

FEBRUARY 6, 1959

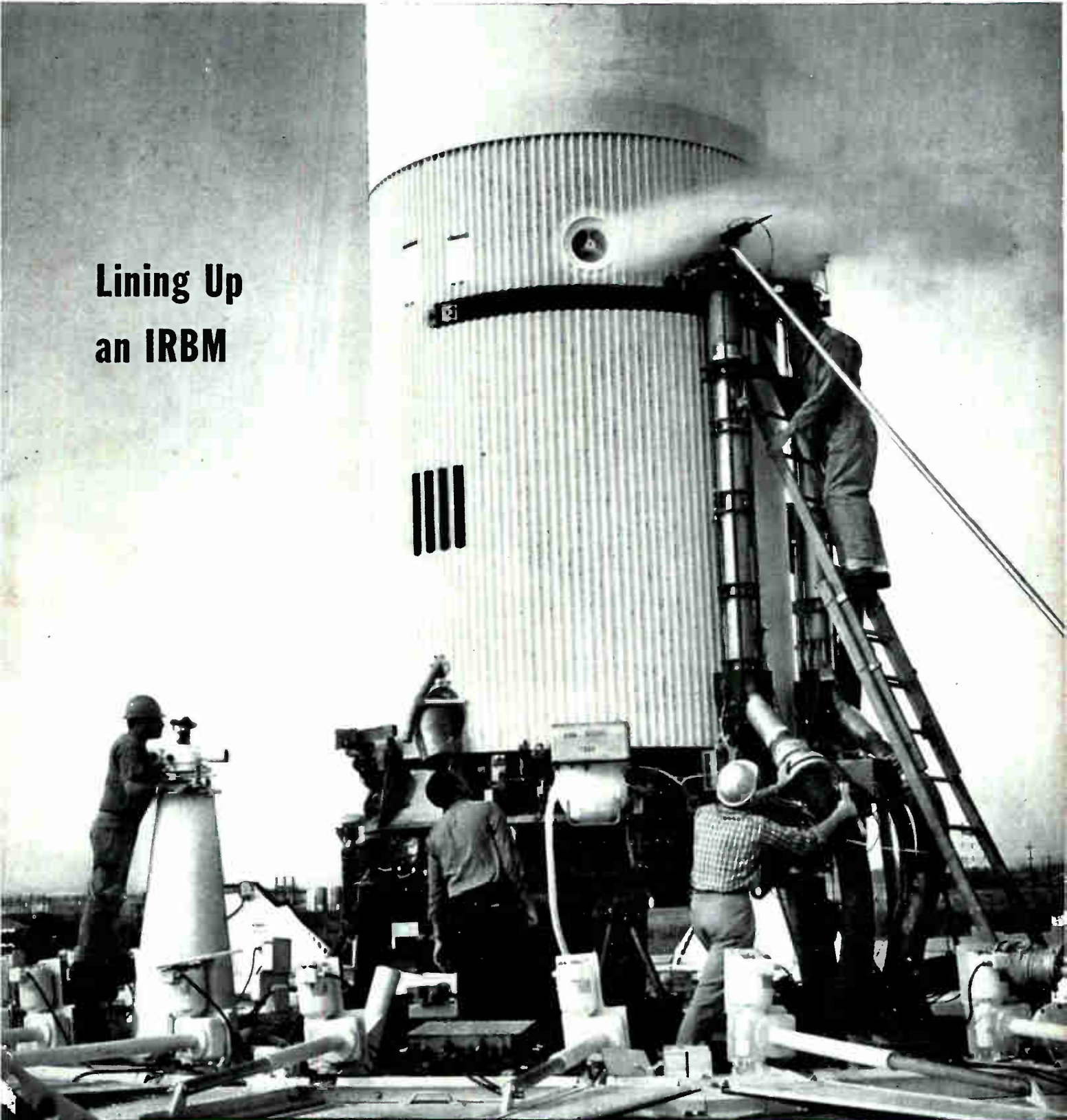
# electronics

A MCGRAW-HILL PUBLICATION

VOL. 32, No. 6

PRICE SEVENTY-FIVE CENTS

Lining Up  
an IRBM

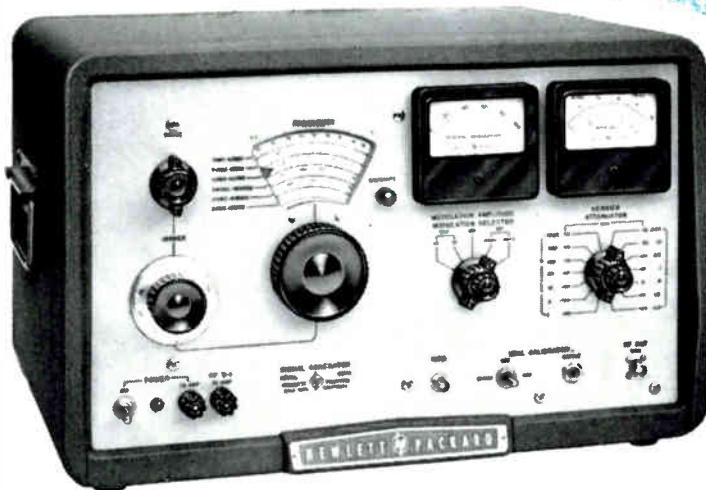


Small Magnetic Tape Recorder Sales Climb

# NOW!

**Constant output level**  
**Constant modulation level**  
**3 volt output into 50 ohms**  
**Low envelope distortion**

**50kc  
TO  
65MC**



## New -hp- 606A HF Signal Generator

Here at last is a compact, convenient, moderately-priced signal generator providing constant output and constant modulation level plus high output from 50 kc to 65 MC. Tedious, error-producing resetting of output level and percent modulation are eliminated.

