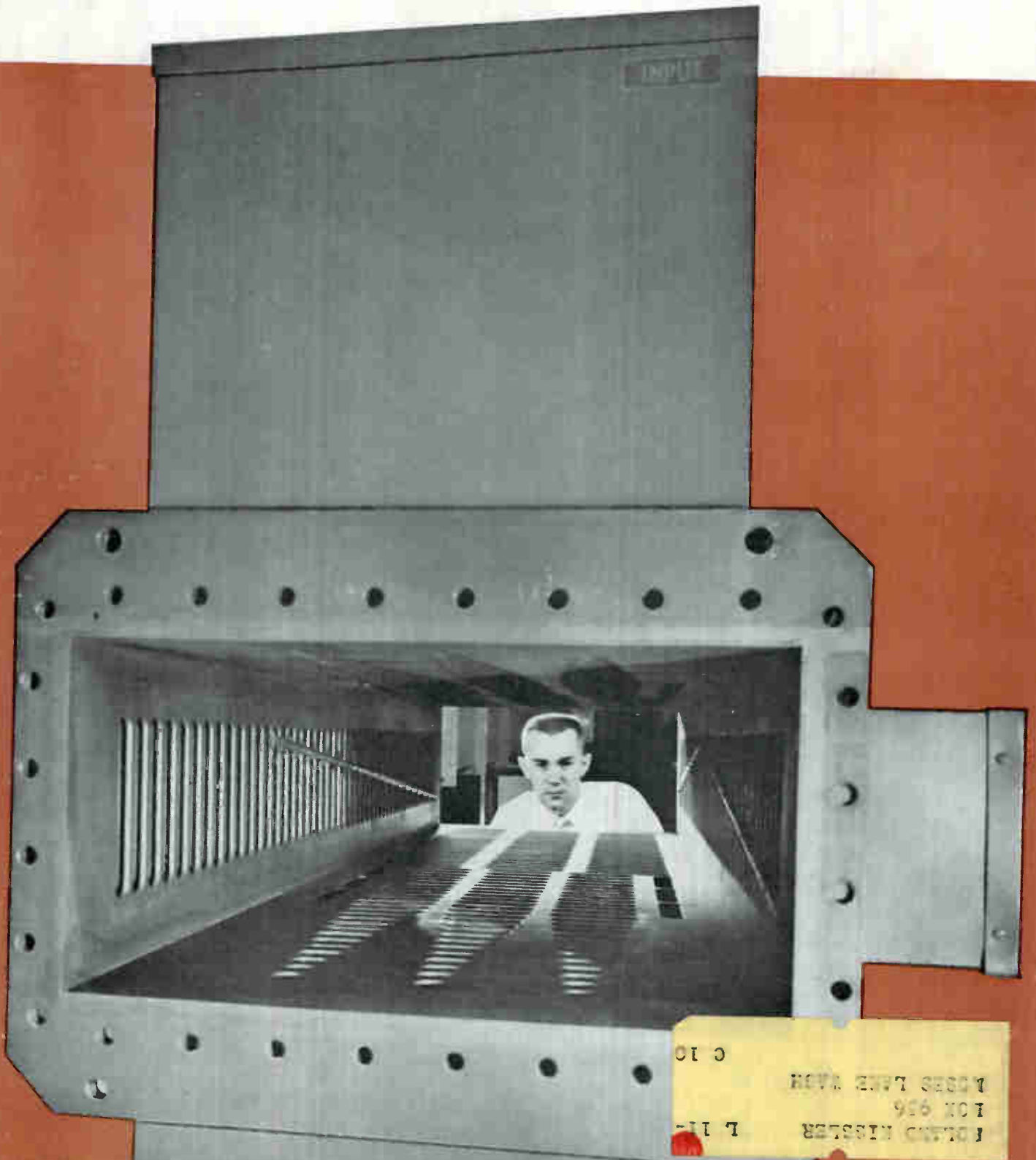


April 14, 1961

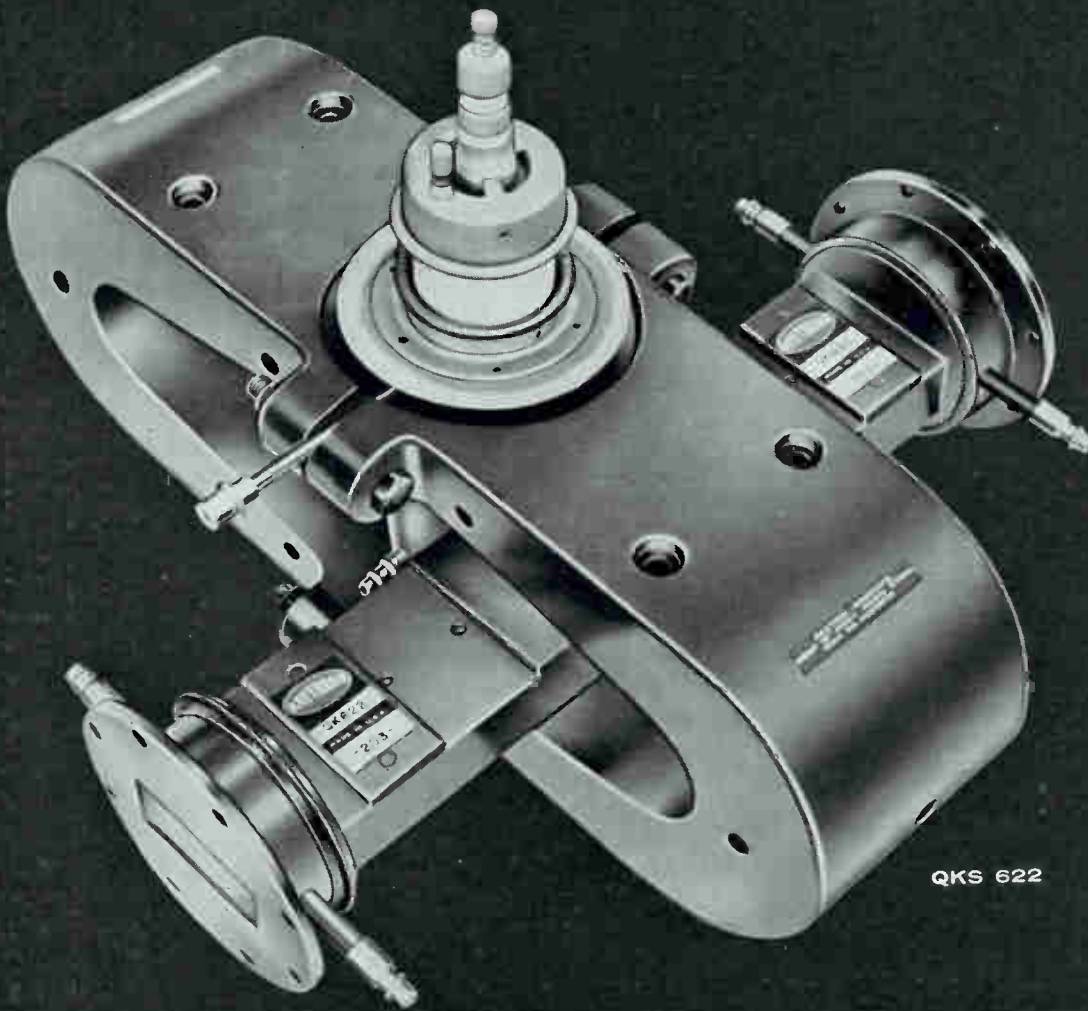
# electronics

*Microwave absorption filter (below) operates at 400-450 Mc,  
suppresses unwanted harmonics, handles 5 megawatts peak, p 86  
Solar research receiver has zero cps intermediate frequency, p 59*

A McGraw-Hill Publication 75 Cents



One of a series of advertisements  
featuring tubes for MOPA chains



**MOPA**  
S-BAND  
CHAIN



## Raytheon pulsed-type Amplitron\* produces 3-megawatt S-band output at efficiencies of 75 to 80%

QKS 622 tubes are used as driver and final amplifier stages of broadband MOPA chain.

Raytheon Amplitrons are ideally suited for high power MOPA applications where extremely high efficiency is required. For example, a single QKS 622 Amplitron can produce up to 15 kw average and 3 megawatts peak power with 70 to 80% efficiency. Easily achieved parallel operation doubles these power outputs. Adequate drive power is supplied by the QKS 622 operating at lower levels.

This unusually compact 2,900 to 3,100 mc Amplitron has been operated at 30-microsecond pulse widths, and can be expected to perform satisfactorily at far greater widths. A companion tube, the QKS 783, covers 2,700 to 2,900 mc. Both tubes are specified for 1,000 hours.

### QKS 622 GENERAL CHARACTERISTICS (Typical Operation)

	DRIVER	FINAL AMPLIFIER
Pulse Duration . . . . .	11 $\mu$ sec . . . . .	10 $\mu$ sec
Duty Cycle . . . . .	.0055 . . . . .	.0050
Peak Anode Voltage . . . . .	48-52 kv . . . . .	50-54 kv
Peak Anode Current . . . . .	20 a . . . . .	66 a
Peak Power Output . . . . .	600 kw . . . . .	3.0 Mw
RF Driver Peak Power . . . . .	48 kw min . . . . .	550 kw min
Cold Insertion Loss . . . . .	0.5db . . . . .	0.5 db
Heater Power . . . . .	None Required . . . . .	

Write for detailed information and application service to Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts. In Canada: Waterloo, Ontario. \*Raytheon Trademark

# RAYTHEON COMPANY



MICROWAVE AND POWER TUBE DIVISION

BOSTON, MASS., BRowning 2-9600 • ENGLEWOOD CLIFFS, N. J., LOWell 7-4911 • BALTIMORE, MD., Southfield 1-0450 • CHICAGO, ILL., National 5-4000  
• DAYTON, OHIO, Baldwin 3-8128 • LOS ANGELES, CALIF., Plymouth 7-3151 • CANADA: Waterloo, Ont., SHERwood 5-6831

# electronics

A McGraw-Hill Publication 75 Cents



W. W. MacDONALD, Editor

J. M. CARROLL, Managing Editor

SENIOR ASSOCIATE EDITORS: Samuel Weber, Roland J. Charest. ASSOCIATE EDITORS: Frank Leary, Michael F. Tomaino, Sylvester P. Carter, William P. O'Brien, John F. Mason, William E. Bushar, Thomas Emma, Sy Vogel, Leslie Solomon, M. M. Perugini, George J. Flynn. ASSISTANT EDITORS: Michael F. Wolff, Nilo Lindgren, Stanley Froud, Stephen B. Gray, Roy J. Bruun, George V. Novotny, Leon H. Dulberger.

REGIONAL EDITORS: Harold C. Hood (Pacific Coast, Los Angeles), Thomas Maguire (New England, Boston), Cletus M. Willey (Midwest, Chicago). BUYERS' GUIDE EDITOR: George Sideris. ART DIRECTOR: Harry Phillips; Howard R. Berry. PRODUCTION EDITOR: John C. Wright, Jr. EDITORIAL ASSISTANTS: Gloria J. Fillipone, Bernice Duffy, Lorraine Rossi, Virginia T. Bastian, Lynn Emery, Avis Pomeranz, Florence Hajaistran, Laura W. Smith, Bette H. Snyder.

JAMES GIRDWOOD, Publisher

## BUSINESS

Business Equipment: Photoelectric, Electrostatic Techniques	26
Island Station Will Control Mercury Capsule. Visit to Kokee Park	28
New Biomedical Lab Going Up In Iowa. More electronics research	30
How Space Astronomy Satellite Operates. New design concepts	32
English Computer to Run Chemical Plant. Full control by July	34
Chicom's Tv Net Plans Bog Down. Only 1 station built in 1960	36
Crosstalk	4
Comment	6
Electronics Newsletter	9
Washington Outlook	14
Financial	22
25 Most Active Stocks	23
Meetings Ahead	39

## ENGINEERING

Microwave filter, the MPF-400, was developed by General Electric designers for one of the largest waveguides made, handles pass-band of 400 to 450 Mc. See p 86	COVER
Microwave Swept Receiver Uses Zero Intermediate Frequency. Solar research receiver has many other applications. By D. W. Casey II	59
Complementary Transistors Simplify Modulator Design. Modulator offers unique advantages. By J. E. Grau and B. F. Humbel	64
Pickup Devices for Very-Low-Frequency Reception. Hall device sensitivity is independent of frequency. By George J. Monser	68
Evaluating Radio Receiver Susceptibility to Interference. Methods for comparing receivers. By B. T. Newman, H. Cahn and R. Keyes	70
A-C Controlled Half-Cycle Magnetic Amplifier. Low time constant and good waveform. By E. Van Winkle	75
Stabilized Delay Circuit Provides High Accuracy. Solid-state timer has accurate delay of from 6 to 120 $\mu$ sec. By C. K. Friend and S. Udalov	78

## DEPARTMENTS

Research and Development. Russians Study 3-D Color Tv	82
Components and Materials. Filters Clear Airways	86
Production Techniques. Preparing Semiconductor Dice	90
New on the Market	94
Literature of the Week	112
People and Plants	114
Index to Advertisers	133





### CONVECTION COOLED

No Blowers or Filters  
Maintenance Free

Highly efficient, radiator type heat sinks eliminate internal blowers, maintenance problems, risk of failure, moving parts, noise and magnetic fields. Units are rated for continuous duty at 50°C ambient.

### EASY SERVICE ACCESS

Dual-deck, swing-out back construction provides simple and fast service access without the need to remove unit from rack. All major component terminals are accessible from rear.

### NO VOLTAGE SPIKES OR OVERSHOOT

Lambda's design prevents output voltage overshoot on "turn on, turn off," or power failure.

### MIL QUALITY

Hermetically-sealed magnetic shielded transformer designed to MIL-T-27A quality and performance. Special, high-purity foil, hermetically-sealed long life electrolytic capacitors.

### SHORT CIRCUIT PROOF

All models are completely protected with magnetic circuit breakers, fuses, and thermal overload.

### REMOTE SENSING

Minimizes effect of power output leads on DC regulation, output impedance and transient response.

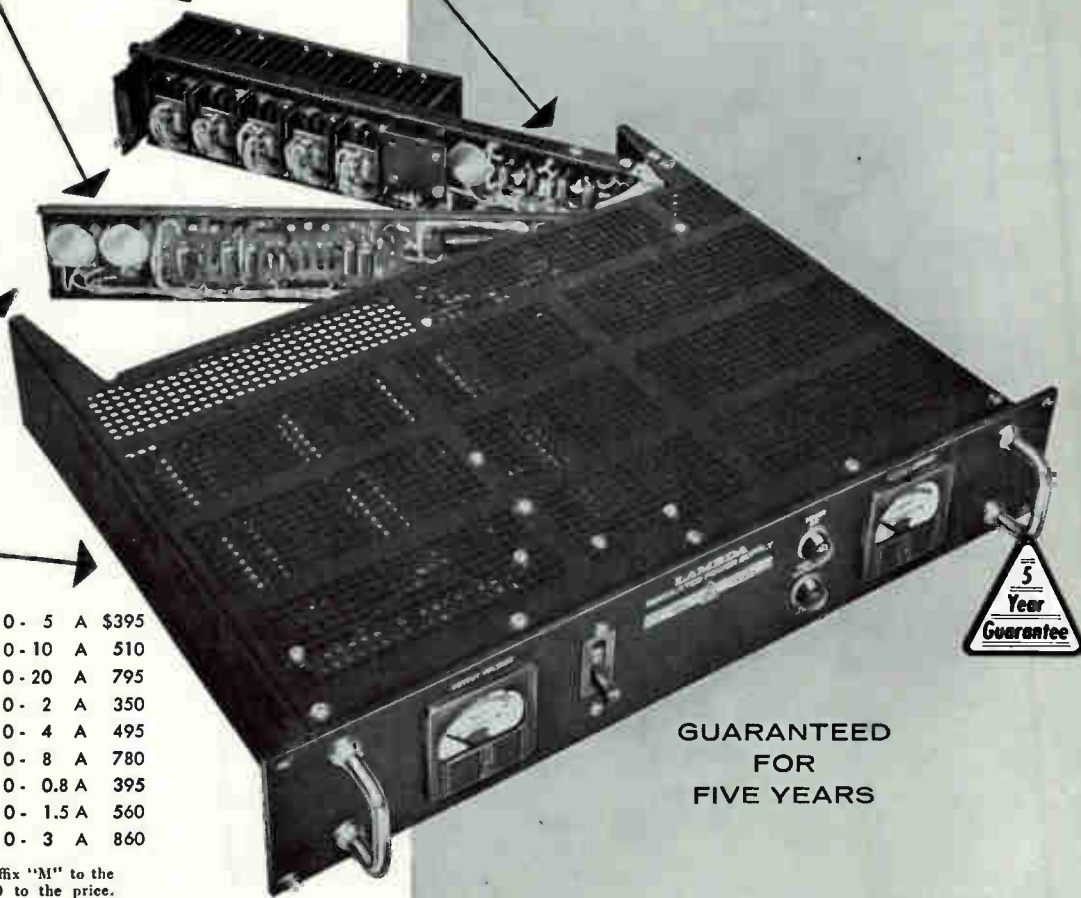
LA 50 - 03A	0 - 34 VDC	0 - 5 A	\$395
LA100 - 03A	0 - 34 VDC	0 - 10 A	510
LA200 - 03A	0 - 34 VDC	0 - 20 A	795
LA 20 - 05A	20 - 105 VDC	0 - 2 A	350
LA 40 - 05A	20 - 105 VDC	0 - 4 A	495
LA 80 - 05A	20 - 105 VDC	0 - 8 A	780
LA 8 - 08A	75 - 330 VDC	0 - 0.8 A	395
LA 15 - 08A	75 - 330 VDC	0 - 1.5 A	560
LA 30 - 08A	75 - 330 VDC	0 - 3 A	860

For metered models add the suffix "M" to the model number and add \$30.00 to the price.

# New LAMBDA

## Transistorized REGULATED POWER SUPPLIES

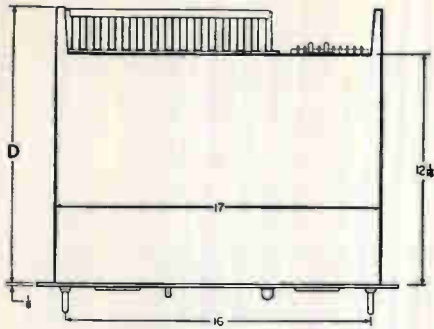
0 - 34 VDC 5, 10 and 20 Amp  
20 - 105 VDC 2, 4 and 8 Amp  
75 - 330 VDC 0.8, 1.5 and 3 Amp



GUARANTEED  
FOR  
FIVE YEARS

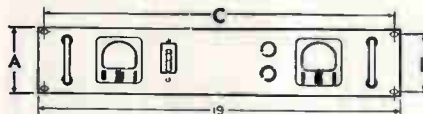


**DIMENSION DRAWINGS**



← Top View of All Models

Front View



MODEL †			
	LA 50-03A LA 20-05A LA 8-08A	LA 100-03A LA 40-05A LA 15-08A	LA 200-03A LA 80-05A LA 30-08A
A	3 1/2"	7"	10 1/2"
B	3"	*4"	*7 1/2"
C	18 3/8"	18 1/4"	18 1/4"
D		14 3/8"	16 1/2"

\* These models notched per RETMA Standards  
† Includes metered models with suffix "M"

**COMPLETE SPECIFICATIONS OF LAMBDA LA SERIES**

**DC OUTPUT (Regulated for line and load)**

Model	Voltage Range	Current Range	Minimum Voltage (1)	Voltage Steps (1)	Price(2)
LA 50-03A	0- 34 VDC	0- 5 AMP	0	2, 4, 8, 16, and 0- 4 volt vernier	\$ 395
LA100-03A	0- 34 VDC	0-10 AMP	0	2, 4, 8, 16, and 0- 4 volt vernier	510
LA200-03A	0- 34 VDC	0-20 AMP	0	2, 4, 8, 16, and 0- 4 volt vernier	795
LA 20-05A	20-105 VDC	0- 2 AMP	20	5, 10, 20, 40, and 0-10 volt vernier	350
LA 40-05A	20-105 VDC	0- 4 AMP	20	5, 10, 20, 40, and 0-10 volt vernier	495
LA 80-05A	20-105 VDC	0- 8 AMP	20	5, 10, 20, 40, and 0-10 volt vernier	780
LA 8-08A	75-330 VDC	0- 0.8 AMP	75	15, 30, 60, 120, and 0-30 volt vernier	395
LA 15-08A	75-330 VDC	0- 1.5 AMP	75	15, 30, 60, 120, and 0-30 volt vernier	560
LA 30-08A	75-330 VDC	0- 3 AMP	75	15, 30, 60, 120, and 0-30 volt vernier	860

(1) The DC output voltage for each model is completely covered by four selector switches plus vernier control. The DC output voltage is the summation of the minimum voltage plus the voltage steps and the continuously variable DC vernier.

(2) Prices are for unmetered models. For metered models add the suffix "M" and add \$30.00 to the price.

- Regulation (line)** . . . . . Better than 0.05 per cent or 8 millivolts (whichever is greater). For input variations from 100-130 VAC.
- Regulation (load)** . . . . . Better than 0.10 per cent or 15 millivolts (whichever is greater). For load variations from 0 to full load.
- Transient Response** . . . . . Output voltage is constant within regulation specifications for step function:
  - (line) . . . . . line voltage change from 100-130 VAC or 130-100 VAC.
  - (load) . . . . . load change from 0 to full load or full load to 0 within 50 microseconds after application.
- Internal Impedance** . . . . . LA 50-03A less than .008 ohms  
LA100-03A less than .004 ohms  
LA200-03A less than .002 ohms  
LA 20-05A less than .06 ohms  
LA 40-05A less than .03 ohms  
LA 80-05A less than .015 ohms  
LA 8-08A less than .5 ohms  
LA 15-08A less than .25 ohms  
LA 30-08A less than .15 ohms
- Ripple and Noise** . . . . . Less than 1 millivolt rms with either terminal grounded.
- Polarity** . . . . . Either positive or negative terminal may be grounded.
- Temperature Coefficient** . . . . . Better than 0.025 %/°C

**AMBIENT TEMPERATURE AND DUTY CYCLE**

Continuous duty at full load up to 50°C (122°F) ambient.

**OVERLOAD PROTECTION:**

- Electrical** . . . . . Magnetic circuit breaker front panel mounted. Special transistor circuitry provides independent protection against transistor complement overload. Fuses provide internal failure protection. Unit cannot be injured by short circuit or overload.
- Thermal** . . . . . Thermostat, manual reset, rear of chassis. Thermal overload indicator light front panel.

**METERS** . . . . . Voltmeter and ammeter on metered models.

**CONTROLS:**

- DC Output Controls** . . . . . Voltage selector switches and adjustable vernier-control rear of chassis.
- Power** . . . . . Magnetic circuit breaker, front panel.
- Remote DC Vernier** . . . . . Provision for remote operation of DC vernier.
- Remote Sensing** . . . . . Provision is made for remote sensing to minimize effect of power output leads on DC regulation, output impedance and transient response.

**PHYSICAL DATA:**

- Mounting** . . . . . Standard 19" Rack Mounting
- Size**
  - LA 50-03A, LA20-05A, LA 8-08A 3 1/2" H x 19" W x 14 3/8"D
  - LA100-03A, LA40-05A, LA15-08A 7" H x 19" W x 14 3/8"D
  - LA200-03A, LA80-05A, LA30-08A 10 1/2" H x 19" W x 16 1/2"D
- Weight**
  - LA 50-03A, LA20-05A, LA 8-08A 55 lb Net 85 lb Ship. Wt.
  - LA100-03A, LA40-05A, LA15-08A 100 lb Net 130 lb Ship. Wt.
  - LA200-03A, LA80-05A, LA30-08A 140 lb Net 170 lb Ship. Wt.
- Panel Finish** . . . . . Black ripple enamel (standard). Special finishes available to customers' specifications at moderate surcharge. Quotation upon request.

- AC INPUT** . . . . . 100-130 VAC, 60 ± 0.3 cycle<sup>3</sup>
  - LA 50-03A . . . . . 360 watts<sup>4</sup>
  - LA100-03A . . . . . 680 watts<sup>4</sup>
  - LA200-03A . . . . . 1225 watts<sup>4</sup>
  - LA 20-05A . . . . . 390 watts<sup>4</sup>
  - LA 40-05A . . . . . 710 watts<sup>4</sup>
  - LA 80-05A . . . . . 1350 watts<sup>4</sup>
  - LA 8-08A . . . . . 415 watts<sup>4</sup>
  - LA 15-08A . . . . . 760 watts<sup>4</sup>
  - LA 30-08A . . . . . 1450 watts<sup>4</sup>

<sup>3</sup>This frequency band amply covers standard commercial power lines in the United States and Canada.

<sup>4</sup>With output loaded to full rating and input at 130 VAC.



**LAMBDA ELECTRONICS CORP.**

515 BROAD HOLLOW ROAD, HUNTINGTON, L. I., NEW YORK 516 MYRTLE 4-4200

Send for complete Lambda Catalog.

CIRCLE 3 ON READER SERVICE CARD

Published weekly, with Electronics Buyers' Guide and Reference issue, as part of the subscription, by McGraw-Hill Publishing Company, Inc. Founder: James H. McGraw (1860-1948).

Title registered U.S. Patent Office; Copyrighted 1961, McGraw-Hill Publishing Company, Inc. All rights reserved, including the right to reproduce the contents of this publication, in whole or in part.

Executive, editorial, circulation and advertising offices McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Telephone Longacre 4-3000. Teletype TWX N.Y. 1-1636. Cable McGrawhill, N.Y. Printed in Albany, N. Y.; second class postage paid.

**OFFICERS OF THE PUBLICATIONS DIVISION:** Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callahan, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

**OFFICERS OF THE CORPORATION:** Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

Subscriptions are solicited only from those actively engaged in the field of the publication. Position and company connection must be indicated on orders. Subscription rates: United States and Possessions, \$6.00 one year; \$9.00 two years; \$12.00 three years. Canada, \$10.00 one year. All other countries \$20.00 one year. Single Copies, United States and Possessions and Canada 75¢; Buyers' Guide \$3.00; Single Copies all other countries \$1.50; Buyers' Guide \$10.00.

The Publisher, upon written request from any subscriber to our New York Office, agrees to refund that part of the subscription price applying to copies not yet mailed.

Subscribers: Please address all correspondence, change of address notices, subscription orders or complaints to Fulfillment Manager, Electronics, at above address. Change of address notices should provide old as well as new address, including postal zone number if any. If possible, attach address label from recent issue. Allow one month for change to become effective.

Postmaster: Please send Form 3579 to Fulfillment Manager, Electronics, 330 West 42nd Street, New York 36, New York.



Audited Paid Circulation

## CROSSTALK

**VLF RECEPTION.** This issue brings another in a series of informative articles by G. J. Monser of American Electronic Laboratories related to the design of LF and VLF antennas. In his latest **ELECTRONICS** article, Monser compares the Hall sensor and loop and whip antennas over the frequency range 10 to 10,000 cycles.

Previous articles by Monser have dealt with design charts for low-frequency antennas (p 90, April 7, 1961 and p 86, March 18, 1960) and designing antennas for maximum low-frequency radiation (p 84, June 3, 1960, coauthored with W. D. Sabin of Motorola). Monser's article begins on p 68.

**BUSINESS EQUIPMENT.** In its search for news of active markets, **ELECTRONICS** has looked closely into the Business Equipment Exposition opening next week at New York's Coliseum. Office and industrial needs in this \$4-billion industry are leading to new applications for electronic technology.

Computer-to-microfilm record filing, automatic-format-control photoelectric typewriter, automated electrostatic address-label printing system, employee transaction reporting stations for solid state accounting equipment—all are new this year. And all are detailed on p 26 along with other electronic office gear developments.

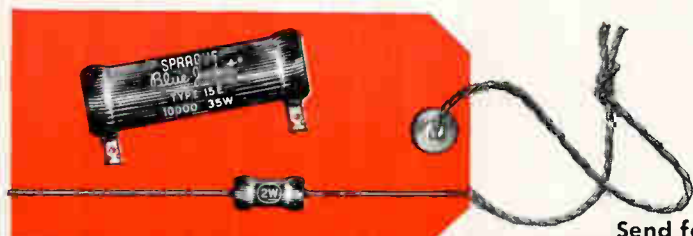
**MAN IN SPACE.** Some day soon you may be hearing quite a bit about a place called Kokee Park. It is in Kauai, Hawaii, and is one of five Project Mercury control stations spread around the world. Primary command function of the \$7-million island station is resetting of the man-in-space capsule's retrorocket timers.

A few days ago the first simulation tests were held at Kokee Park. On hand was Pacific Coast Editor Hood. His exclusive account appears on p 28.

### Coming In Our April 21 Issue

**LASER RADAR.** One highlight of the recent IRE Convention was an experimental radar using a ruby laser transmitter (**ELECTRONICS**, p 182, March 10). Operation of this system is explained in our next issue by M. L. Stitch, E. J. Woodbury and J. H. Morse of Hughes Aircraft Co. in Culver City, Calif.

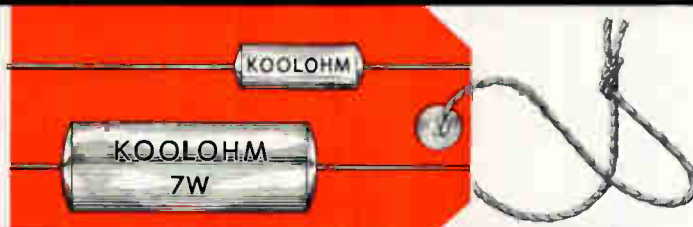
The authors also discuss performance data indicating that the coherent light beam provides a ranging capability of up to 2 or 3 miles at present. Development of the ruby laser, from which the beam is derived, was reported in our issue of June 22, 1960 (p 43).



## BLUE JACKET®

VITREOUS ENAMEL-PROTECTED,  
POWER WIREWOUND RESISTORS.

Send for Bulletins: 7410-A (Axial Lead), 7400-A (Tab Type)



## KOOLOHM®

CERAMIC INSULATED-SHELL,  
POWER WIREWOUND RESISTORS.

Send for Engineering Bulletin: 7300-A

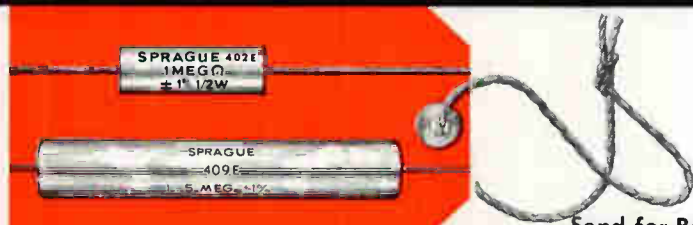


## PERMASEAL®

CAST EPOXY HOUSING,  
PRECISION WIREWOUND RESISTORS.

Send for Engineering Bulletin: 7500

# SPRAGUE RESISTORS



## FILMISTOR®

PRECISION CARBON FILM RESISTORS.

Send for Bulletins: 7000 (Molded shell), 7010-B (Ceramic shell)



## MEG-O-MAX®

GLASS-JACKETED HIGH VOLTAGE,  
HIGH POWER RESISTORS.

Send for Engineering Bulletin: 7200-A



## SPIRAMEG®

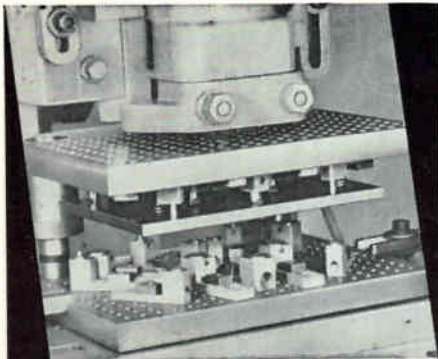
HIGH-RESISTANCE SPIRAL ELEMENT  
RESISTORS.

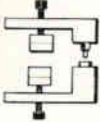
Send for Engineering Bulletin: 7100

SPRAGUE ELECTRIC COMPANY 35 Marshall Street North Adams, Mass.

SPRAGUE COMPONENTS: RESISTORS • CAPACITORS • MAGNETIC COMPONENTS • TRANSISTORS  
INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS





 **Punch Multiple Holes  
in One Operation  
with REUSABLE DI-ACRO  
ADJUSTABLE PUNCHES AND DIES**



Di-Acro Adjustable Punches and Dies offer you an inexpensive means of rapid tooling for multiple punching of holes of a variety of shapes and sizes. They will do the job in a fraction of the time it would take using a single station punch press and at a fraction of the cost of standard tooling. All tooling can be arranged in a countless number of patterns so that most multiple hole punching jobs can be accomplished in one operation. Tooling can be reused again and again. Holes can be as close together as  $\frac{3}{4}$ " on centers. A template locates your punches and dies accurately. All Di-Acro punches and dies are concentric, readily interchangeable. Standard rounds, squares, rectangles, ovals, D's and other shapes in a variety of sizes are available from stock.

Di-Acro Adjustable Punch and Die catalog is complete with detailed instructions and prices on all die sets, punches and dies. Consult the yellow pages of your phone book for the name of your nearest Di-Acro Distributor or write us for your free copy.



Pronounced die-ack-ro



**DI ACRO CORPORATION**

Formerly  
O'Neill-Irwin Mfg. Co.

434 Eighth Avenue Lake City, Minnesota

## COMMENT

### More U Mu

I've just been reading the touching two-way communication on p 6 of your January 6 issue (Comment), and it has found its way to my heart.

This note is just to let you know that we'll be more than happy to make this typewriter available to you or any member of your staff any time you have a typing job that doesn't require use of the 21st letter of the alphabet.

Continued good wishes . . .

FRANK HAYLOCK

SAN MATEO, CALIF.

### Network Design

(Department of Archival Research)

We request your help in solving difficulties which have arisen in network circuit design.

We have studied your issue of April '47, the article "Experiments in Listening" (p 90) by N. D. Webster, technical director, and Franklin Peak, special project engineer, McClatchy Broadcasting Co., Sacramento, Calif. Working in accordance with the details of the diagram, we designed two amplifiers for our public-address equipment. We were puzzled by the network part of the circuit which is given on p 93; we tried with many different output transformers and r-f chokes to achieve the results you mention in the article, but so far we have not found any satisfactory result.

We hope you will help us in the network design . . .

V. R. DAMANI

BORIVALI, EAST BOMBAY  
INDIA

*By forwarding this request to McClatchy Broadcasting, we were able to lead reader Damani to some help with his problem. But what struck us—as these things sometimes do, although by now we ought to stop being surprised—is that an article published in ELECTRONICS 14 years ago is still useful to someone, somewhere.*

### Synopsis of Contract Awards

. . . One of the subscribers to our publication *Synopsis of U.S. Government Proposed Procurement*,

*Sales and Contract Awards* is evidently relying on the *ELECTRONICS Buyers' Guide* for 1960-61 (for his impression) that the *Synopsis* is now \$7 per year. The amount due on a regular subscription is \$10 per year; our subscription rate increased from \$7 to \$10 in April, 1959, and our airmail service increased from \$25 to \$28.

It may be some time before the correction can be made, but when convenient, we shall appreciate the revision in prices. . . .

G. A. BONNSTETTER

U. S. DEPARTMENT OF COMMERCE  
CHICAGO

*Correction will be made in the 1961 Buyers' Guide.*

### Phantastron

Some errors appeared in the illustrations for "Voltage Control of Phantastron Frequency," p 73, Feb. 10, and a fairly important part of the circuit explanation was deleted.

In Fig. 1A, a resistor should be shown between the suppressor grid and  $-E_{cc}$  to permit this grid, which acts as a second control grid, to switch the tube on and off.

In Fig. 1B, the final voltage of the plate waveform (following the exponential recovery) should be  $E_b$  rather than  $E_1$ .

In Fig. 2, the screen of  $V_s$  should be connected to the junction of the 120,000-ohm ( $R_s$ ) and the 680,000-ohm resistors. The screen, instead of the suppressor, should be connected to the junction of the 120,000-ohm and the 22,000-ohm resistors.  $C_s$  is then connected between the screen and the suppressor grids. The  $V_s$  circuitry should be identical with the  $V_1$  circuitry.

Also in Fig. 3, the note should read "All diodes JAN 1N458 except  $D_{11}$ , which is a  $\frac{1}{2}$  M75Z5 75-v Zener diode." This diode drops the summed screen voltages from 110 v in the operating condition and 40 v in the nonoscillating condition, to 35 v and  $-35$  v respectively. The starting pulse is clamped to this voltage by  $D_{11}$ , cutting off  $D_{11}$  and disabling the starter circuit when the phantastrons are oscillating.

W. C. WHITWORTH

MOTOROLA  
SCOTTSDALE, ARIZ.

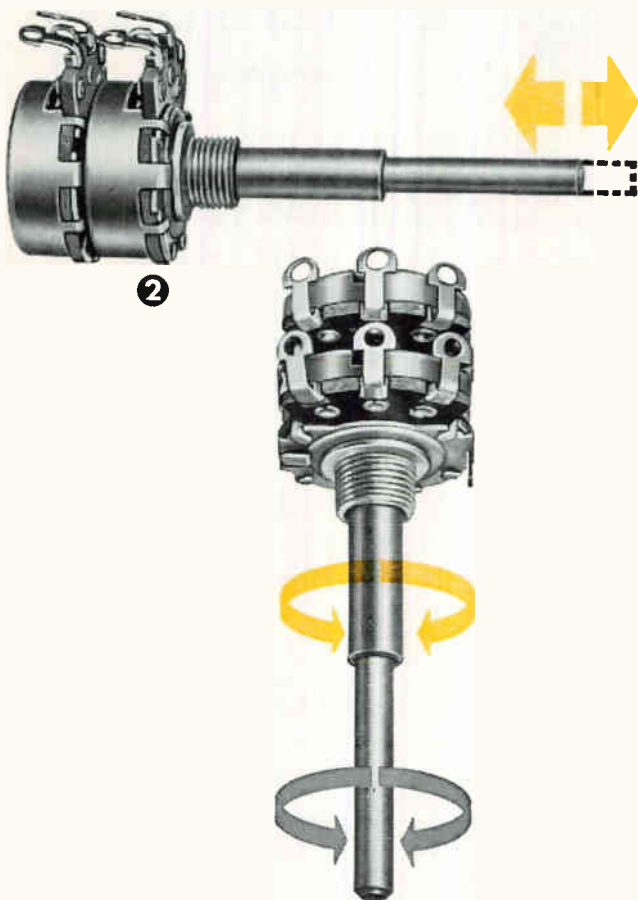


# NEW CONTROLS FOR STEREO

## *Flexibility without Complexity*

Even a wife can appreciate the major points of these special dual-element controls for 2-channel stereo equipment! No longer is it necessary to fiddle with 2 bass controls, 2 treble controls, and 2 volume controls to obtain proper stereo balance—then re-adjust everything when listening to monophonic material. No longer, that is, unless you're an ardent audiophile who would have it no other way.

For these new Stackpole controls "clean-up" the panels of stereo equipment, make them easier to operate and understand . . . yet retain all the flexibility of individual adjustments required on the most elaborate equipment.



- ① **FRICION SHAFT DUAL**—Type LS3: A friction fit between shafts causes both elements of this dual concentric shaft control to operate in tandem when either shaft is turned. Either element can also be adjusted independently by holding one shaft while rotating the other. Once set, either knob can be turned while maintaining stereo balance through a wide range of adjustment.
- ② **CLUTCH SHAFT DUAL**—Type LS1: This wonderfully convenient control allows either simultaneous or individual adjustment of its two elements. A push on the inner shaft engages a clutch which connects both elements together for tandem operation by either shaft. Pulling the inner shaft permits each element to be individually adjusted without disturbing the other.
- ③ **MATCHED ELEMENT TANDEM**—Type L-Tandem: Through precise electrical matching and careful mechanical alignment, this stereo tandem control allows convenient, single-knob adjustment of both channels. It's ideal for adjustment of master volume or of bass or treble in systems where an absolute minimum of panel complexity is desired.

# STACKPOLE

Coldite 70+® fixed composition Resistors • Slide & Snap Switches • Ceramag® Ferrite Cores • Fixed composition Capacitors • Ceramagnet® Ceramic Magnets • Electrical Contacts • Brushes for all rotating electrical equipment • Hundreds of related carbon, graphite, and metal powder products.



*Mechanical and electrical specifications on these dependable 0.75-watt variable composition resistors are available on request. Electronic Components Division, Stackpole Carbon Company, St. Marys, Pa.*



# WHY **for superhet sensitivity in range**

# PAY **monitoring, lab work when the Melabs**



## TEST RECEIVER

**permits field strength readings and rf pulse analysis at extremely low cost!**

For only \$900.00, a microwave receiver of moderate sensitivity and high selectivity, usable with separate synchroscope for pulse observation! The first high-performance, low-cost receiver of its type on the market!

These small, transistorized receivers are available today for the U, L, S, C, X and P bands, with similar models soon to be available in these ranges: 18-26.5 KMC, 26.5-40 KMC. Battery-operated cabinet models also available on special order for portable field use.

Receivers for all frequency bands are identical except for tuning cavity and dial. The DRO-4A display unit designed for use with the receiver can be used with all models, is packaged separately for maximum flexibility. Only one interconnecting video cable is required.

### SPECIFICATIONS

#### Frequency Ranges:

Model RCU-1: 400 MC-1 KMC  
 Model RCL-1: 1-2 KMC  
 Model RCS-1A: 2-4 KMC  
 Model RCJ-1: 4-8 KMC  
 Model RCX-1: 8-12.4 KMC  
 Model RCP-1: 12.4-18 KMC

#### Sensitivity:

- 40 dbm minimum

#### Selectivity:

1% at 3 db (maximum)

#### Video Bandwidth:

4 MC

#### Dial Accuracy:

1%

#### Weight:

Receiver, 15 lbs.; display, 30 lbs.

#### Size:

Receiver, 3½" x 15" x 19"; display, 7" x 15" x 19"

#### Sync sweep speed:

10, 100, 10,000 μsec

#### Price:

\$900.00 (add \$150 for model RCX-1 or Model RCP-1) DRO-4A Display Unit, \$900.00

Employment opportunities at Melabs are exceptional for ambitious engineers and physicists. Write in confidence.

7012

**3300 Hillview Avenue, Palo Alto, California**



# ELECTRONICS NEWSLETTER

## Lofti Satellite Opens VLF Possibilities

PICKABACK Lofti satellite sent up on top of a Transit last Feb. 21 made a few unexpected discoveries during its six-week lifetime. The 57-lb satellite, which failed to separate from its carrier, went into a long orbit 100 miles at perigee and 600 at apogee, which sent it in and out of the upper inosphere. In sending low and very-low-frequency transmissions, it demonstrated that a substantial portion of vlf energy passes through the ionosphere. Common prior assumption was that vlf signals were reflected or absorbed.

Navy, which sponsored the Lofti-Transit launch in the first place, thinks the new discovery may present the possibility of a global system for communicating with submarines, or for groundbased vlf navigation beacons for manned and unmanned satellites.

## Try BMEWS Radars For Space Surveillance

AIR FORCE has given RCA an \$89,000 contract to see if the AN/FPS-49 tracking radars developed for the ballistic-missile early-warning system and the Atlantic Missile Range can be used for space surveillance. Air Force has used the radars for satellite tracking, wants to find out how efficient they'll be for picking up silent satellites from scratch. Three-month study will use the 84-ft instrument at RCA's Moorestown, N. J., defense electronics plant.

USAF officers stress that the contract does not prejudice a call to industry to come up with new ideas for satellite detection and tracking.

## Federal Communications Net Will Serve Civilian Agencies

GENERAL SERVICES Administration and Office of Civil & Defense Mobilization announced last week plans for a unified telecommunica-

tions system to serve the civilian agencies of the federal government. System will connect some 8,000 government offices in 1,750 towns and cities, will include voice, teletypewriter, data and facsimile services, will stretch from Alaska and Hawaii to Puerto Rico and the Virgin Islands.

GSA, which will administer the system, figures it will cost about the same to operate the unified system as it now does to run the less comprehensive nets run for individual agencies. Completion date is about three years away. System will tie into military and commercial networks, use multichannel routing with switching centers located so that messages could bypass possible target areas in case of nuclear attack.

## Soviets Develop Ultrafine Microtome

REPORTS reaching ELECTRONICS from eastern Europe indicate that Soviet scientists have developed an ultramicrotome capable of cutting specimens 0.004 micron thick. The device uses magnetostriction to limit the travel of a lever which passes the specimen along the cutting edge of the microtome.

A crack in a piece of glass serves as the cutting edge. The glass is suspended in a support which is isolated from ambient vibration and atmospheric effects. Specimen is mounted on a lever which is heated under fine control; expansion pushes the material toward the cutting edge. Nickel rods governing the lever are controlled by a magnetic field; magnetostrictive effect limits the response of the lever to heat.

In the field of plasma research, Soviet scientists last week reported amplification of 8-mm microwave signals in an experiment using magnetic mirrors to increase plasma density. In the experimental device, a microwave signal was injected into a Philips-type discharge gap containing a metal-vapor plasma at pressures between  $10^{-1}$  and  $10^{-3}$  mm of mercury. No significant increase in noise level could be attributed

directly to the plasma amplification mechanism. Work was reported by academician Z. S. Chernov at the International Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma held in New York.

## Industry Association Aids Private Microwave Users

ELECTRONIC INDUSTRIES ASSOCIATION last week launched a service to supply manufacturers and users of microwave equipment with necessary technical data for designing, installing and operating private microwave systems. Service was evolved by EIA and the Federal Communications Commission.

Service will use a standard form for compilation of frequency and bandwidth; make, model and rated output; antenna type, input and location; and compass points with which the station is to communicate. FCC, which helped develop the form, requires that most of this information be filed with applications for licenses and renewals.

## Spider, Owl Sonars Studied for Clues

BIOPHYSICS PROJECTS at Harvard University are using electronic techniques to study the sensitive hearing of spiders and owls, with the hope of garnering data on the nature of the human information-handling system, and with reflections on manmade systems.

Biologists at Harvard tap the spider's hearing organ—located near the tip of its leg—with tiny electrodes to find out how the arachnid locates buzzing insects. Spider "ear" has a frequency range from 20 cps to 50 Kc, has several slits in the covering cuticle which responds to separate frequency bands. Nerve fibers have individually recognizable pulse signals; pulse-height analyzer is used to separate signals after amplification.

Owls use a kind of passive sonar to catch mice in the dark; studies show that their hearing mechanism constitutes a highly directional antenna system with a couple of null points.

(Continued on p. 10)

## Establish Joint Test Program For Communications Satellites

ENGLAND, FRANCE and the U. S. last week set up a joint program to test communications satellites. The three nations made it clear they would welcome other countries who wanted to contribute to the effort.

National Aeronautics & Space Administration will launch the satellites as part of projects Relay and Rebound. Relay is a low-altitude active repeater scheduled for 1962. Rebound is the follow-on to Echo, the passive reflector satellite, and is scheduled for 1963.

Britain's General Post Office and France's Center for Telecommunications Studies have agreed to provide ground stations in Europe for transmission of multichannel telephone, telegraph and tv signals. Stations will use accurate tracking and antenna-pointing facilities. Stations will be able to make tests on high and low-frequency signals from active or passive satellites. Locations are being surveyed now.

## High-Speed Camera Shutter Uses Pulsed Image Tube

ELECTRONIC SHUTTER that enables a camera to take as many as 12 pictures in sequence of a self-illuminating object with no time lapse between frames has been developed for Air Force by ITT Laboratories. The device uses pulsed image tubes as shutters. The tube is a diode consisting of a photocathode and a phosphor-screen anode, separated by an electrostatic lens. Timing circuits key successive tubes to take rapid-sequence frames. Theory and circuits are discussed in a Wright Air Development report released last week.

## Ukraine Academy Tackles Wireless Power Transmission

INSTITUTE of Radiotechnical Problems of the Ukrainian Academy of Sciences is trying to figure out how to transmit electrical power by radio beam. Soviet academies have been at this for some time in an effort to save the metals used for stringing wires and cables.

Among other problems, the newly organized IRP also wants to ex-

plore: the use of directed h-f energy for the destruction of rocks; effects of r-f on polymerization processes in plastics; development of ultrasonic instruments for medical use; two- and three-dimensional X-ray photography.

## R-F Reflection Locates Oil and Gas

OIL PROSPECTORS are currently field-testing a system using radio-frequency reflections for locating prospective oil, gas and gas-condensate deposits.

A transmitter stable in both power output and frequency is matched to the low characteristic impedance of the earth, loading the soil and bypassing the high characteristic impedance of free air. Abrupt differences in impedance between hydrocarbons and salt water permit distinguishing these deposits from ground water tables, mineral veins and so forth; drop in resistivity values at oil-water and gas-water interfaces reflects a strong signal to a receiver on the surface. Triangulation techniques and time measurement are used for determining location and depth of deposits.

System was developed by Owens Exploration Inc., can cover 100 acres a day with a 5-man crew. Frequency and power were not disclosed.

## Atlantic Range to Get High-Capacity Data System

UNIVERSAL pulse-code modulation data-recording system for use in tests of long-range missiles and drones will be supplied to the Atlantic Missile Range by Texas Instruments. The solid-state TI system will be able to handle signals received at random, reconstruct them for parallel recording on tape. Data can be decoded directly or on playback. Bit rates will range from 8 Kc to 800 Kc; word lengths from 6 to 64 bits will be handled by the system. As many as 1,152 primary channels and 100 subcommutated channels can be decommutated either directly or on playback. Oscillographic, analog or digital outputs will be available.

## Birdbanding Keeps Track Of Capacitor Quality

TECHNIQUE widely used to keep track of migratory birds and scientifically controlled livestock is helping Faradyne Electronics maintain and improve capacitor quality. The componentmaker tags each of its solid-slug tantalum capacitors with a flexible zinc tag which has lot, batch and unit number stamped into it. The tag follows the unit through production and test, remains on when it's sold. Quality-control engineers gather and record test data on each unit and correlate the data against production parameters (such as variations in anodizing bath or position on a drying rack). Units in field use can also be referred to individually for accumulating still more information in depth.

## Find Low-Error Code For Data Communications

TWO PROFESSORS at the University of North Carolina have announced development of a mathematical code, said to be practically error-proof, for use in sending computer data over toll telephone lines. The two, R. C. Bose, and D. K. Chaudhuri, figure the probability of undetected error is one in 300 years at present transmission speeds over toll lines (of the order of 1,000 bits a second); current error rate is about one a minute. Bose code uses both transverse and longitudinal checks, catches and corrects bursts as well as single-bit errors. System has been tested on Lincoln Lab computers, was developed at Case Institute of Technology. Details were not disclosed.

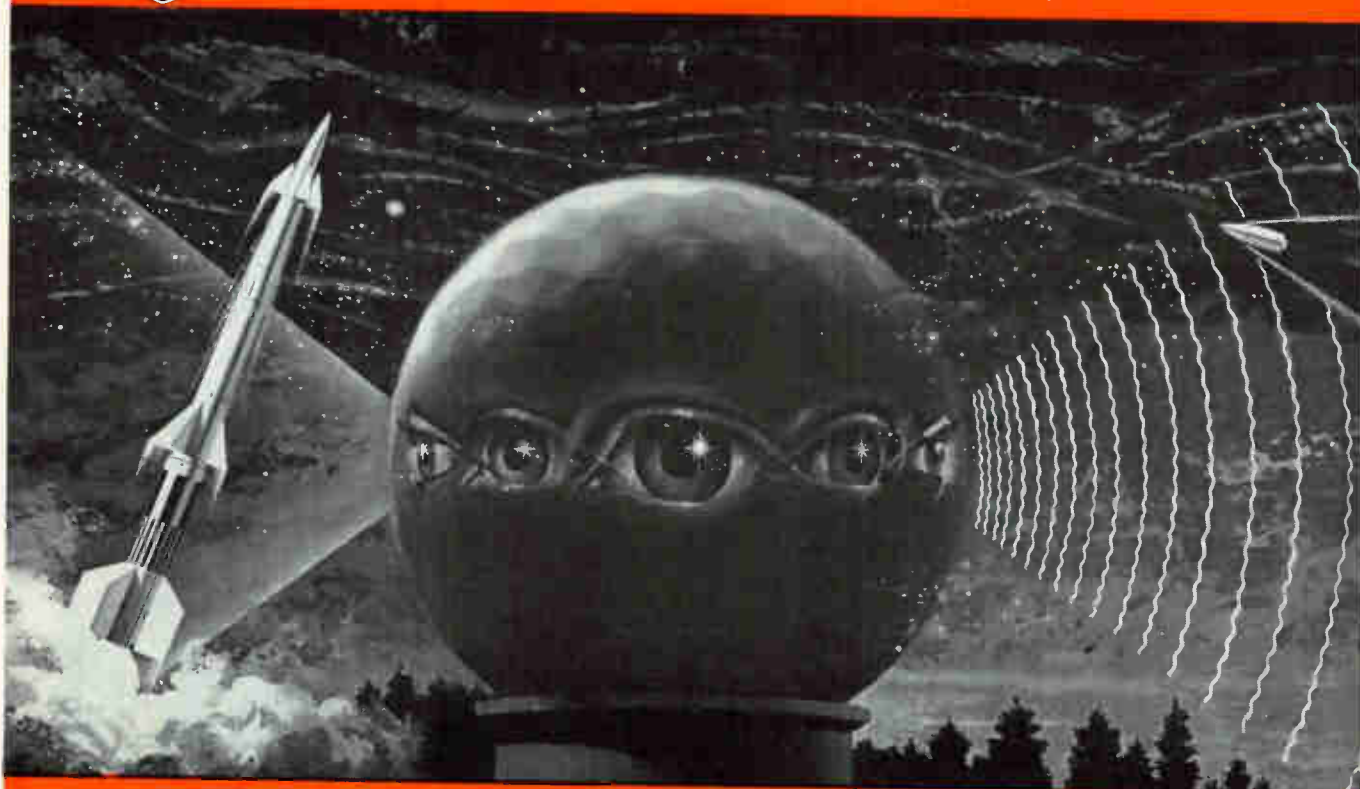
## Radio-Tv Sales Rose in February

RETAIL SALES of television and radio sets began climbing in February after a sharp post-Christmas dip in January, according to figures released last week by Electronic Industries Association. Tv sales reached 452,282, some 52,500 more than were sold in January. Radio sales stood at 666,228, over 85,500 more than January's figure. Totals for the two months were less than equivalent figures for 1960.





## RADAR STRUCTURES: Another prime capability of Goodyear Aircraft



To "see" and stop missiles in space is Nike-Zeus mission. Since ICBM time-to-target is about 30 minutes, system has only few minutes to detect enemy missile, compute course, launch and guide Nike-Zeus missile to intercept point.

### A NEW "EYE" FOR SIGHTING HOSTILE ICBM's

Only active defense against hostile ICBM's under development today is Army's Nike-Zeus anti-missile system. Nike-Zeus combines one of the most sensitive multiple-target radars yet perfected with the Free World's fastest interceptor missile. Object: detection and destruction of ICBM's flashing through space at close to 20,000 m.p.h.

As a leading producer of radar structures of all types, Goodyear Aircraft was selected to work with Bell Telephone Laboratories to develop, design and build the large acquisition radar transmitting and receiving antennas shown here. Working with Western Electric the prime contractor, and a team of major Nike-Zeus subcontractors, Goodyear has already furnished operating prototypes of the antennas. And, currently, work is well under way on manufacturing techniques for volume production. For details on Goodyear's extensive experience in advanced radar structures write Goodyear Aircraft Corporation, Dept. 914KD, Akron 15, Ohio.

# GOODYEAR

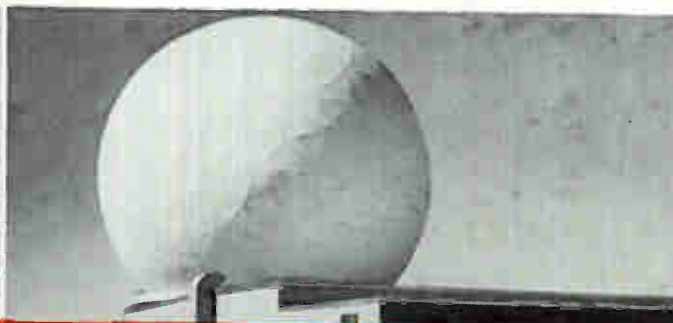
Plants in Litchfield Park, Arizona, and Akron, Ohio

## GOODYEAR AIRCRAFT CORPORATION

The Technical Disciplines involved in these areas offer a challenging future for Engineers and Scientists at Goodyear Aircraft. Write today.

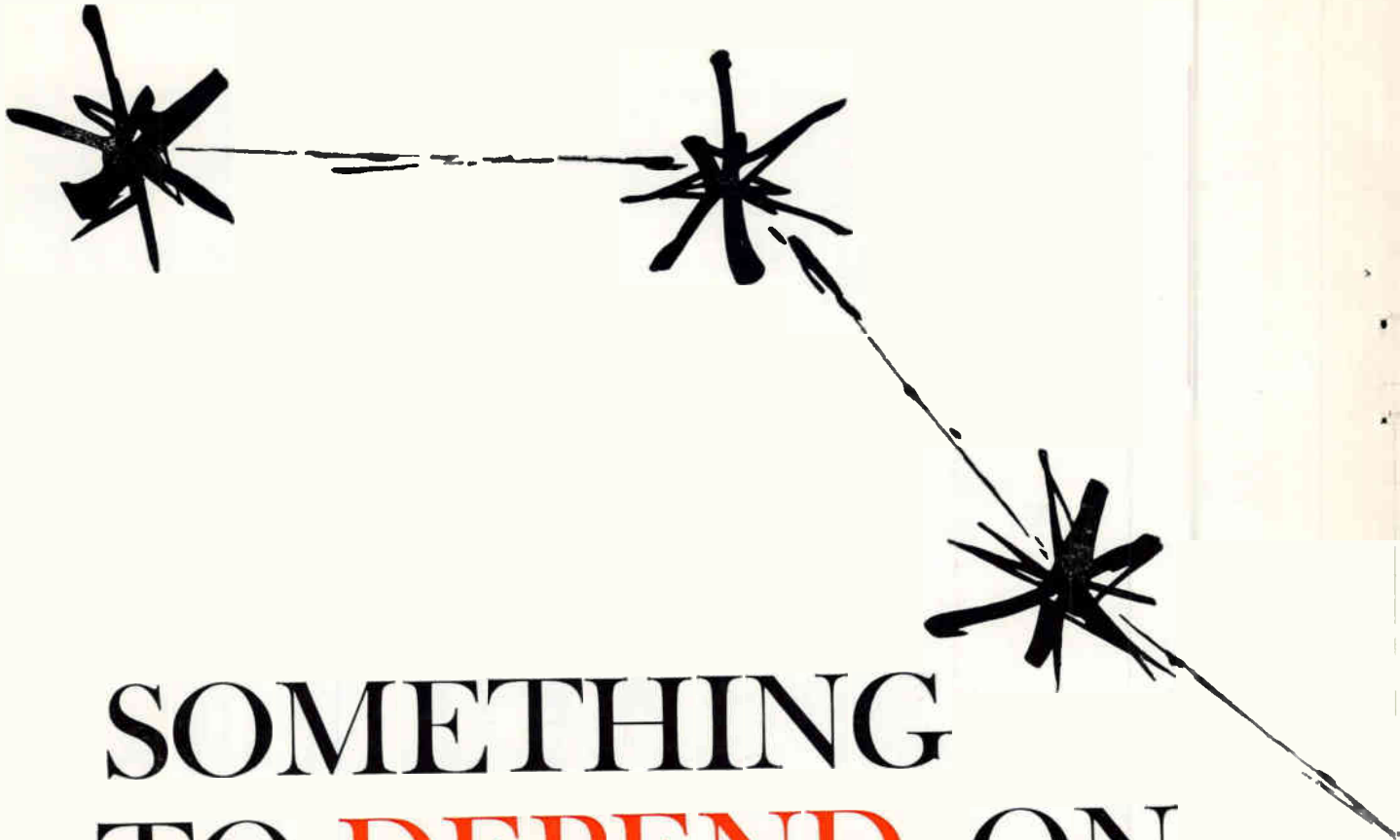


Goodyear-built transmitting antenna consists of three 80-ft. apertures in triangular lineup rotating continuously in azimuth while accurately slaved to the receiving antenna.



World's largest Luneberg lens for focusing radar echoes is housed in this 110-ft. radome. Radome contains 445 triangular plastic panels attached to a space-frame.

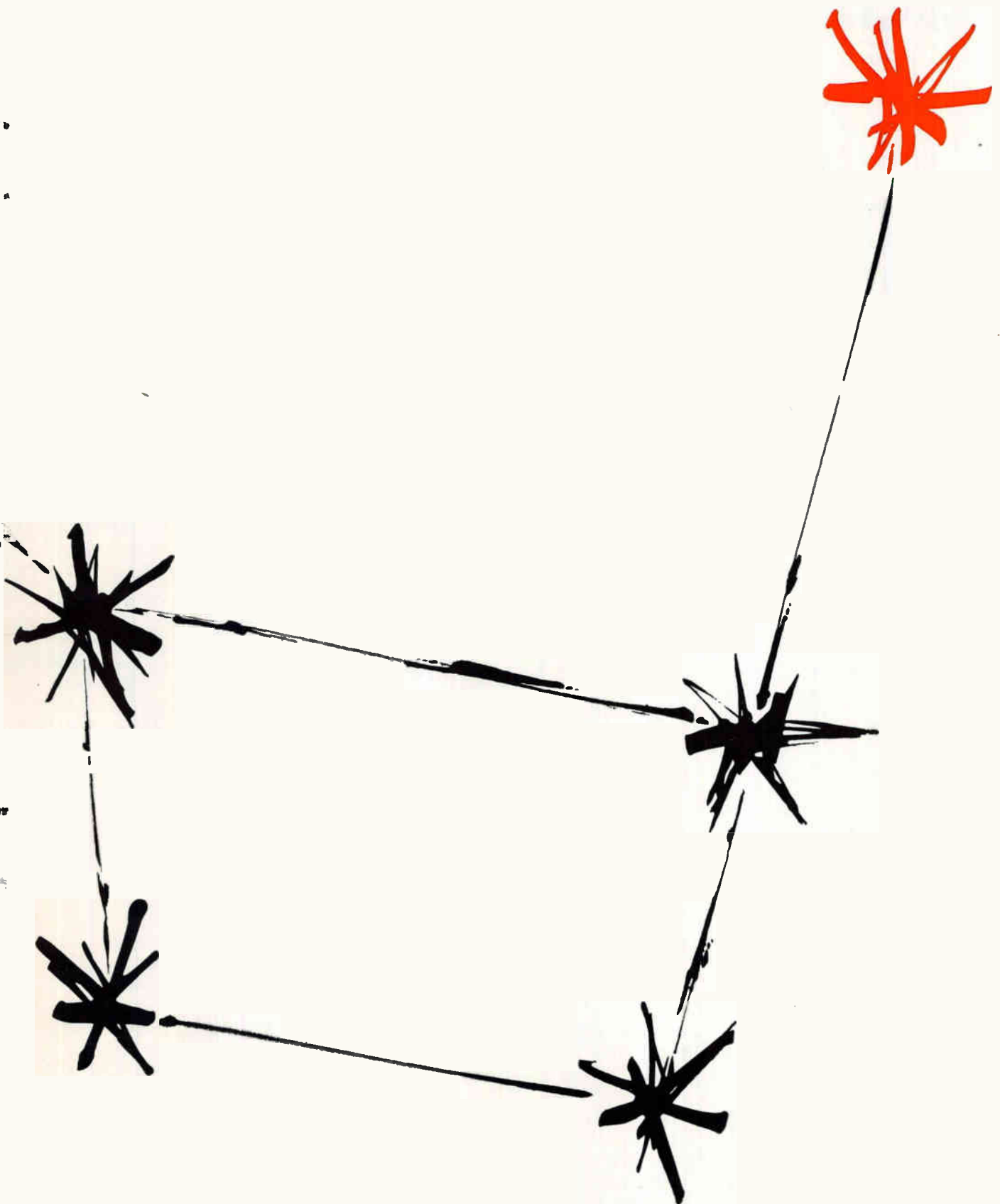




# SOMETHING TO **DEPEND** ON

Is this what you're looking for? **Something to depend on.** A supplier who can turn around fast. Who can make the last-minute changes you need and still deliver on schedule, whenever it seems humanly possible, **and sometimes when it doesn't.** Case history: Recently Giannini Controls received an urgent request from General Electric for delivery of eight non-standard pressure transducers, requiring many modifications. **First units were flight-qualified and shipped twenty days from verbal order.** Ask G. E., ask the people on Titan, Polaris, Mercury, Nike Zeus, Talos, F8U, DC-8, and you'll hear: **When it's from Giannini Controls you get it on time, it works when you get it, and it keeps on working.**

**Giannini Controls Corporation** 1600 South Mountain Avenue. Duarte. California  
**A NAME TO PLAN WITH** SERVO COMPONENTS & SYSTEMS • AIR DATA INSTRUMENTS & SYSTEMS • INERTIAL INSTRUMENTS & SYSTEMS  
Plant locations: Duarte, Pasadena, Glendora and Glendale, California • Caldwell, New Jersey • Buffalo, New York  
GCC 1-16



# BUILT FOR POWER



## Model 693

This attenuator handles input powers of at least 20 watts CW or 10 KW peak applied to either terminal. Available in attenuation values from 1 db to 20 db and covering the frequency range from DC to 1500 mc, the Model 693 has these other

### Weinschel Features:

- Black anodized aluminum body with cooling fins dissipates heat efficiently, preserves stability.
- "Type N" stainless steel connectors giving long service life and excellent corrosion resistance.
- Critical dimension of inner contact depth held to  $\pm 0.005$  inches, closer than that required by government specifications.
- Certificate of calibration showing insertion loss test data with guaranteed accuracy explicitly stated.

For complete specifications on the Model 693 write for Weinschel Engineering Bulletin 362. For special attenuators to meet other requirements contact our Application Engineering Department.

**WEINSCHEL** ENGINEERING 

KENSINGTON, MARYLAND  
Phone: LOckwood 4-0121

TWX: KENS 446

## WASHINGTON OUTLOOK

OLD ARGUMENT about whether or not to appoint a "czar" to run the Navy's antisubmarine warfare research and development programs is simmering again in the Pentagon. Top-echelon supporters of the proposal complain that current ASW R&D is splintered, with Bureau of Naval Weapons, Office of Naval Research, Bureau of Ships all involved. These critics suggest that divided effort and lack of effective central control are prime reasons for present lack of effective means to detect and destroy enemy submarines.

*The Navy doesn't like the idea at all. Admirals argue that, in many respects, antisubmarine defense is a primary or secondary mission of the entire Navy, and any czar to run the program would have to be no less an authority than the Chief of Naval Operations himself. Further, the ASW mission involves subsurface craft, surface ships of all types, and aircraft, and doesn't lend itself readily to the type of "crash-program" approach that worked so well with the Polaris.*

As far as the lack of effective means to detect and destroy submarines is concerned, Navy officials figure that if they had the kind of money to invest in research that's going into the more glamorous fields of space and rocketry, they'd be able to lick many of the problems they now face. Even on short funds (right at the moment, the Navy doesn't even have enough transportation money to send essential personnel to school), the admirals feel they've done a pretty good job of erecting early-warning and tactical antisubmarine defenses.

If the critics have their way, the "czar" would act in a toplevel capacity reporting directly to the Chief of Naval Operations, with conduct of individual R&D projects left in the hands of the contracting agencies. Budget directly ascribable to antisubmarine defense now runs about \$100 million annually (obviously not including such things as procurement of aircraft carriers and aircraft whose major mission is ASW). There is substantial pressure building to boost spending three or four times the present rate.

PROPOSAL to establish an assistant secretaryship of Commerce for Science & Technology is being pushed by Sen. Warren G. Magnuson (D., Wash.), chairman of the Senate Commerce Committee. The proposal is said to be quite palatable to the Kennedy administration as a compromise to the controversial plan to establish a cabinet Department of Science & Technology.

The assistant secretary would pull together Commerce Department research programs now housed in the Bureau of Standards, Weather Bureau, Patent Office, Bureau of the Census, and so forth, and would act as a prime mover to expand nonmilitary government research.

REVISED DEFENSE BUDGET for fiscal 1962, beginning next July 1, earmarks additional funds to "add radar capacity to each battery of the Hawk system." Hawk is the radar-homing anti-aircraft missile system deployed with Army field units. Raytheon is prime contractor for the 22-mile-range missile.

RUMOR IN WASHINGTON has it that Commerce Secretary Hodges promised Chicago Local 1031 of the International Brotherhood of Electrical Workers that the government would try to funnel more defense electronics business into the Chicago area to offset any unemployment caused by imported radio and television parts. Hodges was recently credited for getting the union to postpone a threatened May 1 boycott against any electronic parts produced by countries whose wage rates were not equivalent to U. S. wages.

Meantime the Pentagon is feeling increased pressure to place contracts in regions hard hit by unemployment. Late reports show a record number of major industrial centers which have unemployment rates of at least 6 percent. In February, President Kennedy ordered contracting agencies to take "prompt steps to improve the machinery by which federal contracts can be channeled to firms located in labor surplus areas."



# Measure and record DC current, 0.1 ma to 10 amps without breaking leads, without circuit loading!



New  $\Phi$  428B Clip-on DC Milliammeter with recorder output!



Now you can measure and record dc current to 10 amps without interrupting the circuit and with no circuit loading. You simply slip the jaws of the  $\Phi$  428B probe around a bare or insulated wire and read dc, even in the presence of equally strong ac on the same wire. No need to break leads. The 428B reads dc current directly in 9 ranges by sensing the magnetic flux induced by dc current in the wire.

To measure current difference between two separate wires just clip the probe around them both and read, then reverse one lead and read their sum! For even greater sensitivity you simply increase the number of lead loops through the probe, increasing sensitivity by the same factor as the number of loops.

The recorder/oscilloscope output, dc to 300 cps, makes it easy to record dc levels as well as analyze ground buss, hum and ripple currents on an oscilloscope—all without circuit loading.

$\Phi$  also offers Model 428A Clip-on DC Milliammeter. This instrument is similar to  $\Phi$  428B except that coverage is limited to 3 ma to 1 ampere (6 ranges), the recorder output is not included, and price is somewhat lower.

