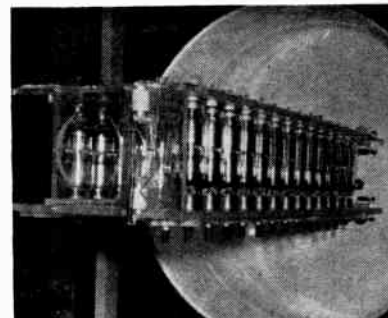
### Construction

The unit converts low-voltage a-c to high-voltage d-c with a cascaded rectifier system driven in parallel by an r-f oscillator. The rectifier array is positioned between and spaced apart from a pair of large curved electrodes that form the tuning capacitance of the oscillator. The strong alternating field between electrodes induce intermittent current through the series-connected rectifiers, building up a large constant potential at the end of the array.

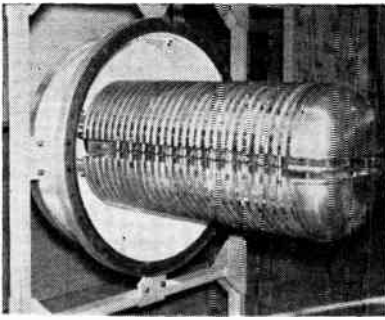
Interelectrode capacitance of rectifier tubes plus surface capacitance of corona shields attached to each rectifier junction provide adequate ripple control. Elimination of the usual filter capacitors with their high stored energy improves reliability.

In the center is an evacuated tube for acceleration of the beam of charged particles. The rectifiers, connected in series between ground and the high-voltage terminal, are positioned in two columns on opposite sides of the acceleration tube. The beam tube and rectifiers are enclosed by a set of corona shields bent into semicircular shape. The shields suppress sparks and corona discharges from the rectifier terminals and provide a large surface capacitance for coupling r-f power to the rectifier tubes.

The assembled elements are positioned between a pair of semicylin-



Bank of rectifiers produce a million volts of electron energy in evacuated beam tube



Corona shields of bent hollow metal tubes form capacitance that couples r-f to rectifiers

dricl electrodes that form the tuning capacitance of an LC circuit. The entire apparatus is enclosed in a grounded pressure vessel. The resonant inductance is toroidal in shape and is mounted inside the vessel at one end and connected in parallel with the tuning electrodes.

#### Operation

In operation, r-f is fed to the toroidal coil at the proper frequency to produce a balanced a-c potential between the two cylindrical electrodes. Some a-c appears across each rectifier because of the capacitance between corona shields and resonant electrodes. A d-c bias is built up across each rectifier equal in amplitude to the induced a-c. Since the rectifiers are in series, the bias potentials add to produce a large d-c between opposite ends of the rectifier array. Electrons are drawn back and forth through the rectifiers from one bank of corona shields to the other by the alternating field between the cylindrical electrodes. Because of the rectifiers, electrons are pumped from ground to the high-voltage terminal against the constant field existing throughout the rectifier set parallel to the acceleration tube. D-c returns to ground through the particle acceleration tube.

The a-c generator is not connected directly to the rectifiers. The resonant electrodes act as a flywheel or energy storage device from which the rectifiers draw power by way of the capacitance of the corona shields. Thus a-c is fed in parallel to each rectifier, whereas d-c is drawn from the rectifiers in series. The high-pressure gas dielectric between resonant circuit and rectifiers permits both adequate d-c insulation and high-frequency a-c coupling.



# NEW

## WESTINGHOUSE HEAVY-DUTY PROXIMITY LIMIT SWITCH

- **WON'T WEAR OUT** . . . completely static, never needs to be replaced
- **WATERPROOF** . . . operates completely submerged in liquid
- **EXPLOSION-PROOF** . . . new Westinghouse switch is "potted" . . . all internal connections are completely sealed
- **CUTS INSTALLATION TIME** . . . trip point is easily adjusted by balance adjusting screw . . . no contact or lever arm adjustment
- **CORROSION RESISTANT** . . . impervious to salt spray
- **DESIGNED FOR MILITARY APPLICATIONS** . . . has passed military shock and vibration tests
- **TWO SENSING HEADS AVAILABLE** . . . for either tripping distances within ½ inch . . . or within 2 inches

Why not get all the facts about the new Westinghouse heavy-duty proximity limit switch . . . see how and where it can save you time and money and give you a better job. Contact your nearby Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, Director Systems Department, 356 Collins Avenue, Pittsburgh 6, Pennsylvania. J-01017

YOU CAN BE SURE...IF IT'S **Westinghouse**

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS

# How Liquid-State Switch Controls A-C

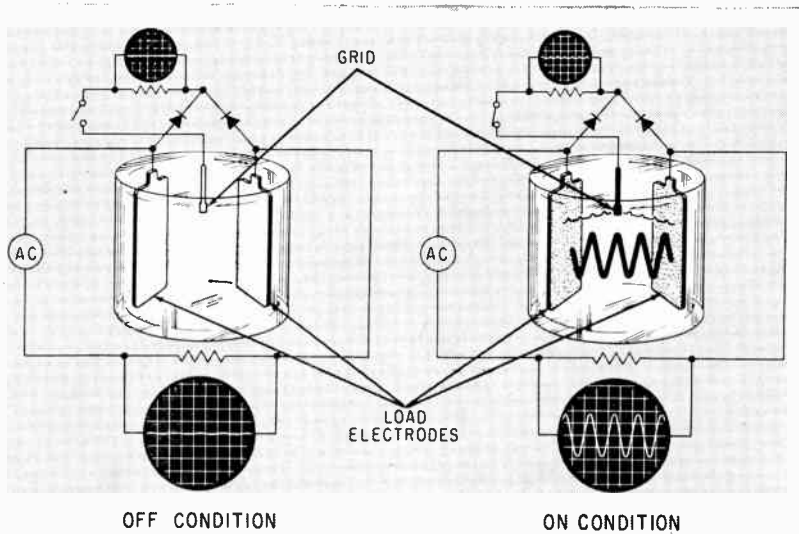


FIG. 1—Schematic diagram of Ovitrone amplifier in off and on state. Diodes block a-c to the grid control circuit and allow the application of pulsating d-c potential on the grid and load-connected electrodes. Magnitude and potential of the control signals can be controlled by using a variable resistor instead of the switch

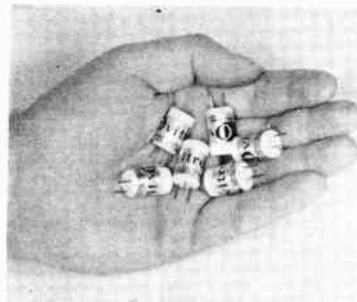
A STATIC COMPONENT for switching and modulating load currents consists of a permanently sealed wet cell that simply contains two load-connected electrodes and a grid control element immersed in an electrolytic bath.

Although component development to date has been devoted largely to commercial and industrial applications requiring control of a-c current in the milliamp to 15-ampere range, there appears virtually no limitation on the current carrying capacity of such a device, according to its inventor, Stanford R. Ovshinsky of Ovitrone Corp., Detroit.

## Neuron Analogy

The electro-ionic concept of current control was inspired, in part, by a theoretical study of the electrochemical dynamics of the human nervous system.

The neuron, or basic nerve cell of the human body, is a highly efficient and ultrareliable control component. This cell is surrounded by a semipermeable membrane which is charged positively on the outside and negatively on the inside. When a stimulus reaches the surface of the membrane, its permeability to



Miniaturized prototype models of Ovitrone Electro-Ionic Control Units

certain ions increases with a corresponding decrease in resistance, and its surface becomes activated by a spreading wave of potential. This change in permeability during passage of impulse is accompanied by impedance changes on the membrane, thus effectively controlling the output of the large energy potential.

The Ovitrone devices are best described as having two membranes considered semipermeable to certain ions upon application of a stimulus from a grid element. This changes the surface condition of the membranes from a nonconducting to a conducting state, thus allowing large amounts of a-c to flow from one electrode to the other through

the medium of the electrolytic field.

This high amperage is controlled entirely by the small energy stimulus, and in a manner which permits either switching or modulation. Moreover, modulation can be continuous without harmful effects.

When the control signal is removed from the grid element, or when another signal of opposite polarity is applied, the conductive surfaces are immediately restored to their original nonconductive state, thus effectively blocking the flow of current through the device.

Due to the simple concept and basic nature of the phenomena involved, the Ovitrone principle of control through electro-ionic surface impedance change is inherently adaptable to a wide range of applications. Working models have been developed for proximity switches, logic devices, circuit breakers, error detectors, modulators, amplifiers, regulators, and time delays.

## Oxide Film

The only changes which take place within the sealed unit are changes in the *surface state* of the electrodes—from nonconductive to conductive, and vice versa. The two load-carrying electrodes are coated with an oxide film. This causes them to act in the circuit as rectifiers back-to-back, and prevents current from flowing through the load.

Upon application of a small d-c potential to the grid control element, the two electrodes are polarized and metal ions are forced into the structure of the oxide film which changes the film from a nonconducting to a conducting state. Thus the load now "sees" two conducting electrodes and current passes between them. There are of course other effects as well—chiefly, the double-layer capacitive effects of the charges which are collected at the electrodes.

The chief function of the electrolyte is to provide convenient, instantaneous means for polarizing the two electrodes from the grid element. However, there is no change in the ionic state of the elec-



utmost  
in  
performance

TYPE 33M

MOLDED  
mylar\*  
CAPACITOR

*applications* | *computers • instrumentation • test equipment*  
*filter networks • transistor circuitry • amplifiers*

Sangamo Type 33M molded mylar\* capacitors combine the excellent electrical performance characteristics of mylar\* dielectric material with a molded case of high moisture resistant thermosetting plastic.

**Temperature Range:** "The Type 33M is designed to operate over the temperature range of  $-55^{\circ}\text{C}$ . to  $+85^{\circ}\text{C}$ . Satisfactory performance at  $125^{\circ}\text{C}$ . can be obtained by derating the voltage to 50% of the  $85^{\circ}\text{C}$ . value."

**Dissipation Factor:** The dissipation factor of the Type 33M capacitor does not exceed 1% at normal equipment operating temperature over the complete audio frequency range.

**Tolerances:** Available in capacitance tolerance values of  $\pm 5\%$ ,  $\pm 10\%$ ,  $\pm 20\%$ .

**Life Test:** These units will withstand a life test of 250 hours at 125% of rated voltage at  $85^{\circ}\text{C}$ . Life tests at  $125^{\circ}\text{C}$ . should be made at 125% of the derated voltage.

**Dielectric Absorption:** Dielectric absorption of Type 33M capacitors is less than half that of oil impregnated paper capacitors.

**Moisture Resistance:** Type 33M capacitors will successfully withstand the moisture resistance tests specified in Spec. MIL-C-91A.

**Insulation Resistance:** The insulation resistance of these capacitors will exceed 5,000 meg/mfd. over the normal operating temperature range.

• Write for engineering bulletin TSC-206A

\*DuPont's trademark for polyester film.

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

SC-59-6

Perfectionists  
choose  
**atlee**  
transistor  
clips



Effective component protection is hard to supply under conditions of violent acceleration, high ambient temperature, and vicious vibration. But in military electronic gear, transistors must get unfailing protection against these threats to reliable operation.



*They get it, most fully, with **atlee** mounting clips.*

**atlee** clips are provably better in three ways:

**HOLDING POWER.** Under severe shock and vibration, these clips actually mold themselves tighter to the transistors. There's no visible shifting or twisting, no lead-breaking resonance, and the dislodging force actually increases.



**COOLING EFFICIENCY.** With **atlee** clips, this approaches to within 10% of "infinity" — the ideal derating curve for a transistor with an infinite heat sink which keeps the case temperature from rising above the ambient level.



**ELECTRICAL INSULATION.** When required, these clips can be coated with Dalcoat B — an exclusive high-dielectric enamel that has twice the dielectric strength of Teflon but conducts heat as well as mica.



There are still more reasons why engineers who seek perfection choose **atlee** transistor clips. They know that Atlas E-E is the pioneering company in the development of component holders of all types, with unequalled years of specialized experience, and a complete line of clips for all case sizes and mounting requirements. They have learned it costs no more to get the best . . . and that Atlas E-E makes these "little things" as though they were the biggest things in the circuit.



*DESIGN FOR RELIABILITY WITH **atlee** — a complete line of superior heat-dissipating holders and shields, plus the experience and skill to help you solve unusual problems of holding and cooling electronic components.*



**ATLAS E-E**

CORPORATION

47 PROSPECT STREET • WOBURN, MASS.

trolytic medium during conduction. The electrolyte has no transducing characteristics of its own, nor is its use based in any way upon Solion principles.

**Life and Reliability**

Both load electrodes and the grid control elements are impervious and nonreactable to the electrolytic bath, and show no indication of dimensional change with age or continuous repeated operation. The grid element has a mutual reduction and oxidation relationship with the two load electrodes which is expressed by the control current. During operation, small amounts of gases are formed by the grid control current only—not by the load current. A catalyst is used to return these gases to solution, thereby achieving a self-regenerative process within the device which prevents depletion of the fluid. When the unit is off, a mutual redox relationship maintains an equilibrium system in which no gases are formed.

Unlike mechanical devices and electron tubes, these devices are not affected by vibration, shock, impact,

**Ultrasound Measures Nose-Cone Thickness**



Nose cones for the Nike-Hercules missile here await inspection by use of an ultrasonic resonance gage made by Branson Instruments of Stamford, Conn. When the transducer is placed against the outside surface of the cone, high-frequency mechanical vibrations are transmitted into the metal. Fed back into an electronic circuit, resonant vibrations are shown by two or more vertical traces in the face of a cathode-ray tube. A scale indicates wall thickness directly. Wall thickness must be held to within  $\pm 0.006$  in.

moisture and position. And unlike transistors, their operation is not dependent upon sensitivity to temperature or influenced by heat deviation characteristics.

### Characteristics

Present Ovitron controls operate with characteristics comparable to magnetic amplifiers, and sufficient tests have been conducted to establish the fact that much greater speeds are obtainable if desired.

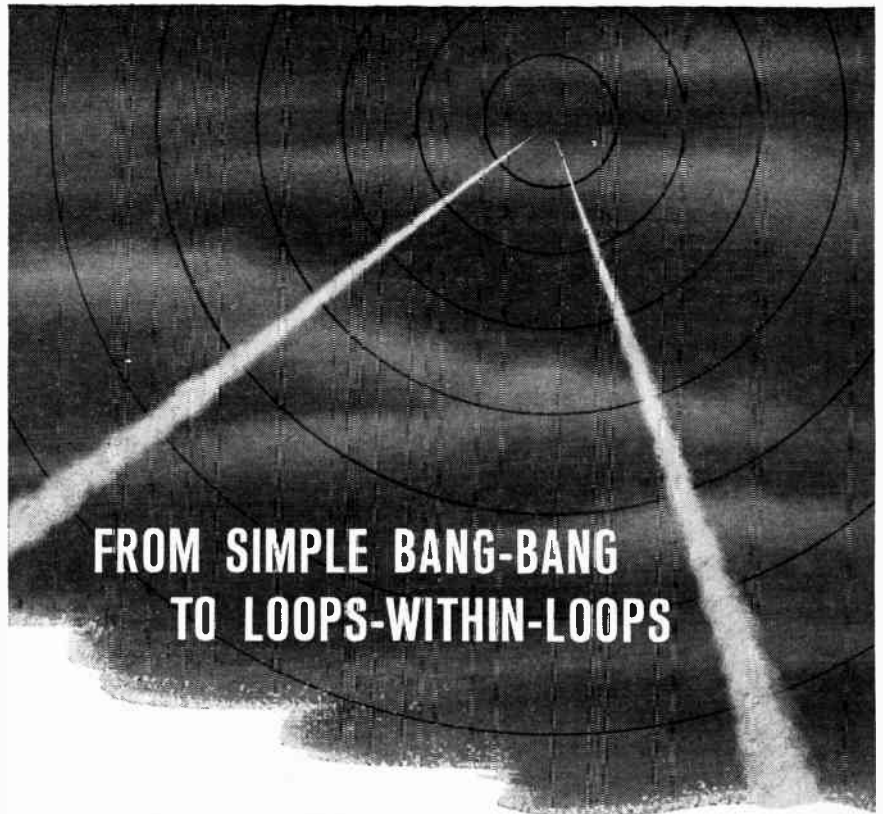
Load voltages of present devices are 3-v a-c minimum, 70-v a-c maximum. Multiple cell units may be supplied to obtain higher ratings. Current rating may be varied by increasing or decreasing size of unit and surface area of load carrying electrodes.

Ratio of control to load current can be varied from 10:1 to 50:1 or even higher, depending on specific application requirements. Speed of response is greater at lower ratios. Recorded control and load current characteristics show surges in the control circuit in the magnitude of 1½-2:1 of the steady state current. Power gain is in the order of 650.

The break time has been controlled between one-half to three cycles of 60-cycle a-c under various conditions. If higher-frequency current is used, speed of response increases accordingly. Applied voltage does have a slight effect on break characteristics, but varying current within rating has no influence.

### Strength of Ceramics

CERAMIC materials are being investigated at the National Bureau of Standards for the Air Force to develop a better understanding of the factors controlling their strength at elevated temperatures. As part of the program, the strength of aluminum oxide single crystals, sapphire and ruby, has recently been studied by J. B. Wachtman, Jr. and L. H. Maxwell at temperatures between 600 C and 1,000 C. The study, "Strength of Single Crystal Sapphire and Ruby As a Function of Temperature," supports the theory that, in properly oriented crystals, plastic deformation relieves stress concentrations, thus increasing crystal strength.



## SERVOSCOPE® SERVO SYSTEM ANALYZER Removes the Doubt All the Way

with complete 5-minute analyses!

Whether a servo system must operate dependably for expediting change of course to avoid mid-air collision, or lock-on to impact...

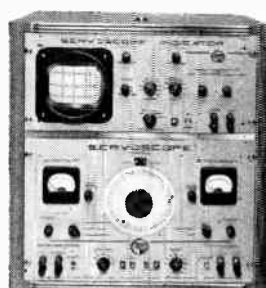
Whether a servo system is a sophisticated inertial guidance system with multiple feed-back loops, or a simple "bang-bang" on-off set-up...whether it leads to a launch, a scramble, or a takeoff...there can be no room for doubt!

SERVOSCOPE servo system analyzers remove all doubt. The full line of five models provides these essential features:

- Wide range coverage (.001 to 100 cps) • Fast direct-setting and read-out • High-accuracy measuring of phase, transient response, and gain • And many others

SO EASY TO USE that a new man can plot a Nyquist, Nichols, or Bode diagram with a SERVOSCOPE after a few minutes demonstration! No wonder SERVOSCOPE plays a role in designing, producing, debugging, or testing of servo systems in all these areas:

MISSILES — AVIATION — INSTRUMENTATION — COMMUNICATIONS — NAVIGATION — ELECTRONIC AND ELECTRICAL ENGINEERING — EDUCATION — COMPUTERS — wherever servo systems are necessary and must be tested.



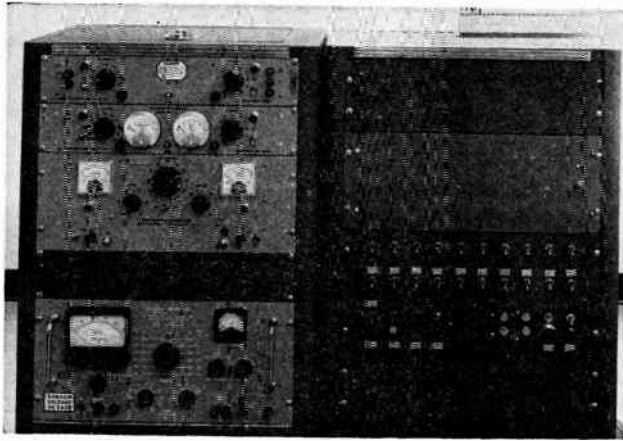
Remove all doubt for yourself by writing today for specifications and application data. Ask for TDS 1100-2.

**SERVO CORPORATION OF AMERICA**  
111 New South Road, Hicksville, L. I., N. Y.  
*Serving Safety Through Science*  
**Industrial Instrumentation Division**



# Set Tests 18 Transistor Values

By R. A. PLANCK, Military Products Division, International Business Machines Corp., Owego, N. Y.



Cabinet at left contains power supplies and bias supply programmer. Transistor rack is atop cabinet at right

TRANSISTOR TEST set which automatically measures in 15 minutes up to 18 d-c parameters of 30 silicon or germanium transistors, with ratings up to 20 w, is described. Data may be recorded directly on punched cards for machine analysis.

A  $h_{fe}$  test circuit (Fig. 1) is the only novel circuit. It allows  $h_{fe}$  to be measured with constant collector voltage and current. The meter relay detects the difference between  $V_c$  and the reference voltage.  $Q_1$  and  $Q_2$  conduct according to the direction the meter relay swings. This starts the motor in the proper direction so that the transistor under test is on or off and changes the col-

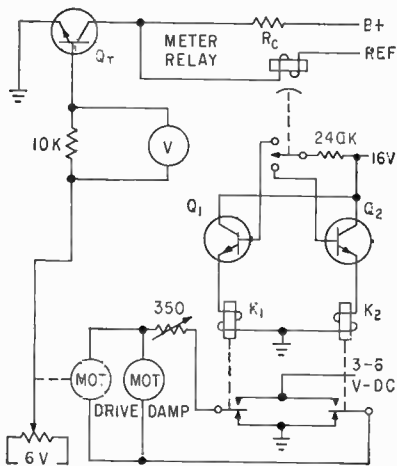


FIG. 1—The  $h_{fe}$  test circuit.  $Q_T$  represents the transistor under test

lector current to the desired value. The collector resistor and  $B+$  were selected so that with desired collector current,  $V_c = (B+) - I_c R_c$ . The circuit is accurate to 2.5 percent and repeatable within 1 percent.

A delay of about 3 seconds in the  $h_{fe}$  circuit allows it to null. Timing of all other circuits is determined by the voltmeter, which delays about  $\frac{1}{3}$  second to allow the circuits to stabilize. The delay is obtained by a series of multivibrators triggering the voltmeter sweep.