Covering the high frequency spectrum, (which includes the 30 and 60 MC radar IF bands) the new

606A is exceptionally useful in driving bridges, antennas and filters, and measuring gain, selectivity and image rejection of receivers and IF circuits.

Output is constant within  $\pm 1$  db over the full frequency range, and is adjustable from +20 dbm (3 volts rms) to -110 dbm (0.1  $\mu$ v rms). No level adjustments are required during operation.

### SPECIFICATIONS

**Frequency Range:** 50 kc to 65 MC in 6 bands.

**Frequency Accuracy:** Within  $\pm 1\%$ .

**Frequency Calibrator:** Crystal oscillator provides check points at 100 kc and 1 MC intervals accurate within 0.01% from 0° to 50° C.

**RF Output Level:** Continuously adjustable from 0.1  $\mu$ v to 3 volts into a 50 ohm resistive load. Calibration is in volts and dbm (0 dbm is 1 milliwatt).

**Output Accuracy:** Within  $\pm 1$  db into 50 ohm resistive load.

**Frequency Response:** Within  $\pm 1$  db into 50 ohm resistive load over entire frequency range at any output level setting.

**Output Impedance:** 50 ohms, SWR less than 1.1:1 at 0.3 v and below.

**Spurious Harmonic Output:** Less than 3%.

**Leakage:** Negligible; permits sensitivity measurements to 0.1  $\mu$ v.

**Amplitude Modulation:** Continuously adjustable from 0 to 100%.

**Internal Modulation:** 0 to 100% sinusoidal modulation at 400 cps  $\pm 5\%$  or 1000 cps  $\pm 5\%$ .

**Modulation Bandwidth:** Dc to 20 kc maximum.

**External Modulation:** 0 to 100% sinusoidal modulation dc to 20 kc.

**Envelope Distortion:** Less than 3% envelope distortion from 0 to 70% modulation at output levels of 1 volt or less.

**Spurious FM:** 0.0025% or 100 cps, whichever is greater, at an output of 1 v or less and 30% amplitude modulation.

**Spurious AM:** Hum and noise sidebands are 70 db below carrier.

**Price:** (cabinet) \$1,200.00. (rack mount) \$1,185.00.

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

**HEWLETT-PACKARD COMPANY** 5023A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.

CABLE "HEWPACK" • DAVENPORT 5-4451 • Field representatives in all principal areas



world's most complete line of signal generators

## Issue at a Glance

A MCGRAW-HILL PUBLICATION  
Vol. 32 No. 6

H. W. MATEER, *Publisher*

JAMES GIRDWOOD, *Associate  
Publisher & Advertising Sales Mgr.*

W. W. MacDONALD, *Editor*

John M. Carroll, *Managing Editor*

*Feature Editor, John Markus.  
Associate Editors: John M. Kinn,  
Jr., Frank Leary, Michael F. To-  
maino, Howard K. Janis, Sylvester  
P. Carter, Haig A. Manoogian,  
Roland J. Charest, William P.  
O'Brien, George Sideris, John F.  
Mason, William E. Bushor, Ronald  
K. Jurgen, Thomas Emma, Samuel  
Weber.*

*Pacific Coast Editor (Los Angeles)  
Harold C. Hood; Midwestern Editor  
(Chicago) Harold Harris; New Eng-  
land Editor (Boston) Thomas Ma-  
guire.*

*Art Director, Harry Phillips, Roy  
Thompson.*

*Production Editor, John C.  
Wright, Jr., Bernice Duffy, Jean L.  
Matin.*

*Market Research, Edward De-  
Jongh, Marilyn Koren.*

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

*R. S. Quint, Assistant Advertis-  
ing Sales Manager and Buyers'  
Guide Manager. Fred Stewart,  
Promotion Manager. Frank H.  
Ward, Business Manager. George  
E. Pomeroy, Classified Manager.  
Hugh J. Quinn, Circulation Man-  
ager.*

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

### BUSINESS

How USSR Guided Lunik. Exclusive report on what happened.....	22
Small Recorder Sales Climb. Brisk component buying seen.....	27
Soviets Reveal Trade Aims. Here's what USSR wants to sell, buy...	30
Electronic "Mine" Halts Tank. War games unit uses transistors...	35
Shoptalk .....	4
Electronics Newsletter .....	11
Washington Outlook .....	12
Financial Roundup .....	15
Over The Counter.....	15
Market Research .....	18
Current Figures .....	18
Meetings Ahead .....	37