## HEWLETT-PACKARD COMPANY

1066 Page Mill Road Palo Alto, California, U.S.A.  
Cable "HEWPACK" Davenport 6-7000

*Sales representatives in all principal areas*

## SPECIFICATIONS

**Current Range:**  $\Phi$  428A, 3 ma to 1 a full scale in 6 ranges  
 $\Phi$  428B, 1 ma to 10 a full scale in 9 ranges

**Accuracy:**  $\pm 3\%$ ,  $\pm 0.1$  ma

**Probe Inductance:**  $< 0.5$   $\mu$ h introduced into measured circuit

**Probe Induced Voltage:**  $< 15$  mv peak into measured circuit

**AC Rejection:** AC with peak value less than full scale affects meter accuracy less than 2% at frequencies above 5 cps and different from carrier (40 KC) and its harmonics. (On 428B 10 amperes range, ac is limited to 4 amperes peak)

**Recorder/Oscillator Output:**  $\Phi$  428B, approximately 1.4 v across 1,400 ohms full scale. Frequency response dc to 300 cps

**Probe Insulation:** 300 v maximum

**Probe Tip:**  $\frac{1}{2}$ "  $\times$   $\frac{9}{32}$ ". Aperture diam.  $\frac{3}{16}$ "

**Size:** Cabinet,  $7\frac{1}{2}$ "  $\times$   $11\frac{1}{2}$ "  $\times$   $14\frac{1}{4}$ "; rack mount,  $19$ "  $\times$   $7$ "  $\times$   $13$ " behind panel

**Weight:** Cabinet, 19 lbs; rack mount, 24 lbs.

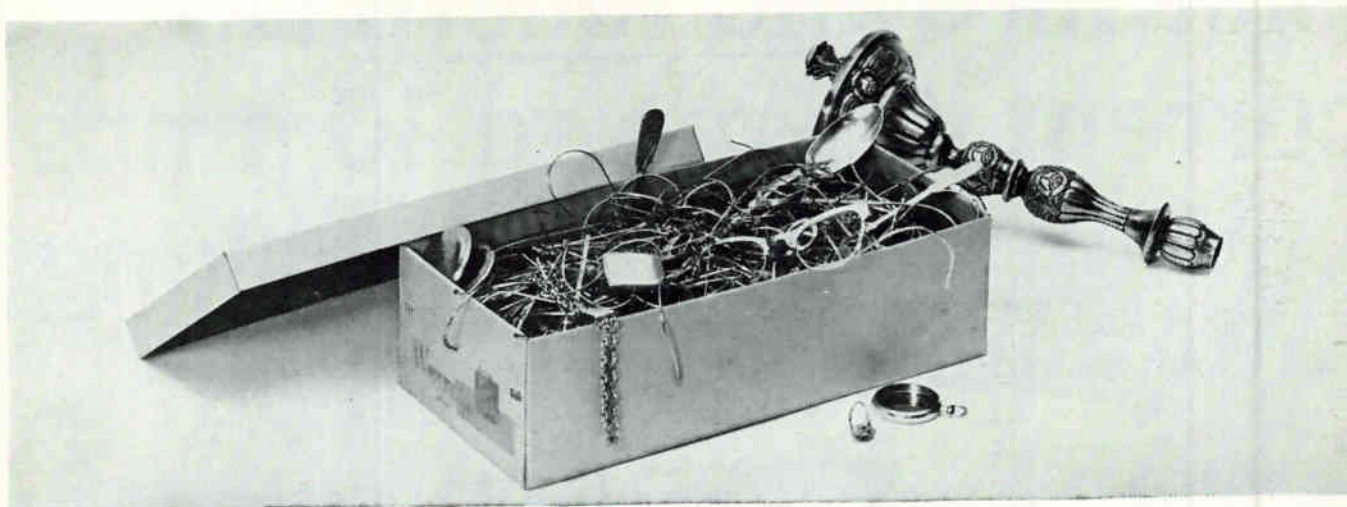
**Price:**  $\Phi$  428A, \$500.00 (cabinet);  $\Phi$  428AR, \$505.00 (rack mount)  
 $\Phi$  428B, \$550.00 (cabinet);  $\Phi$  428BR, \$555.00 (rack mount)



## HEWLETT-PACKARD S. A.

Rue du Vieux Billard No. 1 Geneva, Switzerland  
Cable "HEWPACKSA" Tel. No. (022) 26. 43. 36

# HERE YOU SEE IT



# HERE YOU DON'T!



*Value* is what we're talking about. There isn't a soul alive who would knowingly throw away a gold or silver or platinum watch case or pin or eyeglass frame. Because they're *worth money*. This sense of value is responsible for a considerable part of Handy & Harman's Refining activity. Constantly, we are sent precious metal scrap from retail jewelers all over the country. (Yes, often in shoe boxes.)

And just as constantly we wish that industry had the same sense of value when it comes to their precious metal "waste." Just because it doesn't *look* like anything doesn't mean that it isn't *worth* something.

To show you where profits lurk, we've included a list showing the various forms of precious metal waste.

It is by no means complete (it is possible that you have other forms). May we suggest that—should you be in doubt—you contact the Handy & Harman Refining Center nearest you. Further, if you are not in doubt about your waste bearing precious metals, but you are (or have been) in doubt as to its full value, it will profit you to send it to us. Our Bulletin 24 describes our Refining Division in detail. A copy awaits you at

Plating Solutions  
Precipitates, Sludges and Sediments  
Coated Copper Wire & Racks  
Filter Pads  
Anode Ends  
Tank Scrapings  
Electrolytic Silver  
Hypo Solutions  
X-Ray Film  
Coated Plastics, Ceramics, Glass, Mica, Quartz, etc.  
Chemicals  
Mirror Solutions—Silver Nitrate  
Turnings, Chips, Shavings

Silver on Steel Bearings  
Silver Steel Turnings  
Grindings  
Blanking Scrap, Stampings, Strip, Wire  
Powder Mixtures  
Screen Scrap  
Solder Scrap  
Brazing Alloy Scrap  
Contact Alloy Scrap  
Silver on Steel, Tungsten, Moly Scrap  
Bi-Metal Scrap  
Silver Paint Waste, Wipe Rags, Paper Cans  
Platinum-Bearing Material  
Gold on Moly, Tungsten, Wire

Your No. 1 Source of Supply and Authority on Precious Metals



## HANDY & HARMAN

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

BRIDGEPORT 1, CONNECTICUT  
Clearwater 9-8321

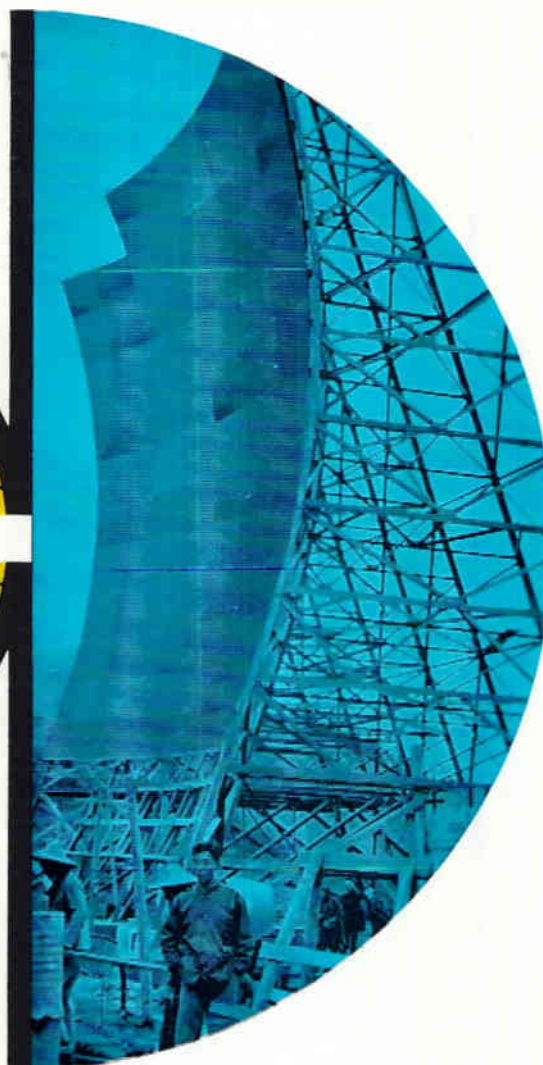
LOS ANGELES (El Monte), CALIF.  
330 N. Gibson Rd.  
Cumberland 3-8181

CANADA: Toronto 28  
141 John St.  
Empire 8-6171

PROVIDENCE 3, R. I.  
425 Richmond St.  
Jackson 1-4100

CHICAGO 22, ILL.  
1900 West Kinzie St.  
SEely 3-1234





**vital  
voice  
for  
far east  
outposts**

**Okinawa-Formosa Signal Corps Communication Link Completes Pacific System** Spanning 400 miles of water, the Far East Scatter System, operated by the Signal Corps, is a highly reliable link in the important Trans-Pacific Scatter System. Alpha personnel engineered the Far East system and provided all site preparation, roads, buildings, antennas . . . as well as the Collins tropospheric scatter equipment. Construction of the stations joining the significant outposts of Okinawa and Formosa took place under the severe topographic and weather conditions of the typhoon-prone Pacific. Field personnel from Alpha are now working side by side with Signal Corps technicians operating this vital multi-channel voice, teletypewriter and data communication link.

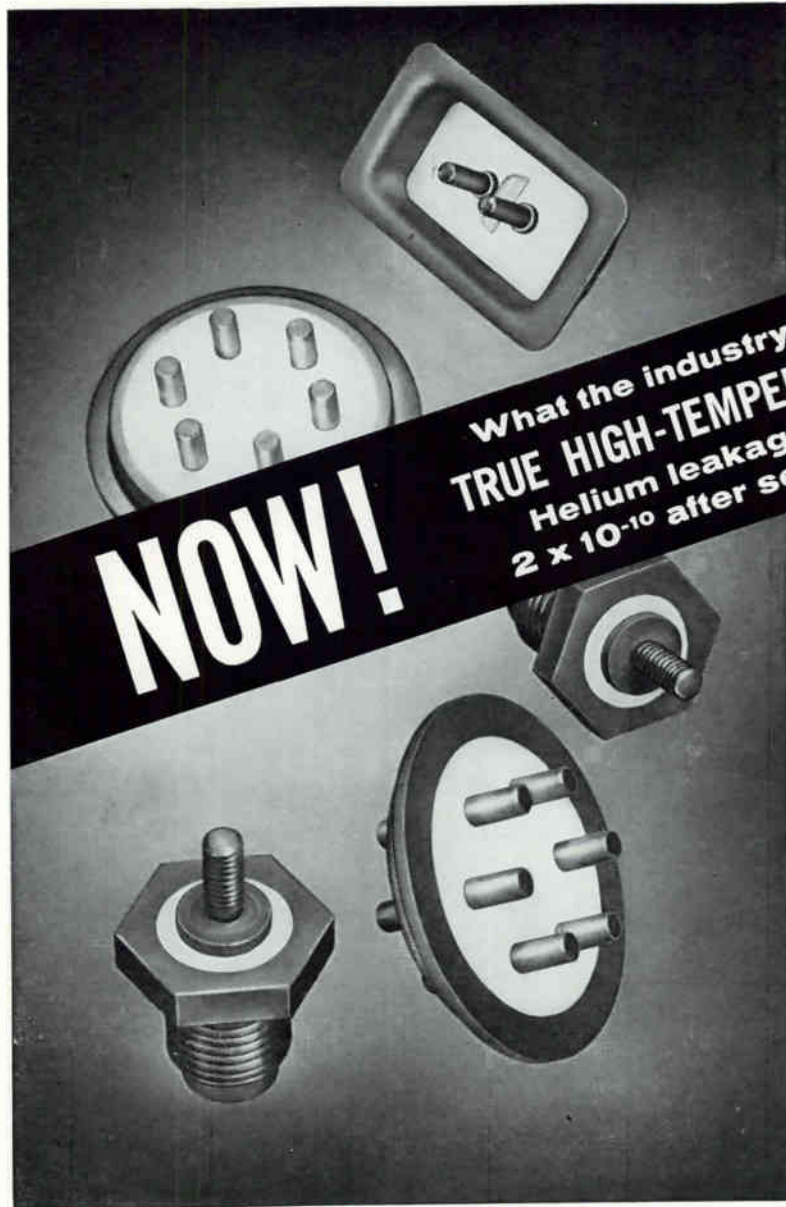


SYSTEMS DESIGNERS, ENGINEERS, CONSTRUCTORS, WORLD-WIDE • RICHARDSON TEXAS • TELEPHONE DALLAS ADams 5-2331

**BIG NEWS in high-temperature  
precision-molded insulation**

# **SUPRAMICA® 620 "BB" ceramoplastic**

Need a precision-molded insulation material with total dimensional stability under the most adverse thermal cycling, operating to 1200°F. . . . or a material with previously unattainable combination of properties? Check these facts about new SUPRAMICA 620 "BB" ceramoplastic:



**NOW!**

What the industry has been waiting for . . .  
**TRUE HIGH-TEMPERATURE HERMETIC SEALS**  
Helium leakage rate cc/sec. less than  
 $2 \times 10^{-10}$  after severe environmental tests.

- Maximum temperature endurance of material 1200°F. (unstressed). Heat distortion temperature of material 1100°F. (ASTM D648-264 PSI)
- SUPRAMICA 620 "BB" ceramoplastic can be precision molded to most intricate geometries with gauge-like tolerances.
- SUPRAMICA 620 "BB" ceramoplastic will not carbonize.
- Absolute hermetic seals achieved directly during the molding cycle. Components meet a helium leakage rate of less than  $2 \times 10^{-10}$  cc/sec., after the following environmental tests:
  1. Samples heat shocked a total of 20 cycles from boiling water for 30 minutes directly to ice water for 10 minutes.
  2. Samples heat shocked a total of 5 cycles, from 350°C. for 1 hour directly to room temperature for 10 minutes, to -70°C. for 1 hour, to room temperature for 10 minutes.
  3. Samples heated to 500°C. for 4 hours and directly to room temperature.
- Thermal expansion factor matches many metals and alloys.
- New SUPRAMICA 620 "BB" ceramoplastic features a dielectric strength of 270 volts/mil, 1/8" thickness per ASTM D-149.

WRITE for Information and Engineering Data Sheets on  
**SUPRAMICA 620 "BB"**  
and other MYCALEX® glass-bonded mica  
or SUPRAMICA ceramoplastic insulations.

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

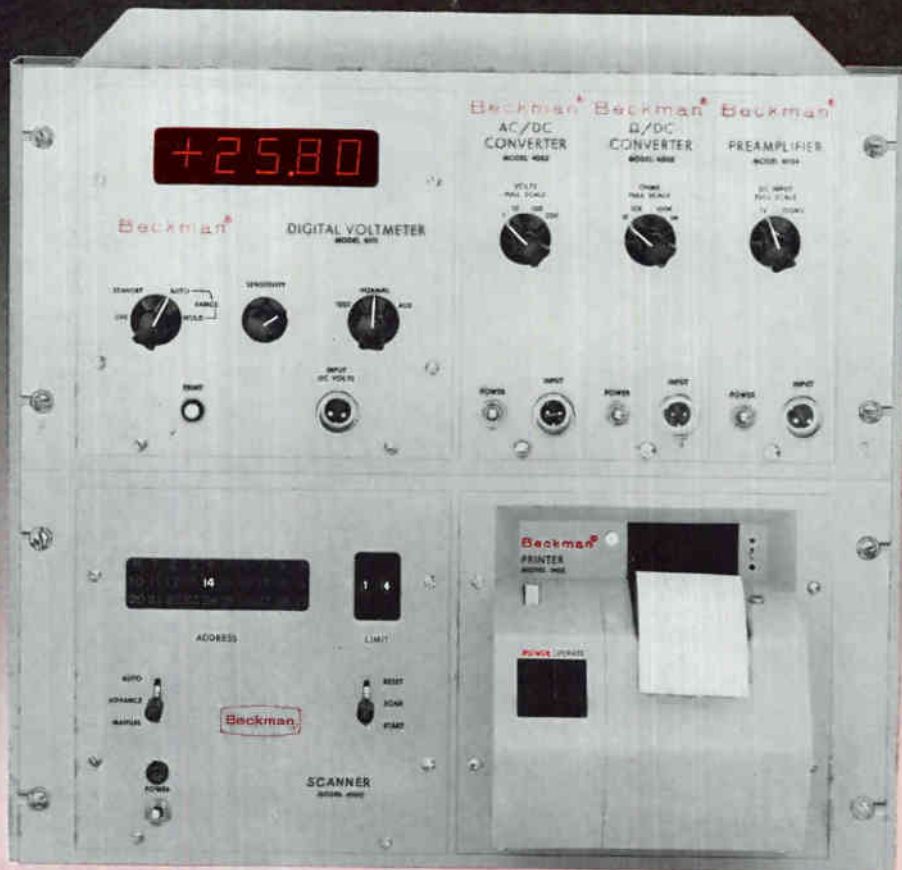
World's largest manufacturer of ceramoplastics, glass-bonded mica and synthetic mica products



**MYCALEX**  
CORPORATION OF AMERICA



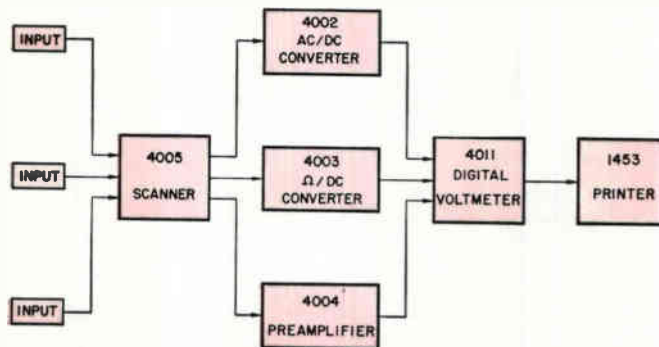
# EXPANDABLE MODULAR DIGITAL MULTIMETER



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

Price for the complete system about \$4800

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



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

BERKELEY DIVISION  
of Beckman Instruments, Inc.

INSTRUMENTAL  
• Beckman  
IN YOUR FUTURE

Richmond, California

# The significant difference is the name . . . .



**MICROPOT®**

The name Borg Micropot is synonymous with potentiometer reliability in military and commercial applications alike. And now, Borg offers *four* series of Trimming Micropot Potentiometers. All are recommended wherever compact, lightweight adjustment of circuit voltages is a critical factor. All models are lead-screw actuated with a safety idle position at each end of travel. All series can be mounted singly or stacked snugly one upon the other. Resistance values from 10 ohms to 1 megohm are available. See your nearest Borg technical representative, distributor, or write for the Micropot data sheets listed below.

*More than 300 standard model variations are derived from the four basic series of Borg Trimming Micropot® Potentiometers*

**2800 Series**

High temperature, wire-wound. Highest quality series . . . 100% immersion-tested for leakage. Request data sheet BED-A173.

**990 Series**

High temperature, wire-wound. High quality series . . . O-ring sealed against leakage. Request data sheet BED-A133.

**992 Series**

105°C temperature max., wirewound; to 50,000 ohm rating. O-ring sealed against leakage. Request data sheet BED-A172.

**993 Series**

105°C temperature max.. deposited carbon film element; up to 1 megohm rating. Request data sheet BED-A172.



Shown Actual Size

CHARACTERISTICS	2800 Series*	990 Series	992 Series	993 Series
Length and Width	1 1/4" x .28"	1 1/4" x .28"	1 1/4" x .28"	1 1/4" x .28"
Depth	.360" max.**	.360" max.**	.360" max.**	5/16"
Power Dissipation	1 watt at 110° C	1 watt at 110° C	1 watt at 40° C	0.5 watt at 40° C
Resistance Range	10 to 50K ohms	10 to 30K ohms	10 to 50K ohms	20K ohms to 1 megohm
Temperature Extremes	-60°C to +175°C	-60°C to +175°C	-55°C to +105°C	-55°C to +105°C
Dielectric Strength	500 V AC, 60 cycle	500 V AC, 60 cycle	500 V AC, 60 cycle	500 V AC, 60 cycle
Adjustment	full range 40 turns	full range 40 turns	full range 40 turns	full range 25 turns

*Terminal types: wire leads (L); solder lugs (SL); printed circuit (PC). Color-coded wire leads are 12"; solder lugs and printed circuit terminals are gold-plated for perfect solderability.*

*\*Each unit 100% tested against leakage. \*\*Dependent upon terminal selection.*



**BORG EQUIPMENT DIVISION**

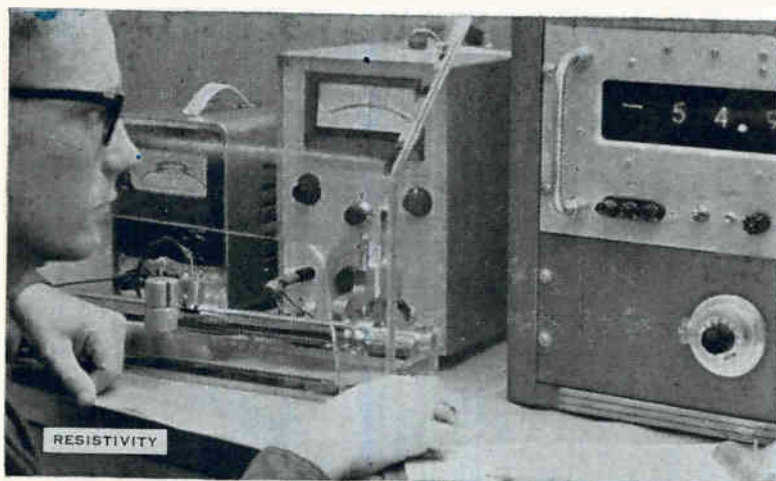
Amphenol-Borg Electronics Corporation  
Janesville, Wisconsin • Phone Pleasant 4-6616

Micropot® Potentiometers • Microdial® Turns-Counting Dials • Sub-Fractional Horsepower Motors • Frequency and Time Standards



# The Untouchables (Part 3)

## Now...Single Crystal Silicon Doped to Your Specification



Single crystal silicon . . . doped to your specific needs . . . is now available from Dow Corning.

**Rigid quality control** of Dow Corning Silicon means greater device yield for you! And you achieve uniformity in device characteristics — the result of greater uniformity in characteristics from rod to rod, greater lateral and radial uniformity within each rod.

**This high quality** is the result of a completely integrated production process — a process that starts with the manufacture of trichlorosilanes and other chemicals basic to silicon production. And at every step of the way, rigid quality control assures the ultimate in quality—purity.

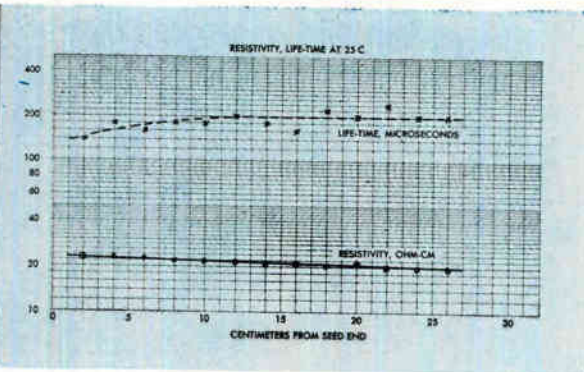
**Doped to specification** single crystal Dow Corning Silicon contains in the order of 0.1 atoms of minority impurity per billion atoms of P-type material . . . about 0.15 atoms of minority impurity per billion atoms of N-type material.

**Low oxygen content** of Dow Corning Silicon reduces the undesirable effects on lifetime associated with the diffusion process. Result — few rejects . . . increased device yield! In the picture at left, infrared transmittance at 9 microns is measured to determine oxygen content. Many materials register at pencil point—much higher than Dow Corning Silicon.

**Crystal orientation** is normally 111, but can be to your specification.

**Specify Dow Corning** single crystal silicon doped to your requirements. Specific resistivities within narrow tolerances from one to 1000-ohms centimeter P-type . . . one to 400-ohms centimeter N-type. Rod diameters from 3 to 25 mm (1/8" to 1") lengths to 250 mm (about 10").

Whatever your need — polycrystalline rod or chunk; high resistivity P-type single crystal rod; single crystal rod doped to your specifications — Dow Corning should lead your list of sources.



Write for "Hyper-Pure Silicon for Semiconductor Devices," Address Dept. 3516a.

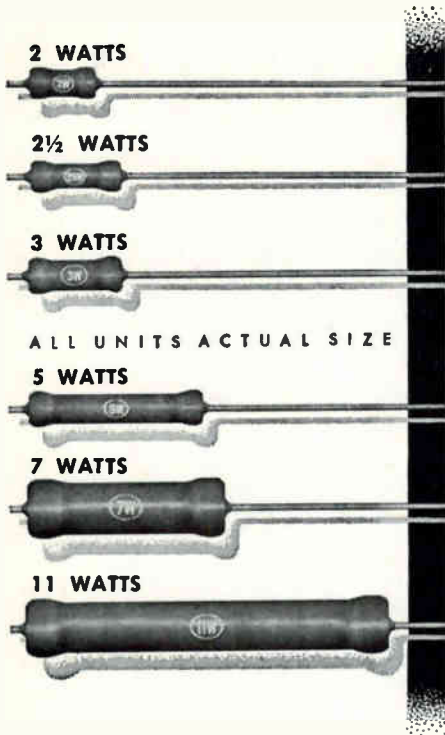
**HYPER-PURE SILICON DIVISION**  
Address: **HEMLOCK, MICHIGAN**

**Dow Corning CORPORATION**  
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.



## Merger Pace Is Stepping Up



### NEXT TIME ... USE TINY *Blue Jacket* WIREWOUND RESISTORS

*Sprague builds reliability... efficiency... economy right into minified Blue Jackets with these important features:*

- \* All-welded end-cap construction with special vitreous-enamel coating for total protection against humidity, mechanical damage, heat, corrosion gives long-term dependability under severe environmental conditions
- \* Available in resistance tolerances as close as  $\pm 1\%$
- \* Low in cost... quick and easy to install

Tiny axial-lead Blue Jackets are specially designed for use with conventional wiring or on printed boards in miniature electronic assemblies. Write for complete technical data in Sprague Engineering Bulletin 7410B.

**SPRAGUE ELECTRIC COMPANY**  
35 Marshall Street, North Adams, Mass.



MERGER ANNOUNCEMENTS are setting a brisk pace for financial news in the electronics industry this Spring. Here are some examples:

LORAL ELECTRONICS CORP., New York City, has announced negotiation talks for the acquisition of Accurate Specialties, Inc., Hackensack, N. J., producer of high purity metals and ceramics for electronics applications. Leon Alpert, Loral president, says the basis of negotiations is an exchange of stock at the ratio of two and one-half shares of Accurate for one share of Loral. Accurate's earnings for the six-month period ended Dec. 31, 1960 were 21 cents a share.

GIANNINI CONTROLS CORP., Duarte, Calif., and Cramer Controls Corp., of Centerbrook, Conn., have entered into an agreement for the acquisition of Cramer by Giannini, subject to approval by Cramer stockholders. An announcement by presidents of both companies indicates the exchange will be made on the basis of 55 shares of Giannini common for 100 shares of Cramer common. If concluded, this will be Giannini's second acquisition this year. The company acquired Conrac, Inc., in February.

LEAR, INC., Santa Monica, Calif., is negotiating to acquire Sprague Engineering Corp., Gardena, Calif. The proposal being discussed would involve a tax-free reorganization and an issue of Lear shares based on one share for each share of Sprague stock now outstanding.

SANBORN COMPANY, Waltham, Mass., and Hewlett-Packard Co., Palo Alto, Calif. will soon begin discussions to determine whether agreement can be reached on merger terms. According to a joint announcement by J. L. Jenks, Sanborn's board chairman, and H-P president David Packard, if officers of the two companies reach agreement, the proposal will require action by the board of directors of

each firm as well as company stockholders. Hewlett-Packard reported sales of slightly over \$60 million last year, while Sanborn had sales in the \$15-million area.

UNIVERSAL MATCH CORP. is negotiating to acquire a Stamford, Conn. firm, Reflectone Electronics, Inc., according to disclosures by presidents of both companies. John L. Wilson, Universal's president, says there will be no dilution of his company's stock equity or per-share earnings as a result of the acquisition. Reflectone's sales are at a \$5-million level and are expected to reach \$7½ million this year. The firm dedicated a new research plant today in Ft. Lauderdale, Fla.

NUCLEAR CORP. OF AMERCA has concluded negotiations through which it has acquired the assets of U. S. Semiconductor Products, Inc., formerly a subsidiary of United Industrial Corp. Acquisition terms involved a purchase price of 600,000 shares of Nuclear common plus an undisclosed amount of cash. U. S. Semiconductor shareholders will be asked to ratify the transaction which will require their two-thirds agreement.

OVITRON CORP., Cos Cob, Conn., has acquired Standard Winding Co., Newburgh, N. Y. manufacturer of electronic components for communications and home entertainment markets. The New York firm anticipates 1961 sales of \$600,000. It makes coils, filters, solenoids and other devices. Among the electronic products being developed by Ovitron are solid state power control, regulation and conversion equipment.

ELECTRONIC SPECIALTY CO., Los Angeles, and D. S. Kennedy & Co., Cohasset, Mass. have concluded negotiations whereby Kennedy shareholders will receive four shares of ESC stock for each five shares of Kennedy they hold. Elec-

tronic Specialty anticipates first-quarter revenues for the period ending Mar. 31 to amount to about \$6 million.

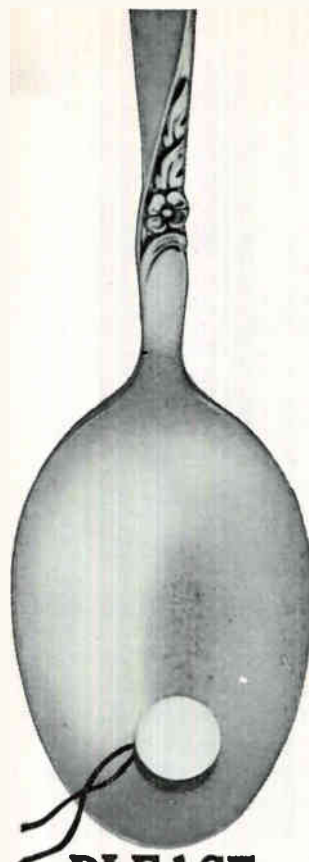
AIRTECHNOLOGY CORP., Cambridge, Mass., has announced purchase of the Electronics division of Advance Industries in the same city. Financial aspects of the transaction have not been disclosed. AirTech has assumed responsibility for completing all outstanding contracts and orders of its acquired company. The two companies occupy the same building and will jointly conduct research and development of space-oriented systems and subsystems.

AMPHENOL-BORG ELECTRONICS CORP., Broadview, Ill. and FXR, Inc., Woodside, N. Y. will ask stockholders to approve merger plans on May 23, following approval of the move by directors of both companies. Under terms of the agreement, three FXR officers owning 192,599 shares of stock will receive 45/100th of a share of Amphenol-Borg for each share of FXR stock. All other shareholders will receive 50/100ths of a share of A-B for each share of FXR held. The Woodside company will operate as a separate division with present management and personnel. FXR makes microwave and electronic test gear.

## 25 MOST ACTIVE STOCKS

	WEEK ENDING MARCH 31, 1961			
	SHARES (IN 100's)	HIGH	LOW	CLOSE
Avco Corp	3,460	21½	19	20¾
Transitron	2,350	41¾	37½	41¼
Lockheed Aircraft	2,166	45½	42½	44¼
Avnet Elec	1,983	36¾	29	36¼
Martin & Co.	1,906	36¾	32¾	35
Gen Tel & Elec	1,465	29¼	28	29
Hycan Mfg	1,448	5½	4½	5
Gen Elec	1,080	66¼	65	65
Sperry Rand	1,062	27¾	27	27¼
Nucl'r Corp of Am	1,033	6¼	5½	5½
Gen Dynamics	999	42	40	41¼
Lear Inc	931	25	23¼	24
Cohu Elec	908	14¼	11¾	14
Ling-Temco	849	34¾	31¾	34¾
Elec & Mus Ind	831	7½	6¾	6¾
Ampex Corp	815	23¾	22½	22¾
Dyn Corp of Amer	814	12¾	11¾	117½
Raytheon Co	740	41¾	39½	40
Standard Kollsman	729	43¼	40½	41¼
Westinghouse Elec	698	44¾	43¼	43¾
US Industries	606	13¼	12	12¾
Universal Controls	553	15¼	14¼	14¾
Int'l Tel & Tel	552	60¼	58¼	59¾
Sterling Precision	506	3¼	27½	27½
Reeves Sndcrft	499	8½	7¾	8¼

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., investment bankers.



**PLEASE  
DON'T  
SWALLOW  
OUR  
MOTOR**

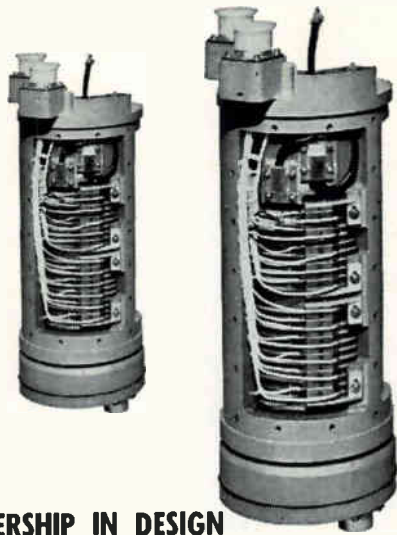
...IT'S HIDING BEHIND THE ASPIRIN. Actually, we set out to build an easy-to-read tiny timer...but we first had to build an aspirin-sized motor to drive it. This assignment might have been a headache for a sorcerer, but A. W. Haydon did it. And there is something magical about these micro-miniature elapsed time indicators and companion events counters. ■ This digital elapsed time indicator has many outstanding features: size is only ½" square x 1¼" long...weight .75 ounce...



meets all mil specs...temp. range -54 to +125°C...vibration to 2000 cps at 20 G...choice of two ranges (hours to 9999, tenths to 999.9)...power input .5 watt, max. In fact, the complete data outweighs the equipment. Send for our heavyweight literature on the 19200 ETI right now. ■ Electrical or electronic, the A. W. Haydon Company works wonders in time. For electronic requirements call Culver City. For electro-mechanical devices call on our wizards in Waterbury.

**THE AWHAYDON COMPANY**  
235 NORTH ELM STREET, WATERBURY 20, CONNECTICUT

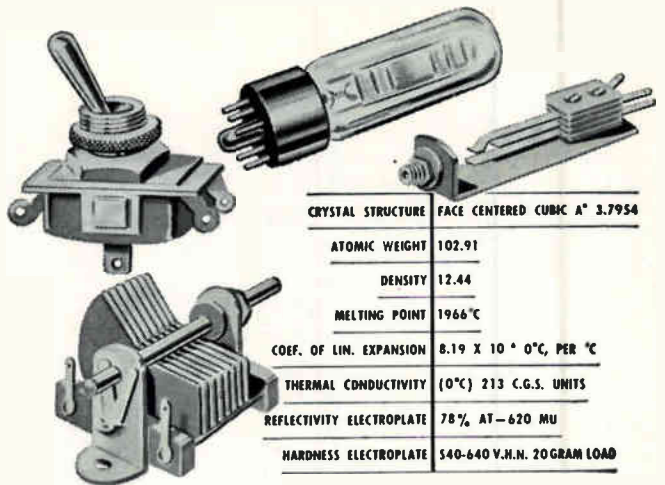




## LEADERSHIP IN DESIGN AND MANUFACTURE OF SLIP RING ASSEMBLIES

Complete facilities, metallurgical and engineering services are available for design and manufacture of slip ring assemblies to critical specifications, ranging in diameter from 1" to 48" and larger—for General Purpose, Radio Frequency and Video Ring Circuits, High Speed Instrumentation, High Voltage Ring Circuits and Power Pulse Slip Rings. A slip ring data file is available—write for your copy.

D. E. MAKEPEACE DIVISION  
PINE & DUNHAM STREET • ATTLEBORO, MASS.



## RHODIUM PLATING RESISTS CORROSION

Rhodium plating offers outstanding protection against surface corrosion under all atmospheric conditions. Used in electrical and electronic applications, it improves efficiency whenever a low-resistance, long-wearing, oxide-free component is required . . . assures low noise level for moving components . . . provides positive action for components subject to long periods of inactivity . . . eliminates partial rectification and unwanted signals by keeping components oxide-free. Send for complete technical data.

CHEMICAL DIVISION  
113 ASTOR STREET • NEWARK, N. J.



## FINE WIRE FOR EVERY APPLICATION

A thoroughly dependable source for fine wire of ductile and non-ductile materials for every application. Special processes have been developed for bare drawing wire as fine as .0004". Wollaston Process for ductile metals . . . Taylor and extrusion methods for non-ductile metals are employed to meet requirements for finer wire. All standard fine wires are stocked for prompt delivery. Full facilities are available for production of fine wire made to customer's individual requirements. Write for details.

BAKER PLATINUM DIVISION  
113 ASTOR STREET • NEWARK, N. J.



## SIMPLIFIED SILVER PLATING FOR ELECTRICAL AND ELECTRONIC COMPONENTS

The simplest, most efficient process for protecting electrical, electronic and lamp components with mirror-bright silver plating in flash to heavy deposits. Silva-Brite is a crystal-clear solution—work is visible during plating process. Plating is quick, easy, non-critical with results assured at current densities from 10 to 40 amps psf—and little or no polishing required. Normal room temperature operation minimizes fumes and bath decomposition. Write for complete information on Silva-Brite and application procedure.

AMERICAN PLATINUM & SILVER DIVISION  
231 N. J. RAILROAD AVENUE • NEWARK, N. J.





**PRECIOUS METAL CONTACTS FOR HIGH-RELIABILITY**

Precious metal contacts in pure or alloyed forms of silver, platinum, palladium and gold provide unmatched resistance to atmospheric corrosion, deformation, arc erosion, binding and metal transfer. Baker high-reliability precious metal contacts are supplied as wire, rod, sheet and in a complete line of fabricated forms. Facilities are also available for manufacture to your specifications.

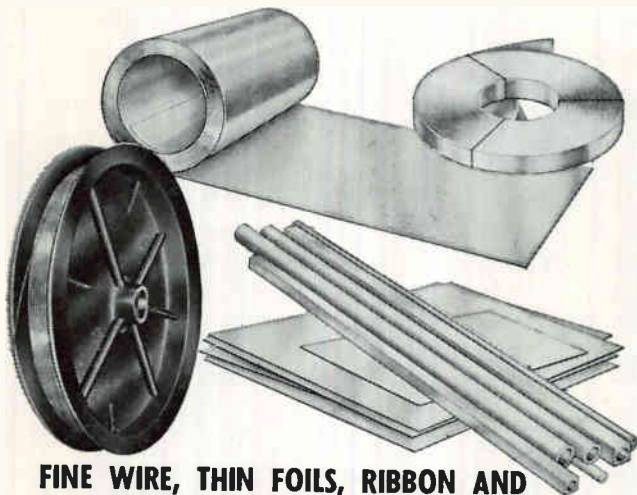
**BAKER CONTACT DIVISION**  
207 GRANT AVE. • NEWARK, HARRISON P.O., N. J.



**IMMERSION GOLD COATING FOR ELECTRICAL AND ELECTRONIC PARTS**

Use Atomex gold immersion solution for more permanent, less expensive coating of printed circuits, metallized plastics, etc. with complete assurance of tarnish resistance and electrical resistivity. In a simplified immersion process, 24K gold is deposited by ionic displacement in a thin, dense, uniform protective layer. • Atomex is the first practical gold immersion solution containing no free cyanide. It eliminates need for costly analytical controls. Write for technical data.

**CHEMICAL DIVISION**  
113 ASTOR STREET • NEWARK, N. J.



**FINE WIRE, THIN FOILS, RIBBON AND TUBING IN NOBLE METALS AND THEIR ALLOYS**

**WIRES:** Bare drawn wire of ductile materials down to .004"—High temperature thermocouple wires—High temperature furnace windings—Potentiometer and Resistance wires—Platinum clad tungsten wire.

**FOILS:** In platinum, palladium and gold down to .0001"—in iridium and rhodium as thin as .001".

**TUBING:** Seamless in platinum, palladium, gold and their alloys. Sizes from .018" with .004" wall up to 1½" with 0.42" wall. • Available in standard or to specification.

**BAKER PLATINUM DIVISION**  
113 ASTOR STREET • NEWARK, N. J.

**ENGELHARD**  
INDUSTRIES, INC.  
EXECUTIVE OFFICES:  
113 ASTOR STREET • NEWARK 2, NEW JERSEY

SALES OFFICES: CHICAGO • DALLAS • DETROIT • HOUSTON • LOS ANGELES • NEW YORK • ORLANDO • PROVIDENCE • SAN FRANCISCO • WASHINGTON, D. C.

*Please send literature as indicated below, addressed to my attention:*

- Slip Ring Assemblies
- Rhodium Plating
- Fine Wire
- SilvaBrite Silver Plating
- Precious Metal Contacts
- Atomex
- Fine Wire, Thin Foils, Ribbons & Tubing

NAME.....  
TITLE.....  
FIRM.....  
STREET.....  
CITY.....ZONE.....STATE.....

# Business Equipment Features

## Photoelectric, Electrostatic Techniques



*Language teaching in individual sound-protected student booth. Dictaphone Corp. equipment uses prerecorded lessons*

By LEON H. DULBERGER, Assistant Editor

the paper. Over 130,000 labels can be produced in an hour.

Also on hand will be a tape reader and buffer unit, normally used with the system to handle the magnetic file tapes and to edit and adjust format for continuous flow of programmed information.

Dictaphone Corp. will demonstrate their electronic classroom, designed for industrial, sales and government training applications. The equipment will be available to provide a five minute course in office economics for exposition visitors. A language teaching system will also be on display.

The firm has added Datafax facsimile to their line of office equipment. Manufactured by Stewart-Warner Corp., Dictaphone will distribute it on a nonexclusive basis. The system can transmit all types of flat, visual images, is designed to operate over standard communication systems. It yields dry, smudgeproof received copy.

Royal McBee Corp. will introduce a typewriter using photoelectric sensing to provide automatic format control without tabulation resetting of any kind. Printed forms of any type, using ordinary ink, are sensed by the photocell which controls vertical and horizontal movement of the carriage.

Pressing the tab key on the typewriter causes the carriage to move to the left until a vertical line is sensed, which halts movement for insertion of data. With no tab setting, the action can be repeated across the sheet for all positions provided on the form.

The machine also provides verti-

cal positioning of the form, using the photocell, after an initial home alignment is found for the carriage.

The typewriter can be operated blindfolded, and may lead to a statistical typing machine that can profitably be used by blind people.

Stromberg div. of General Time will show a master time panel for automatic control of on-off functions such as lighting, heating, ventilation and process equipment. The system can handle 200 separate circuits, uses carrier current pulses, and requires no connection to the terminal stations.

Standard Register Co. will introduce the Stanrecorder, a unit for data collection in plant or office installations. Information ranges from employee time-in, time-out, through various production transactions such as; who performed what job, where, how long it took, number of pieces produced, items scrapped and other data.

Source inputs to the system are; employee identification plates, transaction-operation plates, prepunched cards to designate accountability; numerical keyboard for variable information and built in time clock.

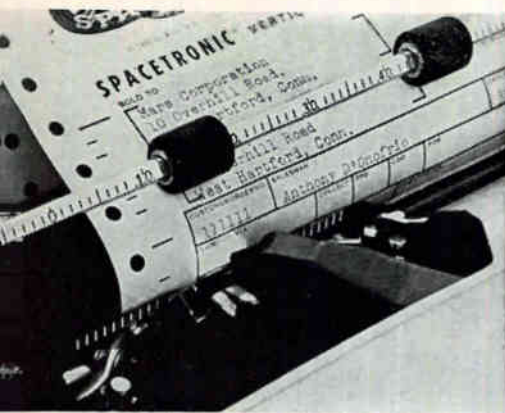
Information logged at the Stanrecorder is printed in both Arabic numerals and English language, plus machine language using a five, bit self-checking code. The marginally punched, continuous forms produced can be processed through the firm's solid-state Stanomatic reader-translator. This system related equipment translates at speeds up to 300 documents per

**NEXT WEEK'S BUSINESS** Equipment Exposition at the New York Coliseum will attract about 60,000 management men to the display of office equipment, much of it electronic, presented by over 70 manufacturers active in this \$4-billion industry.

Set up and operating will be A. B. Dick Company's high-speed electrostatic address-label printer which operates from digital pulse code information. Known as Videograph, the system accepts data from mag tape, punched paper tape, or directly from a computer. A character generator converts digital information into video signals at rates of 20,000 characters per second.

An electrostatic printing tube produces a latent electrostatic image on the treated surface of a moving paper web. The image is developed through use of a thermoplastic toner powder, and fused by an infrared unit permanently to





*Horizontal and vertical tabulating control in typing of forms is achieved by photoelectric sensing device in Royal McBee Corp. typewriter*

minute, into format for machine or computer input on magnetic tape, punched cards or punched tape. Alternately, the forms can be used as source records for manual key-punching.

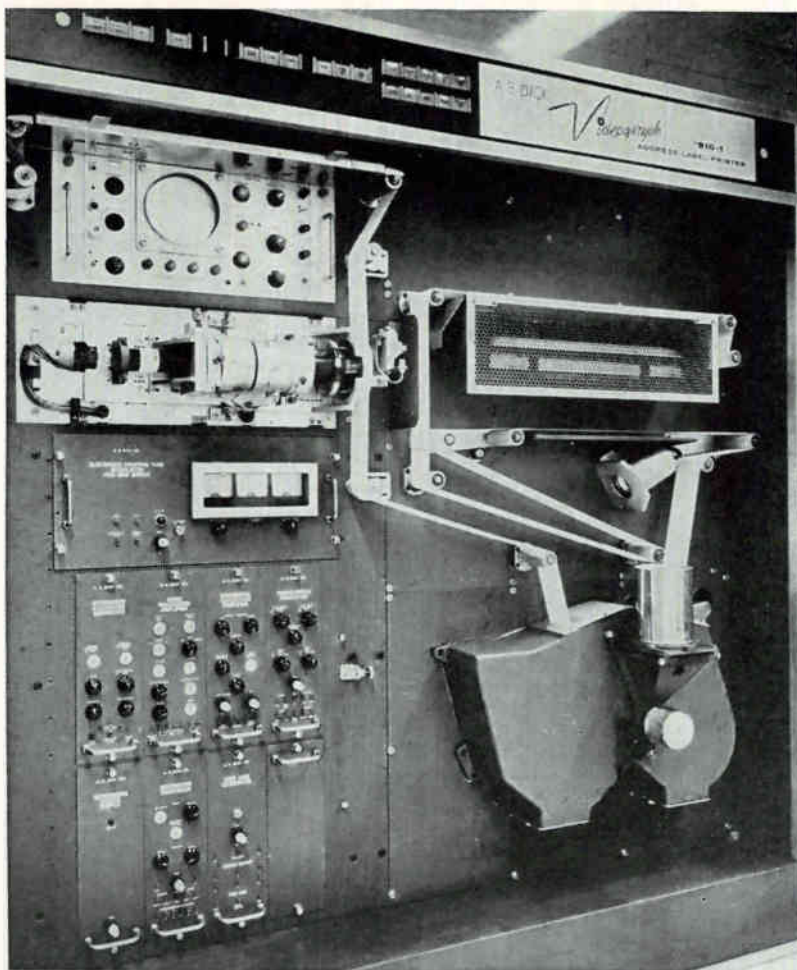
Recordack, a subsidiary of Eastman Kodak Co. will show a full scale model of their computer output microfilmer that converts information from magnetic tape to human language on microfilm, at speeds up to 20,000 characters a second. Called DACOM, for Data-scope Computer Output Microfilmer, (ELECTRONICS, Feb. 24, 1961) the system can produce a page of 64 lines of 126 characters in about one half second. It uses a split optical system to photograph a background form and computer data simultaneously to produce an optically combined microfilm.

A flying-spot character generator and system of lenses and multiplier photo tubes, work with the decoding logic symbols on the magnetic tape to select the letter or figure for display on another crt, where it is recorded on 16-mm film.

Reference stations can be set up to provide ready availability of the microfilm records.

Recordak will show a retrieval station that will have 12½ million lines of computer output data stored. Any requested line can be displayed in 15 seconds on an optical reader. Hard copy of any page can be made on demand at the reader.

Remington Rand will show a model of their Univac mobile computer center van, along with models of the computer equipment it



*Electrostatic address-label printer by A. B. Dick Company produces up to 180,000 labels per minute. Shown is printing tube, panel of electronic system, moving paper web and infrared fuser*



*Unit by Standard Register provides data collection in both machine and man readable language for ultimate processing in solid-state translator, or manual keypunch*

houses. The actual trailer-van carries a complete Univac computer with tabulating card input, and will be used for interim operation by customers upgrading their own equipment to magnetic tape Univac.

The system includes a central

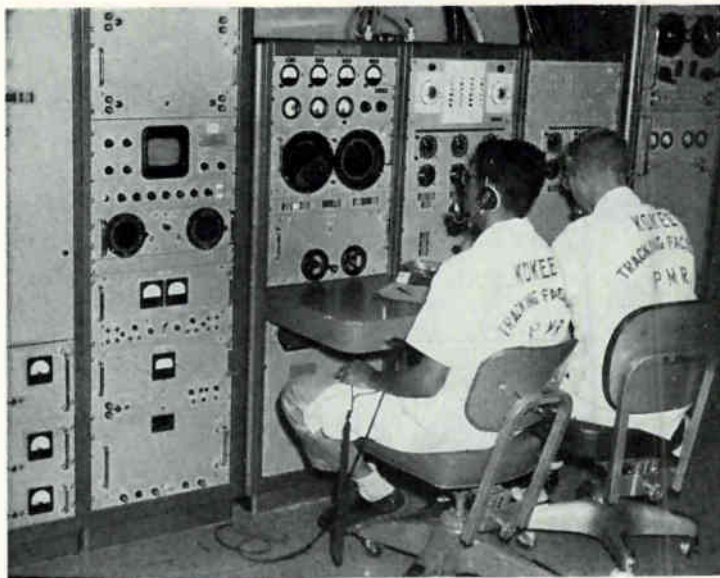
processor with 50,000-digit internal memory, 600-line per minute printer, 450-card a minute reader, and a 150-card a minute read punch. The firm will also show their thin-film memory, part of the Univac 1107 computer.



# Island Station Will Control MERCURY



*Monitor display console. Capsule observer position, right; capsule communicator position, center; aeromedical position, left*



*Active acquisition and control console. This is where manually-placed coordinates are cranked in for initial acquisition. The azimuth and elevation are sent from an up-range station*

*One of five primary installations, Hawaii facility includes radio command, tracking and communications equipment*

By HAROLD C. HOOD

Pacific Coast Editor

**KAUAI, HAWAII**—The Kokee Park control station, one of five such Project Mercury installations around the world, late last month underwent successful initial simulation tests, with space-capsule signals beamed from a NASA fly-by transport.

Primary command function of the \$7-million station, which also incorporates tracking and communications capabilities, is resetting of the capsule's retrorocket timers.

When the first orbiting astronaut goes aloft, hopefully late this year, firing time of these rockets may have to be altered from preset timing to assure correct reentry into the atmosphere.

Initial acquisition of the capsule as it comes over the horizon will be made by an Agave quad helix passive tracking antenna, manually aimed for lock-on with the aid of

teletypewritten coordinates of azimuth and elevation from an up-range station.

This device has a 30-deg bandwidth for adequate searching and receives signals in the 160-dbw area telemetered from the capsule. Agave in turn positions the Velort (VERY LONG Range Tracking radar) and FPS-16 radars.

Velort uses a 12-foot dish, has a range of 700 miles, and acts as a controlling source by the acquisition system for directing other antennas.

The FPS-16, a C-band radar with very narrow beam and a 500-mile range, provides precise tracking data on the capsule's orbit. Information from both of these radars is processed and sent by teletypewriter to Goddard Space Flight Center where it is coordinated with tracking data from other stations.

Mounted atop the Agave array is a 1,530-Mc dipole used for transmission to the capsule.

Inside the telemetry and control

building at Kokee Park is the three-station Mercury monitor display console where an aeromedical doctor, the capsule communicator, and an environmental specialist observe the reactions of and communicate with the orbiting astronaut.

The capsule communicator, or copilot as he is called, will be one of the other six trained astronauts. He will be in voice communication with the capsule and has a radio code key system for back-up communication. In front of him is a duplicate of the capsule instrument panel for checking capsule conditions.

Among his duties are those of sending the command signal for resetting the retrorocket timers if this becomes necessary, verifying telescope retraction, drogue parachute and main parachute deployment and antenna fairing jettison.

The environmental expert will monitor the capsule's altitude, yaw, pitch and roll, as well as pressure,

# CAPSULE



Entrance to Kokee Park Project Mercury site. Transmitting dipole is mounted on quad helix antenna (rear)

temperature and condition of electrical systems.

The aeromedical section contains an electrocardioscope for studying the astronaut's heart action, and dials that indicate respiratory and pulse rate, oxygen in the cabin, body temperature, cabin pressure and temperature inside the flight suit. Beside this console is a pen recorder that records many of these physiological parameters.

Throughout the building other panels and timing devices will indicate many other factors, 86 in all.

Other Mercury control stations are located at Cape Canaveral, Fla., nerve center of the project; Bermuda; Woomera, Australia; and Pt. Arguello, Calif.

Other stations in the network that have tracking but no command functions are located in West Australia; Canton Island; Guaymas, Mexico; White Sands, New Mexico; Eglin AFB, Fla.; and aboard tracking ships in the Atlantic and Indian oceans.

# AIRPAX

## SERIES C-500

MINIATURE ELECTROMAGNETIC  
INDUSTRIAL TYPE

## CIRCUIT BREAKERS



### DESIGNED FOR INDUSTRIAL APPLICATION

This inexpensive, highly reliable combination switch circuit breaker has been developed to protect electrical equipment operating under environmental conditions common to industry. It functions as an overload relay, operational switch and "on-off" indicator.

Standard current ratings for AC  
(60 and 400 CPS) and DC

Short and long time delays or  
instantaneous acting

Series, shunt and relay type units

Delay mechanism is dashpot (hydraulic) type

Choice of terminal types

Trip-free action (holding toggle in ON position  
will not close contacts in presence of overload)

*Send for descriptive bulletin*



CAMBRIDGE DIVISION • CAMBRIDGE, MARYLAND



# New Biomedical Lab Going Up In Iowa

AMES, IOWA—New laboratory devoted to research in biomedical electronics is going up this Spring at Iowa State University.

The \$407,500 building is one result of a four-year-old program to solve veterinary medicine's need for more refined and remote measurements, and electrical engineering's need to train graduate students, free of clinical pressures, in biomedical instrumentation.

The National Institutes of Health are meeting \$200,000 of the cost, the state of Iowa is meeting the remainder. The 12,000-sq-ft lab will encompass three floors.

Cooperation of the Veterinary Medical School is one reason for the success of the biomedical electronics program at ISU, according to Dr. Victor W. Bolie, Chairman, Biomedical Electronics and Joint Professor of EE and Veterinary Physiology and Pharmacology.

Researchers at ISU have developed a broad spectrum of instruments to aid sick people, to telemeter symptoms, body functions.

An infant respirator meters oxygen electronically at a rate that prevents a premature baby from taxing his respiratory system.

A visual signal device tells a deaf mother when her baby cries for attention.

A transistorized device detects and automatically records low-frequency traits of fetal heartbeat.

"Instrumentation alone will never be enough to retain the field of biomedical electronics," says Dr. Bolie.

A dozen of Bolie's first 16 EE graduate students are still in the biomedical electronic program at Ames. Two are professors in other schools, one is in computer design and two veterinarian alumni are teaching physiology.

Graduate students may earn a biomedical electronics minor as part of their master's program by taking courses in organic and physical chemistry, biochemistry and bioelectronics. Doctoral candidates study more basic neuroanatomy, neurophysiology and biomedical electronics.

While the masters-level bioelec-

tronic program deals more with instrumentation, the doctoral-level biomed sequence applies more fundamental engineering ideas to medicine and biology.

Bioelectronic masters-level candidates develop instruments. One, an automatic sphygmomanometer records low-frequency diastolic as well as systolic blood pressure.

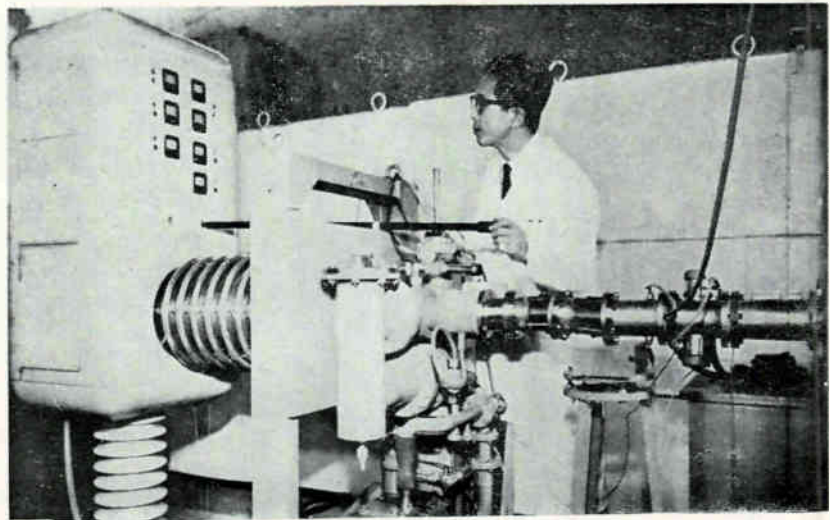
"We had to take a new look at measurement of signals in the low-frequency range, and the need for balanced, fully shielded buildings to avoid interference," Bolie said.

One result: ISU's lab is fitted with specially balanced wiring; separate systems supply 55 volts and 110 volts on either side of ground. No single-ended equipment will be permitted in the building.

One bioelectronics student has developed a compact electronic system for experimental physiology that combines an oscilloscope, automatic stimulator, camera sequencer that programs nerve impulses to the stimulator and respirator into one completely balanced unit capable of measuring low-level signals. Others have developed microelectrodes that measure nerve functions and an electronic spirometer for remote telemetering.

Still in theoretical study stage are a mechanical oscillator that can translate random motions of a subject to power a transistor oscillator and a method to beam r-f energy inside an organism to recharge battery of an implanted transmitter.

## Japanese Develop Neutron Generator



Recently completed by Tokyo Shibaura Company, pulsed neutron generator will soon be installed at the Japan Atomic Energy Research Institute

## Italy Getting Ready For Second Tv Net

ROME—Italian television authorities here are beginning to acquire equipment for this nation's second television service, expected to begin operating later this year.

Latest purchase is an order for seventeen Mark IV Marconi television cameras. These units were

first tried out by the Italians last year when eight pickups were used in coverage of the Olympic Games.

The seventeen new cameras will be used to add on to Radio Italiana Televisione facilities in Rome and Naples. The group presently has 103 camera channels in operation. Fifty-two were supplied by Marconi, 18 by German firms, 17 by American manufacturers, 12 by Pye Ltd. and four by EMI, Ltd.

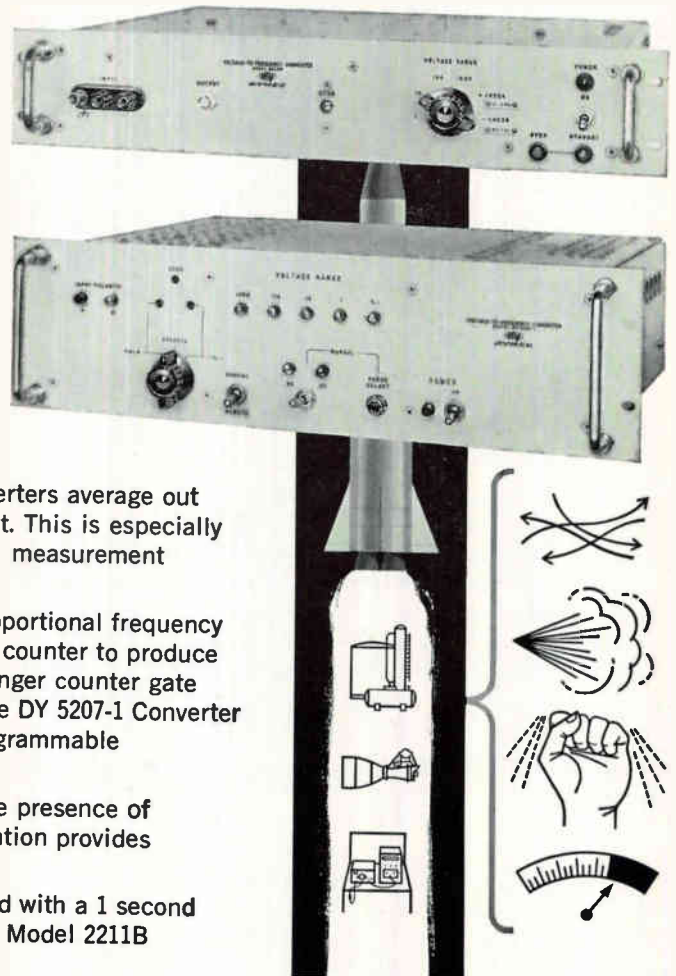


# HERE'S ECONOMICAL, SIMPLE ANALOG/DIGITAL CONVERSION *for accurate systems measurements*

DYMEC

## VOLTAGE-TO-FREQUENCY CONVERTERS—

building-block instruments for high-accuracy voltage measurement, independent of noise or hum



Dymec Models 2210 and 2211A/B Voltage-to-Frequency Converters average out noise and hum to obtain high-accuracy voltage measurement. This is especially advantageous in systems applications. You get higher useful measurement accuracies than with other conversion techniques.

Models 2210 and 2211A/B convert an input dc voltage to a proportional frequency of constant amplitude which is applied to a gated electronic counter to produce a direct digital reading of the input analog voltage. With a longer counter gate time you also can obtain the integral of the input voltage. The DY 5207-1 Converter permits similar measurement of ac input voltages and is programmable for both dc and ac voltage measurements.

In addition to flexible systems use, especially effective in the presence of ac input interference, the Dymec Converter/Counter combination provides an inexpensive digital voltmeter for lab or factory.

Models 2210 and 2211A provide four-digit resolution when used with a 1 second counter gate or three-digit resolution with a 0.1 second gate. Model 2211B provides up to 5 digits of resolution.

Here are brief specifications of Dymec Voltage/Frequency Converters. Call your Dymec/Hewlett-Packard representative or contact Dymec direct for detailed data sheet and application information.

	Dymec 2210/2210R	Dymec 2211AR/BR	Dymec 5207-1										
Ranges: (VDC, $\pm$ , full scale)	$\pm 1$ $\pm 1$ $\pm 10$ $\pm 1$ $\pm 100$ $\pm 10$ $\pm 1000$ $\pm 100$	$\pm 1$ $\pm 1^*$ $\pm 10$ $\pm 1$ $\pm 100$ $\pm 10$ $\pm 1000$ $\pm 100$	DC <table style="display: inline-table; vertical-align: middle;"> <tr> <td><math>\pm 1</math></td> <td>1</td> </tr> <tr> <td><math>\pm 1</math></td> <td>10</td> </tr> <tr> <td><math>\pm 10</math></td> <td>100</td> </tr> <tr> <td><math>\pm 100</math></td> <td>750</td> </tr> <tr> <td><math>\pm 1000</math></td> <td></td> </tr> </table> AC volts, rms, 20 to 100,000 cps	$\pm 1$	1	$\pm 1$	10	$\pm 10$	100	$\pm 100$	750	$\pm 1000$	
$\pm 1$	1												
$\pm 1$	10												
$\pm 10$	100												
$\pm 100$	750												
$\pm 1000$													
Output Frequency:	0-10 KC	2211AR, 0-10 KC 2211BR, 0-100 KC	0-10 KC										
Accuracy:**	$\pm 0.06\%$	2211AR, $\pm 0.02\%$ 2211BR, $\pm 0.03\%$	$\pm 0.06\%$ dc $\pm 0.5\%$ , 50-10,000 cps $\pm 0.75\%$ , 20-100,000 cps										
Stability:***	$\pm 0.03\%$	$\pm 0.02\%$	$\pm 0.03\%$ dc										
Price:	DY 2210, \$660.00 (cabinet) DY 2210R, \$650.00 (rack)	\$1,250.00 (rack)	\$1,850.00 (rack)										

\*Available at extra cost. \*\*Accuracy includes stability, is given in per cent of full scale and is affected by frequency and accuracy of calibration, line voltage variations, temperature changes and accuracy of multi-range input attenuators. Figures given are those attained under normal operating conditions. \*\*\*Given as per cent of full scale per 24-hour day.

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

**DYMEC**  
A Division of Hewlett-Packard Company



Dept. E-4, 395 Page Mill Road, Palo Alto, California • Davenport 6-1755 (Area Code 415)

TWX-117-U

# How Space Astronomy Satellite Operates

A NUMBER OF NEW design concepts are in the National Aeronautics and Space Administration's bizarre-looking gamma ray astronomy satellite (S-15).

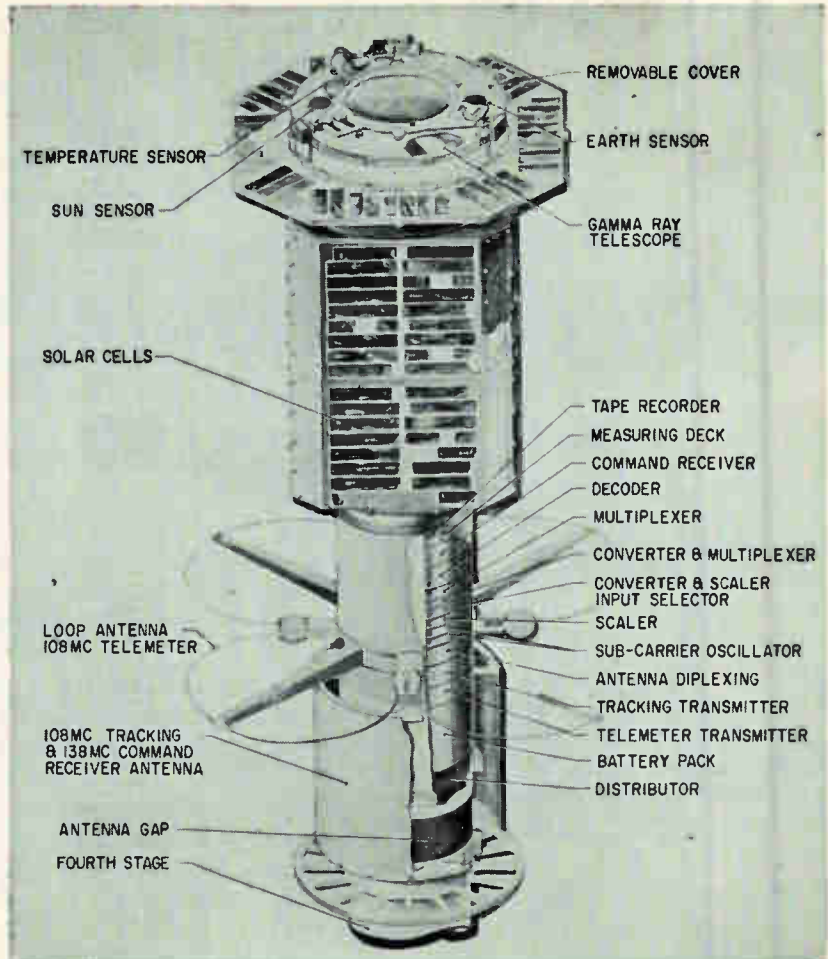
Primary objectives of the experiment are to detect high energy gamma rays from cosmic sources and map their distribution in the sky. This is the first attempt of this kind of space astronomy from a satellite, NASA said.

The 82-lb satellite combines an octagonal 12-in.-diameter, 23½-in.-long aluminum box mounted on a 6-in.-diameter, 20½-in.-long aluminum instrument column. The box provides both a housing for the gamma-ray telescope and for four of the external surfaces for the satellite's solar cells. The 44-in.-long fourth-stage rocket was designed to remain with the satellite to act as a section of a transmitting antenna and provide the additional length and weight (12.8 lb after burnout) needed to attain the S-15's tumbling action.

Solar cells, which recharge the system's 12 nickel cadmium batteries, are also located around the face of a 17-inch-diameter octagonal plate fitted on the top of the box. A thin aluminum shield covers the end of the housing, protecting the telescope from damaging micrometeorites. This shield can be removed by radio command from the earth.

In orbit, the gamma ray astronomy satellite is designed to tumble end-over-end at the rate of about 10 times every minute. This motion enables the gamma-ray telescope, aimed out through the end of the octagonal box, to scan a portion of surrounding space every six seconds.

Sun and earth sensors, peering out through small apertures in the micrometeorite shield, permit scientists on the ground to know at all times the exact orientation of the satellite with respect to the earth, sun and stars, thus pinpointing the direction from which gamma rays are coming. An insulated temperature sensor, also directed out through the thin shield, is designed to study the thermal radiation balance of a body in orbit.



*Cutaway drawing of gamma ray astronomy satellite*

To effect this necessary tumbling, the satellite is equipped with a damping mechanism fitted into the after end of the fourth-stage rocket's motor case. The device is a hollow, mercury-filled cylindrical adaptor, resembling a retainer ring. The S-15 is designed to spin about its longitudinal axis at about 380 rpm. Although it would eventually slow down and begin tumbling by the very nature of its structure, scientists want a controlled tumble, beginning shortly after the satellite orbit begins.

The data transmitted by the S-15 satellite and recorded by the Mini-track stations are processed and reduced at Goddard Space Flight Center.

The composite detected signal is separated into five channels by the use of filters. Discriminators convert this data to voltage amplitudes, which is displayed on an oscilloscope, then recorded on 35mm film.

An orbit's worth of data can be processed in a little over ten minutes and recorded on about 36 feet of film. Also, the light pulse characteristics, elapsed time, and time marks are recorded on binary tape in a format compatible with the experimenters' computer program. A few inches of tape are required for each orbit. These data are then forwarded to the experimenters at MIT, who conduct the final data analysis.

The satellite is launched into a planned elliptical, low inclination orbit in order that (1) the initial spin axis of the payload is in such a direction that the telescope scans the sun during the early part of its lifetime; (2) it has a lifetime in excess of six months; and (3) an appreciable fraction of the time is spent below the inner Van Allen radiation belt.

The S-15 is planned to orbit at an inclination near 28 degrees to



# BALLANTINE model 317 VOLTMETER

# NEW

## MEASURES 300 $\mu$ V to 300 V

at Frequencies

## 10 cps to 11 Mc

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

## SPECIFICATIONS:

**VOLTAGE:** 300  $\mu$ V to 300 V.

**FREQUENCY:** 10 cps to 11 Mc (As a null detector, 5 cps to 30 Mc).

**ACCURACY:** % of reading anywhere on scale at any voltage. 20 cps to 2 Mc — 2%; 10 cps to 6 Mc — 4%; 10 cps to 11 Mc — 6%.

**SCALES:** Voltage, 1 to 3 and 3 to 10, each with 10% overlap. 0 to 10 db scale.

**INPUT IMPEDANCE:** With probe, 10 megohms shunted by 7 pF. Less probe, 2 megohms shunted by 11 pF to 24 pF.

**AMPLIFIER:** Gain of 60 db  $\pm$  1 db from 6 cps to 11 Mc; output 2.5 volts max. from 460 ohms source.

**POWER SUPPLY:** 115/230 V, 50 — 400 cps, 70 watts.

**DIMENSIONS (Inches):** Portable model 13 h x 7½ w x 9½ d. Rack model 8¾ h x 19 w x 8½ d.

**WEIGHT:** 17 pounds, portable or rack models. Approximately 34 pounds shipping weight.



Price:  
**\$445.**

(With probe \$495)

Write for brochure giving many more details

— Since 1932 —

**BALLANTINE LABORATORIES INC.**

Boonton, New Jersey

CHECK WITH BALLANTINE FIRST FOR LABORATORY AC VACUUM TUBE VOLTMETERS, REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY, OR WAVEFORM. WE HAVE A LARGE LINE, WITH ADDITIONS EACH YEAR. ALSO AC/DC AND DC/AC INVERTERS, CALIBRATORS, CALIBRATED WIDE BAND AF AMPLIFIER, DIRECT-READING CAPACITANCE METER, OTHER ACCESSORIES. ASK ABOUT OUR LABORATORY VOLTAGE STANDARDS TO 1,000 MC.



# RCA SERVICES



## -YOUR KEY TO COST CONTROL

Skilled manpower means investment ... in recruiting expenses, training and time.

Your key to manpower cost control is the pool of technical talent available through specialized assistance of RCA Service Company—RCA's military and industrial service arm.

You can "lease" expert manpower for specific needs—thereby cutting costs you would ordinarily incur because of recruiting, training and idle time.

Depending on your requirements, RCA can provide one... five... 100 specialists or more, to give you the support that will help you use your time more efficiently and control your costs.

Regardless of project scope, look to RCA Service Company for assistance in any, or all, of these services:

- Field Engineering
- Systems Engineering Services
- Equipment Installation, Check-out, and Maintenance
- Equipment Repair and Calibration

RCA Service Company has been providing such technical support services on complex equipment and systems to branches of the U. S. Armed Forces, governmental agencies, and prime contractors. This experience and skill assure you of the results you require.

There are times it makes good business sense to utilize outside capabilities to assist you in reaching your project goal more efficiently and economically. Look to RCA for the cost-controlling, technical excellence you require.

For complete information, contact  
J. R. Corcoran, Location 206-2  
RCA Service Company,  
Camden 8, N.J.



The Most Trusted Name  
in Electronics  
RADIO CORPORATION OF AMERICA

## Satellite . . .

the equator. Preliminary plans called for an apogee of about 700 miles and a perigee of about 300 miles. It is intended, in this orbit, to circle the earth approximately every 98 minutes. Its orbital life-time should be over three years.

The gamma-ray telescope has a plastic scintillator covering the top and sides. Inside this cover is a sandwich of crystal layers, composed of sodium iodide and cesium iodide. A third element of the telescope is a Cerenkov detector—a solid layer of clear plastic working in conjunction with multiplier-phototube circuits so that only charged particles arriving from the forward direction are counted.