### Test Performance

Voltages of 0.1 mv to 199.9 mv are measured to  $\pm 2.5$  percent. Current measuring accuracy is: 1  $\mu\text{a}$ , to 5  $\mu\text{a}$ , 20 to 4.5 percent; 5  $\mu\text{a}$  to 10  $\mu\text{a}$ , 4.5 to 2.5 percent, and 10  $\mu\text{a}$  to 20 ma, 2.5 percent. A 5-place digital voltmeter substituted for the 4-place unit used would extend 2.5 percent accuracy to 1  $\mu\text{a}$ .

Consistent of test conditions—important to long term comparison of data—is achieved by applying the same bias and allowing the same test time for each transistor.

### Operation

Major units and operating times of the system are shown in Fig. 2. The circuit programmer has a rotary switch, a dpst relay, a 4-posi-

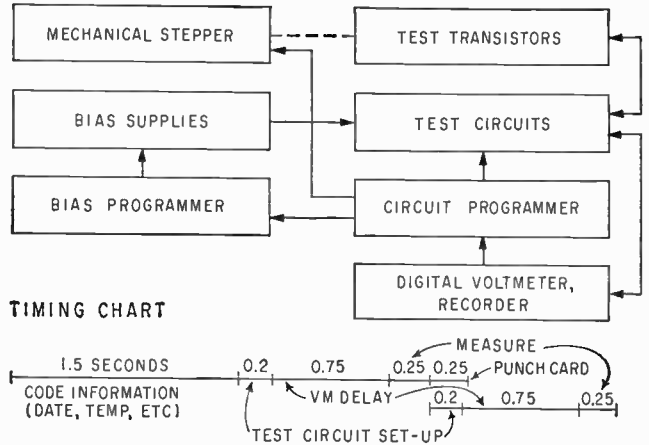


FIG. 2—Circuit programmer is heart of test set. Its program is manually selected by switches in right-hand cabinet

tion wire contact relay and 20 spdt toggle switches. Each measure-read-record cycle ends in a signal which advances the rotary switch and sets up the next test circuit.

A mechanical stepping mechanism delivers each transistor to the test station. A rack with 30 sockets holds the transistors. Contacts connected to the sockets are moved onto stationary contacts by a motor-driven chain. Rack travel is controlled by a 1-cycle clutch and a 6-station geneva disk. On each pulse to the clutch, the rack moves the distance between 2 sockets. The clutch is actuated by the circuit programmer.

### Programming

Selector switches allow the measurement or skipping of any parameter wired on the test circuit panel. Any d-c parameter test can be applied; each test circuit is wired on an individual terminal block for a wire contact relay. The blocks are wired with easily changed taper pins. At present, all measurements being made are standard ones.

A plugboard programs the power supplies. The constant voltage or current to bias the test circuits is selected by the value of resistance used in various places on the plugboard. A board range of biases is provided. Bias voltages of 0.5 to

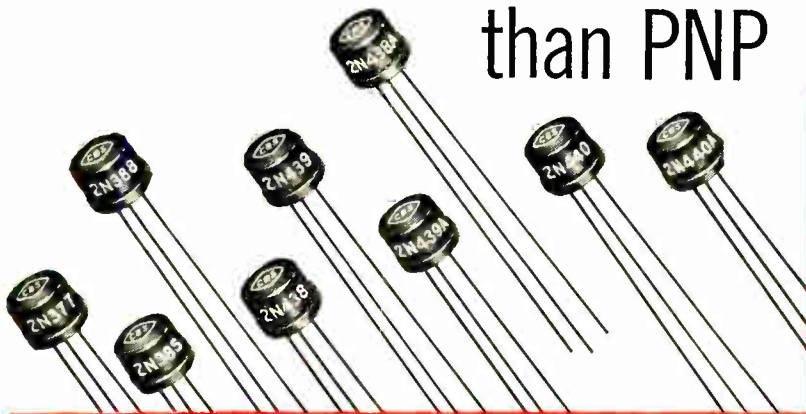


# NPN

## switching transistors

### PROVE MORE RELIABLE

### than PNP



#### CBS NPN Switching Transistors

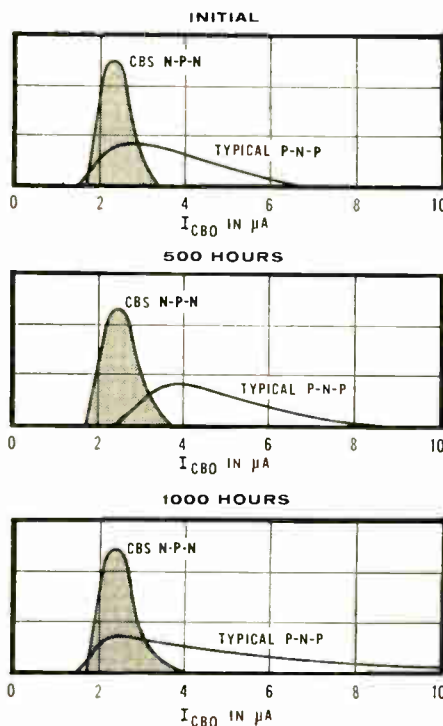
Type	Minimum $BV_{CBO}$ (Volts)	Dissipation @ 25°C (Milliwatts)	Minimum $h_{FE}$ @ $I_C$ (Ma)	Typical $f_{\alpha t}$ (Megacycles)	Application
2N306	20	50	16*	1	Audio Driver
2N312	15	75	25	10	Switching
2N356	20	100	20	100	Core Driver
2N357	20	100	20	200	Core Driver
2N358	20	100	20	300	Core Driver
2N377	25	150	20	200	Core Driver
2N385	25	150	20	200	Core Driver
2N388	25	150	30	200	Core Driver
2N438	30	100	20	50	Logic Circuit
2N438A	30	150	20	50	Logic Circuit
2N439	30	100	30	50	Logic Circuit
2N439A	30	150	30	50	Logic Circuit
2N440	30	100	40	50	Logic Circuit
2N440A	30	150	40	50	Logic Circuit
2N444	15	100	10*	1	Switching
2N445	15	100	20*	1	Switching
2N446	15	100	30*	1	Switching
2N447	15	100	50*	1	Switching
2N556	25	100	15	10	Core Driver
2N558	15	100	20	10	Core Driver
2N634	20	150	15	200	Switching
2N635	20	150	25	200	Switching
2N636	20	150	35	200	Switching
2N1000	40	150	25	100	Core Driver
2N1012	40	150	40	100	Core Driver

\* $h_{FE}$  (a.c. gain)

Operating and storage temperature,  $T_j = -65$  to  $+85^\circ C$

Some design engineers specify PNP switching transistors because they consider them inherently more reliable. Actually NPN transistors can give you superior reliability along with their well-known higher speed. Life tests covering hundreds of thousands of CBS NPN alloy-junction germanium switching transistors proved this during the past year. See graphs comparing these transistors with typical military-approved PNP transistors.

#### Comparative Life Tests NPN vs. PNP Switching Transistors.



The superiority of CBS NPN transistors is achieved by special processing: For example, advanced surface chemistry techniques seal out moisture and contamination. Precise control of alloying produces high back voltages. Thorough bake-out stabilizes gain. The result is reliable NPN computer-type switching transistors featuring fast switching . . . high voltage . . . low cutoff current . . . and low saturation resistance . . . in a welded JETEC TO-9 package

A comprehensive line of these reliable CBS NPN high-speed switching transistors is available now in production quantities. Check the table. Order types you need . . . or write for Bulletin E-353 giving complete data . . . today.

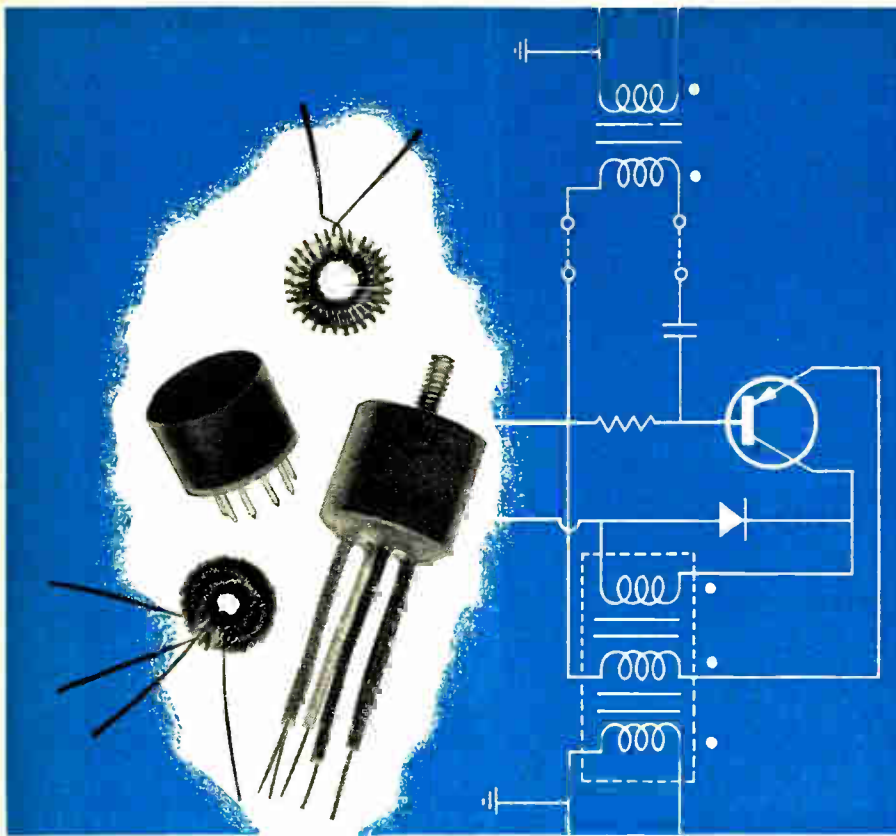
More reliable products through Advanced Engineering



## semiconductors

CBS ELECTRONICS, Semiconductor Operations  
A Division of Columbia Broadcasting System, Inc.

Sales Offices: Lowell, Mass., 900 Chelmsford St., GLENVIEW 4-0446 • Newark, N. J., 32 Green St., MARKET 3-5832 • Melrose Park, Ill., 1990 N. Mannheim Rd., ESTebrook 9-2100 • Los Angeles, Calif., 2120 S. Garfield Ave., RAYmond 3-9081



## ERIE "MAXI-COUPLING" CUSTOM BUILT PULSE TRANSFORMERS

Now you can build even greater reliability and lower power drain into your complex pulsed switching circuits . . . select ERIE "Maxi-coupling" Pulse Transformers to develop perfect pulses, store information or provide close coupling.

ERIE "Maxi-coupling" Pulse Transformers are made to closest tolerances to fully isolate windings for greater efficiency without decreasing coupling.

Numerous styles of encapsulated units have been designed by ERIE for transistor, vacuum tube and magnetic amplifier circuitry. These units can be built to meet MIL-T-27 and MIL-T-21038 specifications.

Write for ERIE Pulse Transformer spec information questionnaire sheet . . . or tell us when to have an ERIE Electronics sales engineer call. Send your inquiry to:

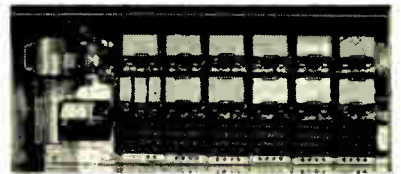
**ERIE ELECTRONICS DIVISION**  
ERIE RESISTOR CORPORATION  
Erie, Pennsylvania

100 v and currents of 10  $\mu$ a to 500 ma are available.

Two d-c power supplies and 1 dry cell battery provide low voltage biases. A high voltage supply and a current regulator provide constant current. Biases are applied to test circuits only after the transistor is connected, to avoid damage.



Top view of transistor rack and mechanical stepping mechanism



Test circuit relay gate (panel is closed in large photo)

Biases are applied through a 12-position wire contact relay which is delayed 10 to 12 msec with respect to the test circuit relay. All biases are removed 8 to 10 msec before the transistor is removed, by using a capacitor to delay relay dropout.

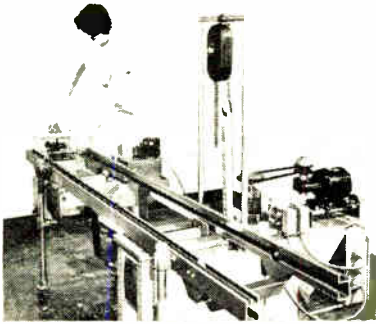
The set is prepared for operation by programming the plugboard, selecting *nnp* or *ppp* by a switch, selecting parameters, loading transistors, positioning the transistor rack and pressing the start button.

Addition of a-c parameter tests is planned. The author acknowledges his appreciation to D. Salisbury and F. Alexander, of IBM Owego, and V. Winkler and F. Jordan, of IBM Poughkeepsie, for their contributions to design and construction of the tester.

## Flux and Solder PC Boards with Waves

FLUX APPLICATOR, circuit board heating bank and conveyor have been added to the Fry Flowsolder solder wave dip soldering machine (ELECTRONICS, p 248, August 1, 1957), to make it an automated soldering system.

The flux applicator provides a wave of flux or solder resist. Fluid is pumped to a tank higher than the wave nozzle so that it is fed

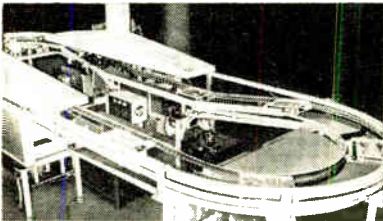


Conveyor carries boards from flux wave to solder wave. Infrared lamps heat board before soldering

through the nozzle by hydrostatic pressure. A vernier control adjusts wave height.

The board heater consists of infrared lamps in a reflector. The conveyor or transfer mechanism is chain-driven at speeds variable from 1 to 14 fpm. Clearance between channels is  $10\frac{1}{2}$  inches. A board carrying fixture, adjustable for boards up to  $9\frac{1}{2}$  inches wide, is included. The equipment is available in the U. S. from Electrovert, Inc., New York, N. Y.

## Use Foaming Flux in P C Soldering System

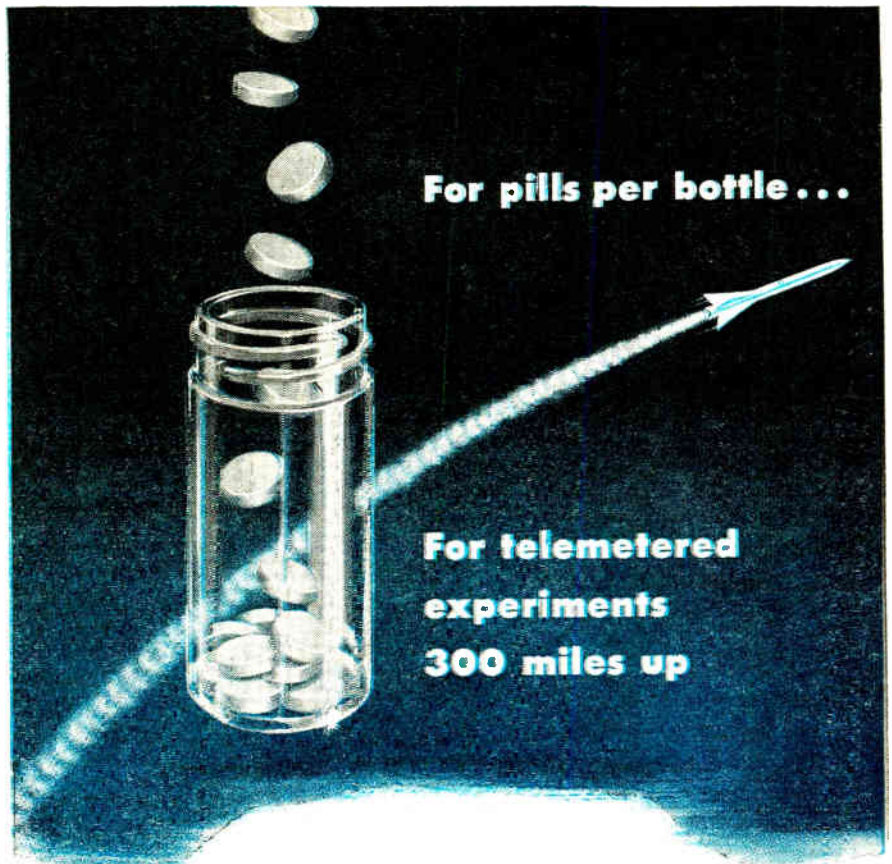


IMPROVED VERSION of the cascade multiwave dip soldering system (ELECTRONICS, p 25, April 18, 1958) is available from Radio Corporation of America, Camden, N. J.

Portions of the conveyerized system apply flux, preheat the boards, solder and clean excess flux. Loading is by hand, into pallets, at rates up to 600 boards an hour. The boards pass at an angle over 4 ripples of solder.

Flux is applied as foam, rather than by brushing. Controlled air jets foam the liquid flux. RCA says this method has been found more efficient than brushing. The flux is made hot and tacky by the heater.

The system can be adapted to process boards in a continuous strip separated after inspection.



# ERIE

## COUNTERS and TIMERS

Some users want a slow count for mechanical or process control... "50... 125... 250" aspirins.

And some want a fast count . . . "98,999... 99,000... 99,001" in a second.

And you may even want to telemeter frequency *and* time interval *and* sequence all in a few instants.

ERIE-Pacific Digital Instruments can:

- count events
- measure frequency, period, time intervals
- function as preset and control devices
- determine sequence

Seven catalog models of ERIE-Pacific instruments are available: the Model 210 Digital Timer, the Model 130 Frequency Counter, Model 100T Digital Tachometer-Counter Transistorized, Model 320 Preset Counter, Model 660 Low Frequency Monitor, Model 700 Digital Scanning Counter, and the Model 400 100kc Universal Counter-Timer illustrated below.

Literature on the ERIE-Pacific line of instruments is available on request along with the name of your local ERIE-Pacific sales engineer. Write to:

*One of the Erie line...*



Model 400 Universal Counter-Timer with frequency 1 cps. to 100,000 cps., time interval 0.5 MS to 278 hours, and only 19" x 3 1/2" x 10". Weight: 15 lbs. \$695.00.

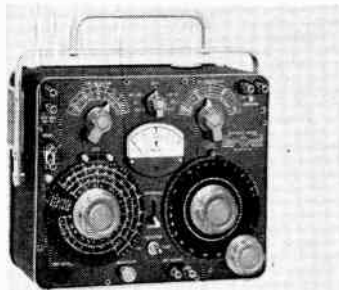


**Openings now for engineers qualified in electronic digital instruments and systems.**

# On The Market

## Impedance Bridge accurate unit

GENERAL RADIO Co., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1650-A impedance bridge is a highly accurate instrument for the measurement of the inductance and storage factor, Q, of inductors, the capacitance and dissipation factor,



D, of capacitors, and the a-c and d-c resistance of all types of resistors. Five separate bridge circuits give flexibility and wide range. One important feature is Orthonull, a new mechanical-gangging device which facilitates measurement of low-Q inductors (or high-D capacitors).

**CIRCLE NO. 200 READER SERVICE CARD**



## TWT Amplifier p-m focused

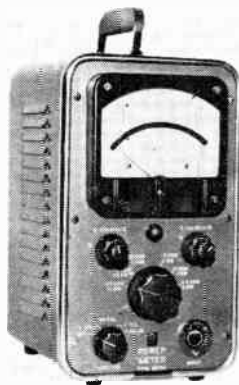
HUGGINS LABORATORIES, 999 E. Arques, Sunnyvale, Calif. Type HA-51 permanent-magnet focused

twt amplifier has a frequency range of 250 to 500 mc. Signal gain is 20 db (min.); power output, 10 dbm (min.); capsule length, 16 $\frac{3}{4}$  in.; net weight, 6 lb.

**CIRCLE NO. 201 READER SERVICE CARD**

## Power Meter $\pm 5$ percent accurate

FXR, INC., 26-12 Borough Place, Woodside 77, N. Y. The B831A temperature compensated power meter incorporates a unique method of controlling the accuracy of r-f power measurements, particularly in the lower power levels. The series 218 temperature compensated thermistor head is used as a



required accessory. In the 218, a second and identical temperature sensitive element is mounted in proximity to the first or r-f element, but outside the r-f field. Both elements react identically to variations of ambient temperature but the circuitry of the B831A reconciles its spurious effect on the r-f sensitive element. This provides virtually drift-free operation, even in the 10  $\mu$ w range.

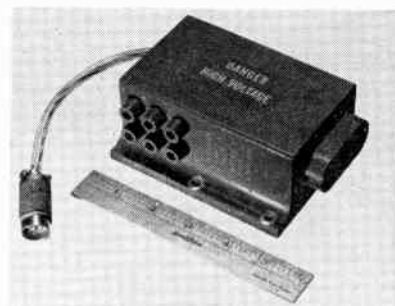
**CIRCLE NO. 202 READER SERVICE CARD**

## Power Supplies for c-r tubes

AVIONICS RESEARCH PRODUCTS CORP., 1215 El Segundo Blvd., El Segundo, Calif. All power requirements for high intensity crt's with pre- and post-acceleration including focus and intensity controls and gate coupling condensers are

provided in a space of less than 2 $\frac{1}{2}$  by 4 by 5.5 in. with the Mark I high-voltage power supply. It meets applicable military specifications and is operational to more than 70,000 ft without pressurization. The practice of using solid state elements throughout results in extremely long life.