### ENGINEERING

Lining Up An IRBM. Prelaunch checks require electronic and optical techniques. See p 62.....	COVER
Instrumenting the Explorer I Satellite. How environmental problems were solved in Explorer I.....By H. L. Richter, Jr. W. Pilkington, J. P. Eyraud, W. S. Shipley and L. W. Randolph	39
Magnetic Drum Provides Analog Time Delay. Drum provides time delay in analog voltages....By H. L. Daniels and D. K. Sampson	44
Wideband Amplifier Design Data. Concise information required to design wideband amplifiers.....By R. H. Engelmann	48
Stable, Low-Cost One-MC Oscillator. Transistorized crystal oscillator gives stable one-mc signal.....By J. F. Mercurio, Jr.	50
F-M Tuner Adapter for Multiplexed Stereo. Four-tube circuit for two-channel output.....By L. Feldman	52
Soft Magnets for Amplifiers. Table lists new materials and the old standbys.....By G. Sideris	55
Tape Recording System Speeds Data Processing. Recording technique and transport cuts data transferal time....By W. D. Woo	56
Waveguide Data Charts. Inductive-post susceptance data for designing X-band waveguide filters.....By E. Sion	60

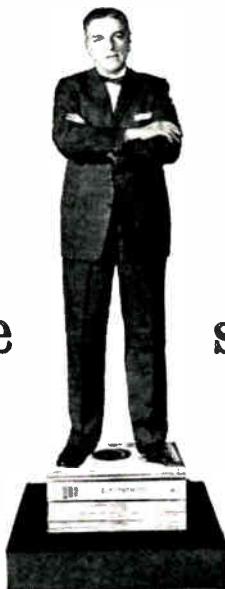
### DEPARTMENTS

Research and Development. Theodolite References Jupiter Guidance.	62
Components and Materials. New Self-Sustained Emission Tube....	66
Production Techniques. Kitting Smooths Production Flow.....	70
On the Market.....	74
Literature of the Week.....	96
Plants and People.....	98
News of Reps.....	101
Comment .....	102
Index to Advertisers.....	114



Art Harrison takes the

stand for **electronics**



Arthur E. Harrison is an avionics systems engineer with Grumman Aircraft Engineering Corporation, a leading manufacturer of weapons systems including anti-submarine, airborne early warning, air-sea rescue, fighter and attack aircraft, etc.

Before coming to Grumman, Mr. Harrison was Director of Engineering with Fairchild's Guided Missiles Division. He is on the guided missile subcommittee of the American Ordnance Association.

Art Harrison has been reading electronics for more than 20 years. He maintains a complete library of bound volumes in his home.

Mr. Harrison has influence on purchasing electronic equipment through his design function, specifying the components and parts that go into systems.

It has been said that leading publications build a "personality" for themselves. This is a quality that cannot be measured with facts and statistics. Here's how Art Harrison characterizes the "personality" of electronics magazine.

*"electronics is a magazine that is edited for the work-a-day engineer, his jobs, and his problems. It offers broader coverage of the electronics industry than any other publication. I am thinking all the way from computers through instrumentation to communication and navigation."*

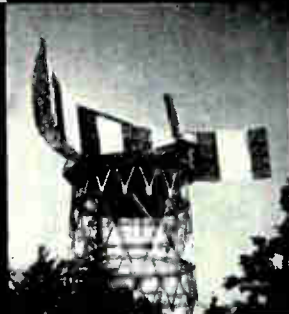
If it's about electronics, read it in electronics.

## electronics

Published WEEKLY plus the mid-year electronics BUYERS' GUIDE  
A McGraw-Hill Publication • 330 West 42nd Street, New York 36, N. Y.







- Radio Telescopes  
28', 60', 84', 140'
- Mobile Antennas 28'
- Scatter Antennas  
28', 60', 120'
- Trackers 28', 60', 84'
- Rotating Radar Antennas  
up to 20' x 120'
- Fixed Radar Antennas  
to 110' x 165' and up



# THE WORLD'S LARGEST ANTENNAS

## ARE COMING FROM KENNEDY

Kennedy builds them big — to meet the expanding needs of electronics. And Kennedy builds them rugged — to withstand the most demanding conditions of climate. Kennedy's facilities and engineering skills are devoted to serving the electronics trade in the development, design, manufacture and installation of all types of antenna systems.

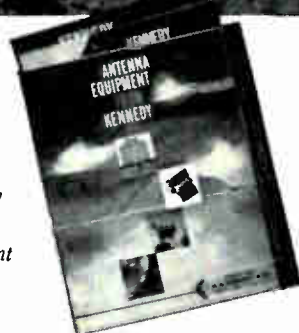
### KENNEDY WAVE GUIDE COMPONENTS...



achieve highest transmitted power, lowest standing wave ratio, trouble-free operation.

- Complete feed systems—designed and installed
- Dual and linear polarization horns
- Transitions
- Duplexers
- Straight sections and bends
- Complete hardware

*For more complete information, send for your free copy of the handy file-size Kennedy Antenna Equipment folder.*