The heart of the telescope is the sandwich of crystals. When a gamma ray falls on these crystals, an electron and a positron are emitted. These react with the crystal structure in such a way that scintillation occurs. Other particles also strike the sandwich, but they are charged, and therefore cause light flashes in the outer plastic scintillator before striking the crystal layers.

The outputs of the multiplier-phototubes which monitor the light flashes from these three telescope components are fed into the electronic system which includes auto-coincidence circuits. These circuits, when commanded to do so from the ground, cancel out all light flashes not related to incoming gamma rays from the forward direction.

The electronic system is versatile in that the experimenter on the ground can, by issuing the proper commands, observe other particles impinging on the telescope. The experimenter can also observe the performance of different parts of the electronic system.

S-15 contains two transmitters, one for tracking and transmitting continuous data and one for tape recording readout. Both transmitters are under ground command control. A 10-channel command receiver controls the experimental functions.

The data transmitter, using a "four leaf" loop antenna projecting out from the instrument column

beneath the telescope housing, operates on a frequency of 107.97 Mc with a power output of approximately 125 mw. The tracking transmitter operates on a frequency of 108.06 Mc with a power of 20-25 mw. The antenna for this transmitter is the entire satellite.

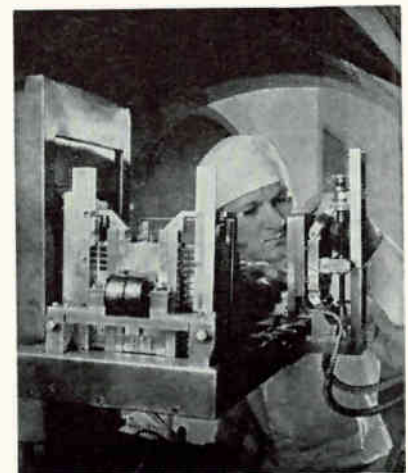
## English Computer To Run Chemical Plant

FLEETWOOD, ENGLAND—A plant here, Imperial Chemical Industries, Ltd., is slated for fully dynamic on-line computer control by the end of July. A computer system being installed by Ferranti, Ltd. will directly control final valves and actuators in the production stream.

The computer is an all-solid state unit, the Argus 1024. System installers say it will replace 100 individual control loops on the plant. Programmed on the Argus word program are the individual three-term control loop equations, values for proportional band, integral and rate terms being stored in the computer from values obtained from normal operator settings on control equipment in similar plants.

Some 300 input signals will be routed to the computer. They will be analog signals converted to binary form in a ten-bit analog/digital converter. Output from the computer will be in electrical form

## New Deposition Gear



Jukebox technique aligns masks for IBM vapor deposition method which makes 135-cryotron memory planes

and will control 100 pneumatic valves.

Group selection time of 100 points is less than 0.06 seconds, according to system engineers.

Overall system cost is claimed to be slightly higher than conventional 100 controller analog systems.

## New Control System For Texas Oil Wells

DALLAS—Mobil Oil reports it has installed one of the most fully automatic systems for controlling oil well operations to date for an "on-land" operation in west Texas. The company is also considering five more similar projects in the same area.

Two similar systems have been in operation for some time, but these control off-shore wells in the Gulf of Mexico and Lake Maracaibo, Venezuela.

The system starts, shuts down, tests, and monitors the wells individually. A built-in alarm system spots various troubles and takes corrective action. The system can make a total of about 240 such decisions.

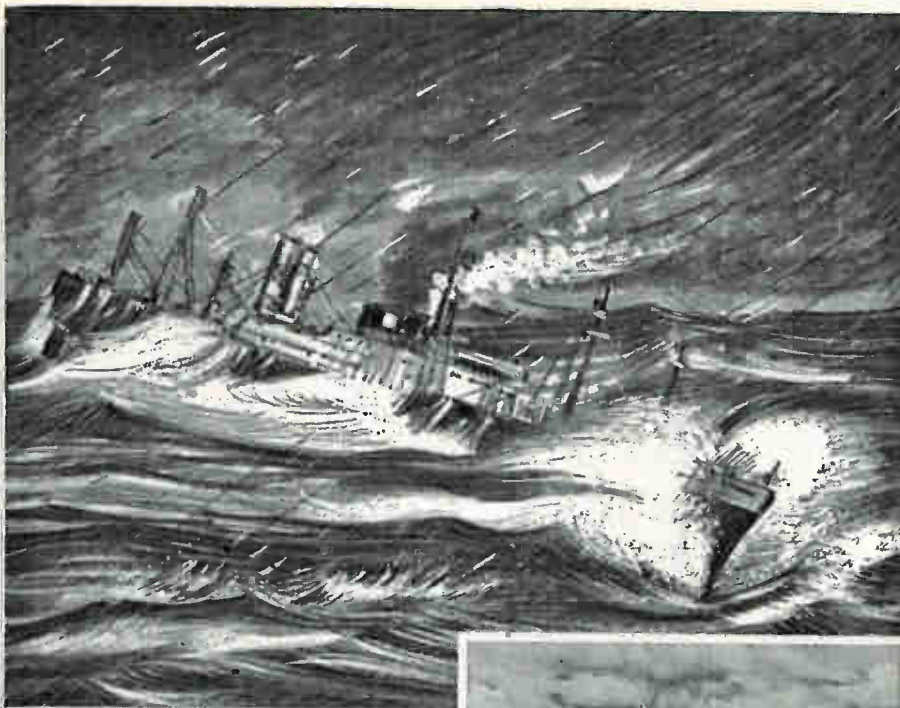
From a central console control panel, a single operator monitors the automatic transfer of oil to pipe lines, the operation of all central tank battery equipment, changes in the status of wells, and oil production volumes.

The central control panel is linked to 11 remote stations by telephone lines.

The system is designed to handle 79 wells in a 4,300-acre area, although only 50 are tied to it at present.

Mobil says the system, which is in a Sacroc project in Scurry County, west Texas, has enabled the firm to reduce tank batteries from 13 to 1. Company says it also provides faster and more complete control of wells, and helps in the recovery of more petroleum gases.

Texas Instruments, which custom-made this system and also the off-shore ones, reports it is currently negotiating proposals for similar systems with other companies.



## Seagoing recorder helps tame the tempest

To poet and pilot alike, the sea is unpredictable. But a long step toward fathoming its mysteries has recently been taken, in the form of an idea which will provide data on the effects of turbulent seas on ship motion. Among the benefits will be the design of hulls and ships better able to meet the challenges of wind and wave.

To help the U.S. Maritime Administration and the David Taylor Model Basin collect data for performing statistical analysis of ship motion, a "Seakeeping Instrumentation System" was designed by Sierra Research Corp. of Buffalo, N.Y. Operating completely unattended for periods of several weeks at a time, the system automatically goes into operation at 4-hour intervals, recording a short run if the weather is calm or a longer run if the weather is rough.

Heart of the system is a 14-channel P.I. instrumentation magnetic tape recorder, capturing such data as wind velocity and direction, ship's heading, roll and pitch, wave height, vertical acceleration, time pulses, and propeller shaft RPM and horsepower. The P.I. recorder was chosen for the system because of its superior reliability — no attention was required during its entire first cruise of four months — and because its compact design involves far less weight, space, and power than conventional recorders.

For details on other P.I. recorders used above and below the sea, check with your local Precision engineering representative or write direct.



S. S. MORMACPRIDE, which gathers data at sea through the automatic, unattended operation of the "Seakeeping Instrumentation System."



Clock, control unit, and recorder mounted in the Gyro Room of the Mormacpride's Bridge Deck.

*P.I. Invites Inquiries from senior engineers seeking a challenging future.*

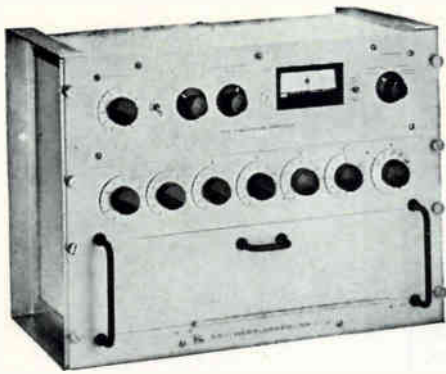


### PRECISION INSTRUMENT COMPANY

1011 Commercial Street • San Carlos • California  
Phone LYtell 1-4441 • TWX: SCAR BEL 30

REPRESENTATIVES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

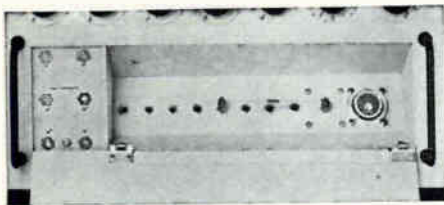




## *new Keithley megohm bridge*

**MODEL 515** measures  $10^5$  to  $10^{15}$  ohms with accuracy of .05 to 1%

The new line-operated 515 Megohm Bridge answers the need for a highly accurate, guarded Wheatstone Bridge for standardization and calibration of resistors in the ranges of  $10^5$  to  $10^{15}$  ohms. It is also ideal for measurement of resistor voltage coefficient, leakage and insulation resistances. Speed of calibration is greatly increased over previously available bridges by a semi-automatic calibration feature. Subsequent direct reading speeds operation. Other features include shielded measuring compartment, self-contained bridge potential, a remote test chamber, bench or rack operation. \$1,500.00



Shielded measuring compartment, easily accessible in front panel, permits critical measurements without stray pickup.



*for details write*

**KEITHLEY  
INSTRUMENTS**

12415 EUCLID AVENUE  
CLEVELAND 6, OHIO

## Chicom's Tv Net Plans Bog Down

HONG KONG—Observers here report Communist China's plans for a nationwide television network have slowed down considerably.

Six television stations are reported operating at these locations: Harbin, Canton, Changchun, Shenyang, Peking and Shanghai.

Of 18 projected stations reported in varying stages of construction since 1959, only one was reported complete during 1960.

About 20,000 television receivers are in use throughout the country. Half of these are in and around Peking. China uses a 625-line system. Nine of the country's 28 major radio equipment factories are said to have begun producing receivers and limited amounts of tv transmission gear.

## Midget Tape Recorders On European Market

TWO EUROPEAN firms announced entry into the race for midget tape recorders this week.

From Vienna comes word of a battery powered unit measuring 4.63 by 3.22 by 1.40 in. with a weight of 0.847 lb.

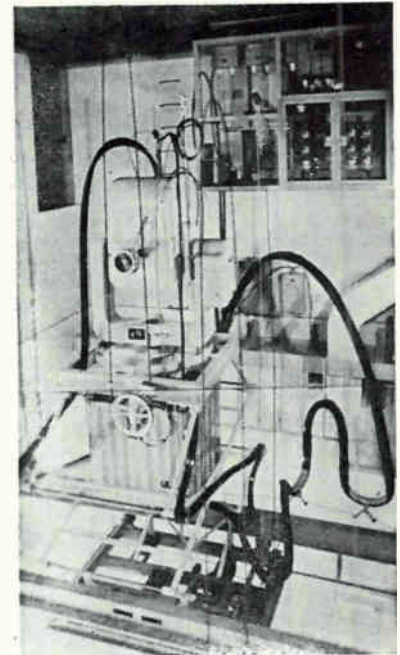
From Amsterdam, announcement is made of a recorder weighing 8 lb., measuring 7.87 by 10.62 by 3.74 in.

The Austrian recorder, made by Ing. V. Stuzzi of Vienna, is fully transistorized and uses printed circuits. It is powered by a nine-volt transistor battery and a 1.5 volt Mignon battery and can operate for 12 hours. The case houses enough tape for 60 minutes of recording without changing reels, and also contains microphone and speakers. Provisions are made for attaching exterior loudspeaker, external microphone, telephone pickup, amplifier or remote control. Price given to Austrian purchasers is equivalent to about \$37.88.

The Dutch recorder works on six  $1\frac{1}{2}$ -volt batteries. Tape coils have a 10-cm diameter, are double tracked and hold 180 cm. length of tape. Total recording time is two hours. The polystyrene case has room for a microphone. Tape transit speed is 4.75 cm per second.

The unit's price in Holland is 278 Guilders, or about \$77.25. Manufacturer is Philips.

## Japan Builds Betatron For Testing Materials



TOKYO—New development by Toshiba is a 15-million electron-volt light-weight betatron (see photo) for nondestructive testing of structural materials.

The company says the equipment is being produced commercially and will be distributed by Mitsui Bussan Kaisha (MBK), its affiliated trading firm.

## Thailand Planning More Tv Coverage

BANGKOK—Construction has started on a \$1.5-million program to extend television coverage outside this capital city of Thailand, according to reports.

Coverage will be spread through three repeater stations to be built at Khonkaen in the northeast, Lampang in the north and Songkhla in the south.

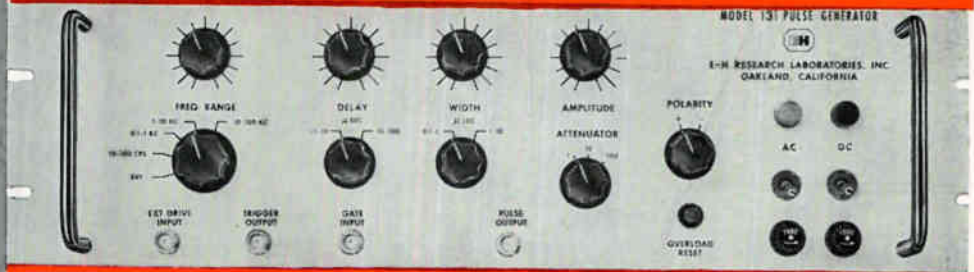
Two television stations are presently operating in Bangkok. Last October there were about 50,000 tv receivers in use in the country.



# E-H

## PRESENTS 4 PULSER THOROUGHBREDS

Which one of these advanced, quality-built instruments is right for your requirements?



### NEW! MODEL 131

Low cost pulse generator with rise time of 10 nanoseconds!

\$575 f.o.b. Oakland, California

If you've been looking for a high-quality pulser with excellent performance characteristics — but without a high price tag — the new E-H 131 was designed for you. The 131's fast rise time and high-power output pulses make it an ideal pulser for laboratory and research applications as well as production line testing of components and solid state devices. Check the 131's specifications. You'll agree it is the outstanding instrument in its price range.

### SPECIFICATIONS

REPETITION RATE: 10 cps to 100 kc, internally controlled, zero to 100 kc externally driven.

RISE TIME: 10 nanoseconds.

PULSE DELAY: Zero to 100 microseconds with respect to the trigger.

TRIGGER (for sync. purposes): Positive 10 volt pulse. EXTERNAL DRIVE: 5 volts RMS or equivalent positive pulse required.

ELECTRONIC GATE: Negative 20 volts required to block the pulse train.

PULSE OUTPUT: 50 volts into a 50 ohm load.

PULSE WIDTH: 100 nanoseconds to 100 microseconds, continuously variable.

POLARITY: Positive or Negative pulses available.

DUTY FACTOR: 10 percent. An automatic limiter prevents overload.

OUTPUT ATTENUATOR: 100:1 coarse selector, 10:1 vernier control.

DIMENSIONS: Standard 19" rack panel, 5 1/4" high.



**E-H MODEL 130** This double pulser has repetition rates to 4 mc, rise and fall time of 10 nanoseconds, pulse widths and delay variable from 100 nsec to 50 milliseconds, and delivers 50 volts at 500 ma at 50% duty cycle. Either pulse polarity, output attenuator, and provisions for external drive and electronic gating. Especially suited for fast circuit applications in transistor testing, computer and missile fields. \$1175 f.o.b., Factory.



**E-H MODEL 121** A high-current pulser delivering a 50 volt pulse into 50 ohms. Rise and fall times 4 nanoseconds. Width variable from 20 nsec to 1 μsec. Repetition rate from 10 cps to 10 mc. Either positive or negative pulses may be selected on the front panel. Ideal for ferrite and magnetic switching studies, applications in high speed transistor and diode switching, and design of logic and memory circuits. \$1675 f.o.b., Factory.



**E-H MODEL 120B** Rise time — 2 nanoseconds — is ahead of the field and offers new tool for fast, high-resolution work. Two outputs independently variable in amplitude (—8 volts into 93 ohms) and widths (2.5 to 25 nsec). Inverting and impedance matching transformer available. Repetition rate 10 cps to 10 mc. Advanced trigger pulse and a fast, flexible gate for complex pulse-time and pulse-amplitude selection. \$1275 f.o.b., Factory.

WRITE, WIRE OR TELEPHONE TODAY FOR MORE INFORMATION — REPRESENTATIVES IN ALL MAJOR CITIES

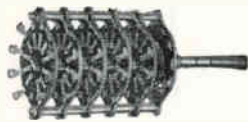


**E-H RESEARCH LABORATORIES, INC.**  
163 ADELIN STREET • TEMPLEBAR 4-3030 • OAKLAND 20, CALIFORNIA

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



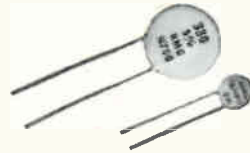
**TANTALUM CAPACITORS** Industry's broadest line. Microminiature to high capacity: 0.33 to 1300 mfd. Sintered wet slug, solid and foil types. Temperature ratings —55 to +200°C.



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



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



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



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



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

## These Mallory Industrial Distributors stock the lines indicated by numerals:

- Key: 1—Tantalum capacitors  
2—Selector switches  
3—Vitreous enamel resistors  
4—Ceramic disc capacitors  
5—Snap-action switches  
6—HC-NP capacitors

Distributor	1	2	3	4	5	6
Standard Radio Parts	1					
Newark Electronics	2					
California Electronics	1 2					
Federated Purchaser	1 2					
Kierulff Electronics	1 2	4 5				
Radio Product Sales	1 2					
Brill Electronics	1 2	4				
Elmar Electronics	1 2 3	4 5				
Zack Electronics	1 2					
Elwyn W. Ley	1 2					
Electronic Supply	1 2					
Shanks & Wright	1 2					
Peninsula Electronics	1 2					
Denver Electronics	1					
Westconn Electronics	1					
Capitol Radio	1					
Electronic Indus. Sales	1 2					
Tucson, Ariz.						
Inglewood, Calif.						
Los Angeles, Calif.						
Los Angeles, Calif.						
Los Angeles, Calif.						
Oakland, Calif.						
Oakland, Calif.						
Palo Alto, Calif.						
Paramount, Calif.						
Pasadena, Calif.						
San Jose, Calif.						
San Diego, Calif.						
San Jose, Calif.						
Denver, Colo.						
Bridgeport, Conn.						
Washington, D.C.						
Washington, D.C.						
Electronic Equipment						
East Coast Radio	1	3 4				
Thurrow Distributors	1					
Allied Radio	1 2					
Chauncey's, Inc.	1 2	4				
Newark Electronics	1 2					
Melvin Electronics	1 2					
Bruce Electronics	3					
Graham Electronics	1 2 3 4 5 6					
Radio Supply	5					
D & H Distributing						
Kann-Ellert Electron.	1 2					
Radio Elec. Serv.	1	5				
Cramer Electronics	1 2 3 4					
DeMambo Rad. Sup.	1 2	5				
Lafayette Radio	1 2 3					
Radio Shack	2					
Radio Specialties	2					
Northwest Radio	1 2 4					
Burstein-Applebee	2					
Walters Radio	2					
Olive Electronics	1	5				
General Radio	1 2					
Eastern Radio	2					
Atlas Electronics	1 2					
Miami, Fla.						
Orlando, Fla.						
Tampa, Fla.						
Chicago, Ill.						
Chicago, Ill.						
Chicago, Ill.						
Oak Park, Ill.						
Springfield, Ill.						
Indianapolis, Ind.						
Wichita, Kansas						
Baltimore, Md.						
Baltimore, Md.						
Baltimore, Md.						
Boston, Mass.						
Boston, Mass.						
Boston, Mass.						
Boston, Mass.						
Detroit, Mich.						
Minneapolis, Minn.						
Kansas City, Mo.						
Kansas City, Mo.						
St. Louis, Mo.						
Camden, N. J.						
Clifton, N. J.						
Perth Amboy, N. J.						
Federated Purchaser	1 2					
Aaron Lippman & Co.	1 2					
Lafayette Radio	1					
State Electronics	2 4					
Federal Electronics	1 2					
Acme Electronics	1 2					
Radio Equipment	2					
Wehler Electronics	1					
Greylock Electronic	1 2					
Peerless Radio	1 2					
Bruno-New York	2					
Electronic Center	1 2 3 4					
Harrison Radio	1 2					
Harvey Radio	1 2 3					
Lafayette Radio	1 2					
Milo Electronics	1 2					
Terminal Hudson Elec.	1 2					
Higgins & Sheer Elec.	1 2					
Morris Electronics	1 2					
Valley Indus. Elec.	1 2					
Westchester Electron.	1 2 4					
Dalton-Hege Radio	1					
Akron Electronic Sup.	1 2					
United Radio	1 3 4					
Pioneer Electronics	1					
Thompson Radio	1 2 4					
Whitehead Radio	1 3					
Allied Supply	1 3 4					
Mountainside, N. J.						
Newark, N. J.						
Newark, N. J.						
Whippany, N. J.						
Binghamton, N. Y.						
Brooklyn, N. Y.						
Buffalo, N. Y.						
Buffalo, N. Y.						
Kingston, N. Y.						
Lynbrook, L.I., N.Y.						
New York, N. Y.						
New York, N. Y.						
New York, N. Y.						
New York, N. Y.						
New York, N. Y.						
New York, N. Y.						
Poughkeepsie, N.Y.						
Syracuse, N. Y.						
Utica, N. Y.						
White Plains, N.Y.						
Winston-Salem, N.C.						
Akron, Ohio						
Cincinnati, Ohio						
Cleveland, Ohio						
Columbus, Ohio						
Columbus, Ohio						
Dayton, Ohio						



# distributors

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

## Distributor Division

Indianapolis 6, Indiana



Srepco, Inc.	2	Dayton, Ohio
Servex Electronics	4	Marion, Ohio
Engineering Supply	1	Tulsa, Okla.
Eoff Electric	4	Portland, Ore.
Television Parts	3 4	New Brighton, Pa.
Cameradio Co.	5	Pittsburgh, Pa.
Radio Parts	1 2	Philadelphia, Pa.
Almo Radio	2	Philadelphia, Pa.
Herbach & Rademan	1	Philadelphia, Pa.
Phila. Electronics	1 2	Philadelphia, Pa.
Radio Elec. Serv.	2	Philadelphia, Pa.
Geo. D. Barbey Co.	6	Reading, Pa.
West Chester Elec.	4	West Chester, Pa.
Electra Distrib.	1 2	Nashville, Tenn.
Engineering Supply	1	Dallas, Texas
McNicol, Inc.	4	El Paso, Texas
Harrison Equip.	1	Houston, Texas
Lenert Co.	1	Houston, Texas
Rucker Electronic	1 2 3 4	Arlington, Va.
F. B. Connelly Co.	1 2 3 4 5	Seattle, Wash.
Radio Parts	3	Milwaukee, Wis.
Canadian Elec. Sup.	1	Montreal, Que.
Wackid Radio	1	Ottawa, Ont.
Alpha Aracon Radio	1	Toronto, Ont.
Electro Sonic Sup.	1	Toronto, Ont.
Wholesale Radio	1	Toronto, Ont.

CIRCLE 200 ON READER SERVICE CARD

April 14, 1961

## MEETINGS AHEAD

Apr. 13-14: Society of Technical Writers and Publishers, Annual Convention; Mark Hopkins Hotel, San Francisco.

Apr. 17-19: Instrumental Methods of Analysis, ISA; Shamrock-Hilton Hotel, Houston.

Apr. 17-21: Strain Gage Techniques, Southwest Research Institute; San Antonio, Tex.

Apr. 18-19: Organic Semiconductors, Inter-Industry Conference, Armour Research Foundation of Illinois Institute of Technology, and ELECTRONICS, McGraw-Hill; Terrace Casino, Morrison Hotel, Chicago.

Apr. 19-21: Southwestern IRE Conf. and Elec. Show, SWIRECO; Memorial Auditorium, Dallas.

Apr. 25-27: Relay Conference, NARM in cooperation with Oklahoma State Univ.; Student Union Bldg., Stillwater, Okla.

May 2-4: Electronic Components Conf., PGCP of IRE, AIEE, EIA, WEMA; Jack Tar Hotel, San Francisco.

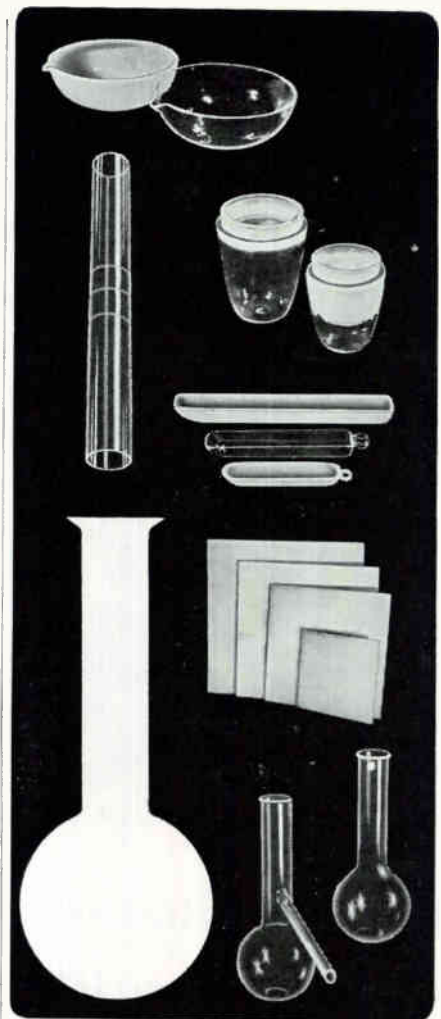
May 22-25: Electronic Parts Distributors Show, Electronic Industry Show Corp.; Conrad Hilton Hotel, Chicago.

Aug. 22-25: WESCON, L.A. & S.F. Sections of IRE, WCEMA; Cow Palace, San Francisco.

Sept. 11-15: Instrument-Automation Conf. and Exhibit, ISA; Sports Arena, Los Angeles.

Oct. 9-11: National Electronics Conf., IRE, AIEE, EIA, SMPTE; Chicago.

Nov. 14-16: Northeast Research & Engineering Meeting, NEREM; Commonwealth Armory and Somerset Hotel, Boston.



## VITREOSIL® PURE FUSED QUARTZ

**IDEAL FOR ALL SEMI-CONDUCTOR METALS**  
Our unique process enables us to supply semi-conductor quality VITREOSIL to close tolerances in crucibles and special fabricated shapes. Now available Quartz to Metal Seals. Write us about your requirements. See our ad in Chemical Engineering, Electronic Engineers Master and Electronic Designers' Catalogues.

## SPECTROSIL® FOR HYPER-PURITY IN SEMI-CONDUCTOR WORK

**PURITY** — purest form of fused silica  
**TRANSPARENCY** — unique optical properties  
**HOMOGENEITY** — completely homogeneous and free from granularity  
**AVAILABILITY** — block material for lenses, prisms, etc; rod, fiber, wool; hollow ware as tubing, crucibles, and special apparatus.

Write for complete, illustrated catalog.

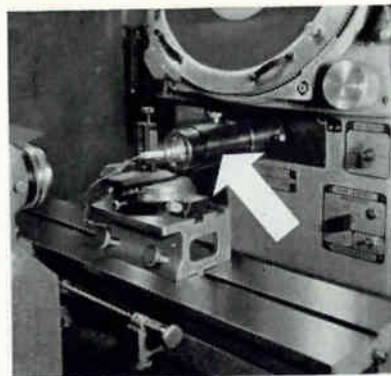


CIRCLE 39 ON READER SERVICE CARD

39

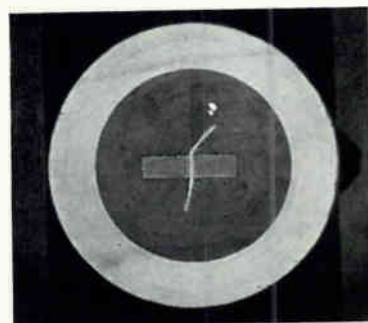


Model FC-14 J & L Optical Comparator



CENTRALITE adapter (arrow) slips easily into place on J & L Optical Comparator — used here to inspect tiny read/record head.

CENTRALITE image of read/record head clearly shows two magnetic poles separated by aluminum foil insulator at 31.25 magnifications.



## NOW...closer inspection of micro-assemblies

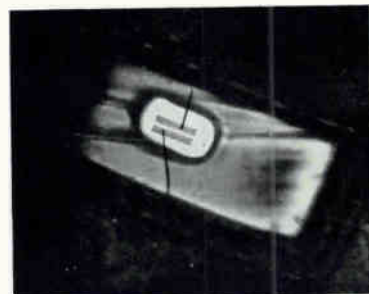
### ...with CENTRALITE and PARABOLITE

Simply slip on a CENTRALITE or PARABOLITE adapter, and your J & L TC-14 or FC-14 Optical Comparator becomes even *more* versatile. You'll use it for critical inspection jobs that may have previously seemed impossible.

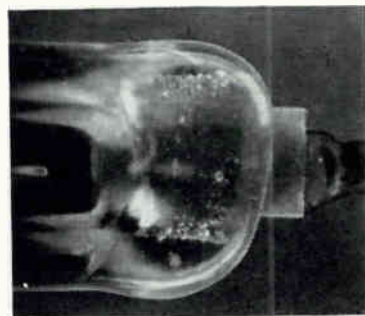
For example, CENTRALITE provides a highly concentrated light which now permits the projection of a precise image of a tiny read/record head used in a computer component. Light is concentrated intensely on the part and reflected back through the J & L projection system onto the Comparator screen. CENTRALITE is also used for micro-inspection of a mesa diode assembly.

PARABOLITE permits detailed examination of a tiny tunnel diode assembly by surrounding it with concentrated light. Simply by rotating the diode, you can take a close look at seal, bubble configuration at fusion points, gold contact to wafer, and other critical details.

Solve *your* inspection problems with J & L Optical Inspection Equipment. Send for Catalog LO-6013 now.



Micro inspection of this mesa diode assembly at 100 magnifications is clearly detailed with CENTRALITE.



PARABOLITE makes possible a sharp close-up of bubble configuration at the fusion point of this tunnel diode (50 magnifications).



# JONES & LAMSON MACHINE COMPANY

539 Clinton Street, Springfield, Vermont

Turret Lathes • Automatic Lathes • Tape Controlled Machines • Thread & Form Grinders • Optical Comparators • Thread Tools



● Sperry garnet materials, products of Sperry research, are especially applicable for low frequency and high average power requirements under extreme temperature conditions. They are also superior, under certain conditions, in high peak power applications.

Important uses of Sperry garnet materials are in resonance isolators and in 3- and 4-port circulators for frequencies from 350 to 1500 mc and over broad temperature ranges.

Sperry garnets also are highly satisfactory in higher frequency devices—up to and including the X-band—where a maximum degree of temperature stability is necessary with high average power. Typical devices using certain of these materials operate from  $-65^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ , and at very high power levels.

Bars nominally measure  $1\frac{1}{2}'' \times 1'' \times 6''$ .

Complete information relative to Sperry solid state materials furnished on request.

# GARNET



## materials

by

## SPERRY



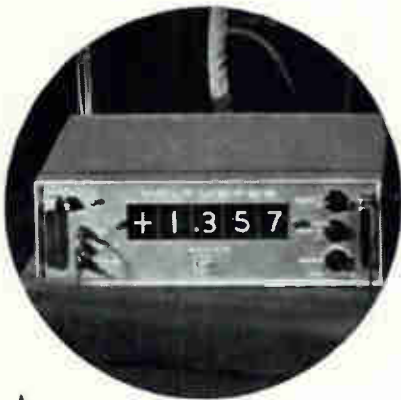
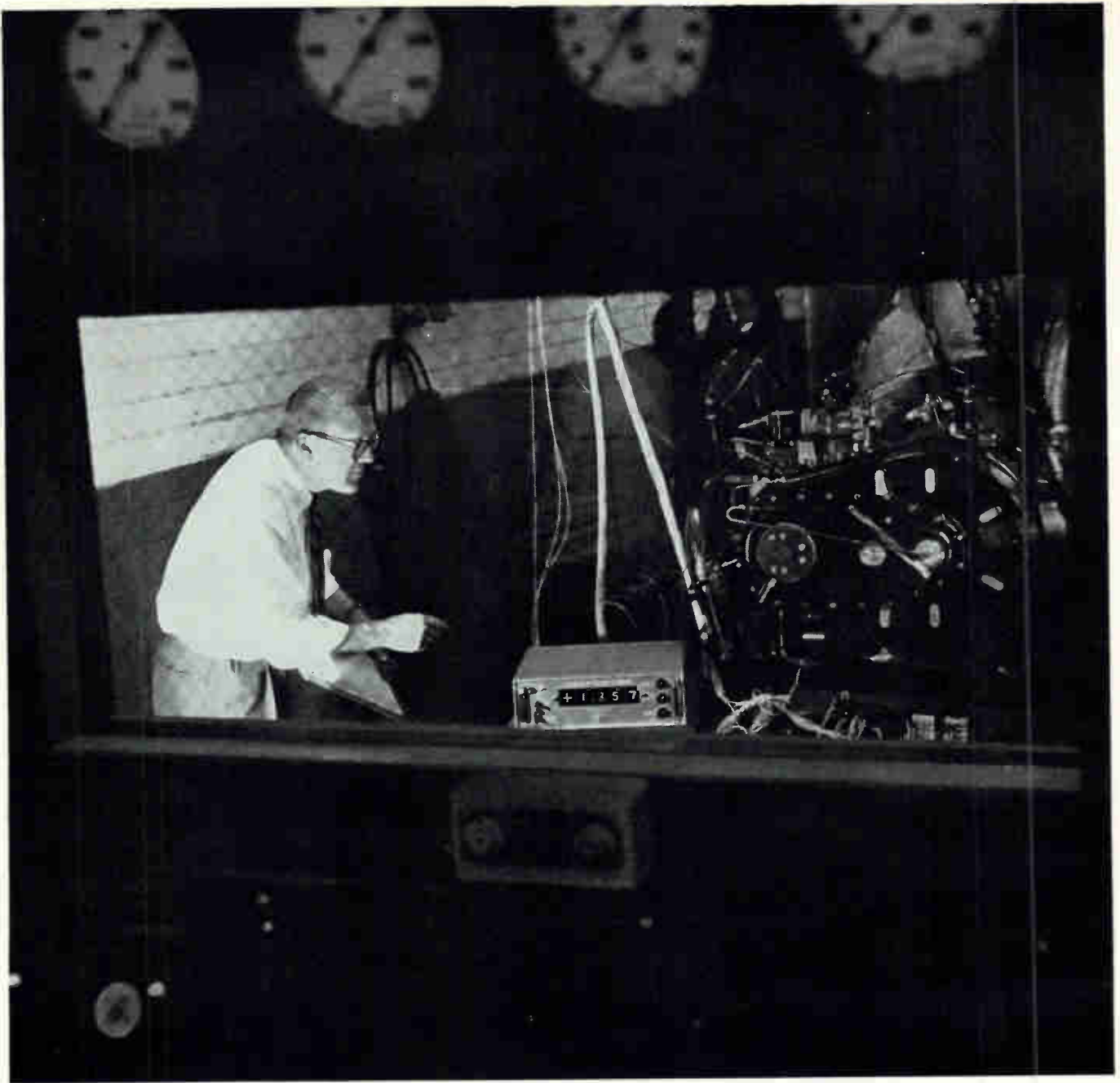
# SPERRY

### NOMINAL CHARACTERISTICS

MODEL	DENSITY (gm/cm <sup>3</sup> )	4 Ms (Gauss)			$\Delta H$ Oersteds at 9150 mc, 25°C	g-Factor
		-55°C	25°C	+125°C		
D80A1	5.05	1950	1750	1400	50	2.02
D80A2-1	5.25	1600	1475	1300	60	2.02
D80A2-2	5.40	1350	1250	1100	85	2.03
D80A2-3	5.60	950	1000	850	125	2.04
D80A2-4	5.75	700	750	750	225	2.06

Curie Temperature,  $T_c = 280^{\circ}\text{C}$  for all materials  
Nominal Bar Size— $\frac{1}{2}'' \times 1'' \times 6''$

SPERRY MICROWAVE ELECTRONICS COMPANY, CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATION  
Microline Instruments • Radar Test Sets • Systems Instrumentation • Solid State Devices and Materials • Microwave Components and Antennas



## NO STEPPING SWITCHES IN THIS ULTRA-RELIABLE DVM:

Cubic announces a new digital voltmeter design that eliminates stepping switches and, with them, the need for periodic maintenance. The new Cubic V-70 uses the same ultra-reliable reed relays developed for submarine cables. These reed relays are sealed in glass and have practically unlimited life. They are noiseless and completely unaffected by operating position.

*Accurate:* The V-70 reads any d-c voltage from 0.001 to 999.9 volts with an absolute accuracy of 0.01% plus or minus 1 digit. The Cubic V-70 Digital Voltmeter provides these and other premium features at a cost of only \$1,580. For details, write to Dept. E-103, Industrial Division, Cubic Corporation, San Diego 11, Calif. (in Europe: Cubic Europa S.p.A., Via Archimede 185, Rome).

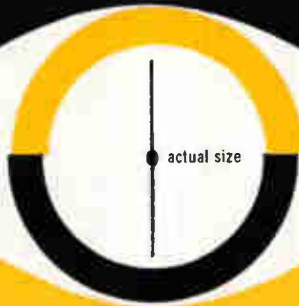
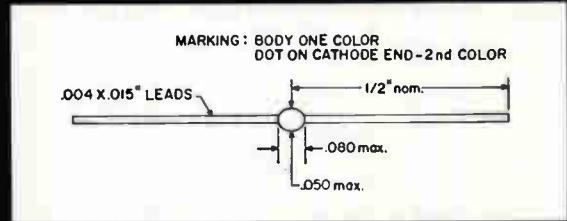
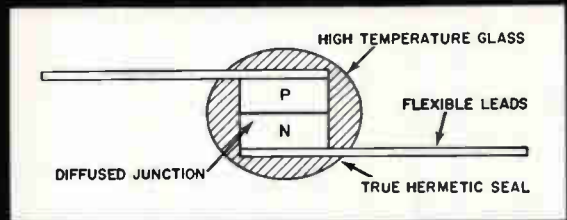
*Cubic manufactures a complete line of quality digital instruments, including a-c and d-c voltmeters, ohmmeters, ratiometers, scanners and printer controls.*



INDUSTRIAL DIVISION  
SAN DIEGO, CALIF., U.S.A. ROME, ITALY



# ANOTHER FIRST FROM Transitron



WITH A TRUE HERMETIC SEAL

# MICRO ZENER DIODES

## NO COMPROMISE!

Development by Transitron scientists and engineers of a new concept in glass packaging has now made it possible to introduce the industry's first micro-diode with true hermetic sealing. This is the new micro voltage regulator ("zener") series... a series in which the glass is melted *around* the silicon body that forms the working part of the device. Achievement of a direct high-temperature glass-to-metal seal means that there are no plastics... no multi-part packaging... no "gunk"... no degrading of characteristics with humidity. Absolute hermetic sealing makes this the most reliable and efficient micro-regulator ever developed, ideal for voltage regulating and reference service wherever space and weight economies are required.

Micro Zener Diodes are produced exclusively by Transitron. The first series is available immediately; other diodes are under development and will be marketed shortly.

For more information write for Bulletin PB-71E.

TYPE	SPECIFICATIONS @ 25° C		CURRENT RATINGS	
	Voltage <sup>①</sup> @ I <sub>Z</sub> = 5ma (Volts)	Maximum Dynamic Resistance <sup>②</sup> (ohms)	Maximum Average <sup>③</sup> Operating (ma) Current	
			@ 25° C	@ 100° C
TMD-01*	5.1	15	17.8	4.4
TMD-02	5.6	15	15.5	4.0
TMD-03*	6.2	15	14.5	3.7
TMD-04	6.8	15	13.0	3.3
TMD-05	7.5	15	12.0	3.1
TMD-06	8.2	15	11.0	2.8
TMD-07*	9.1	15	10.0	2.5
TMD-08	10.0	15	9.0	2.3

① Voltage tolerance ±10%. For ±5% Voltage Tolerance use "A" suffix (e.g. TMD-03A).

② Dynamic Resistance is measured by imposing a small (10% of DC bias) AC current upon the DC Test Current, 5 MADC.

③ Assume linear derating between 25° C and 100° C.

\*Production types

### ADDITIONAL CHARACTERISTICS AND RATINGS

Operating and Storage Temperature Range -55° C to +150° C

Maximum power dissipation at 25° C 100 mW

Typical forward voltage at 5.0 mA 0.75 volt

# Transitron

electronic corporation  
wakefield, melrose, boston, mass.



SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U.S.A. AND EUROPE • CABLE ADDRESS: TRELCO



SEND FOR A COPY OF 28-PAGE CATALOG 66SR WHICH PROVIDES OPERATING DATA ON BREEZE CUSTOM UNITS AND DRAWINGS AND SPECIFICATIONS OF ALL STANDARD SLIP RING ASSEMBLIES.

# COMBINING CUSTOM AND STANDARD SLIP RING ASSEMBLIES

## FOR LOWER COSTS - FASTER DELIVERY

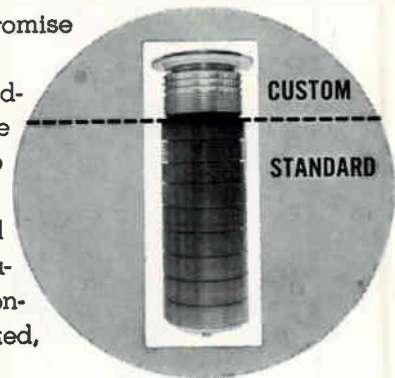
This slip ring assembly controls, powers and monitors the centrifuge arm of a motion simulator. Its production required the combination of highly creative engineering skills, well-equipped manufacturing facilities and diversified production methods available to you at Breeze.

The unit, having a duty cycle of 2000 amps, is only 48" high, yet contains 425 slip rings. These include both standard rings and rings engineered for this application. There are rings of flat and cylindrical design, electroplated rings and rings of fabricated construction in the assembly.

Whatever your slip ring requirement, it can be met without compromise at Breeze.

For general applications, Breeze offers a line of field-proven standards with ring envelope diameters from 1" through 10½". These are flat, fabricated assemblies built from off-the-shelf components to insure rapid delivery at reduced costs.

For custom applications including general purpose control and power, radio frequency and video, high voltage, high speed instrumentation and switching, Breeze produces flat, cylindrical or concentric assemblies using all standard construction methods, fabricated, electroplated and plastic molded.

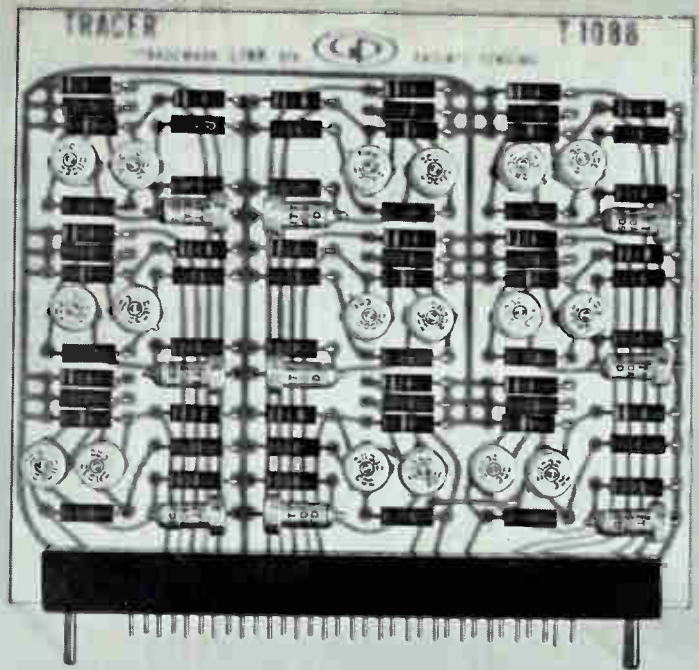
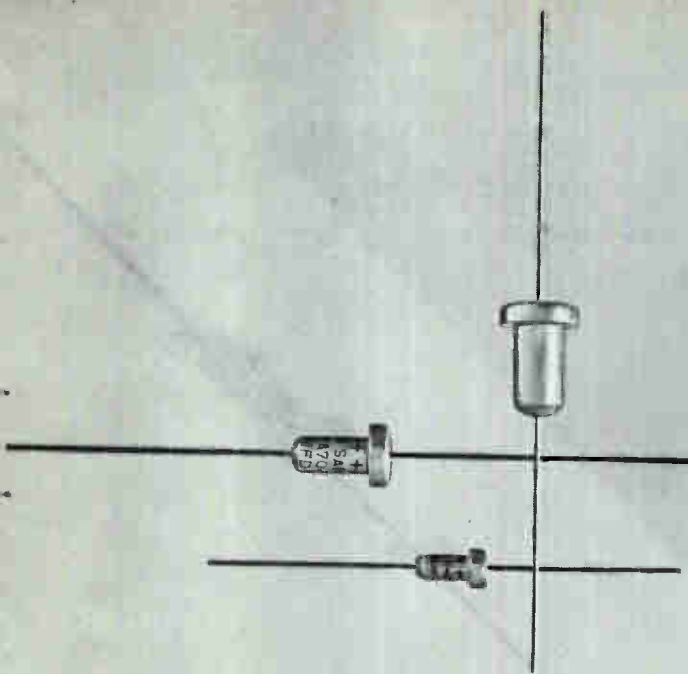


### **BREEZE CORPORATIONS, INC.**

700 Liberty Avenue, Union, New Jersey • Telephone: MURdock 6-4000

*Manufacturers of electrical, electro-mechanical and hydro-mechanical components and systems and fabricated metal products.*



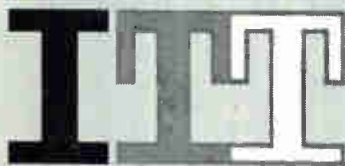


*Link Division of General Precision, Inc. specified ITT capacitors for this vital portion of its Tracer Identification and Control System, which demands utmost reliability and long life expectancy from every component.*

**TOTAL PROCESS CONTROL AND DISCIPLINED PRODUCTION DELIVER**

# HIGH-RELIABILITY WET-ANODE TANTALUM CAPACITORS FROM ITT

ITT wet-anode tantalum capacitors meet MIL-C-3965B—a fact proved by independent laboratory qualifications tests on ITT capacitors. The reliability and long life expectancy of these competitively-priced capacitors are direct results of ITT's total process control and disciplined production procedures, above and beyond testing standards more stringent than normal industry practice—and backed by ITT's world-wide facilities and experience.



**COMPONENTS DIVISION**  
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION  
815 SAN ANTONIO RD., PALO ALTO, CALIF.

Phone these ITT-CD Capacitor Sales Offices:

Albuquerque . . . . . AX 9-8013	Los Angeles . . . . . HI 6-6325
Boston . . . . . CA 7-2980	Miami . . . . . MI 4-3311
Chicago . . . . . SP 7-2250	Minneapolis . . . . . WE 9-0457
Cleveland . . . . . GR 5-3080	New York . . . . . LO 5-1820
Dallas . . . . . EM 1-1765	Philadelphia . . . . . TR 8-3737
Dayton . . . . . BA 8-5493	Phoenix . . . . . WH 5-2471
Denver . . . . . KE 4-5091	Rochester . . . . . FI 2-1413
Detroit . . . . . TO 8-3322	San Francisco . . . . . LY 1-7321
Fort Wayne . . . . . HA 0641	Seattle . . . . . MA 2-5433
Kansas City . . . . . JE 1-5236	St. Louis . . . . . EV 2-3500

#### IN STOCK AT ITT DISTRIBUTORS:

- TWO TYPES—M-Type and P-Type, for applications from -55 to 85 and 125 C. respectively
- 29 VALUES—from 1.75 to 330 mfd's over a working voltage range to 125 VDC and maximum surge voltages to 140 VDC
- COMPACT AND RUGGED—sintered tantalum slug in fine-silver cases for 2000-hour life at maximum temperature and working voltage
- GUARANTEED—to 80,000 ft. and accelerations of 20 G's with a 0.1 in. excursion in 50-2000 cps range
- LONG STORAGE LIFE—tantalum-oxide dielectric is completely stable; assures trouble-free operation

**COMPLETE SPECIFICATIONS ON ITT** wet- and solid-anode tantalum capacitors are available on request. Write on your letterhead, please, to the address below.

**ENGINEERS:** Your ITT representative has a complete set of qualifications and quality control tests for your inspection.

# HOW TO GET THE POWER TRANSISTORS YOU NEED?



**JUST ASK DELCO.** For even though our catalog lists only a handful of germanium power transistors, there is only a handful out of all those ever catalogued that we don't make. And those only because nobody ever asked for them.

We've made, by the millions, both large and small power transistors. Both diamond and round base. Both industrial and military types. And each in a wide variety of parameters that have proved themselves reliable in nearly every conceivable application.

You get Delco transistors fast. You get Delco transistors in any quantity. And for all their high reliability, you get them reasonably priced. All you have to do is contact our nearest sales office or distributor—and ask for them.

Union, New Jersey  
324 Chestnut Street  
MURdock 7-3770

Santa Monica, California  
726 Santa Monica Blvd.  
UPton 0-8807

Chicago, Illinois  
5750 West 51st Street  
PORtsmouth 7-3500

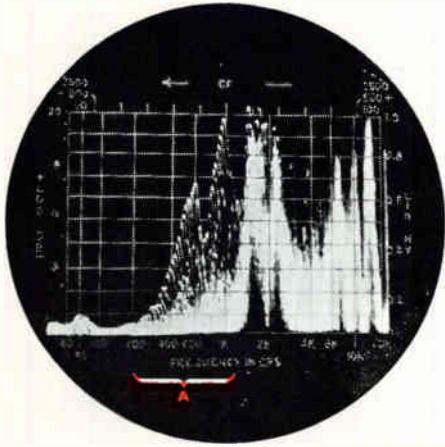
Detroit, Michigan  
57 Harper Avenue  
TRinity 3-6560

**DELCO**  
RELIABILITY  
**RADIO**  
RELIABILITY

Division of  
General Motors  
Kokomo, Indiana



# fast, direct-reading, easy-to-use



"Coast-down" analysis of Gyro Motor by Model LP-1a Spectrum Analyzer. Area A shows decreasing fundamental frequency, resonant rise and decay, and vibration components over 60 successive scans in one minute.

The Model LP-1a "quick-look" helps locate and evaluate discrete or random signals faster and easier by scanning the entire spectrum logarithmically from 40 cps to 20 kc. Once every second it automatically separates, measures and plots the frequency and voltage of waveform components on the calibrated X and Y axes, respectively, of a long persistence 5" CRT.

For very detailed analysis, linear segments 40 to 5000 cps wide, centerable between 0 and 20 kc, may be magnified on the screen. Amplitude ratios of up to 40 db can be simultaneously measured.

**High sampling rate and panoramic displays assure**

- 1 Minimum risk of missing weak signals or spectrum holes.
- 2 Fast measurements by eliminating slow point by point plots.
- 3 Simultaneous measurement of signals with widely divergent amplitudes and/or frequencies.
- 4 Continuous analysis of rapid changes in spectral content or design parameters.

Proved in hundreds of research, design and production installations, the LP-1a is a valuable tool for Noise and Vibration analysis. Harmonic and IM measurements. • General waveform studies. • Power Spectral Density analysis. • Response Curve Tracing.

## SUMMARY OF SPECIFICATIONS:

**Frequency Range:** 20 cps—22.5 Kc.

- (1) Preset linear frequency scans: any segment width of 200, 1000, 5000 cps centerable from 0-20 Kc : Variable from 40 cps to 5000 cps with Auxiliary Function Unit C.
- (2) Preset Log Scan—40 cps to 20 Kc

**Frequency Scales:** Linear and Log

**Center Frequency Control:** Calibrated 0-20 Kc (used on lin scan)

**Dynamic Range:** 60 db

**Amplitude Scales:** Linear and 2 decade log (Expandable to 60 db)

**Sensitivity:** 500  $\mu$ v to 500 v for full scale linear deflection

**Voltage Accuracy:** Lin Sweep (40 cps—22.5 Kc) :  $\pm 5\%$  or  $\pm 0.5$  db.  
Log Sweep (40 cps—20 KC) :  $\pm 10\%$  on lin ampl. scale,  $\pm 1.5$  db on log ampl. scale.

**Scan Rate:** 1/sec., internally generated; adjustable with accessory equipments

**Resolution:** For log scan, automatically optimized. For lin scan, preset 30, 75 and 170 cps at 200, 1000 and 5000 cps sweep-width, respectively. Variable from 10 cps to 1 kc with Auxiliary Function Unit C.

# PANORAMIC LP-1a

## SONIC SPECTRUM ANALYZER

### 20 cps-22.5 kc.

#### HIGHLIGHT FEATURES:

- 1-sec. "quick-look" at entire spectrum (40 cps—20 kc)
- Magnified analysis on reduced sweep widths
- Direct reading frequency—selective voltmeter
- Exceptionally stable circuitry; better than 5 cps/hr.
- Economical
- Simple Operation

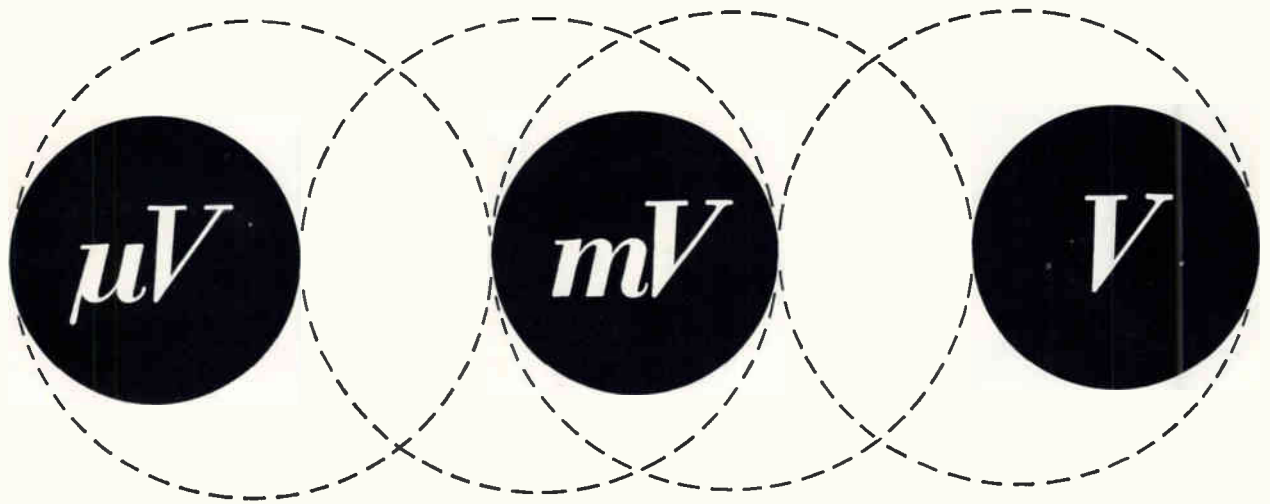


Write, wire or phone NOW for detailed information and specifications on the Model LP-1a.

Ask for Vols. 1, 2 and 5 of the "Panoramic Analyzer" . . . featuring applications and techniques of Spectrum Analysis, and get on our regular mailing list for this helpful publication. NEW CATALOG DIGEST AVAILABLE

**PANORAMIC RADIO PRODUCTS, INC.**  
530 South Fulton Avenue, Mount Vernon, N.Y. • Phone: OWens 9-4600  
TWX: MT-V-N.Y.-5229 • Cables: Panoramic, Mount Vernon, N.Y. State





# electronic millivoltmeters

## internal calibration

It should be noted that all Philips electronic voltmeters contain calibration standards which enable the user easily and rapidly to check, and, if necessary, to re-calibrate his voltmeter at any time without the use of additional instruments.

### VHF Voltmeter, type GM 6025

**Frequency range:** 0.1 Mc/s - 800 Mc/s  
flat from 1 Mc/s - 300 Mc/s  
-1 dB at 0.1 Mc/s  
+1 dB at 800 Mc/s

**Measuring range:** 10 mV (f.s.d.) - 10 V divided into 7 ranges in a 1-3-10 sequence

**Overall accuracy:** <5% with respect to full scale

**Input resistance:** 65 kΩ at 1 Mc/s ; 50 kΩ at 100 Mc/s ;  
35 kΩ at 200 Mc/s

**Input capacitance:** 1 μF

**Replacement of the probe crystal:**  
the probe crystal can be easily replaced and the instrument rapidly re-calibrated by the user

For measurements on 50 Ω -coaxial lines the T-connector, type GM 6050T, can be ordered



# PHILIPS *electronic measuring*

Sold and serviced by Philips Organizations all over the world

Further information will gladly be supplied by:

**N.V. Philips' Gloeilampenfabrieken, EMA-Department, Eindhoven, the Netherlands**

For Canada: Philips Electronics Ind. Ltd., 116 Vanderhoof Ave., Toronto 17, Ont.



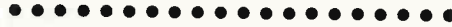


### DC Microvoltmeter, type GM 6020

	input I	input II
<b>Measuring range:</b>	100 $\mu$ V (f.s.d.) - 10 V in 11 steps	10 mV (f.s.d.) - 1000 V in 11 steps
<b>Input impedance:</b>	1 M $\Omega$ ( $\pm$ 1.5%) in parallel with 20 $\mu$ F	100 M $\Omega$ ( $\pm$ 1.5%) in parallel with 10 $\mu$ F
<b>Overall accuracy:</b>	with respect to full scale $\pm$ 3%	
<b>Pre-deflection:</b>	< 5 $\mu$ V	
<b>Drift:</b>	1 $\mu$ V per hour after 1 hour of warming-up	

Automatic polarity indication

DC currents may be measured directly from 100  $\mu$ A (f.s.d.) up to 10  $\mu$ A



### LF Millivoltmeter, type GM 6012

<b>Frequency range:</b>	2 c/s - 1 Mc/s
<b>Measuring range:</b>	1 mV (f.s.d.) - 300 V in 12 steps
<b>dB scale:</b>	-80 dB up to +52 dB (0 dB = 1 mW into 600 $\Omega$ )
<b>Input impedance:</b>	4 M $\Omega$ in parallel with 20 $\mu$ F (up to 3 V); 10 M $\Omega$ in parallel with 10 $\mu$ F (in the other ranges)
<b>Overall accuracy:</b>	with respect to full scale $\pm$ 2.5%, 5 c/s - 100 kc/s $\pm$ 5%, 2 c/s - 1 Mc/s
<b>Pre-deflection:</b>	< 100 $\mu$ V



### HF Millivoltmeter, type GM 6014

	without pre-attenuator	with pre-attenuator
<b>Frequency range:</b>	1 kc s-30 Mc s	10 kc s-30 Mc/s
<b>Measuring range:</b>	1 mV (f.s.d.) - 300 mV in 6 steps	100 mV (f.s.d.) - 30 V in 6 steps
<b>dB scale:</b>	-80 dB up to -8 dB	-40 dB up to +32dB
<b>Damping at 10 kc/s:</b>	1 M $\Omega$	50 M $\Omega$
	1 Mc/s: 700 k $\Omega$	10 M $\Omega$
	30 Mc/s: 50 k $\Omega$	2 M $\Omega$
<b>Input capacitance:</b>	7 $\mu$ F	2 $\mu$ F
<b>Pre-deflection:</b>	compensated by electrical zero setting	

#### Variations of the frequency characteristic:

< 5% over the whole range, with respect to the response at the frequency of the calibration voltages

**Overall accuracy:**  $\pm$  3% with respect to full-scale and with reference to the frequency characteristic

*instruments:*

*quality tools for industry and research*





The lower end of the frequency spectrum has become a focal point for important motion studies involving submarines, ships, helicopters, trains, and automobiles. Honeywell's latest contribution in this area is the LAR 7500 Magnetic Tape System. By combining savings in manpower and tape with increased flexibility in playback speeds, the LAR 7500 brings new economy and convenience to long-

term studies of low frequency phenomena.

This system is the ideal recording tool for motion studies extending down to zero frequency. Time base changes can be provided on playback within a range of *real time to 1000:1*. In addition, the LAR 7500 lets you playback over a large range of speeds *without changing heads, belts, or*

*pulleys*. And with the use of thin base tape, this system gives you better than *two days of motion recording* with each 14" reel.

Get all the facts on the new LAR 7500 Magnetic Tape System by calling your nearby Honeywell field engineer. He'll give you valuable assistance in matching a Honeywell data system to your exact requirements. Be sure to ask about the Honeywell Automatic Wave Analyzer Systems for accurate and high-speed analysis of recorded data.

MINNEAPOLIS-HONEYWELL, Industrial Systems Division,  
10723 Hanna  
Street, Beltsville,  
Maryland.

# Honeywell

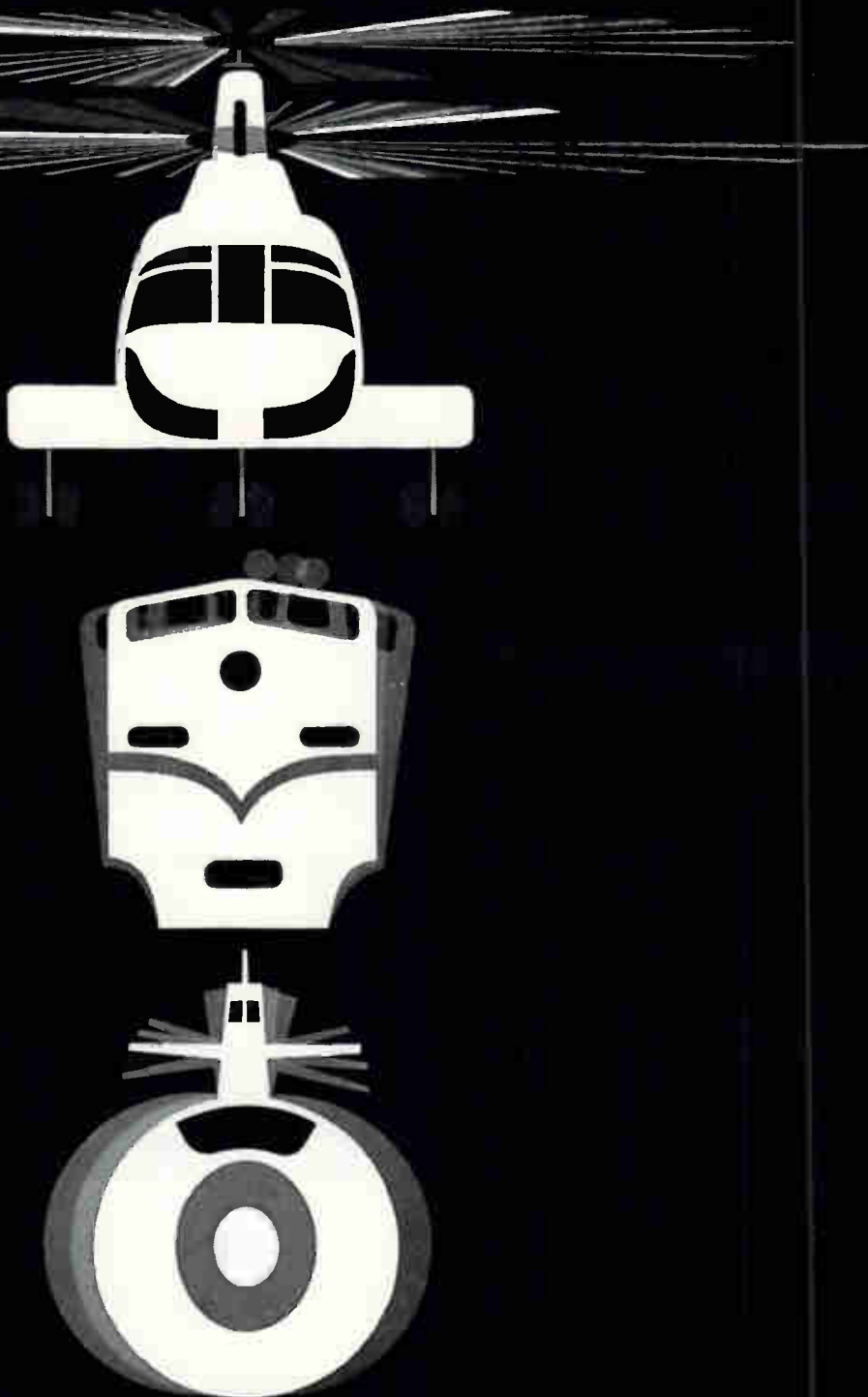


*First in Control*

SINCE 1885

HONEYWELL INTERNATIONAL Sales and service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan:

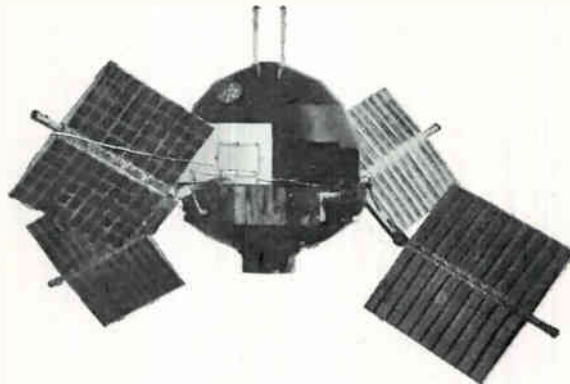
THE  
STRANGE  
LANGUAGE  
OF  
MOTION







THREE AND ONE-HALF TIMES ACTUAL SIZE.



**DESIGNED ESPECIALLY FOR MISSILE CIRCUITRY AND MAXIMUM RELIABILITY APPLICATIONS**

**CANNON GOLDEN-D SUBMINIATURE PLUGS**

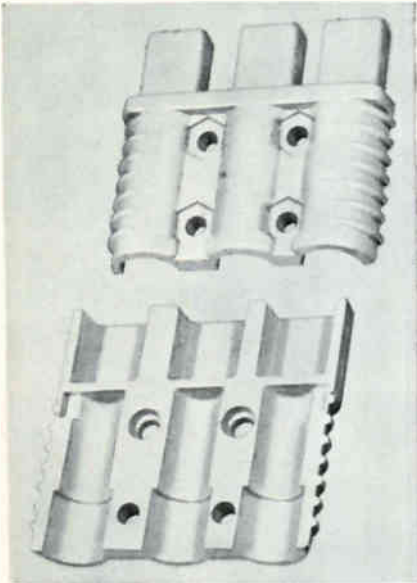
The "Golden-D" Cannon Plugs are engineered to deliver superior performance in a subminiature size! Supplementing our famous standard D-Subminiature line, the "Golden-D" has these new design features: • MONO-BLOC INSULATORS • PROBE-PROOF CLOSED-ENTRY SOCKET CONTACTS • LOW ENGAGEMENT/SEPARATION FORCES • GOLDEN CADMIUM SHELL FINISH • MATES WITH ANY CANNON "D" OF SAME SIZE AND LAYOUT. Wherever maximum reliability is needed in a subminiature multi-contact plug—for both military and industrial applications—ask for the new "Golden-D" ... another reason why you should contact the world's most experienced plug manufacturer for *all* your plug requirements. The "Golden-D" is available in four types with a large variety of contact layouts. For further information write to:



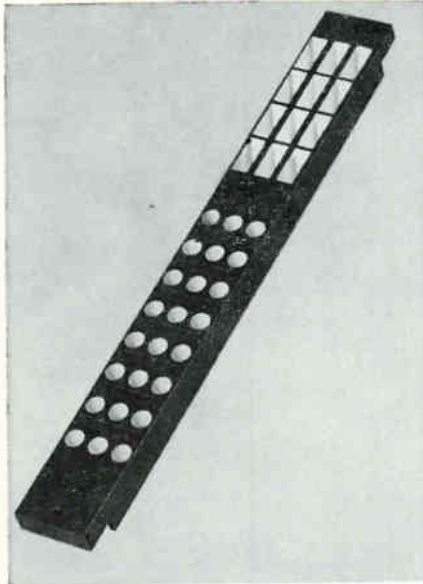
**CANNON ELECTRIC COMPANY, 3208 Humboldt St., Los Angeles 31, Calif.**

# G-E LEXAN® POLYCARBONATE RESIN

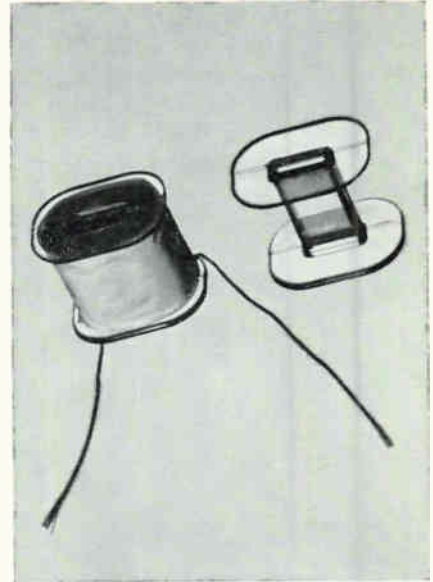
## TOUGHEST OF PLASTICS!



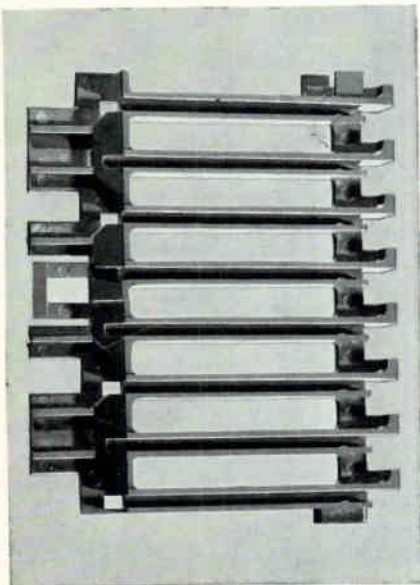
**STRENGTH** LEXAN resin has an impact strength of more than 12 foot-pounds per inch of notch — higher than any other plastic! This toughness, plus heat resistance and good electrical properties, make LEXAN resin an outstanding choice for 3-pole connectors used in rugged service on electric trucks.



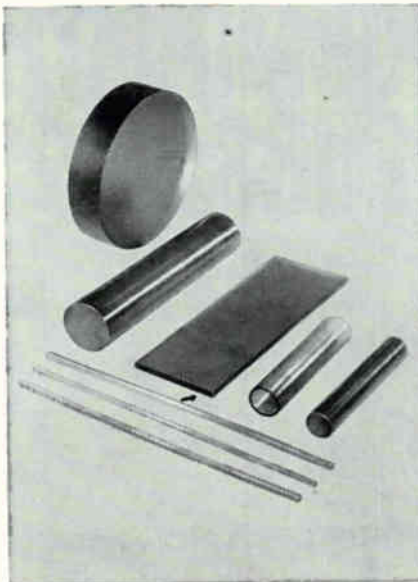
**HEAT STABILITY** Lampholder terminal block is used inside electronic equipment where heat is difficult to dissipate. LEXAN polycarbonate resin replaced another thermoplastic which melted under severe thermal conditions. LEXAN has a heat distortion point as high as 290°F. Also keeps high strength in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



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



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



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

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

**LEXAN®**  
Polycarbonate Resin

**GENERAL  ELECTRIC**



# Arnold SOLID STATE POWER SUPPLIES

- small, lightweight, and regulated . . . designed to meet MIL-E-5272B
- 100% tested for reliability
- Sine wave, square wave or DC outputs
- Quick delivery on units below



## DC TO SINE WAVE *Model KB* (Stock Item)



Input Voltage: . . . . . 24-30 VDC  
 Output Voltage: . . . . . 115 VRMS  
 Output Frequency: . . . . . 400 cps  
 (other frequencies available)  
 Output Power: . . . . . 50 volt-amps  
 Frequency Regulation: . . . . . 0.3% for 6 V  
 line variations  
 Harmonic Distortion (Total): . . . . . 2% at  
 specified load (4% max.)  
 Size and Weight: . . . . . 2 1/2" x 4" x 2 1/2"  
 high; 26 oz.

## DC TO DC *Model 591HC*



Input Voltage . . . . . 24-30 VDC  
 Output Voltage Range . . . . . from 6 VDC  
 to 3500 VDC  
 Output Power . . . . . 60 watts (max.)  
 regulated  
 Regulation . . . . . ±1.0% for 6 V line  
 variations;  
 ±1.5% for 50% load  
 variations  
 Ripple . . . . . 0.3% RMS  
 Size and Weight . . . . . 3" OD x 3 3/8" high;  
 22 oz.