**CIRCLE NO. 203 READER SERVICE CARD**



## Tap Welder for potentiometers

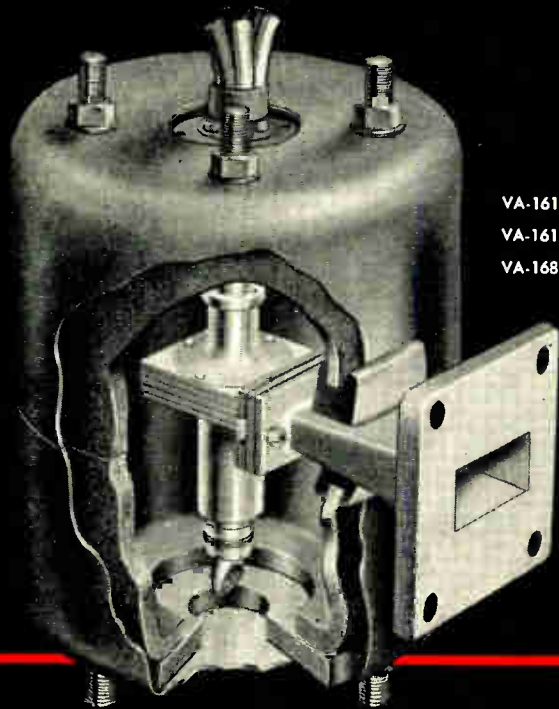
EWALD INSTRUMENTS, Box 124, Kent, Conn., has developed the Flash-Flow welder, a tap welder for potentiometers with built-in audi-



ble ohmmeter. The welder can be used to put taps onto single turns of windings made of 0.0005 to 0.008 in. diameter wire. It will handle most of the commonly used winding alloys in both precious and non-precious metals. The Flash-Flow

FOR  
WIDEBAND  
SYSTEM USE

VA-161  
VA-161B  
VA-168

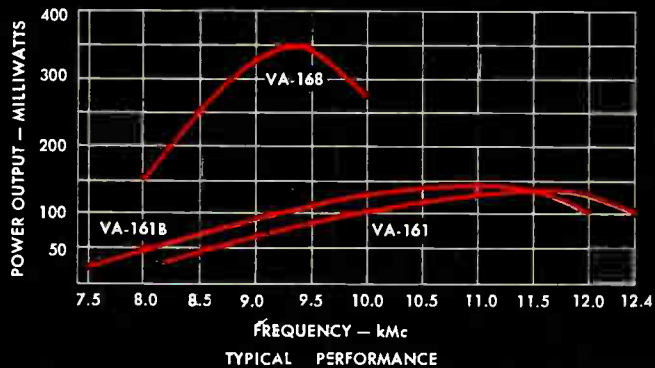


**VARIAN**

## BACKWARD WAVE OSCILLATORS

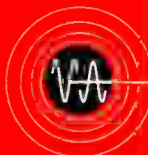
Features:

- SMALL SIZE
- LOW VOLTAGE
- LONG LIFE
- RUGGED CONSTRUCTION



Varian X-band BWO's are now the standard of the industry for systems requiring long life, low voltage operation, and small size. Characteristic of Varian BWO's is a uniform power output and helix voltage relationship with frequency. The metal and ceramic construction offers the most reliable tube at the lowest cost and assures dependability in severe environments.

Varian makes a wide variety of Klystrons and Wave Tubes for use in Radar, Communications, Test and Instrumentation, and for Severe Environmental Service Applications. Over 100 are described and pictured in our new catalog. Write for your copy — address Tube Division.



**VARIAN associates**

PALO ALTO 1, CALIFORNIA

Representatives throughout the world

ELECTRONIC TUBES, MICROWAVE TUBES, BACKWARD WAVE OSCILLATORS, WAVE TUBE EQUIPMENT, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, NAVY & AIR ELECTRONICS, RADAR, WATCHCLOCK, STABILIZER, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES



# GIRLS GIRLS

We're proud  
of our **GIRLS**

WESTern PENNSylvania has long been noted for its top-caliber male workers. But we're proud of our gals, too! And there's a wealth of them. In fact, only 17% of our total employed work force are women—compared with percentages as high as 46% in other sections of the state. Reduced to figures, it means 25,000 skilled and semiskilled female workers are available NOW! And we've got variety—from wartime-trained "Rosie the Riveter" to a prim and efficient "Gal Friday" skilled in office work.

And this incomparable asset is located

- ... in a geographic area within overnight shipping of 11 major industrial and consumer markets
- ... in a college area that graduates 3,000 science and engineering students each year
- ... in an industrial area with 44 development corporations prepared to provide 100% financing for new plants with interest rates as low as 2%

If you're interested, we'll be glad to give you full details on the male and female work forces in WESTern PENNSylvania, plus information about raw materials, 100% financing for new plants, and market surveys.

## WEST PENN POWER

an operating unit of the WEST PENN ELECTRIC SYSTEM



WEST PENN POWER, Area Development Department  
Cabin Hill, Greensburg, Pennsylvania E-15

Yes, I'm interested in details of WESTern PENNSylvania's labor supply—as well as:

Plant Location Services Booklet  100% Financing

Relocating or Establishing a Branch Plant

Please handle in confidence and mail to:

Company \_\_\_\_\_ Phone \_\_\_\_\_

Individual \_\_\_\_\_ Title \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

process uses a thin ribbon material to obtain tap connections with low terminal resistance. Use of this ribbon also greatly simplifies the handling of the tap material, and reduces the need for operator skill.

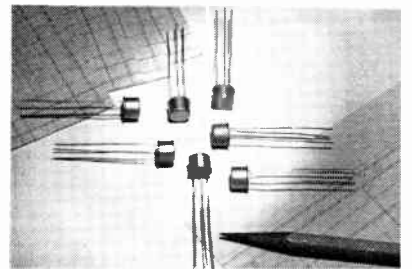
CIRCLE NO. 204 READER SERVICE CARD



### Voltmeter phase-angle

NORTH ATLANTIC INDUSTRIES, INC., 603 Main St., Westbury, N. Y. Model 301 broadband phase angle voltmeter provides in one unit a conventional vtvm, a phase meter and a voltmeter that measures both quadrature and in-phase components with respect to a reference. It is adjustable to any frequency in the range 10 to 100,000 cps. Voltage measurement range is 1 mv to 300 v full scale, in 12 steps. Instrument is readily applicable as a phase-sensitive null indicator, ratiometer, detector for synchro bridges and for use in amplifier alignment and transducer calibration.

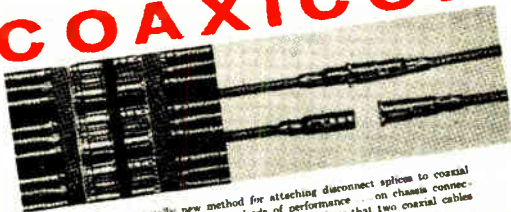
CIRCLE NO. 205 READER SERVICE CARD



### Silicon Transistors fixed-bed mounting

GENERAL ELECTRIC Co., Syracuse, N. Y., announces seven silicon h-f transistors designed for both amplifier and switching circuits and JEDEC type-designated 2N332 through 2N338. Fixed-bed mounting using a ceramic disk results in an extremely low thermal resistance which permits lower junction temperatures at high dissipation

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, computer, 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 burning 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.

**AMP INCORPORATED**  
GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan  
Reprint of an AMP advertisement for publication in 1958—prepared by W. Russell Berger, Inc.

**A**

**COAXIAL  
DISCONNECT  
IN SECONDS!**

**COAXICON**—brand new. One stroke of the A-MP precision tool does it. Two strokes and you have the pin and receptacle units permanently attached to coaxial cable. For low level circuitry, either panel mounted or free hanging.

- Reliability—the highest. Cost—lower than anything you're now using.
- Further, coaxial cable is fully supported against vibration.
- All this in seconds . . . no more burned insulation . . . no more tedious soldering . . . no more doubtful connections. Attachments at unbelievable speed that give you the finest termination at the lowest total installed cost.

**AMP INCORPORATED**  
GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan  
Reprint of an AMP advertisement for publication in 1958—prepared by W. Russell Berger, Inc.

...and now,  
**COAXICON fits a wider  
range of cable sizes**

COAXICON offers not only the fastest method of attaching disconnects to your shielded wire . . . it is not only the most reliable disconnect you can buy—for either free hanging or panel mounted applications . . . not only the most economical on the market . . . but . . . COAXICON now fits shielded cable sizes up to 1/4" O.D. with interchangeable contacts that permit a wide variation of inner conductor diameters in each cable size.

Further, COAXICON mounting clips accommodate a wide range of panel thicknesses for through-panel applications. Whether your requirements include RG type coaxial cable, standard coaxial cable or other shielded cable types, with solid or stranded conductors, look to AMP for the precise Coaxicon Disconnect you need.

If you're not now using the A-MP Coaxicon, send for literature today. It can solve many shielded circuit problems for you.

You are cordially invited to visit us at The WESCON Show in San Francisco, August 18-21, 1959, Booths 2501, 2502, 2604.

**AMP INCORPORATED**

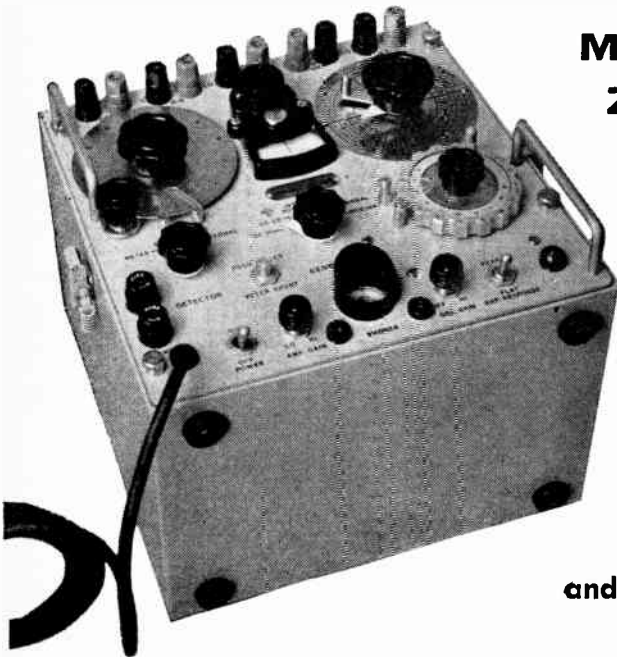
**GENERAL OFFICES: HARRISBURG, PENNSYLVANIA**

A-MP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Japan

**LABORATORY ACCURACY • MILITARY RUGGEDNESS**

# IMPEDANCE BRIDGE

**MODEL  
ZB-1**



★ AC and DC  
Resistance

★ Inductance  
and Storage  
Factor

★ Capacitance  
and Dissipation Factor

The Model ZB-1 provides for measurement of AC and DC resistance, inductance and storage factor, capacitance and dissipation factor. It is a laboratory instrument in accuracy, range and versatility in addition to being compact, portable and ruggedly constructed. It meets all the requirements of the Military Impedance Bridge Model AN/URM-90.

## SPECIFICATIONS

### RANGE:

RESISTANCE ..... 0.001 ohm to 11 megohms A-C or D-C (8 ranges)  
CAPACITANCE ..... 1 uuf to 1100 uf (7 ranges)  
INDUCTANCE ..... 1 uh to 1100 h (7 ranges)  
D ..... 0.001 to 1.0 at 1 KC } Provision for external  
Q ..... 0.02 to 1000 at 1 KC } extension

### ACCURACY

RESISTANCE	0.1 ohm range	±0.35%	INDUCTANCE	100 uh and below	±2 uh
	100 K ohm range	±0.2%		10 h and above	±10%
	All other	±0.15%		All other	±1%
CAPACITANCE	100 uuf and below	±2 uuf	D FACTOR		±(5%+0.0025)
	100 uuf range (above		Q FACTOR	to 10 hy	±(5%+0.0025)
	100 uuf)	±2%		at 100 hy	±(5%+0.015)
	All other	±0.5%		at 1000 hy	±(5%+0.055)
INTERNAL OSCILLATOR FREQUENCY	1 KC ±1%				
INTERNAL D-C SUPPLY	10 V at 250 ma. (D-C Low) 200 V at 10 ma. (D-C High)				
INTERNAL DETECTOR	Response flat or selective at 1 KC; sensitivity control provided.				
POWER LINE	115 volts, 50-1000 cycles, 18 watts.				
DIMENSIONS	10 1/4" x 11 1/4" x 11 1/4" overall with cover.				
WEIGHT	21 lbs.				
ACCESSORIES SUPPLIED	Set of red and black test leads (19" long) with 2 alligator clips.				



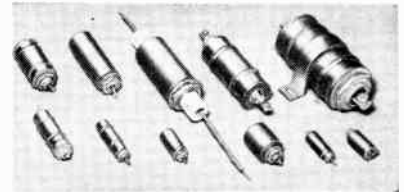
For complete technical  
specifications write . . .

**Industrial Instruments:**

89 COMMERCE ROAD, CEDAR GROVE, N. J.

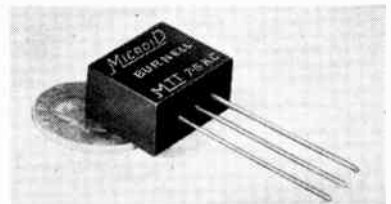
levels. Accelerated life tests were run at an ambient temperature of 150 C and a dissipation of 75 mw. The military spec for these transistor types derates to zero dissipation at 150 C. Over the 1,000-hr tests, beta increased only about 20 percent and  $I_{c0}$  was typically 2 millimicroamperes at 25 C. At 150 C,  $I_{c0}$  is typical about 1  $\mu$ a.

CIRCLE NO. 206 READER SERVICE CARD



## R-I Filters bulkhead-mounting

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass., offers a series of 68 bulkhead-mounting low-pass filters for suppression of electronic interference generated by electrical and electronic equipment. Current ratings are from 5 ma to 50 amperes. Units meet military environmental conditions and operate at high temperatures. Complete technical information is listed in engineering bulletin 8100, available on letterhead request.



## Filters microminiature

BURNELL & CO., 10 Pelham Parkway, Pelham, N. Y. Type MTT Microid band pass filters for transistorized circuitry measure 1/2 by 1/2 by 1/8 in. and weigh 0.3 oz. Range is 7.35-100 kc; bandwidth, 15 percent at 3 db and +60 -40 percent at 40 db. Fully encapsulated, they exceed MIL specs.

CIRCLE NO. 207 READER SERVICE CARD

## TWT Amplifier light, compact

MENLO PARK ENGINEERING, 711 Hamilton Ave., Menlo Park, Calif.,





## ELECTRONIC ENGINEERS

- ATLAS** Slated to become the first operational ICBM of the United States.
- VEGA** The multi-stage rocket scheduled to become the first U. S. space vehicle in the "medium energy" class. Capable of sending a 1,000 lb. payload to the moon.
- CENTAUR** Will become the first U. S. space vehicle in the "high energy" class. Capable of putting a five ton payload into satellite orbit.
- AZUSA** The most accurate missile tracking system available today. Currently being used on virtually all ballistic missiles fired at Cape Canaveral.

Electronic design and development on these and other advanced space programs at Astronautics has created a variety of interesting assignments at a most advanced state of the art. If you have a degree in electrical engineering and between three and ten years of experience, you may qualify for one of the long-range positions now available. Immediate openings exist in the following specialties:

Test Equipment · Telemetry · Radiation Systems (Not Nuclear) · Electrical Design · Missile Instrumentation · Trajectory Measurement and Orbit Determination · Automatic Controls · Autopilot · Servomechanisms · Electronic Packaging

Our engineering representatives will be conducting

### INTERVIEWS

in these cities soon:

Albuquerque · Boston · Chicago · Cleveland · Dayton · Denver · Detroit · El Paso · Fort Wayne · Hagerstown · Houston · Rockford · Indianapolis · Los Angeles · Milwaukee · New Orleans · New York · Oklahoma City · Philadelphia · Pittsburgh · St. Louis · Salt Lake City · San Francisco · Schenectady · South Bend · Syracuse · Washington, D.C. · Youngstown

Qualified Electronic Engineers are urged to send a detailed resume at once so advance arrangements can be made for a confidential interview. Write to Mr. T. W. Wills, Engineering Personnel Administrator, Department 130-90,

**CONVAIR/ASTRONAUTICS**  
CONVAIR DIVISION OF  
**GENERAL DYNAMICS**

5615 KEARNY VILLA ROAD, SAN DIEGO, CALIFORNIA

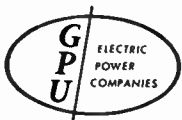
# PRESSED FOR TIME AND CRAMPED FOR SPACE?



Let **GPU Site-Service** solve your problem with a wide choice of sites with room for growth!

In GPU territory—heart of the world's richest market—there's plenty of space and every other factor you need for growth. Available, too, are choice locations, many with modern buildings. To be ready faster for expansion by saving site-seeking time and trouble, phone, wire or write today. Your inquiry will receive prompt, *confidential* attention.

**GPU Site-Service** . . . the one central source of plant location information for nearly half of Pennsylvania and New Jersey.



Metropolitan Edison Co.  
Pennsylvania Electric Co.  
New Jersey Power & Light Co.  
Jersey Central Power & Light Co.

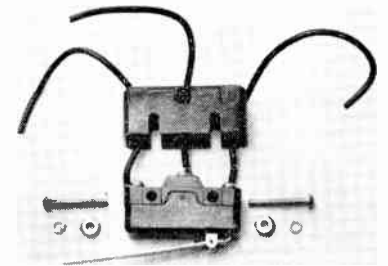


## GENERAL PUBLIC UTILITIES CORPORATION

Att: Wm. J. Jomieson, Area Development Director, Dept. E-5 • 67 Brood St. New York 4, N. Y. • Whitehall 3-5600

announces TA 36 PM permanent magnet focused twt amplifier, applicable to many uses in the operating frequency range of 0.5 to 1.0 kmc. The ruggedized power supply provides 0.1 percent regulation, with maximum ripple on the helix less than 10 mv. Front panel metering is provided for helix voltage, helix current and beam current. Unit is designed for relay rack or cabinet mounting.

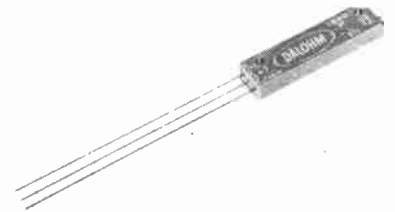
CIRCLE NO. 208 READER SERVICE CARD



### Terminal Protector long life

ROBERTSHAW-FULTON CONTROLS CO., P. O. Box 449, Columbus 16, Ohio. A new terminal protector, for use with basic switches having one inch mounting centers, has 11 knockouts, making possible many wiring possibilities. It may be used with either solder or screw terminals, in either flat or step base switches. It is made of high impact material for long life.

CIRCLE NO. 209 READER SERVICE CARD

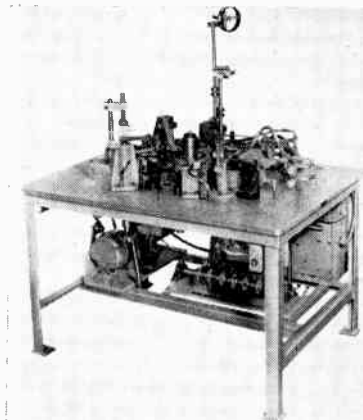


### Trimmer Pot completely sealed

DALE PRODUCTS INC., Box 136, Columbus, Neb. Type 1000 W trimmer pot meets all humidity requirements of MIL-STD-202A, Method 106A or MIL-E-5272A, Procedure I. Power rating is 2.5 w to 70 C, mounted per MIL-R-19A with marking away from panel; 1.25 w to 70 C in free air. Resistance tolerance is  $\pm 5$  percent standard; resistance range from 10 ohms to 50

K ohms, depending on value required. Temperature coefficient is 50 ppm/deg C maximum. End resistance is 3 percent maximum on all values; nominal resolution, from 0.1 to 1.5 percent; linearity, below  $\pm 3$  percent on all values.

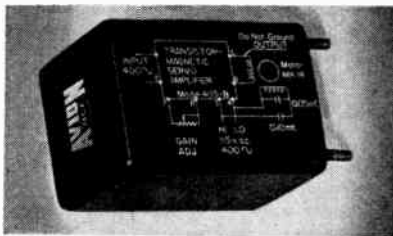
CIRCLE NO. 210 READER SERVICE CARD



### Soldering Machine for cat whisker wire

KAHLE ENGINEERING Co., Union City, N. J., announces a new machine that automatically feeds cat whisker wire from a spool into a tiny hole and solders it. The machine then precision cuts the wire and forms it into an "S" shape. The unit has been production tested for the intricate operations involved in automatically soldering cat whisker wires into the prong of ceramic crystal diodes. However the principle of the machine may be applied to similar operations involving similar shapes or parts.

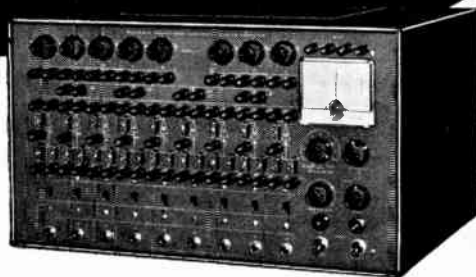
CIRCLE NO. 211 READER SERVICE CARD



### Servo Amplifier compact unit

AVION DIVISION, ACF Industries, Inc., 11 Park Place, Paramus, N. J. Model 403 transistor-magnetic servo amplifier is a compact, completely self-contained unit. It

# NEW! An Electronic ANALOG COMPUTER KIT for just \$199<sup>95</sup>



- Simulates Mechanical Problems, Processes and Conditions
- Solves Mathematical Problems (Add, Sub., Divide, Multiply, Integrate, Differentiate, get Transfer Functions)
- In a Class by Itself, But Compares in Functions to Computers Costing Over \$1,000.00
- Easy to Build in 35 to 40 Hours With No Experience

The lowest priced computer of its quality available anywhere, the new Heathkit EC-1 Computer now puts advanced engineering techniques within reach of all.

*Industry* will find the EC-1 invaluable in trial solutions to mechanical and mathematical problems . . . shortens engineering time, speeds up preliminary work, frees the advanced-computer time for more complex problems and final solutions. And the EC-1 aids in training computer operators and acquainting engineers with computer versatility and operation.

*Schools and colleges* will find the EC-1 ideal for teaching and demonstrating in engineering, physics, and math classes; perfect for laboratory use in teaching computer design and applications.

*Individuals* will find the EC-1 a fascinating helper in solving mathematical and mechanical problems. To consultants and those who work alone, the EC-1 soon becomes an indispensable path to speedy, trustworthy solutions.