ANTENNA EQUIPMENT

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

COHASSET, MASS. EVERGREEN 3-1200



*West Coast Affiliate...*

**SATELLITE-KENNEDY, INC. of CALIFORNIA**  
P.O. Box 1711, Monterey, California - FRontler 3-2461

# SHOPTALK . . .

## electronics

Feb. 6, 1959

Vol. 32, No. 6

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

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

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

Single copies 75¢ in the United States and possessions and Canada; \$1.50 for all other foreign countries. Buyers' Guide \$3.00. Subscription rates—United States and possessions, \$6.00 a year; \$9.00 for two years; \$12.00 for three years. Canada, \$10.00 a year; \$16.00 for two years; \$20.00 for three years. All other countries \$20.00 a year; \$30.00 for two years; \$40.00 for three years. Second class postage paid at Albany, N. Y. Printed in U.S.A. Copyright 1959 by McGraw-Hill Publishing Co., Inc.—All Rights Reserved. Title registered in U. S. Patent Office. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11; 68 Post Street, San Francisco 4; McGraw-Hill House, London E. C. 4; 15 Landgrat-Wilhelm, Frankfurt/Main; National Press Bldg., Washington 4, D. C.; Six Penn Center Plaza, Philadelphia 3; 1111 Henry W. Oliver Bldg., Pittsburgh 22; 55 Public Square, Cleveland 33; 856 Penobscot Bldg., Detroit 26; 3615 Olive St., St. Louis 8; 350 Park Square Bldg., Boston 16; 1321 Rhodes-Haverty Bldg., Atlanta 3; 1125 West Sixth St., Los Angeles 17; 1740 Broadway, Denver 2; 901 Vaughn Bldg., Dallas 1. ELECTRONICS is indexed regularly in The Engineering Index.

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

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



Member ABP and ABC

**SOVIET ELECTRONICS.** A little more than a year ago, the Soviet government put the full weight of a monolithic state behind its drive to build up the electronics industry in the Soviet Union. Since then noteworthy progress has been made, not only in the Soviet Union but also in Iron Curtain countries such as Red China, Hungary and Czechoslovakia.

Since late 1956, Associate Editor Janis, ably assisted by McGraw-Hill World News bureau chiefs overseas, has scanned every scrap of information available on Soviet electronics.

Last month, two developments put Soviet electronics even more in the news: launching of the Red moon rocket Lunik and the U.S. visit of Soviet First Deputy Premier Mikoyan.

First details on Lunik came from Moscow Bureau Chief Gibson, who relayed the Soviet government's 5,000-word communique on the rocket's "technical details" ("Soviets Give Data on Sun Satellite" p 66, Jan. 30).

A lot of questions remained unanswered. Then came a cabled query from Bonn Bureau Chief Herlitzer. Would ELECTRONICS be interested in the full technical story on Lunik's guidance, instrumentation and control? Of course we were interested and off went an okay to Herlitzer, plus our check for his confidential source. There are still some unanswered questions but you will know a lot more about Soviet missile guidance after reading our exclusive story "How Russia Guided Lunik" on p 22.

Out of First Deputy Premier Mikoyan's visit comes some idea of what electronic equipment and components the Soviet Union would like to ship to the U.S. and what they want in return.

Associate Editor Manoogian attended a reception for Mikoyan in Washington. There he had a very exclusive interview with the FDP—Manoogian and Mikoyan spoke to each other in Armenian.

Manoogian later got details by checking with other high Soviet officials. End product is the story "Soviets Reveal Trade Aims" on p 30.

### Coming In Our February 13 Issue . . .

**INDUCTION HEATING.** Use of hydrogen thyratrons as rapid switching elements in induction heating equipment has many advantages, according to H. L. Van Der Horst of N. V. Philips of Eindhoven, Netherlands.

In thyratrons, heavy current can flow with low anode voltage; efficiency is high, so forced cooling is not required. Short ionization and deionization times permit oscillation at frequencies up to 10 kc. Van Der Horst describes a heating generator that develops 12 kw in the workpiece using this type of tube.

**WAVEFORM DETECTOR.** Automatic waveform detection applied to the high-speed testing of ferrite cores, transistors, transformers or other components not only eliminates inherent disadvantages of other methods, but also achieves greater sorting speed and accuracy.

IBM's B. Augusta describes an automatic waveform detection system in which the amplitude of a sampling trigger pulse is compared with combined amplitudes of trigger pulse and unknown waveform at sample time.

**KLYSTRON CONTROL.** Close frequency control in reflex klystrons is a common, yet frequently touchy problem. M. C. Harp of Lenkurt Electric in San Carlos, Calif., has devised a control method using magnetic amplifiers and transistors for a 6-mc microwave link handling up to 240 voice channels.

# ONLY OFFERS BOTH

## SILICON TRANSISTORS

# PNP • NPN

for COMPLEMENTARY CIRCUITS

because characteristics are so similar as to permit full and confident use

Specify RAYTHEON and get these significant advantages:



Higher, more constant beta

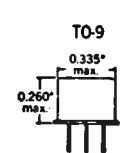

Lower saturation voltage

Low noise type available in both PNP and NPN

Made by the Raytheon reliable fusion alloy process which assures more constant characteristics over the entire temperature range

### FOR LARGE SIGNAL APPLICATIONS

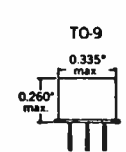

Temperature Range  $-65^{\circ}\text{C}$  to  $+160^{\circ}\text{C}$

 TO-9 0.335" max. 0.260" max.	 E3-51 0.370" max.	Type	$I_{E0}$ or $I_{C0}$ at $V_{CE} = 20 V_{dc}$ $\mu\text{A}$	$V_{CE}$ max. volts	$h_{FE}^{\dagger}$ ave.	$r_b'$ $f = 1\text{Mc}$ ohms	$r_c$ kilohms	Noise Figure db (max.)	$c_{ob}$ $f = 100\text{Kc}$ ave. $\mu\mu\text{f}$	$f_{ab}$ ave. Kc
		PNP       NPN		2N327A	0.005	-40	15	1200	500	30
2N328A	0.005			-35	30	1400	500	30	65	300
2N329A	0.005			-30	60	1500	500	30	65	400
2N330A	0.005			-30	25	1300	500	15	65	250
2N619	0.005			50	15	2000	500	30	35	200
2N620	0.005			40	30	2500	500	30	35	350
2N621	0.005			30	60	2700	500	30	35	500
2N622	0.005			30	25	2400	500	15	35	300