## DC TO SQUARE WAVE *Model 591ACB*



Input Voltage . . . . . 24-30 VDC  
 Output Voltage Range . . . . . 1.0 to 3500  
 VRMS, square wave, 400  
 cps (other frequencies  
 available)  
 Output Power . . . . . 50 V. A.  
 Regulation . . . . . Frequency and Voltage:  
 ±1.0% for 6 V line  
 variations; ±1.0% for  
 50% load variations  
 Size and Weight . . . . . 3" OD x 3" high;  
 19 oz.

Constant frequency, voltage and output as battery discharges. Units withstand short circuit, reversed polarity and input voltage transients of 60 volts. Load power factors as low as 0.2 (lead or lag) may be applied.

Literature with performance curves sent on request. Literature includes "easy to order" information—no need to write complicated specifications.



**ARNOLD MAGNETICS CORP.**  
 6050 W. Jefferson Blvd., Los Angeles 16, Calif.  
 Vermont 7-5313

CIRCLE 211 ON READER SERVICE CARD

April 14, 1961

# In RF connectors

**GREMAR**

is **FIRST** in

**VERSATILITY!**

## MOST COMPLETE LINE!

Greomar makes more series of RF connectors and components than are available from any other source . . . and then some! Greomar exclusives include *Red Line* miniature RF connectors for use with MIL-type sub-miniature coaxial cables; power dividers; impedance transformers . . . and others.

## MOST COMPLETE STOCKS!

Greomar always has more than 750,000 assembled RF connectors of more than 2000 types on the shelf . . . plus over 8,000,000 component parts always ready for speedy assembly of standard connectors or quick adaptation to your special requirements.

## MOST COMPLETE SERVICE!

Because Greomar connectronics® concentrates engineering, production and quality control on RF connectors and components only, you can depend on Greomar to solve your design, delivery and reliability problems quickest. Try us and see. Address your inquiry to:



descriptive literature  
 available on request



**GREMAR**

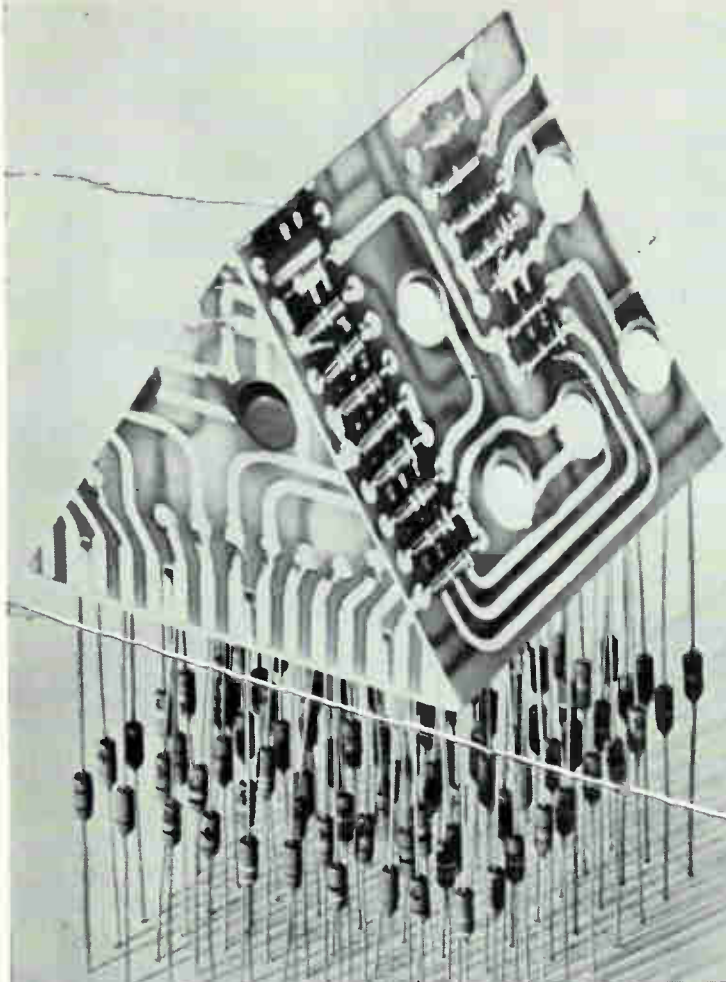
MANUFACTURING COMPANY, INC.  
 RELIABILITY THROUGH QUALITY CONTROL

Dept. A

Wakefield, Mass., CRystal 9-4580

CIRCLE 53 ON READER SERVICE CARD

53



**NOW—FROM THE HOUSE OF ZENERS\***

# Hoffman GLASS SILICON REFERENCE DEVICES TYPES 1N935-1N939

Hoffman now offers you a subminiature series of temperature-compensated silicon zener reference devices with a temperature coefficient ranging from  $\pm .01$  through  $\pm .0005$  percent per degree centigrade. Designated types 1N935-1N939, these new units are hermetically sealed in the industry-preferred 500mW glass package. They meet the stringent environmental and life test requirements of MIL-S/19500B and are easily adaptable to all forms of circuitry, including printed boards and subminiature modules.

#### ELECTRICAL CHARACTERISTICS AT 7.5 mA

EIA Type Number	Voltage Range @ 7.5 mA and @ 25° C. Ambient Volts	Voltage-Temperature Coefficient %/°C.	Temperature Range Reference 25°C. (°C)	Maximum Dynamic Resistance (Ohms)†
1N935	8.55 - 9.45	$\pm .01$	0 to +75	20
1N935A	8.55 - 9.45	$\pm .01$	-55 to +100	20
1N935B	8.55 - 9.45	$\pm .01$	-55 to +150	20
1N936	8.55 - 9.45	$\pm .005$	0 to +75	20
1N936A	8.55 - 9.45	$\pm .005$	-55 to +100	20
1N936B	8.55 - 9.45	$\pm .005$	-55 to +150	20
1N937	8.55 - 9.45	$\pm .002$	0 to +75	20
1N937A	8.55 - 9.45	$\pm .002$	-55 to +100	20
1N937B	8.55 - 9.45	$\pm .002$	-55 to +150	20
1N938	8.55 - 9.45	$\pm .001$	0 to +75	20
1N938A	8.55 - 9.45	$\pm .001$	-55 to +100	20
1N938B	8.55 - 9.45	$\pm .001$	-55 to +150	20
1N939	8.55 - 9.45	$\pm .0005$	0 to +75	20
1N939A	8.55 - 9.45	$\pm .0005$	-55 to +100	20
1N939B	8.55 - 9.45	$\pm .0005$	-55 to +150	20

† Measured by superimposing .75 mA rms AC on 7.5 mADC

**\*70% of All Zener Reference Devices Ever Made Are Hoffman Made!**

As the company which introduced the first commercially available silicon zener diode back in 1953, Hoffman is your logical source of dependable zener devices. Among other notable Hoffman "firsts" in this field was the development, in 1955, of the 1N430 zener reference element, a revolutionary device able to maintain a constant voltage over a wide temperature range. Two years later, Hoffman developed the then unique 1N1530 to meet the demand for miniaturization and for printed circuit applications. Now Hoffman brings its experience, the most extensive in the field, to the Types 1N935-1N939.



Type 1N430, introduced by Hoffman in 1955. Type 1N1530, introduced by Hoffman in 1957.

Hoffman experience and reliability are yours in the industry's widest selection of zener devices for limiting, clipping, reference, or regulation. You can depend upon the leader, the pioneer—HOFFMAN.

Hoffman's types 1N935-1N939, introduced in 1961.

## Hoffman / ELECTRONICS CORPORATION

Semiconductor Division



930 Pltner Avenue, Evanston, Illinois  
Phone: UNIVERSITY 9-2400 TWX: Evanston, Illinois 338  
Plants: El Monte, California and Evanston, Illinois





G-E Inductrol regulators accurately hold a constant load voltage where incoming supply variations or load fluctuations exist, or provide an adjustable output voltage for any range desired.

Inductrol regulators provide highly accurate, highly reliable voltage control for BMEWS.

GENERAL ELECTRIC INDUCTROL\* REGULATORS PROVIDE . . .

## Precise, automatic voltage control for Free World's largest radar installation

*Automatic  $\pm 1\%$  accuracy . . . stepless control . . . maximum reliability.* These are just some of the voltage-control requirements for the U.S. Air Force's giant Ballistic Missile Early Warning System (BMEWS). General Electric Inductrol regulators meet them *all* in providing precise voltage control for both the BMEWS high-voltage transmitter and receiver power supplies.

**INDUCTROL REGULATORS** offer you these advantages, too, for a wide variety of applications—including radar, communications equipment, rectifiers, computers, laboratory equipment and many others. You also benefit from these other important Inductrol regulator features: drift-free control; 100 percent overload capacity; 97 to over 99 percent efficiency; load, power-factor and frequency compensation; no harmful waveform distortion; and rugged, compact design.

**RELIABILITY** is inherent in the simple induction principle of General Electric's Inductrol regulator design. There are no tubes to replace, no sliding brushes or contacts to wear out, and no separate d-c power supply. Thus, operation is essentially maintenance-free.

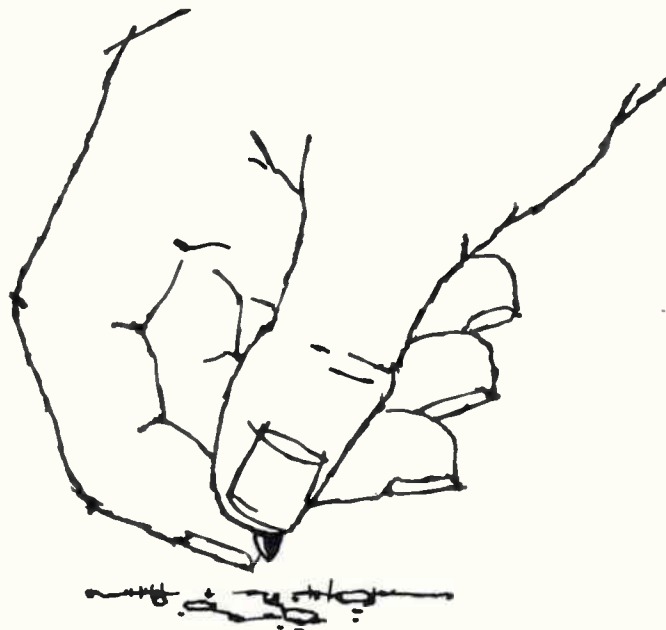
**FOR MORE INFORMATION**, contact your nearby G-E Sales Office, or write General Electric Company, Section 457-04, Schenectady 5, N. Y. *Voltage Regulator Products Section, Pittsfield, Mass.*

*\* Registered trade-mark of General Electric Co.*

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

CIRCLE 55 ON READER SERVICE



## planting for tomorrow

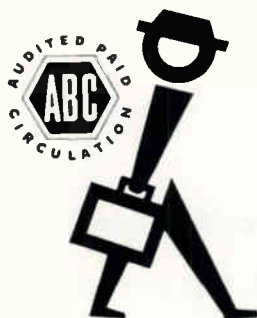
You've heard of the "hard sell" and the "soft sell" — but many of our advertisers are also interested in the "long sell".

This is *planned* advertising. You might call it "planting for tomorrow".

The sales seed in an advertising message bears abundant fruit if sown in fertile ground . . . readers of this publication, for example, who, in *buying* this issue, have demonstrated their interest in what we have to say.

As a member of the Audit Bureau of Circulations\*, our circulation records have been audited and the facts published — by this impartial organization of advertisers, advertising agencies, and publishers. These bedrock facts about our circulation audience can help you to plan more productive advertising.

Is your own planned selling based on circulation facts? You can be ABC-sure. Ask to see a copy of our latest circulation report.



# electronics

A MCGRAW-HILL PUBLICATION • 330 W. 42nd ST. • NEW YORK 36, N. Y. 

\* Through the reports issued by the Audit Bureau of Circulations, this publication, along with other publisher members of ABC, voluntarily and regularly give the buyers of advertising more verified factual information than is available for any other advertising media at any time.



# NEW

## ELECTROSTATIC FOCUS & DEFLECTION VIDICON

*Provides new degree of  
freedom in TV camera design*

GEC's new 7522 electrostatic focus and deflection vidicon was developed to fill the need for smaller, lighter, more versatile image pickup tubes.

External components for magnetic focus and deflection have been eliminated and total power requirements for beam focusing and deflection have been reduced to less than 100 milliwatts.

The GEC 7522 is capable of any type scan . . . sawtooth to spiral, over a wide and variable range of frequencies.

The ruggedized version, the GEC 1343, was developed for aircraft and missile environments. Electrical characteristics are identical to the 7522.



### *features:*

- ★ Resolution 500 Lines
- ★ Accelerating Voltage 300v
- ★ Deflection Voltage 30v per plate
- ★ Sensitivity .090 microamps/micro-watts radiant energy at 4800A
- ★ Operates with completely transistorized circuits
- ★ Size 7522 1"x6-1/4"  
1343 1"x5-5/8"
- ★ Availability From Stock

*For further information on this revolutionary new GEC Vidicon development, as well as our complete line of pickup, scan conversion, and image conversion tubes, write today for information.*

*. . . .where tube research begins*



**GENERAL ELECTRODYNAMICS CORPORATION**

4430 FOREST LANE • GARLAND, TEXAS

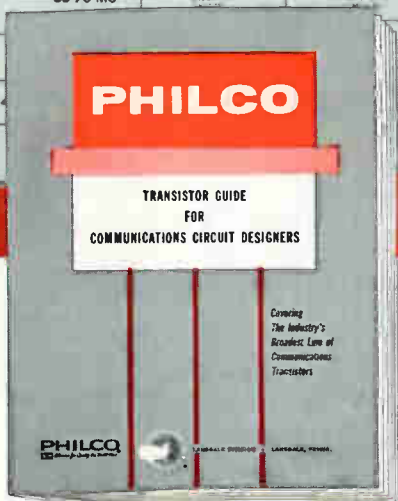
April 14, 1961

CIRCLE 57 ON READER SERVICE CARD 57

# The industry's broadest line of COMMUNICATIONS TRANSISTORS

## PHILCO COMMUNICATIONS TRANSISTORS

Frequency	RF Amplifiers	RF Amplifiers	Mixers and Converters	Low-Level Oscillators	High-Level Oscillators	Multipiers	Audio or Video Amplifiers
0-20 KC							2N223 2N224 2N225 2N387 2N407 2N1120 2N335 2N597 2N600
20 KC-2 MC	2N1788 2N1785 2N1790 2N1807 2N273 2N344 2N346	2N1728 2N1747 2N1865 2N1864 2N1867 2N1750 2N1877 2N1878 2N346 2N393	2N1727 2N1786 2N1789 2N1877 2N177 2N344 2N346 2N346	2N1797 2N1785 2N1789 2N344 2N346 2N1787 2N773	2N155A 2N1867 2N597 2N1267 2N773	2N1867 2N1267 2N773	2N597 2N600 2N1787 2N773 2N388 2N1748A 2N1749
2-10 MC	2N1747 2N1867 2N1746 2N1267 2N346	2N1747 2N1746 2N1858 2N1866 2N1867 2N1267 2N773 2N346	2N1746 2N1747 2N1866 2N1867 2N1867 2N1867 2N773 2N346	2N1746 2N1267 2N773 2N773 2N346	2N155A 2N1867 2N1267 2N773	2N1747 2N1867 2N1267 2N773	2N1267 2N773 2N1748A 2N1749 2N1245 2N1270 2N776 2N502A
10-30 MC	2N1743 2N1747 2N1867 2N502A 2N1746 2N773	2N1743 2N1867 2N1747 2N1867 2N1746 2N773	2N1743 2N1867 2N1747 2N1867 2N1746 2N773	2N1743 2N1867 2N1747 2N1867 2N1746 2N773	2N155A 2N1270 2N776	2N1744 2N1747 2N1867 2N1270 2N776 2N1188A	2N1745 2N502A 2N1742 2N1270 2N776
30-70 MC	2N1743 2N1745 2N1746 2N1747 2N1748	2N1743 2N1745 2N1746 2N1747 2N1748	2N1743 2N1745 2N1746 2N1747 2N1748	2N1743 2N1745 2N1746 2N1747 2N1748	2N155A 2N1270 2N776	2N1744 2N1746 2N1747 2N1748 2N776	2N1742 2N502A 2N1740 2N776 2N600



You'll find one Exactly Right for your requirements

Whatever your specific requirements . . . in gain, noise figure, AGC and other electrical characteristics . . . you'll find a Philco communications transistor that meets your needs precisely.

Unlike other manufacturers, who offer only limited lines of "general-purpose" transistors, Philco designs and produces transistors to meet specific requirements. Philco can do this only because the exclusive Philco Precision-Etch\* process of manufacture permits precise control of all parameters and absolute uniformity.

To increase circuit efficiency and reliability, to reduce cost and to make your design easier . . . look first to the Philco line, which offers you the industry's widest range of communications transistors. You'll find one *exactly right* for your requirements.

\*Trademark Philco Corp.

### NEW! Transistor Guide for Communications Circuit Designers

To make it faster and easier for you to find the Philco communications transistor that best meets your needs, put this new guide to work for you. 12 pages of application information, descriptions of major types and a complete selector chart will speed your work. For your copy, write Dept. E41461.

Philco Transistors are immediately available in quantities 1-999 from your Philco Industrial Semiconductor Distributor.

# PHILCO®

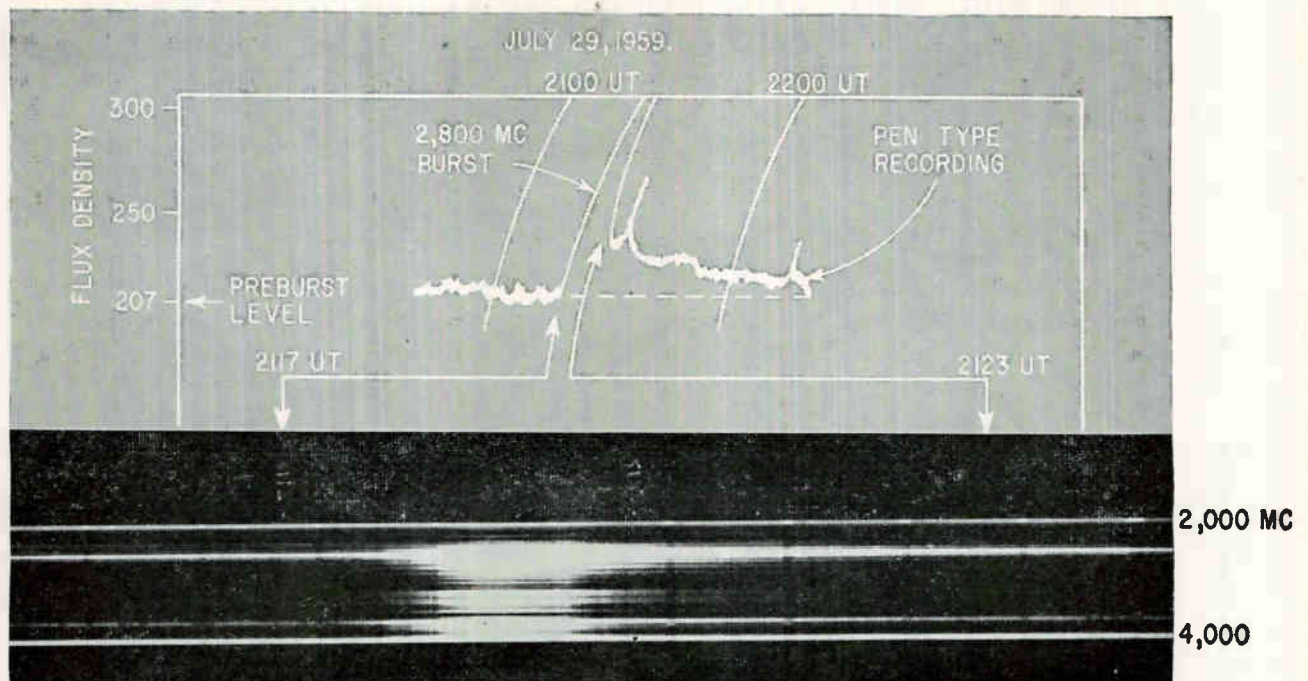


Famous for Quality the World Over

LANSDALE DIVISION • LANSDALE, PENNSYLVANIA







Strip film recording made with swept frequency receiver (bottom) compared with pen type spot frequency recording (top) showing typical solar storm

# Microwave Swept Receiver Uses Zero Intermediate Frequency

*Swept frequency receiver allows observation and display across a broad microwave frequency spectrum. Use of a zero frequency i-f improves the noise figure, eliminates images and permits use of simple video i-f amplifiers*

By DWIGHT W. CASEY II,  
Senior Engineer,  
Kellogg Space Communications  
Laboratory, IIT, Fort Wayne, Indiana

PREVIOUS swept-frequency solar radiation measurements were conducted to frequencies of approximately 600 Mc<sup>1</sup>, while S-band measurements have been carried out on a spot-frequency basis<sup>2</sup> only. The S-band swept receiver permits continuous reliable measurement of solar radiation throughout the range

of 2,000 to 4,000 Mc. The system was designed and built for the Observatory of the University of Michigan, Ann Arbor, Michigan, under contract 311929 (NONR-1224(16)).

The S-band swept receiver is a wide-band superheterodyne with an electronically swept local oscillator and zero-frequency i-f. A sweep rate of 10 cps is provided, although the receiver can be switched to manual operation for spot frequency observations. Some features of the

receiver include high sensitivity (-97 dbm for a 5-Mc r-f bandwidth), extreme gain stability with time and uniformity over the band, minimum noise figure, maximum noise figure versus frequency stability, elimination of image-frequency rejection through the use of zero-frequency i-f and accurate noise figure and system gain calibration.

The equipment consists of an r-f head, high-voltage sweep control unit and control and display racks.

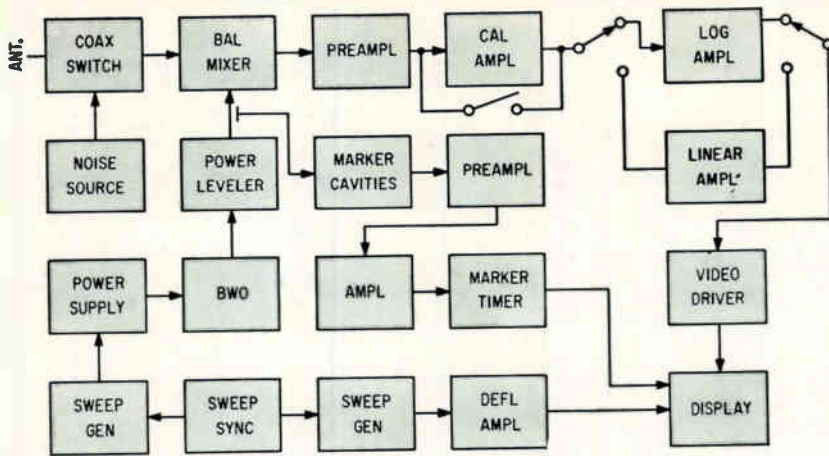


FIG. 1—Block diagram of the S-band swept receiver

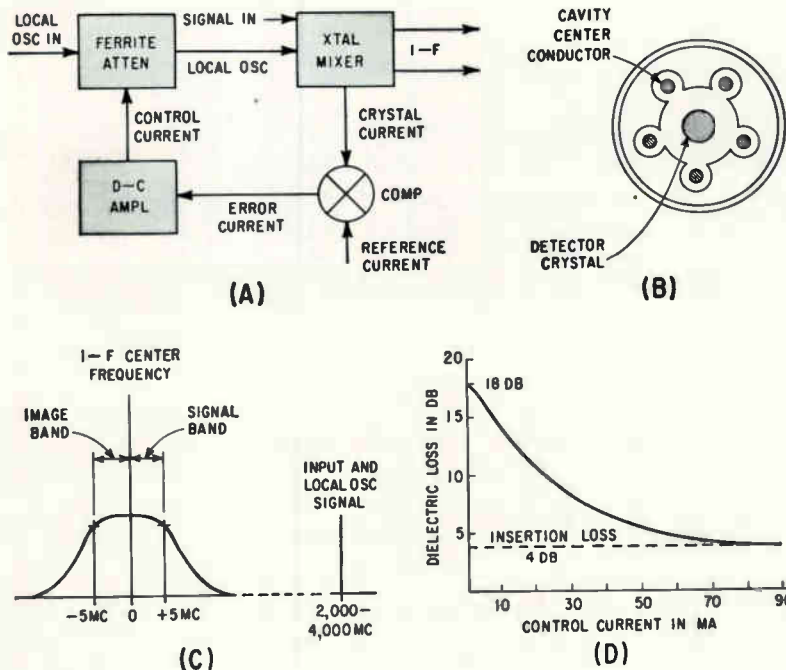


FIG. 2—Crystal current control circuit (A), arrangement of frequency marker cavities (B), i-f bandwidth and center frequency curve (C) and ferrite attenuator loss curve (D)

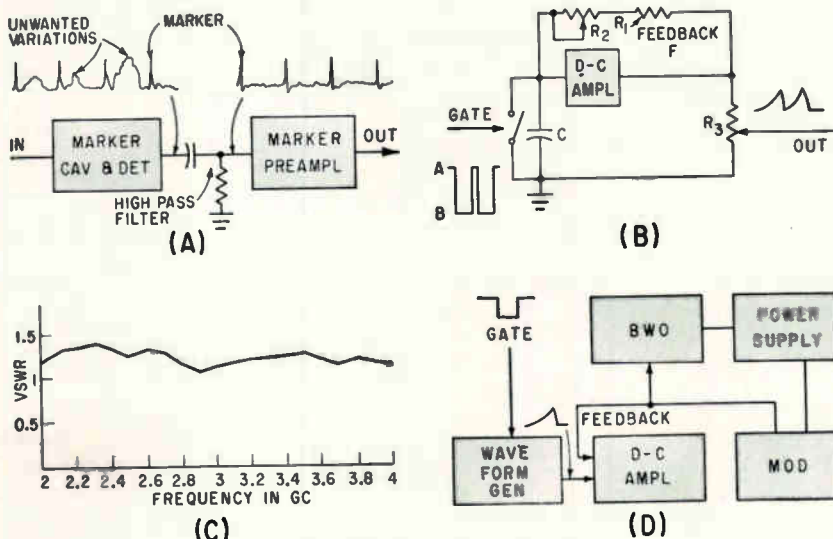


FIG. 3—Marker R-C high-pass filter (A), exponential sweep waveform generator (B), noise source (C) and local oscillator sweep control (D)

A functional block diagram is shown in Fig. 1.

The r-f head unit, packaged for mounting at the feed point of a parabolic-reflector antenna, consists of an S-band calibrated noise source, coaxial switch, balanced hybrid mixer, zero-frequency i-f preamplifier, ferrite-electronic local oscillator power leveler, marker cavities and detector and marker preamplifier. Video and marker signals are transmitted through coaxial cables to the remote control and display racks. The control rack contains a calibration video amplifier, switch-selected log and linear-video amplifiers, video driver amplifier, marker amplifier and timer system, sweep synchronizer, deflection sweep generator and amplifier, system low-voltage power supplies and manual system controls. The display rack holds two high-resolution cathode-ray tubes and high-voltage power supplies and a system low-voltage power supply.

The high-voltage sweep-control unit at the base of the antenna pedestal houses the backward-wave local oscillator and all high-voltage power supplies and control circuits for automatically or manually sweeping or tuning the local oscillator. Local-oscillator power is fed through a low-loss cable to the r-f head.

Protective circuits and devices are provided to guard against equipment failure or malfunction.

The main functions of the r-f head unit are to convert r-f energy to i-f energy and provide for system calibration. The unit also contains marker and video i-f preamplification. Location of the r-f head at the antenna, and i-f preamplification are necessary to maintain minimum system noise figure.

A broadband coaxial switch, with 0.1-db insertion loss and 60-db isolation, couples power to the receiver either from the antenna or from the calibrated noise source. The switch is manually and remotely controlled from the control rack.

A balanced mixer, consisting of a 3-db hybrid directional coupler and 1N21E and ER crystals, accepts signal power from the coaxial switch. Although crystal mounts represented a difficult design problem, the mixer provides a response



that is flat within 0.5 db across the band.

Mixer crystal current is stabilized against conversion loss variations (gain and noise-figure variations) due to local oscillator power fluctuations. An electronic control circuit with a current-sensitive ferrite attenuator insures constant and stable crystal current. The ferrite attenuator is a ferrite dielectric, the conductivity, or loss, of which is determined by an induced electric field. The field strength depends upon the amount of direct, or control, current passed through a coil surrounding the dielectric. Figure 2D is a graph of the dielectric loss, in decibels, as a function of control current in the coil. When the current is zero the attenuator loss is approximately 18 db. At maximum current the loss approaches a constant value of 4 db, this being the insertion loss of the attenuator. Thus, a dynamic S-band attenuation range of 14 db is realized as the control current is varied from 0 to 80 milliamperes.

The crystal current control circuit is shown in Fig. 2A. The current is compared with a predetermined reference current and the error drives a transistorized chopper-stabilized d-c amplifier. The amplifier output current controls the ferrite attenuator. The attenuator, depending on the error polarity, increases or decreases the local oscillator power to the mixer, thus stabilizing the mixer crystal current.

Operation of the mixer is such that the separate i-f outputs are in phase with desired signals, but are 180 degrees out of phase with local-oscillator contributed noise. Signal addition and local-oscillator noise cancellation are performed in the first stage of the zero-frequency i-f preamplifier.

To eliminate the problem of image rejection, zero-frequency i-f techniques are used. Zero-frequency i-f connotes an intermediate center frequency of zero cycles a second or a local-oscillator frequency coincident with that of the incoming signal. Figure 2C is a diagram of bandwidth and center frequency. The signal band extends from zero to 5 Mc (the bandwidth of the video i-f amplifier). The image band ex-

tends from zero to minus 5 Mc. Although the image band still introduces system noise, it now contributes the same desired signal as the signal band. It is as if the image and signals bands were folded, yielding a maximum of 3 db more signal over that of a conventional receiver while causing no increase in the apparent receiver noise level. This method allows up to 3 db improvement in noise figure, eliminates the image rejection problem and permits the use of simple video amplifiers in place of conventional i-f amplifiers.

The separate i-f outputs of the crystal mixer are each transformer coupled to separate video cascode amplifiers. The cascode configuration, consisting of type 6688 tubes triode connected, in both the grounded-cathode and grounded-grid sections, is used to obtain minimum noise-figure. The cascode units share a common load resistor. Desired signals are added while local oscillator noise is cancelled. The lower frequency cutoff of the amplifiers is 75 Kc to prevent the noise-figure deterioration effects of inverse-frequency crystal noise.

The cascode output signal is amplified by two feedback-pair video amplifiers to a level suitable for coaxial-line transmission to amplifiers in the control rack.

Frequency markers are obtained at 500 Mc intervals in S-band from five resonant cavities. The cavities and crystal mount are integrated into a unit that measures  $1\frac{1}{2}$  inches in diameter by  $3\frac{1}{2}$  inches long. The layout consists of a coaxial crystal mount surrounded by five coaxial resonant cavities as shown in Fig. 2B. The resonators (cavities) are inductively coupled to the central coaxial line such that each resonator acts as a bandstop filter at resonance. Each cavity is independently tuned to a marker frequency, hence, the detected output exhibits a sharp dip when the input frequency from the local oscillator sweeps across a cavity frequency.

Since unwanted, although slower, voltage variations appear at the detected output with the markers, an RC high-pass filter shown in Fig. 3A passes the markers and attenuates the slower unwanted varia-

tions. The markers are amplified by the marker preamplifier of three feedback-pair video amplifiers to a level suitable for coaxial-line transmission to the control rack.

A noise source was designed for this equipment using a fluorescent light as a gas discharge tube. The unit consists of a waveguide mount for the discharge tube that impedance matches generated noise to the  $H_{10}$  waveguide mode. A transition from the waveguide mode to coaxial line furnishes a good impedance match over the entire range of 2,000 to 4,000 Mc. The overall vswr of the noise source is shown in Fig. 3C. The noise source is operated from the control rack.

The first noise source tried was the coaxial type using a neon gas discharge tube. Three units of the same model were tried in succession, but each exhibited the same detrimental characteristic. The gas discharge arc was not stable but moved cyclically at 50 Kc. Local oscillator power entering the noise source from the mixer was modulated at this rate and fed back to the mixer whereupon a 50 Kc component was added to the noise entering the preamplifier. This component completely masked the calibration noise. Varying the noise source current and/or changing the gas pressure of the discharge tube had no effect.

To cover the range of 2,000 to 4,000 Mc continuously, a local oscillator of the backward-wave type is swept electronically at 10 sweeps a second in synchronism with the cathode-ray tube display sweep.

A backward-wave oscillator requires that the helix voltage be varied exponentially to insure a linear frequency-time relationship. To provide this characteristic, an exponential waveform generator is used and is shown in Fig. 3B. The generator is a gated bootstrap circuit using positive feedback to derive the exponential waveform. The switch in Fig. 3B is a gated triode. When the gating pulse is at level  $B$  the switch (triode) is open and capacitor  $C$  starts to charge. The rate of charge is determined by the time constant  $(R_1 + R_2)C$  and the amount of positive feedback  $F$ . The amount of feedback is greater than unity and is chosen such that the

charging current increases as a function of time. For the duration of the gating pulse, capacitor  $C$  charges in an increasing exponential manner and the voltage waveform is that shown at the output. During the time the gating pulse is at level  $A$  however, the switch (triode) is closed and capacitor  $C$  rapidly discharges. Potentiometer  $R_2$  controls the charging rate of the capacitor, hence the exponential waveform, insuring the correct sweep waveform for a linear BWO frequency-time variation. Potentiometer  $R_1$  is a sweep amplitude control; the amplitude being variable from zero to 30 volts. Adjustments  $R_2$  and  $R_1$  permit replacement of BWO's whose characteristics vary somewhat from tube to tube while maintaining a linear frequency sweep to within  $\pm 5$  percent.

Since the sweep voltage range is about  $-3,000$  volts, a fixed high-voltage power supply ( $-4,000$  volts maximum and regulated to 0.1 percent) is provided. A block diagram of the backward-wave oscillator control is shown in Fig. 3D. The backward-wave oscillator and sweep control tube (modulator) are series connected across the high-voltage supply. The collector of the backward-wave oscillator is at ground potential while the cathode of the modulator, a constant-current device, is returned to the high-voltage tap. Thus the helix voltage of the backward-wave oscillator is controlled by varying the control-grid level and hence the plate voltage of the modulator. To accomplish this in a stable manner, a d-c amplifier is provided between the bootstrap waveform generator and the sweep-control tube (modulator), with voltage feedback from the backward-wave oscillator cathode to the input of the d-c amplifier. A large amount of d-c, and sweep signal stabilization is realized, thus insuring minimum frequency drift and maximum sweep linearity.

Power-supply ripple and control-loop pickup have been minimized to prevent undesirable frequency modulation of the backward-wave oscillator power output. The output power, which varies approximately 8 to 10 db over the frequency range, is coaxially coupled to the r-f head.

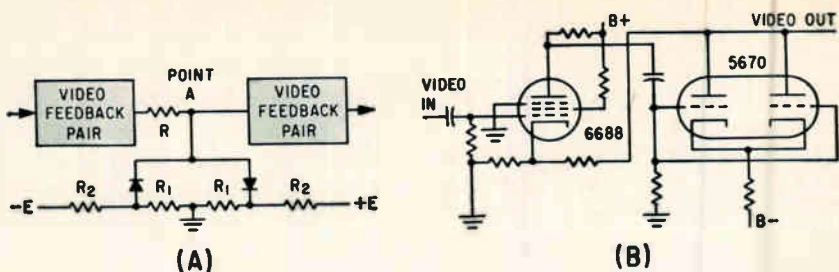


FIG. 4—Interstage diode gain switching circuit (A) and typical video feedback pair (B)

Extensive use of protective devices and circuits in the local oscillator sweep control unit prevents damage to the backward-wave oscillator and power supplies due to primary power interruptions or component failures.

Video signals from the r-f head unit are amplified by a cable-terminating unit, logarithmic or linear video amplifiers and a video driver unit. The output of the video driver is sufficient to drive the grid of the cathode-ray display tube. All amplifiers feature feedback-pair construction to insure a maximum of gain stability as a function of time. Figure 4B represents a typical feedback pair. Types 6688 and 5670 tubes make up the feedback pairs in all but a few instances where the type 5687 tube is substituted to accommodate high signal levels. The tubes have a minimum transconductance variation with time thus contributing toward long-time gain stability. The 6688 tube is connected as a pentode amplifier for maximum gain. The output of the 6688 is capacitively coupled to the 5670. The 5670 triode uses both triode sections in parallel for maximum  $g_m$  and minimum  $r_p$  to obtain a wide bandwidth at a voltage gain of approximately 2 to 1. Cathode degeneration is used in the triode amplifier to further stabilize the transconductance. Negative voltage feedback is obtained by directly coupling the plate circuit of the triode amplifier to the cathode circuit of the 6688. The feedback factor is the ratio of the 6688 cathode resistor to the plate load resistance of the 5670. A feature of the incorporated pair, due to the large amount of negative voltage feedback, is low dynamic output impedance.

Since the video bandwidth cannot be stabilized with feedback-pair techniques, each amplifier is main-

tained at approximately 3 to 4 times the overall video bandwidth. The cable-terminating amplifier contains three stable LC low-pass filters of constant- $k$  configuration that provide accurate selectable video bandwidths of 5.0 Mc, 2.5 Mc and 1.0 Mc. Thus, passive filters maintain stable system bandwidths independently of amplifier bandwidth variation.

The logarithmic amplifier, designed by a derived mathematical technique, compresses a 60 db input range to a 20 db output range, approximately a true logarithmic characteristic within  $\pm 1$  db. Type 6688 and 5670 tubes are used as feedback pairs (see Fig. 4B), the amplifier consisting of seven pairs. Interstage diode gain-switching techniques provide the compression characteristic. A typical diode interstage is shown in Fig. 4A. Two diodes are provided for bipolar compression. The diodes are normally biased to the off condition by voltage divider resistors  $R_1$  and  $R_2$ . The diode bias voltages are equal, but of opposite polarity, and correspond to the signal level (point A) at which the diodes will conduct. At signal levels below that required for conduction, the diodes are cut off, presenting a high impedance, and the interstage signal voltage loss is negligible. However, when the signal exceeds the bias voltage the diodes conduct and assume a low impedance. Since the diode impedance is negligible, the interstage becomes a voltage divider consisting of  $R$  and  $R_1$ , and the ratio  $R_1/(R + R_1)$  determines the compressed signal level at point A.

A maximum amplifier voltage gain of 2,000 (66 db) is realized and a gain control at the amplifier output provides better than 10 to 1 control.

The linear amplifier, for use in the presence of low-level signals,



provides a 40 db dynamic voltage range, linear to within  $\pm 5$  percent. This amplifier consists of seven feedback pairs. Interstage coupling is of the normal RC type. A maximum voltage gain of 18,000 (85 db) is realized and an output gain control covers better than a 10 to 1 range.

The video driver unit consisting of a feedback pair is designed for maximum gain stability and output dynamic voltage range. This feedback pair uses a 5687 dual triode with the triode sections paralleled in place of the 5670 tube. This substitution permits up to 40 volts peak-to-peak linear drive to the display tube. Two outputs are provided, one direct (nonvariable) and the other amplitude controllable over a wide range. The dual output permits simultaneous drive to the display tube and monitoring with a pen-type recorder.

Frequency markers from the marker preamplifier in the r-f head unit are fed to the marker control circuit. Three feedback-pair stages amplify the markers to a level of 5 volts. The signals are then fed to a Schmitt trigger circuit. A trigger sensitivity control is adjusted so that the Schmitt circuit will switch at a trigger level of  $3\frac{1}{2}$  volts. Therefore, the circuit responds to the 5-volt marker pulses but is insensitive to the lower amplitude noise and unwanted variations. The output voltage of approximately 60 volts amplitude is sufficient to drive the blocking oscillator output stage to provide well defined 10 microsecond marker pulses. The low-impedance output, provided with a gain control, is serially connected to a time-coded clock switch that passes the marker pulses at preset time intervals. Since marker signals are mixed with the video information at the output of the video driver amplifier, a series diode prevents undue loading on the driver.

A free-running unsymmetrical multivibrator synchronizer provides time coincidence between the local oscillator and display-tube sweeps. The sweep duration time is 90 milliseconds, while the retrace time is 10 milliseconds yielding a 10 cps sweep rate. One output from the multivibrator gates the sweep circuits for the local oscillator,

while a second provides retrace blanking for the cathode-ray tube. A third output gates the cathode-ray tube horizontal sweep circuit. The sweep generator, a bootstrap design, provides a linear sawtooth voltage at the 10-cps rate. The sweep generator is similar to the exponential waveform generator in that positive current feedback is used. Loop gain is unity and the waveform is a linearly increasing voltage as a function of time. The low impedance output is amplitude adjustable and drives the horizontal deflection amplifier. The deflection amplifier is directly coupled and uses 40 db of negative current feedback. The feedback is required to assure that the horizontal deflection coil drive current is a linear function to within  $\pm 1$  percent of the input sawtooth voltage.

The indicator tube has a resolution of 1,400 lines across the 5 inch face, and is magnetically focused and deflected. Video and marker signals are applied to the control grid to obtain an intensity-modulated display. Since the horizontal display sweep is linear and synchronous with respect to the local-oscillator sweep, the trace is calibrated directly in frequency. The display appears in a moving film as a raster thus adding time as a third dimension. Retrace blanking R is applied to the cathode.

The cathode-ray tube high-voltage power supply is regulated to better than 1 percent and is delay-relay controlled to prevent premature application of high voltage.

For absolute measurement of solar noise power over the entire frequency range, the receiver must be calibrated with respect to absolute noise level or noise temperature. A calibrated S-band noise source, a highly gain stabilized (better than 0.01 db per day) video calibration amplifier and a calibrated switch-type attenuator are used. The calibration system transfers the input to the balanced mixer through the coaxial switch from the antenna to the S-band noise source which has a well defined noise level or temperature. This known noise temperature produces a density on the output recording film. The video amplifier attenuator is decreased in steps of 1 or 2 db and the output levels are

recorded as stepped calibration densities on the film. Recorded film densities due to solar radiation can be compared to the calibration densities, or gray levels, to determine absolute power.

To maintain a relatively stable noise figure and gain characteristic it was necessary to temperature control the r-f head unit because large temperature fluctuations of the mixer cause excessive conversion-loss variations and hence gain and noise-figure fluctuations. Careful design of microwave components is the main contribution to uniform characteristics over the bands while gain-time stability is realized through extreme gain stabilization of all amplifiers.

The first sweep-frequency recording of solar electromagnetic radiation covering 2,000 to 4,000 Mc made by the University of Michigan using the receiver is shown in the lead photo. The data was recorded in 1959 and was substantiated at the same time by A. E. Covington in Ottawa, where it was recorded at a spot-frequency of 2,800 Mc one minute earlier.

Although the receiver was originally designed for measurement of solar electromagnetic radiation, its use and application of incorporated techniques are not limited to solar studies or to S-band. These techniques are directly applicable to L, C, X and higher bands.

Extended applications of the developed techniques include accurate calibration and range extension of radar systems, ICBM detection, celestial navigation, measurement of absolute antenna gain, or wherever wide-band, low noise, gain stable receiver characteristics are required.

The author acknowledges his associates of the Space Communications Laboratory, Fort Wayne Division of ITT Kellogg, for their efforts in the design and development of the equipment. Special thanks are also due personnel of the Observatory of the University of Michigan who made the program possible.

#### REFERENCES

- (1) A. Maxwell, G. Swarup and A. R. Thompson, The Radio Spectrum of Solar Activity, *Proc IRE*, 46, p 142, Jan., 1958.
- (2) W. J. Medd and A. E. Covington, Discussion of 10.7 cm Solar Radio Flux Measurements and an Estimation of the Accuracy of Observation, *Proc IRE*, 46, p 112, Jan., 1958.

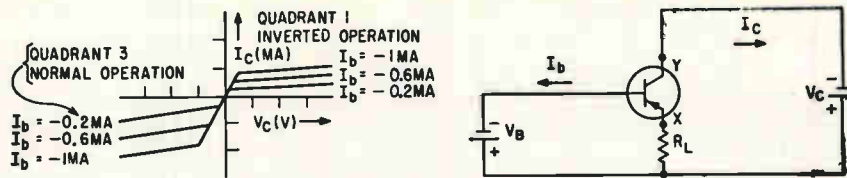


FIG. 1—Static characteristics of *pnp* transistor

# Complementary Transistors Simplify Modulator Design

*Complementary transistor modulator has carrier and signal suppression at output, gain greater than 3 db and high linearity. Used with teleprinters, speech scramblers and ssb transmitters*

By JAMES E. GRAU and BERNARD F. HUMBEL,

U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J.

THE COMPLEMENTARY transistor modulator<sup>1</sup> is a low powered device that offers these advantages: carrier and signal suppression at the output; available gain greater than 3 db; only one transformer necessary (complementary transistors eliminate the second transformer); high linearity; and no special power supply voltages. The ring modulator using four solid-state diodes, which has an insertion loss of at least 3 db, offers similar advantages. However, the gain of the complementary transistor modulator is approximately 7 db higher.

The developmental modulator discussed here was equipped with complementary symmetrical transistors: Sylvania small-signal, a-f experimental types GT942 and GT939. All measurements were made at low frequencies (3 Kc and 250 cps). Thus, this modulator cannot be used above approximately 20 Kc without substituting transistors suitable for higher frequencies. Requirements for complementary symmetry are not high, however. From

twelve randomly selected transistors all could be balanced by adjustment of a 10K balancing potentiometer. Any set of *nnp* and *pnp* transistors with comparable characteristics could have been used.

Circuits using complementary symmetry make use of two properties exhibited by *pnp* and *nnp* junction transistors<sup>2</sup>: (1) Under normal bias, the current flowing in each electrode of a *pnp* transistor is the opposite of the corresponding electrode current in an *nnp* transistor. (2) The polarity of an input signal necessary to increase conduction in a *pnp* transistor is the opposite of that necessary to increase conduction in an *nnp* transistor.

In this modulator, the transistors work in both modes of operation, normal and inverted.

In Fig. 1 the *pnp* transistor is biased for normal operation in a common collector configuration. Terminal X designates the emitter of the transistor and Y designates the collector. With a negative bias on the collector and base, the cur-

rent through the load is negative since it produces a negative voltage across  $R_L$  with respect to ground. Curves for normal operation are in quadrant 3.

If collector bias is reversed, the Y-terminal becomes the emitter, X the collector, and the collector current flows in the opposite direction (quadrant 1) through the load. The circuit becomes a common emitter configuration because the former (normal operation) collector-base diode is now forward biased (low resistance) and the former (normal operation) emitter-base diode is now reverse biased (high resistance direction)<sup>3</sup>. Current is lower because the  $\alpha$  inverted is lower than the  $\alpha$  normal, approximately 0.8 as compared to 0.99 (bilateral transistors with equal  $\alpha$ 's in both directions are available). Inverted and normal operation are used to achieve signal and carrier suppression in the output.

Potentiometer  $R_b$  ( $R_{b1} + R_{b2}$  in Fig. 2A) is used for the balancing of *pnp* and *nnp* transistors with



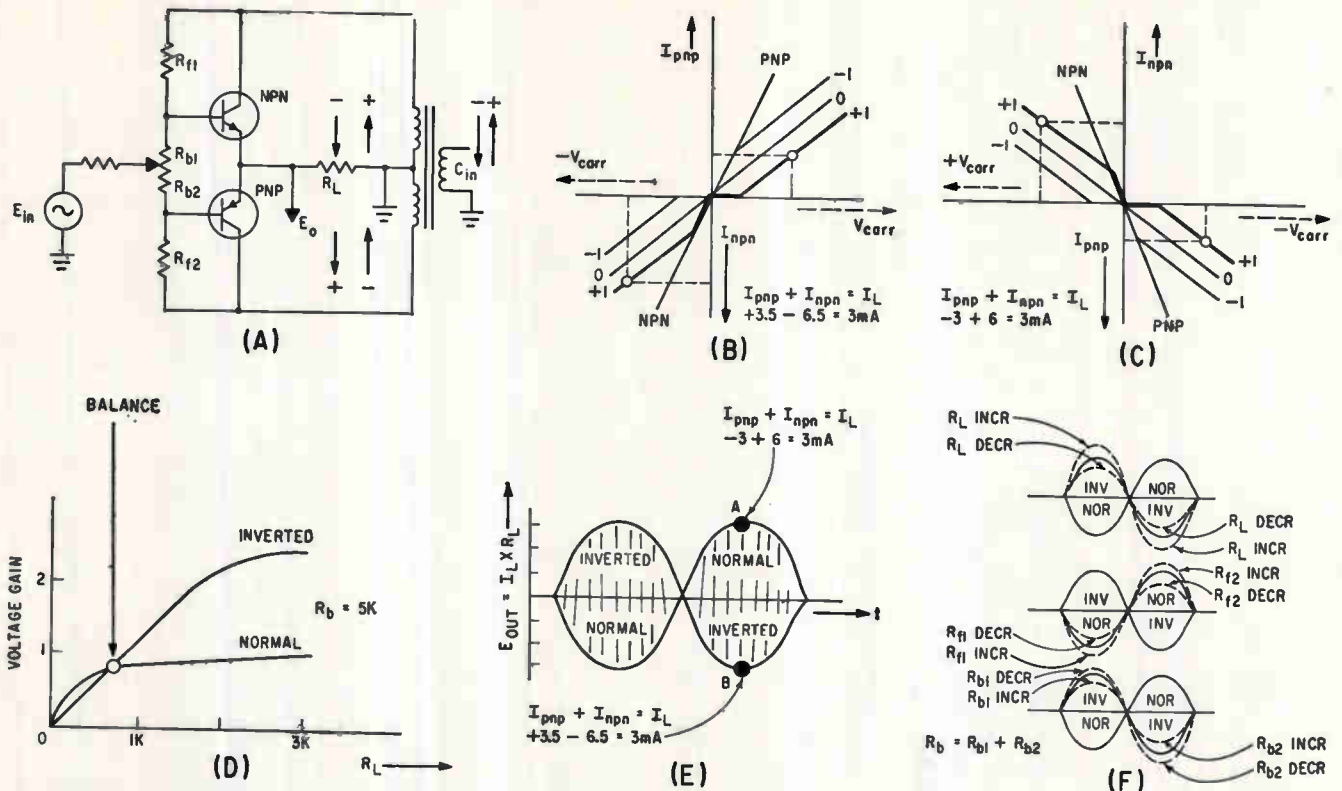


FIG. 2—In (A),  $R_b$  balances  $pnp$  and  $npn$  transistors with unequal characteristics. In inverted operation (B), each transistor works as common emitter configuration. In normal operation (C), transistors work as common collector circuit with voltage gain near one. Voltage gain of modulator is made equal in normal and inverted mode by varying  $R_L$  (D). Desired output waveshape for both modes (E). In (F), effects of changing  $R_L$ ,  $R_f$ , and  $R_b$

unequal characteristics.

In push-pull, the carrier fed in always biases both transistors at the same time, either for normal or inverted operation.

Feedback potentiometers  $R_{f1}$  and  $R_{f2}$  have been inserted to adjust for fine correction of the asymmetry of the desired output envelope.

The signal is fed in single-ended to the base circuit of each transistor through potentiometer  $R_b$ . The carrier is fed in, in push-pull to the modulator, thus biasing both the  $npn$  and  $pnp$  transistors, normally for the first half-cycle and inverted for the next half-cycle of the carrier.

The slider of the potentiometer proportions the values of  $R_{b1}$  and  $R_{b2}$ . Thus, the potentiometer allows the balance of complementary transistors with unequal betas inverted, since in inverted operation each transistor works as a common emitter configuration (Fig. 2B) and the approximate voltage gain for this mode of transistor operation is:  $\beta_i R_L / (R_{b1} \text{ or } R_{b2})$ . In nor-

mal operation (Fig. 2C) the transistors work as a common collector circuit with a voltage gain near one. Resistors  $R_{b1}$  and  $R_{b2}$  ( $R_b = 10 \text{ Kohm}$ ) have little effect on the output envelope since a common collector configuration has a high input resistance (500,000 ohms).

By making the voltage gain of the modulator equal in the normal and inverted mode (by  $R_L$ ), the input signal is balanced in the output, that is, the input signal is suppressed (Fig. 2D). Since the transistors work in common collector configuration during the normal mode and in common emitter configuration during the inverted mode,  $R_L$  has a different effect on the output voltage gain for each mode. Figure 2D shows the relationship for the transistor parameters of one transistor. The intersection of the two  $R_b$  curves delivers the desired balance (equal voltage gains) with a load resistor of 800 ohms.

Figure 3 shows the typical transistor characteristics for the normal

and inverted modes of operation of a common emitter configuration. It shows the circuit characteristics for the  $pnp$  transistor of the modulator using the input voltage ( $E_{in}$ ) as a parameter. In the inverted mode, compare the slope of the  $E_{in}$  curves (Fig. 3B) to the constant current  $I_B$  curves in Fig. 3A. This difference arises because in the inverted mode (terminal Y being the emitter) the carrier  $V_c$  is in series with  $E_{in}$  in the emitter-base circuit. As  $V_{ov}$  ( $V_c$ ) increases so does  $I_B$  even though  $E_{in}$  remains constant. For the inverted mode of Fig. 3B,  $I_B$  is approximately equal to:

$$I_B = \frac{E_{in} + (V_c - I_B R_c)}{R_{b2} + r_b}$$

where  $R_c$  = source resistor of the carrier;  $R_{b2}$  =  $pnp$  transistor's section of  $R_b$ ;  $V_c$  = carrier voltage identical to  $V_{ov}$  in Fig. 3B and 3C;  $r_b$  = transistors base resistance; and  $I_B$  = emitter current.

By increasing  $R_{b2}$ , the slope of the  $E_{in}$  curves and the differential input voltage-output voltage gain

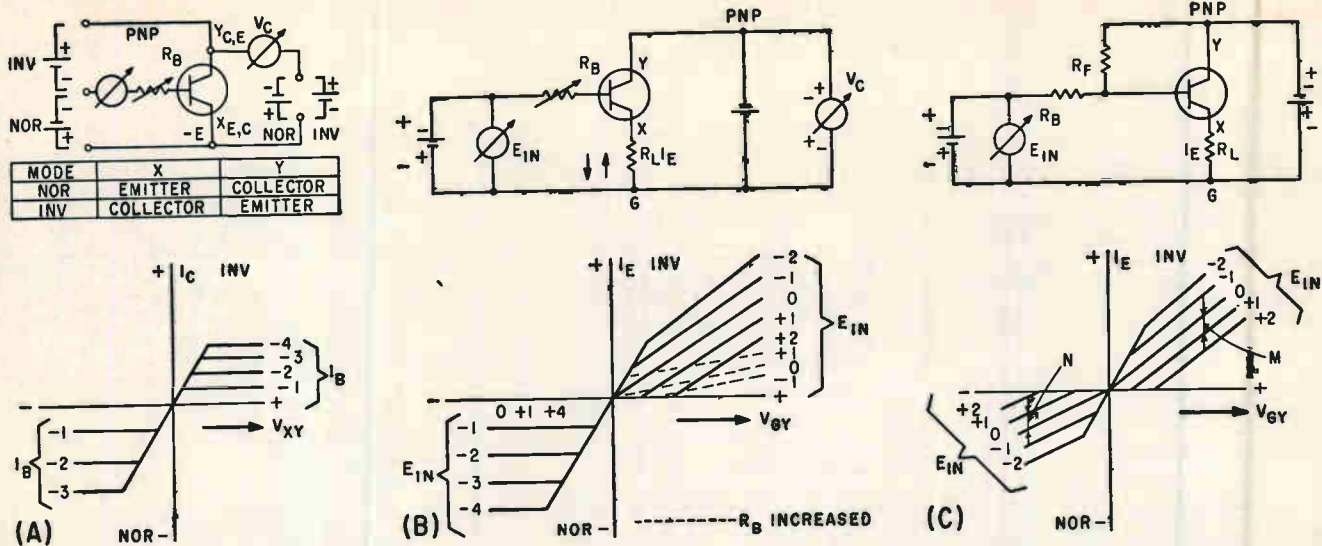


FIG. 3—Circuit characteristics of pnp transistor. Measurement of the normal and inverted mode in common emitter configuration (A); circuit and characteristic as applied in modulator (B); in (C), resistor  $R_f$  between collector and base causes normal characteristics to slope by feeding part of carrier current back to the base

can be changed (see Fig. 3B).

In the normal mode (Fig. 3B) the characteristic is still similar to that of Fig. 3A. The input voltage will, therefore, generate output currents only during the negative half period which corresponds to a duty cycle of  $\pi$ . This operation is not desirable because the voltage barrier of the base-emitter diode causes crossover distortion in the modulation envelope. Figure 3C shows that a resistor  $R_f$  connecting the collector to the base causes the normal characteristics to slope by feeding a part of the carrier current back to the base, thus prebiasing the base-emitter diode. The duty cycle for  $E_{in}$  during the normal mode is now increased to  $2\pi$ . At the same time the voltage gain of the emitter follower (common-collector) operation can be lowered by reducing  $R_f$ , while  $R_c$  and  $R_e$  act as a voltage divider for  $E_{in}$ .

Figures 2B and 2C show the characteristic curves for both the npn and pnp transistors for the Fig. 2A circuit. Figure 2B shows the characteristic curves for the inverted mode and Fig. 2C for the normal mode of transistor operation. The current corresponding to the positive or negative half cycle of the carrier is generated separately during different time intervals and then superimposed in the common load resistor.

By adjusting  $R_c$ ,  $R_f$  and  $R_L$  (Fig. 2F) a balanced bridge network is realized and the output waveshape

is similar to that of a switched modulator.

Input voltage controls the current in each transistor. The difference of output currents in the npn and pnp branch for every instant of the carrier voltage, applied simultaneously to the two transistors, generates a voltage across  $R_L$ . Peak amplitude will change proportionately to the input voltage. Polarity of the voltage across  $R_L$  depends on polarity of the instantaneous amplitude of the input signal and the carrier signal (see Fig. 4). In Fig. 2A assume an input signal of 1 v. During the inverted mode in Fig. 2B the current follows the heavy curve. After passing the knee the pnp current  $I_{pnp}$  and the npn current  $I_{npn}$  form parallel straight lines. The difference of currents will be a negative current of constant peak amplitude as in Fig. 2E, point B. In the normal mode two currents are generated as shown in Fig. 2C, in the same way as in Fig. 2B, but the difference of the two currents is now positive as in Fig. 2E, point A. Figure 2E gives the desired output waveshape, with equal voltage gain for both inverted and normal modes. If input voltage is zero, the characteristics of Fig. 2B and Fig. 2C form a straight line. The difference is zero for any carrier amplitude, which is an indication of a fully suppressed carrier. Changing over to negative amplitudes for  $E_{in}$ , the output phase reverses,

which is typical for double sideband, suppressed carrier modulation. The process of generating the desired output waveshape for a full cycle of input signal is shown in Fig. 4.

For evaluating the modulator, a series of measurements, defined as follows, was carried out:

(1) Available power gain is the ratio of power output (modulated wave) to available signal power input. However, the signal input and output circuits were not matched for maximum power transfer (for a low power modulator, linearity and low distortion are more important than a slight additional power gain by matching). Carrier frequency source impedance was chosen in accordance with the a-f standard of 600 ohms. Signal source impedance was 1,800 ohms for the lowest distortion possible in the output product. It can be changed to 600 ohms with only a slight impairment of distortion. Voltage to the modulator from the 600 ohm signal source is then higher than the  $emf/2$  (which corresponds to the matched condition), the input impedance of the modulator being approximately three times higher than the output impedance of the signal source. Load impedance, however, was adjusted for the best symmetry of the output wave shape. Signal input power was calculated as if the matching condition of maximum power transfer were fulfilled



$$P_{in} = \left( \frac{emf}{2} \right)^2 / R_{source}$$

Output power was calculated by:

$$P_{out} = (E_{out\ rms})^2 / R_{load}$$

Power gain obtained is defined as:

available power gain =

$$\frac{\text{modulated output power}}{\text{available signal input power}}$$

(2) Linearity of a modulator is the ratio of input signal amplitude to output amplitude, carrier voltage being held constant. This ratio stays constant over a wide range in a linear modulator

$$\text{linearity} = \frac{\text{signal input amplitude}}{\text{output amplitude}}$$

(3) Signal suppression is the ratio of the amplitudes of the desired sidebands (carrier  $\pm$  signal) to the signal at the modulator output

$$\text{signal suppression} = \frac{\text{desired sideband amplitude (carrier } \pm \text{ signal)}}{\text{signal amplitude at the output}}$$

(4) Carrier suppression expresses the ratio of the amplitude of the desired sidebands (carrier  $\pm$  signal) to the carrier at the modulator output:

$$\text{carrier suppression} = \frac{\text{desired sideband amplitude (carrier } \pm \text{ signal)}}{\text{carrier amplitude at the output}}$$

(5) The modulation distortion products comprise all the unwanted products like  $f_c \pm 2f_s$ ,  $2f_c \pm f_s$ ,  $3f_c \pm f_s$ . These distortion products were also measured. The equipment used to perform the measurements were: hp test oscillator, model 650 A; hp wide range oscillator, model 200 CD; hp oscilloscope, model 130A; hp vacuum tube voltmeter, model 400L; and GR wave analyzer, type 736A.

The first measurements show the linearity of the modulator (Fig. 5A); the output amplitude of one sideband is plotted against the input signal amplitude, carrier voltage = parameter. From a high level of the input signal, output amplitude is no longer linear. The input voltage at which this nonlinearity reaches 10 percent is a reference point for the measurements of output frequency components. The power gain is given for the linear portion of the output versus input voltage curve. Along the linear part of the curve the gain

remains constant (see Fig. 5A).

The second measurements (Fig. 5B) establish the curves relating the output amplitude of one sideband versus the carrier voltage, input voltage = parameter. Since carrier voltage must be greater or equal to signal voltage, two curves for two different signal voltages have been plotted. From a certain carrier voltage up, the output amplitudes remain unchanged.

The output frequency spectrum was measured at a signal input voltage (0.7 v) at which 10 percent nonlinearity of the output voltage occurs.

To summarize the test results, some typical values of the modulator are listed: carrier frequency, 2.8 Kc; signal frequency, 250 cps; max signal voltage (rms) for 10 percent nonlinearity,  $E_s$ , 0.7 v; input impedance,  $R_i$ , 1,800 ohms; carrier voltage (rms),  $E_c$ , 1.27 v; carrier impedance,  $R_c$ , 600 ohms;

output impedance,  $R_L$ , 800 ohms; available gain at the above mentioned signal and carrier voltages, 3.3 db; signal suppression as referred to the amplitude of one desired output sideband, 31.5 db; carrier suppression as referred to the amplitude of one desired output sideband, 28.5 db.

The complementary transistor modulator can in many applications replace other carrier and signal suppressed modulators. Some possible applications are:

(1) To convert rectangular teleprinter signals into carrier frequency signals with 180-deg phase modulation without a change of the carrier amplitude. No limitations with respect to baud length or teleprinter speed. Accurate and jitter-free switching is obtained.

(2) With respect to its possibility of single ended d-c input and output: (a) Pulse transmission containing d-c components over a-c channels. Tests are being conducted. This application may be of importance on digital coding and decoding as well as scrambling of speech. (b) Direct-current amplifier for negative and positive input voltages (currents): two modulators cascaded and fed with the same carrier deliver some gain (approximately 6 db) and have a higher stability than d-c amplifiers. Only a carrier supply is needed; no additional d-c supply.

(3) In connection with its good carrier and signal suppression: The modulator has been tested experimentally in a speech inversion experiment. The inverted sideband was located below a carrier of 5 Kc in the frequency range of the input signal. Up and down modulation was accomplished with two modulators. In this difficult carrier frequency application (ssb) this modulator could bring considerable savings on components and a reduction in size and weight as compared to standard techniques.

## REFERENCES

- (1) G. F. Vogt, Carrier-Suppressed Modulator, Applications for Patent, Signal Corps Docket No. 11,265.
- (2) G. C. Seiklal, Symmetrical Properties of Transistors and Their Applications, *Proc IRE*, p 717, June, 1953.
- (3) L. P. Hunter, "Handbook of Semiconductor Electronics," pp 16-19 to 16-22, McGraw-Hill Book Co., Inc., New York, 1956.
- (4) Lo, Endres, Zawles, Waldhauer, Gheng, "Transistor Electronics," p 215, Prentice Hall, Inc., Englewood Cliffs, N. J., 1955.

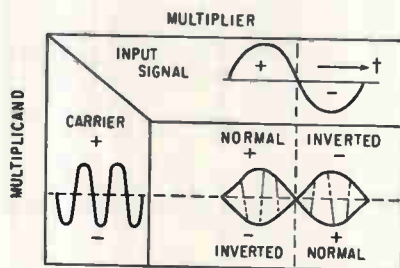
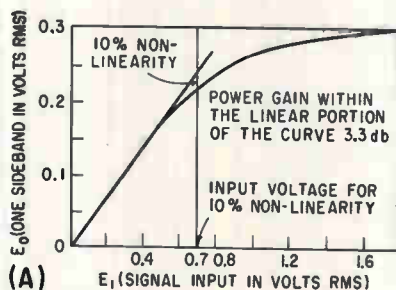
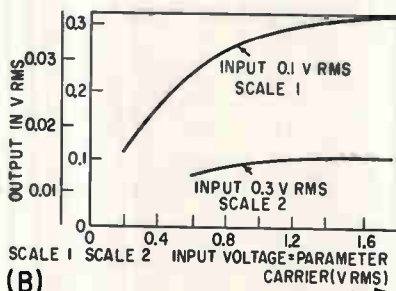


FIG. 4—Process of generating output wave shape



(A)



(B)

FIG. 5—Measured linearity of the modulator (A), and output voltage of one sideband (B) measured against carrier voltage

# Pickup Devices for Very-Low-Frequency

by only 7 db over the frequency range 10 to 10,000 cycles. Loop

By **GEORGE J. MONSER**,  
American Electronic Laboratories, Inc.,  
Lansdale, Pa.

COMMUNICATION and navigation systems, such as Radux-Omega, operate at frequencies below 10,000 cycles because these low frequencies permit considerable operating range. Research into low-frequency pickups has led to the Hall device as a receiving element, rather than loop and whip antennas conventionally used.

Applications<sup>1, 2, 3, 4</sup> of the Hall device include measurement of air-gap magnetic fields in motors and generators, leakage flux of solenoids, the earth's magnetic field and other related uses where magnetic fields are intentionally created as part of the design. Figures 1A and 1B show commercially available Hall sensors. To improve sensitivity the basic Hall device is frequently equipped with flux

collectors as shown in Figure 1C. Sensitivities neighboring 1 micro-gauss (equivalent to 0.03 volt per meter field intensity) are attainable using such flux concentrators.

Sensitivity is measured by providing a signal-to-noise ratio of unity in the input circuit of the receiving equipment. This sensitivity is dependent upon the incident flux density, the noise-ratio ( $N_R$ ) of the device (which is frequency dependent), and the square root of the input-circuit bandwidth. Similar functional relationships for the whip and the air core loop are presented as Eq. 3 and 4. With these equations, a Hall sensor equipped with flux collectors to increase the incident flux on the sensor, is compared with a small air-core loop antenna and a short vertical whip antenna. The results are summarized in Table I. These results show that the Hall sensor, unlike the

whip and the loop, has a sensitivity that is nearly frequency independent between 10 cps and 10 Kc. Figure 2 shows the spatial relationships of the field vectors for several distances from the antenna: only the electric field vector changes its relative direction, while the magnetic vector remains constant so that reorientation of the Hall sensor, with distance, is not necessary.

Hall voltage and incident flux density are related by

$$V_H = h_H B \quad (1)$$

where  $h_H = RI/t$ , is the transfer constant,  $R$  is Hall coefficient,  $I$  is bias current in the sample,  $t$  is thickness of sample and  $B$  is flux density incident on sample.

Response is a function of flux density and not a rate-of-change of flux linkages, so that d-c reception is possible; moreover, the device is nonreciprocal, and cannot be used

## CHARACTERISTICS OF THE HALL DEVICE

(1) The Hall Device is best suited for extremely low frequency applications requiring  $Q$  of unity or less. The extent to which circuit  $Q$  may be reduced at these low frequencies is limited, imposing a further restriction on the application.

(2) The relation between signal level and induced voltage for the Hall device exceeds that for conventional pickups. Hence, for unity signal-to-noise ratio, signal level must be higher, other factors assumed constant.

(3) In conventional pickups sensitivity is independent of frequency for constant  $Q$  operation. This is not so for the Hall device.

(4) Excess noise (above thermal noise) in the InSb wafer is an important factor below 1 Kc.

(5) Partial compensation of the interrelated design factors provides a nearly constant sensitivity for the Hall device from d-c to 10 Kc.

(6) Both the Hall device and loop are orientation sensitive. With flux collectors, the Hall device is still more directional

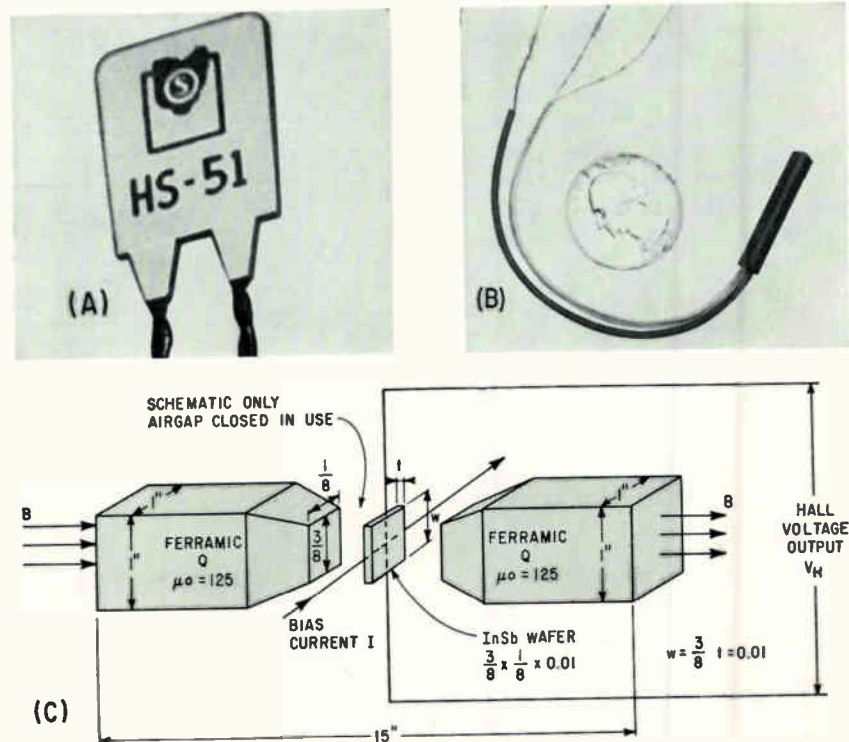


FIG. 1—Examples of available Hall sensors (A) and (B). Method of increasing effectiveness of the Hall sensor by using flux collectors (C) to concentrate the magnetic field



# Reception

The Hall device's sensitivity changes

and whip antennas experience a 60-db sensitivity change over the same range

as a radiating source. Pickup can be enhanced by using flux collectors.

The sensitivity of the device is  $S \propto w/t$  where  $w$  = length of sample in the direction of the Hall voltage and  $t$  = thickness of the sample.

Increasing  $w$  for better sensitivity causes the source resistance, typically about  $\frac{1}{2}$  ohm, to increase. This resistance is frequency insensitive except for skin effects and change-in-resistance with temperature for the semiconductor.

The relationship between electric field intensity  $E_s$  and Hall voltage  $V_H$  then internal noise  $E_n$  for the device is found. Finally, the ratio of  $V_H$  to  $E_n$  is set equal to 1 to determine a minimum value of electric field intensity  $E_{s(\min)}$  required to ensure this unity signal to noise ratio.