Set up scores of complex problems with the assortment of precision components and patch cords supplied. Read problem results directly on the 3-range computer meter, or use an external read-out device such as the Heathkit OR-1 DC Oscilloscope, or a recording galvanometer. Meter can be switched to read output of any amplifier for problem results or balancing purposes. Informative manuals provided show how to set up and solve typical problems, illustrate operating procedures, and supply basic computer information, references, and construction procedure. Shpg. Wt. 43 lbs.

**SPECIFICATIONS:** Amplifiers: 9 D.C. Operational Amplifiers using one 6U8 per amplifier; each solves mathematical problems; each balanced by individual panel control without removing problem set-up. Computing components mount on connectors and plug into panel sockets. Open loop gain approximately 1000. Output—60 to +60 volts at 3 ma. Power Supplies: +300 volts at 25 ma electronically regulated; variable from +25G to +350 by control with meter reference for setting +300 volts. Negative 150 volts at 40 ma regulated by VR tube. Coefficient Potentiometers: Five on panel. Initial Condition Potentiometers: Three on panel; used to introduce initial velocity, acceleration, etc. on the three "given" quantities. Repetitive Operation: Multivibrator cycles a relay at adjustable rates (.1 to 15 CPS), to repeat the solution any number of times; permits observation of effect on solution of changing parameters. Meter: 50-0-50 ua movement. Power Requirements: 105-125 volts, 50-60 cycles, 100 watts. Dimensions: 19 1/2" W. x 11 1/2" H. x 15" D.

Order Direct by Mail or see your nearest Authorized Heathkit Dealer

**FREE CATALOG**

Mail the coupon now for the Free Heathkit Catalog describing over 100 easy-to-build Heathkit products including test equipment, ham radio gear, marine equipment and hi-fi components.

**HEATH COMPANY BENTON HARBOR 14, MICH.**

Ⓜ a subsidiary of Daystrom, Inc.

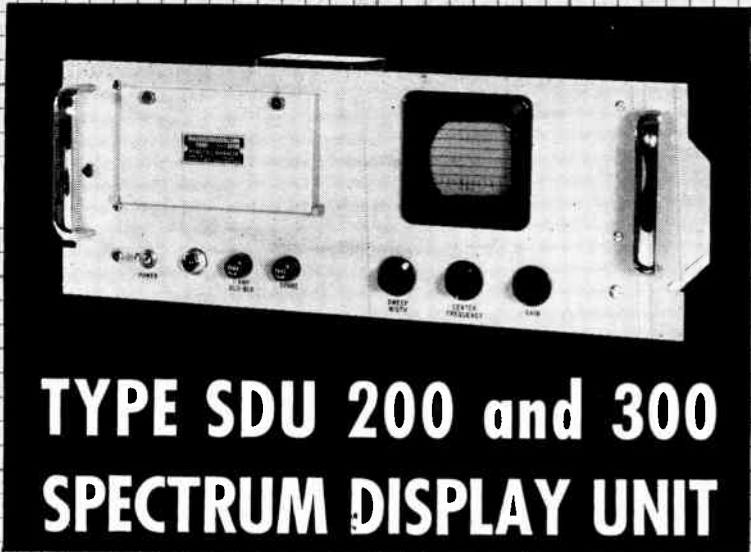
Please send the latest Free Heathkit catalog.

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ ZONE \_\_\_\_\_ STATE \_\_\_\_\_

ALL PRICES F.O.B. BENTON HARBOR, MICH. PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.



## TYPE SDU 200 and 300 SPECTRUM DISPLAY UNIT

THE purpose of the Spectrum Display Unit is to provide a visual indication of the signal to which a receiver is tuned, as well as to provide a visual indication of signals in a band of frequencies above and below that being received. The signals are displayed on a cathode-ray tube. The CRT has a calibrated screen allowing both frequency and relative amplitude of received signals to be determined.

### SPECIFICATIONS

Maximum Sweep Width—  
 SDU-200 ..... 2 megacycles  
 SDU-300 ..... 3 megacycles

Input Center Frequency ..... 21.4mc or 30.0mc

Second IF Amplifier Frequency ..... 4.3 megacycles

Sensitivity for full deflection: 5 microvolts to receiver

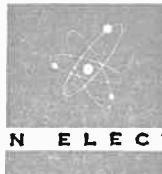
Resolution ..... approximately 20kc

Power Input ..... 117v, 50-60cps, approximately 95w

Size ..... 19" x 7" x 13"

## NEMS·CLARKE CO.

A DIVISION  
 OF VITRO  
 CORPORATION  
 OF AMERICA



919 JESUP-BLAIR DRIVE  
 SILVER SPRING, MARYLAND  
 MUNICIPAL AIRPORT  
 MARTINSBURG, WEST VIRGINIA

PRECISION ELECTRONICS SINCE 1909

drives a 3.5-w Mark XIV or equivalent size motor from low-level a-c signals. It requires only 115-v, 400-cycle excitation. Servo stabilization is inherent in the design. Model 403-A has an input impedance of 30,000 ohms and a gain of 2,000 times; the 403-B, an input impedance of 500,000 ohms and gain of 900 times.

CIRCLE NO. 212 READER SERVICE CARD



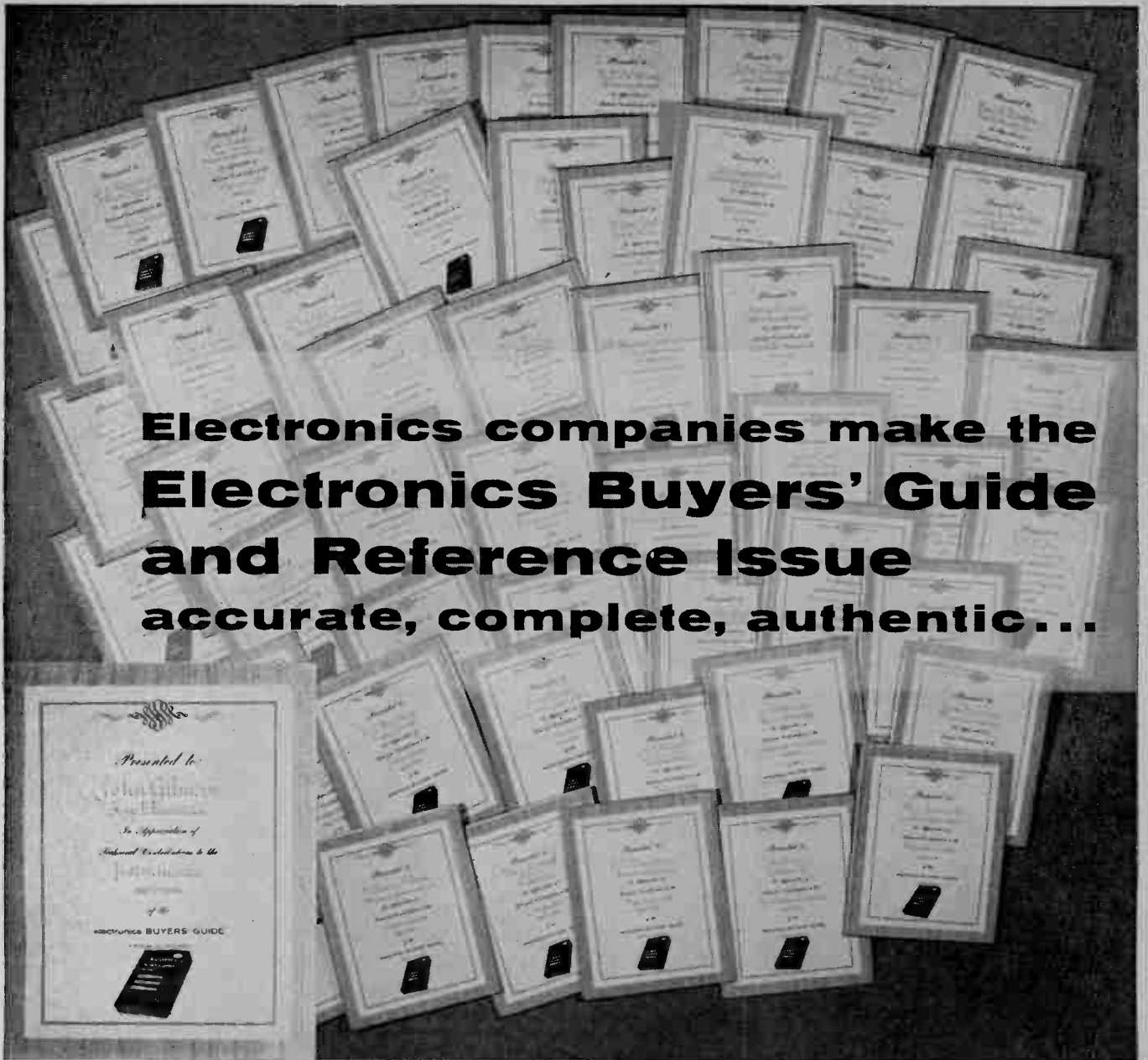
### Ring-Gun simply operated

WALDES KOHINOOR, INC., 47-16 Austel Place, Long Island City 1, N. Y. A new ring-gun is designed for high-speed, mass-production assembly of Truarc series 5103 Crescent rings, series 5133 E-rings and series 5144 reinforced E-rings. Rapid loading with Rol-Pak tape-wrapped stacked rings, illustrated in photo at top, assures a constant supply of the fasteners. In photo at bottom, the tool has been used to install three series 5144 rings on the roller studs. In each case, the tool was placed over the stud, the tongue of the actuating lever inserted into the groove and the trigger compressed.

CIRCLE NO. 213 READER SERVICE CARD

### Insulating Parts oxide ceramics

MATERIALS FOR ELECTRONICS, INC., 152-25 138th Ave., Jamaica 34, N. Y. Degussit ceramics in pure sintered alumina, sintered spinel, sintered zirconium oxide (stabilized), sintered magnesium oxide and kaolin bonded corundum. Insulat-



**Electronics companies make the  
Electronics Buyers' Guide  
and Reference Issue  
accurate, complete, authentic...**

For nineteen years, firms in the electronics industry have made direct contributions to the accuracy, completeness and authenticity of the BUYERS' GUIDE.

Recently, the staff of the BUYERS' GUIDE decided to award plaques to express appreciation to those in the industry who had made direct contributions to improve the product listings. The photograph above represents a few of the awards that have been made.

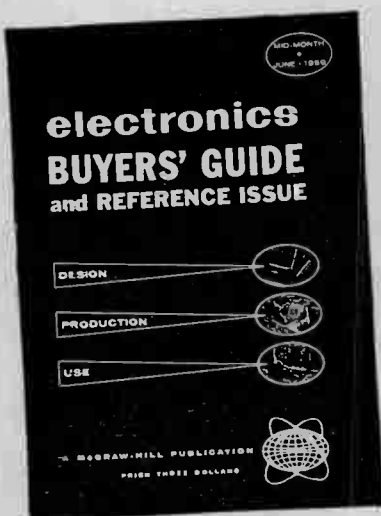
The awarding of the plaques is but one indication of how the BUYERS' GUIDE evolved over the years... a cooperative effort between the publication and the industry it serves.

Only through years of experience can a buyers' guide reflect the needs of an industry as complex and dynamic as electronics... one more reason why the BUYERS' GUIDE is the ONE accepted product and data book in the field.

Published mid-year as the 53rd issue of **electronics**

A McGRAW-HILL PUBLICATION

330 WEST 42ND STREET, NEW YORK 36, N.Y.



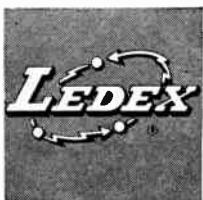
**For remote control switching jobs . . .**  
*stepping, counting, programming,*  
*circuit selecting, sequencing and homing*



*I specify*  
**LEDEX SELECTOR SWITCHES**

*because...*

*sizes from sub-miniature, with  
 switch positions to meet all requirements  
 any operating voltage from 3 to 300 volts DC  
 variety of models stocked for immediate delivery  
 hermetically sealed models are offered  
 compactness eliminates "bulk" problems  
 silver alloy contacts give long switch life  
 the economical solution to multiple circuit switching  
 experienced LEDEX engineers are available to help  
 LEDEX means dependability  
 write for descriptive literature today!*

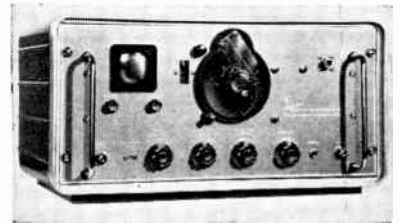


**G. H. LELAND, INC.**  
 DAYTON 2, OHIO, U.S.A.

In Canada: Marsland Engineering, Ltd., Kitchener, Ontario  
 In Europe: NSF Ltd., 31-32 Alfred Pl., London, England; NSF, GmbH, Nürnberg, Germany

ing parts made from pure alumina body (A1-23) may be sintered into shapes without adding sintering auxiliaries. They are stable in oxidizing and reducing gases, high vacuum, against all tube metals and can be metalized by any process.

**CIRCLE NO. 214 READER SERVICE CARD**



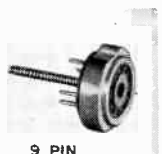
**Frequency Meter**  
**self-contained**

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn, N. Y. Type 504 is a self-contained precision heterodyne frequency meter that provides direct reading of frequency from 100 to over 10,000 mc to an accuracy of 0.03 percent. A simple twist of the wrist permits the meter operator to read frequency to 0.1 mc without any longhand interpolation, thanks to a unique automatic interpolation device. Calibration charts are not necessary.

**CIRCLE NO. 215 READER SERVICE CARD**



7 PIN



9 PIN

**Tube Socket Saver**  
**meets MIL specs**

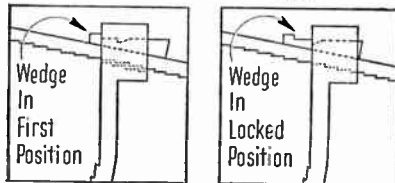
FORWAY INDUSTRIES, INC., 122 Green Ave., Woodbury, N. J., has available a tube socket saver for 7 and 9 pin miniature, and octal type sockets. Designed for use in electron tube testers, these savers are inserted into the sockets of the test set panel. When the contacts become worn, the expendable saver can be thrown away, and a new one replaced without rewiring the test set. Height of the base is held to a minimum and therefore the socket saver will fit into a limited space. Maximum height above the

See us at Booth 1017—Wescon Show, San Francisco

## new! *Weckesser* nylon Wedge Lock BAND CLAMP

TWO-POSITION  
WEDGE PERMITS  
ADJUSTMENT FOR  
TEMPORARY ASSEMBLY . . .

Patent  
Pending



BUT . . .  
ONCE  
IT'S LOCKED,  
YOU'VE GOT  
TO CUT IT LOOSE!

- Another Weckesser "first" • Just introduced at the I.R.E. Show • First practical band clamp that locks and holds permanently • Solid DuPont Zytel 101 (Nylon) • Easy assembly with screwdriver or forked tool—One size for cable diameters  $\frac{1}{8}$ " to  $1\frac{1}{4}$ "

Send for free samples and bulletin

Manufacturers of Nylon, Teflon and Ethocel Cable Clamps,  
Molded Nylon Screws and Nuts, Nylon Threaded Rod and Washers

# *Weckesser* COMPANY

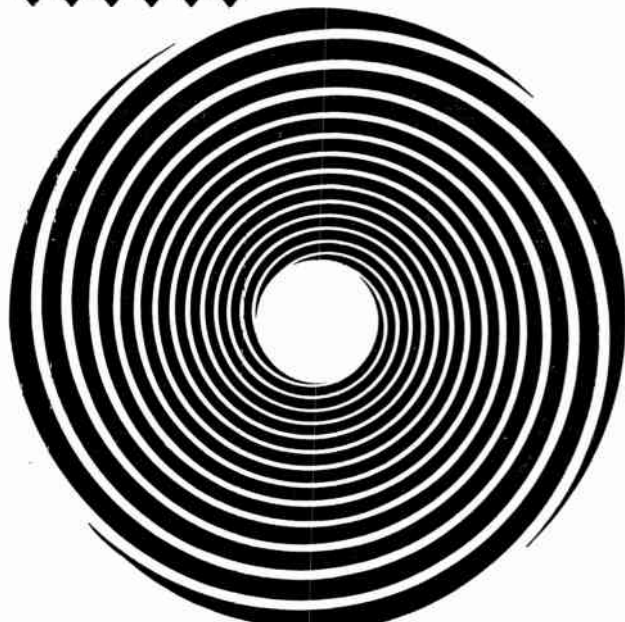
5701 Northwest Highway • Chicago 46, Ill.

CIRCLE NO. 119 READER SERVICE CARD

## CIRCULATORS

Basically, the Rantec circulator is a non-reciprocal hybrid junction with three or more ports. Non-basically, the circulator is finding more and more use in advanced radar and microwave systems. In addition, Rantec research and development has led to many other sophisticated "active" and "passive" microwave ferrite components. Your inquiry is welcomed.

**r a n t e c** corporation • calabasca, california

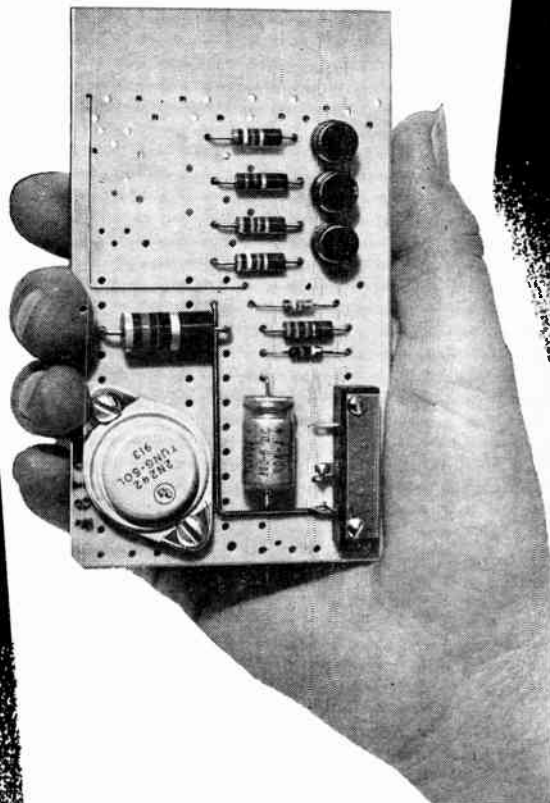


at Wescon, visit Rantec . . . booth 315

CIRCLE NO. 120 READER SERVICE CARD

ELECTRONICS • AUGUST 14, 1959

## TRANSISTOR CIRCUITRY ENGINEERING "KNOW HOW" AND PRODUCTION



- How to get the optimum performance and reliability from an electronic component is often directly related to research and engineering "know-how" of transistor circuitry.

The Acme Electric research and engineering staff have a wealth of experience to develop assemblies in this specialized field of manufacturing. A letter outlining your problem will have our prompt attention.

### ACME ELECTRIC CORPORATION

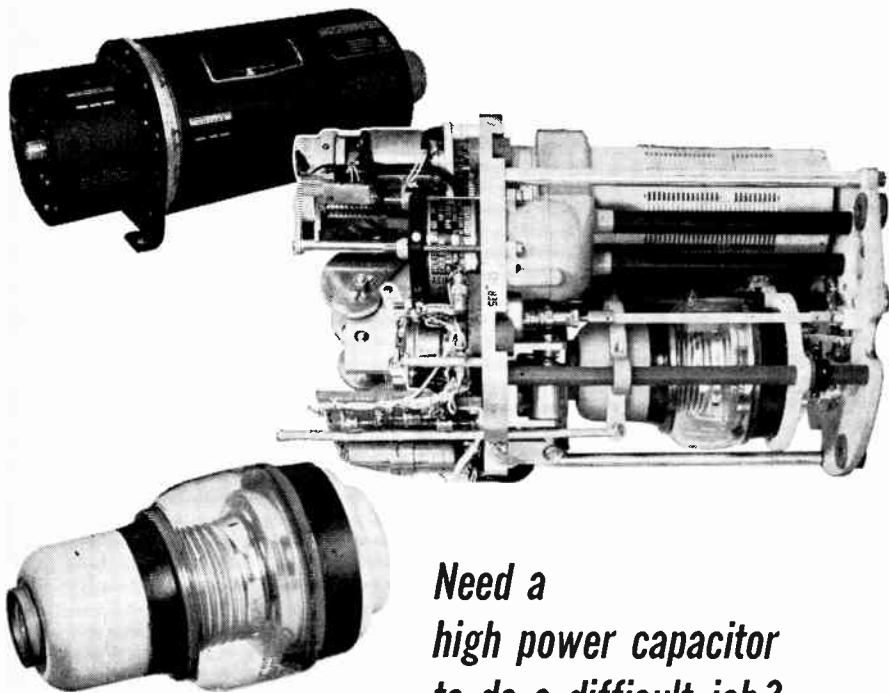
318 WATER ST.

CUBA, N. Y.

West Coast: 12822 Yukon Avenue • Hawthorne, Calif.

# Acme Electric

CIRCLE NO. 95 READER SERVICE CARD



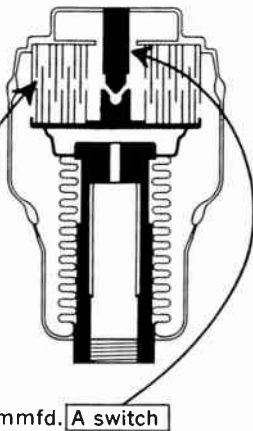
*Need a  
high power capacitor  
to do a difficult job?*

## JENNINGS VACUUM CAPACITORS

Jennings Vacuum Capacitors combine imaginative engineering with the innate advantages of a vacuum dielectric to accomplish circuit designs impossible to obtain with other capacitive devices.

An example of the creative engineering obtainable at Jennings is our type UCSSLPS variable vacuum capacitor. This capacitor was designed for use in Remington Rand's new UNIVAC 3200 Series Automatic Antenna Coupler whose superior performance is achieved through advanced circuit design using the highest quality components.

Apparent requirements, in this application, were for two capacitors and a shorting relay to allow switching from a high voltage capacitor to a low voltage capacitor, or switch both capacitors out of the system completely. Space limitations, however, presented an obstacle. The problem was solved by designing one capacitor with two sets of plates of different lengths which by sliding in and out would meet the different voltage and capacitance requirements. It has a test voltage rating of 5 kv at 750 mmfd increasing to 23.5 kv at 40 mmfd and 30 kv at 10 mmfd. A switch is incorporated inside the vacuum to short out the total capacity under very high frequency operation. This also has the added advantage of having a common starting point, or a pre-set point, for the automatic tuning mechanism.