$\dagger$ for PNP,  $I_B = -0.1\text{mA}$ ;  $V_{CE} = -0.5\text{V}$ ; for NPN,  $I_B = 0.5\text{mA}$ ;  $V_{CE} = 1.5\text{V}$

### FOR SMALL SIGNAL APPLICATIONS

Temperature Range  $-65^{\circ}\text{C}$  to  $+160^{\circ}\text{C}$

 TO-9 0.335" max. 0.260" max.	 E3-51 0.370" max.	Type	$I_{E0}$ or $I_{C0}$ at $V_{CE} = 20 V_{dc}$ $\mu\text{A}$	$V_{CE}$ max. volts	$h_{fe}^*$ ave.	$h_{ie}^*$ max. ohms	$h_{oe}^*$ max. $\mu\text{mhos}$	Noise* Figure db	$c_{ob}$ $f = 100\text{Kc}$ ave. $\mu\mu\text{f}$	$f_{ab}$ ave. Kc
		PNP       NPN		2N1034	0.005	-40	15	3000	70	30
2N1035	0.005			-35	30	3000	85	30	65	300
2N1036	0.005			-30	60	3000	100	30	65	400
2N1037	0.005			-35	30	3000	85	15	65	250
2N1074	0.005			50	15	3500	70	30	35	200
2N1075	0.005			40	30	3500	85	30	35	350
2N1076	0.005			30	60	3500	100	30	35	500
2N1077	0.005			30	25	3500	85	15	35	300

\* $V_C = 5\text{V}$ ;  $I_E = 3\text{mA}$



## SEMICONDUCTOR DIVISION RAYTHEON MANUFACTURING CO.

SILICON AND GERMANIUM DIODES AND TRANSISTORS • SILICON RECTIFIERS  
 New York, Plaza 9-3900 • Boston, Hillcrest 4-6700 • Baltimore, Southfield 1-1237 • Washington, D. C., Republic 7-6565  
 Chicago, National 5-4000 • Cleveland, Winton 1-7005 • Kansas City, Plaza 3-5330 • Los Angeles, Normandie 5-4221



# X



# addo-x

model 3541E printing calculator with accumulating register

*multiply—add—subtract—fast—with this versatile, double register machine—speed up all percentage, invoice, job cost and payroll calculations with the machine that stores all the products and totals until the operation is completed—then provides a grand total—*

*"addo-x" stands for a family of versatile, time-proven adding and calculating machines—backed by nation-wide service facilities—lifetime guarantee repair parts availability*

*see your dealer for on-your-job proof or write: "addo-x" 300 Park Avenue, New York 22, NY*

### MULTIVERTER CONVERTS "BEEP" TO NUMERAL

The MULTIVERTER is the first solid state, high-speed digital  $\leftrightarrow$  analog conversion system accurate to .01%. It is also the first converter to solve various complicated arithmetic problems, including square root, during the process of conversion.

A typical MULTIVERTER application is its use in converting analog data received from the orbiting "Explorer." Information telemetered from the satellite and recorded on magnetic tape is converted to numbers by the MULTIVERTER and fed into a digital computer. The result: usable and accurate new knowledge of outer space.

## Satellite "Interpreter"

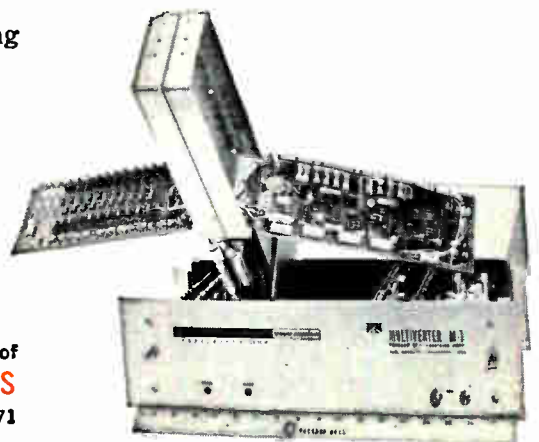
### ENGINEERING BEYOND THE EXPECTED

The need for highly accurate measurement in an accelerating technology called for a solid state converter with an accuracy of .01% and a speed of four microseconds per bit. The MULTIVERTER and related accessories resulted. One immediate application has been the interconnection of Packard Bell's TRICE, the first incremental differential analyzer to operate in real time, with various analog systems. Other applications include Missile Impact Prediction, Coordinate Conversion, Orbit Prediction and Solid State Automatic Checkout Systems.