Observe that  $V_H = h_H B$  and  $B =$

$CE_s$ , so that  $V_H = h_H (CE_s) = (h_H C) E_s$ , where  $C$  = conversion constant uniquely specified in far field only. Thermal noise at room temperature is

$$E_n = (4KTRBW)^{1/2} = 1.26 \times 10^{-10}(RBW)^{1/2}$$

where  $K$  is Boltzman's constant,  $T$  is the temperature in degrees Kelvin,  $R$  is the Hall device source resistance and  $BW$  is the bandwidth. Adjusting for the excess noise<sup>1</sup>,  $E'_n = N_n E_n$  where  $N_n$  is the noise ratio.

Using the above relationships and measurement data<sup>1</sup>, numerical values for a particular InSb wafer (with flux collectors) are computed as follows:  $V_H = 17.7 \times 10^{-6} E_s$ ,  $E'_n = 13.3 \times 10^{-11} (N_n) (BW)^{1/2}$  from which

$$E_{s(\min)} = \frac{7.5 \times 10^{-4} (N_n) (BW)^{1/2}}{7.5 \times 10^{-4} (N_n) (fQ)^{1/2}} \quad (2)$$

where  $BW$  = input circuit bandwidth in cps,  $f$  = frequency and

$Q = f/BW$  = input circuit merit factor.

Equation (2) compares the Hall device with the loop and whip. Since the source impedance is resistive, bandwidth is set external to the sensor. Therefore, the required electric field intensity for unity signal-to-noise ratio should be frequency independent except for  $(N_n)$  variation which approaches unity above 1 Kc. Reference 1 reports a measured flat response from 30 cps to 15 Kc supporting the theory.

Similarly, the following relationships are found for the loop and whip

$$\text{(Loop)} \quad E_{s(\min)} = \frac{L^{1/2}}{66.3 NAQ} = \frac{L^{1/2} BW^{1/2}}{66.3 NAf} \quad (3)$$

$$\text{(Whip)} \quad E_{s(\min)} = \frac{1}{10^{10} HQC^{1/2}} = \frac{1}{BW^{1/2} 10^{10} HfC^{1/2}} \quad (4)$$

where  $L$  is the inductance of the loop in Henries,  $N$  is the number of turns in the loop,  $A$  is the area of the loop in square meters,  $H$  is the whip length in meters,  $C$  is the whip capacitance in farad  $\times 10^{-12}$ ,  $Q$  is the input-circuit merit factor and  $f$  is the operating frequency.

Equations 3 and 4 show that improved loop and whip sensitivity is obtained as the frequency is increased, provided the input circuit bandwidth is held constant. Since the internal impedance of the loop and the whip are highly reactive, external tuning is required in the input circuit. At these frequencies the  $Q$ 's are high, so that additional damping resistance is frequently required in the input circuit to ensure the desired bandwidth. Loop and whip pickup elements differ from the Hall sensor, which has a resistive source impedance, and is hence better suited for broadband applications.

## REFERENCES

- (1) M. Epstein and R. B. Schulz; Magnetic-Field Pickup for Low-Frequency Radio-Interference Measuring Sets, *IRE Nat. Convention Record*, 8, 1959.
- (2) R. K. Willardson, et al; Indium Antimonide for Semi Conductor Device Feasibility Studies, Report 1, Battelle Memorial Institute, Aug. 1959.
- (3) W. J. Grubbs, Hall Devices, A Survey, Digest of Technical Papers: Solid State Symposium, III, Feb. 1959.
- (4) W. E. Bulman; Hall-Effect Generators, *Electronic Design*, Mar. 4, 1959.
- (5) G. H. Suits, et al; Excess Noise in InSb, *Applied Physics*, 27, 1385, 1956.

## FIELD INTENSITY TO GIVE UNITY OUTPUT

Operating Frequency (CPS)	Bandwidth (CPS)	Input in Microvolts Per Meter		
		Hall Sensor	Loop <sup>a</sup>	Whip <sup>b</sup>
10,000	10	2,400	0.15	0.13
1,000	10	2,400	1.5	1.32
20	10	5,200	76	66
10	10	5,300	153	132

<sup>a</sup> Where  $H = 5$  in,  $W = 15$  in and  $N = 2$  turns

<sup>b</sup> Where  $H = 15$  in

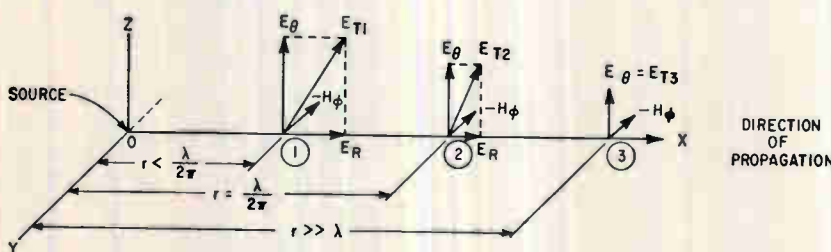
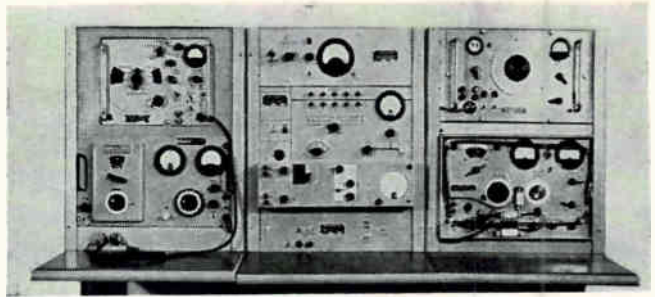


FIG. 2—Diagram shows that only the electric vector's position in space changes with distance from antenna; this effect does not necessitate changing the Hall sensor's alignment as operating range is altered

*Test procedures and equipment show how to compare the abilities of radio receivers to function in a crowded or artificially jammed spectrum*



Test equipment for evaluating receivers

# Evaluating Radio Receiver

By B. T. NEWMAN, General Electronic Laboratories, Inc., Cambridge, Mass..

THE EVER-INCREASING dependence upon radio communication and the ever-mounting crowding of the radio spectrum have accelerated the demand for high-performance receivers that can operate with maximum resistance to interference. Thus, there is a need for testing specifications, methods and standards by which a receiver can be graded. This paper describes methods for testing voice-communication receivers—a-m, f-m and single sideband (ssb)—and for objectively grading receiver performance in interference.

These methods and techniques have been reviewed by Signal Corps receiver and communications engineers to obtain their criticism and advice. This article is a summary of work performed over a period of five years at General Electronic Laboratories (GEL).

The following discussion describes objective testing and scoring methods that are helpful to the design engineer in grading receiver performance by comparing performance with idealized standards. These standards are based upon an ideal receiver that does not necessarily have the best possible characteristics but, rather, those which are easily definable.

The ideal receiver is given the following characteristics: (a) a rectangular selectivity curve and a bandwidth equal to that required for perfect intelligibility of the message; (b) no depression of the desired signal; (c) perfect ampli-

tude linearity in all amplifiers, and perfect limiting in all (f-m) limiters. Since the definition of the ideal receiver also defines its performance, the ideal receiver provides criteria upon which to base test results of practical receivers. A standard such as this allows the comparison of any one receiver with any other receiver. Furthermore, if the interference environment is known, it is possible to select the optimum receiver, basing the selection on test results that can be referred to a universal standard.

One of the aims of the standardized test procedure is to remove complications from the procedure. It is most desirable to test a receiver without removing it from its case or rack, and to not require a great amount of special equipment. Receiver performance will be studied in the presence of interfer-

ence, examining these characteristics and effects: selectivity, dynamic amplitude range, depression, impulse suppression and audio response.

The selectivity of a receiver determines the extent to which the receiver can differentiate on a frequency basis between several signals at the input. Since interference involves the reception of two or more signals, selectivity does in part determine the susceptibility of a receiver to degraded performance.

Operation of receiver circuits should be linear with respect to the desired signal over the amplitude range of expected signals. If not, cross-modulation effects can decrease the signal-to-noise ratio at the output terminals. This decrease is due to the mixing of the desired and interfering signals to generate new frequencies.

Another effect due to nonlinear amplitude range is desensitization. Desensitization refers to the reduction in gain of an amplifier when operating at nominally high signal levels. An undesired signal may shift the operating point of an amplifier to a nonlinear operating region, thereby reducing the gain of an amplifier for weaker signals.

A by-product of interference is depression. Also known as capture, this occurs in certain portions of a receiver when two signals are present. Depression is characterized by the reduction in level of one of two input signals by the receiver cir-

Frequency Bands of Equal Contribution to Articulation Index (Male Voices)

No.	Limits in cps	Mean in cps
1	200 to 330	270
2	330 to 430	380
3	430 to 560	490
4	560 to 700	630
5	700 to 840	770
6	840 to 1,000	920
7	1,000 to 1,150	1,070
8	1,150 to 1,310	1,230
9	1,310 to 1,480	1,400
10	1,480 to 1,660	1,570
11	1,660 to 1,830	1,740
12	1,830 to 2,020	1,920
13	2,020 to 2,240	2,130
14	2,240 to 2,500	2,370
15	2,500 to 2,820	2,660
16	2,820 to 3,200	3,000
17	3,200 to 3,650	3,400
18	3,650 to 4,250	3,950
19	4,250 to 5,050	4,650
20	5,050 to 6,100	5,600



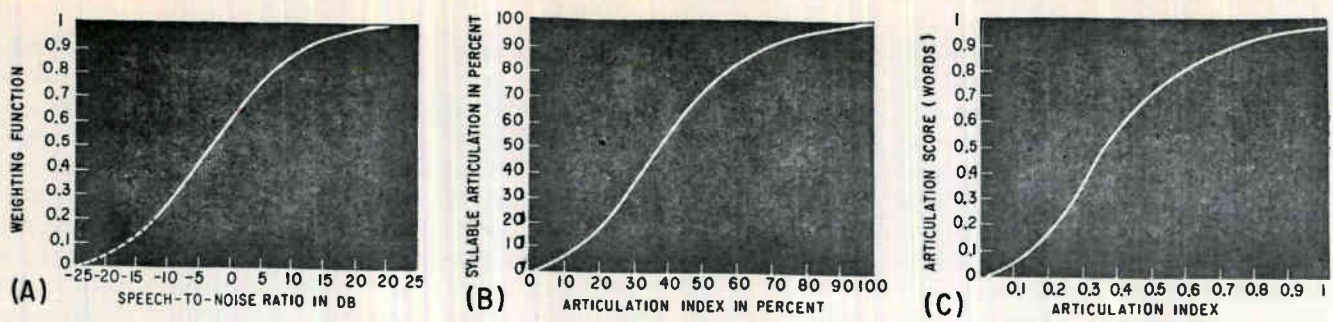


FIG. 1—Weighting function versus S/N (A). Syllable (B) and the word (C) articulation against articulation index

# Susceptibility to Interference

H. CAHN and R. KEYES, U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J.

cuts, due to the presence of the other. Depression is undesirable if the stronger signal is the interference. Depression occurs primarily in the detector of a receiver.

Impulse suppression is necessary because of disturbances caused by impulsive interference. These disturbances can be effective over periods that are much longer than the duration of the original impulsive disturbances because of pulse lengthening effects caused by the narrow bandwidth of the receiver. Thus, impulse suppression should take place early in the receiver.

Another effect that may be caused by impulsive interference is overhang. Overhang effects can be produced by interfering pulses of sufficient amplitude to cause one or more tubes to draw grid current. The charge produced on coupling capacitors is then sufficient to reduce the gain radically or even cut off the tube for a period following the removal of the pulse. Overhang can be reduced or eliminated by direct coupling, discharge diodes or small coupling time constants.

A voice communications receiver should be capable of passing all of the frequency components in the transmitted message. The output low-pass filter should pass the entire spectrum of speech frequencies that contribute to intelligibility; this spectrum extends from 200 cps to about 6,000 cps. Beyond these limits, the response should drop off rapidly. A wider audio bandwidth will allow interference, cross-modu-

lation and harmonic components generated in the detector and components falling outside the transmitted speech band, as well as random noise, to pass and reduce the output S/N (signal-noise ratio).

In the design of speech transmission systems, a knowledge of the factors that influence the intelligibility of a speech signal is important. While the present understanding of these factors is by no means complete, some important results were obtained by French and Steinberg of the Bell Telephone Laboratories. Using word scores obtained from listener tests performed with audio filters inserted between speech source and listener in an otherwise high-fidelity audio system, French and Steinberg introduced the concept of articulation index. This index equals unity in

a communications channel that passes all of the speech frequencies required for 100-percent intelligibility. The passband of the channel can be divided into an upper and a lower frequency range by sharp-cutoff high and low-pass filters. If the cutoff frequencies are adjusted to result in equal intelligibility in the two ranges, the intelligibility in each range corresponds to an articulation index of one-half. This measurement defines the frequency limits of two bands of equal intelligibility. For a composite of men's and women's voices, a cutoff frequency of 1,900 cps yields a word score of 68 percent. No frequency in the audio range makes an indispensable contribution to intelligibility since either half of the audio spectrum will yield the same word score and articulation

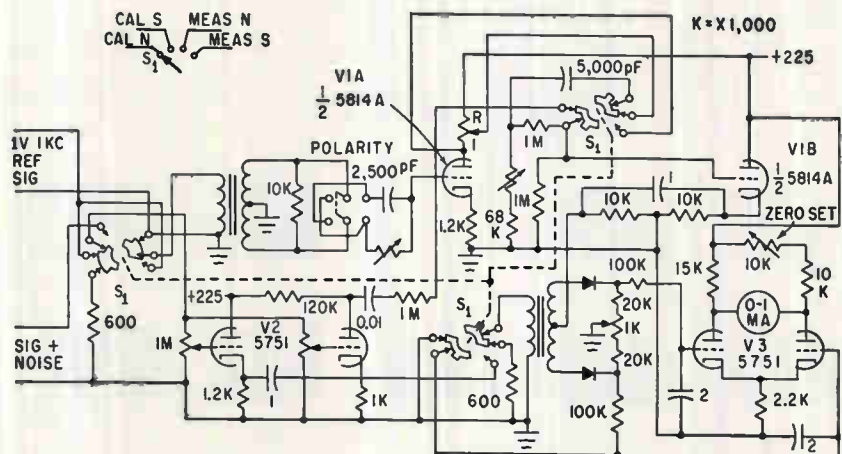


FIG. 2—With  $S_1$  at the indicated position, the correlator calibrates noise

index. Division of the audio spectrum with filters has yielded 20 frequency bands of which each contributed 0.05 to the total articulation index. These bands of equal contribution to intelligibility have become known as French and Steinberg bands. The frequency limits of each of these bands are shown in the Table. Frequency components outside the range from 200 to 6,100 cps do not contribute noticeably to intelligibility. To determine the expected intelligibility of the output of a system with known audio frequency response characteristics, count the number of contributing bands of equal intelligibility to determine the articulation index. Each band contributes a maximum of 0.05 to the articulation index as long as the speech-to-noise ratio exceeds or equals 30 db within that band. If this is not true, a weighing factor that depends upon the speech-to-noise ratio in the band must be applied to 0.05. Figure 1A shows the amount of weighting that must be assigned to each band as a function of speech-to-noise ratio in the band. The speech-to-noise ratio is determined from the long-term average

of both speech and noise voltage. Summation of the weighted contributions yields the articulation index of the output speech. The articulation index is related to syllable articulation (Fig. 1B) and to the articulation word score (Fig. 1C). The computation yields correct results only when interference consists of random noise and there is no amplitude distortion.

Although most of the equipment in these tests is conventional laboratory apparatus, a noise generator, correlator, and impulse generator had to be designed.

The noise generator provides a signal source for simulating broadband noise jamming. A nominally 300-Kc-wide noise spectrum is provided, and this spectrum is tunable to any portion of the frequency spectrum in the range 500 Kc to 55 Mc. Noise is generated by a 60-Mc i-f strip having a bandwidth of 300 Kc. Output of the i-f strip is mixed with a local oscillator tuning the range 60.5 Mc to 115 Mc. The difference frequencies fall in the range of 0.5 Mc to 55 Mc, this range being fed through a wideband amplifier and used as the noise output spectrum.

The correlator (Fig. 2) facilitates meaningful measurements of S/N ratios in active networks under two-signal conditions. It measures the output signal or the output noise, without either the signal or the noise from the input of the system under test. The correlator is a phase-sensitive detector and requires two inputs, a reference signal derived from the modulating source, and the signal-plus-noise input to be obtained from the output of the system. The noise component in the signal-plus-noise spectrum is isolated for measurement by cancelling the signal component. This is done in a resistive adder by adjusting the reference signal to the same amplitude as the signal component of the signal-plus-noise input. The phase opposition adjustment is made with a phase-shifting network. The signal component is measured by synchronous detection in a balanced modulator wherein the noise components cancel and only the d-c component due to the signal is metered.

The impulse generator evaluates the performance of a receiver by providing a source of high peak-to-average pulsed interference. For effective impulse-suppression evaluation, a pulse source capable of close to 100-percent modulation is necessary. The impulse generator (Fig. 3) reaches this degree of percentage modulation. This generator is a transistor electronic switch driven by a multivibrator. The pulse rate is 1,500 pps with a pulse duration of 10  $\mu$ sec. Choice of the 10- $\mu$ sec pulse duration was made because this pulse length represents a spread of frequency components over a greater bandwidth than the acceptance band of most receivers. The 1,500-pps repetition rate was arbitrarily chosen.

To permit a meaningful comparison of receivers, the mode of operation of the receiver under test must be specified. A recommended procedure for standardizing receiver gain, signal levels and miscellaneous control settings is included in test specifications covering modulation types<sup>1, 2, 3</sup>. This procedure attempts to operate the receiver in the range in which it was designed to operate. The receiver is tuned, the r-f gain controls are adjusted to provide maxi-

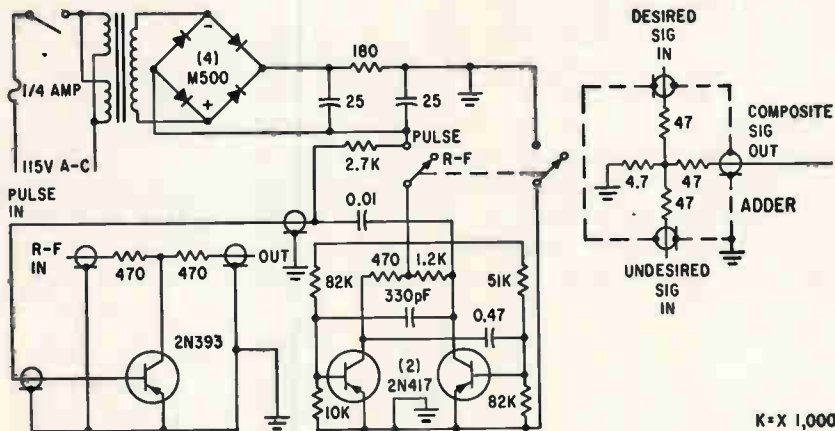


FIG. 3—The impulse generator (left) modulates r-f input, thus producing an undesired signal for the adder (right)

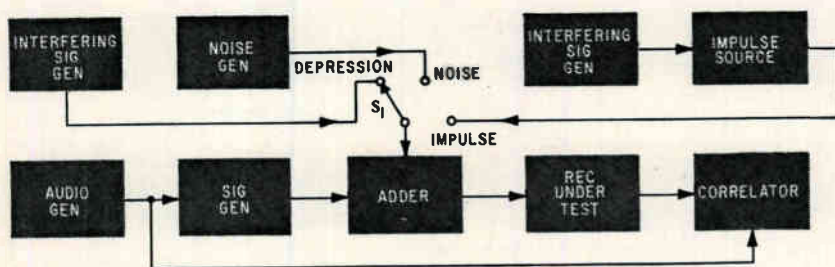


FIG. 4—Simplified arrangement shown by positions of S<sub>1</sub> indicates setups for depression, noise and impulse tests



mum output, while the audio gain control is adjusted to provide a nominal output level.

It is first necessary to know what signal frequencies present after the detector will reach the ear of the operator; this is the audio bandwidth test. These frequencies include the desired signal modulation components as well as interference components. Sine-wave output from an audio generator modulates a signal generator that produces a modulated r-f signal of the type to be received. This r-f signal is applied to the antenna terminal of the receiver. Audio voltage is measured at the audio output of the receiver, as the modulating frequency is varied.

To learn what range of radio frequencies, and at what levels, can contribute to the audio response the overall bandwidth test is carried out. A modulated carrier is applied to the receiver antenna terminals. Audio output voltage is measured as the carrier frequency of the test signal is tuned across the acceptance band of the receiver; alternately, the signal generator is maintained on a fixed frequency, and the receiver is tuned across the test signal. A second carrier is added to the test signal at the input of those receivers where the presence of such an interfering carrier affects overall selectivity.

The extent to which the desired message components at the output of a receiver are reduced by the presence of an interfering signal is measured in the depression test (Fig. 4). If the frequency separation of the desired and undesired carriers affects the results, this is taken into account in the measurements. An audio generator modulates a signal generator and provides a reference signal for the correlator that measures the desired signal components at the receiver output. The desired modulated signal is added to an interfering carrier obtained from another generator and the sum of the two signals is applied to the receiver input terminals. At the output of the receiver, the level of the desired modulation component is measured with the correlator, as the signal-to-interference ratio (S/I) at the input is varied.

The noise test (Fig. 4) gives in-

formation as to the extent to which an interfering signal, especially of the broad spectrum type, produces undesired outputs, both by itself and through interaction with the desired signal. The test result includes the effects of depression and overall bandwidth. At the receiver input, a modulated carrier is superimposed on an r-f noise band centered about carrier frequency. Modulation for the carrier is obtained from an audio generator, whose output is also used as a reference in the correlator. The correlator measures signal and noise at the output of the receiver so that the S/N can be obtained.

In the impulse test (Fig. 4), the desired signal is the same as in the noise test, but the interference consists of an interrupted, or pulsed, carrier. A standard repetition rate and pulse length is used. The S/N at the output of the receiver is determined by using the correlator to measure signal and noise.

The development of the noise, depression and impulse tests for ssb receivers has revealed that the correlator shown in Fig. 2 is not sufficiently compatible with ssb systems to be useful for output S/N measurements. This incompatibility is due to its dependence upon phase information. An alternative procedure for measuring desired signal and noise components at the output of an ssb receiver has been developed. This uses a wave analyzer for the depression test and a distortion analyzer for the noise and impulse tests.<sup>4</sup> The depression test is performed using the wave analyzer to indicate the level of desired signal component in the receiver output. With the receiver output connected to the wave-analyzer input, the wave analyzer is tuned to the modulating frequency of the desired signal and peaked. This is done at an input S/N of +30 db. Then the data is obtained by plotting the reduction in desired signal indicated on the wave analyzer as a function of input S/N. In this test the interfering signal is a c-w carrier.

The noise and impulse ssb tests use a distortion analyzer for determining receiver output S/N. The procedure for obtaining output S/N is similar to that developed for the wave analyzer.

In the following sections each of the four tests developed for ssb receiver susceptibility testing will be discussed and evaluated. Consult the fifth reference for the methods of performing the tests.<sup>5</sup>

Because of the linear demodulation technique used in ssb, the measured selectivity is a composite of the r-f and audio-selectivity characteristics. In contrast to the a-m and f-m susceptibility tests, the r-f and a-f selectivity characteristics are inseparable when the receiver is treated as a black box.

In most cases the audio filter will predominate in determining the upper cutoff frequency and slope of the composite selectivity curve. In the low audio range the degree of attenuation will be largely influenced by the sideband filter, which produces heavy attenuation around the carrier frequency.

The development of the depression test has shown that due to the linear operation of an ssb receiver, an ssb receiver should exhibit little or no weak-signal depression in the presence of a stronger c-w interfering signal.

The ssb noise test is equivalent to the a-m noise test. The major difference lies in the method for computing the input noise density as a result of the different bandwidths. Tests have shown that the effective bandwidth of the noise generator is 600 Kc. The following discussion shows how to determine the attenuator setting necessary on the noise generator to produce  $10^{-3}$   $\mu$ v of noise in a 5.9-Kc passband, as is desired to perform the ssb noise test.

Determine the noise in a 5.9-Kc passband with no attenuation. The maximum noise voltage output is 0.1 volt over the 600-Kc bandwidth when the meter reads 0 db. The noise power in a passband varies directly as the width of the passband.

$$\frac{P_1}{P_2} = \frac{E_1^2/R}{E_2^2/R} = \frac{E_1^2}{E_2^2} = \frac{BW_1}{BW_2}$$

$$E_1 = E_2 (BW_1/BW_2)^{1/2}$$

where  $E_1$  = noise voltage in 5.9-Kc passband,  $E_2$  = noise voltage in 600-Kc passband = 0.1 volt,  $BW_1$  = 5.9 Kc, and  $BW_2$  = 600 Kc. Hence,  $E_1 = 9,915 \mu$ v. The attenuation is  $9,915 \mu$ v/100  $\mu$ v, or, 40 db. Since there is 20 db of attenuation in the adding network, the attenuation in

the noise source is 20 db.

The ssb impulse test is similar to the a-m noise test. The difference is the value of the reference  $S/N'$  at the input that is used to derive the scores. To compute the input  $S/N'$  that gives  $(S/N)_{out} = 0$  db at the output of an ideal ssb receiver, assume that the output pulses are of 1-volt amplitude. The spectrum of the pulse train contains the 1.5-Kc fundamental and harmonics. Analysis of the spectrum shows that for the pulse width and pulse repetition rate in the impulse generator, the first four harmonics are equal at a peak amplitude of 0.03 volt. Therefore, the interference at the output is  $[4 \times (0.03)^2/2]^{\frac{1}{2}} = 0.042$  v rms.

Evaluation of the test results is facilitated by scoring techniques. Scoring of the test data results in a numerical score for the result of each receiver test, and the scores obtained for different receivers permit comparison of the performance of the different receivers. Two different sets of scoring procedures are presented. The first, a short-form scoring method, can be applied quickly and results in a percentile score for each test that allows quick comparison between receivers. The scores are arranged so that unity, or 100 percent, corresponds to the performance of a postulated ideal receiver.

The second scoring method is more comprehensive, and requires slightly more work. It is based on an assumed tolerable value of degradation in intelligibility at the receiver output. For each test it yields a score which indicates the increase in the number of decibels of  $(S/N)_{in}$  required for the receiver under test, over the  $(S/N)_{in}$  at the input of the postulated ideal receiver, for identical performance at the output of both. The score is given in db, with 0 db representing the performance of the ideal receiver. This scoring method permits comparison of receivers on a quantitative performance basis, because signal-to-interference ratios at the receiver output determine intelligibility. The db score also makes it possible to evaluate receivers on an absolute basis.

The scores give a useful number for comparing receivers. However, to appraise an individual receiver, it is desirable that the scores of the tests be referred to some common denominator, preferably in the form of intelligibility.<sup>6</sup>

To facilitate the comparison of receivers, a histogram of receiver test scores is useful (Fig. 5). Each receiver is represented by a performance profile of test scores, which are based on the short form scoring method; a similar diagram based on  $S/N$  scores would differ

only in the numerical scale. Assume that one of the a-m receivers listed in Fig. 5 is to be chosen for operation in a band being interfered with by a wide-deviation f-m transmitter. The interfering signal would therefore fall within the receiver acceptance band for short intervals at a time, these intervals being determined by the overall bandwidth. The character of the interference as seen by the receiver will then be pulsed carrier. Receiver A has the highest impulse score but also has much excess bandwidth, so that either B or C should be considered. Of B and C, C is to be preferred on the basis of better audio response. However, remember that additional electrical or mechanical characteristics must also be considered.

The authors thank the U. S. Army Research and Development Laboratories at Fort Monmouth, under whose auspices these testing methods were devised, and all who were engaged in this research as well as all who gave advice and assistance. Among these are J. C. R. Licklider, Lewis Billig, Ben Newman, Kaspar Kasparian, Harry Schwarzlander and David Beau-bien.

## REFERENCES

- (1) Specification for Methods of Evaluating the Susceptibility of AM Communications Receivers (unclassified), Supplement to the Final Report, Signal Corps Contract No. DA 36-039 sc-78240, General Electronic Laboratories, Inc. (GEL), Cambridge, Mass., Sept. 1959.
- (2) Specification for Methods of Evaluating the Susceptibility of FM Communications Receivers (unclassified), Supplement to the Final Report, Signal Corps Contract No. DA 36-039 sc-78240, GEL, Cambridge, Mass., Sept. 1959.
- (3) Specification for Methods of Evaluating the Susceptibility of SSB Communications Receivers (unclassified), Supplement to the Final Report, Signal Corps Contract No. DA 36-039 sc-78240, GEL, Cambridge, Mass., Sept. 1959.
- (4) Anti-Jamming Evaluation Techniques (confidential), Final Technical Report, Signal Corps Contract No. DA 36-039 sc-72345, GEL, Cambridge, Mass., Jan. 1958.
- (5) Anti-Jamming Evaluation Techniques (confidential), Final Report, Signal Corps Contract No. DA 36-039 sc-64460, GEL, Cambridge, Mass., Aug. 1956.
- (6) Susceptibility Evaluation of Radio Communications Receivers and Systems Guide Manual, (unclassified), Signal Corps Contract No. DA 36-039 sc-78240, GEL, Cambridge, Mass., Sept. 1959.

## BIBLIOGRAPHY

- H. Schwarzlander, Intelligibility Evaluation of Voice Communications, *ELBETRONICS*, May 29, 1959.
- N. R. French and J. C. Steinberg, Factors governing the Intelligibility of Speech Sounds, *J Acoust Soc Amer*, 19, p 90, 1947; *Bell Tel Syst Tech Pub*, Monograph B-1436, 1947.
- Anti-Jamming Testers, Final Technical Report, Signal Corps Contract No. DA 36-039 sc-72788 (unclassified), GEL, Cambridge, Mass., July 1958.

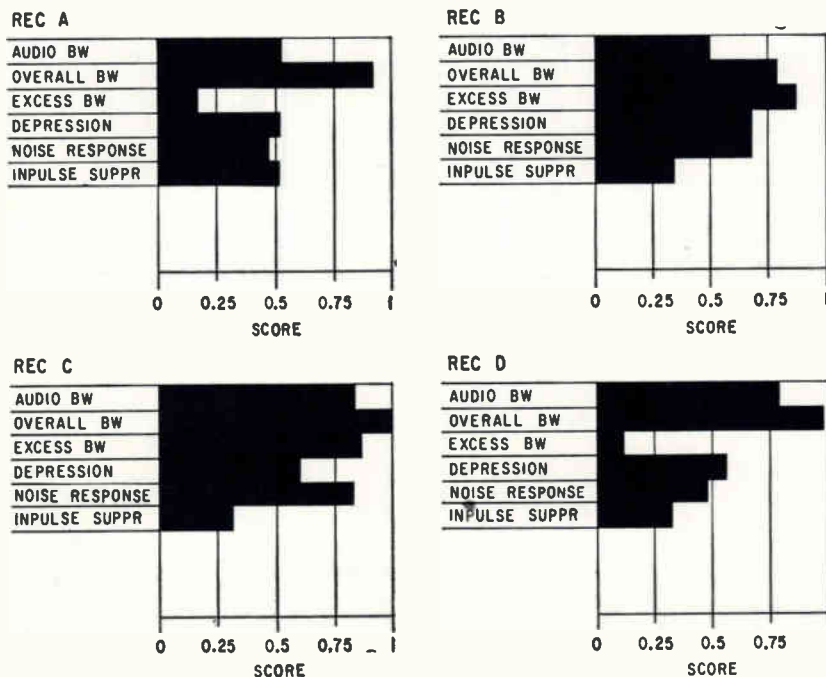
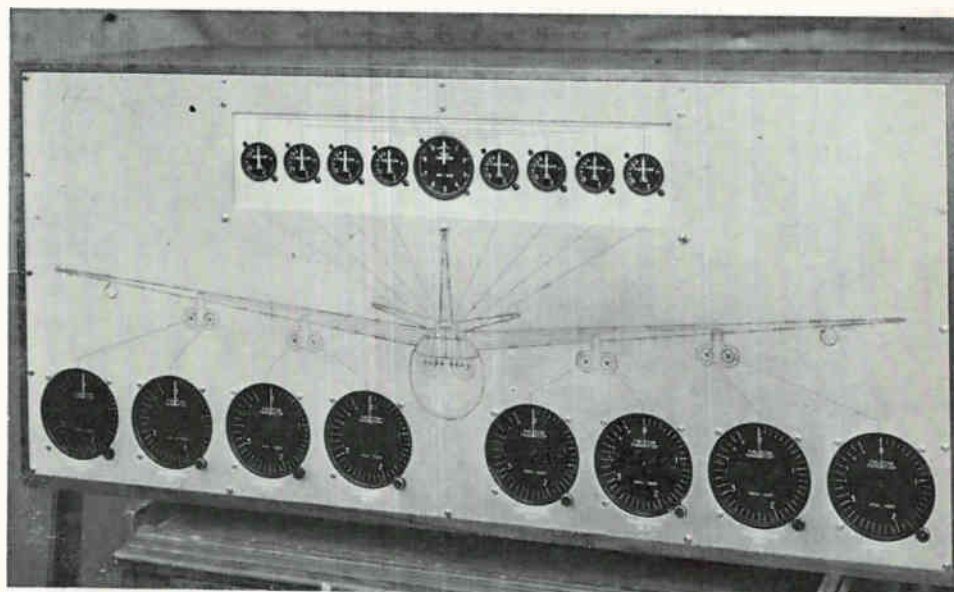


FIG. 5—Bar graphs compare four receivers by giving their short-form scores for six different performance tests



# A-C Controlled Half-Cycle Magnetic Amplifier

*Four self-saturating  
elements combined  
in full-wave device.  
Circuit is used in  
jet aircraft fuel-flow  
indicator systems*



*Demonstration mock-up shows the complete multiengine jet fuel flow indicating system for an eight-engine airplane*

By EDGAR VAN WINKLE

Bendix Corporation,  
Teterboro, N. J.

THIS MAGNETIC AMPLIFIER circuit shows advantages over previous circuits, especially in servo motor applications. This circuit has a good output waveform, low time constant and is a-c controlled. Four self-saturating elements are combined into a full-wave device; each element consists of a core and a rectifier. An a-c suppressed-carrier signal is fed to the control winding and the output across the load is also an a-c suppressed-carrier signal. By varying output connections, it is possible to get a d-c output with reversible polarity.

The output circuit resembles that of a Logan full-wave self-saturating magnetic amplifier. The Logan circuit, however, needs a large impedance in the control winding. If this impedance is resistive it reduces power gain, and if inductive, it has a long time constant.

An improvement of the Logan

circuit, described by Ramey in 1950, uses the same output circuit but changes the control circuit to produce one that has a high gain with low time constant.

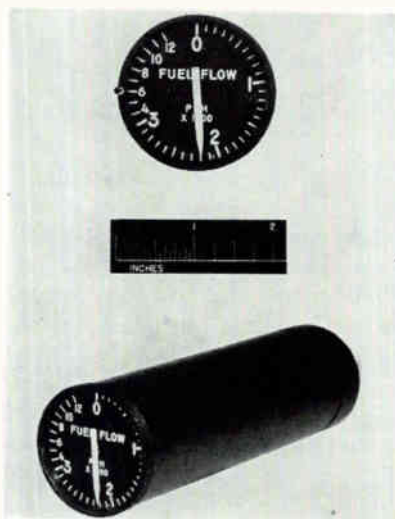
The Lufcy half-wave magnetic amplifier, developed later, eliminates the control-circuit rectifier. An extra winding added to the core

winding biases the core flux, advances the firing of one core and retards the firing of the other. High gain with low time constant is obtained, but control is by d-c supply and the output is a half-wave voltage that can be used to drive a servo motor at reduced rating.

Many special variations of these circuits exist.

The complete circuit of the new amplifier is shown in Fig. 1. It requires a power transformer *A*, four toroidal cores (*B* to *E*) with rectangular B-H curves having one power winding and two control windings on each core, four bias capacitors *F*, *G*, *H* and *I* used for flux setting purposes, four diodes *J*, *K*, *L* and *M* to self-saturate each core, and a ring gating circuit *N* to control the current flow in the control windings. The resistors in the ring gating circuit are current-limiting.

Faraday's law of induction states that if there is a closed path in space and the magnetic flux surrounded by it varies with time, then the emf induced around the path equals the negative rate of



*Fuel flow indicator unit is contained in a case two inches in diameter, 6½ inches long; magnetic amplifier is built inside each unit*

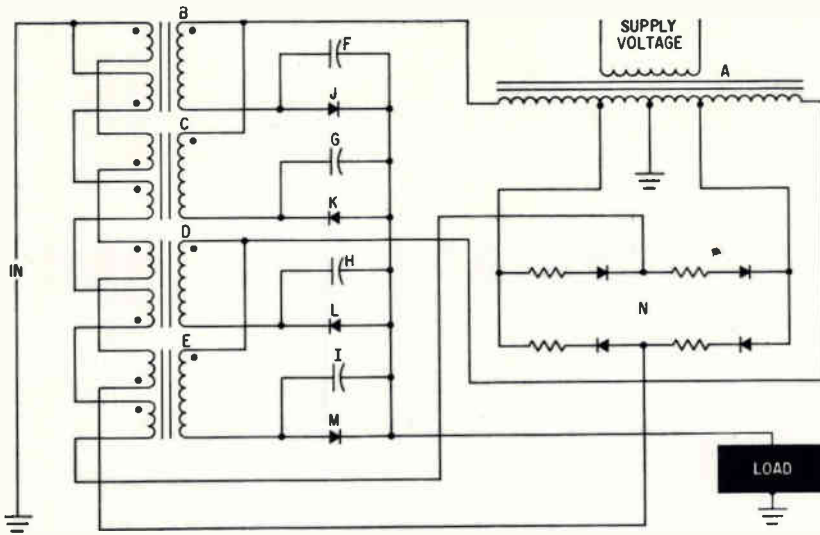


FIG. 1—Schematic diagram of basic a-c controlled magnetic amplifier. Four toroidal cores with rectangular B-H curves are used

with less power from the control source, and is the means of obtaining high-gain magnetic amplifiers. Bias can be obtained by an extra control winding, by a resistor in parallel with the power winding rectifier, or by a capacitor in parallel with this rectifier. The last method is the most efficient.

A resistance has to be added to the control winding of a d-c magnetic amplifier to limit the current induced during the prefling interval before the core saturates. This resistance causes a power loss in the control circuit. An inductor could replace this resistor, but at the expense of time constant.

Ramey eliminated this loss by inserting a diode in the control circuit to limit the current. The circuit in Fig. 1 accomplishes this with a diode gating circuit, without requiring a voltage build-up before the control circuit operates.

A second control winding of reversed polarity increases power gain. With the reversed control windings, an a-c input produces flux changes in the same direction in both halves of the cycle. The same power gain is obtained with an a-c control signal that could be obtained with a d-c circuit, neglecting the current-limiting impedance.

In addition to high gain, the magnetic amplifier has the advantage in a-c servo work of a-c signal control and a line phase a-c output. The high gain is accompanied by a time delay of one-half cycle of the carrier and a 400-cps amplifier is only 3 db down at 125 cps. The gating circuit provides a linear control from null up to saturation. The gating circuit resistors can be adjusted for core mismatch. Substitution of capacitor bias for a bias winding simplifies adjustment, and gives more winding space on the core for active elements. Other advantages of magnetic amplifiers such as quadrature rejection, ruggedness and isolation between input and output are retained.

In the output circuit, cores B and C provide full-wave output of one phase and cores D and E provide a full-wave output of the opposite phase.

When the power half-cycle starts in any one coil, the line voltage starts increasing and when the volt-seconds from the line equal the

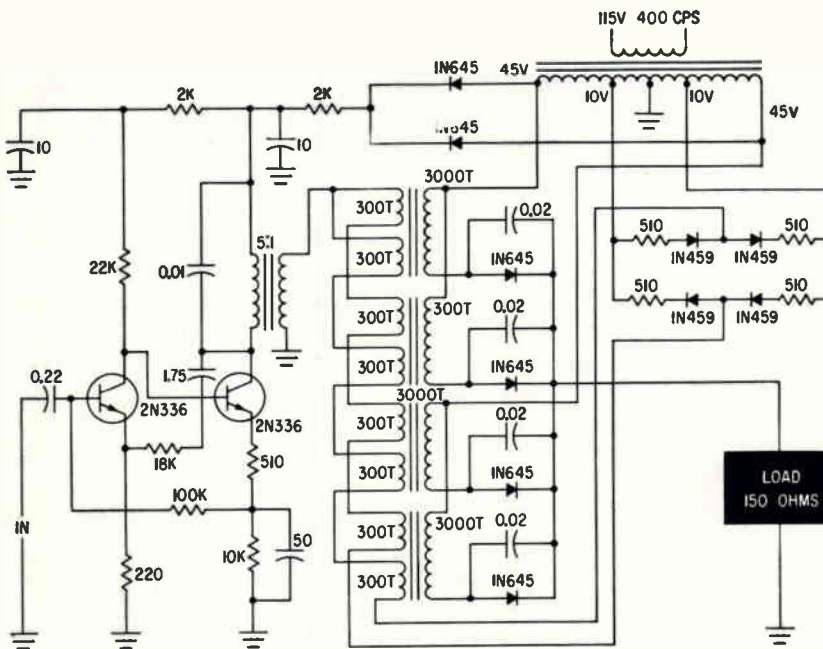


FIG. 2—Diagram of actual circuit complete with two-stage silicon transistor preamplifier at left, as used in aircraft fuel flow indicating system

change of the flux in lines or maxwells per second, or  $E = -d\theta/dt \times 10^{-8}$  volts. If a coil has  $N$  turns and the flux is confined within a core and thus enclosed by all  $N$  turns, the emf induced in the coil is  $\int E dt = -N\phi \times 10^{-8}$  volts where  $\phi$  is the flux density. If  $\phi$  is in webers, the time integral of voltage across the coil equals the negative product of coil turns and the flux in webers. The voltage time integral is basic in designing magnetic amplifiers.

Load action in a magnetic amplifier depends on the core material. Cores with oriented particles are

needed to provide a rectangular hysteresis loop. With this flux current loop, a bias or control action will provide an initial value of flux retention for the instant when the power or load half-cycle begins. At this instant, the line voltage starts increasing and when the volt-seconds from the line equal the volt-seconds required to saturate the core, the core  $\mu$  changes to a value of one and line voltage is impressed across the total of the coil and load impedance.

Presetting the core flux means that control action can be obtained



volt-seconds required to saturate the core, the core  $\mu$  changes to a value of one, and line voltage is impressed across the total of the coil and load resistance. The circuit current is then determined by this total circuit resistance. The power half-cycle starts when the line voltage changes direction to the correct polarity to have the rectifier, which has to be in series with the coil, change from a high impedance value to a low one. Before the core saturates, the line current is limited by the coercive force of the material; after saturation it is limited only by total circuit resistance. The voltage across the coil almost equals the line voltage until the core saturates, and after saturation is determined by the coil resistance.

The number of degrees of line voltage that load current flows—the conduction angle—is determined by the value of the core flux at the beginning of the power cycle.

Again,  $\int E dt = -N\phi$  when  $\phi$  is expressed in webers. The  $\int E dt = E_m \int \sin \omega t dt = (-E_m/\omega) \cos \omega t = \phi/A$  or  $\phi = BA$  so  $NBA = (E_m/\omega) \cos \omega t$ , or  $B = (E_m/\omega NA) \cos \omega t$  so that if a voltage of  $E_m \sin \omega t$  is applied to a core, the flux is a function of  $(E_m/\omega NA) \cos \omega t$ .

$B_s$  is the value of saturation flux density of the core.  $E_m$  is chosen so that  $E_m/\omega NA = B_s$ , or  $E_m = B_s \omega NA$ . If the flux at the beginning of the power cycle is zero, then the flux at 90 deg is equal to  $[(E_m/N \omega A) \cos \omega t]_{\omega t = \pi/2} = E_m/N \omega A = B_s$  so that the core saturates at 90 deg. Due to the flux retention or square loop saturation curve the flux will be at  $B_s$  (the residual flux) at 180 deg, only slightly less than  $B_s$ . Assuming the control coil is open circuited and using germanium or silicon diodes, the reverse current is too small to bring the flux from  $B_s$  back to zero in the next 180 deg. It is then necessary to bias the flux. The bias level is self-adjusting for line voltage fluctuation since an increase of  $E$  will also increase the reverse bias on the next half-cycle.

With each core firing at 90 deg on its power cycle, the control current advances the firing angle of one core and retards the firing of a second core to produce an output

symmetrical around the 90 deg phase angle and to provide a linear response for the control signal.

The input circuit operation is determined by current in the input coils. Magnetizing force  $H$  is defined as the magnetomotive force  $F$  per unit length  $l$  or  $H = F/l$ . Quantity  $F$  in the cgs systems is measured in gilberts each equal to  $10/4\pi$  or 0.7958 ampere turns. One ampere turn =  $4\pi/10$  units of mmf so that  $F = 1.257 NI$  where  $NI$  stands for ampere turns.  $H$  then equals  $1.257 NI/l$  where  $l$  is in centimeters and  $H$  in oersteds. The form most often used is  $I = l H/1.257 N$ . For a toroidal core with a mean core diameter in inches  $D$  the expression is  $I = 6.35 HD/N$ .

The ferromagnetic materials most often used are Delta Max and Orthonol. Both saturate at about 14 kilogauss, require a coercive force of about 0.5 oersteds at 400 cps, and have a generally rectangular hysteresis loop. The coercive force is one-half of the width of the B-H curve. It can be shown that square-loop material maintains the inductor current in phase with the voltage.

The control current required to vary the flux was found to be  $I = 6.35 HD/N$  in phase with the voltage. The voltage is determined by the required flux change. At zero phase angle, two cores are proceeding towards saturation and two cores to a flux values of zero. The first two cores induce equal and opposite voltages in the control winding at all times, and these two voltages cancel. There are two control windings, but due to the gating circuit only one has a closed path, the other being open. The active winding must have sufficient voltage to maintain the flux of one core at  $B_s$  and to change the remaining core to  $-B_s$ . Thus one core will have a flux change of zero and the other of  $2B_s$ . If a voltage  $B_s \sin \omega t$  is applied to a core, the flux is a function of  $(E_m/\omega NA) \cos \omega t$ . The control current operates for a full half-cycle and  $[(E_m/\omega NA) \cos \omega t]_{\omega t = \pi} = 2E_m/N \omega A$ . This must equal  $2B_s$  to fully reset one set of cores, or  $2B_s = 2E_m/N \omega A$  or  $E_m = N \omega A B_s$ . The control power  $W_c$  is the product of these two values, or  $W_c = N \omega A B_s \times 6.35 \times HD_m/N \omega A = 6.35 HD_m B_s$ .

Control power is thus a function of the core material, core area, core length, and operating frequency, but is independent of the number of turns on the control winding. In the next half-cycle the gating circuit opens the control winding that resets two cores and the other control winding repeats the process to reset the remaining two cores.

The schematic in Fig. 2 shows the amplifier as used in a served indicator for a fuel-flow system in jet aircraft. The complete system filter networks. The coupling in a demonstration mockup is shown in photographs. The toroid cores used are Delta Max 5340-D-2 wound with 3,000 turns of No. 40 wire on the power winding and 300 turns of No. 41 wire on each control winding. The power windings were excited by a 90-volt center-tapped transformer with the 0.02- $\mu$ f capacitors for firing the cores at the 90-deg phase angle with the circuit drawing 60 milliamperes at null. The power gain of the circuit was 500; 2 millivolts input caused a 2-watt output across a 150-ohm load.

The gating circuit was operated by a 20-volt center-tapped transformer with 500-ohm resistors for current limiting, and balancing the circuit at null.

The transistor preamplifier shown in Fig. 2 has two stages with d-c feedback for operating-point stabilization. The power supply uses the same power winding as the magnetic amplifier, and R-C transformer is tuned to eliminate phase shift in the transformer.

The stabilized gain of the preamplifier is adjusted to about 350. The magnetic amplifier has a volt-tapped transformer and the reset gain of seven, but with the 5-to-1 step-down coupling transformer is essentially a power-gain device. The input impedance is over 10,000 ohms so as not to overload the input device. The amplifier consists of a high-gain amplifier using silicon transistors with a minimum number of additional components and a large amount of feedback to obtain temperature stabilization and good reproducibility on the production line. The original circuit used type 905 transistors, and recent designs are now using 2N336 transistors.

# Stabilized Delay Circuit Provides High Accuracy

*Timing errors are minimized in solid-state timing delay generator. Stability of better than 0.2 percent full scale is achieved over temperature range of 24 C with accuracy better than 0.7 percent*

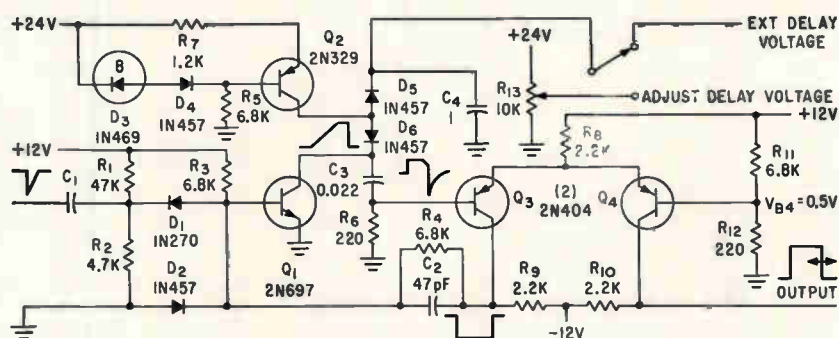


FIG. 1—Transistors  $Q_3$  and  $Q_4$  of time-delay circuit are mounted on common heat sink to reduce timing error

By CLIFFORD K. FRIEND  
SERGEI UDALOV

Gilfillan Bros. Inc., Los Angeles, Calif.

MANY ELECTRONIC CIRCUITS, particularly in radar systems, require a precise, voltage-controlled, time-delay generator. A radar range tracker must generate an accurate voltage analog of the time between transmission of a pulse and the receipt of the radar echo. The accuracy of the voltage analog in the range tracker is usually determined by a voltage-controlled time-delay circuit.

Time delay circuits usually contain a linear sawtooth generator and a sensitive amplitude-sensing

circuit to form a common gate having a time duration directly proportional to an applied control voltage. A time delay circuit that achieves a high degree of accuracy and stability is shown in Fig. 1. Here the sawtooth generating function is incorporated into a gate-generating circuit. High accuracy is achieved because the timing components, consisting of a capacitor and a constant-current generator, are not connected to any load during the timing portion of the cycle.

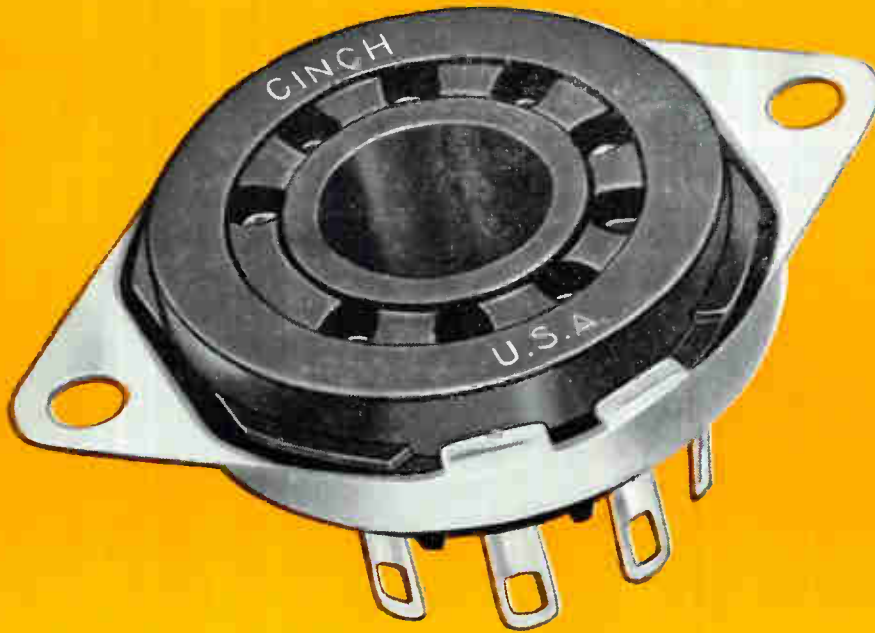
Operation depends upon a linear rise of voltage across a capacitor being charged by a constant current. In its quiescent state, the collector of transistor  $Q_1$  is clamped to ground by the positive bias ap-

plied to its base. This places a low initial voltage across capacitor  $C_1$ . Transistor  $Q_2$  is a constant-current generator. Zener diode  $D_3$  determines the current through  $Q_2$ . With a Zener voltage of 6 v and  $R_7 = 1,200$  ohms, the current through  $Q_2$  is about 5 ma. Transistors  $Q_3$  and  $Q_4$  form a differential amplifier. With the amplifier in its steady state,  $Q_3$  is saturated and  $Q_4$  is cut off, and collector voltages of  $Q_3$  and  $Q_4$  are 0 v and -12 v respectively.

Operation of the time delay circuit is started by a negative trigger through  $D_1$  to the base of  $Q_1$ . The trigger, after being amplified by  $Q_1$ , is coupled through  $C_2$  to the base of  $Q_3$ . Amplified again by  $Q_3$ , the trigger is fed back through  $R_4$  to

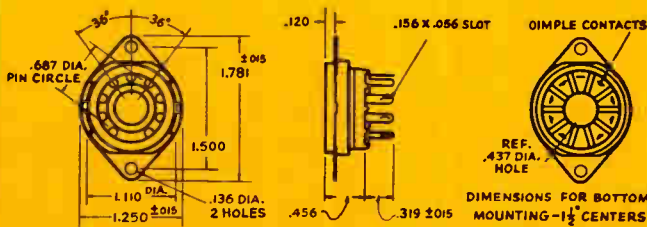


ONLY  
FROM  
CINCH®



# NOVAR TUBE SOCKETS

DEVELOPED IN CONJUNCTION WITH THE NOVAR TUBE



## ELECTRICAL RATINGS

1½" Mtg. Ctr. Socket Ratings

- a. Adj. terminals (sea level)  
b. Terminal to ground (sea level)  
current rating—9 amperes  
contact resistance—0.05 OHMS MAX.

Volts	
AC RMS	DC
3000	4800
4300	7050

## NOVAR SOCKET ASSEMBLIES

BOTTOM MOUNTING	CINCH PART NUMBER	BOTTOM MOUNTING (HIGH VOLTAGE)	CINCH PART NUMBER
1½ mounting centers GP Black (CFG)	149 19 00 033	1½ mounting centers— curled saddle—high voltage	149 18 00 035
Mica (MFE)	149 19 10 034	GP Black (CFG)	149 18 10 036
		Mica (MFE)	
1-5/16 mounting centers— curled saddle	149 19 00 037	<b>TOP MOUNTING</b>	
GP Black (CFG)	149 19 10 038	1-5/16 mounting centers— pressed-on saddle	149 19 00 041
Mica (MFE)		GP Black (CFG)	149 19 10 042
		Mica (MFE)	
1-5/16 mounting centers— pressed-on saddle	149 19 00 039		
GP Black (CFG)	149 19 10 040		
Mica (MFE)			

- Cinch is the *only* source for Novar Sockets.
- Fits Present Chassis Cutouts. You don't have to redesign chassis to accommodate the Cinch Novar Socket; physical dimensions are the same as octal sockets.
- Electrical and mechanical tests performed according to EIA Standards.
- Contact Design. Contacts are designed for long-lasting resiliency and to withstand fatigue. This means dependable operation and reliability.
- Contact Finishes: insure constant voltage performance. Different finishes are available for extraordinary environmental conditions.

*Write for full information today! Complete engineering data and detailed specifications are yours for the asking. Or, phone NEVada 2-2000.*



**Cinch**  
ELECTRONIC  
COMPONENTS

## CINCH MANUFACTURING COMPANY

1026 South Homan Avenue • Chicago 24, Ill.

Division of United-Carr Fastener Corporation, Boston, Massachusetts



Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; and St. Louis, Missouri

the base of  $Q_1$ . Polarity of the voltage fed back from the collector of  $Q_2$  results in regenerative action that cuts  $Q_1$  off.

Fast regeneration is achieved by minimizing the time delay through  $Q_1$  and  $Q_2$  and by speed-up capacitor  $C_s$  across feedback resistor  $R_s$ . Thus far circuit operation is similar to that of a multivibrator.

When  $Q_1$  is cut off, a constant charging current of 5 ma begins to flow into  $C_s$ . This current generates a positive voltage step across  $R_s$ . The voltage keeps  $Q_1$  and  $Q_2$  cut off after the trigger has been removed. Amplitude of the step remains at a constant level of about +1 v as long as the charging current through  $C_s$  remains constant.

Current flowing into  $C_s$  generates a linear voltage ramp at the collector of  $Q_1$ . This voltage continues to rise until clamped by  $D_s$  at the delay voltage,  $V_d$ . Clamping the collector voltage of  $Q_1$  at  $V_d$  causes the positive voltage step across  $R_s$  to decay to zero with a time constant of  $R_s C_s$ , or 4.8  $\mu$ sec. When the voltage on the base of  $Q_2$  drops to about 0.5 v,  $Q_2$  begins to conduct and the regenerative action is repeated, this time returning  $Q_1$  to its initial state of saturation.

During the active part of the cycle, a positive-going pulse is generated at the collector of  $Q_2$ . The time duration of this pulse is equal to the time delay generated by the circuit. Length of this time delay can be adjusted by varying  $V_d$ . In Fig. 1, the magnitude of  $V_d$  is limited to about +17.5 v, because at least 6 v must be maintained across  $Q_2$ . Thus, with the circuit parameter shown, the maximum time delay is about 120  $\mu$ sec and the minimum time delay is about 6  $\mu$ sec. Waveforms are shown in Fig. 2.

Variation of delay time with temperature is minimized by the circuit. Factors affecting the delay time of the circuit are determined by examining the expression for the total delay time

$$T_d = C_s \left[ \frac{V_d + (V_{D_s} - V_o - V_{D_s})}{i_{ch}} - R_s \right] - R_s C_s \log_e \left[ \frac{V_{B_1} + (V_{B_{E_2}} - V_{B_{E_1}})}{i_{ch} R_s} \right] \quad (1)$$

where  $T_d$  = time delay of the circuit,  $V_d$  = delay voltage,  $V_{D_s}$  = junction voltage of diode  $D_s$ ,  $V_{D_s}$  =

junction voltage of diode  $D_o$ ,  $V_c$  = collector voltage across  $Q_1$  in saturation,  $i_{ch}$  = charging current,  $V_{B_{E_2}}$  = voltage across base-to-emitter junction of  $Q_2$ ,  $V_{B_{E_1}}$  = voltage across base-to-emitter junction of  $Q_1$ , and  $V_{B_1}$  = voltage at the base of  $Q_1$ .

The first term on the right hand side of Eq. 1 expresses the time required by the collector voltage of  $Q_1$  to reach delay voltage  $V_d$  and determines the major portion of the time delay.

The additional time required by the circuit to return to its initial state is expressed by the second term. The negative sign accounts for the fact that the logarithm of a number less than 1 is taken.

Assuming that the charging current,  $i_{ch}$ , is stabilized, the terms in Eq. 1 that vary with temperature are  $V_{D_s}$ ,  $V_{D_o}$ ,  $V_{B_{E_2}}$ , and  $V_{B_{E_1}}$ . Effect of  $V_o$  upon the time delay can be neglected since the magnitude of this voltage is small due to  $Q_1$  being saturated. The junction voltage of pick-off diode  $D_s$ , however, varies by about 2.6 millivolts per deg C. Placing diode  $D_s$  between the collector of  $Q_2$  and  $C_s$  compensates for the effect of the voltage drift introduced by  $D_s$ .

In an uncompensated circuit, the time delay defined by the second term of Eq. 1 is primarily deter-

mined by the phase-to-emitter voltage of  $Q_2$ . Since this voltage varies with temperature, it is a source of timing error. By adding transistor  $Q_1$  and using a common heat sink, this source of timing error is reduced to the difference between base-to-emitter voltage of  $Q_1$  and  $Q_2$ .

Stability of the charging current,  $i_{ch}$ , is determined from

$$i_{ch} = \frac{V_z + (V_{B_{E_2}} - V_{D_s})}{R_s} \quad (2)$$

where  $V_z$  = Zener voltage of  $D_s$ ,  $V_{B_{E_2}}$  = base-to-emitter voltage of  $Q_2$  and  $V_{D_s}$  = voltage across the stabilization diode  $D_s$ .

By choosing the parameters of diode  $D_s$  to be identical to those of the emitter-to-base junction of  $Q_2$ , stability of  $i_{ch}$  is achieved.

Linearity of time delay is a function of charging current  $i_{ch}$ . Because a transistor is used as the current source, the collector-to-base resistance determines the change in the charging current versus collector voltage. Since the effect of the collector resistance of  $Q_1$  is partially compensated by the inverse resistance of  $D_s$ , the collector resistance of  $Q_2$  alone determines the linearity of the circuit. The deviation from linear voltage rise is determined from the expression for the voltage across  $C_s$  during the active part of the cycle

$$V_{C_s}(t) = V_o + \frac{1}{C_s} \int_0^t \left( i_{ch} - \frac{Kt}{r_{cs}} \right) dt \quad (3)$$

where  $V_o$  = initial voltage across  $C_s$ ,  $K$  = average rate of rise of voltage across  $C_s$  and  $r_{cs}$  = collector-to-base resistance of  $Q_2$  at the value of charging current.

The term  $Kt/r_{cs}$  determines the deviation of the charging current from the value specified in Eq. 2. Using  $K = 0.135$  v/ $\mu$ sec,  $r_{cs} = 0.5$  megohm, and  $t = 120$   $\mu$ sec, the deviation from linearity resulting from the collector resistance of  $Q_2$  being finite is less than 0.65 percent.

The time delay can be increased to more than 120  $\mu$ sec by either increasing the value of  $C_s$  or by decreasing the charging current  $i_{ch}$ . The former method is preferred, since reduction in  $i_{ch}$  will increase stability of the time delay.

The authors thank L. Sanders and L. Maggi for their assistance.

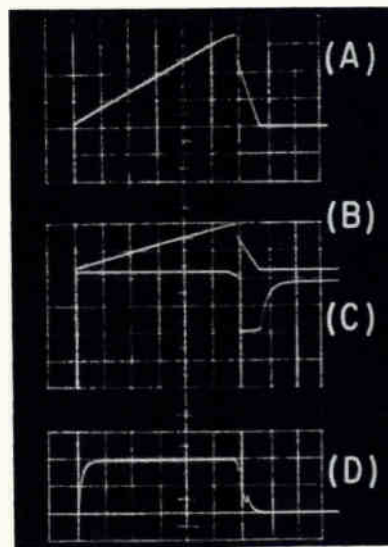


FIG. 2—Waveforms and vertical scales are: collector  $Q_1$ , 5 v/div (A); collector  $Q_1$ , 10 v/div (B); voltage across  $R_s$ , 2 v/div (C); and collector  $Q_1$ , 5 v/div (D). All have horizontal scale of 20  $\mu$ sec/div



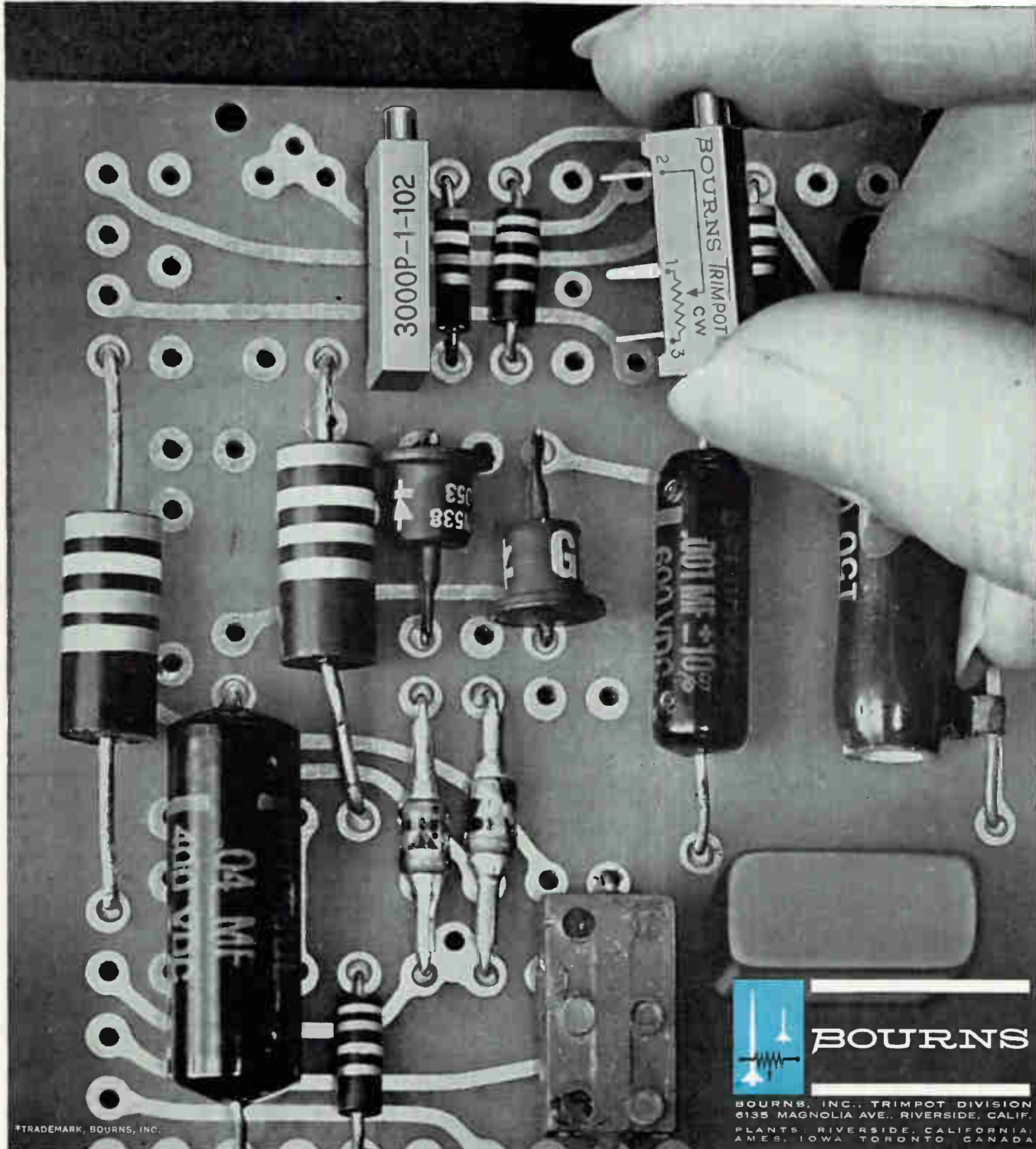
# Now—an Even Smaller High-Temperature Trimpot® Potentiometer

Here, just  $\frac{3}{4}$ " in length, is a wirewound potentiometer that is completely humidity-proof and operates at 175°C! Ideal for your printed circuit applications, it withstands 30G vibration and 100G shock, dissipates 0.5 watt at 70°C (0.2 watt at 125°C), and has tapered pins for quick, easy mounting.

Sealed against humidity in a high-temperature plastic case, the Model 3000 is stocked in resistances of 50 ohms to 20K. A Resistor\* carbon version, Model 3001, is available with resistances of 20K to 1 Meg. Write for complete data and list of stocking distributors.

rate. For maximum stability, the unit incorporates a ceramic mandrel. Reliability is outstanding. The exclusive Silverweld® bond between terminal and resistance wire is virtually indestructible under thermal or mechanical stress.

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



\*TRADEMARK, BOURNS, INC.

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

# Russians Experiment With 3-D Color Tv

**EXPERIMENTAL** three-dimensional color television system was described in a Russian publication.<sup>1</sup> Although methods for broadcasting the signal have not been developed and other problems remain, the equipment is said to permit important experimentation in technical requirements and in perception by human observers.

The following description of the project is based on a translation of the article that was prepared under contract by the United States Joint Publications Research Service. This federal government organization was established to fulfill translation and research needs of government departments.

Television broadcasting in Russia is limited to black and white, although Moscow and Leningrad tv centers are said to be making experimental compatible color television broadcasts.

Color television improves discrimination of objects and three-dimensional television has demonstrated its value in remote control of mechanisms. As a result, efforts are being made to combine the two.

An experimental apparatus called stereocolor has been constructed for three-dimensional color television. The system was developed under direction of Prof. P. V. Shmakov at the television department of the Leningrad Electrical Engineering Institute of Communications. It is being used to investigate such problems as the influence of color on perception of depth and the effects on the stereocolor picture of bandwidth and of certain types of flicker.

Stereocolor television pictures are obtained by taking two color television pictures of the same object from different points. The two pictures, called the stereo pair, differ from each other in horizontal parallax. The left and right images of the stereo pair can be transmitted simultaneously on two channels or successively on a single channel. Reproduction of color in this system is accomplished in the same

manner as in other color television systems.

Use of the scanning-beam method in the transmitting portion of the system is justified by its use in color television. However, if both images of the stereo pair are transmitted simultaneously, it cannot be used in stereocolor television. Successive transmission of each image or part of an image is possible with a scanning-beam camera as well as simultaneous transmission of the three colors. Therefore it was used in the system. In addition, a control device makes possible experiments with either simultaneous or sequential transmission systems for the stereo pair.

A variety of methods of operating the two scanning tubes sequentially are possible. They could be commutated synchronously with frames, with margins or with lines. Because commutating the scanning tubes at the standard frequency of frames or margins causes flicker, commutation at line frequency was chosen.

The stereocolor signals are generated by 18LK8Zh scanning tubes spaced 180 mm apart on the camera. A special commutator was used to regulate sequential on and off switching of the scanning tubes at line frequency. To form the left and right images of the stereo pair, one line is scanned by one tube while the other tube is blanked. Then the first tube is blanked while the second tube scans a line.

A stereoscopic viewer was incorporated in the camera for the convenience of the operator. Angular rotation of the optical axis is possible within limits of 10 degrees to allow changes in the region of stereoscopic vision.

A system of multiplier phototubes that transform light reflected from the object into color-selected signals is set up in the studio. Signals from the phototubes are fed to a video mixer and then to a circuit that corrects scanning tube aper-

ture distortion. Preamplifiers increase signal level to 1 watt and correct afterglow of the mosaic on the scanning tubes.

After preamplification, the signals are supplied to a color corrector where they are transformed into signals corresponding to the primary colors. The transformed video signals then enter the gamma corrector where they are pre-distorted according to the nonlinear modulation characteristic of the pickup tubes. The signals are then fed to the stereocolor receiving video control system, which consists of two 53LK4Ts tubes and a double set of color video control units.

Specially modified tubes are used in the receiver to obtain a stereoscopic color picture. The left and right images are combined by half transparent mirrors. Separation of the stereo pair is achieved with polaroid sheets positioned in front of the tubes with their planes of polarization mutually perpendicular. The three-dimensional image is visible with polaroid glasses when it is projected on a mirror through the two sheets.

The system operates at the standard frequency band of 6.5 Mc. The same requirements apply to adjustments of color channels as to other color television systems. A video control black and white two-dimensional unit and a control oscilloscope are included in the system.

Because the picture is obtained by scanning the scene with light beams, extraneous light must be kept from the studio. The studio is illuminated by pulsating light sources during retrace of the scanning tubes. Special pulses simultaneously blank the multiplier phototubes.

The first stereocolor television picture was demonstrated on December 10, 1959. All viewers were said to have noted depth of the picture, adequacy of brightness and the satisfactory reproduction of colors. Because of the 180 mm





# OHMITE Tantalum Slug Capacitors NOW $\pm 10\%$

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

Resulting from advanced manufacturing processes and quality control techniques, this new engineering development improves previous broad tolerances of  $-15+20\%$  and  $-15+50\%$ .

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

For the complete picture of Ohmite's *big, full line* of wet-electrolytic tantalum slug capacitors, *request Bulletin 159F today!*



## OHMITE MANUFACTURING COMPANY

3610 Howard Street, Skokie, Illinois

Rheostats Power Resistors Precision Resistors  
Variable Transformers Tantalum Capacitors  
Tap Switches Relays R.F. Chokes  
Germanium Diodes Micromodules



**Fast Delivery of MIL and Commercial Stock Values From Factory and Distributors**

TANTALUM SLUG



TANTALUM FOIL— ETCHED AND PLAIN



TANTALUM WIRE



after  
**62**  
years

...no soldering  
application's  
too difficult!