Jennings capacitors are obtainable either fixed or variable and since there is no dielectric to puncture they are self healing after moderate arc-over.

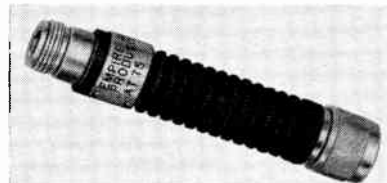
**Catalog literature on over 300 types of vacuum capacitors, switches, and relays is available for more detailed information.**

**Jennings**

RADIO MANUFACTURING CORPORATION  
970 McLAUGHLIN AVE., P. O. BOX 1278, SAN JOSE 8, CALIF.

panel of the 7 and 9 pin is only 11/32 in.

**CIRCLE NO. 216 READER SERVICE CARD**



### Attenuator Pad high power

EMPIRE DEVICES PRODUCTS CORP., Amsterdam, N. Y. Model AT-75 coaxial attenuator pad has a high power rating (up to 4 w continuous and 2 kw peak). Units are recommended for use as laboratory standards of attenuation at microwave frequencies, calibration and periodic checking of attenuators in signal generators and other measuring instruments, and as isolating pads when a source must "see" a low vswr not provided by the load.

**CIRCLE NO. 217 READER SERVICE CARD**



### Power Rectifier heavy-duty

TRANSITRON ELECTRONIC CORP., Wakefield, Mass. A new heavy-duty stud-mounted silicon rectifier features a high-current rating of 35 amperes at 150 C case temperature. A standard 1/2 in. hex base encapsulation provides ease of mounting and an adequate heat-sink. Piv ratings range from 50 to 400 v. Operating and storage temperatures range from -65 to 200 C.

**CIRCLE NO. 218 READER SERVICE CARD**

### Rotary Switch replaceable wafers

CHICAGO DYNAMIC INDUSTRIES, INC., 1725 Diversey Blvd., Chicago 14, Ill., offers a rotary switch, any wafer of which lifts out without unsoldering or disassembling for



Expanding the Frontiers  
of Space Technology in

## COMMUNICATIONS

■ As man's explorations reach further into outer space, it becomes necessary to make great improvements in communications. One of Lockheed's many contributions in this field is a miniaturized satellite tape recorder, capable of storing three million pieces of scientific data anywhere in its travels and on returning to within range of earth stations, transmit it on command.

Other Lockheed design and developed equipment is successfully providing highly accurate information on temperature, pressure, acceleration, vibration, thrust, vehicle attitude and other conditions during hypersonic flight.

### ENGINEERS AND SCIENTISTS

Lockheed Missiles and Space Division programs reach far into the future and require a bold and imaginative approach where only theory now exists. If you are experienced in space communications or in closely related work, we invite you to join us in one of the nation's most interesting and challenging basic technical programs. Write: Research and Development Staff, Dept. H-2-22, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

## Lockheed

### MISSILES AND SPACE DIVISION

Weapons Systems Manager for  
Navy POLARIS FBM,  
DISCOVERER SATELLITE,  
Army KINGFISHER,  
Air Force Q-5 and X-7

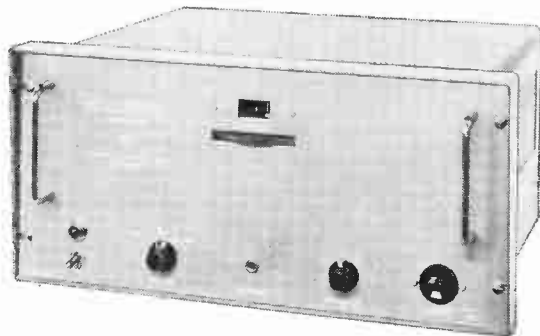
SUNNYVALE, PALO ALTO, VAN NUYS,  
SANTA CRUZ, SANTA MARIA, CALIFORNIA  
CAPE CANAVERAL, FLORIDA  
ALAMOGORDO, NEW MEXICO • HAWAII

# NEW Powertron

## AC ELECTRONIC GENERATOR

MODEL 150  
**\$495<sup>00</sup>**

PRECISION  
AC POWER  
SUPPLY FOR  
LABORATORY &  
PRODUCTION USE



### SPECIFICATIONS

Power Output .....	160 V.A.	Total Distortion .....	Less than 1%
Fixed Frequency .....	400 CPS (other freq. avail.)	Regulation .....	Less than 1%
Variable Frequency .....	350-450 CPS	Operates with load of any power factor	
External Frequency .....	50-4000 CPS	Small size .....	8 3/4" x 19" Panel

Also Available — Model 250 — 250 VA Power Output

Representatives in Principal Cities



**INDUSTRIAL TEST EQUIPMENT CO.**  
55 EAST 11th STREET • NEW YORK 3, N. Y.

CIRCLE NO. 121 READER SERVICE CARD

## AMCI

## TYPE 1026

# SLOTTED LINES

for  
accurate  
measurement of  
impedance in rigid  
and flexible coaxial  
transmission lines.

### FEATURES:

- Rated residual VSWR under 1.01
- Rated error in detected signal under 1.005
- Available in 20, 40, 60, 80, and 130 inch lengths.

Write for  
Bulletin E-958

The outer conductor of the Type 1026 Slotted Lines is made of two substantial aluminum castings, carefully machined and dowelled together, with the important surfaces finished by a hand scraping operation. The inner conductor is ground to a close tolerance, supported by compensated dielectric pins, and longitudinally positioned by a compensated dielectric anchor at the feed end.

AMCI Tapered Reducers, Instrument Loads, and Impedance Standard Lines are available for use with the Type 1026 Slotted Lines in making measurements of a wide range of rigid and flexible coaxial lines.



ANTENNA SYSTEMS—COMPONENTS—AIR NAVIGATION AIDS—INSTRUMENTS

**ALFORD** Manufacturing Co. Inc.

299 ATLANTIC AVE., BOSTON, MASS.

**marion**  
advancement  
in instrument  
design



ACTUAL  
SIZE

**MM-1 MEDALIST\* meter**

Today's most readable, modern miniature meter. Shielded...no error from magnetic panels. Rugged Marion Coaxial mechanism. Max. weight 1.6 oz. In all standard ranges, various colors. Single hole mounting. Data on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Co., Manchester, New Hampshire, U.S.A.  
\*T.M. Reg. U.S. Pat. Off. U.S. & Foreign Patents  
Copyright © 1959, Marion

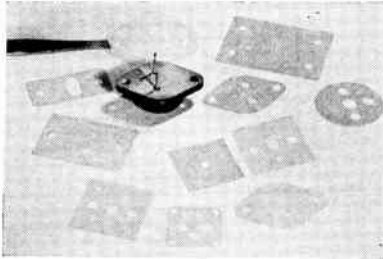
**marion**  
"WHERE ELECTRONICS MEETS THE EYE"  
**meters**



At Wescon, Booth 2614-2616  
CIRCLE NO. 122 READER SERVICE CARD

cleaning or replacement. Switches are available in sizes approximately 2 by 2 in., 3 by 3 in. and 4 by 4 in. with lengths to accommodate up to 36 wafers. Wafers can be made to include printed circuitry and components in addition to their normal switching function.

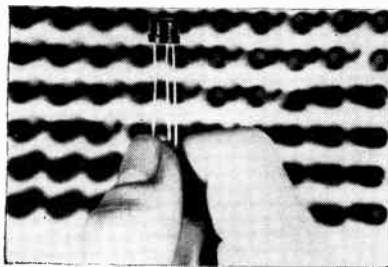
CIRCLE NO. 219 READER SERVICE CARD



**Mica Wafers  
protect transistors**

FORD RADIO & MICA CORP., 536-540 63rd St., Brooklyn 20, N. Y., is now producing mica wafers stamped to fit the bases of standard transistors and diodes. An excellent insulator with dielectric strength of up to 6,000 v/mil, the mica prevents grounding with the chassis. A thermal conductivity of 0.00014 to 0.0008 allows rapid transfer of transistor or diode heat to chassis heat sinks, thereby preventing runaway semiconductor performance caused by overheating.

CIRCLE NO. 220 READER SERVICE CARD



**Diode Switch  
multijunction**

WESTINGHOUSE ELECTRIC CORP., P. O. Box 2088, Pittsburgh 30, Pa., announces a 200-mw Dynistor diode switch. It is a multijunction, two-terminal germanium switch that can transfer from a blocking to a conductive condition in fractions of a microsecond. It is ideal for applications in computers and core-driver circuitry. It can also be used as a protection against transient

*Artisan*

**ELECTRONIC  
ORGAN**

for your  
**HOME!**

**BUILD-IT-  
YOURSELF  
SAVE!**



Now you can own a professional electronic organ and save up to 50% on an easy pay-as-you-build plan . . . The world famous ARTISAN ORGAN—in 14 models from the popular 2-manual Home entertainment style to the majestic 4-manual Theatre and Church style is now available in kit form. Simple step-by-step instructions, pictorial diagrams and schematics make this an ideal spare-time project for anyone.

**FREE LITERATURE on REQUEST**

Get the Artisan Story before you purchase any Organ, Kit or commercial model.

ARTISAN MUSIC HALL New Home of  
ARTISAN ORGANS



**ORGAN  
KITS  
and  
COMPONENTS**

**ELECTRONIC  
ORGAN ARTS, INC.**

4949 YORK BLVD., Dept. E-8  
LOS ANGELES 42, CALIF.

CIRCLE NO. 123 READER SERVICE CARD

send for this

**FREE**

**EICO  
Electronics  
Catalog**



you save 50% on Top-Quality  
Test Instruments  
Hi-Fi • Ham Gear  
**KITS AND WIRED**  
for professional and home use

**TEST INSTRUMENTS**  
battery eliminators  
battery testers  
bridges  
decade boxes  
electronic switch  
flyback tester  
oscilloscopes  
probes  
signal and sweep generators  
tube testers  
transistor tester  
vacuum tube voltmeters  
volt-ohm-milliammeters

**HI-FI**  
stereo and monaural tuners  
preamplifiers  
power amplifiers  
integrated amplifiers  
speaker systems

**HAM GEAR**  
cw transmitter  
modulator-driver  
grid dip meter

**OVER 1½ MILLION**  
EICO instruments in use throughout the world.

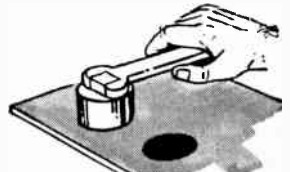
LIFETIME service and calibration guarantee. IN STOCK at your neighborhood EICO dealer. Send now for FREE catalog E8

**EICO** 33-00 N. Blvd., L. I. C. 1, N. Y.  
... praised by the experts  
as BEST BUYS IN ELECTRONICS  
© 1958 ELECTRONIC INSTR. CO., INC.

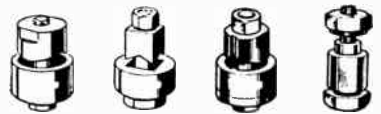
**Cut Holes  
In Less Than  
90 Seconds!**



with  
**Walseo**  
**CHASSIS PUNCHES**



Make any size hole you want for sockets, plugs, meters, others . . . do it faster with less effort with famous Walseo L.T.\* Chassis Punches. Easy to use . . . last a lifetime. Send postcard for free literature.



(\*L.T. is Walseo's exclusive "Low-Torque" design)

**WALSCO ELECTRONICS MFG. CO.**  
Division of Textron Inc.

Western Plant: Los Angeles 18, California  
Main Plant: ROCKFORD, ILLINOIS, U.S.A.

CIRCLE NO. 124 READER SERVICE CARD  
AUGUST 14, 1959 • ELECTRONICS

# dekatron<sup>®</sup>

**FOR FAST AND ACCURATE COUNTING**



**cold-cathode glow transfer counting TUBES up to 20,000 counts/sec**



**DELTA ENGINEERING CORP.,**

When developing this high-speed Automatic Counting Machine, evaluated many preset counters. Delta decided on an electronic count control using Baird-Atomic Dekatron counting tubes. The machine can tally up to 5-million manufactured parts an hour with an accuracy of 1/10 of 1% — an application requiring the extreme reliability and performance gained by Dekatron's more than 10 years of service.

For full details on Dekatron glow-transfer tubes and patented drive circuits, write to . . . .

**Baird-Atomic, Inc.**

33 UNIVERSITY RD. CAMBRIDGE 38, MASS.



*Instrumentation for Better Analysis*

CIRCLE NO. 125 READER SERVICE CARD

## MEET ROLLY CHAREST



Associate Editor  
**electronics**

**RESUME:**

Charest, Roland J., Boston University, BS in Journalism. Formerly New England editor for electronics. Navy sonarman. Writer, reporter, editor for Lynn Item, Boston Globe, Boston Traveler. Won a New England Associated

Press (AP) award in 1955 for writing feature articles in the major city newspaper class.

**PRESENT OCCUPATION:**

Rolly Charest supports Managing Editor Jack Carroll for editorial content accuracy and expediting putting each weekly issue to bed. Rolly reworks headlines for greater readability, is involved in makeup, and helps polish editorial content. Rolly's across-the-board background assures you accuracy in the face of journalistic pressures; articles in this week's issue that could be held over to the next deadline, but are not. The readers' interests come first!

**REFERENCES:**

If you're not a subscriber, if your subscription is expiring, if you will miss exciting features "in-the-works" by electronics 26-man staff, fill in box on Reader Service Card. Easy to use. Postage is free.

**electronics**

A McGraw-Hill Publication • 330 W. 42nd St., New York 36

# Color-Lite

the touch of  
**BRILLIANCE**



...in panel design

Only COLOR-LITES permit the design of compact, low cost panels. Their small size and clean, neat appearance assist in the design of more functional indicator panels for test equipment, production machinery, missile test stands and aircraft.

Design your next panel with COLOR-LITE subminiature indicator lights in mind. For unusually high quality, easy to install panel indicator lights, always specify COLOR-LITE

Write for COLOR-LITE Catalog A-58.

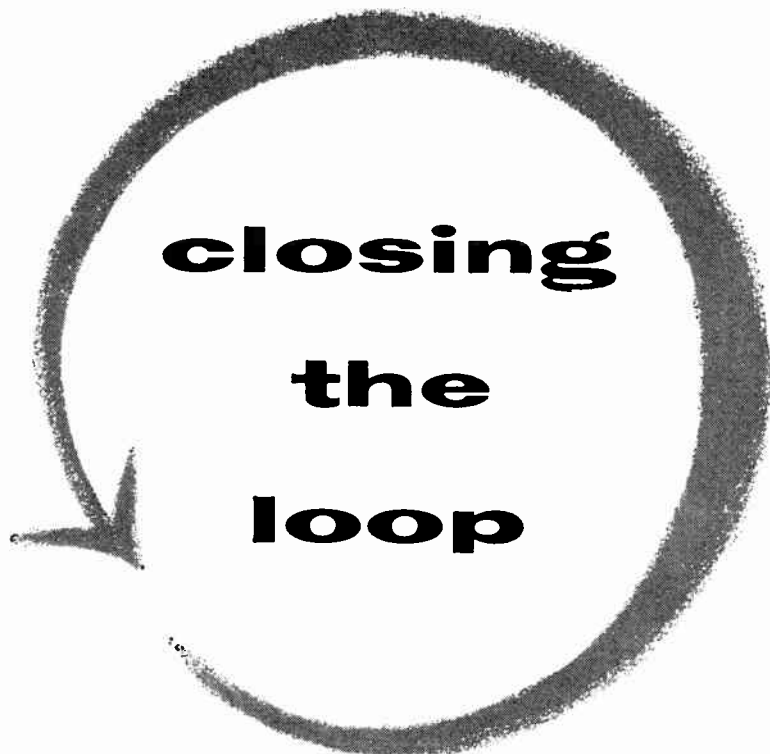
**THE SLOAN CO.**

4029 Burbank Blvd.

Burbank, California

Victoria 9-4667





At Motorola in Phoenix, engineers find unique opportunities for personal and professional growth in an atmosphere that encourages initiative and independence. Organized on a project basis, your engineering assignments begin with the original design, follow through development and production stages, and conclude only with final field evaluation. As an engineer, you are responsible for "closing the loop". The effectiveness of this *project approach* is borne out by Motorola's achievements in the military electronics field. If you are a creative engineer interested in the opportunity to carry your ideas through to completion, and if you like the idea of living in the brightest, healthiest climate in the United States, write today to Kel Rowan, Dept. A-8.



**MOTOROLA**

Western Military Electronics Center 8201 E. McDowell Rd. Phoenix, Arizona



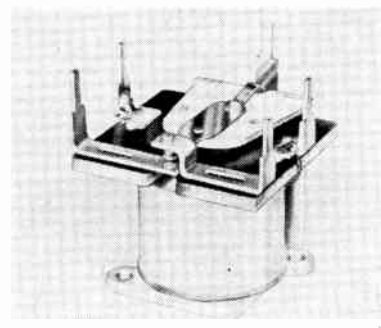
## OPPORTUNITIES

Electronic Engineers, Mechanical Engineers, Physicists—SYSTEM ANALYSIS, DESIGN AND TEST—Radar • Missile Guidance • Navigation • Combat Surveillance • Communications • Field Engineering • Data Processing and Display—CIRCUIT DESIGN, DEVELOPMENT AND PACKAGING—Microwave • Pulse and Video • Antenna • Transistor • R-F and I-F • Servos • Digital and Analog TECHNICAL WRITERS AND ILLUSTRATORS, QUALITY CONTROL ENGINEERS, RELIABILITY ENGINEERS

Motorola also offers opportunities at Riverside, California and Chicago, Illinois

overvoltages, as an oscillator, a saw-tooth wave generator, a fast acting relay, and a phase controlled rectifier. It is available in four break-over-voltage categories ranging from 50 to 200 v.

CIRCLE NO. 221 READER SERVICE CARD



## D-C Relay for p-c use

PRICE ELECTRIC CORP., Frederick, Md., announces a midget rugged spdt relay developed for use in printed circuitry where relay is self supporting. It is designed for use in radiosonde, mobile communications and commercial applications. Standard operating voltage is 3 through 24 v d-c; d-c resistance range, 8,500 ohms; d-c power requirement, 0.10 w. Standard contact rating is up to 1 ampere 50 v d-c, resistive.

CIRCLE NO. 222 READER SERVICE CARD

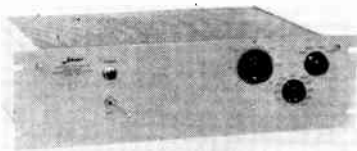


## Resistance Furnace high vacuum

NRC EQUIPMENT CORP., 160 Charlemont St., Newton 61, Mass., announces a high-vacuum resistance furnace with the hot zone capacity to handle production as well as laboratory work and with the ability to operate at temperatures as

high as 2,400 C (4,400 F). It is expected to find widespread application for heat-treating, brazing, sintering and testing of both reactive metals and ceramics. Completely self-contained, with the furnace chamber, pumping system, power supply, and controls in one cabinet, the model 2915 can be operated at absolute pressures of  $10^{-7}$  mm of mercury, or under inert atmospheres. Vacuum is achieved by a 30 cfm rotary gas ballast pump for roughing operation, and a 6-in. high vacuum oil diffusion pump for evacuation in the high vacuum ranges.

CIRCLE NO. 223 READER SERVICE CARD



### Power Supply high stability

INTERSTATE ELECTRONICS CORP., 707 E. Vermont Ave., Anaheim, Calif. Model 304 is a 25 ma, 500 to 2,500 v, continuously adjustable power supply. Ripple is less than 0.5 mv. Load change is less than 0.002 percent for 0 to 25 ma output. Regulation is 0.003 percent change for line change of 97 to 137. Stability is 0.01 percent per hour, 0.1 percent per day.

CIRCLE NO. 224 READER SERVICE CARD



### Miniature Connector snap-fit assembly

FLUOROCARBON PRODUCTS, INC., Camden 1, N. J. Featuring cost-saving snap-fit assembly a new Chemelec miniature connector is made of Nylon FM101. Entire unit weighs only 0.053 oz. The male and female sections are 0.490 and 0.580 in. in length respectively, 0.306 in. wide and 0.453 in. deep.

CIRCLE NO. 225 READER SERVICE CARD



## -and now the vibration test!

Shock — testing on the rocks? If vibration and shock are your headache, you could build your own pots to lick this problem! But look out for foul play in the shaft and bushings, under shock — you can lose your accuracy right there! And make sure your pet design includes a contact with no resonances, minimum mass, low wiper pressure — yet with excellent linearity! Oh, you'll be plenty busy!

But the easy way is to come to Ace! Our shockless pots incorporate, through exclusive precision production methods, fantastically close bearing fit. And our own specially balanced contacts place extremely low mass at the edge-wipe end, under low brush pressure, for steady contact under shock. Tempered precious metals and low contact resistance mean long, corrosion-free wear. Tested to 50 G's at 2000 cycles.



Our complete pot line incorporates all these anti-shock design features. Under extreme servo applications, this 1/2" servo-mount Series 500 Acepot delivers 0.3% linearity. See us at WESCON Booth 3414

**ACE** ELECTRONICS ASSOCIATES, INC.  
99 Dover Street, Somerville 44, Mass.  
SOMerset 6-5130 TMX SMVL 181 West. Union WUX

Acepot®

Acetrim\*

Acesol®

Aceohm®

\*Reg. Appl. for



**★ ULTRA LOW**

*capacitance & attenuation*

WE ARE SPECIALLY ORGANIZED TO HANDLE DIRECT ORDERS OR ENQUIRIES FROM OVERSEAS  
**SPOT DELIVERIES FOR U.S.**  
 BILLED IN DOLLARS—  
 SETTLEMENT BY YOUR CHECK  
**CABLE OR AIRMAIL TODAY**

TYPE	$\mu\text{F}/\text{ft}$	IMPED. $\Omega$	O.D.
C1	7.3	150	.36'
C11	6.3	173	.36'
C2	6.3	171	.44'
C22	5.5	184	.44'
C3	5.4	197	.64'
C33	4.8	220	.64'
C4	4.6	229	1.03'
C44	4.1	252	1.03'



**NEW** 'MX and SM' SUBMINIATURE CONNECTORS  
 Constant 50 $\Omega$ -63 $\Omega$ -70 $\Omega$  impedances

TRANSRADIO LTD. 138A Cromwell Rd. London SW7 ENGLAND CABLES: TRANSRAD, LONDON

CIRCLE NO. 127 READER SERVICE CARD

# Literature of

## MATERIALS

**Control Cable.** Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y. Bulletin DM5844 deals with thermoplastic all-purpose control cable with polyethylene insulation, double Densheath (PVC) jackets.