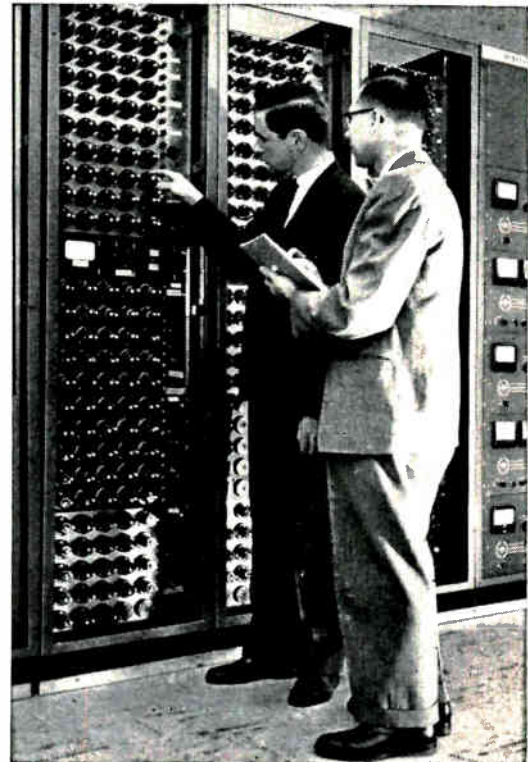
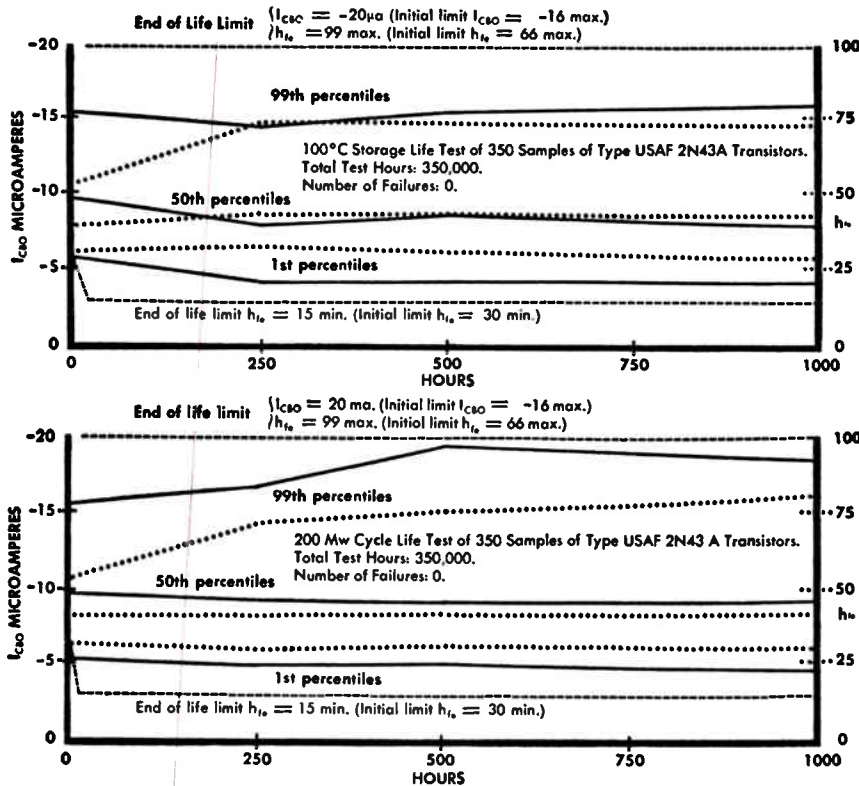
Packard Bell Computer Corp., a subsidiary of

**PACKARD BELL ELECTRONICS**

12333 W. Olympic Blvd., Los Angeles 64, Calif., BR 2-2171



## One-million unit-hours without failure



**G-E 2N43A LIFE-TEST DATA OBTAINED AT 1000-HOUR POINTS.** Upper chart shows results of 100°C storage test (25°C storage test not shown). Lower chart shows results of 200 mw operating test. Broken lines in each chart indicate  $h_{FE}$ . Solid lines indicate  $I_{C50}$  in microamperes. After 1000 hours of testing, there were no failures. The 2N43A transistor's high standard of quality is inherent in all G-E germanium PNP audio and switching transistors.

Dick Welch (left), Transistor Evaluation Engineering, and Lee Leinweber, Transistor Production Engineering, take readings at cycled-life-test rack. In addition to electrical testing, G-E 2N43A transistors are subjected to all mechanical-test requirements specified in MIL-T-19500/18.

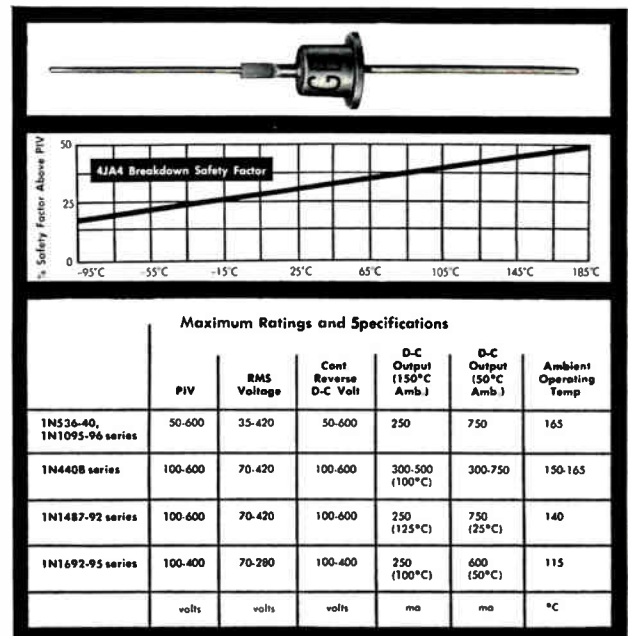
## 20% Safety Factor for silicon rectifiers aids designers

Designers who now apply their own safety factor to the published peak inverse voltage rating may avoid this step by using G-E low-current silicon rectifiers.