# Kester Solder

Kester's latest development . . . "44" RESIN-CORE SOLDER has a perfected activated resin flux for faster assembly line soldering. Like all Kester Flux-Core Solders, it will solve many circuit design and development requirements. Used by leading electronic manufacturers everywhere.

Other Rosin-Resin Flux-Core Solders also available as well as many "Specialized" Flux-Core Solders.

Write today for free 96-page Kester technical manual "SOLDER... Its Fundamentals and Usage."

## KESTER SOLDER COMPANY

4204 Wrightwood Avenue, Chicago 39, Illinois  
Newark 5, New Jersey • Brantford, Canada  
ANAHEIM, CALIFORNIA

Over 62 Years' Experience in Solder And Flux Manufacturing

separation of the camera pickups for left and right images, the impression of depth was somewhat exaggerated when small objects were examined in the foreground. However, this characteristic is felt to be useful under certain conditions.

Efforts are being made to develop methods for stabilizing the channel and for transmitting signals from the stereo pair picture.

### REFERENCE

(1) V. Dzhakoniy, *Radio*, 4, p 29, Moscow, April 1960.

## Dual-Armature Voltmeter Speeds Measurements

By F. W. KEAR,  
Supervisor, R & D Lab.,  
Lytle Corp., Albuquerque, N. M.

POLARITY-SEEKING voltmeter automatically switches d-c input voltages to the correct polarity for the meter movement. As well as protecting the meter from voltage of incorrect polarity, automatic polarity switching is convenient and time-saving when large numbers of voltage measurements must be made involving voltages of both polarities.

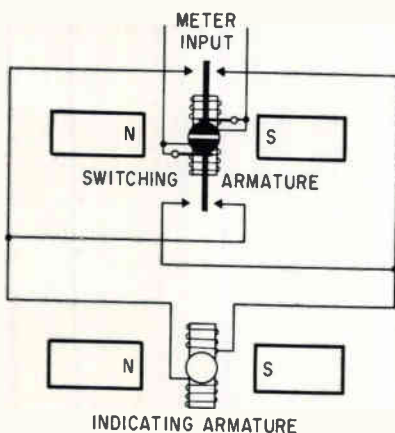
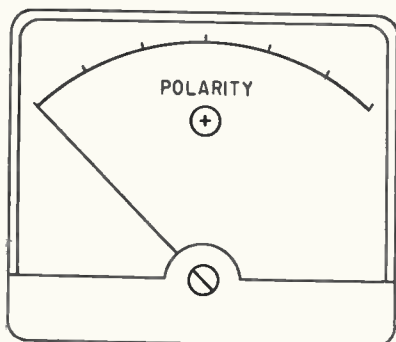
The instrument can be incorporated into test equipment that requires voltage to be measured relative to ground or to some other reference level without requiring manual operation of a polarity-reversing switch. When the voltage to be measured is applied at the meter input, its polarity as well as its magnitude is indicated on the meter face.

The dual-armature meter shown in the figure has a conventional indicating armature that deflects a pointer to the right when voltage of the correct polarity is applied to it. A second armature drives a normally open dpdt switch. An adjustable helical spring holds the switch contact arms at the open position when no current is flowing in the switching armature to avoid accidental application of incorrectly polarized voltage to the indicating armature.

When the d-c voltage to be measured is applied to the meter input



terminals, the switching armature rotates in a direction determined by polarity of the voltage. The switch contact arms complete a circuit from each input terminal through slip rings to each side of the indicating armature. If polarity of the input voltage is reversed, the switching armature rotates in the opposite direction reversing the connections from the input terminals to the indicating armature. Thus voltage to the indicating armature always has the same relative polarity regardless of polarity of the voltage at the input terminals.



Dual-armature meter indicates polarity as well as magnitude of measured voltage

The switching armature also operates a polarity-indicating device. Polarity of the measured voltage relative to one input terminal is indicated by lamps or flags on the meter face.

Both armatures are balanced to limit the torque required to operate the meter. In addition, the switching armature is wound to produce maximum torque for the range of currents that will be encountered by the armature.

## DIRECTIONAL COUPLERS • RF LOAD RESISTORS COAXIAL TUNERS • RF WATTMETERS • VSWR METERS



RF Power and VSWR measuring instruments are rugged and accurate in both field and laboratory use. The patented circuit produces an output essentially independent of frequency. Over 3800 models of coupler units available. MICRO-MATCH instruments meet highest government and commercial standards, combine highest quality with low cost.

### RF POWER and VSWR Instruments

Model No.	Frequency Range (mcs.)	Power Range Incident & Reflected (watts)	RF Connectors and Impedance
263	0.5 - 225	0 - 10; 100; 1000	Type N* 52 ohms
706N	28 - 2000	0 - 400	Type N* 52 ohms
711N	25 - 1000	0 - 30; 75; 300	N plus 83-1R Adapters
712N	25 - 1000	0 - 2.5; 5; 10	N plus 83-1R Adapters
722N	1000 - 3000	0 - 4	Type N 52 ohms
723N	1000 - 3000	0 - 12	Type N 52 ohms
405B8	28 - 2000	0 - 4000	1 3/8" Flange 51.5 ohms
445A10	20 - 2000	0 - 40,000	3 1/8" Flange 50.0 ohms

### DC OUTPUT DIRECTIONAL COUPLERS

Model No.	Frequency Range (mcs.)	Power Range Incident & Reflected (watts)	RF Connectors and Impedance
574N1	42 - 2000	1.2	Type N* 52 ohms
574N6	28 - 2000	0 - 400	Type N* 52 ohms
594N2	1000 - 3000	0 - 4	Type N 52 ohms
594N3	1000 - 3000	0 - 12	Type N 52 ohms
402B8	28 - 2000	0 - 4000	1 3/8" Flange 51.5 ohms
442A9	28 - 2000	0 - 12,000	3 1/8" Flange 50.0 ohms

### RF OUTPUT DIRECTIONAL COUPLERS

Model No.	Frequency Range (mcs.)	Coupling Attenuation	RF Connectors and Impedance
313N3	300 - 2000	30 db	Type N* 52 ohms
313N5	60 - 2000	50 db	Type N* 52 ohms
442A40	200 - 1000	40 db	3 1/8" Flange 50.0 ohms

### ABSORPTION TYPE RF WATTMETERS

Model No.	Frequency Range (mcs.)	Power Range (watts)	RF Connectors and Impedance
621N	1 to over 1000	0 - 120 milliwatts	Type N* 52 ohms
625C5	50 - 1000	0 - 120	Type C 50 ohms
651N	25 - 1000	0 - 25; 100; 500	Type N 52 ohms
611A7	50 - 1000	0 - 1200	3 1/8" Flange 50 ohms
612A	44 - 1000	0 - 6000	3 1/8" Flange 50 ohms

### RF LOAD RESISTORS

Model No.	Frequency Range (mcs.)	RF Power Dissipation (watts)	RF Connectors and Impedance
603N	3000	20 (air cooled)	Type N 52 ohms
633N	3000	50 (air cooled)	Type N* 52 ohms
636N	3000	600 (air cooled)	Type N* 52 ohms
638A	2000	6000 (water cooled)	3 1/8" Flange 50.0 ohms

### CALORIMETRIC TYPE Primary Standard of RF Power

Model No.	Frequency Range (mcs.)	Power Range	RF Connectors and Impedance
641N	0 - 3000	0 - 3; 10; 30; 100; 300	Type N 52 ohms

### COAXIAL LINE TUNERS

Model No.	Frequency Range (mcs.)	Range of Correction	RF Connectors and Impedance
151N	200 - 1000	Tunes a load with a VSWR of 2.00 max. down to a VSWR of 1.00	Type N 50 ohms
152N	500 - 4000	Tunes a load with a VSWR of 2.00 max. down to a VSWR of 1.00	Type N 50 ohms

\*Also available with UHF, C, and HN Connectors.

For more information, write:

**M. C. JONES ELECTRONICS CO., INC.**

185 N. MAIN STREET, BRISTOL, CONN.

SUBSIDIARY OF



# Filters Clear Airways of Harmonics

INTERFERENCE PROBLEMS in radio signals extend all across the spectrum. A look at microwaves indicates the magnitude of these problems. Troubles occur between high-power radars, which produce as many as a dozen harmonic frequencies in addition to their fundamentals, and sensitive microwave links. Increasing difficulties will be caused by the increase in number and power of today's 12,000-plus radar transmitters, and an estimated doubling of the current 7,000 microwave relay stations in the next five years.

Today over New York City, there are about 200,000 fundamental frequency pulses per second radiated from radar transmitters alone. Including harmonics, this number goes up to a million or more pulses per second. In this environment, many different types of sending and receiving systems are operating. These include weather radars, airport radars, air-defense systems, satellite communications, tropospheric scatter, telephone and tv, and so on. In the next decade, the interference situation could become chaotic, without careful control and planning to clear the air of unwanted harmonics.

Back in 1955, experts at General Electric, including Tomiyasu, Forrer and Williamson, and Hiebert of Rand Corporation, set out to study radio-interference problems on a modest scale. Within a year, their work attracted attention of the military, and Air Force support came from Rome Air Development Center.

An elaborate analyses center was established to predict the radio environment faced by transmitters. Objectives of the program determined the spectro-output of high-power microwave tubes, and the development of techniques to reduce unwanted harmonics to levels where interference would not occur. A redesign of power tubes was not the complete answer, and attention was turned to the control of spurious output of the tubes by means of external filters.

Much of this work has been under military wraps. But in the past year, some security has been lifted, and General Electric' has translated some of these filter designs into a line of filters whose work extends from the 400 mc to 10,000 mc. These filters provide increased fundamental power handling capability in the waveguide transmis-

sion line by overcoming waveguide breakdown problems prevalent in equipment generating harmonics.

The electrical ratings and mechanical data on filters developed to keep pace with the rapidly increasing utilization of the microwave spectrum are given in table.

In normal applications, these filters are located in the waveguide transmission line between the output tube and the antenna, and as close as possible to the output tube. Six of the filters cover the S, C, L and uhf bands and are relatively small and lightweight. The MPF-400 filter for the uhf range, is believed to be the largest built to date (see cover). Additional frequency coverage will be provided by new filters now under development.

The filters absorb the unwanted harmonic signals produced by the transmitting tubes, but still allow the intended fundamental frequency to pass through with power undiminished. Strength of the harmonics is reduced to 100,000 the strength of the original signal, with but 2 percent insertion loss. Types now in development meet needs as high as 40,000 mc.

Effective solution to the microwave problem lies in increasing the power handling capability of the waveguide system of the output side of the tube by eliminating waveguide arcing which results from harmonics.

The filter itself is constructed and installed so that apertures are positioned along the inside walls of the main waveguide. Harmonic signals are leaked away by a series of coupling slots and muffed in their secondary waveguides.

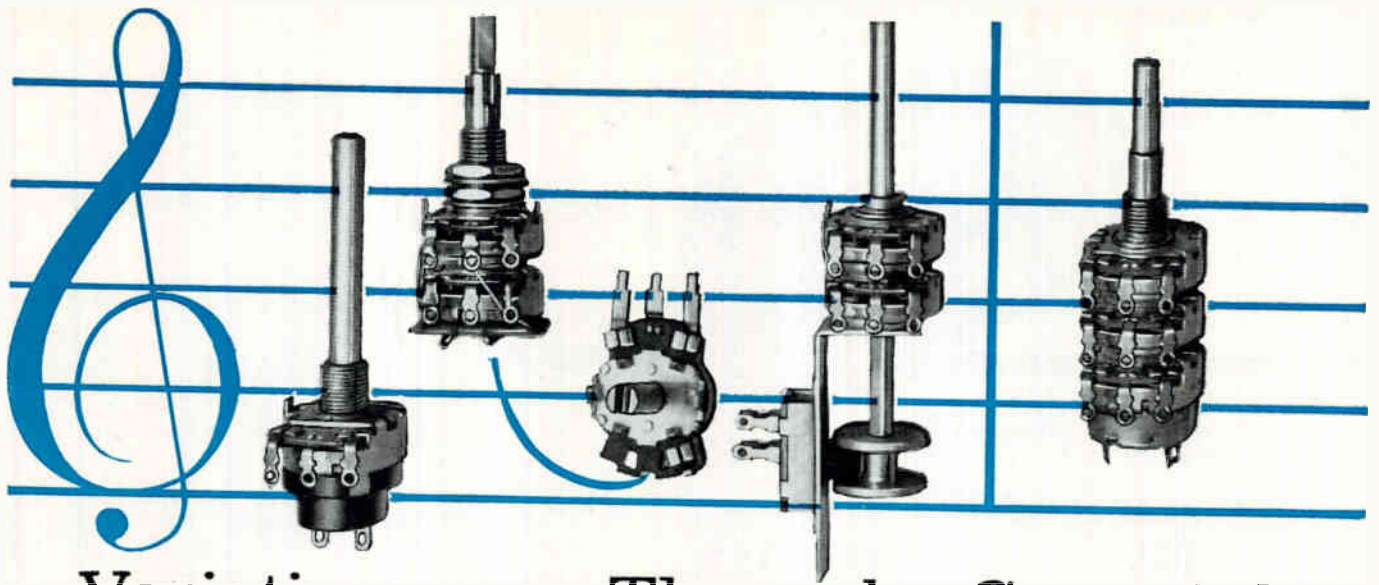
The development of the filter techniques has been possible by close affiliation of General Electric with military agencies.

In a typical radar transmitter, filters are placed as close to the output power amplifier as practical, see diagram. As an example of how the filter can increase fundamental power handling, consider a typical high-power radar transmitter. In

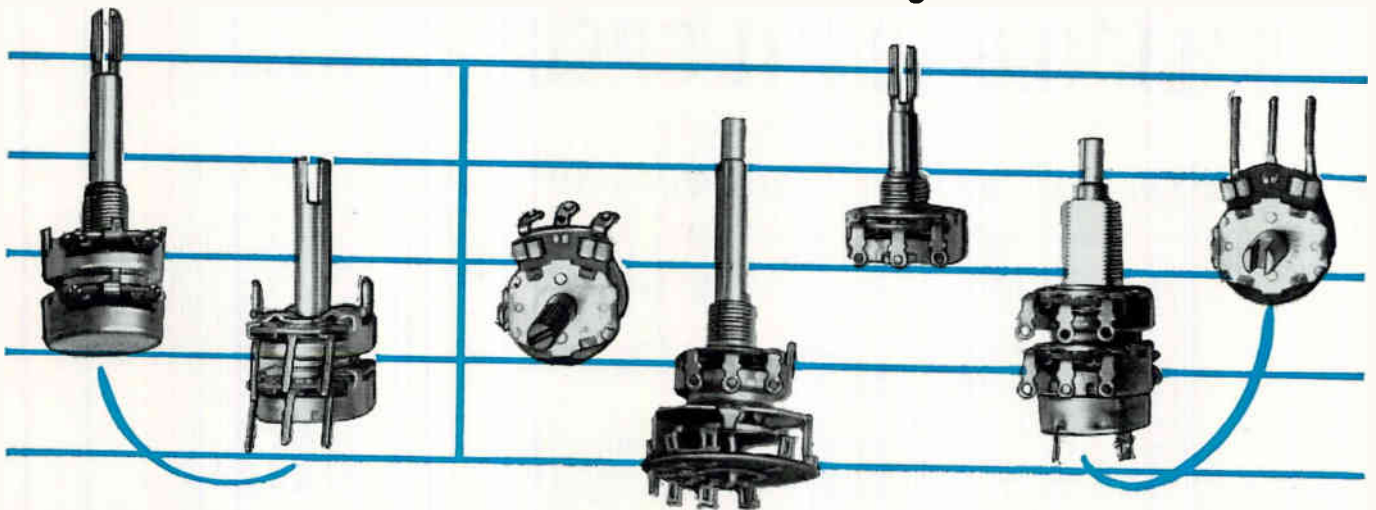
CHARACTERISTICS OF HARMONIC ABSORPTION FILTERS

ELECTRICAL	MPF-2501	MPF-2502	MPF-1001	MPF-400	MPF-1000	MPF-800	MPF-2001
Pass Band Freq. Range (kmc)	2.6-3.1	2.6-3.6	1.2-1.4	0.40-0.45	5.0-6	0.76-0.98	2.35-2.7
Peak Power (megawatts)	5	5	10	5	1	0.1	20
Stop Bands Freq. Range (kmc)	4.8-6.2 7.8-9.3 10.4-12.4	6.0-7.2 7.8-10.4	2.4-2.8 3.6-4.2 4.8-5.6 6-7	0.80-0.90 1.20-1.35 1.60-1.80	10.0-12.0 15.0-18.0	1.51-1.97 2.26-2.96	4.7-5.4 6.75-8.1 9.4-10.8
MECHANICAL							
Dimen. (Inches)	36 x 9.5 dia	36 x 9.5 dia	51 x 24	166 x 49 x 34.5	25 x 7 dia	72 x 25 x 12	48 x 15 dia
Weight (Approx.)	50 lbs	50 lbs	175 lbs	1,200 lbs	25 lbs	250 lbs	100 lbs





## Variations on a Theme by Centralab



The Conventional Model 2 Composition Variable Resistor has 15 separate identities\*...and potentially more!

Versatility is music to the ears of CENTRALAB engineering and production people—which is one of the reasons that our 15/16" composition variable resistor (known as the Model 2) is such a favorite. The basic unit, rated at 1/2 watt, with resistances from 200 ohms to 10 megohms, in various tapers, is highly adaptable.

It is available as a single, dual or twin control, metal or plastic shaft, with a choice of 5 types of switches

(snap action, push-push, push-pull, slide, or rotary), 5 types of mountings (bushing, twist-tab, snap-tite\*, "doghouse" bracket or "grasshopper"), 3 types of terminals (solder lug, wire wrap, or printed circuit), with unlimited variations and combinations.

Harmonizing with your requirements is our business. We probably make the type of Model 2 you need—if not, we can develop it for you. We're always interested in an additional variation on our favorite theme.

\* Described in our brand-new Model 2 Brochure, available free by requesting Bulletin #42-1081.

**Centralab**  
CR

THE ELECTRONICS DIVISION OF GLOBE-UNION INC.  
 914D East Keefe Avenue • Milwaukee 1, Wisconsin  
 Centralab Canada Limited Ajax, Ontario

\*Trade Mark B-6113

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

April 14, 1961

CIRCLE 87 ON READER SERVICE CARD 87



## Gertsch CRT-3 Subminiature Coaxial RatioTran®

- ONLY 2½" IN DIAMETER
- ACCURATE TO 0.001%

# -QUALIFIED TO MIL SPECS

*These units are now in service in several major missile systems*

**EXCELLENT PERFORMANCE.** This Gertsch AC voltage divider, has inherent characteristics of high input impedance, low effective output impedance, and very low phase shift. Input voltage: 0.35 f (f in cps) or 140-volt max. at 400 cps.

Frequency range: 50 to 10,000 cps. Unit is ageless, requiring no calibration tests. Performance approaches that of the ideal divider.

**MANY TYPES.** Subminiature RatioTrans are available with 4-place, 5-, and 6-place resolution, and in a wide variety of decade arrangements. Available either servo mount or flange mount. Complete data sent on request. Bulletin CRT-3. Or contact your Gertsch representative.

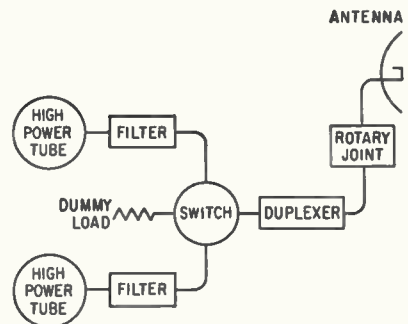
- SHOCK:** ..... MIL-S-901B (5 foot drop, 400-lb. hammer)
- VIBRATION**
- OPERATING:** ..... MIL-STD-167, Type I
- NON-OPERATING:** ..... MIL-E-4970, Proc. III
- SALT SPRAY:** ..... MIL-E-5272A
- DRIP PROOF:** ..... MIL-STD-108
- FUNGUS:** ..... MIL-E-5272
- HUMIDITY:** ..... MIL-STD-202A
- HIGH TEMP.**
- OPERATING:** ..... + 52° C
- NON-OPERATING:** ..... + 71° C
- LOW TEMP.**
- OPERATING:** ..... - 18° C
- NON-OPERATING:** ..... - 54° C
- DIELECTRIC**
- STRENGTH:** ..... .900 V RMS. 60 cps

# =Gertsch=

GERTSCH PRODUCTS, INC.

**N.B.S. TRACEABILITY**  
These instruments can be supplied with certificates of accuracy showing traceability to N.B.S., to meet requirements of U.S.A.F. Bulletin NR. 520 (17 May, 1960) and other such requirements.

3211 S. La Cienega Blvd., Los Angeles 16, Calif. • Upton 0-2761 • Vermont 9-2201



Typical layout of radar transmitter using harmonic absorption filters

many systems, the *vswr* in the transmission line is as great as 1.5:1. If the incident electrical field is normalized to a value of one volt per centimeter, then at some positions along the line the electric field has a magnitude of 1.2. In typical systems the level of harmonic power may be as great as -20 db referred to the carrier frequency power. The normalized incident electric field (for modes well above cut-off) for a harmonic signal then is 0.1-v per cm. This signal often propagates with a *vswr* of 10 or more at some frequencies so that at some positions along the line the harmonic electric field will have a magnitude of 0.18-v per cm.

If the line is long enough for the standing wave peak of the fundamental to add in phase with the standing wave peak of the harmonic, then the equivalent electric field amplitude is 1.38-v per cm. The power corresponding to these fields may be compared by squaring as follows:

$$\left(\frac{E_f + E_h}{E_f}\right)^2 = 1.33$$

where  $E_f$  is 1.2-v per cm and  $E_h$  is 0.18-v per cm. Thus, if the above transmitter operates very close to the voltage breakdown level, then removal of the harmonics from the line will allow transmission of one-third more fundamental power before the same breakdown value is reached.

The exact increase of fundamental power capability depends not only on the filter design, but also on the layout and operating conditions of the transmission line.

### REFERENCE

- (1) V. G. Price, Manager, Filter Section, Traveling Wave Tube Product Section, Power Tube Department, General Electric Co., Palo Alto, Calif.



## Sets Up Advisory Group For Microminiaturization

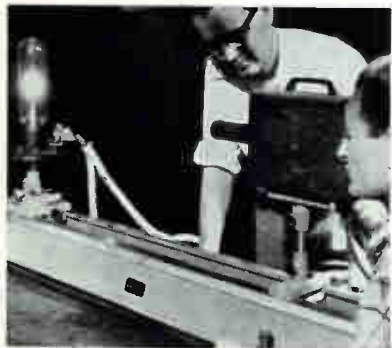
THE ELECTRONIC Industries Association's Subcommittee on Micro-miniature Components for Computer Use has been given full committee status within the EIA Engineering Department and will function as an advisory committee on user recommendations for discrete microminiature components for all applications, the association announced today.

The group, re-designated the Microminiature Components Advisory Committee, has been given an across the board advisory function. As in the past, it will be staffed by representatives of user groups who will prepare user requirements for referral to standardizing committees of the EIA Engineering Department.

Edward Keonjian, of the Arma Division of American Bosch Arma Corp. at Garden City, N. Y., will continue as chairman of the committee.

The committee was given the advisory function in recognition of the widespread use of microminiature components in fields other than computer. The action was taken after approval by chairman of the EIA Panels on Industrial Electronics, Component Parts, Consumer Products, and Military Products.

## Calibrating Temperatures Up to 10,000 C



Automatic pyrometer that can continuously measure and control temperatures up to 10,000 C is tested by engineers of Atomics International, a division of North American Aviation, Inc. A standard lamp is used for calibrating the device during test operation. Unit will be manufactured by Pyrometer Instruments Co., Inc., Bergenfield, N. J.

CIRCLE 89 ON READER SERVICE CARD→



*For 100% production line  
testing of components...*

## CEC's new RADIFLO LEAK DETECTOR



Above: Activation unit.

Below: Scintillation counter.



There's nothing like CEC's new Type 24-510 Radiflo Leak Detector. This radioactive tracer sensing system detects leaks as small as 10<sup>-11</sup> atm cc/sec... makes 100% testing of hermetically sealed electronic and electrical components economically feasible.

Radiflo provides automated activation. Once the activation unit has been programmed, and components are locked in, a single push-button begins a cycle that pressurizes parts with Krypton 85, a non-toxic, inert radioactive gas. Up to 10,000 components can be activated at one time. Inspectors simply place activated components into scintillation counters - up to 2500/operator/hour. "Leakers" are detected and leak rates measured by indicated intensity of radiation.

For complete information, call your nearest CEC sales and service office or write for Bulletin CEC 24510-X1.

Analytical & Control Division **CEC**

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF Bell & Howell • FINER PRODUCTS THROUGH IMAGINATION

# Prepare Semiconductor Dice in High Volume

LARGE QUANTITIES of semiconductor crystal blanks are needed to supply the automated MADT transistor production lines at the Lansdale Division of Philco Corp., Lansdale,

Pa. Volume requirements have led to equipment improvements which speed up crystal pulling, dicing and etching.

Czochralski pullers used to grow

single crystals of germanium (a 1-1-0 orientation is desired) have been modified to reduce downtime and make the crystals more uniform. A continuous feed enables very large crystals to be grown.

Billets of germanium are fed into the melt at the same rate as the crystal is withdrawn. Each puller is equipped with a sealable tube leading to the crucible. A billet is suspended in the tube by a clamp lowered at a rate set by the pulling controls.

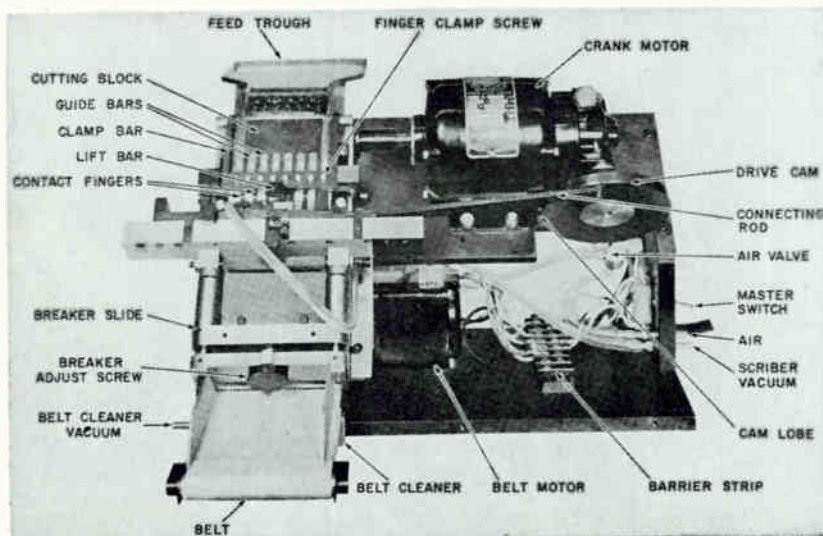
More recently, some pullers have been equipped with double feed tubes. Five crystals can be pulled from the melt before the furnace is shut down. A port, built into a chamber surrounding the pulling spindle, permits removal of finished crystals and attachment of fresh seeds without contaminating the melt.

Billets are about two feet long and weigh some 2,000 grams. They are prepared in zone refining machines which have 10 tubes ganged to the same controls and programmer.

Crucibles for germanium have a collar several inches high rising above the melt. The heat of the collar soaks the crystal as it is pulled, extending the crystal-growing period and reducing dislocations. Conventional pullers are used for silicon as the quartz crucibles employed require frequent replacement.

After crystals have been oriented by x-ray diffraction, they are butt-mounted on cantilever-type sawing fixtures. Cantilever mounting requires holding cement on only one end of the crystal, minimizing wafer cleaning and reducing impurities in reclaimed scrap. Wafering is done on conventional diamond saw indexing machines.

Wafer resistivities are checked with direct-reading instruments. The operator is required to adjust the test set only to the thickness of the batch being tested. Each wafer is positioned under a four-point probe which is depressed by the



Automatic scriber (strip-to-blank) with location of parts



Billet is loaded into feed tube of crystal puller



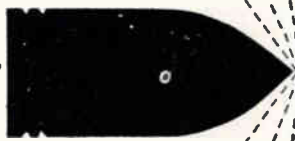
Crystal is removed through port



Wafer resistivity test set



*To recall a bullet 12,000 miles away*



*requires Motorola systems reliability*

**THE B-70 M&TC** major system management contract places in the hands of a single contractor, Motorola, an unprecedented responsibility: positive recall of a Mach 3, nuclear deterrent force. At speeds over 2,000 mph—faster than a rifle bullet—crew and aircraft safety, as well as mission success, demand integration of myriad electronic functions with simplified controls and displays. ☆ The integrated M&TC system includes the functions of world-wide command communications (LRR) linked to the SAC Command Network; line-of-sight, short-range communications (SRR); improved tactical air navigational aids (TACAN); air-by-air IFF; air-by-ground IFF; aerospace ground support equipment (AGE); air-to-air rendezvous equipment; instrument landing system (ILS); and crew intercommunications. ☆ Motorola's role as a major electronic system contractor for the B-70 Valkyrie's Mission and Traffic Control typifies its systems management capabilities. Detailed information is available on request.

**Military Electronics Division**



**MOTOROLA**

*Qualified technical personnel  
are invited to apply*

CHICAGO 51, Illinois, 1450 North Cicero Avenue  
SCOTTSDALE, Arizona, 8201 East McDowell Road  
RIVERSIDE, California, 8330 Indiana Avenue



## THE SPARE PARTS PROBLEM

The Electronics Business may not be the most tranquil enterprise for anyone to get into — either as a buyer or seller — as evidenced by one of the problems currently plaguing both component makers and their customers. In a nutshell, the trouble is "equivalent" parts, made by a low bidder, failing to behave as the originals did. The explanation, while not as simple as this, seems to boil down to the fact that specs and descriptive data alone aren't enough for anyone to duplicate the performance of somebody else's original part. It could be a matter of the inability of the blueprint and the mimeograph machine to be a satisfactory substitute for the original manufacturer's experience, engineering skill, assembly methods and quality control.

No one can argue the merits of saving money, and a good part at the lowest possible cost is a commendable achievement. But when "low quote" means failure of critical equipment and personal hazard,

there's not much to be said for economy. On the other hand, if the low man *does* get all the information he needs to build an exact replacement of the original part (assuming he can build it), he is automatically getting the benefit of a great deal of work done and paid for by the original manufacturer. The polite term is usually "proprietary data." Understandably, this arouses the "unfair competition" ogre.

We don't like to give away proprietary information any more than the next person. Neither do we like to see unreliable components endangering life and limb. We think part of the answer may be to give the second man the same *problem* you gave the original supplier — not the blueprinted solution to imitate. Then test his result as carefully as you did the original successful one. This way, the odds are strongly in favor of your getting something that *will* work — and perhaps work even better.

What do you think the answer is?

\* E. W. Schrader, Western Editor of DESIGN NEWS, made some good observations on this whole subject, see pp. 6-7, Jan. 16 Issue.

# SIGMA

SIGMA INSTRUMENTS, INC.  
62 Pearl St., So. Braintree 85, Mass.

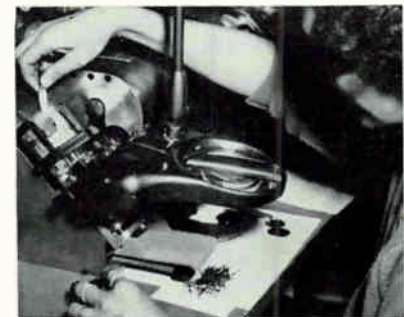
actuation of a hand operated lever.

Lapped wafers are polished in miniature barrel etchers. These are beakers, partially filled with etchant. After they are loaded with wafers, they are set at an angle in holders built into a rack. The holders have a mechanical drive, for rotation, heaters and temperature controllers.

Motorized scribing machines cut the wafers into strips and dice. These machines make it unnecessary to mount the wafers on plates for dicing. After a diamond tool scribes a horizontal line, a bar breaks off the strips or dice. Feed troughs guide the material to scribing and breaking positions. Strip or dice are discharged on a miniature belt. The operator picks off scrap and the good dice drop into a conveyor as the belt goes around a roller.



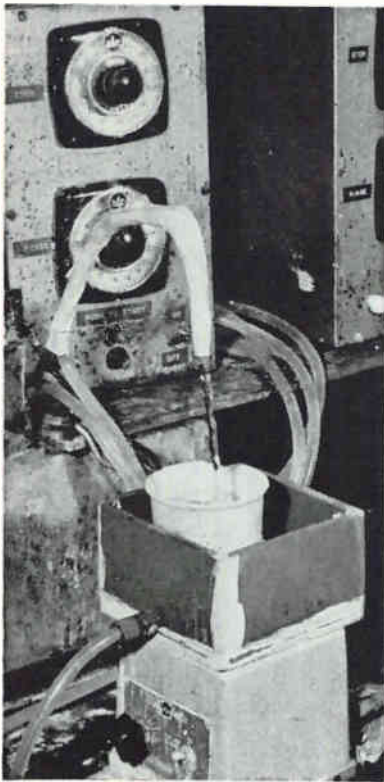
*Wafers are polished in miniature barrel etchers*



*Motorized scriber cuts wafers into strips*

Philco etches the dice in a beaker with perforated sides. It doubles as a rinsing unit. Dice and a magnetic bar stirrer are loaded into the beaker. The beaker is placed in a catch basin over the magnetic stirring unit. Temperature-controlled etchant goes into the beaker. The load is stirred vigorously for the time required to achieve the desired





*Dice are etched and rinsed in perforated beaker*

dice thickness. Then, deionized water is automatically released to stop the etching and to wash the dice.

Dice are sorted in a roller micrometer and diffused in batches in a vacuum furnace with an arsenic atmosphere. Impurity gradients of sample dice are profiled on test equipment. The emitter and collector pits are etched and plated with equipment similar to that used on the automatic transistor production lines.

### Barrel Spray Coats Electron Tube Parts

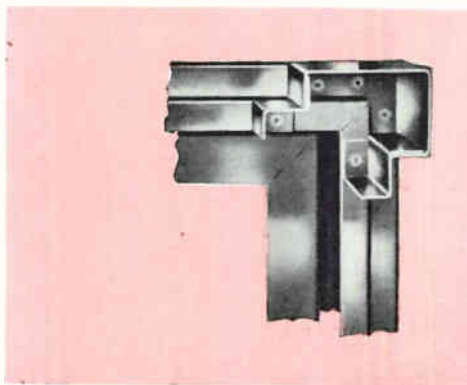
ROTATING BARREL spraying machine is reported to apply uniform coatings on small parts. It was designed by Startrite Design Ltd., Gillingham, Kent, England, to coat thermionic tube mica insulators with a suspension of magnesia in water. Parts fed into the barrel pass through a spray from a gun which reciprocates in the barrel and operates on each forward stroke. A timer, heater, fan and air cleaner are used to obtain even coating of parts in batches.

# RUGGED

## is the WORD!

The big  
difference in  
**Sheet Metal Cabinetry**  
for **Electronics**  
and **Instrumentation**  
is offered only

by *Equipto*



### SWAY — PROOF CORNER CONSTRUCTION

Double ledge, double plane corner construction\* provides greater structural stability with increased static load carrying capacity and the reduction of torsion to a minimum. Note the unique reinforced corner construction and points of weld — an exclusive Equipto feature.

\*U.S. PATENT APPLIED FOR

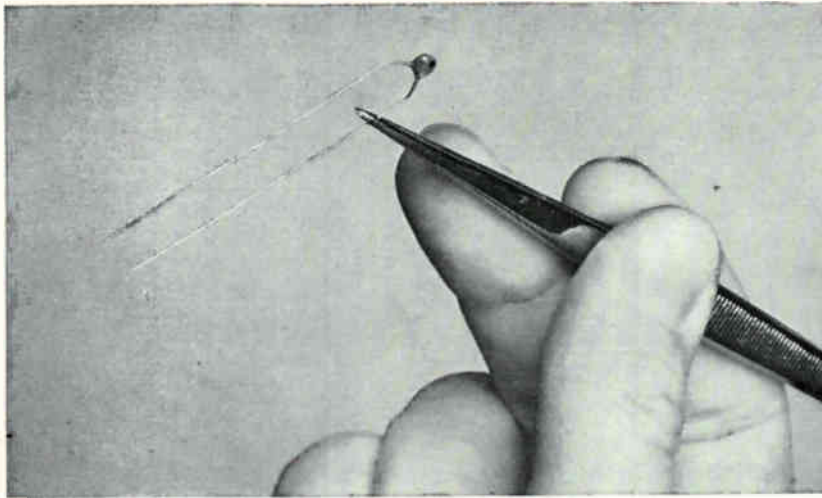
Get the Facts! Write today for descriptive Brochure No. 100.



*Equipto* ELECTRONICS CORPORATION

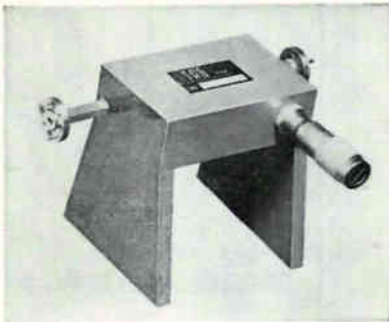
2 NORTH WEBSTER STREET • NAPERVILLE 1, ILLINOIS

# New On The Market



## Small Capacitors LOW VOLTAGE

COMPACT capacitor introduced by Sprague Electric Co., North Adams, Mass. is expected to find wide application in hearing aids. Only  $\frac{1}{4}$  inch in diameter, it is rated at 0.02 microfarad at 3 volts.



## Tunable Isolator MILLIMETER BANDS

TUNABLE ferrite isolator for K-band is announced by Technical Research Group, Inc., 9 Union Square, Somerville, Mass.

The Ferimat operates over the full waveguide frequency range, with performance ratings as follows: vswr 1.25 max; isolation 20 db-min; loss, 1.5 db max.

Applications include laboratory test bench equipment, experimental microwave circuits, signal generators and broadband countermeasures systems.

**CIRCLE 302 ON READER SERVICE CARD**

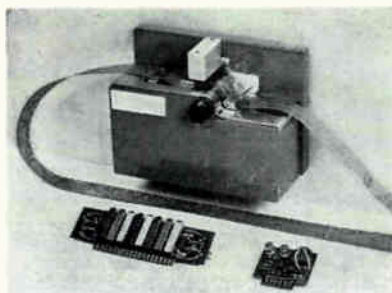
The largest in this line of micro Hypercon capacitors is rated at 0.1 microfarad at 3 volts and is  $\frac{3}{8}$  inch in diameter.

**CIRCLE 301 ON READER SERVICE CARD**

## Paper Tape Reader SLOW-SPEED USES

LOW COST, compact photoelectric paper tape reader that reads any 5, 7, or 8 hole perforated paper tape at rates up to 20 characters per second has been introduced by Invac Corp., 14 Huron Drive, Natick, Mass. Tape reader is designed for slow-speed applications where cost and size are primary requirements such as in business data processing and telemeter data reduction.

Photoelectric techniques elimi-



nate most electrical and electro-mechanical components normally

used in slow-speed tape readers. Features include all solid-state circuits, self cleaning, no tape access time, positive tape indexing, up to 60 percent light transmissivity, and a long life, low-temperature light source that does not affect the photocells. Reader unit is 6 by 4 $\frac{1}{2}$  by 4 inches.

Price of a rack-mounting tape reader, complete with amplifiers and drive circuits, is \$395.

**CIRCLE 303 ON READER SERVICE CARD**

## Thermionic Converter 10-WATT OUTPUT

PRACTICAL vapor thermionic converter with a 10-watt power output has been developed by the General Electric Power Tube Dept., Schenectady 5, New York. The sealed-off cesium vapor device has an integral radiator and reservoir. Power output of 2.4 watts per sq cm and efficiency of 11 percent was achieved at cathode temperature of 1,300 C.

To test seal ruggedness the converter was cycled 20 times between room and operating temperature (1,300 C). The device has 168 hours of steady-state operation.

Volume production will depend on the design and development of systems using the device.

**CIRCLE 304 ON READER SERVICE CARD**



## Cadmium Sulphide Cell 10 MA CELL CURRENT

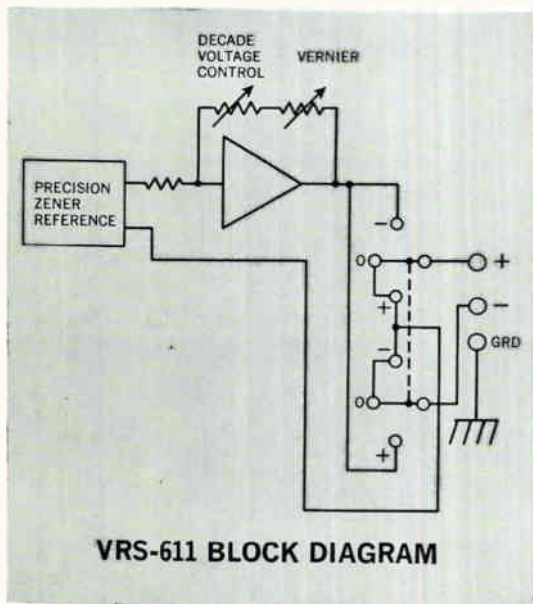
MINIATURE photoconductive cadmium sulphide cell with high sensitivity to visible light and dissipation rating of 1 watt has been announced by Amperex Electronic Corp., Semiconductor and Special Purpose Tube Division, 230 Duffy Avenue, Hicksville, L. I., N. Y. The ORP90 can actuate relays directly. It has a dark current of 2.5 micro-amp, and an average cell current of 10 ma with 5 foot candles illumination (color 2,700 K). The cell is



# IN PRECISION CALIBRATION EPSCO DELIVERS ITS SPECIFICATION

## FEATURES:

- Selectable Voltages, in 1 millivolt steps, from 0 to  $\pm 11.112$  V
- High Resolution and Selection Capability: 1 part in 10,000; with vernier adjustment, 1 in 100,000
- Close Reference Control of Zener current and load maximizing stability
- Low Output Impedance: 0.05 ohms (50 milliohms) DC
- Overload Proof
- Vernier Control. Permits operator to vary output continuously over a  $\pm 2$  millivolt range for any setting
- Chopper-Stabilized, High Gain Amplifier
- Predicted Mean Time to Failure: 15,000 hours



## APPLICATIONS:

- Insert precisely known voltages of small magnitude for calibration of low level data gathering systems
- Calibrate precision amplifiers
- Calibrate voltmeters
- Working secondary standard for laboratories and quality control departments
- Make precision voltage measurements




## NEED A LOW-RANGE, LOW-COST VOLTAGE REFERENCE SOURCE?

Absolute accuracy of  $\pm 0.025\%$  . . . selectable voltages from 0 to  $\pm 11.112$  V . . . make Epsco's new VRS 611 the most accurate and flexible voltage reference source for the money!

Designed as a "Workhorse Cousin" to Epsco's higher-range VR607, the portable "611" voltage reference source meets the needs of quality control departments, electric equipment manufacturers, research laboratories, armed forces repair facilities and component manufacturers.

Available as a portable unit (shown above), in sturdy rack mount for fixed installation . . . or with battery power for in-field calibrations. All models ready for immediate delivery. Call or write for details. Price \$625.00

**Epsco**  **INSTRUMENTS**

A division of Epsco, Incorporated, 275 Massachusetts Ave., Cambridge 39, Mass., UNIVERSITY 4-4950

designed for relay and illumination stabilizer applications. It can be mounted directly in the probes of flame-control apparatus.

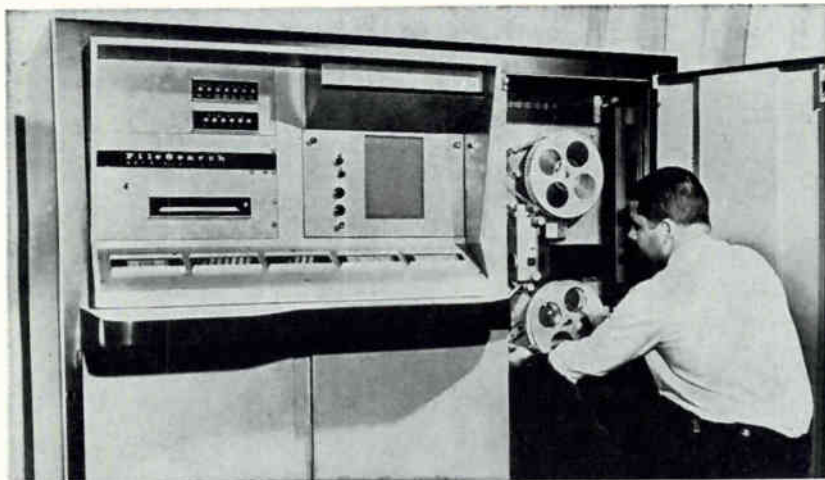
The cell is a side sensitive device

mounted in a hermetically sealed glass envelope with a conventional 7-pin miniature base.

**CIRCLE 305 ON READER SERVICE CARD**

tics. Model 511 laser stimulator is being introduced by Edgerton, Germeshausen & Grier, Inc., 160 Brookline Ave., Boston 15, Mass.

**CIRCLE 308 ON READER SERVICE CARD**



## Transistor Heat Sinks

ALLOW HIGHER POWER

TRANSISTOR dielectric heat sinks are available off-the-shelf from National Beryllia Corp., First & Haskell Ave., Haskell, N. J. Used to insulate semiconductor devices from the chassis, the heat sinks use beryllium oxide to resist the flow of electricity but not the flow of heat. The heat sinks allow semiconductor temperatures 50 percent lower than conventional dielectric materials.

Berlox heat sinks have low capacitance, thus minimize problems in h-f circuits, are available to match JEDEC outlines TO3, 5, 8,

## File Searcher

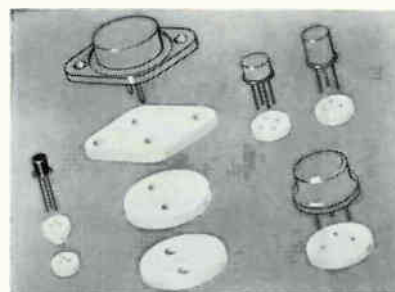
MIROFILM SYSTEM

MACHINE that can automatically search a 32,000-page file and present desired information has been developed by FMA, Inc., 142 Nevada St., El Segundo, Calif. Called FileSearch, the machine uses optical and electronic techniques to retrieve stored information from microfilmed files.

The system stores 32,000 standard-sized magazine pages on a single reel of microfilm and searches

at the rate of 6,400 pages a minute. Input is by punched card and output is printed copy or film. A console (71 x 55 x 50 inches) contains all equipment except recording camera and simple indexing machine. No computers or card readers are required. Up to six input requests can be handled simultaneously.

**CIRCLE 306 ON READER SERVICE CARD**



9, 11, 12, 16, 18, 33, 38 and 39. Standard thickness is  $\frac{1}{8}$  in. Other TO size, custom shape or thickness, available on special order.

**CIRCLE 309 ON READER SERVICE CARD**



## Tantalum Capacitors

WET-ELECTROLYTIC

OHMITE MFG. CO., 3650 Howard St., Skokie, Ill. Tantalum, wet-electrolytic capacitors, series TW (wire type) and series TS (slug type) can be supplied with single-ended lead termination. With this type of construction, both the cathode and anode leads extend from the same end of the capacitor. Leads are properly coded for easy identification. Single-ended lead termination finds use in fast assembly operations on modules and p-c terminal boards.

**CIRCLE 307 ON READER SERVICE CARD**

## Laser Light Source

OPTICAL MASER STUDIES

CLOSE optical coupling between flash tube and crystal, and the use of a special U-shaped Xenon-filled flash tube increase the efficiency of light source by a factor of about 10 over that of the conventional spiral flash tube.

The flashhead contains from 4 to 10 flash tubes, dependent on the light requirements and diameter of crystal. Crystals approximately 2 inches long and up to  $\frac{1}{2}$  inch in diameter can be accommodated. Flash tubes may be connected in series or series-parallel.

The energy storage bank has a maximum output of 1,280 watt-seconds. Recycling time is 2 seconds. Flash rate is determined by crystal and flash tube characteris-



## Spectrum Analyzer

50-100 GC

POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N. Y. Model DA-70 spectrum analyzer covers the 50 Gc to 100 Gc range in 3 bands, all contained in one tuning head. The wide band display of up to 1,000 Mc can be used to observe a pulsed signal as narrow



*this is the  
actual size of the*  
**NEW, COMPACT,  
PROGRAMMABLE,  
HALF-RACK,  
REGATRAN<sup>®</sup>  
POWER  
SUPPLIES...**

*with continuously variable  
current limiter...*

These new Regatrans are sparing only of space . . . delivering super-regulated, virtually ripple-free d-c power with the instant start-up and very high reliability of solid-state circuitry . . . and offering a group of features hitherto unprecedented in d-c power supplies of this size.

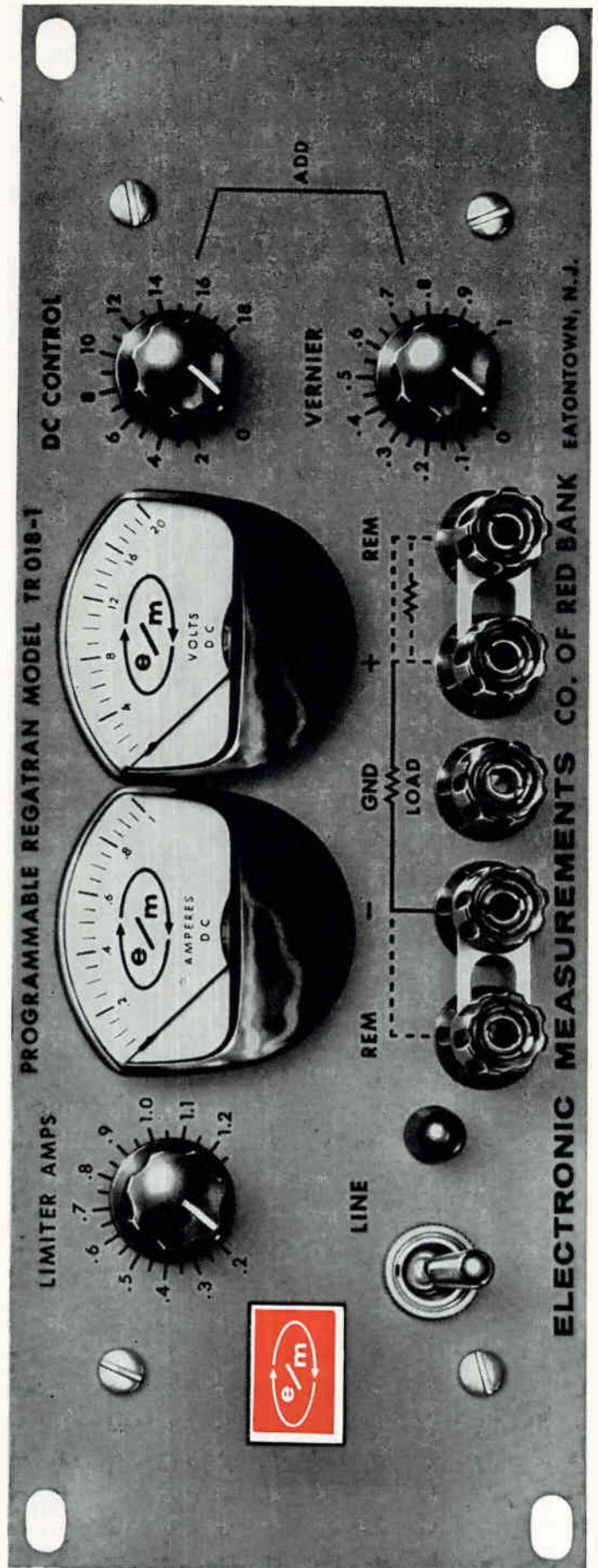
**REGULATION, LINE OR LOAD, 0.1% OR 0.01 V**

MODEL NUMBER	DC OUTPUT		MAX. RMS RIPPLE
	VOLTS	AMPS	
TR212A	0-100	0-100 MA	250 $\mu$ V
TR018-1	0-18	0-1 AMP	150 $\mu$ V
TR036-0.2	0-36	0-200 MA	150 $\mu$ V

For a closer look, ask your local Electronic Measurements representative for a copy of Specification Sheet 5000 . . . or write direct.

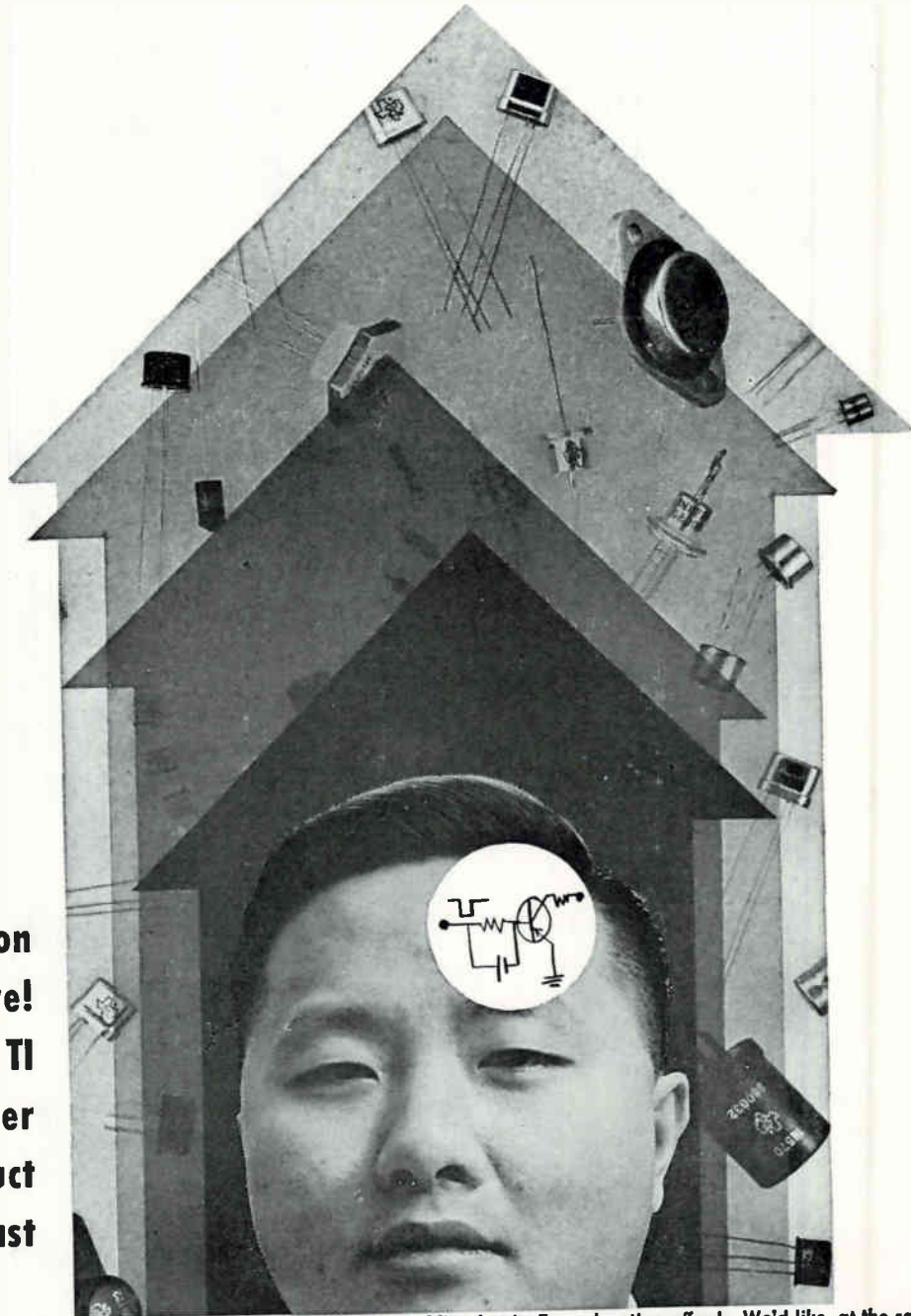


©Reg. U.S. Pat. Off. Patents Issued and Pending.



Consider, for example, basic diffusion studies of P impurities in N germanium, and associated problems in thermal conversion and impurity density distribution./That's where Morris Chang (MIT '52) started as product engineer at Texas Instruments Semiconductor-Components division in 1958. His immediate objective was to develop NPN diffused base HF germanium transistors. But more than that, his overriding goal was to develop a producible product. With impressive speed, Chang moved his product from original idea into mass production and saw it successfully sold to military and commercial markets./Chang, too, moved forward. He was made supervisor of diffused device development in TI's germanium products group, working on very HF switchers and amplifiers, epitaxial techniques and surface and reliability studies./Unique success story? No — an example of the professional growth opportunity fostered by a fast-growing, aggressive company./Unique opportunity? We think so. TI is engineer-managed, sales-minded. It all adds up to a rewarding environment for the engineer who wants to see his ideas take form as new products.

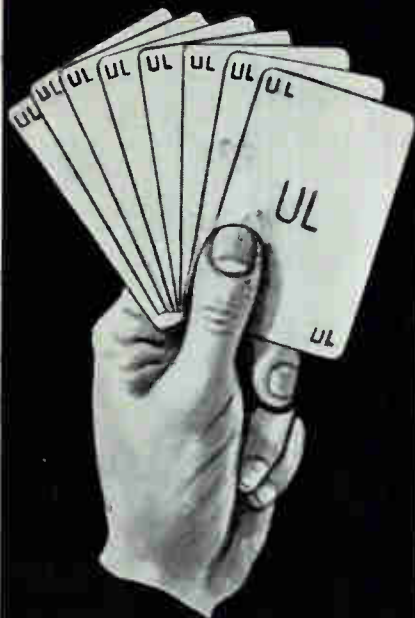
SEMICONDUCTOR-COMPONENTS DIVISION  
**TEXAS**  **INSTRUMENTS**  
INCORPORATED



**Your Invitation  
to Come Alive!  
at TI  
... where the engineer  
and his product  
grow fast**

**RSVP** We'd like you to know more about TI: its opportunities and the rewarding way of life that its Texas location affords. We'd like, at the same time, to know more about you. A confidential exchange of information may prove the catalyst to lead you to the professional fulfillment you've established as your personal goal. Write: C. A. Beslo, Dept. 115, Texas Instruments Incorporated, Semiconductor-Components Division, P. O. Box 5012, Dallas 22, Texas.





We deal in

**ULTRA-LOW**

FREQUENCY  
LEVEL  
AMPLITUDE

- VIBRATION MEASUREMENT
- DATA INSTRUMENTATION
- DATA TRANSMISSION,  
RECORDING AND PROCESSING

every day

001 cps



Many space age customers now benefit from our unique capabilities in R&D and manufacturing. These capabilities stem from years of experience in dealing with the demanding, classical problems in the earth sciences. Our competent staff of 250, and our complete electromechanical manufacturing facilities in our new 60,000 sq. ft. plant are ready to serve you. We invite inquiries concerning your specific problems.



**GEOTECH**

The Geotechnical Corporation  
3401 Shiloh Road, Garland, Texas  
Phone BR 8-8102

CIRCLE 201 ON READER SERVICE CARD  
April 14, 1961

as 0.01  $\mu$ sec. Among its many applications are measuring the spectral characteristics of pulse modulated signals, and simplifying field intensity measurements.

CIRCLE 310 ON READER SERVICE CARD

### Miniature Relay

ELGIN ADVANCE RELAYS, Elgin National Watch Co., 2435 North Naomi St., Burbank, Calif. Miniature d-c relay occupies less than  $\frac{1}{2}$  cubic inch of space when unenclosed.

CIRCLE 311 ON READER SERVICE CARD



### Test Unit

#### TRANSFER FUNCTION

BOONSHAFT AND FUCHS, INC., Hatboro Industrial Park, Hatboro, Pa., announces model 711 transfer function analyzer for determining frequency response measurements. It features wide frequency range, high noise rejection, fast read-out, extreme accuracy. The data are presented as in-phase and quadrature components, as well as amplitude and phase versus frequency.

CIRCLE 312 ON READER SERVICE CARD



### Communication Receiver HIGH FREQUENCY

COLLINS RADIO CO., Cedar Rapids, Iowa, introduces the 51S-1 h-f

**An invitation to  
DEVICE  
DEVELOPMENT  
ENGINEERS  
TEXAS INSTRUMENTS  
S-C DIVISION  
offers you**

1. A key position with the leader in the field.
2. Real opportunity for personal, professional advancement.
3. Relaxed living in modern Dallas, Texas.

At Texas Instruments, solid-state device development engineers will find the opportunity to pioneer in the application of unique phenomena in semiconductor materials to create specialized components. Studies involve high-speed, high-frequency mesa transistors; epitaxial devices; computer devices; and new devices of your own creation.

REQUIREMENTS: degree in Electrical Engineering, Physical Chemistry or Physics and experience in semiconductor or related development areas.

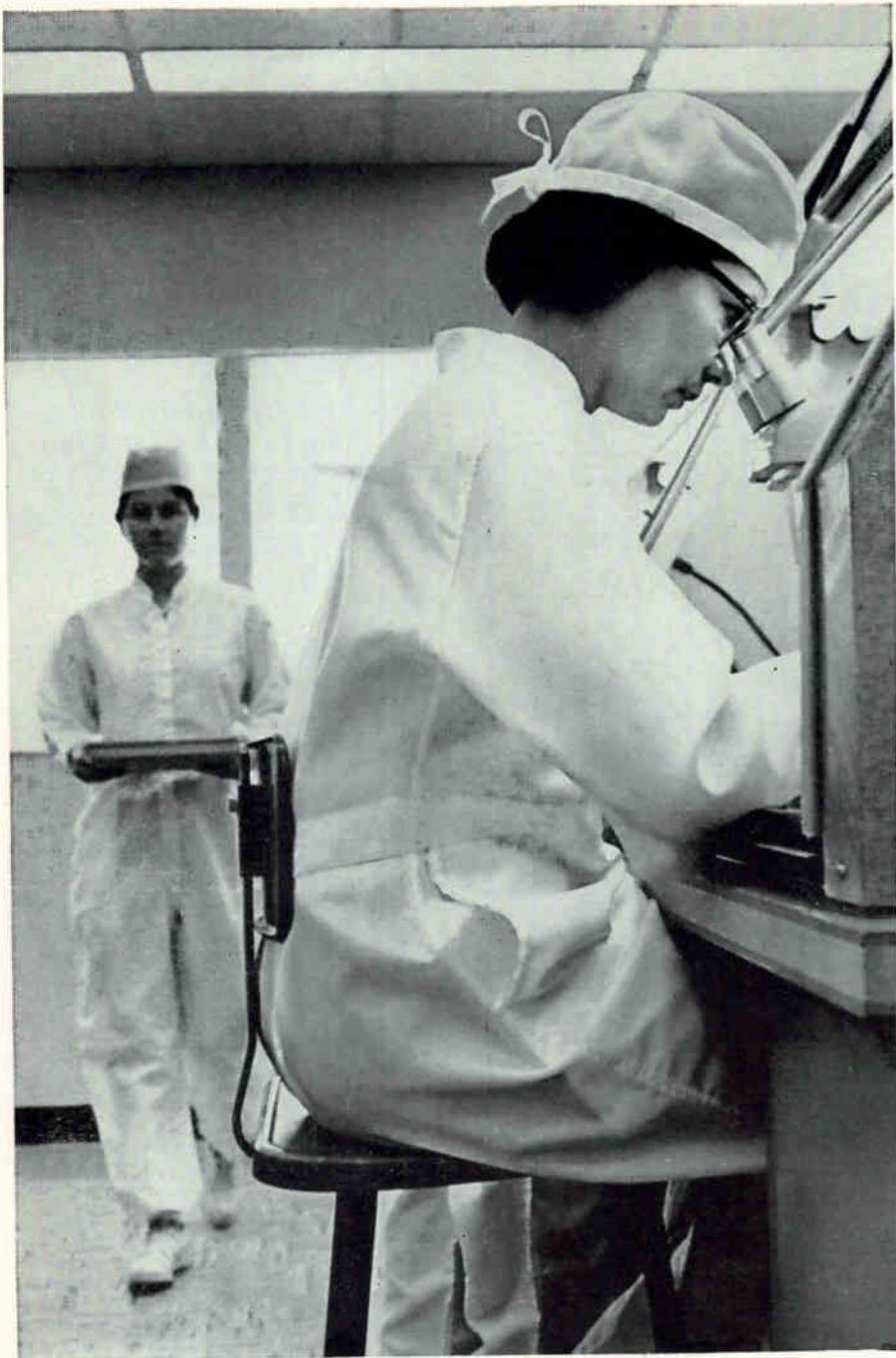
RSVP

TEXAS INSTRUMENTS INCORPORATED  
Semiconductor-Components Division  
Mr. C. A. Besio  
Box 5012, Dept. 115, Dallas 22, Texas

For more information on opportunities for Device Development Engineers with TI in Texas, please return coupon together with brief statement of your qualifications.

NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_  
STATE \_\_\_\_\_  
My field is \_\_\_\_\_

CIRCLE 379 ON READER SERVICE CARD



Precision operations like those at The Barden Corp. require rigid quality standards. Lint problems have been greatly minimized with uniforms of "Dacron".

## FOR LINT-FREE UNIFORMS it's DACRON® polyester fiber

Uniforms of filament "Dacron"® polyester fill a very real need where quality control is required. The smooth surface of filament "Dacron" cannot generate lint and thus contributes to White Room cleanliness. And "Dacron" does much more for uniforms—builds economy through long wear and minimum upkeep.

Uniforms of "Dacron" also lend themselves to either commercial or home laundering. So remember, efficient White Room maintenance is not really complete without the clean, fresh, lint-free benefits that uniforms of "Dacron" provide.

FOR SPECIAL ADVICE ON UNIFORMS, write: Uniform Counseling Service, E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Dept., Centre Road Bldg., Wilmington 98, Del.

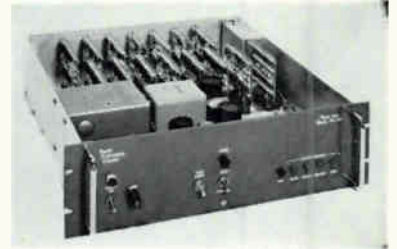


Better Things for Better Living . . . through Chemistry

®/™ DACRON/™ IS DU PONT'S REGISTERED TRADEMARK FOR ITS POLYESTER FIBER. DU PONT MAKES FIBERS, NOT THE FABRIC OR UNIFORMS SHOWN.

communication receiver. Continuous coverage of the 2-30 Mc range is provided in 1 Mc bands with 1 Kc increments on the main tuning dial. Additional coverage from 0.2-2.0 Mc permits broadcast monitoring or lab use. Reception of upper sideband, lower sideband, a-m or c-w signals is provided at any frequency within the tuning range.

**CIRCLE 313 ON READER SERVICE CARD**



### Time Rate Generator TRANSISTORIZED

BINARY ELECTRONICS CO., 824 E. Walnut Ave., Fullerton, Calif. Model 101 timing unit generates crystal referenced timing pulses as required by various test instrumentation recording devices. It is suitable for any lab or field use requiring timing rates. Outputs are available for driving instrumentation camera neon timing lights, recording oscillograph galvanometers, slow speed chart recorder timing solenoids and magnetic tape.

**CIRCLE 314 ON READER SERVICE CARD**

### Measuring System

ELECTRO SCIENTIFIC INDUSTRIES, 7524 S. W. Macadam Ave., Portland 19, Ore. Capacitance measuring system (0.01 percent) measures two or three-terminal capacitors ranging from 0 to 0.12  $\mu$ f with a resolution of 0.0001 pf on the lowest range.

**CIRCLE 315 ON READER SERVICE CARD**

### Recorder/Reproducer VIDEO BAND

MINCOM DIVISION, Minnesota Mining and Mfg. Co., 2049 S. Barrington Ave., Los Angeles 25, Calif. Bandwidth of the CM-100 video band recorder reproducer now is extended to 1.2 Mc at 120 ips; proportionate increase at all six



speeds. Standard 7-track production model easily converts to 14 tracks.

**CIRCLE 316 ON READER SERVICE CARD**

## Epoxy Silver Solder LOW RESISTIVITY

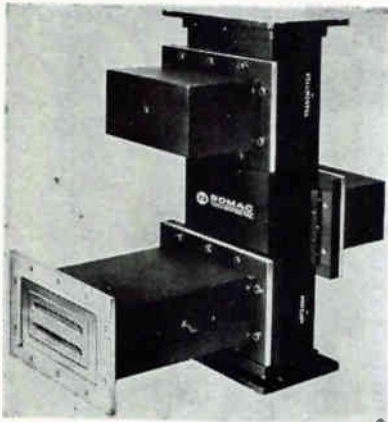
EPOXY PRODUCTS, INC., 137 Coit St., Irvington, N. J. A silver conductive epoxy with a resistivity approaching the resistance of metals—between 0.01 ohm-cm and 0.0001 ohm-cm—has been developed. Epoxy solder has two principal advantages over conventional solder or brazing: it can be used at low temperatures for components which are heat sensitive and it has no flux or residue to contaminate sensitive electronic components. It is ideal for repairing printed circuits.

**CIRCLE 317 ON READER SERVICE CARD**

## Servo Actuator

COMPU DYNE CORP., Hatboro, Pa. A self-contained servo-actuator contains a servo amplifier, servo valve and hydraulic cylinder. Applicable to control valves or positioning tables under high speeds.

**CIRCLE 318 ON READER SERVICE CARD**



## Waveguide Duplexers BRANCHED TYPE

BOMAC LABORATORIES, INC., Salem Road, Beverly, Mass. Used in radar applications, this unit utilizes one TR and two ATR tubes to switch transmitter power to the antenna during the transmitted pulse while switching the incoming signal from the antenna to the receiver between pulses. Use of two ATR tubes minimizes incoming signal loss in the



# HIGH RELIABILITY

## Sub-Miniature MISSILE RELAYS

The history of Dunco FC Relays is one of never ending development to keep these durable, subminiature units fully abreast of the steadily advancing missile and aircraft requirements. As a result, they are prominently identified with many of today's most successful missile programs. Continued engineering of every detail aims to keep them there tomorrow!

*Write for Dunco Data Bulletin FC*

## NEW!

### 10-AMPERE TYPE with all-welded construction

Constructed for fully dependable 10-ampere DC service, these sturdy little DP-DT Dunco FC-215 relays withstand 30 G vibration to 2,000 cycles and 50 G shock. Throughout, they are uniquely designed to meet or surpass MIL-R-5757 and MIL-R-25018 requirements.

*Write for Dunco Data Bulletin FC-215*

# STRUTHERS-DUNN

Pitman, New Jersey

5,348 RELAY TYPES

Sales Engineering offices in: Atlanta • Boston • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Dayton • Denver • Detroit • High Point • Kansas City • Los Angeles • Montreal • New York • Orlando • Pittsburgh • St. Louis • San Carlos • Seattle • Toronto

# New

## SIG GEN AM BRIDGE 1/4% SIG GEN FM

from **MARCONI**

### LF/MF/HF SIG GEN MODEL 144H

New Signal Generator 144H has exceptional frequency coverage and electronic calibrated incremental frequency control—a popular feature borrowed from our 1066 series FM generators. The highly accurate level monitoring is by protected thermocouple which cannot be overloaded. A full-view dial, ALC and two crystal checks contribute to accuracy and ease of use.

**Freq:** 10Kc to 72Mc; 8 bands  
**Stability:** .002% / 10 minutes  
**Output:** .1 $\mu$ V to 2V  $\pm$  .5db. ALC  
 $\Delta$ f: calibrated, .01 to 1% of  $f_c$   
**AM:** 0-80%, 20cps to 20Kc  $\pm$  1db  
**Price:** \$1190



### 1/4% LCR BRIDGE MODEL 1313

This new Universal Bridge adds to the wide variety from which an engineer must choose. But Model 1313 has both 1/4% accuracy and direct readout; combines exceptional discrimination with ease of use. Detector AGC, variable frequency of operation, functional styling are all plus features.