CIRCLE NO. 250 READER SERVICE CARD

**Thermoplastic.** The Polynor Corp. of Penna., 2140 Fairmont Ave., Reading, Pa., has available a bulletin on mill shapes of Polypenco Penton chlorinated polyether resins.

CIRCLE NO. 251 READER SERVICE CARD

**Laminated Plastics.** Formica Corp., 4614 Spring Grove Ave., Cincinnati 32, Ohio. More than 50 industrial Formica laminated plastic grades for a wide variety of products are described in a "Designer's Fact Book."

CIRCLE NO. 252 READER SERVICE CARD

## COMPONENTS

**Subminiature Resistors.** Erie Precision Resistor Corp., 675 Barbey St., Brooklyn 7, N. Y. The "Min-istor" brochure details a line of subminiature wire wound resistors. A handy temperature conversion chart is included.

CIRCLE NO. 253 READER SERVICE CARD

**Transistor Mica Washer.** Ford Radio & Mica Corp., 536 63rd St., Brooklyn 20, N. Y. Bulletin 2965 describes 15 basic insulating washers to be used with popular types of transistors and diodes.

CIRCLE NO. 254 READER SERVICE CARD

**Motor Frames.** Air-Marine Motors, Inc., 369 Bayview Ave., Amityville, L. I. N. Y. A brochure covers the company's entire line of basic induction motor frame designs.

CIRCLE NO. 255 READER SERVICE CARD

**Subminiature Switches.** Unimax Switch Division, The W. L. Maxson Corp., Ives Road, Wallingford, Conn. Subminiature switches that

No quicker, more accurate way to get information on **PRODUCTS** and **SERVICES** than . . . .

**electronics BUYERS' GUIDE**

keep it at your fingertips!

ABC ABP

**electronics BUYERS' GUIDE**

A McGRAW-HILL PUBLICATION

330 WEST 42nd ST. NEW YORK 36, N. Y.

### MEET TOM EMMA

Associate Editor, electronics  
**FINANCE EXPERT**



Thomas Emma, BA, Columbia, is a U.S. Naval Reserve officer who was formerly a technical writer with IT&T. Tom prepares "Financial Roundup"—a regular weekly business feature. In the coming months Tom will be concerned with radio communications, but he will be specifically involved with spectrum usage problems. To keep abreast of finance in electronics, turn to Tom's weekly coverage of latest developments. To subscribe or renew your subscription, fill in box on Reader Service Card. Easy to use. Postage free.

ABC **electronics** ABP

A McGraw-Hill Publication

West 42nd Street, New York 36, N. Y.

# the Week

meet military specifications for a wide variety of rigorous services are described in the new 16-page catalog No. 159.

**CIRCLE NO. 256 READER SERVICE CARD**

## EQUIPMENT

**Graphic Level Recorder.** General Radio Co., West Concord, Mass. A 10-page technical paper on a 20-cps to 200-kc transistorized, high-speed, graphic level recorder appears in a recent issue of the *Experimenter*.

**CIRCLE NO. 257 READER SERVICE CARD**

**Digital Voltmeter.** Franklin Electronics Inc., Bridgeport, Pa. Bulletin 309 describes a new series of digital voltmeters and multi-meters for use in automatic data systems and for precision laboratory use.

**CIRCLE NO. 258 READER SERVICE CARD**

**Power Supplies.** Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J. Four-page catalog No. 114A describes the Magitran line of solid state regulated power supplies.

**CIRCLE NO. 259 READER SERVICE CARD**

## FACILITIES

**Precision Pots.** Spectrol Electronics Corp., 1704 S. Del Mar Ave., San Gabriel, Calif. A 100-page catalog contains complete specification sheets for ordering standard wire wound single and multiturn precision pots. It also describes Spectrol's facilities and qualifications for design and production.

**CIRCLE NO. 260 READER SERVICE CARD**

**Transistor Heat Dissipator.** International Electronic Research Corp., 145 W. Magnolia Blvd., Burbank, Calif. A 22-page test report covers the subject of properly cooling transistors for improved performance and reliability by the use of type TO-3 transistor heat dissipators. Request copies on company letterhead.

8605



He's bragging about  
how the cable works!

## Hickory Brand Coaxial Cable, that is!

- Polyethylene insulation assures maximum operating efficiency

Hickory Brand Coaxial Cables are especially adaptable to applications requiring high, very high and ultra-high frequencies.

The dielectric material of these RG/U Cables is polyethylene . . . shielding braid is single or double copper, single tinned copper or double silver as required.

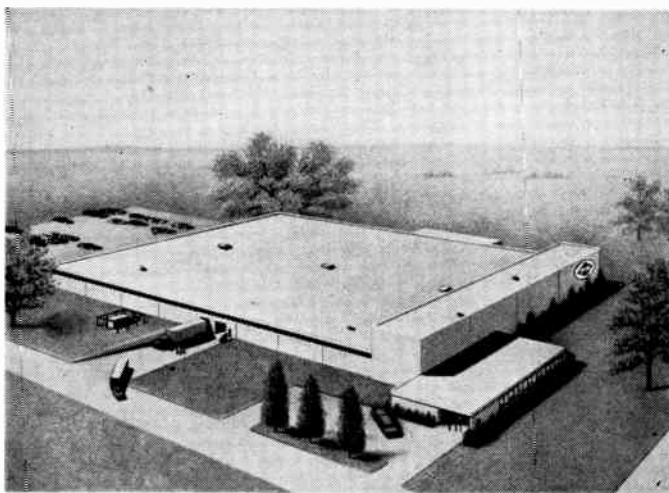
Quality-engineered Hickory Brand Electronic Wires and Cables are precision-manufactured to meet the most exacting specifications.



Write for complete information on the full line of

## HICKORY BRAND Electronic Wires and Cables

Manufactured by  
SUPERIOR CABLE CORPORATION, Hickory, North Carolina



## PIW Moving to New Building

THE PHILADELPHIA INSULATED WIRE COMPANY announces construction of a new plant in Moorestown, N. J. New facility will have a manufacturing area of 50,000 sq ft and will be located on a 10-acre tract of ground.

Robert W. Campbell, sales manager of PIW, says the one-story plant has been designed specifically for the efficient production of insulated wire and cable, and will expand the present productive capacity for Teflon, vinyl, nylon, polyethylene hook-up wire and multiconductor cable, as well as new products such as Teflon 100. A complete line of standard hook-up wires and cables, as well as specialty constructions to customers' specifications, are available from this 138-year-old company.

PIW is presently involved in a considerable amount of Department of Defense contract work, plus commercial applications in the electronic and electrical fields.

Space for the general offices, as well as all manufacturing and warehousing facilities, will be at the new address. Construction will be completed on or about August 15. Until this date the general offices and factory will continue in operation in Philadelphia.



## Robinson Joins McLean Labs

MCLEAN ENGINEERING LABORATORIES, INC. of Princeton, N. J., has

appointed James G. Robinson as technical assistant to the president and company procurement director. McLean manufactures a line of packaged fans and blowers for electronic applications and for general industrial use.

Robinson was for 9 years a director of procurement and government contract administration for the Applied Science Corp. of Princeton.

## III Expands Facilities

CONSTRUCTION was recently completed on two new additions to the plant of Industrial Instruments, Inc., in Cedar Grove, N. J. Company manufactures electrical test equip-

ment and electrolytic conductivity apparatus.

The expansion will double the present facilities devoted to the engineering department, and provide increased space for stockroom, manufacturing, quality control activities, and a new metal finishing department.

## Kennedy Now With Polarad

D. LAWRENCE JAFFE, president and chairman of the board of Polarad Electronics Corp., Long Island City, N. Y., announces the appointment of W. Vernon (Bud) Kennedy as manager of contracts administration for the company.

Kennedy was formerly chief of Financial and Economic Division, Fort Monmouth Procurement Office, Signal Corps; administrative assistant to the vice-president of the electronics division of Stromberg-Carlson; and more recently assistant to the president of A.R.F. Products, Inc., River Forest, Ill. In his new position he will be responsible for the negotiation and administration of all defense prime and sub-contracts of the company.



## NBFAA Honors Kidde Engineer

SAMUEL M. BAGNO (left) was recently presented a plaque by the National Burglar and Fire Alarm Association at a banquet held at the Sheraton-Ritz Carlton Hotel, Atlantic City, N. J. The award was made by Frank Guibert, outgoing president of the Association.

The plaque, the first ever awarded



# ARE YOU PROPERLY GEARED FOR MINIATURIZATION?

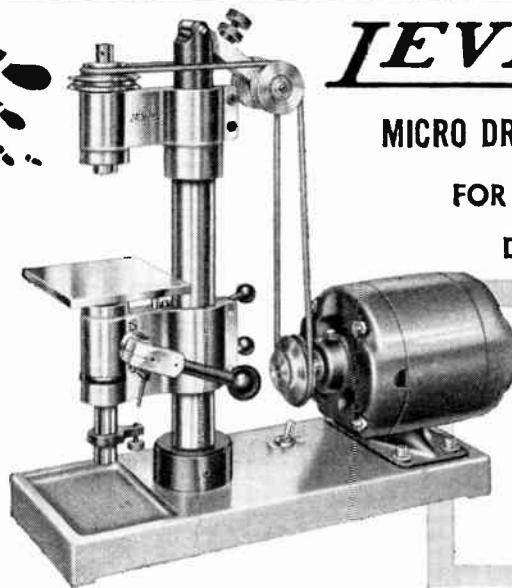
SMALL DRILLS MUST BE HELD IN PRECISION  
COLLETS TO ASSURE ACCURACY



A super-sensitive drill press in  
which drills are held in precision  
collets to eliminate chucking errors.

Table is keyed to prevent any  
play. Feed is by raising table.

No quill to cause drag.



## LEVIN<sup>®</sup>

### MICRO DRILL PRESS

FOR VERY SMALL HOLES  
DOWN TO .002"

For complete details  
of Micro-Drilling  
equipment  
send for catalog T.  
Louis Levin & Son, Inc.  
3610 So. Broadway  
Los Angeles 7, Calif.

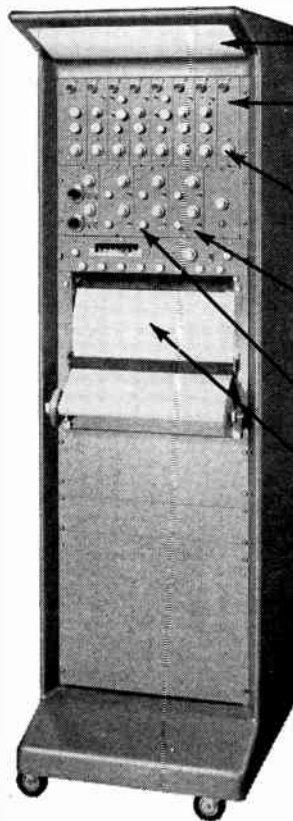
CIRCLE NO. 128 READER SERVICE CARD

**the most versatile...most sensitive  
direct writing recorder available!**

## THE OFFNER ALL-TRANSISTOR TYPE R DYNOGRAPH

Whatever your application for direct writing records . . . investigate the ability of the Offner Type R Dynograph to do the job *better* and more *simply*. Its features of superiority are unmatched!

- stable d-c sensitivity of one microvolt per mm
- true differential input
- high input impedance
- response to beyond 150 cps
- reluctance, differential transformer, strain gages with a-c or d-c excitation, thermocouples, etc., used with all preamplifiers
- deflection time less than 1.5 milliseconds (2.5 ms with preamplifiers)
- fixed precision calibration
- instant warm-up
- precision source for d-c and 400 cycle excitation, self-contained
- zero suppression, twenty times full scale, both directions



Illuminated canopy.

Type 9800 series input couplers provide all input, control and balance functions.

Type 481 Preamplifier provides sensitivities from one microvolt to 5 volts per mm.

Type 482 power amplifiers—may be used without preamplifiers for up to 10 mv/cm sensitivity.

Zero suppression control.

504-A paper drive—speeds from 1 to 250 mm/sec. Electrical speed shift 1 to 250 mm per minute available. Zero weave high precision drive, 850 ft. capacity (heat or electric) 1500 ft. (ink). Front loading, with full unobstructed record visible from front.

**OTHER MODELS  
AVAILABLE**

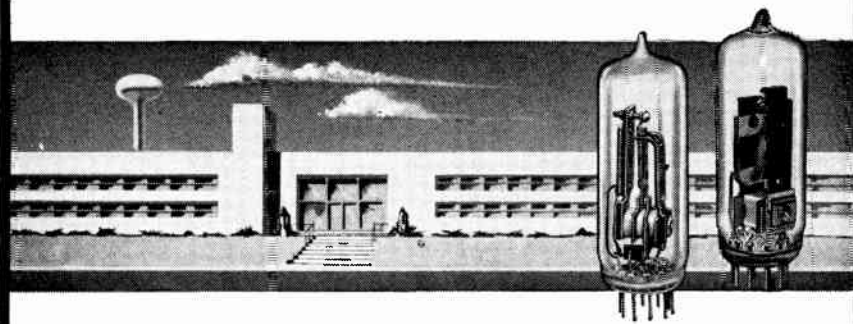
1 to 19 channels, console, rack,  
and portable assemblies.

**OFFNER ELECTRONICS INC.**  
3906 River Road, Schiller Park, Ill. (Suburb of Chicago)



Write on your company letterhead for details and specifications.

# MINIATURE TIME DELAY RELAYS



**Low-cost for commercial applications**

Curtiss-Wright offers a reliable and inexpensive thermal time delay relay in the "G" and "K" Series—miniature size hermetically sealed in glass.

**SPECIFICATIONS**

Time delay.....Preset 3 to 60 seconds  
 Contact arrangement.....SPST or SPDT  
 Heater voltage...6.3, 26.5, 117 AC or DC std.  
 Weight.....Less than one ounce  
 Base.....Miniature 9 pin  
 Size.....T6 1/2 bulb—Max. hgt. 2 3/8"

*The Components Department also manufactures digital (stepping) motors, ultrasonic delay lines, and other units for electronic systems.*

WRITE FOR  
 COMPLETE  
 COMPONENTS  
 CATALOG  
 159

ELECTRONICS DIVISION  
**CURTISS-WRIGHT**  
 CORPORATION • WEST CALDWELL, N. J.

CIRCLE NO. 129 READER SERVICE CARD

by the NBFAA, is in recognition of his pioneering contributions in the development of electronic devices for the electrical protection industry.

Bagno is chief engineer of Kidde Ultrasonic & Detection Alarms, Inc., Clifton, N. J., and Guibert is general manager of Newark District Telegraph, Newark, N. J.



## Name Gagnon V-P


APPOINTMENT of William J. Gagnon as vice president of Bradley Semiconductor Corp., New Haven, Conn., is announced. He has been general sales manager of the firm since he joined it in 1954.

In naming him to the key post, Charles D. Bradley, president, pointed out that Gagnon has spearheaded a major sales expansion program aimed at the addition of new electronic products to the company's line. As a result of developments by Bradley's engineering staff, an entirely new division has been set up for the production of silicon diodes. Although only a year old, the new division is rapidly assuming a major share of the company's total output.

To support the expansion program with new product developments, Gagnon said he will shortly announce the addition of more engineers which will triple the size of the firm's engineering staff.

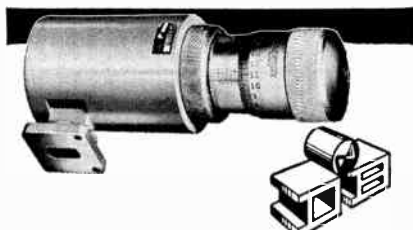
## McMahon Takes New Post

TRANSISTOR APPLICATIONS, INC., Boston, Mass., announces that Robert E. McMahon has joined the or-



**FOREMOST**  
 in  
**SONAR**

**EDO CORPORATION**  
 College Point, L.I., N.Y.  
 Since 1925



## BROAD BAND CAVITY WAVEMETERS

—gas filled for  
 sustained accuracy

Accuracy is so high these instruments may be used as secondary standards. Units are unaffected by changes in humidity, altitude or barometric pressure. Only 12 sizes serve from 2.6 KMC to 140 KMC. You save budget money on the number of sizes needed. Literature on request.



**DE MORNAY-BONARDI**  
 780 SOUTH ARROYO PARKWAY • PASADENA, CALIF.

See us at Booth #512 at the Wscon Show  
 CIRCLE NO. 130 READER SERVICE CARD

# Spotlight on Space!

ganization as a vice president and chief engineer.

McMahon was formerly a staff member at MIT's Lincoln Laboratory and pioneered in early transistor switching circuits. He developed impulse switching, a technique for increasing the speed of ferrite core memories.

## News of Reps

CONTROL ELECTRONICS CO., INC., Huntington Station, N. Y., names four sales reps:

The Col-Ins-Co. of Orlando, Fla., will cover Florida, Georgia, Alabama, Mississippi, Tennessee, North and South Carolina. Malcolm Ross & Company of Los Angeles will handle sales in Arizona, Nevada and southern California. Ernest E. Whittaker of Ontario will have all sales in Canada, while Southern Industrial Electronics, Inc., in Dallas will handle sales in Texas, Oklahoma, Arkansas and Louisiana.

Appointment of David G. DeHaas Co. of San Diego as sales rep for the Polytechnic Research & Development Co., Inc., Brooklyn, N. Y., is announced. Territory will be San Diego and Imperial Counties, Calif.

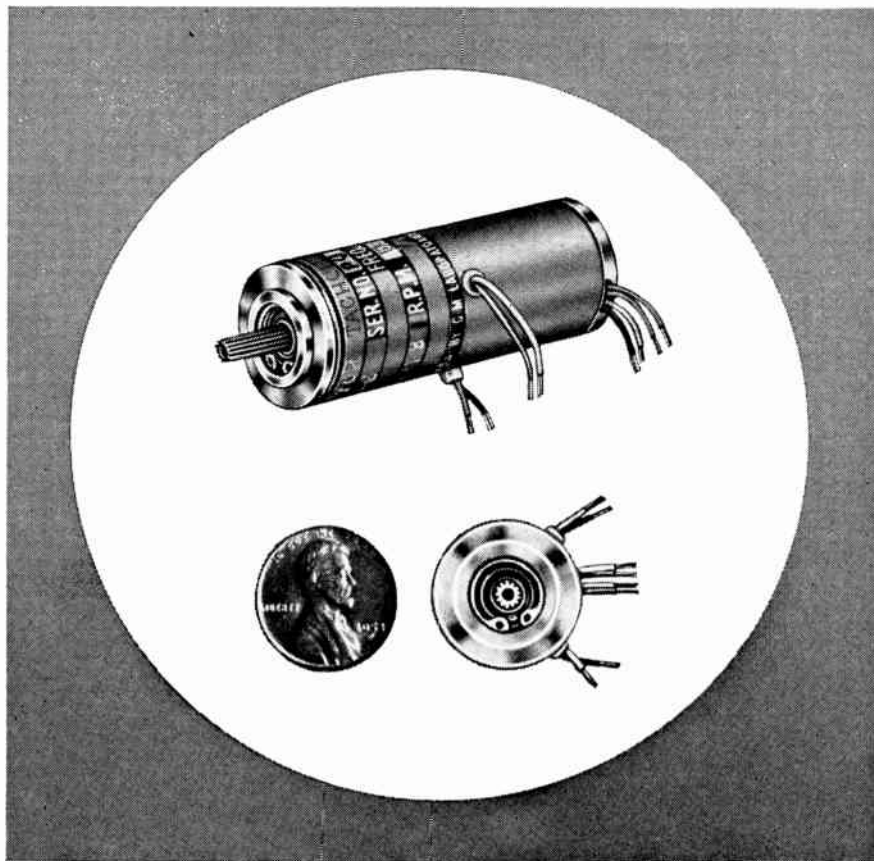
Balco Research Laboratories, Inc., Newark, N. J., appoints Electro-sources, Inc. of Palo Alto sales rep for the northern California-Nevada territory. Balco specializes in development of high temperature plastic film capacitors.

Dayton Associates of Dayton, Ohio, now represents Telemeter Magnetics, Inc., Los Angeles, Calif., in Ohio and western Pa.

C. J. Fox has been appointed electronics sales engineer with E. V. Roberts and Associates, Los Angeles engineering representative.

Gordon T. Cook, and Robert J. Underbrink have joined the Burt C. Porter Co., Seattle, Wash., engineering rep, as sales engineers.

Electronic Components Sales, Inc., Littleton, Colo., will cover Colorado, Wyoming, New Mexico and Utah for Grayhill, Inc.



## NEW SIZE 8 MOTOR GENERATOR

*for transistor operation*

Tested to conform to all applicable Government Specifications for humidity, salt-spray, temperature, altitude, vibration!  
Promptly available in prototype and sample quantities.

- Outside Diameter: 0.750 inches.
- Weight: 2.9 ounces maximum.
- Tachometer-generator operates on 18 volts, 400 cycles.
- Gradient: 0.23 volts per 1000 RPM.
- Maximum null voltage: 0.015 RMS.
- Both fixed and control phase of motor wound for 18 volts, 400 cycles.
- Stall Torque: 0.3 ounce-inch, with no-load speed of 5400 RPM.
- Pinion Data: Precision Class 2, 13 tooth, 120 pitch, 20° pressure angle.



Write for full information, G-M Recommended Procurement Specification No. 665 and Catalog.