General Electric's PIV figures are set by allowing a 20% safety margin at  $-65^{\circ}\text{C}$ . This margin is applied at the point of sharp breakdown voltage and increases with temperature until a maximum safety factor of 33% is reached at  $150^{\circ}\text{C}$ .

If you are derating published PIV figures to provide over-voltage protection, you may be buying costlier cells than you need, or, in series applications, more cells than necessary. Thus the built-in safety margin of G-E low-current silicon rectifiers could save you money. Note: This safety factor is provided for over-voltage protection only. Designs should, in all cases, be maintained within published maximum ratings.

This is only one reason why you should consider G-E low-current silicon rectifiers for all your power requirements. You'll find these devices more attractive to use than ever before—both in quality and price—with equally fine values in low-current silicon stacks. Stud-mounted units are also available. Ask your G-E semiconductor representative for the "big news" on low-current silicon rectifiers.





# for General Electric audio transistors

General Electric's 1958 process and quality-control advances were reflected in recent life-test results exhibited by G.E.'s line of germanium PNP audio transistors. Random samples of Type-2N43A transistors were subjected to rigorous mechanical testing . . . drop-shock, detergent-bomb, lead-fatigue (i.e., all the MIL-T-19500/18 mechanical test requirements). Then a total of 1050 Type 2N43A transistors were put on Life Test, with the following results:

350 (10 lots, 35 units each) were given a 100°C storage test for 1000 hours. No failures.

350 (10 lots, 35 units each) were given a 25°C storage test for 1000 hours. No failures.

350 (10 lots, 35 units each) were given a 200 mw cycled-life test for 1000 hours. No failures.

Engineering test data indicate that, without exception, parameters remained stable (see curves at left).

The G-E 2N43A transistor is representative of the outstanding quality built into General Electric's entire line of germanium PNP audio and switching transistors.

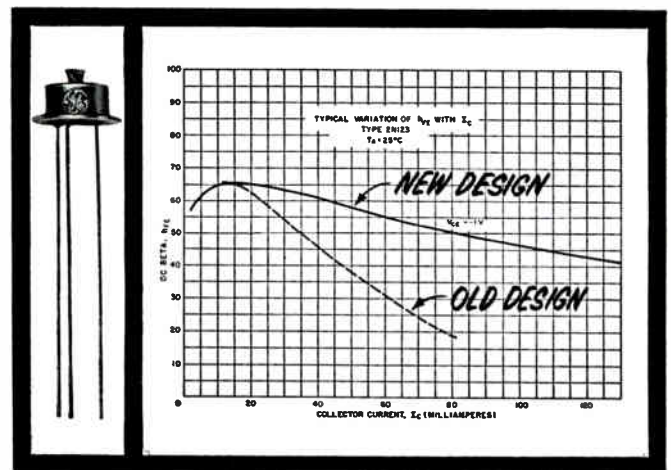
RATINGS: AUDIO AND LOW-FREQUENCY SWITCHING TRANSISTORS								
		2N43	2N43A	2N44	2N44A	2N1056	2N1057	
Collector-to-base Voltage (25°C)	$V_{CB}$	-45	-45	-45	-45	-60	-45	volts
Collector-to-emitter V. (25°C)	$V_{CE}$	-30	-30	-30	-30	-75	-45	volts
Total Dissipation (25°C)	$P_C$	240	240	240	240	240	240	mw
Forward D-c Current Gain, Common Emitter $I_C/I_B$ ( $V_{CE} = -1v$ ; $I_C = -20 ma$ )	$h_{FE}$	53	53	31	31	32	58	
	( $V_{CE} = -1v$ ; $I_C = -100 ma$ )	48	48	25	25		52	
Collector Cutoff Current ( $V_{CBO} = -45v$ ) ( $V_{CB} = 75v$ ; $I_E = 0$ )	$I_{CO}$	-8	-8	-8	-8		-18	$\mu a$
	$I_{CO}$							$\mu a$

NOTE: All figures represent design-center ratings.

## High frequency transistors modified for higher Beta

Recent design improvements in high frequency switching transistors (Types 2N123 and 2N450) have improved their d-c beta at higher collector currents. The result is higher gain and improved saturation characteristics at these high currents.

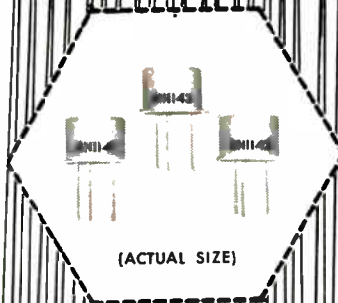
Refinements in quality control tests have also been put into practice on the production line. These units are affected: Types 2N123, 2N450 and the 2N396 series. Units are aged at 100°C for 96 hours to stabilize characteristics. All transistors are subjected to a high-pressure detergent test for hermetic sealing. D-C characteristics are warranted to be within the limits shown on specification sheets. As a result, these transistors are now widely accepted in missile computer work and other rigorous applications.



General Electric Company, Semiconductor Products Dept., Section S2529-6, Electronics Park, Syracuse, N. Y.