**L:** 1 $\mu$ H to 110H, 7 decades  
**C:** 1 $\mu$ F to 110 $\mu$ F, 7 decades  
**R:** .01 $\Omega$  to 110M $\Omega$ , 8 Decades  
**Accuracy:** 1/4%  
**Discrimination:** 5000 div'ns/Decade  
**Frequency:** 1Kc, 10 Kc. 100 cps to 20Kc with ext. osc.  
**Readout:** Direct—no multiplying factors



Make no Mistake—Measure with MARCONI 1313.

### MISSILE COMMAND SIG GEN MODEL 1066B/2

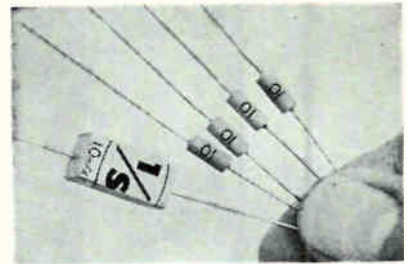
Marconi 1066 series FM signal generators are in use wherever FM equipment is designed or maintained. Because it was designed for this specific job, new 1066B/2 precisely meets requirements for aligning Range Command Receivers. It has freq. accuracy .01%, wide deviation, handles 100Kc modulation with multiple tones, and measures peak deviations.

**Frequency:** 400-550 Mc  
**Accuracy:** .01% at 1Mc points  
**Output:** .1 $\mu$ V to 1V into 52 $\Omega$   
**FM:** 0-300Kc  
 $\Delta$ f: Frequency calibrated, 0-100Kc  
**Mod. Freq.** 100cps—100Kc



transmitter, and eliminates the need for a critical transmitter line length.

CIRCLE 319 ON READER SERVICE CARD



### Ceramic Capacitors SUBMINIATURE

STATNETICS CORP., 5121 Weeks Ave., San Diego 10, Calif. These subminiature, hermetically sealed ceramic capacitors are designed for compact printed board use in commercial, industrial and military applications. They are suited for computer transistor circuitry where low series resistance at high pulse rates must be combined with exacting subminiature tolerances. Operating range at 100 wvdc from - 55 to 125 C.

CIRCLE 320 ON READER SERVICE CARD

### Waveguides

ELECTRONIC SPECIALTY CO., Technicraft Div., 116 Waterbury Rd., Thomaston, Conn. High pressure flexible waveguides for use in high power radar utilize 45 pounds pressure for L-band application.

CIRCLE 321 ON READER SERVICE CARD



### Carrier-Amplifier MINIATURIZED

PACIFIC TELEMETERING SYSTEMS, 10810 W. Washington Blvd., Culver City, Calif. Model MCS-101 is a miniaturized carrier-amplifier system for use with low level output transducers. It features all solid-state modular construction with printed circuit interwiring. It pro-



**MARCONI**  
INSTRUMENTS



111 CEDAR LANE • ENGLEWOOD, NEW JERSEY  
MAIN PLANT, ST ALBANS, ENGLAND



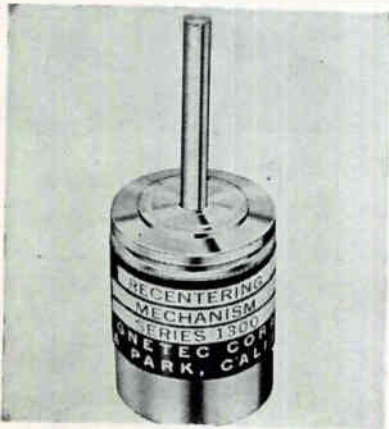
vides the excitation to the transducer, amplifies and detects the transducer output, and provides a 5 v d-c output signal.

**CIRCLE 322 ON READER SERVICE CARD**

### Microwave Radio

LENKURT ELECTRIC CO., INC., San Carlos, Calif. Broadband microwave radio system can be supplied with arrangements for hot standby at one millisecond and for space or frequency diversity.

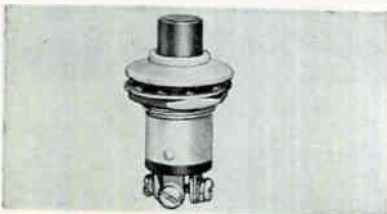
**CIRCLE 323 ON READER SERVICE CARD**



### Recentering Device MEETS ALL SPECS

MAGNETEC CORP., 7232 Eton Ave., Canoga Park, Calif. Series 1300 recentering mechanism is designed principally for returning to center the shaft of components such as synchros, potentiometer, encoders, commutator switches, gear trains, and the like. Units are available with standard servo-mounts, or mountings for inclusion in the original design of components. They are obtainable with adjustable stops up to 320 deg rotation, and meet MIL specifications.

**CIRCLE 324 ON READER SERVICE CARD**



### Terminal Switch HEAVY DUTY

CONTROL SWITCH DIVISION, Controls Co. of America, Folcroft, Pa. Model

April 14, 1961

# NOW

## Design your own Voltage Regulating Transformer with NEW Sorensen Series M

A new concept in magnetic regulator engineering—  
custom design at standard model prices and delivery.

Sorensen's new Series M line of magnetic voltage regulators offers you a choice of thousands of design combinations to meet your specific requirements for line, filament or power supply application.

Line regulation to  $\pm 1\%$ . Complete line isolation. Low external field. Four convenient case styles. Output ratings from 10 to 10,000 VA. Includes all popular a-c voltages and windings rated for d-c supply service at voltages from 2.3 to 1000 vdc. Harmonic filtered units available.

Get complete information on this new concept in voltage regulating transformers today. Write for Sorensen's 10-page Series M bulletin. Sorensen & Co., Richards Ave., South Norwalk, Connecticut, or contact your local Sorensen representative.

1.1



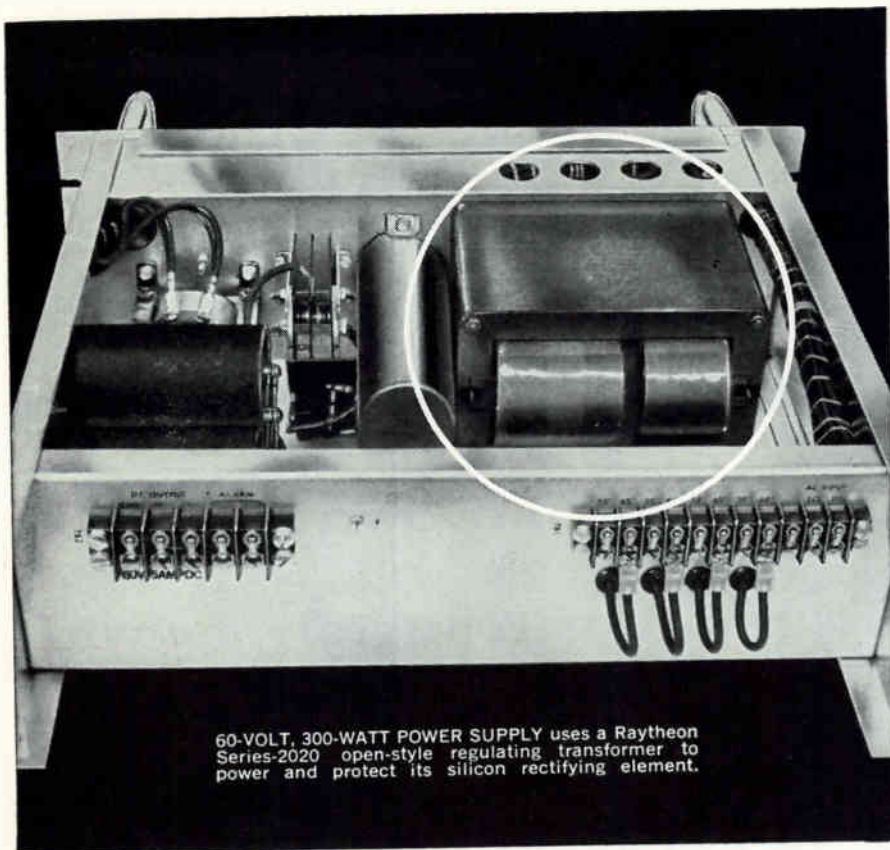
### CONTROLLED POWER PRODUCTS

The widest line — your wisest choice

A SUBSIDIARY OF RAYTHEON COMPANY

**CIRCLE 103 ON READER SERVICE CARD**

103



60-VOLT, 300-WATT POWER SUPPLY uses a Raytheon Series-2020 open-style regulating transformer to power and protect its silicon rectifying element.

**POWER • PROTECTION • REGULATION  
ALL THREE  
IN ONE TRANSFORMER!**

**Does your power transformer protect semiconductor rectifiers?**

How do you protect the silicon and germanium rectifiers in that advanced design power supply? Do you use elaborate circuitry or —like many power supply designers—are you using a Raytheon 2020 Voltage Regulating Transformer?

These versatile units provide stabilized voltages within  $\pm 1\%$  and are available in any of 2,020 standard models for solid-state and vacuum-tube rectifiers. You match your exact requirement from a full range of standard designs and ratings from 20 to 20,000 VA.

Write today for Catalog 4-265 with convenient Selection Guide and Power Supply Design Data. Raytheon Company, Commercial Apparatus & Systems Division, Keeler Avenue, South Norwalk, Connecticut.

**RAYTHEON**

**RAYTHEON COMPANY**

COMMERCIAL APPARATUS & SYSTEMS DIVISION

*Raytheon voltage regulators are also available from your local Raytheon distributor*

C124P3 terminal switch is a normally opened switch rated at 10 amp at 28 v d-c resistance, 5 amp at 28 v d-c inductance, 3 amp at 28 v d-c lamp or 15 (0.75 pf) at 120 a-c. It requires only a  $\frac{1}{8}$  in. mounting hole and features aluminum casing and adapter, 25,000 operations minimum life at rated load and requires only 4 lb operating pressure.

**CIRCLE 325 ON READER SERVICE CARD**



**Film Capacitors  
SUBMINIATURE**

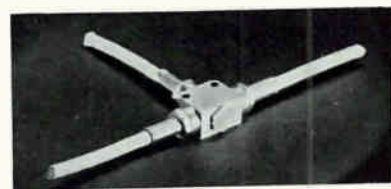
COMPONENT RESEARCH CO., INC., 3019 S. Orange Drive, Los Angeles 16, Calif., has developed a series of subminiature Teflon capacitors with low temperature coefficient and high stability for critical guidance systems in spacecraft and missile systems. Various temperature coefficients are available from zero to 120 ppm/deg C for precise matching with precision resistors and inductors. Tolerances to 0.1 percent are available.

**CIRCLE 326 ON READER SERVICE CARD**

**Resistors**

CORNING ELECTRONIC COMPONENTS, Bradford, Pa. Massive resistors for high power applications are available in a standard line.

**CIRCLE 327 ON READER SERVICE CARD**



**Junction Block  
CRIMP-TYPE**

SEAELECTRO CORP., 610 Fayette Ave., Mamaroneck, N.Y., has available a junction block for tapping runs of subminiature coaxial cable. This ConheX junction block features crimp-on cable connections that reduce assembly time approximately



# GUDELACE®...



## the lacing tape with a NON-SKID tread

You can't see it, but it's there! Gudelace is built to grip—Gudebrod fills flat braided nylon with just the right amount of wax to produce a non-skid surface. Gudelace construction means no slips—so no tight pulls to cause strangulation and cold flow.

But Gudelace is soft and flat—stress is distributed evenly over the full width of the tape. No worry about cut thru or harshness to injure insulation . . . or fingers.

Specify Gudelace for *real* economy—faster lacing with fewer rejects.

**Write for free Data Book.**  
It shows how Gudelace and other Gudebrod lacing materials fit your requirements.



## GUDEBROD BROS. SILK CO., INC.

**ELECTRONICS DIVISION**  
225 West 34th Street  
New York 1, New York

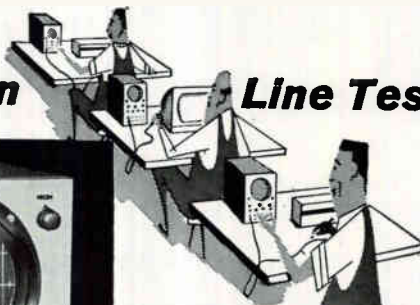
**WEST COAST OFFICE**  
2833 S. Olive Street  
Los Angeles 7, Calif.

**EXECUTIVE OFFICES**  
12 South 12th Street  
Philadelphia 7, Pa.

**CIRCLE 202 ON READER SERVICE CARD**

**For Production**

**Line Testing...**



## EICO SCOPES

give you:

- professional performance
- reliability
- ruggedness
- versatility

... at moderate cost

EICO's high quality standards and low initial cost add up to true economy: EICO units outperform scopes selling for two or three times EICO's prices. With kits, the initial cost is even lower. And the experience each operator gains in building his own, increases his efficiency, and enables him to keep his scope in better condition, with less "down" time.

	prices		freq. resp. (sinusoidal)		sensitivity (rms)	
	kit	wired	vert.	horiz.	vert.	horiz.
5" Push-Pull Scope #425	\$44.95	\$79.95	5 cps to 400 kc	5 cps to 400 kc	75 mv/in	0.1V/in
5" DC-4.5 MC Scope #460	79.95	129.95	DC-4.5 mc/flat	1 cps to 400 kc flat	25 mv/in	0.6V/in

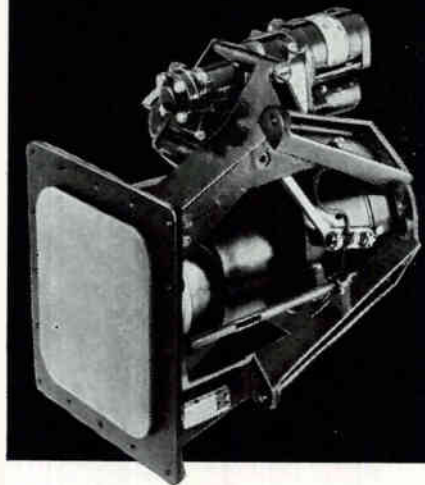


See the 41 additional EICO test instruments helpful for your lab and production work. Write for free Catalog & name of neighborhood Distributor.

**3300 NORTHERN BOULEVARD, Dept. E-4B, L. I. C., 1, N. Y.**

**CIRCLE 203 ON READER SERVICE CARD**

## Another electromechanical problem solved by AiResearch



**This ram air scoop** is another example of AiResearch's ability to design and integrate structural and electromechanical systems for control functions.

Through its use, air is provided for emergency cabin pressurization and the cooling of electronic components. The unit is composed of a retractable aluminum ram air scoop, extended and withdrawn by a 400 cycle rotary actuator, a self-contained 350 watt heating element and an integral check valve.

The most experienced company in the development and production of control systems for airborne and ground use, AiResearch has the ideal facilities and know-how to handle problems concerning electromechanical systems and components of all types for aircraft, ground handling, ground support and missile systems.

### OTHER ELECTROMECHANICAL COMPONENTS AND SYSTEMS

AC and DC Motors, Generators and Controls • Static Inverters and Converters • Linear and Rotary Actuators • Power Servos • Hoists • Temperature and Positioning Controls • Sensors • Programmers • Missile Launchers • Radar Positioners • Power Supplies • Williamsgrip Connectors

Your inquiries are invited.



**AiResearch Manufacturing Division**

**Los Angeles 45, California**



# **TWA** flies where the **BUSINESS** is!



Los Angeles ... key West Coast Air Freight center



Rome ... ever-expanding market for all U.S. goods

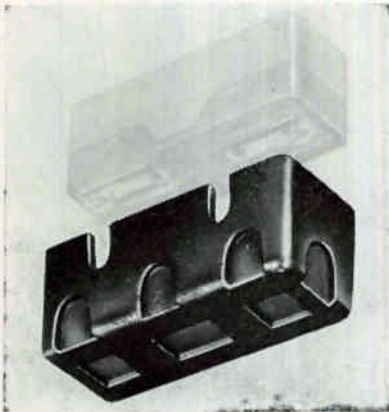
**ONLY TWA** carries freight between 70 thriving U. S. cities and 23 busy world centers overseas. Daily **JETSTREAM EXPRESS** flights ... world's most dependable, longest-range all-cargo service ... fly your shipments non-stop coast-to-coast and to Europe. Next time you ship, call your freight forwarder...or TWA Air Freight.





60 percent. Unit is designed to maintain optimum electrical characteristics in both the main cable run and the tap cable run.

**CIRCLE 328 ON READER SERVICE CARD**



### Terminal Cover FOR SWITCHES

UNIMAX SWITCH DIVISION, The W. L. Maxson Corp., Ives Road, Wallingford, Conn. Mechanical and electrical protection for the terminals of Unimax precision snap-acting switches is provided by the type TC-1 terminal cover. Molded of high-strength phenolic, this cover fits over the base of any series 2HB, 2HL, WHB, and DMX switch.

**CIRCLE 329 ON READER SERVICE CARD**

### Microwave Diodes HIGH FREQUENCY

SYLVANIA ELECTRIC PRODUCTS INC., Woburn, Mass. Microwave silicon varactor diodes, with cutoff frequencies as high as 150 Gc at -45 v breakdown voltage, have been developed through epitaxial techniques. They exhibit frequencies

as high as 100 Gc and capacitance values as low as 0.15 pf at - 6 v.

**CIRCLE 330 ON READER SERVICE CARD**

### Transistor Series

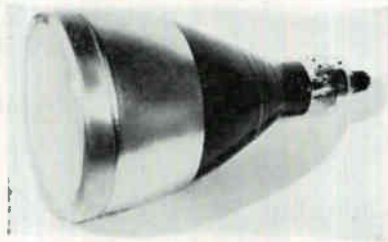
TEXAS INSTRUMENTS INC., P. O. Box 5012, Dallas 22, Texas. Three silicon power transistor series include the 2N1936-2N1937 rated at 100 watts dissipation, and two other series at 50 and 10 watts in the "thermoslug" TO-5 case.

**CIRCLE 331 ON READER SERVICE CARD**

### Fail-Safe Switch SOLID TYPE

ALPHA-TRONICS CORP., 1033 Encgracia Ave., Torrance, Calif. Switch type FS-101 will disconnect the power source from the device under test within 1  $\mu$ sec after the safe limit of current is exceeded. It is ideal for incoming inspection of electronic modules, transistors and development laboratories.

**CIRCLE 332 ON READER SERVICE CARD**



### Cathode-Ray Tube FAST WRITING

ALLEN B. DUMONT LABORATORIES, division of Fairchild Camera and Instrument Corp., Clifton, N.J. Type 12AMP is a single-beam crt with a 12 $\frac{1}{8}$ -in. diameter face plate. The

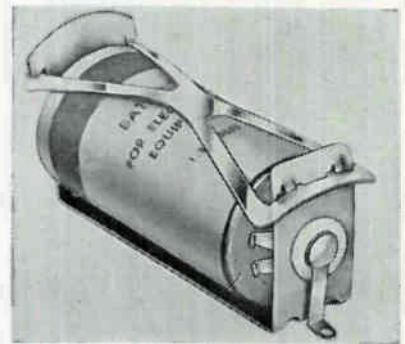
electrostatic focus and deflection tube features a low drive electron gun that permits use of transistorized video circuitry.

**CIRCLE 333 ON READER SERVICE CARD**

### X-Band Isolator MINIATURE SIZE

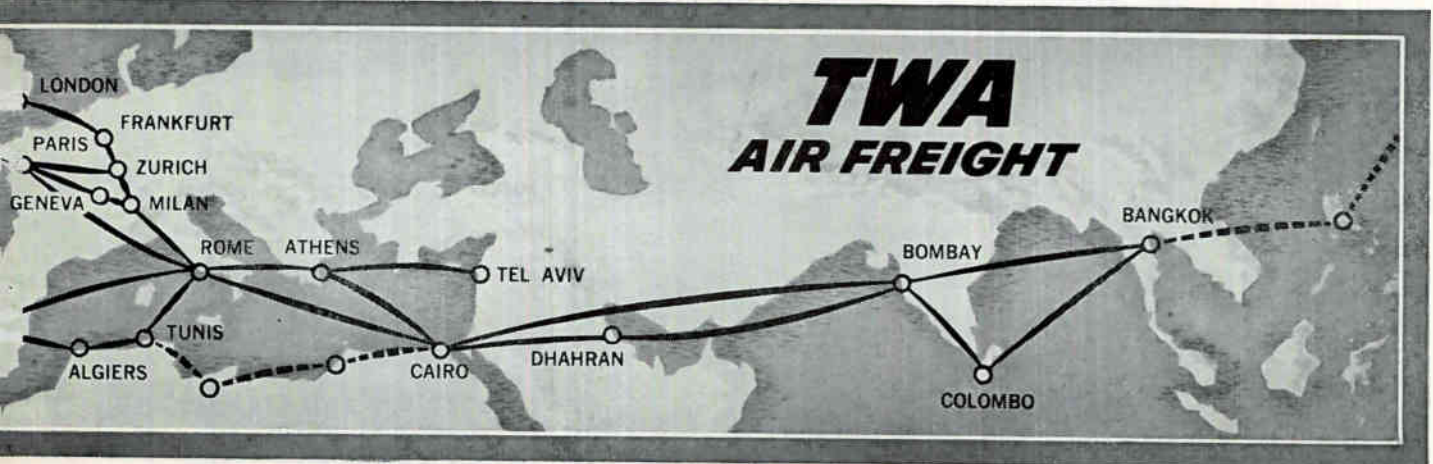
E & M LABORATORIES, 15145 Califa St., Van Nuys, Calif. Model XM3, a  $\frac{1}{2}$ -in. X-band isolator covers the frequency spectrum from 9,250 to 9,500 Mc. It provides a minimum isolation of 15 db, with a maximum insertion loss of 0.5 db and max vswr of 1.2, over the temperature range of - 40 C to + 85 C. Price is \$200 in single quantities.

**CIRCLE 334 ON READER SERVICE CARD**

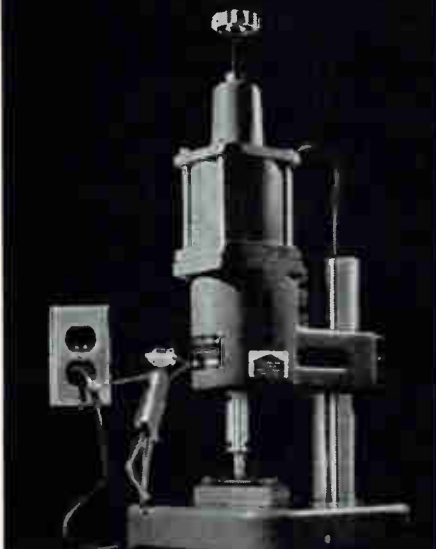


### Battery Holder CORROSION-PROOF

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass. The Cambion D cell carbon battery holder, No. 2890, is 3.010 in. long by 1 $\frac{1}{8}$  in. wide. A spring-loaded end allows insertion of cell in tight spots no longer than the holder itself. Special design feature is a locking strap that holds battery in place, even under the most severe



You can solve  
all your staking  
problems for just  
\$135 with the NEW  
portable, all electric  
**ELECTROSTAKE**



**BLACK & WEBSTER**  
INC.

570 PLEASANT STREET,  
WATERTOWN 72, MASS.

Gentlemen:

Please send me information about the Series 4 Black and Webster ElectroStake models F.S., B.S. & S.M.S. which:

1. stake up to 120 units per minute with controlled impact to 3500 lbs.
2. are easily movable from job to job
3. never need air lines
4. don't require skilled labor
5. set up easier and quicker
6. cut costs, time, labor

NAME \_\_\_\_\_

COMPANY \_\_\_\_\_

STREET \_\_\_\_\_

CITY \_\_\_\_\_

ZONE \_\_\_\_\_

STATE \_\_\_\_\_

DEPT. E

conditions of shock and vibration. Price is .95 each in quantities of 50-99.

CIRCLE 335 ON READER SERVICE CARD



### Rotary Joint IN-LINE TYPE

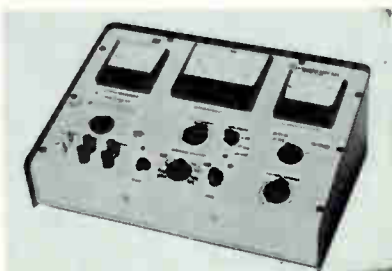
CANOGA, CORP., P. O. Box 550, Van Nuys, Calif. Model RJSL-1A is a high power microwave rotary joint of the in-line variety employing two 90 deg plane bends which convert it to a U-shaped type with coaxial non-contacting choke joints, ball bearings and an O-ring type of pressurizing seal. It operates in a frequency range of 2,240 to 2,300 Mc; vswr 1.2; power handling capacity 4 Mw peak with 25 Kw average; vswr wow 0.02; insertion loss 0.02 db; flanges UG-435A/U. Price is \$2,500.

CIRCLE 336 ON READER SERVICE CARD

### Terminal Assemblies CERAMIC-METAL

THE BENDIX CORP., Red Bank division, Eatontown, N. J. Ceramic-metal terminal assemblies (called Cerameterms) are claimed to be practically indestructible. They also provide a high degree of reliability in transistors, relays, capacitor banks, and other components.

CIRCLE 337 ON READER SERVICE CARD



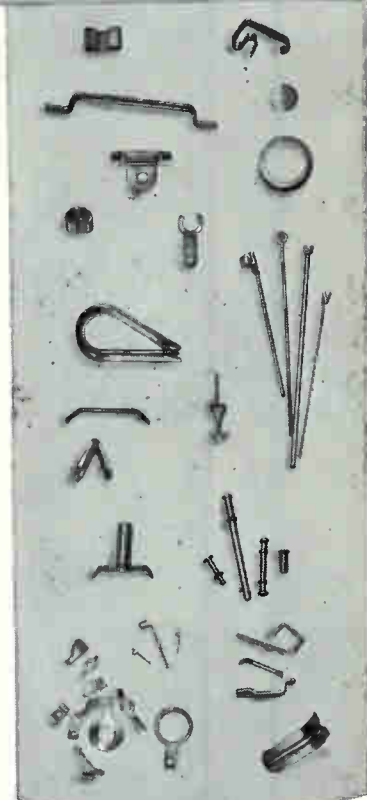
### Transistor Tester SIMPLE TO USE

ARMOUR STABLVOLT division of Magnetic Research Corp., 316 West

Let us show  
you how to  
**KEEP  
COMPONENT  
COSTS  
DOWN!**



## PRECISION WIRE FORMS



Send a sample or blue print  
for estimates.

Art Wire specializes in wire forms designed for today's automatic production lines . . . manufactured with the precision and uniformity that assure the economy of an uninterrupted work flow. Reduced down-time, and the lower costs made possible by Art Wire's modern production methods mean greater savings to you, and greater profit in your operations.

### ART WIRE AND STAMPING CO.

18 Boyden Place, Newark 2, N. J.

CIRCLE 204 ON READER SERVICE CARD

electronics



El Segundo Blvd., Hawthorne, Calif. Accurate testing of *nnp* and *pnnp* transistors is made rapid and simple by the model T-340 transistor tester. Ideal for incoming inspection and production line testing, it measures the four basic parameters necessary to check a transistor's performance.

**CIRCLE 338 ON READER SERVICE CARD**

## Servo Actuator

AMERICAN ELECTRONICS, INC., 1725 West Sixth St., Los Angeles 17, Calif. An electric model for the control of missile flight surfaces features 8-millisecond response. Source of motion is a constant speed miniaturized motor.

**CIRCLE 339 ON READER SERVICE CARD**



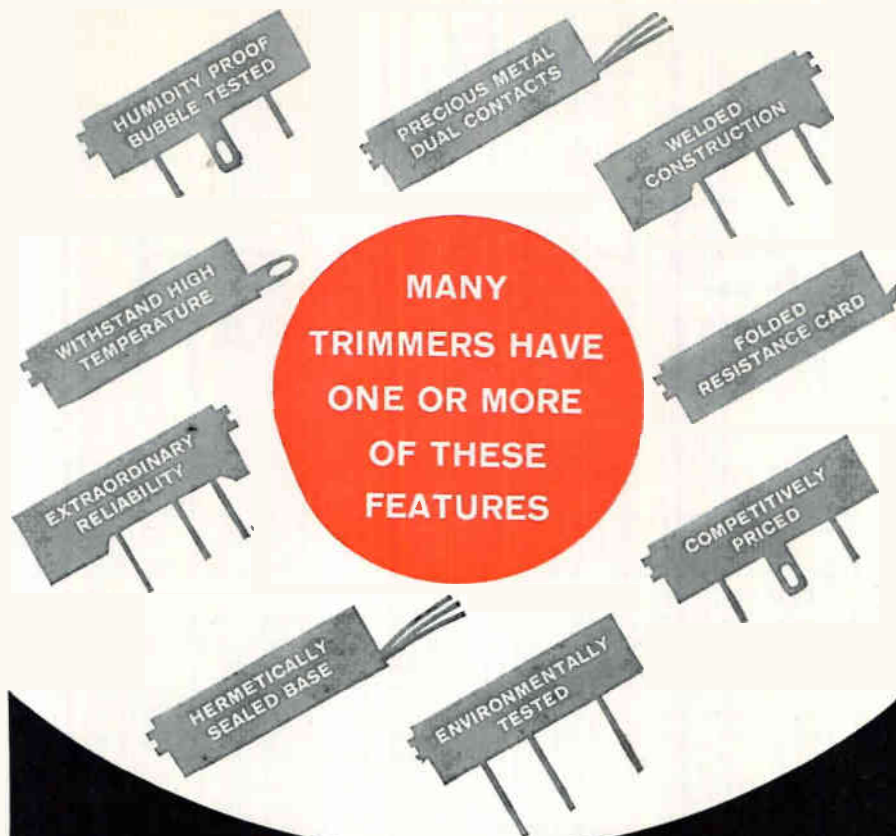
## Silicon Diodes COMPUTER-RECTIFIER

DELTA SEMICONDUCTORS, INC., 835 Production Place, Newport Beach, Calif., announces all purpose glass silicon computer-rectifier diodes that combine 400 ma forward conductance at 1 v, 30 nsec recovery measured on a sampling oscilloscope and 0.025  $\mu$ a reverse leakage current. Designated the DW series, individual numbers are available with peak inverse voltages from 40 v to 275 v.

**CIRCLE 340 ON READER SERVICE CARD**

## Capacitor SOLID TANTALUM

KEMET CO., 11901 Madison Ave., Cleveland 1, Ohio, announces a 75-v solid tantalum capacitor in standard EIA capacitance values up to and including 15  $\mu$ f in tolerances of  $\pm$  20, 10, and 5 percent. The capacitors are hermetically sealed in the four case sizes specified in MIL-C-26655A for CS12 and



# ONE HAS THEM ALL



## TRIMMERS

**You get all the important features in stock TIC Trimmers — you don't pay more for a lot of extras.**

Every TIC trimmer is bubble tested at 90°C to be certain it is sealed, meeting or exceeding MIL STD-202 for moisture resistance.

The inherent quality construction withstands temperatures to 225°C and shock at 150 G's for 11 milliseconds — vibration 5-3000 cps at 50 G's. Resistances to 100 K ohms are provided without sacrificing reliability as the unique design of the resistance element eliminates the need for using extremely fine resistance wire. Dual wipers on winding and take-off bar provide positive electrical contact and maximum reliability.

A choice of four types of leads are available on all stock trimmers — flexible insulated wire, printed circuit pins or solder lugs on end or bottom of housing.

These twenty-five turn precise trimmers offer *all* the plus features—not just a few.

Compare — features — price — reliability. Specify TIC Trimmers.

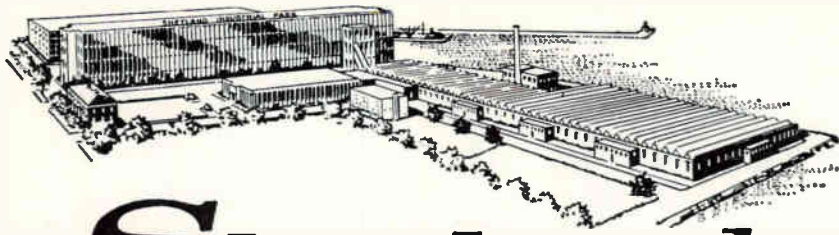
Available from stock for immediate delivery.



## TECHNOLOGY INSTRUMENT CORPORATION

569 Main Street, Acton, Massachusetts • COLonial 3-7711

DISTRIBUTED NATIONALLY BY AVNET CORPORATION



# Shetland INDUSTRIAL PARK

SALEM • MASSACHUSETTS  
(ONE BLOCK FROM ROUTE 1A IN SALEM)

## Modern Facilities • For Lease in Units Adaptable for Today's Requirements

- An experienced Property Management Team aware of your individual needs
- Flexibility in negotiating each lease for the benefit of both parties
- Good industrial neighbors maintaining clean operations
- Adequate opportunity for future expansion of your business, up to 100,000 sq. ft. on one floor
- Ample employee parking
- Available skilled and unskilled labor market
- Lowest insurance rates, reasonable rental
- Heavy floor loads, ample power, water and processed steam
- Nearest volume industrial space to Boston. 30 minute drive over good highways
- Ten minutes to Route 128. Fifteen minutes to Route 1

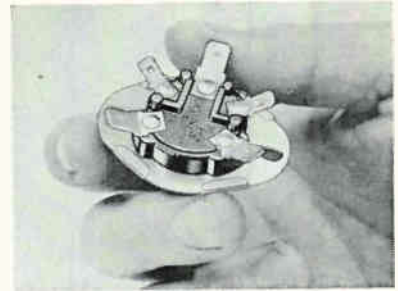
for Complete Information Call or Write

### SHETLAND INDUSTRIAL PARK, INC.

47 CONGRESS STREET, SALEM, MASS. Tel. Pioneer 4-0556  
CIRCLE 205 ON READER SERVICE CARD

CS13 styles. They will operate at temperatures ranging from - 55 to + 125 C.

CIRCLE 341 ON READER SERVICE CARD



### Control Thermostat INTERNAL HEATER

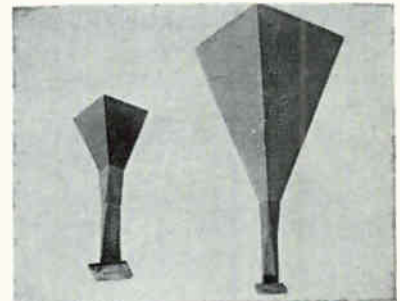
THERM-O-DISC, INC., Mansfield, O. Type 29T is a rugged, dependable, snap-action bimetal disk thermostat with an internal heater. The internal heater creates its own temperature or ambient inside the thermostat. This additional internal ambient is used to lower the operating point of the thermostat. By remotely controlling the voltage on the internal heater, the 29T can be made to operate through a range of temperatures.

CIRCLE 342 ON READER SERVICE CARD

### Deviation Calibrator

ADVANCED MEASUREMENT INSTRUMENTS, INC., 109 Dover St., Somerville 44, Mass. An f-m monitor deviation calibrator combines the functions of five instruments required by the carrier-dropout method.

CIRCLE 343 ON READER SERVICE CARD



### Waveguide Horn LOW SIDELOBE

WILEY ELECTRONICS CO., 2045 W. Cheryl Drive, Phoenix, Ariz., announces a linearly polarized waveguide horn. Gains of 31 db and efficiencies of 70 percent are available

**FASTENERS FROM**

**DIE CAST ZINC ALLOY**

**Zinc Alloy CAP NUTS**

Wing Nuts

Cap Nuts

Thumb Nuts

Standard Washer Diam.
 Full Washer Diam.

**EXCLUSIVE WASHER BASE**

Exclusive High Series

Regular Series

**widest range of types and thread sizes FROM STOCK**

New exclusive types never before available—standard or full dia. washer base with open or closed ends—no separate washer needed . . . speed assembly. Also high series with 50% greater thread depth . . . and regular series in open or closed end. 15 hex sizes, threads from #4 to 5/8". ALL GRC CAP NUTS feature rustproof, corrosion resistant surfaces, uniform accuracy . . . are completely free of tool marks and cut-off burrs. GRC's exclusive methods—die casting zinc alloy or molding Nylon and Delrin fasteners in one high speed automatic operation—assure high quality at lowest possible cost.

Write, wire, phone TODAY for SAMPLES. Prices your copy of GRC's NEW INDUSTRIAL FASTENER CATALOG

**MOLED NYLON & DELRIN**

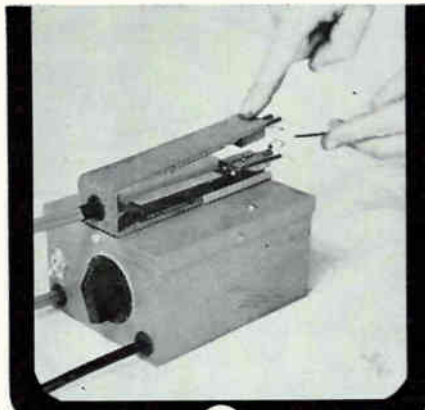
Screws

Hex Nuts

Washers

Screw Insulators

**GRIES REPRODUCER CORP.**  
World's Foremost Producer of Small Die Castings  
151 Beechwood Ave. • New Rochelle, N. Y.  
Phone: NEw Rochelle 3-8600



### MODEL G THERMAL WIRE STRIPPER

- Strips both Teflon and low-melting plastics.
- No blades to cut or nick wire.
- Has continuously-variable heat control.
- Strips any size wire without adjustment.
- Use either as bench or hand tool.
- Designed for production-line use.
- Price \$69.50 FOB Altadena, Calif.
- Always available from stock.

Western Electronic Products Co.  
2420 North Lake Avenue, Altadena, Calif.

CIRCLE 206 ON READER SERVICE CARD



"SO LITTLE **BIG**"  
YET SO

(TRITE BUT TRUE)



miniature instrumentation designed for space vehicle and airborne applications is little in size but big, really big in performance. Reliability is inherent in the design and rugged construction.



**MINIATURE  
ADJUSTABLE SEQUENCE TIMER  
MODEL 4-23**

**FEATURES:**

- Small and Compact — 1½" x 2½" x 3"
- Lightweight — 11 oz.
- Accurate — Better than 0.3%, Self-contained Voltage Regulation
- Adjustable Time Span — 1 sec. to 45 min.
- Multiple Switch Closures
- Low Current Drain — less than 70 milliamps
- Modular Construction for up to 100 Switches with Optional Remote or Manual Reset Feature



**ROTOFLEX®  
COMMUTATOR  
MODEL 6-15**

**FEATURES:**

- Low Noise — No Sliding Contacts
- Variable Sweep Rate
- Small, Rugged, Compact — 2-13/16" x 3-1/4" x 1"
- External Shaft for Synchronization (Drive or Driven) with other Precision Instrumentation
- Continuous Current Rating 50 ma
- Open Circuit Resistance — Greater than 5 x 10<sup>9</sup> Ohms

All are environmentally tested to surpass MIL-E-5272C for Vibration, Shock and Acceleration.

These are typical of modular type, off-the-shelf catalog items in the line of space instrumentation.



**Miniature  
Wide-Band  
Amplifier  
MODEL 8-12**

**FEATURES:**

- Gain Stability to 90° C.
- Compact — 1-3/8" x 2-5/8" x 1-3/16"
- Excellent Linearity — Low Distortion
- Ultra Stable
- Wide Band
- Continuously Adjustable Gain
- Lightweight

For further information write

**TECHNOLOGY INSTRUMENT CORP.  
OF ACTON**



FORMERLY  
ACTON  
LABORATORIES, INC.

©12-60

533 MAIN STREET, ACTON, MASS.

CIRCLE 207 ON READER SERVICE CARD

April 14, 1961

Horn design employs a square aperture with diagonal polarization. The resultant aperture illumination is tapered in all planes, which results in a circularly symmetrical pattern with extremely low side lobes and constant phase over the entire aperture.

CIRCLE 344 ON READER SERVICE CARD

**Frame Grid**

RAYTHEON CO., Industrial Components Division, 55 Chapel St., Newton 58, Mass. Five miniature tubes allow close spacing, result in high transconductance, low noise.

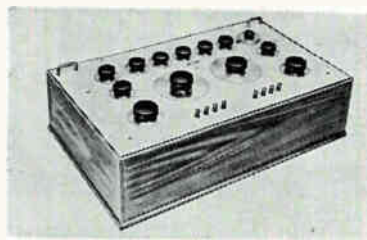
CIRCLE 345 ON READER SERVICE CARD

**Work Table**

**FEATURES VERSATILITY**

LEITCH-HUARD CORP., Manchester, N. H. Work table is particularly adaptable to use in industry where appearance, flexibility or mobility are required. The GP-100 versatile metal table combines Swaptop's established interchangeable top and table leveler system with a rigid table frame that is virtually free of dust traps. The tables cost less than most old-style "in plant" constructed tables and assemble quickly with just a screw-driver and adjustable wrench. They come in 4, 5 and 6 ft lengths.

CIRCLE 346 ON READER SERVICE CARD



**Terminal Strip  
BARRIER TYPE**

ELOTEC CORP., 145 N. Lidcombe, El Monte, Calif., announces a line of barrier type terminal strips featuring miniature size, high dielectric strength, and providing savings in labor and production time. Units are designed for fast, positive connections without the need for terminal lugs or taper pins.

CIRCLE 347 ON READER SERVICE CARD

New  
**ULTRAGraph**  
440

**Direct Writing**  
Light Beam  
*Oscillograph*  
Up to 56 Channels



**A MAJOR ADVANCEMENT IN  
THE STATE-OF-THE-ART**

- ★ Ultra-fast dry developing process begins at the moment of record exposure.
- ★ Uniform frequency response from 0 to 8000 cps
- ★ Sensitivities from 5.1 μa/inch
- ★ Records trace velocities to 50,000"/second
- ★ Push button speed controls from 0.1 to 160"/second
- ★ Recording paper 12" x 400'
- ★ Interchangeable direct writing and wet-process record magazines
- ★ All indicators and controls located on front panel console

**PLUS MANY OTHER  
NEW FEATURES**

Request Bulletin CEI-321



From The Home of Planned Pioneering

**century**

**ELECTRONICS & INSTRUMENTS, INC.**

TWUX-1407 . . . Phone LUther 4-7111

P. O. Box 6216, Pine Station, Tulsa 10, Oklahoma

Serviced by Systems Engineering Offices of

**Airsupply-Aero Engineering Company**  
in U. S. A.

Vibro-Meter Corporation, Fribourg, Switzerland  
in Free Europe

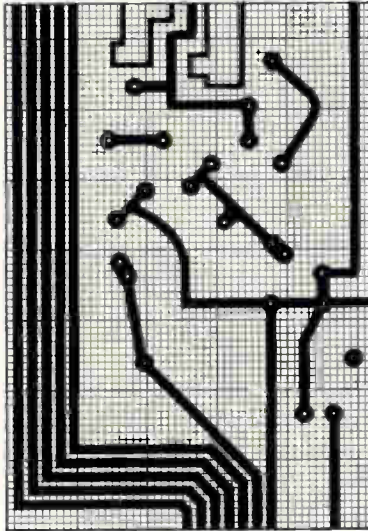
Published by Chart-Pak, Inc., originator of the tape method of drafting

## CHART-PAK DIE-CUT PRINTED CIRCUIT SYMBOLS CUT TEDIOUS DRAFTING

You don't have to draw all the circles, ovals, fillets, teardrops, elbows, tees and radii for printed-circuit master drawings, anymore.

Chart-Pak brings them to you die-cut from pressure-sensitive black crepe paper — a thousand in each handy, low-cost roll. You just strip them off a convenient split backing—*press them down!*

You get accurate, opaque, non-reflective symbols that reproduce perfectly. You make revisions easily, yet Chart-Pak doesn't come off by itself. Ten symbols available, in many decimal sizes.



### Circuits "Tape-Up" Fast on Chart-Pak Precision Grid

Crisp, clean lines make it easy to position Chart-Pak symbols and tapes, precisely, on this grid. Distances between any two lines are guaranteed accurate within plus or minus .005".

Chart-Pak precision grids are printed on tough, stable .0075" DuPont "Mylar"® — can be used over and over again. Available with 30" x 20" grid area; 8 or 10 lines per inch.



Write for new Chart-Pak Catalog of pressure-sensitive materials that simplify drafting.

## CHART-PAK, INC.

ORIGINATOR OF THE TAPE METHOD OF DRAFTING

161 RIVER ROAD, LEEDS, MASS.  
Dealers in principal cities

CIRCLE 208 ON READER SERVICE CARD

### Conductor Paths come in a roll, too!

Chart-Pak circuit tapes give you fast, "inkless" conductor paths (1/32" or wider) — accurate to plus or minus .002" in width.



New!  
"Tape-Saver"  
Package

Available all-black — also in white-back tape, handy for registering two circuits, back to back, on a Precision Grid. (You see white, but it disappears when photographed against white background.)

## Literature of

**RELAY DATA** Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y. Data sheet describes RB coaxial relay d-c, single pole double throw.

CIRCLE 348 ON READER SERVICE CARD

**SWITCHES** Micro Switch, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. A 20-page catalog gives photos and condensed descriptions of over 200 items, including several types of switches and switch-circuit assemblies.

CIRCLE 349 ON READER SERVICE CARD

**PLASTIC PROTECTORS** S. S. White Industrial Div., 10 East 40th St., New York 16, N. Y. Bulletin offered on rectangular plastic protectors for miniature electronic pin connectors.

CIRCLE 350 ON READER SERVICE CARD

**CONNECTORS** Kings Electronics Co., Inc., 40 Marbledale Rd., Tuckahoe, N. Y. Several series and connector types plus telephone jacks and plugs are covered in a 120-page catalog. Included is a cross reference index, from the company's to military numbers and vice versa.

CIRCLE 351 ON READER SERVICE CARD

**MAGNETIC HEAD** Westrex Recording Equipment Dept., 6601 Romaine St., Hollywood 38, Calif. Data sheet describes a magnetic head designed for recording or reproducing on tape or film.

CIRCLE 352 ON READER SERVICE CARD

**ACCELEROMETER** Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. Design features of a strain gage accelerometer family, type 4-203, are available in a 2-page bulletin.

CIRCLE 353 ON READER SERVICE CARD

**TRANSISTORS, DIODES** Silicon Transistor Corp., Carle Place, N. Y. A short form catalog reviews silicon power transistors, intermediate and high power, and silicon glass diodes, including mili-



### DO YOU KNOW . . .

. . . there is an electronic distributor who can furnish up-to-date information on Clevite silicon and germanium diodes and give same day shipment from stock.

**CLEVITE**  
T S P

CLEVITE  
TRANSISTOR  
PRODUCTS

*Semiconductor*  
DISTRIBUTOR



*Specialists INC.*

5706 W. North Ave., Chicago 39, Ill., NA 2-8860



# the Week

tary types, general purpose, fast switching, controlled forward, high power and high current switching types.

CIRCLE 354 ON READER SERVICE CARD

**TWT POWER SUPPLY** Watkins-Johnson Co., 3333 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif. A specification sheet features a fully solid-state, low noise traveling-wave tube power supply.

CIRCLE 355 ON READER SERVICE CARD

**RECORDERS.** Curtiss Wright Corp., Princeton, N. J. Miniature recorders with four inch writing widths are covered in a single sheet.

CIRCLE 356 ON READER SERVICE CARD

**PRODUCT CATALOG** Electro Scientific Industries, 7524 S. W. Macadam Ave., Portland 19, Ore. A short form catalog presents the company's line of precision measurements instruments, Dekaline components, resistance networks and ESAC computers.

CIRCLE 357 ON READER SERVICE CARD

**SPECTROPHOTOMETERS** Beckman Scientific and Process Instruments Division, Fullerton, Calif., has published a brochure on a series of double-beam, ratio recording DK spectrophotometers and other standard instruments.

CIRCLE 358 ON READER SERVICE CARD

**SCALER** Radiation Equipment and Accessories Corp., 665 Merrick Rd., Lynbrook, N. Y. Data sheet reviews the transistorized G-M scaler which features cold cathode decades.

CIRCLE 359 ON READER SERVICE CARD

**CAPACITORS** Vitramon, Inc., Box 544, Bridgeport 1, Conn. Catalog, 16 pages, describes solid state porcelain capacitors and micro-miniature ceramic capacitors. Includes military and commercial part numbers, typical curves, dimensional drawings and special designs.

CIRCLE 360 ON READER SERVICE CARD



## start clean!

with this new ultra-low distortion,  
stable-amplitude oscillator

When the specs get critical, you need an oscillator that won't add distortion and instability of its own. Here's a stable-amplitude, low-distortion oscillator — Krohn-Hite's new Model 446 — that gives you a *cleaner* sine wave than any other oscillator you've ever worked with!

Amplitude stability is ultra-high: 0.001 db (0.01%), due to a unique infinite-gain AVC circuit (patent pending). Amplitude bounce near line frequency is no longer a problem — less than 0.05%. Distortion — phenomenally low: less than 0.01%.

But that's not all. The 446 push-button oscillator offers continuous frequency coverage from one cycle to 100 kc. Voltage output is continuously adjustable from 0 to 10 volts, with infinite resolution all the way.

And when you need *power* along with stable amplitude and low distortion, team up the Model 446 oscillator with Krohn-Hite's Model UF-101A ultra-low distortion 50-watt amplifier. Here's an amplifier which preserves the stability and distortion-free characteristics, even at a full 50 watts. Frequency response of the amplifier — from 20 cps to 20 kc at full power. A convenient load impedance switch offers a choice of 1, 2, 4, 8 and 225 ohms.

Together, this oscillator and amplifier provide a highly-stable, low-distortion, variable-frequency Power Source (Model LDS-115) — for the most critical meter calibration or measurement needs. Send for technical literature on these new Krohn-Hite instruments.



**KROHN-HITE CORPORATION**

580 Massachusetts Avenue • Cambridge 39, Mass.  
Pioneering in Quality Electronic Instruments



## H. H. Smith, Inc. Gets Added Space

HERMAN H. SMITH, INC., manufacturer and distributor of electronic components, has purchased 16,000 ft of additional space adjacent to its main Brooklyn, N. Y., plant.

Ira L. Landis, president of Smith, announces the new space will be used for manufacturing and warehousing purposes. Business has climbed steadily since the company was founded in 1946, he said, and this is Smith's second expansion.

Under Landis' leadership, Smith sales have gone from \$500,000 in 1954 when he took command, to almost \$3 million in 1960.

The company now services over

4,000 accounts throughout the nation. It has a chain of sales reps across the nation and also exports its products. The company's new catalog lists some 4,000 standard electronic parts as well as hundreds of new components developed within the past year.

One key development in the Smith growth, the company says, was the introduction some years ago of a schematic drawing for its type of product. This enabled engineers and designers to know exactly the specifications of even the tiniest component parts and made designing their projects that much easier.



### Digitronics Elects Board Member

RICHARD M. MOCK was recently elected a member of the board of directors of Digitronics Corp., Albertson, L. I., N. Y.

Mock is chairman of the executive committee of Lear Inc., and served as president of that organization for more than ten years.

### Scientists Organize New Corporation

ORGANIZED by two young scientists, Ian Shivack and Allen Chertoff, a new company, Computer Techniques, Inc., recently began manufacturing logic elements for computers in Long Island City, N. Y.

Shivack is serving as president, and Chertoff as vice president. Both men were formerly with the data systems division of Harman-Kardon—Shivack as vice president, and Chertoff as vice president for R&D.

The company will be producing a complete line of micromodular encapsulated transistor logic elements as well as custom designed solid state circuitry packaged in conformance with modular concepts. Eventual product line will include

analog and digital subassemblies for use in both military and industrial data systems.

### Set Up New Company In Rochester

RF COMMUNICATIONS ASSOCIATES, INC., a new company formed for the development and manufacture of electronics communications equipment, has been established in Rochester, N. Y., by three engineers formerly associated with General Dynamics/Electronics (until recently, Stromberg-Carlson Division) of General Dynamics Corp.

Principals of the new firm are William J. Stolze, president; Elmer W. Schwittek, executive vice president; and Roger R. Bettin, vice president, engineering.



### Sylvania Appoints Plant Manager

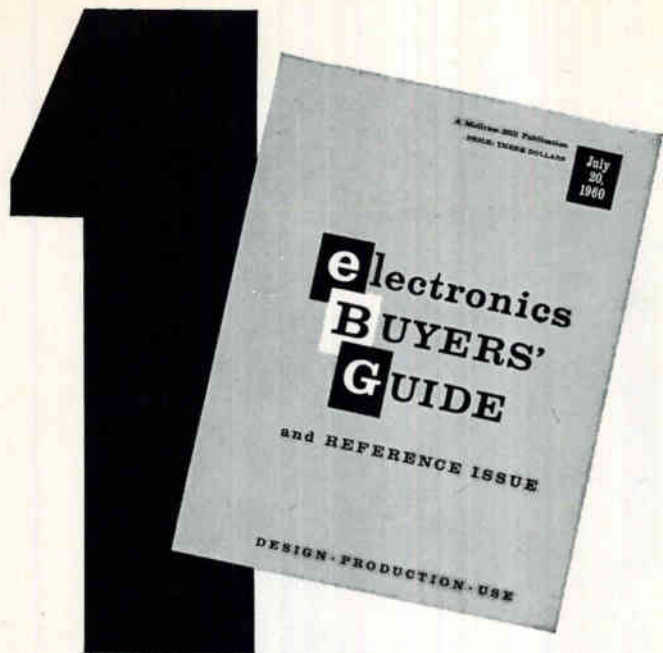
APPOINTMENT of Gerald E. LaRochelle as manager of the Muncy, Pa., plant of the computer products operations of Sylvania Electric Products Inc. is announced.

LaRochelle joined Sylvania in 1958 as supervisor of production of the data systems operations in Needham, Mass., and was named manufacturing superintendent in 1959.

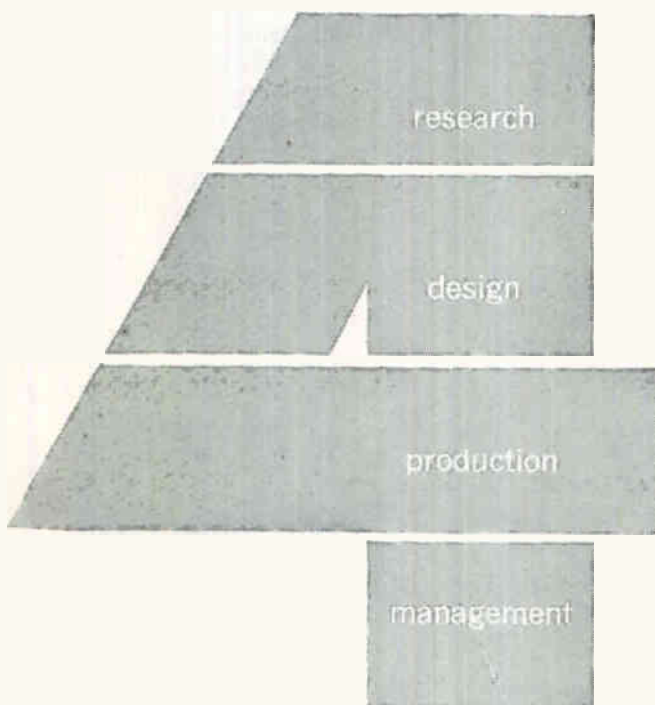
### Nonnemaker Takes New RCA Post

GEORGE M. NONNEMAKER, with RCA since 1956, has been appointed manager of signal processing products, at the Missile Electronics and Controls division, Defense Elec-





**FIRST CHOICE OF ALL 4!**



Edited and refined by the daily experience of users for 20 years. Unmatched for accuracy and completeness. Major corporations frequently order extra copies in addition to the hundreds of copies already received by employees who are regularly paying subscribers to **electronics**. The BUYERS' GUIDE is equally useful to men in research, design, production and management. Gives more information in less space.

*gives more to all 4!*

**electronics BUYERS' GUIDE**  
and REFERENCE ISSUE

with **POWER** to spare...



SEALED CELLS



VENTED CELLS

**NICAD**

## NEW Nickel Cadmium Rechargeable Batteries

### SEALED CELLS

Hermetic and rechargeable, boasting exceptionally long life, Nicad batteries are always ready to operate in any position—with power to spare—even under adverse operating conditions.

### VENTED CELLS

Vented cells will maintain good voltage even at extremely high discharge rates over a wide temperature range. Get more information on these constant voltage batteries.

Write Dept. E-612.



**NICAD DIVISION**

**Gould - National Batteries, Inc.**

St. Paul 1, Minnesota

CIRCLE 209 ON READER SERVICE CARD

## tunable RF AMPLIFIER

300-1000 MCS



- Low Noise Figure
- Tuning Range to 150 mcs
- 10 mcs Bandwidth

- Single Control Tunability
- High Gain
- High Reliability

This versatile and dependable UHF RF amplifier permits the user to vary the frequency of the amplifier up to  $\pm 10\%$  of nominal center frequency (not to exceed 150 mcs range) in the frequency range of 300 - 1000 mcs. Tuning is done by means of a slotted shaft accessible through the front panel.

The amplifier is supplied complete with power supply, mounted on a  $3\frac{1}{2}$ " high panel to fit a standard rack.

### GENERAL SPECIFICATIONS — MODEL UH-2 (AT)

Center Frequency	300 mcs to 1000 mcs
Freq. Range (tunable)	Up to $\pm 10\%$ of nominal F <sup>o</sup> (not to exceed 150 mcs range)
Bandwidth	10 mcs nominal
Noise Figure	5.5 db at 400 mcs; 9.0 db at 1000 mcs
Gain	18 db nominal (representative values)
Source and Output Impedance	50 ohms

Write for further information.

**Applied Research inc.**

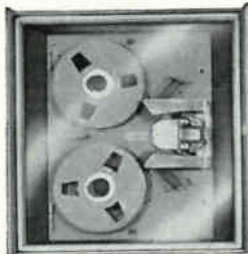
76 South Bayles Avenue

Port Washington, N. Y.

OVER  
100 BILLION BITS  
WITHOUT A  
DROPOUT  
!

# RELIABILITY

WITH  
POTTER  
HIGH  
DENSITY  
RECORDING



906 II HIGH SPEED DIGITAL  
MAGNETIC TAPE HANDLER

**TYPICAL CAPABILITIES OF  
POTTER HIGH DENSITY  
SYSTEMS**

High Density Systems by Potter can include such outstanding characteristics as:

**RELIABILITY:**

Transient error rate... 1 in  $10^7$  to  $10^8$  max. at 1500 ppi  
Permanent error rate... 1 in  $10^8$  to  $10^9$  max. at 1500 ppi

Reread time to recover transient errors... less than .005% of "on-line" time at 1500 ppi

BIT DENSITIES up to 2,000/inch  
TAPE SPEED up to 150 ips

NUMBER OF CHANNELS up to 20 per inch of tape width

**INTERCHANNEL TIME  
DISPLACEMENT**

Less than 0.2 microsecond at buffer output

**INTERBLOCK GAP**

May be as short as 0.3"; 0.75" typical for dual read/write operation at 100 ips

**ERROR DETECTION**

Parity channel provides single error detection

**ERROR CORRECTION**

Single parity channel makes possible single error correction

**AND MANY OTHERS**

write for details

For more than 40 hours of continuous operation, Potter High Density systems have recorded 100 billion bits without a single dropout. And — they've done it at the fantastic rate of 240,000 decimal characters per second. Only with the revolutionary new recording technique do you get this combination of extreme capacity with ultimate reliability.

In the 40-hour test, less than 2 seconds re-read time were required to recover information lost through transient error. More than 20,000 passes of the tape can be made without losing information or significantly increasing the reading error rate.

Tested and proven in computer systems, Potter High Density Recording is presently available in the Potter 906II High Speed Digital Magnetic Tape Handler, and will be available in other Potter Tape Systems.

Write today for details on how High Density Recording can be applied to your data handling problem.

tronic Products, in Burlington, Mass.

In his new position, Nonnemaker is responsible for the technical direction and management of the division's seeker and sensor equipment, electromagnetic environment simulator equipment and general electronics equipment product lines.



**Heinz Gorges Joins  
Cook Electric Team**

COOK ELECTRIC CO., Chicago, Ill., announces the appointment of Heinz A. Gorges as director for advanced projects for the Cook Technical Center division in Morton Grove, Ill. This is a newly created post.

Prior to joining Cook Electric, Gorges was scientific assistant to the director of the aeroballistics division of the George C. Marshall Space Flight Center at Huntsville, Ala., which is under the direction of Wernher von Braun.



**Garstang Takes  
Centralab Post**

APPOINTMENT of William W. Garstang as manager, special products, at Centralab, the electronics division of Globe-Union Inc., is announced. His duties will include  
*(Continued on p 121)*

POTTER INSTRUMENT COMPANY, INC. • SUNNYSIDE BOULEVARD, PLAINVIEW, NEW YORK



A NEW SERVICE

▼  
**NOTICE  
TO  
READERS**

▲  
**FREE  
REPRINT  
OF THE  
MONTH**

Each month the editors of *electronics* are selecting a significant article and offering it in reprint form —FREE—to readers.

The April free reprint is an article by Richard P. Rufer — Designing Avalanche Switching Circuits.

It is a seven page article from the April 7th issue. Avalanche characteristics of transistors are not usually specified on data sheets so this article goes into the factors including a test set-up, that are important for this mode of operations. The basic avalanche circuits are presented and explained, and factors influencing wave-shape are discussed.

Order your free copy now by checking the appropriate box on the Reader Service Card in this issue.

**electronics**

April 14, 1961

*Expanding activity in a variety of missile programs has created new opportunities for long range*

**Materials Research  
at AVCO/RAD**

*Assignments now exist for:*

**Electromechanical Engineer**

Familiar with the design and construction of equipment for pumping, metering, and mixing viscous or thixotropic resin systems. Experience with spray equipment desirable. Should have a sound fundamental background with emphasis on the development of prototype and novel equipment.

**Electrical Engineer**

B.S. minimum with 2-5 years experience in microwave measurements, to work on the development of new radar absorption materials.

*At Avco/RAD you will find a liberal benefit program and excellent salaries commensurate with your experience.*

Send Resume to Mr. J. E. Bergin, Employment Supervisor, Dept. ES

**AVCO**

*Research & Advanced Development*

A Division of Avco Corporation

201 Lowell St., Wilmington, Mass.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

CIRCLE 337 ON READER SERVICE CARD

**IS YOUR  
ADVERTISING  
SELLING  
THE BIG 4**

?

Tough competition and smart selling demand that the electronics man be reached and sold wherever you find him: *Research, Design, Production, and Management*. Only *electronics* is edited to interest and influence all four key buyers. Put your advertising where it works *hardest*....

in **electronics**

**demanding  
specifications  
call for....**



**FREQUENCY SELECTIVE  
DEVICES OF HIGH  
QUALITY UNVARYING  
PERFORMANCE**

**RESONANT REED RELAYS AND OSCILLATOR CONTROLS**

are tuning fork type electro-mechanical devices. They are highly stable, super-sensitive, reliable and versatile—ready to serve in a variety of applications including remote control, data transmission, signaling systems, tone generation, frequency standards, frequency detection and telemetering. Resonators are engineered to provide the finest method of frequency detection and generation in the audio range.

Frequencies—67 cps to 1600 cps. Complete specifications and application data available on request.



**SECURITY  
DEVICES  
LABORATORY**

ROCHESTER 21, NEW YORK

CIRCLE 119 ON READER SERVICE CARD

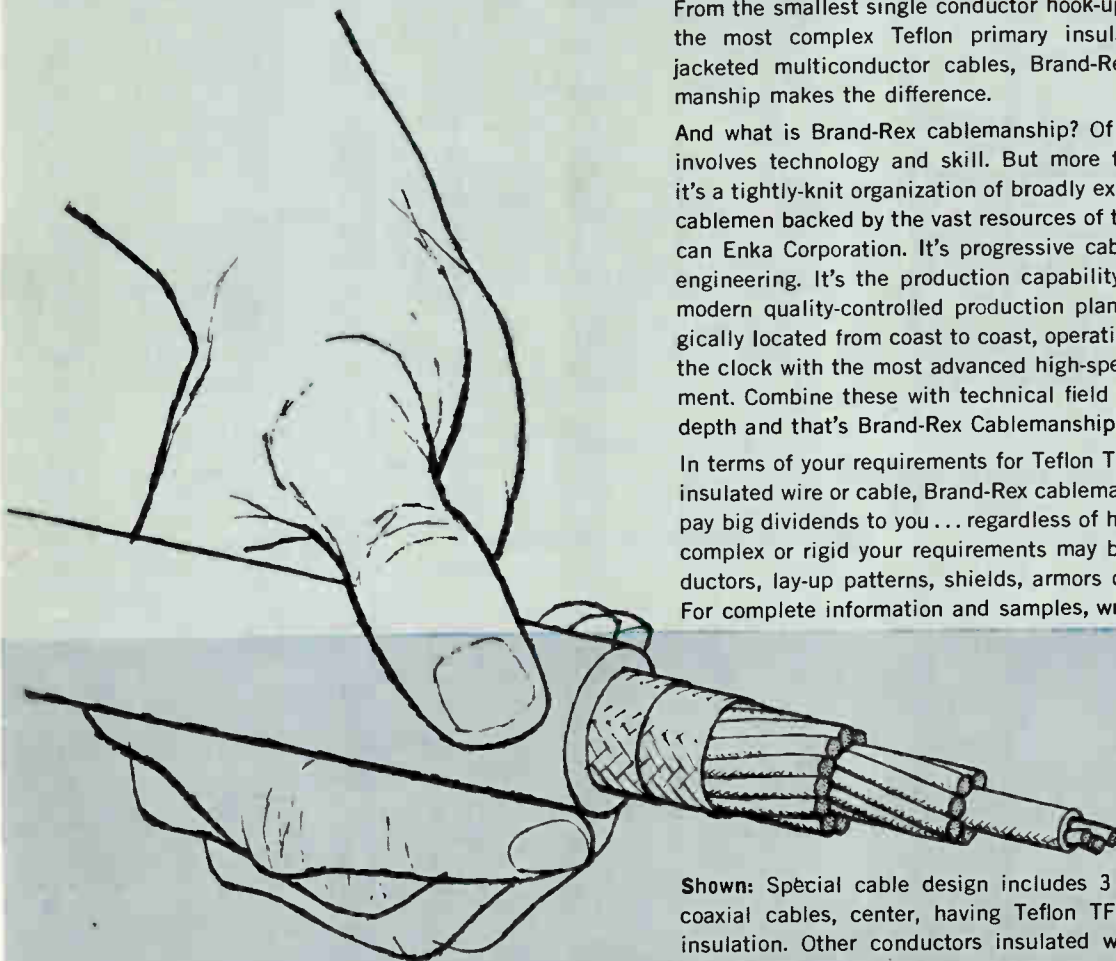
# BRAND-REX CABLEMANSHIP

**the big difference in Teflon®  
Insulated Wire and Cable!**

From the smallest single conductor hook-up wires to the most complex Teflon primary insulated and jacketed multiconductor cables, Brand-Rex Cablemanship makes the difference.

And what is Brand-Rex cablemanship? Of course it involves technology and skill. But more than that, it's a tightly-knit organization of broadly experienced cablemen backed by the vast resources of the American Enka Corporation. It's progressive cable design engineering. It's the production capability of three modern quality-controlled production plants, strategically located from coast to coast, operating around the clock with the most advanced high-speed equipment. Combine these with technical field service in depth and that's Brand-Rex Cablemanship!

In terms of your requirements for Teflon TFE or FEP insulated wire or cable, Brand-Rex cablemanship will pay big dividends to you... regardless of how varied, complex or rigid your requirements may be for conductors, lay-up patterns, shields, armors or jackets. For complete information and samples, write today!



**Shown:** Special cable design includes 3 miniature coaxial cables, center, having Teflon TFE primary insulation. Other conductors insulated with Teflon FEP. Braids Dacron. Jacket Neoprene.



**Left:** Cables can be furnished with individual coaxials, pairs, triples or other components positioned within the cable exactly to specs. **Center:** Brand-Rex coaxial cables use Teflon dielectrics and meets all government and commercial requirements. **Right:** Brand-Rex quality-control procedures cover every step of manufacture.

®Registered Trademark of DuPont



DIVISION OF



American **ENKA** Corporation

Dept. T, 38 Sudbury Road, Concord, Massachusetts

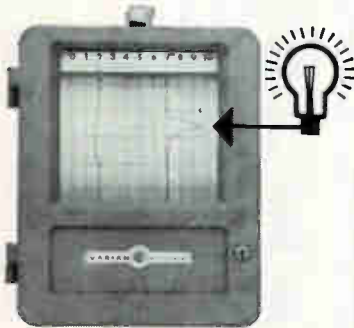
Telephone: EMerson 9-9630

Vinyl, Teflon, Polyethylene, Nylon Wire and Cables, Electrical Tubing and Sleeving — UHF Cast Plastics.



VARIAN  
Potentiometer  
RECORDERS

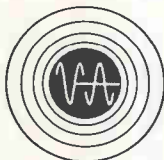
Offer exceptional  
versatility because...



THERE ARE ACCESSORIES FOR  
**ALARM/CONTROL**

Alarm and control switches, and retransmitting slide wires, add a valuable dimension of simple control to the already-versatile two-channel G-22. With these optional accessories they can work unattended to control two variables within the 1% accuracy of the recorder, while making a permanent record of what has happened.

1% accuracy, spans from 10 mv to 500 v, 1 second full-scale balance time, two chart speeds standard, four optional ( $\frac{1}{2}$ "/hr. to 16"/min.), full scale zero adjust, event markers and other options. Portable and rack-mounted models available from \$1,075. Write Instrument Division:



**VARIAN**  
associates

PALO ALTO 1, CALIFORNIA

CIRCLE 212 ON READER SERVICE CARD

April 14, 1961

sales, manufacture and engineering supervision for new products and processes acquired by Centralab as a result of cross-licensing arrangements with foreign companies.

Garstang was formerly chief engineer of the electronics division of Allen-Bradley Co.



Bidermann Joins  
Whittaker Gyro

WILLIAM R. BIDERMAN has been appointed to the newly created position of chief production engineer of Telecomputing Corporation's Whittaker Gyro Division, Van Nuys, Calif.

Under his supervision, a product engineering section is being established to extend Whittaker Gyro's efficiency and quality control from the design stage through all phases of production on gyroscopes, accelerometers and guidance systems.

Bidermann was formerly assistant general manager of Kearfott's microwave division in Van Nuys.



Weston Appoints  
R. L. Shapcott

APPOINTMENT of Ralph L. Shapcott as director of manufacturing and assistant general manager of Daystrom, Inc., Weston Instruments Division, Poughkeepsie, N. Y., is announced. The Poughkeepsie plant

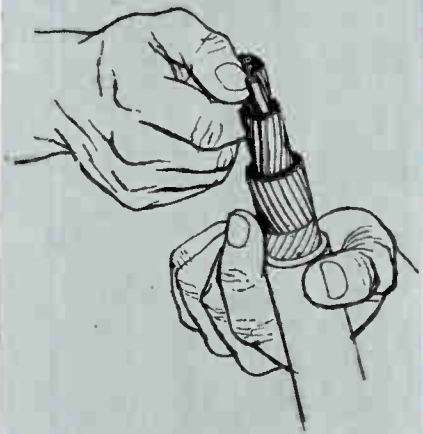
**BRAND-REX  
CABLEMANSHIP**

The Big Difference  
In MIL-C-1377B  
Neoprene  
Jacketed Cables!

Missile men, especially, know the advantages of Neoprene jacketed cables . . . low temperature flexibility, abrasion resistance and resiliency. And missile men who are also cablemen know it pays at the count down to count on Brand-Rex Cablemanship! And you should too.

There's more to the absolute reliability of Brand-Rex cables than just rigid adherence to specifications. Brand-Rex Cablemanship combines technology, skill, broad cable engineering services, production capability of three coast-to-coast plants and technical field service . . . all delivered by a tightly-knit organization backed by the vast resources of the American Enka Corporation.

Whatever your requirements for wire or cable, regardless of the rigidity of your specifications for conductors, layup patterns, insulation materials, shielding or armoring, you can count on the Cablemanship of Brand-Rex.



Write for samples and information today!



DIVISION OF

American **ENKA** Corporation  
Sudbury Road, Concord, Massachusetts  
Telephone: EMerson 9-9630

CIRCLE 121 ON READER SERVICE CARD

121

**IN LESS THAN  
4 SECONDS**

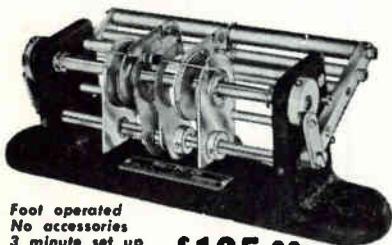
FROM THIS

TO THIS

OR THIS

**WITH THE REVOLUTIONARY  
PRODUCTION AID TOOL!**

**"PIG-TAILOR"®**



Foot operated  
No accessories  
3 minute set up

**\$125.00**

**'PIG-TAILORING'**

a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.