# 5-WAY RELIABILITY

IN YOUR CIRCUIT DESIGN

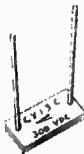
WITH  
**Vitramon®**  
CAPACITORS

AT WESCON BOOTH 1413

The latest additions to the growing line of "Vitramon" Capacitors feature smaller mounting area, lower inductance, and more versatility of application — plus all the phenomenal electrical characteristics for which "Vitramon" Capacitors are noted — fine silver electrodes fused to pure porcelain enamel, perfectly bonded to provide stability, wide temperature range, humidity immunity, low loss, low noise.

## RADIAL SERIES

- Thin design — 5/64" to 7/64"
- Versatile mounting — can be used axially, radially, or on edge
- Ideal for minute circuit assemblies
- 0.5 to 1200 mmf; 500 to 50 vdc



## PARALLEL SERIES

- Tiny mounting area — 11/64" x 9/32"
- Designed for automatic insertion
- Packed for cartridge feeding
- Capacitance through 1000 mmf. at 100 vdc



## CO-AXIAL SERIES

- Compatible with MIL-C-10950B
- Very low inductance
- Flexible leads
- Maximum height from mounting surface 1/4"
- To 1000 mmf at 300 vdc



## AXIAL SERIES

- Extremely rugged
- 4 case sizes from 3/8" to 29/32"
- 0.5 to 6800 mmf; 500 to 300 vdc



## AXIAL-RADIAL SERIES

- Mounted axially or radially
- 4 case sizes from 3/8" to 27/32"
- 0.5 to 5600 mmf; 500 to 300 vdc



**Vitramon®**  
Incorporated

BOX 544 • BRIDGEPORT 1, CONN.

# COMMENT

## Transistor Amplifiers

(Re: "Designing High-Quality A-F Transistor Amplifiers," p 60, June 12.)

On p 61 (Fig. 2), Mr. Minton's schematic shows two transistors purported to be in class B push-pull operation.

I believe that an error exists. Instead of emitter-to-emitter and collector-to-collector connections, a series circuit exists in part by connection of Q<sub>1</sub> collector to Q<sub>2</sub> emitter through the secondary of T<sub>1</sub>.

N. P. SMITH

RADIO CORP. OF AMERICA  
LOS ANGELES

Our redrafting error. The two transistors should be connected collector-to-collector through the secondary of T<sub>1</sub> and emitter-to-emitter through the primary.

## Radar Test Systems

The June 5 issue of ELECTRONICS included an article (p 58) entitled "Radar Test Systems to Shorten Checkout Time," written by Major Wm. F. Kroemmelbein. The front cover was devoted to a picture of such a system in operation on the flight line.

As you may or may not know, that "system" is the AN/GPM-25 radar system tester developed for the U. S. Air Force by the mechanical division of General Mills. We are proud of this accomplishment, and were very happy to cooperate with Major Kroemmelbein in preparation of his article by furnishing the front cover photo, certain technical information, schematics, etc. We were naturally disappointed, however, when we learned that ELECTRONICS had totally omitted the name of our firm from the published text.

We believe your readers would be interested . . .

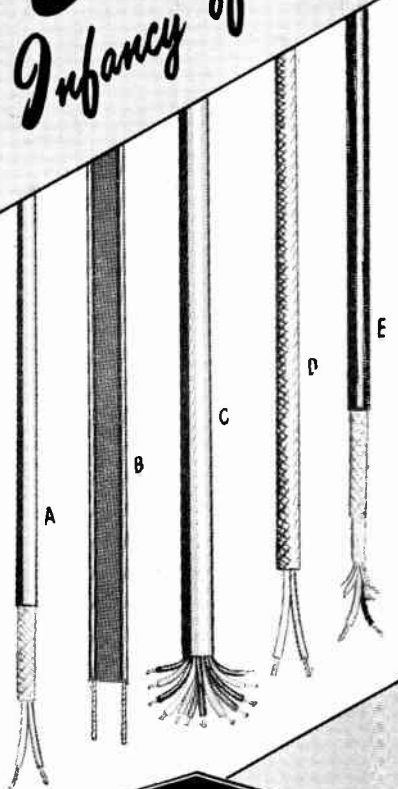
LLOYD E. PEARSON

GENERAL MILLS INC.  
MINNEAPOLIS

## Bank Automation

We read with interest your recent article covering today's rapid

Since the  
Infancy of Radio



**CORNISH**

Wires • Cables

For dependable electrical characteristics and all-around satisfaction . . . specify these BLUE CHIP products, true Partners in Performance to the fabulous Electronic Industry.

- A Microphone Cable (Rubber or Plastic)
- B TV Lead-in Cable
- C Intercommunication Cable
- D Shielded Intercomm. Cable
- E Plastic Shielded Cable

CONSULTATION WITHOUT OBLIGATION

**CORNISH WIRE CO., INC.**

50 Church Street New York 7, N. Y.

from Warehouse Stocks in

Atlanta Charlotte Chicago Cincinnati  
Dallas Detroit Kansas City  
Los Angeles Minneapolis Philadelphia  
Rochester St. Louis San Francisco  
Seattle Williamstown

Additional Sales Offices  
Boston Bridgeport Cleveland  
Denver Pittsburgh

Made by Engineers for Engineers™

strides toward bank automation ("Big Bid for Bank Market," p 40, May 29).

However, the reference to National Cash Register as not having yet released equipment details is inaccurate. To the contrary, NCR was one of the first companies in the office equipment industry to announce a complete bank automation system based on magnetic character recognition as later recommended by the American Bankers Association. This announcement (in 1957) listed specifications of the various units of the system.

Today, more than 4,500 Post-Tronic machines, the nucleus of the NCR system, have been installed in more than 1,000 banks in all 50 states. These machines are posting electronically over 20 percent of the nation's checking accounts. In recent months, NCR has also demonstrated operating prototypes of forthcoming units of the system to bankers from all sections of the country. These include the fully automated Post-Tronic, the magnetic character sorter, magnetic amount printer, magnetic qualification printer, and other units.

O. B. GARDNER

NATIONAL CASH REGISTER CO.  
DAYTON, O.

A misunderstanding merely. We were referring to the type of "equipment details" later discussed in the article: operating details of the electronic circuitry which reads and recognizes the magnetic characters.

#### One -ing After Another

(Re: "Circuit Design Using Magnetostrictive Filters," p 72, June 19).

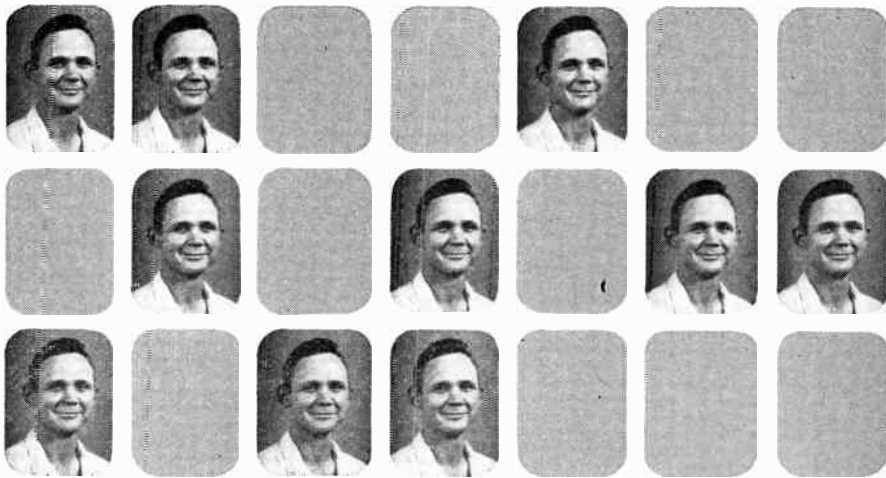
I have seen the published article—a very good layout. One small error did creep in. In the bibliographical reference, you referred to *Electronic & Radio Engineering*; it should be *Electronic & Radio Engineer*.

I would appreciate it if you would publish an amendment.

ALAN THIELE

COSSOR RADIO & ELECTRONICS LTD.  
HARLOW, ESSEX, U. K.

Done.



TI Needs More Roy Neely's BS EE, Texas A&M

## MANUFACTURING ENGINEERS

Men like Roy Neely are needed for planning and coordinating the design engineering and manufacturing of electro-mechanical apparatus—engineers who have 3 to 10 years experience with manufacturing processes, tooling, scheduling and costs. Such experience can be used immediately. Your resume will get prompt attention by John R. Pinkston.

PROFESSIONAL  
PLACEMENT

APPARATUS  
DIVISION

TEXAS INSTRUMENTS  
INCORPORATED  
6000 LEMMON AVENUE  
DALLAS 9, TEXAS

there's a  
**STURGES BATTERY**  
for EVERY JOB  
requiring portable power

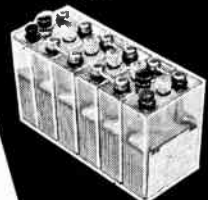
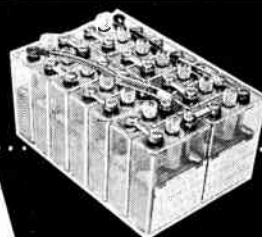
- From 2 volt basic components for laboratory use to high voltage applications required in electronics, sound recording, photographic, electrical instrument and television lighting fields, Sturges nonspill storage batteries have exceptionally high output.
- Uniformly high voltage is maintained throughout discharge period.
- Nonspill structural features limit emission of corrosive acid spray during charging.
- Transparent molded plastic case allows visual inspection of condition and electrolytic level.

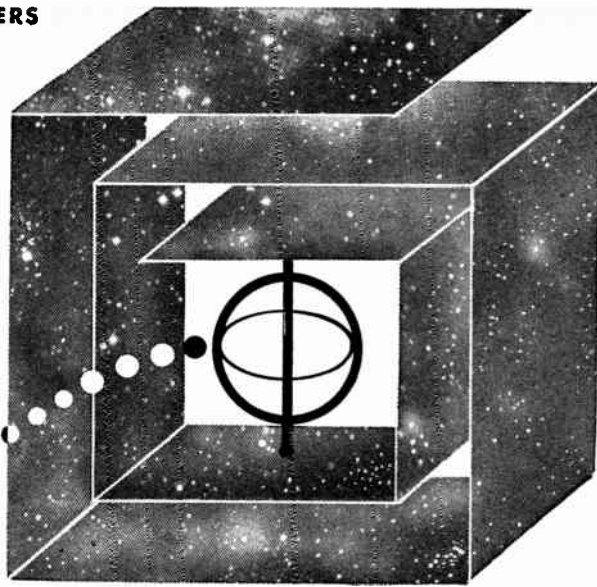


SPECIAL PURPOSE BATTERIES  
CAN BE TAILORED TO FILL  
YOUR INDIVIDUAL SPECIFICATIONS.

manufactured by  
**ELECTRONIC BATTERIES, INC.**

Bush Terminal Building No. 4 • 28-34 35th Street, Brooklyn 32, New York





*Republic Aviation  
Offers You  
Dynamically  
Balanced Careers*

**THIS MEANS:**

**Choice of advancement in a scientific specialty or technical management, with equal benefits and recognition**

**Wide range electronic R&D programs that provide the opportunity you need to move ahead**

**All the added advantages that accrue from working with a prime systems contractor**

A multitude of projects in advanced electronics are now underway at Republic Aviation — projects that offer broad avenues to success for the ambitious electronic engineer. Republic has a program to match your interest, whether it be in space technology, missiles, manned aircraft or ground support equipment. And you will find your colleagues at Republic to be men of the highest ability and imagination, men who possess broad state-of-the-art knowledge that will add to your technical competence.

Facilities and equipment are of the most advanced type and will be supplemented later this year by a new \$14,000,000 Research Center.

Professional Opportunities at all levels in the following areas:

**Inertial Guidance & Navigation • Digital Computer Development • Systems Engineering • Information Theory • Telemetry-SSB Technique • Doppler Radar • Countermeasures • Radome & Antenna Design • Microwave Circuitry & Components • Receiver & Transmitter Design • Airborne Navigational Systems • Jamming and Anti-Jamming • Miniaturization-Transistorization • Ranging Systems • Propagation Studies • Ground Support Equipment**

Address your resume in strict confidence to:

Mr. George R. Hickman

Engineering Employment Manager, Dept. 11H-3.



**REPUBLIC AVIATION**

Farmingdale, Long Island, New York

## A FINER CLIMATE



## TO WORK IN...



## ...TO LIVE IN

*At Sylvania's  
Mountain View Operations  
in California*

(SAN FRANCISCO BAY AREA)

*you'll discover  
more than just one  
kind of climate.*

**PROFESSIONAL CLIMATE**—Advanced programs will challenge your technical creativity. You'll make major contributions in the fields of electronic defense, radar, communications and data processing systems. Because Sylvania is one of the nation's fastest growing electronics organizations, there are an unusual number of growth opportunities.

**LIVING CLIMATE**—You and your family will enjoy the healthful atmosphere and sunny climate of the San Francisco Peninsula. You'll find plentiful housing, excellent shops, fine schools and year round recreation.

Openings in:

System Studies / Circuit Design / Computers & Data Handling / Electronic Packaging / Development Engineering / Concept & Planning / Advanced ECM Circuitry / Equipment Development / Product Engineering / Tube Engineering / Tube Application Engineering / Mechanical Engineering / Tube Production Engineering / Theoretical Physics / Experimental Physics / Mathematics / Microwave Engineering / Engineering Writing / Tube Research Engineering

*You may communicate in confidence  
to Wayne L. Pearson*

Mountain View Operations / SYLVANIA ELECTRONIC SYSTEMS  
A Division of

**SYLVANIA**  
Subsidiary of  
GENERAL TELEPHONE & ELECTRONICS

P.O. Box 188  
Mountain View, California



ENGINEERS • SCIENTISTS

General Electric's Heavy Military Electronics Dept.

**AWARDED CONTRACT FOR**

Systems Integration, Engineering, and Management of...

**AIR WEAPONS CONTROL SYSTEM 212L**

*A universal electronic control system to meet the vast problem of Air Defense outside of the Continental United States.*

Systems-oriented engineers and scientists will appreciate the broadband technical challenge of the Air Weapons Control System 212L. There are important openings for men who are experienced in: WEAPONS SYSTEMS ANALYSIS • MATHEMATICAL ANALYSIS OF ENGINEERING PROBLEMS • COMPUTER PROGRAMMING • MILITARY COMMUNICATION SYSTEMS • RADAR SYSTEMS • WEAPONS CONTROL SYSTEMS • ELECTRONIC CIRCUITRY • INDUSTRIAL & MILITARY PSYCHOLOGY.

● Working in close cooperation with the USAF, it is Heavy Military's responsibility to integrate all subsystems—data acquisition, communications, data processing and display—plus various defensive weapons into a well coordinated and efficient operating system.

**VERSATILE AIR CONTROL APPLICATIONS** The revolutionary 212L can be used to defend a single airfield, or, by linking control sites together, it could be used in a limited action to provide air control for an area the size of Alaska. Similarly, by linking the capabilities of countries together, a system could be provided for the air control of an en-

tire continent. Designed for both fixed and mobile applications, the 212L will be used primarily outside the U. S. since the SAGE system is used for the defense of this country.

**HMED IS ALSO DESIGNING THE "HEART" OF THE SYSTEM**

In addition to its prime mission of providing systems management, HMED will design, develop and produce the data processing and display subsystem which is the "heart" of the 212L. Capable of rapidly and automatically detecting and tracking air targets, the subsystem operates without human assistance, except under unusual circumstances.

**OTHER FAR-RANGING PROGRAMS AT HEAVY MILITARY**

*At the present time additional far-ranging programs are being pursued in diverse and important areas at HMED:*

- Fixed & Mobile Radar
- Shipborne Radar
- Underwater Detection Systems
- Missile Guidance
- Data Handling Systems
- Communications

Individuals with experience in systems analysis or specific equipment design in the areas listed above are invited to forward their resume in complete confidence to Mr. George Callender, Div. 69-WF.

HEAVY MILITARY ELECTRONICS DEPARTMENT

**GENERAL**  **ELECTRIC**  
COURT STREET SYRACUSE, N. Y.

**EXPERIMENTAL MACHINE DESIGN  
ENGINEERING MECHANICS AND ANALYSIS  
HEAT TRANSFER, PROCESS ENGINEERING  
METAL CONVERTING TOOL AND EQUIPMENT DESIGN  
PLASTIC CONVERTING TOOL AND EQUIPMENT DESIGN  
MATHEMATICS, STATISTICS, COMPUTER PROGRAMMING**

**Outstanding and Challenging Opportunities at all Levels of Experience for the Properly Qualified Engineer or Scientist in the Above Fields of Specialties.**

The Central Research and Engineering Division is now recruiting to fill several newly created positions in its Engineering Department. All these positions involve projects in long range research, engineering, and development of radically new methods and materials to insure a leading position for the company's products of metal, glass, plastic, and paper in the fields of rigid and flexible packaging.

The qualifications for these positions include a minimum of a Bachelor of Science degree in Engineering, Physics, or Mathematics; adequate industrial experience; and a record of aggressive pursuit of research and development objectives. Advanced degrees are required in some of the open positions and desirable for all of them. Persons with advanced degrees will be given preference.

Staff members are encouraged to promote their professional stature by active participation in their professional society at the local and national level. Research facilities of the Company's new Chicago laboratories are believed second to none, and are located so as to allow staff members to live in some of the finest western and southern suburbs of the city. Salary and other benefits meet the highest industrial standards.

Please write, giving a brief resume of qualifications, to

**Director of Research - Engineering  
Central Research and Engineering Division  
CONTINENTAL CAN COMPANY  
7622 So. Racine Ave., Chicago 20, Illinois**

**the specialty: ELECTRONICS  
the field: HELICOPTERS  
the openings: AVIONICS INSTRUCTORS  
FIELD SERVICE  
REPRESENTATIVES**

World's foremost designer and builder of helicopters now has openings for two types of specialists in the field of electronics.

**AVIONICS INSTRUCTORS**—Good opportunity for advancement available to men with a minimum of four years' experience in electronics and aircraft maintenance. Teaching background or a sincere desire to teach is essential. Positions entail instruction of commercial and military customers in helicopter stabilization systems, Doppler radar, servo-mechanisms and electrical systems. Of paramount importance is a thorough understanding of flight controls, hydraulics, mechanics and electronics. Occasional travel is required of men in these positions.

**ELECTRONIC FIELD SERVICE REPRESENTATIVES**—Unusually interesting work here for men with advanced electronics training and experience. Though not essential, previous helicopter experience is desirable. Assignments require the ability to check circuitry and effect repairs, along with the further ability to make suggestions which can lead to design improvements. Work involves use of all types of electronic test equipment.

*If you feel you qualify fully for either type of position outlined above, please send your resume to Mr. James L. Purfield.*

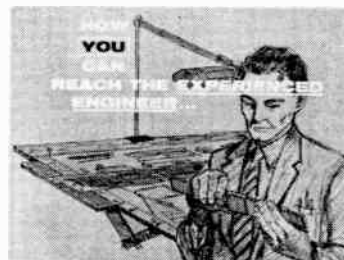
**SIKORSKY AIRCRAFT**  
One of the Divisions of United Aircraft Corporation  
**Stratford, Connecticut**

**PERSONNEL MANAGERS**

**LOOKING FOR  
Experienced Engineers . . .  
Technical Personnel?**

Write for a free copy of:

**"How You Can Reach The  
Experienced Engineer . . ."**



The top-flight engineers and technical personnel you want are at a premium . . . as this twelve page booklet points out. How you can reach and influence these men is the story told.

The booklet tells where to find the experienced engineer. It explains how you can make contact . . . channel and concentrate your employment advertising to just the men with the job qualifications you want. Included are testimonials from personnel men who use technical publications successfully . . . sample advertisements that got results . . . helpful hints to consider and pitfalls to avoid when you prepare your copy and layout for an Employment Opportunity advertisement.

Write for your free copy to:

**V. C. Downey  
Classified Advertising Division  
McGraw-Hill Publishing Co., Inc.  
P.O. Box 12  
New York 36, New York**



**MANUFACTURERS REPRESENTATIVES**  
 Openings for experienced component sales engineering organizations interested in the following territories: New England States;—Minnesota, Iowa, Wisconsin;—South Carolina, Georgia, Alabama;—Kansas, Missouri, Arkansas;—Louisiana, Mississippi;—New Mexico, Arizona.  
 Firm is well established producer of wide range of electronic wiring devices with excellent product acceptance.  
 RW-2253, Electronics  
 520 N. Michigan Ave., Chicago 11, Ill.

**• CONTACTS •**  
**FOR THE FIELD OF ELECTRONICS**

**"HOW TO MAKE MONEY IN Mobile Radio Maintenance"**  
 AUTHORITATIVE GUIDEBOOK  
 ABOUT THE BOOM IN TWO-WAY MOBILE-RADIO. GIVES FACTS, FIGURES, PAY RATES.  
**WRITE TODAY!** **FREE**  
 LAMPKIN LABORATORIES, INC. Instruments Div. BRADENTON, FLA.

**PROFESSIONAL SERVICES**

**MEASUREMENTS**  
*Research & Manufacturing Engineers*  
 Harry W. Houck  
 Specialist in the Design and Development of Electronic Test Instruments  
 Boonton, New Jersey

**TELECHROME MFG. CORP.**  
*Electronic Design Specialists*  
**COLOR TELEVISION EQUIPMENT**  
 Flying Spot Scanners, Color Synthesizers, Keyers, Monitors, Oscilloscopes and Related Apparatus Telemetering for Guided Missiles.  
 J. R. Popkin-Clurman, *Pres. & Dir. of Eng.*  
 28 Ranick Dr. Amityville, L. I., N. Y.

**YARDNEY ELECTRIC CORP.**  
*"Pioneers in Compact Power" \**  
**Electro-Chemical Generators of Energy**  
*"from milliwatts to megawatts" \**  
 40-50 Leonard Street **WORTH 6-3100**  
 New York 13, N. Y. \* T.M.

**Consult these SPECIALISTS**  
 Let them save your time by bringing their broad experience in their specialty to bear on your problems.



**"Hey, Chazzo — why don't you go out and do something worthwhile?"**

Don't take our word for it that this engineer's name was really Chazzo. The ancient documents are virtually undecipherable and spelled atrociously anyway. Perfectly understandable, however, is Chazzo's annoyance. We engineers have always been plagued by our ineptness at communicating to others the "worthwhile-ness" of our projects.