**PIG-TAILORING eliminates:** • Diagonal cutters • Long nose pliers • Operator judgment • 90% operator training time • Broken components • Broken leads • Short circuits from clippings • 65% chassis handling • Excessive lead tautness • Haphazard assembly methods.

**PIG-TAILORING provides:** • Uniform component position • Uniform marking exposure • Miniaturization spacing control • "S" leads for terminals • "U" leads for printed circuits • Individual cut and bend lengths • Better time/rate analysis • Closer cost control • Invaluable labor saving • Immediate cost recovery.

**Pays for itself in 2 weeks**

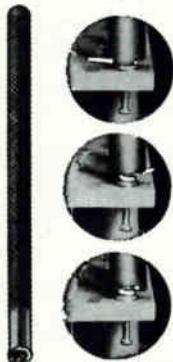
**"SPIN-PIN"®**

Close-up views of "SPIN-PIN" illustrate fast assembly of tailored-lead wire to terminal.

- No Training
- No Pliers
- No Clippings
- Uniform Crimps
- 22 Sizes

**PAYS FOR ITSELF  
THE FIRST DAY!**

**\$500**  
EACH



Write for illustrated book to Dept. E-4



**BRUNO-NEW YORK INDUSTRIES CORP.**

DESIGNERS & MANUFACTURERS OF ELECTRONIC EQUIPMENT  
460 WEST 34th STREET • NEW YORK 1, N. Y.

produces recording, controlling, and electronic gaging instruments for general industry.

Prior to joining Daystrom last year, Shapcott was general manager of the industrial instruments division of Fischer & Porter Co., Hatboro, Pa.



**Astrosonics Names  
Hughes To Top Post**

ELECTION of Nathaniel Hughes, formerly with General Precision, to executive vice president of Astrosonics, Inc., New York, N. Y., is announced.

Hughes will be responsible for operations and product development for the new company, which develops and produces sonic and ultrasonic products for commercial and military use.

**Radar Relay Forms  
Electronic Division**

THE BOARD of directors of Radar Relay, Inc., Santa Monica, Calif., recently created a new division called Ratronics, which will handle the company's growing activity in the field of printed circuitry.

Kenneth Klier has been named manager of the new division.

**Computer Systems  
Hires Pfeiffer**

LOUIS JAMES PFEIFFER has joined the applications engineering staff of Computer Systems, Inc., producer of precision electronic analog computers for broad industrial, commercial, scientific and military use. He will be located at CSI's Monmouth Junction, N. J., laboratory.

Pfeiffer was formerly a member of the management operations

catalog no. 4C-61

**ROYAL**  
Electronic Cables

made right to be RIGHT on the job

COAXIAL  
TRIAxIAL  
CONTROL  
SIGNAL  
TV CABLES  
MIL. SPEC  
CUSTOM

ROYAL ELECTRIC CORPORATION

**NEED  
CABLE  
DATA?**

Whatever your part in engineering and building electronic equipment, here's the NEW catalog that should be at your fingertips for CABLES! New Catalog No. 4C-61 gives complete charts on Royal RG and special application cables, physical and electrical characteristics, testing procedures, engineering tables (impedance, attenuation, etc.). Valuable information, too, on MIL-spec, signal, control and other multi-conductor cables.

**WRITE for your copy — TODAY!**

**Royal Electric Corporation**  
301 Saratoga Avenue  
Pawtucket, Rhode Island

In Canada: Royal Electric Company  
(Quebec) Ltd.,  
Pointe Claire, Quebec

**ROYAL**  
ELECTRIC

... an associate of

**CIRCLE 213 ON READER SERVICE CARD**  
electronic



# Electroplated WIRES

Wires for electrical contacts in a wide range of diameters may be plated with Rhodium, Gold, or Platinum. Electrical contacts, capable of handling currents at very low voltages, can be made with utmost reliability. The precious metals do not form an insulating barrier of oxides as would be the case with base metals.



Write for Latest Brochure

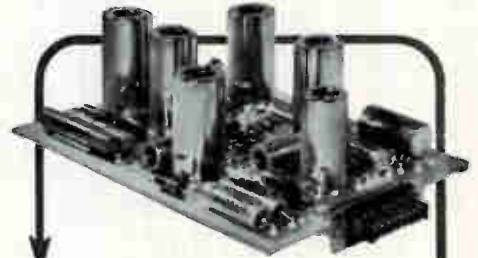


**SIGMUND COHN MFG. CO., INC.**

121 SOUTH COLUMBUS AVENUE, MOUNT VERNON, N.Y.

CIRCLE 214 ON READER SERVICE CARD

# Your best buy in operational amplifiers ?



## THE PHILBRICK USA-4J UNIVERSAL STABILIZED AMPLIFIER!

Choose this amplifier when the need for exceptional reliability justifies the price, and enjoy the bonus of remarkably high performance. Its reliability statistics prove it the best buy in the industrial and process control fields, although the USA-4J was originally designed for military use.

- **LOW DRIFT AND NOISE:**  
well under 50 microvolts rms.
- **GAIN:** 100 MILLION minimum open loop at dc; greater than unity at one megacycle; output, over  $\pm 100$  volts.
- **COOL RUNNING:**  
tubes and resistors operate at a fraction of wattage ratings; capacitors operate generally below  $\frac{1}{3}$  their voltage ratings.
- **MIL STD PARTS:**  
used exclusively.
- **EMINENTLY SENSIBLE COST:** Just **\$185**

FOR COMPLETE INFORMATION WRITE

GEORGE A.  
**PHILBRICK**  
RESEARCHES, INC.

127 CLARENDON ST. BOSTON 16, MASS.  
COMMONWEALTH 6-5375, TWX; BS 1032, FAX; BSN  
REPRESENTATIVES IN PRINCIPAL CITIES  
EXPORT OFFICE: 240 W. 17TH ST., N. Y. 11, N. Y.  
TEL. CHELSEA 3-5200, CABLE: TRILRUSH

# MICRO-SWEEPER PORTABLE PLUG-IN SWEEP GENERATOR



MODEL S-145

Prices subject to change without notice.  
S-131 ..... \$98.90      S-145 ..... \$98.90

A small lightweight sweep generator that attaches directly to oscilloscope panels.

Increases the useful operating time of your scope.

Will sweep IF stages and wide band amplifiers for alignment.

Can be used as a fixed frequency generator, stable to one part in  $10^4$ .

Will measure transient response of filters and other circuits.

Cables and batteries not required. Ready for instant operation after plug in. Sweeps speeds up to 1 microsecond/centimeter can be used from those on your scope.

FOR COMPLETE INFORMATION WRITE TO

**TELTRONICS**  
INC.

277 MAIN STREET — NASHUA, N.H.

CIRCLE 215 ON READER SERVICE CARD



**Fast  
Shipment  
FROM**

**WORLD'S  
LARGEST**

**STOCK** of  
**STAINLESS  
STEEL**

**A N - M S  
COMMERCIAL**

**BOLTS**

**SCREWS**—Complete range of machine and self tapping with slotted or Phillips recessed heads, both magnetic and non-magnetic.

**NUTS**—Cap, Hex, Castle, Slotted, Square, Wing, etc.

**PINS**—dowel, taper, etc. Plus washers, rivets, threaded rod, studs, nails, many more.

**"SPECIALS"**—fabricated to your specs on extremely short notice.

**WRITE • WIRE • PHONE**

**FOR QUOTATION OR SHIPMENT  
ASK FOR CATALOG**

**ALLMETAL®**

**Screw Products Company, Inc.**  
Manufacturers of Stainless Fasteners Since 1929

821 Stewart Avenue, Garden City, L.I., N.Y.  
Phone: Pioneer 1-1200 TWX GCY 603

Midwest Division  
6424 W. Belmont Avenue, Chicago 34, Illinois  
Phone: Avenue 2-3232 TWX CG 3185

West Coast Division—Office and Warehouse  
5822 West Washington Blvd., Culver City, Calif.  
Phone: Webster 3-9595 TWX LA 1472

team of Hess, Inc., Perth Amboy, N. J.

### Narda Gets New Plant And Management

COMPLETION of the move by the Narda Ultrasonics Corp. from its former Westbury, L. I., location to a new modern plant facility at Syosset, L. I., has been announced by Stuart C. Dorman, recently elected president of the firm.

The new management team, headed by Dorman, includes Walter Venghaus, vice president; Alfred Werner, director of marketing; and John Thoren, controller.

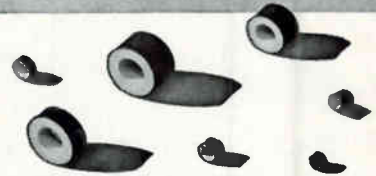
### PEOPLE IN BRIEF

Eugene A. Lawson leaves Telex Co. to become production control manager for Transistor Electronics Corp. Lewis M. Duckor, formerly with Colvin Labs, appointed chief engineer for electronic products by American-Standard Controls Div. Edward P. Laffie promoted to manager of semiconductor quality control at CBS Electronics. Paul Schwartz advances at Lumatron Electronics to chief engineer. Guy B. Richardson, Jr., recently retired from the Air Force, has accepted the position of special consultant to the president of General Precision, Inc. Marvel W. Scheldorf moves up to senior engineer in electronics research at the Armour Research Foundation of Illinois Institute of Technology. Ralph Ferry leaves Allied Control to join the Line Electric Co. as project engineer. William H. Fahringer promoted to mass memory systems manager by Bryant Computer Products Div., Ex-Cell-O Corp. Peter Wargo of General Electric advances to manager of engineering for the cathode ray tube dept. John A. F. Gerrard, formerly with Texas Instruments, named director of electronics engineering for Bendix-Pacific Div. of the Bendix Corp. Leonard G. Abraham, Jr. transfers from the General Electric Research Labs to Sylvania Electric Products, Inc., as engineering specialist for the company's applied research laboratory.

# TOUGH



**... AS A  
TURTLE'S BACK**



**ARMAG\*-PROTECTED  
DYNACOR®  
BOBBIN CORES  
AT NO EXTRA COST!**

Tough-as-tortoise-shell Armag armor is an exclusive Dynacor development. It is a thin, non-metallic laminated jacket for bobbin cores that replaces the defects of nylon materials and polyester tape with *very definite advantages*—and, you pay no premium for Armag extra protection.

Tough Armag is suitable for use with normal encapsulation techniques on both ceramic and stainless steel bobbins. It withstands 180°C without deterioration—is completely compatible with poured potted compounds—has no abrasive effect on copper wire during winding—fabricates easily to close-tolerance dimensions—inner layer is compressible to assure tight fit on bobbin—does not shrink, age or discolor.

Write for Engineering Bulletins DN 1500, DN 1000A, DN 1003 for complete performance and specification data covering the wide range of Dynacor low cost Standard, Special and Custom Bobbin Cores—all available with Armag non-metallic armor.

\*TRADEMARK

**DYNACOR**

**DYNACOR, INC.**  
A SUBSIDIARY OF SPRAGUE ELECTRIC CO.  
1006 Westmore Ave. • Rockville, Maryland  
CIRCLE 216 ON READER SERVICE CARD  
electronics



# TELREX LABORATORIES

Designers and Manufacturers of

## COMMERCIAL SERVICE "BEAMED-POWER" ARRAYS AND TWO-WAY SYSTEMS

Model illustrates a wide-spaced, 12 element circular polarized optimum-tuned skewed dipole "SPIRALRAY" antenna. Provides unusually high gain, even response, in all polarization planes, vertical, horizontal or oblique with unusually high signal-to-noise ratio.

NO OTHER CIRCULAR POLARIZED ARRAY known to the art today can provide the linear high gain and signal-to-noise ratio in all radiation planes.

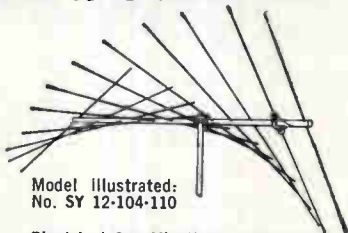
The ideal antenna for missile tracking, telemetering and no-fade response to mobile (or moving) stations.

Models available to extend the practical range of 2-Way Communication Systems.

Model SY-12-104-11  
\$265.00

Model MSY-104-110  
\$390.00

(f.o.b. Asbury  
Park, N. J.)



Model Illustrated:  
No. SY 12-104-110

Electrical Specifications—Model No. SY-12-104-110: Polarization, circular, linear within 1/2 db. Gain 13 db. F/B-Ratio 30 db. V/S/W/R (50 ohm cable) 1.1/1. Beamwidth at half power points 33 degrees. Max. power input 300 w, with "Balun" supplied.

Mechanical Specifications: Boom diameter 2" O.D. x 25 ft. All aluminum boom and elements. Weight approx 25 lbs. Rated wind-load 90 mph. No ice load. Available for 120 mph wind load. (Model No. MSY-104-110).

ANTENNAS

SINCE  
1921

Communication and TV Antennas  
**telrex** LABORATORIES

ASBURY PARK 25, NEW JERSEY, U.S.A.

- Telrex is equipped to design and supply to our specifications or yours, Broad-band or single frequency, fixed or rotary arrays for communications, FM, TV, scatter-propagation, etc.

- Consultants and suppliers to communication firms, universities, propagation laboratories and the Armed Forces.

CIRCLE 217 ON READER SERVICE CARD

## COMPUTER SYSTEMS ENGINEERS

SALARY: TO \$20,000

Several immediate openings exist at Hughes-Fullerton for Computer Systems Engineers qualified in the design and testing of large scale digital systems—and in the preparation of proposals for large scale digital computers.

These professional assignments involve such R & D areas as:

- Solid state digital circuitry involving millimicrosecond logic
- Microwave carrier digital circuits
- Sub-microsecond core memory
- Thin film storage techniques
- Functional circuit concepts
- Micro-miniaturization concepts
- Tunnel diodes ■ Microwave parametrons ■ Circuit organization for maximal-speed computing.

Located in Southern California's Orange County (the nation's fastest growing electronics center), Hughes-Fullerton offers you: a stimulating working environment; private or semi-private offices; long-term stability.

**CALL COLLECT TODAY!**

For complete information on these challenging assignments, call us collect today! Ask for:

**Mr. B. P. RAMSTACK at:**  
Trojan 1-4080, ext. 3741.

Or, airmail resume to: HUGHES-FULLERTON R & D, P. O. Box 2097, Fullerton 1, California.

**HUGHES**

HUGHES AIRCRAFT COMPANY

modern, low-cost  
way to  
precision  
measurements ...



## AEROVOX DECADE BOXES

Inductance, Resistance and Capacitance Decades in extra-compact and rugged design for accurate and dependable performance. Quality components used throughout to provide the same precise quality standards, electrically and mechanically, as finest lab-type equipment.

Units housed in heavy-duty, seamless steel cases with durable gray finish. All one size—5 1/2" L x 3 3/8" W x 2 1/8" H. Black face plates with white markings. Highest value multiplier on left.

Available from all Aerovox Parts Distributors, write for descriptive literature...

**AEROVOX  
CORPORATION**

DISTRIBUTOR DIVISION

New Bedford

Massachusetts

CIRCLE 218 ON READER SERVICE CARD

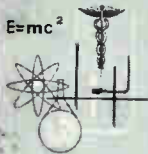
April 14, 1961

# 140 KMC

ULTRAMICROWAVE\*

EQUIPMENT

BY



*-it works*

*-it's accurate*

*-it's available*

Complete data on request

DE MORNAY  BONARDI

**DE MORNAY-BONARDI**  
780 SOUTH ARROYO PARKWAY • PASADENA, CALIF.

\*TRADE MARK De Mornay-Bonardi  
for its millimeter wave equipment

CIRCLE 219 ON READER SERVICE CARD

# electronics

## WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

**ATTENTION:  
ENGINEERS, SCIENTISTS, PHYSICISTS**

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

**STRICTLY CONFIDENTIAL**

Your Qualification form will be handled as "Strictly Confidential" by ELECTRONICS. Our processing system is such that your form will be forwarded within 24 hours to the proper executives in the companies you select. You will be contacted at your home by the interested companies.

**WHAT TO DO**

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely.
6. Mail to: D. Hawksby, Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

COMPANY	SEE PAGE	KEY #
ARMOUR RESEARCH FOUNDATION Illinois Institute of Technology Chicago, Illinois	120*	1
AVCO/RAD A Div. of Avco Corp. Wilmington, Massachusetts	134	2
THE BENDIX CORPORATION Kansas City Division Kansas City, Missouri	131, 132*	3
ERIE ELECTRONICS DIV. Erie Resistor Corp. Erie, Pa.	128	4
ESQUIRE PERSONNEL Chicago, Illinois	128	5
GENERAL DYNAMICS/ELECTRONICS A Div. of General Dynamics Corp. Rochester, New York	129*	6
GENERAL ELECTRIC COMPANY Light Military Electronics Dept. Utica, New York	127	7
HOUSTON INSTRUMENT CORPORATION Houston, Texas	128	8
LITTON SYSTEMS INC. Guidance & Control Systems Div. Beverly Hills, California	62*	10
McGRAW-HILL PUBLISHING CO., INC. New York, New York	128	11
NORTHROP CORPORATION Beverly Hills, California	46, 47*	12

Continued on page 128

(cut here)

(cut here)

### electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

**Personal Background**

NAME .....

HOME ADDRESS.....

CITY..... ZONE..... STATE.....

HOME TELEPHONE.....

**Education**

PROFESSIONAL DEGREE(S).....

MAJOR(S) .....

UNIVERSITY .....

DATE(S) .....

**FIELDS OF EXPERIENCE (Please Check)**

4141

<input type="checkbox"/> Aerospace	<input type="checkbox"/> Fire Control	<input type="checkbox"/> Radar
<input type="checkbox"/> Antennas	<input type="checkbox"/> Human Factors	<input type="checkbox"/> Radio-TV
<input type="checkbox"/> ASW	<input type="checkbox"/> Infrared	<input type="checkbox"/> Simulators
<input type="checkbox"/> Circuits	<input type="checkbox"/> Instrumentation	<input type="checkbox"/> Solid State
<input type="checkbox"/> Communications	<input type="checkbox"/> Medicine	<input type="checkbox"/> Telemetry
<input type="checkbox"/> Components	<input type="checkbox"/> Microwave	<input type="checkbox"/> Transformers
<input type="checkbox"/> Computers	<input type="checkbox"/> Navigation	<input type="checkbox"/> Other .....
<input type="checkbox"/> ECM	<input type="checkbox"/> Operations Research	<input type="checkbox"/> .....
<input type="checkbox"/> Electron Tubes	<input type="checkbox"/> Optics	<input type="checkbox"/> .....
<input type="checkbox"/> Engineering Writing	<input type="checkbox"/> Packaging	<input type="checkbox"/> .....

**CATEGORY OF SPECIALIZATION**

Please indicate number of months experience in proper black(s)

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	.....	.....
RESEARCH (Applied)	.....	.....
SYSTEMS (New Concepts)	.....	.....
DEVELOPMENT (Model)	.....	.....
DESIGN (Product)	.....	.....
MANUFACTURING (Product)	.....	.....
FIELD (Service)	.....	.....
SALES (Proposals & Products)	.....	.....

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

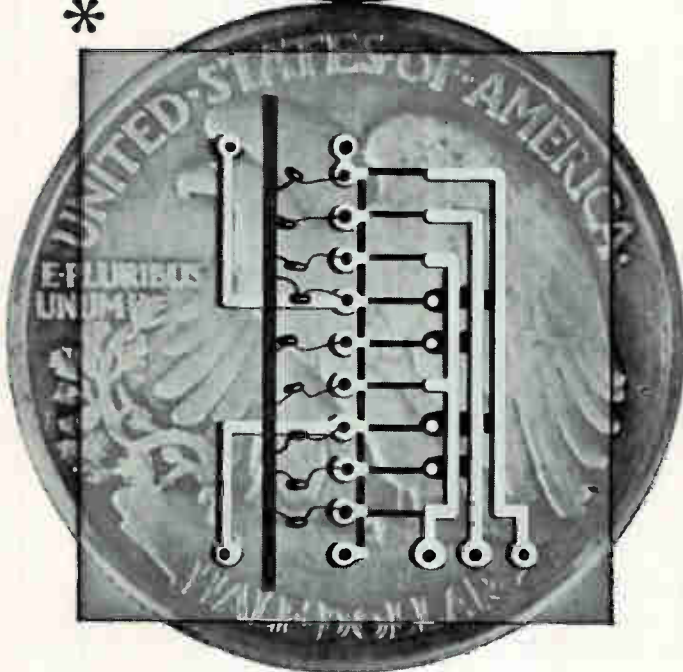
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25



From Applied Research  
to Product Application...

## CHOOSE YOUR OPPORTUNITY IN MICROELECTRONICS

at G.E.'s Light Military  
Electronics Department



*Areas  
of  
Immediate  
Opportunity*

- High Vacuum Technology
- Microelectronic Circuit Development
- Evaporation Process Engineering
- Semiconductor Design and Applications
- Thin Film Circuit Applications
- Circuit Packaging Design
- Chemical Process Engineering
- Thin Film Process Engineering
- Solid State Physics

Of special importance to career-oriented scientists and engineers is the fact that Light Military's approach to thin film circuitry and microelectronic module development is *both* research *and* application oriented.

Simultaneous with basic and applied research studies are equally intense engineering efforts to *practicalize* new concepts and apply them

early in the cycle to advance development and design programs now underway in airborne, missile and satellite communications; guidance and digital data processing systems.

If your experience is in any of the above areas, and you want to move forward rapidly as a member of one of our growing research or development groups, we invite your early inquiry.

For immediate consideration, write in strictest confidence to Mr. R. Bach, Dept. 69-WO

\* Enlargement of Double Nor Circuit, includes 2 transistors, 2 Zener diodes, 4 diodes, 2 capacitors, 4 resistors. Photo retouched for reproduction.

**LMED**

LIGHT MILITARY ELECTRONICS DEPARTMENT

**GENERAL ELECTRIC**

FRENCH ROAD, UTICA, NEW YORK  
CIRCLE 381 ON READER SERVICE CARD

# CHIEF ELECTRONICS ENGINEER

An excellent opportunity is available for a competent engineer with proven creative ability. Applicant must have a B.S. or M.S. degree in electrical engineering from a leading university and must have at least five years experience in the design of commercial electronic laboratory instruments.

This opening is ideally suited for an independent type of engineer who can supervise but who requires minimum supervision. It is an excellent ground floor opportunity in a small but rapidly growing and financially healthy company. *(Stock option participation plan would be negotiated to obtain the right man. This plus participation in management is the next best thing to having your own company.)* All work will pertain to developing a line of new products with many novel features. Applicant should be capable of adding new, technically sound, and salable ideas of his own over a reasonable period of time.

Our interest also extends to small undercapitalized companies with promising products who may wish to consolidate with us.

Write to: E. V. Hardway, Jr., President



**houston instrument corporation**

P. O. BOX 22234 • Houston 27, Texas

PLANT: 4930 TERMINAL AVE., BELLAIRE, TEXAS

MOhawk 7-7405 • CABLE: HOINCO • TWX: 28

CIRCLE 382 READER SERVICE CARD

# electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

(Continued from page 126)

COMPANY	SEE PAGE	KEY #
PERKIN-ELMER CORPORATION Norwalk, Connecticut	128	13
PHILADELPHIA NAVAL SHIPYARD Philadelphia, Pa.	132*	14
PHILCO WESTERN DEVELOPMENT LABS. Palo Alto, California	58*	15
REPUBLIC AVIATION Farmingdale, L. I., New York	130*	16
TEXAS INSTRUMENTS INC. Semiconductor-Components Div. Dallas, Texas.	98, 99	17

\*These advertisements appeared in the 4/7/61 issue.

## TRANSFORMER ENGINEER

With experience in the design and development of Hi-Frequency and Pulse transformers for commercial and military applications.

Ideal opportunity for ambitious man to develop full potential of present small department. Salary—open. Location—Erie, Pa. Call or send resume to: Chief Engineer

**Erie Electronics Division**  
Erie Resistor Corporation  
645 West 12th Street Erie, Pa.

CIRCLE 385 ON READER SERVICE CARD

# PROJECT ENGINEER

Commercial Instrument Development

Position requires a strong technical understanding of EE and/or Physics related to the design of complex electro-optical laboratory instruments.

You must have 5 years experience in translating design into working instrumentation. Excellent salary and fringe benefit program.

Send resume to  
Howard M. Moran

**Perkin-Elmer**  
Corporation

MAIN AVE. • ROUTE 7 • NORWALK, CONN.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

CIRCLE 383 READER SERVICE CARD

ME's, CHEM E's, EE's plus CIVILS

When you think of INTEREST  
think of your job

When you think of GROWTH  
think of your job

When you think of CHALLENGE  
think of your job

When you think of your job  
think of McGraw-Hill

If you like to write, and engineering is your profession, consult with us about a career in engineering-journalism. For additional information, write: Mr. Jack Coyne, Room 506, McGraw-Hill Publishing Company, 330 West 42nd Street, New York 36, New York.

CIRCLE 384 ON READER SERVICE CARD

## Wanted Electrical or Electronic Engineering

Graduate, between 25 and 32 years of age for sales engineering work by manufacturer of electronic components, including High Speed Relays, Choppers, and Pressure Switches.

Location: Chicago or Cleveland  
Write Harry E. Beane, Vice President

THE BRISTOL COMPANY  
Waterbury 20, Connecticut

## TECHNICAL DIRECTOR

Inertial Guidance Systems..... \$22,000  
Our client, a leading company in the electronics industry, needs man who will assume complete responsibility over all administrative & engineering personnel in R&D and Production. Prefer advanced degree with 8 or more yrs. experience. Mail resume in complete confidence. Client assumes interviewing, moving and agency expense.

ESQUIRE PERSONNEL  
202 S. State St. Chicago 4, Illinois

CIRCLE 386 ON READER SERVICE CARD



## MANUFACTURERS' REPRESENTATIVES

IN THE ELECTRONIC INDUSTRY

## SAMUEL K. MACDONALD, INC.

manufacturers representatives over 25 years  
1531 SPRUCE STREET, PHILA. 2, PA.

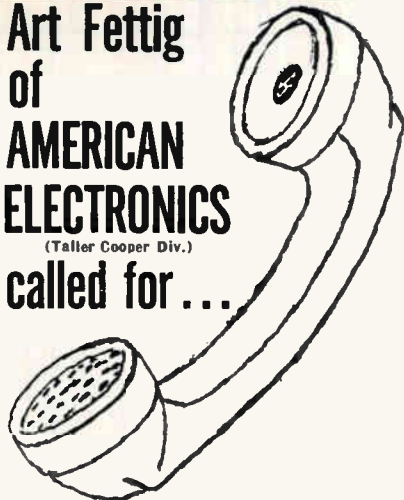
Territory: Pennsylvania • New Jersey  
Delaware • Maryland  
Virginia • West Virginia  
District of Columbia

Other Offices:  
Pittsburgh  
Baltimore  
Washington, D.C.

CIRCLE 387 ON READER SERVICE CARD



Art Fettig of AMERICAN ELECTRONICS (Taller Cooper Div.) called for...

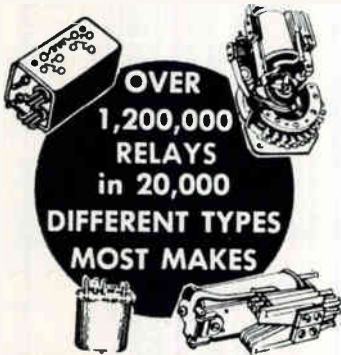


TELEPHONE TYPE RELAYS



ARTHUR FETTIG, Purchasing Agent

"I needed 300 telephone type relays... in a hurry. I called UNIVERSAL RELAY and I got action. Order was processed and shipped in less than 48 hours. Performance like this, to my knowledge and experience, is a regular practice at... UNIVERSAL RELAY."



OVER 1,200,000 RELAYS in 20,000 DIFFERENT TYPES MOST MAKES

- PRODUCTION QUANTITIES IN STOCK
• DELIVERY ON OFF-THE-SHELF ITEMS WITHIN 48 HOURS. DELIVERY WITHIN ONE WEEK ON RELAYS REQUIRING ASSEMBLY AND/OR ADJUSTMENT.

WE DELIVER RELAYS NOT PROMISES



FREE...

Send for NEW catalog "E"

Universal RELAY CORP.

42A White St., New York 13, N. Y. WALKER 5-9257

CIRCLE 460 ON READER SERVICE CARD

April 14, 1961

SPECIAL PURPOSE TUBES

Table listing various tube types and their prices, including OA2, OA3, OB2, etc., and their corresponding values.

ALL TUBES ARE NEW, INDIVIDUALLY CARTONED, FULLY GUARANTEED

western engineers

Orders for less than \$10 cannot be processed

ELK GROVE, CALIFORNIA

SUPPLIERS OF ELECTRON TUBES SINCE 1932

CIRCLE 461 ON READER SERVICE CARD

All cables listed here are from conversion kits manufactured for Lockheed Aircraft and bear inspection stamps and 1958 Date of Manufacture. New, clean, made up cables at a fraction of the true value. **IN STOCK—IMMEDIATE SHIPMENT.**

<b>RG 71/U or RG 71 A/U 93Ω Coax Cable UG260B/U each end</b>			
Length	1-10	11-49	50 Up
2 ft. 6 in.	\$1.09	\$ .99	\$ .90
4 ft. 6 in.	1.21	1.09	.99
6 ft.	1.30	1.17	1.05
9 ft.	1.48	1.33	1.20
10 ft.	1.54	1.40	1.26
11 ft.	1.60	1.44	1.30
16 ft.	1.90	1.71	1.54
17 ft.	1.96	1.77	1.60
18 ft.	2.02	1.82	1.64
31 ft.	2.80	2.52	2.27
33 ft.	2.92	2.63	2.37
35 ft.	3.04	2.74	2.47
<b>UG260B/U One end</b>			
95 ft.	\$6.19	\$5.55	\$5.00
110 ft.	7.07	6.37	5.73
130 ft.	8.27	7.44	6.70
140 ft.	8.87	8.00	7.20
<b>UG260B/U One end UG603A/U One end</b>			
2 ft. 6 in.	\$1.42	\$1.28	\$1.15
35 ft.	3.37	2.94	2.65
<b>UG603 A/U One end</b>			
85 ft.	\$5.90	\$5.30	\$4.77
130 ft.	8.60	7.74	6.97
<b>RG 9 B/U 52Ω CoAx Cable UG 1185/U Each End</b>			
1 ft. 3 in.	\$2.21	\$2.00	\$1.80
1 ft. 8 in.	2.31	2.08	1.88
2 ft. 10 in.	2.52	2.27	2.04
3 ft.	2.56	2.30	2.07
4 ft.	2.76	2.48	2.23
6 ft. 6 in.	3.26	2.93	2.64
7 ft. 6 in.	3.46	3.11	2.80
8 ft. 6 in.	3.66	3.30	2.97
18 ft.	5.56	5.00	4.50
26 ft.	7.16	6.44	5.80
<b>UG 1185/U One End UG 573 A/U One End</b>			
1 ft. 3 in.	\$2.96	\$2.66	\$2.40
1 ft. 10 in.	3.09	2.79	2.50
2 ft. 6 in.	3.21	2.89	2.60
<b>UG 1185/U One End UG 571/U One End</b>			
3 ft.	\$2.86	\$2.57	\$2.30
4 ft. 8 in.	3.20	2.88	2.60
<b>PL 259 One End</b>			
25 ft.	\$5.49	\$4.94	\$4.44
<b>RG 8 A/U with UG 1185/U One End UG 573 A/U One End</b>			
6 ft.	\$3.43	\$3.10	\$2.79
<b>RG 59 A/U 73Ω CoAx Cable UG 260 B/U Each End</b>			
3 ft. 6 in.	\$1.12	\$1.00	\$ .90
3 ft. 9 in.	1.12	1.00	.90
35 ft.	2.69	2.40	2.16
36 ft. 6 in.	2.77	2.50	2.25
<b>UG 260 B/U One End UG 603 A/U One End</b>			
1 ft. 10 in.	\$1.35	\$1.21	\$1.09
2 ft.	1.37	1.23	1.10
4 ft.	1.47	1.32	1.20
10 ft.	1.77	1.60	1.44
10 ft. 6 in.	1.80	1.62	1.46
36 ft. 6 in.	3.10	2.79	2.51

**TRANSCO "Y" Type Coaxial Switch SPDT**

Miniature Light weight CoAx switch with low VSWR and broad band width. Works to 11 KMC. Separate actuator coils for each circuit. Type "N" connectors, 50 Ohm nominal impedance. Actuator voltage 28 volts DC, 6 Watts each coil. TRANSCO Number 11100. Our price \$20.00 each. **LARGE QUANTITY AVAILABLE.**

**TRANSCO "A" Type Coaxial Switch SP4T**

Same action and specs. as the above "Y" type but has 4 solenoids to operate the contacts, allowing complete control over make-before-break or break-before-make and contact of all positions simultaneously. TRANSCO Number 14100. Our Price \$30.00 each.

**SAGE Broadband Coaxial Crystal Holders**

Type 101BDJ 150 to 4000 MCS.—Uses SYLVANIA TRIPOLAR CRYSTAL IN358A Type N Male to BNC output (female)—With DC Return. Our Price \$18.00 Complete IN358A Crystal only \$10.00—Sage Mount only \$9.00.

**"Red" Johnson ELECTRONICS**

3311 Park — PALO ALTO, CALIFORNIA — DAVenport 6-6085

CIRCLE 462 ON READER SERVICE CARD

**GET IT from GOODHEART!**

**0.1% SORENSEN Line Voltage Regulator**

±5000s, Brand new at low surplus price! Input 95-130 V. 1 ph., with taps for 50 or 60 cy. Use for any power up to 5000 watts. Output adjustable 110-120 V and holds to ±0.1% at line frequency, or to ±0.25% if line frequency drifts 5%. Regulates against line changes of 95-130V and against load changes from 0 to 5 KVA. Maximum harmonics less than 3%. Recovery time 0.15 seconds. Input to the control section can be moved to the point where you will use the power, thus compensating for line drop. In rack cabinet 28" h., 22" wd., 15" dp. Net wt 190 lbs. Shpg wt 285 lbs FOB Utica, N. Y. In original factory pack suitable for export, including SPARE PARTS group. Sorensen catalog net price is \$695.00 **\$349.50** less spares. Our price, WITH SPARES . . .



Write us, stating your specific needs in Line Voltage Regulators, Receivers, Signal Generators, Transmitters, Tuning-Fork Frequency Standards, Graphic Recorders, etc., all at low surplus prices, all certified and guaranteed unconditionally.

**R. E. GOODHEART CO.**

P. O. Box 1220-E Beverly Hills, Calif.

CIRCLE 463 ON READER SERVICE CARD

**• KLYSTRON SPECIAL •**

726 B. C. ....	\$15.00	2K50 .....	\$72.00
5721 .....	125.00	2K54 .....	15.00
6115 .....	50.00	2K55 .....	25.00
6116 .....	75.00	2K56 .....	50.00
6390 .....	175.00	3K21 .....	150.00
2K22 .....	22.50	QK185 .....	35.00
2K23 .....	22.50	QK290 .....	350.00
2K25 .....	9.00	QK291 .....	350.00
2K28 .....	27.50	QK292 .....	350.00
2K29 .....	27.50	QK293 .....	350.00
2K33A .....	200.00	QK294 .....	350.00
2K33B .....	300.00	QK295 .....	450.00
2K39 .....	170.00	V23 .....	450.00
2K41 .....	75.00	V27 .....	600.00
2K42 .....	150.00	V28 .....	975.00
2K43 .....	144.00	V45 .....	450.00
2K44 .....	100.00	V270 .....	125.00
2K45 .....	25.00	VA94 .....	350.00
2K48 .....	50.00	X12 .....	75.00

**LIBERTY ELECTRONICS, Inc.**  
582 Broadway New York 12, N. Y.  
WALKER 5-6000 Cables: TELSERSUP

CIRCLE 464 ON READER SERVICE CARD

**• 500 Ma/400 PIV SILICON RECTIFIERS •**

Guaranteed First Quality • Individually Boxed  
Always Available • Immediate Delivery  
Lots of 100, \$.40 each Less Than 50, \$.50 each  
Write or Phone For Quantity Prices  
**ELECTRA PARTS, Inc.**  
135 Liberty St. N. Y. C. 6, N. Y. WOrth 2-4473

CIRCLE 465 ON READER SERVICE CARD

**WANTED**

Wanted: Microscopic particles opaque or chromophilic 5 to 40 microns in size by 5 micron increments. Needed by research project. Funds available. Write Murco Research, Inc., P. O. Box 6006, Jacksonville 5, Florida.

*If there is anything you want . . .*

that other readers of this paper can supply

*or—something you don't want*

that other readers can use, advertise it in the

**SEARCHLIGHT SECTION**



# 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 ...../4/14/61

# MINIATURE CONNECTORS

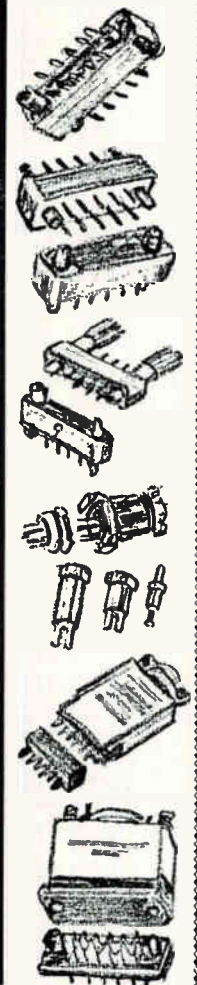
**AT BELOW MANUFACTURERS' O. E. M. PRICES!**

• Immediate Delivery from Stock • All New . . . Quality Guaranteed

WINCHESTER	US COM- PONENTS	CONTI- NENTAL
A7H	.35	.35
A7H-28	.35	.35
A7P	.60	.60
A7S	.99	.85
A10H	.45	.40
A10P	1.25	1.00
A10S		1.29
A11S		1.40
A15H	.40	.40
A15S	1.25	1.05
A15S	1.73	1.48
A18H	.47	.40
A18P	1.20	1.20
A18S	2.00	1.54
A20P		1.50
A20S		2.20
B24PR		
FT5	.15	
FT9	.15	
H9C	.35	.35
H10	.20	.20
H19 C	.25	.25
H19S	.25	.25
HG9		
HG9C		
HMRE-9PG		1.95
HMRE-14PG	2.80	
HMRE-20PG	3.35	
HMRE-26PG	4.15	3.95
HMRE-34PG	4.77	
HMRE-41PG	5.47	
JF1P-15		
JF1P-25		
JF4		
JF4S		
K6T	1.15	
K12TC	.98	
K15STC	1.25	
K27S		
K25S	1.95	
KM6S		1.30
KM10S	1.40	
KM15S	1.50	
KM18S	1.90	
LMR30P-R		
M4M14	.65	
M4P	.34	.34
M4S	.57	.55
M5P	.38	.37
M5S	.67	.64
M5TS-7	.12	
M4TS-7	.12	
M7P	.45	.43
M7S	.85	.75
M9P	.52	
M9S	1.04	.96
M10P		.75
M12P	.95	
MA-QRE-18P		2.00
MA-QRE-18S		2.10
MA-QRE-34P		3.75
MA-QRE-34S		3.75
MFB-550	.50	
MR-30P		
MRE-7H	.30	.30
MRE-7PG	.80	.80
MRE-7SG	1.25	1.10
MRE-8H H1	.52	.52
MRE-8PG	.84	.94
MRE-8SG	1.33	1.33
MRE-8H H1	.52	.40
MRE-9PG	.99	.95
MRE-9SG	1.44	1.30
MRE-11SG		1.70
MRE-11H1		.60
MRE-12-2H	.60	
MRE-12-2P	1.60	
MRE-12-2S	2.25	
MRE-14H	.50	.40
MRE-14PG	.90	.75
MRE-14SG	1.67	1.25
MRE-18H 1	.50	.40
MRE-18PG	1.15	1.00
MRE-18SG	2.12	1.58
MRE-20H	.55	.45
MRE-20PG	1.35	1.15
MRE-20SG	2.40	2.20
MRE-21H	.50	.40
MRE-21PG	1.41	1.00
MRE-21SG	2.56	1.75
MRE-26H	.50	.40
MRE-26PG	1.45	1.25
MRE-26SG	2.87	2.20
MRE-28SG		1.75
MRE-34H	.65	.50
MRE-34PG	1.85	1.35
MRE-34SG	3.81	2.35
MRE-41H	.75	.75
MRE-41PG	2.45	2.25
MRE-41SG	3.99	3.75
MRE-50H 1		.80
MRE-50PG	2.67	2.00
MRE-50SG	5.42	3.73
MRE-75H 1	.90	.90
MRE-75PG	4.20	2.60
MRE-75SG	8.49	5.20

WINCHESTER	US COM- PONENTS	CONTI- NENTAL
MRE-104H		1.50
MRE-104PG		6.79
MRE-104SG		9.75
MS9		
MTS-7	.10	
MTS-12	.10	
PMIP	.25	
PM6H	.54	
PM6P	.60	
PM6S	.73	
QRE-12B	.54	
QRE-12PHN	.50	
QRE-12P	1.73	1.62
QRE-12P-8	1.90	
QRE-12S	1.73	1.50
QRE-12S		1.65
QRE-18PHN	.55	
QRE-18P	2.27	1.50
QRE-18S	2.27	1.50
QRE-18SHN		2.00
QRE-24B	.54	
QRE-24H	.68	.68
QRE-24PHN		
QRE-24P	2.95	2.65
QRE-24S	2.95	2.65
QRE-34B	.54	
QRE-34H	.73	.70
QRE-34P	4.25	3.70
QRE-34S	3.99	3.29
RE-10P		1.95
RE-10S		2.25
RE-12P	1.60	1.45
RE-12S	2.85	2.15
RE-18P	2.10	1.60
RE-18S	3.40	1.75
RE-24P	3.20	
RE-24S	3.90	
SA-7P	.60	.60
SA-7S	1.65	.99
SA-9H		.50
SA-9P	1.00	1.00
SA-9S		1.29
SA-10P	.80	.80
SA-10S	1.40	1.40
SA-15H	1.00	1.00
SA-15P		1.25
SA-15S		1.75
SA-18H		.50
SA-18P		1.20
SA-18S		1.65
SM-15S		
SM-1H	.18	
SM-1P	.12	
SM-1S	.18	
SM-2H	.12	
SM-2P	.23	
SM-2S	.49	
SMRE-20H 1	1.00	1.00
SMRE-20SG	2.95	
SMRE-26H	1.00	
W11S-5K3394		
XMRE-14H-3		
XMRE-50P		
XMRE-50S		
XMRE-50H		
#201	5.80	
#275		
#301		
#302		
#422		
#450		
#451		
#750	.08	
#751	.08	
#752	.08	
#753	.08	
#754	.08	
#755	.08	
#756	.08	
#760	.08	
#761	.08	
#762	.08	
#763	.08	
#765	.08	
#766	.08	
#770	.08	
#776	.08	
#780	.08	
#785	.08	
#801	.08	
#850	.08	
#861	.08	
#902	.08	

(\* Denotes  
make available.  
Prices on request  
(Hoods sold  
only with  
connectors)



**• ADDITIONAL CONNECTORS •**

CONTINENTAL	US COM- PONENTS
T14	UPCC-FD11A
PCB-20	UPCC-M11A 1.25
PCSC-15	1.05 UPCC93-D6A
PCSC-18	1.40 UPCC93-D10
PCSC-22	1.95 UPCC93-D15
PCSC-25	2.38 UPCC93-D18A
MB-6-53	UPCC-D22A 1.35
MB-10-53	1.25 ARMEL
SM7-20H	.80 EP15P
SM7-20P	.85 EP25P
SM7-20S	1.35 ELCON
SM11-20H	.60 MP-14P
SM11-20S	1.70 MP-18P
SM14-20H	.60 MP-18S
SM14-20P	1.40 MP-22P
SM20-20H	.65 MP-22S
SM20-20S	2.25 VIKING
SM26-20P	2.25 VP4-28C6
SM26-20S	2.90 VP6-28B6
SM34-20H	.75 VP7-28B6
XC-145-22	VR7-2AA5
XC-500-47-1X	VR9-2BG6
GA-10187	12.00 VR9-2AD6
#25034-16P	

LOWER PRICES ON  
PRODUCTION QUANTITIES  
THIS IS ONLY A PARTIAL LISTING.  
ADDITIONAL ITEMS RECEIVED  
CONSTANTLY.

**alexander  
mogull** company  
wholesale electronic components  
17 WARREN STREET • NEW YORK 7, N. Y. • WOrth 4-0865

CIRCLE 466 ON READER SERVICE CARD

**MIT MODEL 9 PULSER  
1 MEGAWATT-HARD TUBE**

Output pulse power 25KV at 40 amp. Max duty ratio: .002. Uses 6C21 pulse tube. Pulse duration .25 to 2 microsec. Input 115 volts 60 cycle AC. Includes power supply in separate cabinet and driver. Fully guaranteed as new condition. Full Desc. MIT Rad. Lab. series "Pulse Generators." Vol. 5 pg. 152.

**MIT MODEL 3 PULSER**

Output: 144kw (12kv at 12 amp). Duty ratio: .001 max. Pulse duration: .5, 1 and 2 micro sec. Input: 115v 400 to 2000 cps and 24vdc. \$325 ea. Full desc. Vol. 5 MIT Rad. Lab. series pg. 140.

**AN/AAS-6** Infrared Detection System, complete. New \$5500.

**AN/TPS-1D RADAR**

500 KW. 1220-1350 MGS. 160 nautical mile search range P.P.I. and A Scope. MTI. Thyatron Mod. 5126 Magnetron. Like new. Complete system incl. Spare parts and gas generator field supply.

**RADIO RESEARCH  
INSTRUMENT CO.**

550  
FIFTH AVE.  
NEW YORK  
JUDSON  
6-4691

**TS117/AP FREQUENCY METER**

10 cm. 2400 to 3400 mcs calibrated Wavemeter with crystal mount and resonance meter. Mfg. Sperry. New. \$149.50 each.

**CARCINOTRON**

Type CM 705A Freq. 3000 to 4000 mc. CW output 200 watts min. Factory New.

**2C40 LIGHTHOUSE CAVITY**

AN/APW11A transmitter cavity for 2C40. Complete S band coverage at max. power. Temperature compensated. New \$77.50 ea.

**AUTOMATIC TRACKING RADAR**

SCR 584 is in like new condition, ready to go, and in stock for immediate delivery. Fully Desc. MIT Rad. Lab. Series. Vol. 1, pp. 207-210, 238, 284.

**ANTENNA PEDESTAL**

**SCR 584-MP 61B**

Full azimuth and elevation sweeps. 360 degrees in azimuth. 210 degrees in elevation. Accurate to 1 mil. or better over system. Complete for full tracking response. Angle acceleration rate: AZ 9 degrees per second squared EL 4 degrees per second squared. Angle slewing rate: AZ 20 degrees per sec. EL 10 degrees per sec. Angle tracking rate: 10 degrees per sec. Quantity in stock for immediate shipment. Complete description in McGraw-Hill Radiation Laboratory Series, Volume 1, page 284 and page 209, and Volume 26, page 233.

**Mr. Used  
Equipment  
Dealer:**

When you advertise in the Searchlight Section . . . You have hired your most persuasive salesman.

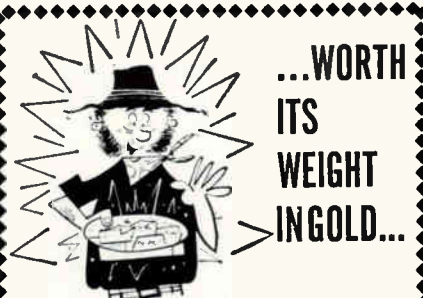
He's efficient . . . He thrives on long hours . . . His territory is the entire nation . . . and overseas . . . He doesn't see buyers of used and new surplus equipment; they see him—regularly. They depend on him.

He is Searchlight—The section of this publication where wise dealers advertise and list their stocks for sale.

**SEARCHLIGHT  
SECTION**

Classified Advertising Div.  
Post Office Box 12  
New York 36, N. Y.

CIRCLE 467 ON READER SERVICE CARD



...WORTH  
ITS  
WEIGHT  
INGOLD...

... the NEW 1961 edition of the  
\*GREENSHEET CATALOG.

\* A complete 48 page catalog of specialized industrial ELECTRONIC TUBES and COMPONENTS . . . featuring BARRY ELECTRONICS savings to industry.

Circle Reader Service Card No. 470 for your copy. Before you purchase TUBES, COMPONENTS or EQUIPMENT . . . look at your \*GREENSHEET and compare our high quality and sensible prices. Send us your request for quotation which will be immediately expedited.

**BARRY  
ELECTRONICS**

512 BROADWAY,  
NEW YORK 12, N.Y.

11 YEARS OF BUYERS' CONFIDENCE

**CORPORATION**

WALKER 5-7000  
TWX: NY1-3731

CIRCLE 470 ON READER SERVICE CARD

**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

CIRCLE 471 ON READER SERVICE CARD

★ 14 VOLT-DC POWER SUPPLY ★

● BRAND NEW . . . IN ORIGINAL CASES ●

INPUT:  
115 Volts-60 Cycles  
OUTPUT:  
14 Volts @ 2 Amps  
Filtered and  
Completely Housed



F.O.B.—N. Y. Complete \$14.95

★ STEPPING RELAYS ★

Resortable 12 VDC coils, 3 deck, 10 pos. w/add. 1A & 1B contact at reset position \$8.95



**ADVANCE ELECTRONICS**

6 West B'Way. • New York 7, N.Y. • R Ector 2-0270

CIRCLE 472 ON READER SERVICE CARD

**"TAB" SILICON 750MA\* DIODES TOP HATS**

General Purpose 400 PIV at 300 MA  
Special 2 for \$1 20 for \$7

Factory Tested		Guaranteed!	
rms/piv 17/25 34¢	rms/piv 35/50 55¢	rms/piv 70/100 70¢	rms/piv 140/200 34¢
rms/piv 210/300 42¢	rms/piv 280/400 55¢	rms/piv 350/500 70¢	rms/piv 420/600 \$1.00
rms/piv 490/700 \$1.25	rms/piv 560/800 \$1.50	rms/piv 630/900 \$1.70	rms/piv 700/1000 \$2.00

Low Priced \*T200 Silicon Diodes rated 360 pIV/260rms @ 200 MA. @ 100°C 36¢ each; 10 for \$3.25; 100 for \$27; 1000 for \$230.

\* CAPACITOR INPUT DERATE 20% !  
(\$5 or more this item we pay P.P./U.S.A.)

**LAB—TEST EQUIPMENT SPECIALS !!!**

- Kay Megasweep R8 Sweep or Sig. Gen. 50Kc-800Mc Sweep width 0-60MC & Freq Meter (CP \$395.) \$72
- Kay Megaligner IF Marker Generator 19-49Mc/± 0.5Mc \$24
- Dumont #229 Dual Beam Scope Vert. Amp. 35V/ Sens. 200Kc Response. Sweep Gen. 2Cps-30Kc Built in Calibrator (CP \$1250.) \$378
- Tektronix #511A Scope. Vert. Amp.—.25V/Cm Sens. 5Cps/10Mc Response. Rise Time .04 N/Sec. has built in trigger Amp. Cal. Sweep 0.1 Sec to 1/2 Sec. Built in Calibrator, Sweep Magnifier, Attenuator (CP \$895.) \$342
- Inet "Magnivol" regulated (2 meter) Power Supply #RR28-30, 22-30VDC @ 30A±.25% Reg. Ripple less than 300mV (CP \$895.) \$261
- Sperry #486 Klystron Power Supply 3 Regulated Supplies 0-300, 0-500, 0-5Kv DC & 6.3VAC. metered (CP \$1900) \$250
- Pirani Gauge Consolidated Vacuum #PG-1B/1-20 Microns .025-.75 MM w/o—4V Supply Built in (Metered) \$48
- Pirani "CVC" Vacuum Gauge Tubes Matched Pairs \$16
- Lambda #35 Regulated Power Supply 100-200VDC @ 300Ma, 2 x 6.3VAC @ 5A Reg. Type \$120
- Measurements #78E Signal Gen. 40-75Mc up to 225Mc on Harmonics Calibrated Output \$40
- TS13/AP X-Band Oscillator, Wave Mtr Power Mtr \$49
- TS14/AP S-Band Test Set—Sig. Gen. Int. Pulse Mod \$45

**WE BUY, SWAP & SELL**

**"TAB"**

TERMS: Money Back Guaranteed! Our 17th year. \$2 min. order F.O.B. N.Y.C. Add shpg. charges or for C.O.D. 25% Dep. Prices shown subject to change.

111-FE LIBERTY ST., N.Y. 6, N.Y.  
Send 25¢ for Catalog

PHONE: RECTOR 2-8245

CIRCLE 468 ON READER SERVICE CARD

**RW "SPECIAL OF THE MONTH"  
SUMMATION BRIDGE AN/URM-20**

1000-4000Mc. RF power measuring Bolometer Wheatstone bridge wattmeter. c/o TR-731/URM1 Wattmeter & MX-1806/URM-20 Wave Guide Kit. New \$95.00

**STANDARD LAB RECEIVER APR-4**

w/4 tuning units, 38-2200Mc checked out \$259.50  
w/5 tuning units, 38-4000Mc checked out \$389.50  
TS-226A/AP Power meter for AP8-13 & 16, xmtr of AN/APG-11. Measures 0-1,000 watts to ± 2 db. Built-in calibration. 115v, 50-2400 cy. Excellent \$19.95

Write for Bulletin 32—Loads of Bargains

**R. W. Electronics**

2430 S. Michigan Ave. Chicago 16, Ill.  
CAIumet 5-1281

CIRCLE 469 ON READER SERVICE CARD



# INDEX TO ADVERTISERS



## Audited Paid Circulation

Aerovox Corp. Distributor Div. . . . .	125	Giannini Controls, Corp. . . . .	12, 13
*Airpax Electronics, Inc. . . . .	29	Gertsch Products, Inc. . . . .	88
*Allmetal Screw Products Co. Inc. . . . .	124	Good Year Aircraft Corp. . . . .	11
Alpha Corp. . . . .	17	Gould National Batteries, Inc. Nicaid Division . . . . .	115
*Applied Research, Inc. . . . .	115	*Gremar Mr. Co. . . . .	53
*Arnold Magnetics Corp. . . . .	53	Gries Reproducer Corp. . . . .	110
*Art Wire & Stamping Co. . . . .	108	*Gudebrod Bros. Silk Co. Inc. . . . .	105
Avco Corp. Research & Development	119		
*Ballantine Labs. Inc. . . . .	33	*Handy & Harman . . . . .	16
*Beckman Instruments, Inc. Berkeley Div. . . . .	19	Haydon Co. Inc., A. W. . . . .	23
Black & Webster, Inc. . . . .	108	*Hewlett-Packard Co. . . . .	15
*Borg Equipment Division, Amphenol- Borg Electronics Corp. . . . .	20	Hoffman Electronics Corp. Semiconductor Div. . . . .	54
Bourns Labs. Inc. . . . .	81	*Hughes Aircraft Co. . . . .	125
Brand-Rex Div. . . . .	120, 121		
Breeze Corporation . . . . .	44	*International Telephone & Telegraph Components Div. . . . .	45
Bruno-New York Ind. Corp. . . . .	122		
Cannon Electric Co. . . . .	51	*Jones Electronics Co. Inc. M. C. . . . .	85
*Centralab, The Electronics Division of Globe-Union Inc. . . . .	87	Jones & Lamson Machine Co. . . . .	40
Century Electronics & Instruments, Inc. . . . .	111	Keithley Instruments, Inc. . . . .	36
Chart-Pak, Inc. . . . .	112	*Kester Solder Co. . . . .	84
*Cinch Mfg. Corp. . . . .	79	*Krohn-Hite Corp. . . . .	113
*Cohn Corp., Sigmund . . . . .	123		
Consolidated Electrodynamics Corp.	89	*Lambda Electronics Corp. . . . .	2, 3
Cubic Corp. . . . .	42		
Delco Radio . . . . .	46	McGraw-Hill Book Co. . . . .	133
*DeMornay-Bonardi . . . . .	125	Mallory & Co. Inc. P. R. . . . .	38, 39
Di Acro Corporation . . . . .	6	*Marconi Instruments Ltd. . . . .	102
*Dow Corning Corp. . . . .	21	Melabs . . . . .	8
Du Pont de Nemours & Co. E. I. Textile Fibre Division . . . . .	100	*Minneapolis-Honeywell Reg. Co. Industrial Systems Division . . . . .	50
*Dymec, A Division of Hewlett- Packard Company . . . . .	31	*Motorola Inc. . . . .	91
Dynacor, Inc. A Subsidiary of Sprague Electric Co. . . . .	124	*Mycalex Corp. of America . . . . .	18
*E-H Research Labs. Inc. . . . .	37	Ohmite Mfg. Co. . . . .	88
*Electronics Instrument Co. Inc. (EICO) . . . . .	105		
Electronic Measurements Co. Inc. . . . .	97	*Panoramic Radio Products Inc. . . . .	47
Englehard Industries, Inc. . . . .	24, 25	*Philbrick Researches, Inc. Geo. A. . . . .	123
*Epsco Instruments A Division of Epsco Inc. . . . .	95	*Philco Corp., Lansdale Division . . . . .	58
Equipto Electronic Corp. . . . .	93	Philips Gloeilampenfabrieken N. V. . . . .	48, 49
		Potter Instrument Co., Inc. . . . .	116
		Precision Instrument Co. . . . .	35
Garrett Corp. . . . .	105		
*General Electric Co. Chemical Material Dept. . . . .	52		
Voltage Regulator Products . . . . .	55		
*General Electrodynamics Corp. . . . .	57		
Geotechnical Corporation, The . . . . .	99		

\* See Advertisement in the July 20, 1960 issue of Electronics Buyers' Guide for complete line of products or services.



## MATHEMATICAL HANDBOOK FOR SCIENTISTS AND ENGINEERS

Helpful reference to facts and data in all areas of mathematics . . . and an outline of mathematical methods vital in today's engineering and science applications. Each chapter provides review of an entire subject. Covers Boolean algebra, random processes, calculus, statistics, and much more. By G. A. Korn, Univ. of Ariz., and T. M. Korn. 943 pp., 110 tables, \$20.00

## MISSILE CONFIGURATION DESIGN

Basic principles of configuration design of missiles, with emphasis on aerodynamic aspects. Presents full treatment of all factors in preliminary design of configurations . . . discusses advantages and limitations of various designs . . . gives formulas and data for optimum design for any type mission. By S. S. Chin, The Martin Co. 270 pp., 159 illus., \$11.00

## ELECTRONICS

Covers the physical basis of electronic devices and their circuit representations. Explains physical phenomena occurring in such electronic devices as vacuum tubes, transistors, tunnel diodes, etc. Circuit analysis is presented by graphical techniques . . . and the book treats both linear and piecewise-linear equivalent circuits. By P. M. Chirilian, Stevens Inst. of Tech., and A. H. Zemanian, N.Y.U. 335 pp., 246 illus., \$8.75

## INTRODUCTION TO PRINCIPLES OF COMMUNICATION THEORY

Describes fundamentals of non-deterministic or random time functions and their application to analysis and design of communication systems. Treats frequency vs. time domain, two-terminal pair linear systems, information theory, probability, noise, and more. By J. C. Hancock, Purdue Univ. 263 pp., illus., \$9.50

## SCIENCE IN SPACE

Authoritatively presents today's advances—and tomorrow's opportunities for experiment and research—in all areas of space science. Some of the world's leading scientists explore the broad spectrum of space investigation—from information on gravity and space vehicles . . . through fields and particles in space . . . to data on life sciences, etc. Edited by L. V. Berkner and H. Odishaw, Natl. Academy of Scien. 439 pp., 106 illus. and tables, \$7.00

## 10 DAYS' FREE EXAMINATION

McGraw-Hill Book Co., Dept. L-4-14  
327 W. 41st St., New York, 36, N. Y.

Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep plus few cents for delivery costs, and return unwanted book(s) postpaid. (We pay delivery costs if you remit with this coupon—same return privilege.)

- Korn & Korn—Math. Hdbk. for Scien. & Engr., \$20.00.  
 Chin—Missile Config. Des., \$11.00  
 Chirilian & Zemanian—Electron., \$8.75  
 Hancock—Intro. to Prin. of Comm. Theory, \$9.50  
 Berkner & Odishaw—Scien. In Space, \$7.00

Name . . . . .

Address . . . . .

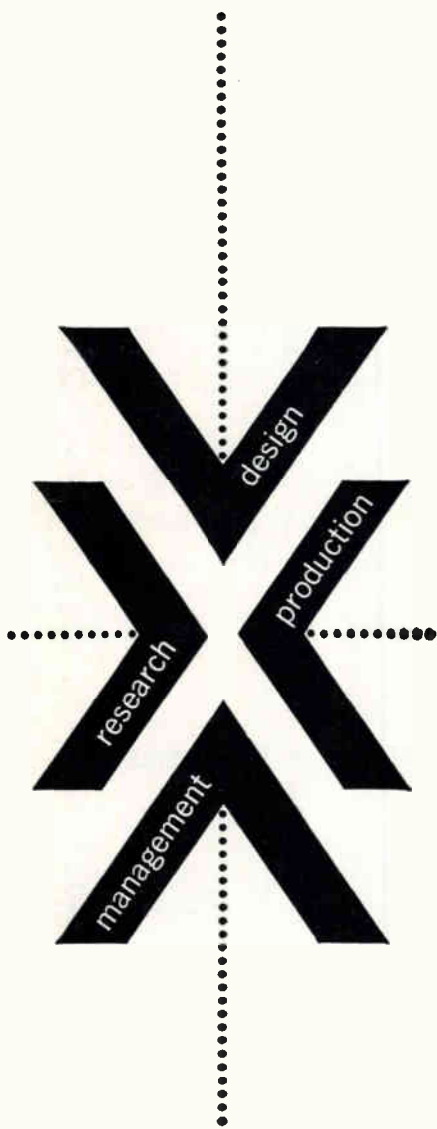
City . . . . . Zone . . . . . State . . . . .

Company . . . . .

Position . . . . .

For price and terms outside U.S. write McGraw-Hill Intl., N.Y.C. 36

L-4-14



it's read  
more  
by all 4!

**electronics** magazine covers engineering and technically interpreted market trends every week. Government, military and economic developments, new applications, and technical data you'll want to file and keep. Subscribe now and read it first (don't be low man on a routing slip). Mail the reader service card (postpaid) to **electronics**, the magazine that helps you to know and to grow! Rates: three years for \$12; one year for \$6; Canadian, one year for \$10; foreign, one year for \$20. Annual **electronics** BUYERS' GUIDE (single issue price \$3.00) included with every subscription.

subscribe today to  
**electronics**

\*Radio Corp. of America.....4th cover  
\*RCA Service Company..... 84  
\*Raytheon Company.....2nd cover, 104  
Royal Electric Corp..... 122

Security Devices Laboratory..... 119  
Semiconductor Specialists, Inc..... 112  
Shetland Industrial Park, Inc..... 110  
\*Sigma Instruments, Inc..... 92  
Sorensen & Co..... 108  
\*Sperry Microwave Electronics  
Company, Sperry Rand Corp..... 41  
Sprague Electric Co.....5, 22  
Stackpole Carbon Co..... 7  
Struthers-Dunn ..... 101

TWA Airfreight .....106, 107  
\*Technology Instrument Corp. of  
Acton ..... 111  
\*Technology Instrument Corp..... 109  
Telrex Laboratories ..... 125  
\*Texas Instruments Incorporated  
Semiconductor Components  
Division .....98, 99  
Teletronics Inc. .... 128  
Thermal American Fused Quartz  
Co., Inc. .... 39  
\*Transitron Electronic Corp..... 48

\*Varian Associates .....8rd cover, 121

\*Weinschel Engineering ..... 14  
Western Electronic Products Co... 110

\* See Advertisement In the July 20, 1960 issue of **Electronics Buyers' Guide** for complete line of products or services.

CLASSIFIED ADVERTISING  
F. J. Eberle, Business Mgr.

EMPLOYMENT  
OPPORTUNITIES .....127, 128

EQUIPMENT  
(Used or Surplus New)  
For Sale .....129-132

MANUFACTURERS' REPRESENTATIVES  
MacDonald Inc., Samuel K..... 128

WANTED  
Miscellaneous ..... 130

This index and our Reader Service Numbers are published as a service. Every precaution is taken to make them accurate, but **ELECTRONICS** assumes no responsibilities for errors or omissions.

**electronics**



Audit Bureau  
of Circulations



Associated Business  
Publications

Audited Paid Circulation

BRUCE A. WINNER  
Advertising Sales Manager

R. S. QUINT, Assistant Publisher **Buyers' Guide** and Business Manager; FRED STEWART, Promotion Manager; B. ANELLO, Marketing Service Manager; RICHARD J. TOMLINSON, Production Manager; GEORGE E. POMEROY, Classified Manager; HUGH J. QUINN, Circulation Manager.

ATLANTA M. Miller; HOUSTON Joseph A. Page; DALLAS Robert T. Wood; LONDON Edward E. Schirmer; FRANKFURT Stanley R. Kimes; GENEVA Michael R. Zeynel.

ADVERTISING REPRESENTATIVES: NEW YORK Donald H. Miller, Henry M. Shaw, George F. Werner; BOSTON William S. Hodgkinson, Donald R. Furth; PITTSBURGH David M. Watson; PHILADELPHIA Warren H. Gardner, William J. Boyle; CHICAGO Harvey W. Wernecke, Martin J. Galloway; CLEVELAND P. T. Fegley; SAN FRANCISCO T. H. Carmody, R. C. Alcorn; LOS ANGELES D. A. McMillan, Marshall Freeman; DENVER J. Patten;

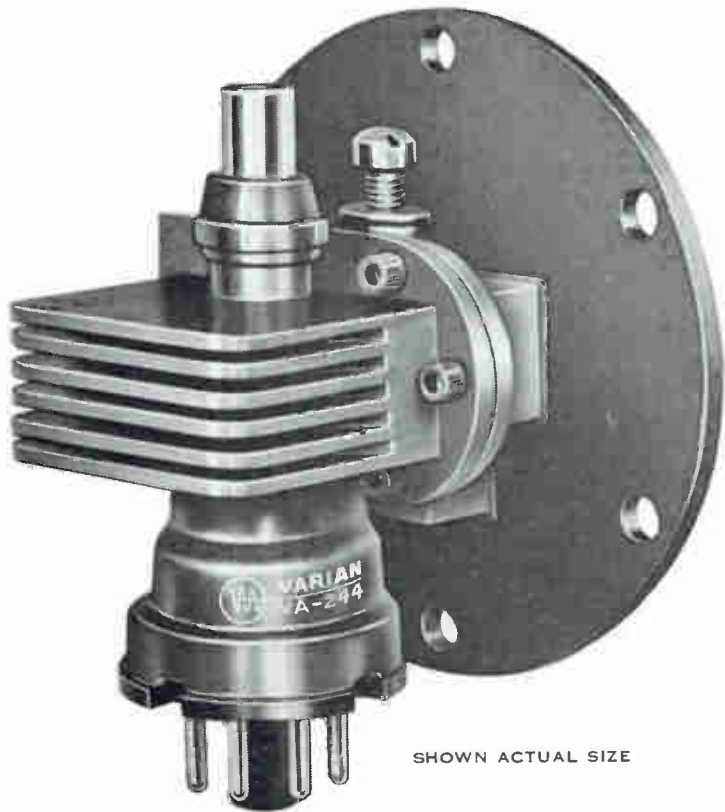
BRANCH OFFICES: National Press Bldg., Washington 4, D.C.; McGraw-Hill Bldg., Copley Square, Boston 16; Four Gateway Center, Pittsburgh 22; Six Penn Center Plaza, Philadelphia 3; 520 North Michigan Avenue, Chicago 11; 55 Public Square, Cleveland 13; 255 California Street, San Francisco 11; 1125 West Sixth St., Los Angeles 17; 1740 Broadway, Denver 2; 1301 Rhodes-Haverly Bldg., Atlanta 3; 901 Vaughn Bldg., Dallas 1; Prudential Bldg., Holcombe Blvd., Houston 25; McGraw-Hill Publishing Co., Ltd., 34 Dover Street, London, England; 85 Westendstrasse, Frankfurt/Main; 2 Place de Port, Geneva.



FOR MICROWAVE  
RELAY SERVICE:

# NOW 3 TUBES DO THE JOB OF 23!

Varian Associates' VA-244 series of reflex klystrons is designed for versatility in microwave relay applications. Three high-performance tubes can do jobs which formerly required 23 different types. They're engineered for flexibility, ideal for equipment in the common carrier bands. Series covers the microwave spectrum from 5.8 to 7.9 kMc. Use VA-244 series klystrons as transmitter tubes with average power output of 1 watt. As local oscillators, they operate at reduced voltages, with average power output of 60 milliwatts. Reliable, exceptionally stable, fully conduction-cooled. Low FM distortion, improved single-screw tuning.



SHOWN ACTUAL SIZE

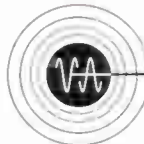
## FREQUENCY RANGE

**TUBE #1:** VA-244A 5.8-6.6 kMc

**TUBE #2:** VA-244B 6.5-7.3 kMc

**TUBE #3:** VA-244C 7.1-7.9 kMc

The versatility of the VA-244 series minimizes manufacturers' and customers' stocking problems. Order in quantity to take advantage of price reductions. For technical data, write Tube Division.



**VARIAN** associates

PALO ALTO 1, CALIFORNIA

BOMAC LABORATORIES, INC.  
VARIAN ASSOCIATES OF CANADA, LTD.  
S-F-D LABORATORIES, INC.  
SEMICON ASSOCIATES, INC.  
SEMICON OF CALIFORNIA, INC.  
VARIAN A.G. (SWITZERLAND)

**RCA-7895**



**nuvistor**  
**INDUSTRIAL TRIODE**

For Critical Industrial Applications—Tiny, new nuvistor triode with amplification factor of 64 provides high gain with low noise in a wide variety of amplifier applications, and has excellent stability as an oscillator from very low audio frequencies up into the UHF region.

When compactness, low drain, freedom from interface resistance, exceptional uniformity of characteristics from tube to tube, and ability to withstand vibration and mechanical shock are decisive industrial equipment design factors, RCA-7895 is the triode for you.

**RCA-7895 Nuvistor Design Features:**

**Mechanical ruggedness:** Ceramic-and-metal construction withstands impact acceleration of 1000 g; and 48 hours of 2.5 g vibrational acceleration at 60 cps. **High-temperature processing:** Special high-temperature brazing, exhaust and seal-off operations minimize structural strain and distortion. **Low heater power:** Only 0.85 watt (135 ma at 6.3 volts). **High transconductance** at low plate current and voltage: 9400 micromhos at 7 ma and 110 volts. **Very high interelectrode resistance:** 1000 megohms minimum. **Very low reverse grid current:** 0.1 microampere maximum. **Operation at full ratings at any altitude.**

**RCA-7895 for:** COMMUNICATIONS EQUIPMENT • CONTROL AND INSTRUMENTATION EQUIPMENT • TV CAMERAS • MEDICAL DIAGNOSTIC EQUIPMENT • TEST AND MEASURING EQUIPMENT • OTHER CRITICAL INDUSTRIAL APPLICATIONS

For additional information, contact your RCA Field Representative. For 7895 Technical Bulletin, write Commercial Engineering, RCA Electron Tube Division, Harrison, N.J.

**RCA FIELD OFFICES**

Newark 2, New Jersey, 744 Broad Street, Humboldt 5-3900 • Detroit 2, Mich., 714 New Center Bldg., TRinity 5-5800  
Chicago 54, Illinois, Suite 1154, Merchandise Mart Plaza, Whitehall 4-2900 • Los Angeles 22, California, 6801 E.  
Washington Blvd., Raymond 3-8361 • Burlingame, Calif., 1838 El Camino Real, Oxford 7-1620



The Most Trusted Name in Electronics  
RADIO CORPORATION OF AMERICA