At Bendix, Kansas City, we're engaged in a program which is supremely "worthwhile," and we hope to communicate with you very clearly and specifically about it. (Be warned that our motives are a little selfish—we expect to kindle your professional enthusiasm to the point of making you eager to join us). Here, though, we may say little more than this: As a long term prime contractor for the AEC we design, develop and manufacture electronic and electro-mechanical devices which meet almost fantastic levels of reliability for the expanding atomic weapons program.

If you read very carefully between the lines above you will sense that here is a technically exciting, dynamic environment, the sort of climate a man can grow in.

We invite you to make this a 2-way communication. If your resume shows at least 5 years' experience in the activities listed at right, we'll tell you much more about the openings which await you at various levels. This is surely worth looking into . . . now.

- COMPONENTS
- ELECTRONIC AUTOMATION
- MICRO-MINIATURIZATION
- MICROWAVE TECHNIQUES
- RELIABILITY
- VACUUM TUBE APPLICATION

*Mail brief confidential resume to*  
**MR. T. H. TILLMAN**  
**BENDIX, BOX 303-KE**  
**KANSAS CITY, MISSOURI**



**KANSAS CITY, MISSOURI**  
**LONG TERM PRIME CONTRACTOR FOR ATOMIC ENERGY COMMISSION**

**ADDRESS BOX NO. REPLIES TO:** Box No. Classified Adv. Div. of this publication. Send to office nearest you.  
**NEW YORK 36: P. O. BOX 12**  
**CHICAGO 11: 520 N. Michigan Ave.**  
**SAN FRANCISCO 1: 98 Post St.**

**POSITIONS VACANT**

**Communications Technician wanted for assignment in North Africa.** Familiarity with all aspects of H. F. Systems Essential. Salary commensurate with experience. Give full particulars. Reply to: The Ohio Oil Company, Room 7010, Findlay, Ohio.

**B.S. and M.S. Electrical Engineers for research work on instrumentation and control problems related to the steel industry.** Salary commensurate with training and experience. Large Research Laboratory, Pittsburgh Area. Forward complete resume and salary requirements to P-2283, Electronics.

**TECHNICAL SALES—SEMICONDUCTOR FIELD**

Large mid-east firm working in rapidly expanding field of ultra high purity silicon requires technical salesman. Must be willing to travel.

Degree in electronics, physics, chemistry, metallurgy, or engineering preferred. Age—25-35 years old. Previous experience in semiconductor or electronics field preferred.

Send complete resume, including salary requirements, etc. to

**SW-2231, Electronics**  
 Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

# LOS ALAMOS SCIENTIFIC LABORATORY

of the University of California

**LOS ALAMOS, NEW MEXICO**

has openings in its

**NUCLEAR ROCKET PROPULSION PROGRAM**

for

## ELECTRONICS ENGINEERS

B.S. to Ph.D. with related experience for design and test work in

- REACTOR CONTROLS
- ROCKET-THRUST CONTROLS
- INSTRUMENTATION
- SERVO-MECHANISMS
- TRANSISTOR CIRCUITS
- ANALOG COMPUTERS
- FAST PULSE EQUIPMENT

For personal interview on August 18, 19, 20 and 21

PHONE

**MR. ROBERT C. MEIER** Sutter 1-3566 San Francisco

## ELECTRICAL-ELECTRONICS ENGINEERS

Unusual opportunities available for creative electrical-electronic engineers with B.S. or advanced degrees, and with two or more years experience.

**DESIGN** . . . electro mechanical design for a variety of high speed automatic machinery.

**DEVELOPMENT** . . . feed-back systems for automatic machine and process control.

**APPLICATION** . . . systems engineering for coordinated drive and process control.

In these challenging permanent positions you will use your creative electrical talents in solving highly complex applied research problems for a company that offers unlimited growth potential.

Liberal company benefits, salary commensurate with ability and experience.

## Continental Can Company, Inc.

Metal Research and Development Laboratories  
1350 West 76th Street, Chicago 20, Illinois

### SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

#### DISPLAYED RATE

The advertising rate is \$24.75 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

#### UNDISPLAYED RATE

\$2.40 a line, minimum 3 lines. To figure advance payment count 5 average words as a line. PROPOSALS, \$2.40 a line an insertion. BOX NUMBERS count as one line additional in undisplayed ads. DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

#### lab grade TEST EQUIPMENT for sale

standard brands—military surplus  
(new or professionally reconditioned)  
experienced problem solvers and budget-cutters

ENGINEERING ASSOCIATES

434 Patterson Road Dayton 19, Ohio

## SEARCHLIGHT Equipment Locating Service

#### NO COST OR OBLIGATION

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used electronic equipment and components *not currently advertised*. (This service is for USER-BUYERS only).

**How to use:** Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

Searchlight Equipment  
Locating Service

c/o ELECTRONICS

P. O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service  
c/o ELECTRONICS

P. O. Box 12, N. Y. 36, N. Y.

Please help us locate the following equipment components.

.....  
 .....  
 .....  
 NAME .....  
 TITLE .....  
 COMPANY .....  
 STREET .....  
 CITY ..... 8/14/59

# ELECTRONIC

WAR TERMINATION INVENTORIES

WRITE OR WIRE FOR INFORMATION ON OUR COMPLETE LINE OF SURPLUS ELECTRONIC COMPONENTS. ALL PRICES NET F.O.B. PASADENA, CALIFORNIA

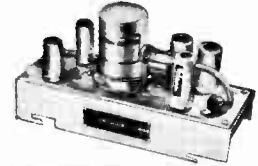


**C&H**  
SALES CO.  
2176-E East Colorado St.  
Pasadena 8, California  
RYan 1-7393

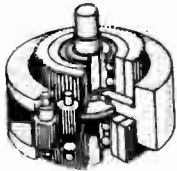
## OPERATIONAL DC AMPLIFIER with BROWN INSTRUMENT CHOPPER

AM-1023 Made by Gillfillan Bros., Inc. Useful for computers . . . for polarity inversion . . . for isolation . . . and to amplify voltages from DC to 10 cps. Useful closed-loop gain is from 0.1 to 500. Maximum output range is from -150 v to +150 v. Drift less than 10 mv/hour. Input point tends to go to ground potential because of the feedback loop and internal circuitry; therefore determines the input impedance. Accuracy of the gain figure is important in instrumentation. It is the closed-loop gain divided by the open-loop-gain of 200,000; accuracy to match, a predetermined gain of 500 is accurate to 1/4%, and lesser gains exceed the accuracy of practicable obtainable resistors. The amplifier is complete with tubes, chopper and circuit diagram. The circuit diagram gives the voltages to be furnished by an external power supply. The Brown Converter ("For Continuous Balance System") is the late type 6-pin plug-in with two-pin side connector.

Complete amplifier unit . . . . . \$49.50



### SIMPLE DIFFERENTIAL WITH BALL-BEARING SUN GEARS



The 1:1 reverse ratio spur gears are 48-tooth, 32 pitch brass with 3/16" available face. On one side, the shaft is 23.64" dia. for 1 1/16" and has a pin hole, then increases in dia. to .377" for the remaining 3/16" of length. On the other side, the shaft is .377 dia. 1/4" lg. 2-13/16" dia. is required to clear the body. Stock no. A6-115. . . . . each \$15.00

### 60 CYCLE GEARED SERVO MOTORS

mfr. Kollsman (dim. 1-23/32" x 2-13/16")

- ≠1906P-0160-05 2 rpm, induction, 25 oz. in. torque 115 volts, 60 cycle weight 6.7 oz. . . . . \$30.00
- ≠1396D-0163-025 60 rpm, synchronous, 9 oz. in. torque 115 volts, 60 cycle weight 6.7 oz. . . . . \$39.50



### SIMPLE DIFFERENTIAL WITH SPACED-OUT SUN GEARS



1:1 reverse ratio spur gears are aluminum, 3/32" face, 32 pitch, 32 tooth on one side, 48 tooth on the other. The body is 3/4" thick, but the sun gears are spaced out so that they are 1 1/2" apart, 1/4" dia. shaft on each side is 23/32" long. OA length 3 1/8". Requires 1-23/32" dia. to clear the body. Stock no. A6-124. . . . . each \$4.50

### SYNCHROS SERVOS



- 1CT cont. Trans 90/55V 60 cy. . . . . \$34.50
- 1DG Diff. Gen. 90/90V 60 cy. . . . . 34.50
- 1F Syn. Mtr. 115/90V 60 cy. . . . . 34.50
- 1G Gen. 115V 60 cy. . . . . 34.50
- 1 HDG . . . . . 37.50
- 1HCT . . . . . 37.50
- 1HG . . . . . 37.50
- 1SF Syn. Mtr. 115/90V 400 cy. . . . . 12.50
- 5CT Cont. Trans. 90/55V 60 cy. . . . . 34.50
- 5D Diff. Mtr. 90/90V 60 cy. . . . . 34.50
- 5DG Diff. Gen. 90/90V 60 cy. . . . . 34.50
- 5F Syn. Mtr. 115/90VAC 60 cy. . . . . 34.50
- 5G Syn. Gen. 115/90VAC 60 cy. . . . . 34.50
- 5MCT Cont. Trans. 90/55V 60 cy. . . . . 37.50
- 5SDG Diff. Gen. 90/90V 400 cy. . . . . 12.50
- 6DG Diff. Gen. 90/90V 60 cy. . . . . 25.00
- 6G Syn. Gen. 115/90VAC 60 cy. . . . . 34.50
- 7G Syn. Gen. 115/90VAC 60 cy. . . . . 42.50
- 7DG differential generator, 90/90 volts, 60 cycle . . . . . 37.50
- C56701 Type 11-4 Rep. 115V 60 cy. . . . . 20.00
- C69405-2 Type 1-1 Transm. 115V 60 cy. . . . . 20.00
- C69406 Syn. Transm. 115V 60 cy. . . . . 20.00
- C69406-1 Type 11-2 Rep. 115V 60 cy. . . . . 20.00
- C76166 Volt. Rec. 115V 60 cy. . . . . 10.00
- C78248 Syn. Transm. 115V 60 cy. . . . . 12.50
- C78249 Syn. Diff. 115V 60 cy. . . . . 5.00
- C78410 Repeater 115V 60 cy. . . . . 20.00
- C78863 Repeater 115V 60 cy. . . . . 7.50
- C79331 Transm. Type 1-4 115V 60 cy. . . . . 20.00
- B51 Bendix Autosyn Mtr. 22V 60 cy. . . . . 7.50
- 403 Kollsman Autosyn Mtr. 32V 60 cy. . . . . 7.50
- FPE-25-11 Diehl Servo 75/115 v 60 cy. . . . . 12.50
- FPE 49-7 Diehl servo motor, 115 volts, 60 cycle, 10 watts . . . . . 30.00
- FPE-43-1 Resolver 400 cy. . . . . 19.50
- FJE-43-9 Resolver 115V 400 cy. . . . . 15.00
- R110-2A Kearfott Cont. Mfr. . . . . 17.50
- R111-2A . . . . . 20.00
- R112-2D-B . . . . . 22.50
- R200-1-A Kearfott Cont. Trans. . . . . 15.00
- R220-1 Kearfott Receiver . . . . . 20.00
- R235-1D Kearfott Resolver . . . . . 20.00
- AY201-2B . . . . . 15.00
- AY201-3B . . . . . 12.50
- AY201S-1B . . . . . 15.00
- AY221-34 . . . . . 10.00

### MINNEAPOLIS-HONEYWELL RATE GYRO (Control Flight)



Part no. JG7005A, 115 volts A.C., 400 cycle, single phase potentiometer take off resistance 530 ohms. Speed 21,000 r.p.m. Angular momentum 2 1/2 million, CM<sup>2</sup>/sec. Weight 2 lbs. Dimensions 4-7/32 x 3-29/32 x 3-31/64. Price \$22.50

### VARIABLE SPEED BALL DISC INTEGRATORS (All Shafts Ball Bearing Supported)

No. 145 Forward & Reverse 2 1/4-0-2 1/4. Input shaft spline gear 12 teeth 9/32" dia. 3/8" long. Output shaft 15/64" dia. x 15/32" long. Control shaft 11/32" x 3/8" long. Cast aluminum construction. Approx. size 3" x 3" x 2 3/4. . . . . \$17.50

No. 146 Forward & Reverse 4-0-4. Input shaft 5/16" dia. x 3/4" long. Output shaft 15/64" dia. x 9/16" long. Control shaft 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4 1/2" x 4 1/2" x 4". . . . . \$18.50 ea.



### SMALL DC MOTORS



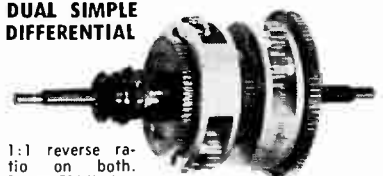
- (approx. size overall 3 3/4" x 1 1/4" dia.):
- 5067043 Delco 12 VDC PM 1" x 1" x 2", 10,000 rpm. . . . . \$7.50
  - 5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled . . . . . 15.00 ea.
  - 5069600 Delco PM 27.5 VDC 250 rpm . . . . . 12.50
  - ≠5069625 120 rpm, mfr. Delco, 27 VDC governor controlled . . . . . \$15.00
  - 5069230 Delco PM 27.5 VDC 145 rpm . . . . . 15.00
  - 5068750 Delco 27.5 VDC 160 rpm w. brake 6.50
  - 5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2") . . . . . 5.00
  - 5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled . . . . . 15.00 ea.
  - ≠5069800 575 rpm, mfr. Delco, 27 VDC, PM reversible governor controlled, equipped with 27 VDC clutch . . . . . \$17.50
  - 5072735 Delco 27 VDC 200 rpm governor controlled. . . . . 15.00
  - 58A10A11B GE 24 VDC 110 rpm . . . . . 10.00
  - 58A10AJ37 GE 27 VDC 250 rpm reversible 10.00
  - 58A10AJ52 27 VDC 145 rpm reversible 12.50
  - 58A10AJ50, G.E., 12 VDC, 140 rpm . . . . . 15.00
  - 58A10FJ401B, G.E. 2B VDC, 215 rpm, 10 oz. in., 7 amp, contains brake . . . . . 15.00
  - 58A10FJ421, G.E. 26 VDC, 4 rpm, reversible, 6 oz. in., .65 amp . . . . . 15.00
  - S. S. FD6-21 Diehl 24 VDC PM 10,000 rpm. 1" x 1" x 2". . . . . 4.00
  - ≠S5FD6-34-1 14,000 rpm, mfr. Diehl, 24 VDC PM . . . . . 5.00

### SIMPLE DIFFERENTIAL



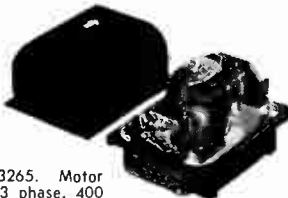
1:1 reverse ratio, 60 teeth on large gear, 1/4" shaft. Size: 3" long with 1-15/16" dia. Stock no. A6-104. . . . . each \$3.95

### DUAL SIMPLE DIFFERENTIAL



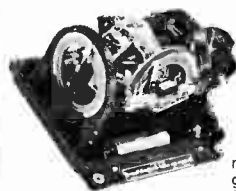
1:1 reverse ratio on both. Size: 3 1/4" long x 1-7/16" dia. Shaft size: 1/8" and 5/32". Stock no. A6-107. . . . . each \$7.50

### SPERRY VERTICAL GYRO



Part #653265. Motor 115 volts, 3 phase, 400 cycle, 8 watts, 20,000 RPM. 3-minute runup, synchro pickoffs, roll 360°, pitch B5°. Synchro excitation 26 volts, 400 cycle, 150 m.a. Vertical accuracy ±1/2°. Weight 3 1/2 lbs. Approx. dim. 5 3/4" L., 4 1/2" W., 4 1/2" H. Price \$35.00

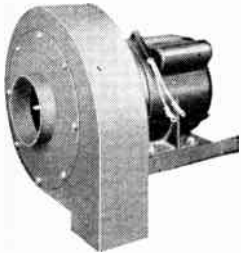
### HONEYWELL VERTICAL GYRO MODEL JG7003A-1



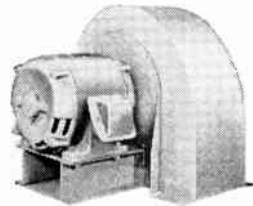
115 volts, 400 cycles, single phase, 35 watts. Pitch and roll potentiometer pick offs B90 ohms, 40 volts max. AC or DC. Speed 20,000 rpm, ang. momentum 12,500,000 gm-cm<sup>2</sup>/sec. Erection system 27 VAC. 400 cycles, time 5 min. to 1/2". Weight 5.5 lbs. Price \$35.00 each

# INDEX TO ADVERTISERS

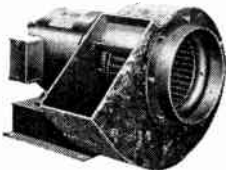
# NEED SPECIAL BLOWERS?



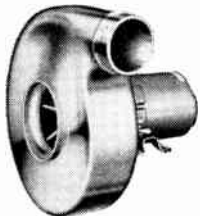
ELECTRONIC COOLING



HEAVY MACHINERY COOLING



INSULATED FOR TEMPERATURES



NO-CORROSION  
ALUMINUM CONSTRUCTION

**PEERLESS  
ELECTRIC  
SUPPLIES  
BOTH  
BLOWERS  
AND MOTORS  
AS A  
COMPLETE  
UNIT!**

- Meet government specifications!
- Air requirements up to 8" static pressure!
- Special finishes, fungus-treated, insulated, etc.!
- High and low temperature requirements!
- Special units for space conditions!

*Contact us today! We're interested in your inquiry!*

**Peerless  
Electric**

FAN AND BLOWER DIVISION

**THE Peerless Electric CO**

FANS · BLOWERS · MOTORS

1446 W. MARKET ST. WARREN, OHIO

AMP Incorporated .....	87	Ofner Electronics, Inc. ....	107
Ace Electronics Associates, Inc. ....	103	Ohmite Manufacturing Company .....	7
Aeme Electric Corporation .....	95	Peerless Electric Co. ....	118
Alford Mfg. Co., Inc. ....	97	Phileo Corporation .....	48
American Electronics Co., Inc. ....	40	Radio Corporation of America ..13, 4th Cover	
American Electronics, Inc. ....	32	Radio Materials Corp. ....	41
American Lava Corporation .....	20	Rantec Corporation .....	95
Ampex Magnetic Tape .....	21	Raytheon Company .....	37, 73
Anaconda Wire & Cable Company .....	22, 23	Resistance Products Co. ....	24
Atlas E-E Corporation .....	78	Sungamo Electric Co. ....	77
B & H Instrument Co., Inc. ....	42	Servo Corporation of America .....	79
Baird-Atomic, Inc. ....	99	Sloan Co., The .....	99
Belden Wire & Cable Co. ....	31	Sprague Electric Company .....	5
Bird Electronic Corp. ....	46	Standard Electric Time Company .....	2
Burnell & Co., Inc. ....	3	Stevens Mfg. Co., Inc. ....	71
CBS Electronics .....	81	Superior Cable Corporation .....	105
Clare & Co., C. P. ....	45	Superior Electric Company .....	35, 36
Collins Radio Company .....	27	Temco Aircraft Corporation .....	47
Columbus Electronics Corp. ....	43	Texas Instruments Incorporated .....	111
Cornish Wire Co., Inc. ....	110	Transradio Ltd. ....	104
Convair Astronautics .....	89	Trio Laboratories, Inc. ....	29
Curtiss-Wright Corporation .....	108	United Transformer Corporation ..2nd Cover	
Dale Products, Inc. ....	17, 18	Varian Associates .....	85
Daven Company .....	3rd Cover	Vitramon, Incorporated .....	110
DeMornay-Bonardi .....	108	Walsco Electronics Mfg. Co. ....	98
duPont de Nemours & Co. (Inc.), E. I. Pigments Dept. ....	16	Weckesser Company .....	95
Edo Corporation .....	108	West Penn Power .....	86
Eitel-McCullough, Inc. ....	10	Westinghouse Electric Corp. ....14, 31, 75	
Electronic Batteries Inc. ....	111		
Electronic Instrument Co. (EICO) .....	98		
Electronic Organ Arts, Inc. ....	98		
Eric Resistor Corporation .....	82, 83		
Essex Wire Corporation .....	12		
G-M Laboratories, Inc. ....	109		
G-M Servo Motors .....	109		
General Public Utilities Corp. ....	90		
Good-All Electric Mfg. Co. ....	38, 39		
Goodrich Company, B. F. ....	25		
Heath Company .....	91		
Hewlett-Packard Company .....	8, 9		
Industrial Instruments .....	88		
Industrial Test Equipment Co. ....	97		
International Business Machines Corp. ....	69		
International Electronics Mfg. Co. ....	74		
Jennings Radio Mfg. Corp. ....	96		
Kleinschmidt Div. of Smith-Corona Marchant, Inc. ....	6		
Laboratory for Electronics, Inc. ....	15		
Lampkin Laboratories, Inc. ....	115		
Leland, Inc., G. H. ....	94		
Levin & Son, Inc., Louis. ....	107		
Lockheed Aircraft Corp. ....	97		
Magnavox Company .....	41		
Marion Instrument Div. Minneapolis-Honeywell Regulator Co. ....	98		
Mitten Mfg. Co., Inc., James. ....	26		
Motorola .....	100		
Myaclex Corporation of America. ....	30		
Nems-Clarke Co. ....	92		
Professional Services .....	115		

## CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES. 112-116

## EQUIPMENT

(Used or Surplus New)

For Sale .....116, 117

## ADVERTISERS INDEX

Bendix Aviation Corp. Kansas City Div. ..	115
C & H Sales Company .....	117
Continental Can Company, Inc. ....	114, 116
Engineering Associates .....	116
General Electric Company .....	113
Los Alamos Scientific Laboratory .....	116
Republic Aviation Corp. ....	112
Sikorsky Aircraft .....	114
Sylvania, sub. of General Telephone & Electronic .....	112

This index is published as a service. Every care is taken to make it accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.