GENERAL  ELECTRIC

# NEW TI DIFFUSED-BASE

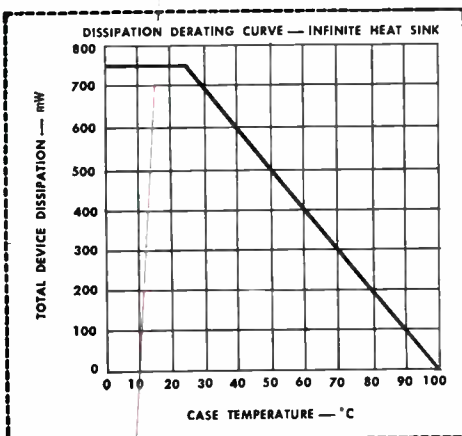


## 750 MC • 750 mW

Guaranteed current gains of 12, 10 and 8 db minimum at 100 mc with new TI 2N1141, 2N1142 and 2N1143 diffused-base "mesa" germanium transistors! Alpha cutoff ratings up to 750 mc coupled with 750 mW power dissipation at 25°C case temperature make these newest TI transistors ideal for military VHF power oscillators and amplifiers where assured reliability and performance are of primary importance.

All units are 100% production stabilized at temperatures well above their 100°C rated junction operating point ... far exceed MIL-T-19500A specifications ... and are *in stock now*.

Contact your nearest TI sales office or nearby TI distributor today ... *for immediate delivery*.



### absolute maximum ratings @ 25°C case temperature

	2N1141	2N1142	2N1143
Collector Voltage Referred to Base . . . . .	-35	-30	-25
Emitter Voltage Referred to Base . . . . .	-1	-0.7	-0.5
Collector Current . . . . .	-100	-100	-100
Emitter Current . . . . .	100	100	100
Device Dissipation (infinite heat sink) . . . . .	750	750	750
Collector Junction Temperature . . . . .	+100	+100	+100
Storage Temperature Range . . . . .	-65 to +100		
Thermal Resistance Junction to Mounting Base . . . . .	0.1	0.1	0.1

### typical characteristics @ 25°C case temperature

	2N1141	2N1142	2N1143
Frequency Cutoff (Common Base) . . . . .	750	600	480
Collector Reverse Current, $V_{CB} = -15V, I_E = 0$ . . . . .	1	1	1
Saturation Voltage, $I_C = -70mA, I_B = 17.5mA$ . . . . .	2	2	2
Small Signal Short Circuit Forward Current Transfer Ratio, $V_{CB} = -10V, I_C = -10mA, f = 1000cps$ . . . . .	0.97	0.97	0.97

TEXAS INSTRUMENTS SALES OFFICES  
 DALLAS • NEW YORK • CHICAGO • LOS ANGELES  
 BOSTON • DAYTON • DENVER • DETROIT • GARDEN CITY, L. I.  
 OTTAWA • PHILADELPHIA • ST. PAUL • SAN DIEGO  
 SAN FRANCISCO • SEATTLE • SYRACUSE • WASHINGTON, D. C.

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

## **ELECTRONICS NEWSLETTER**

**BEFORE LUNIK WAS LAUNCHED** Jan. 2, the Soviets fired a number of test mockups consisting of operational first stage and dummy second and third stages. McGraw-Hill World News learned that this was to gain data on control and resistance built up as the vehicle passed through the earth's atmosphere. During tests an unknown number of liquid-fueled, 484,000-pound-thrust engines burned out on launching pad. With regard to possible unsuccessful Soviet lunar shots, observers cite two points: (1) 25-mile apogee of mockup trajectory for stage testing is believed too low to have been picked up by American radar picket fence in Turkey; (2) Hawaiian tracking stations, which picked up Lunik signals before Soviet announcement, would probably have picked up previous probes if they reached the same point, but then failed to orbit (see p 22).

*Transistorized ignition system is being ordered by Detroit Arsenal from the Electric Auto-Lite Co., Toledo, Ohio. Orders cover prototype sets that meet particular military specifications.*

**NEW ATLAS GUIDANCE CONTRACTS** totaling \$110 million were received last week by GE, confirming earlier letter contracts. Three new contracts, for additional R&D as well as production of radio command guidance systems, bring GE's contract total for Atlas guidance to \$193 million. The equipment will go to Vandenberg AFB, Calif., Warren AFB, Wyo., and Offutt AFB, Neb.

**SALES** of electronic products for business and industry are expected to rise by 27 percent this year over factory sales of \$1.4 billion in 1958. So says RCA President John L. Burns. He adds that in data-processing systems alone a rise of more than 70 percent to about \$600 million is anticipated. Meanwhile, says Burns, "industry sales of defense electronic products in 1959 can be expected to rise by at least 14 percent over last year's \$3.6 billion."

**FIVE NATO NATIONS** may spend as much as \$500 million in building the Army-Raytheon low-altitude Hawk air defense missile. European firms involved are: Ateliers de Construction Electrique de Charleroi, Belgium; Telefunken, West Germany; Finmeccanica, Italy; Philips, Holland; Thomson-Houston, France. T-H is expected to be chief coordinator, but each firm will be prime contractor in its own country. Holding company set up by the five firms will retain Hawk license rights.

**AIRLINES** of Europe and North America are studying means of speeding reservations messages automatically over linked teletypewriter systems.

That, says International Air Transport Association, is one goal of an airlines committee. Second, long range phase of effort is integration of electronic data-processing systems into proposed interline reservations process. First step towards this is survey of data-processing equipment now in use or planned for the near future.

*Missile measurement ship, the S. S. American Mariner, has been put into service tracking ballistic missiles and checking their performance on the Atlantic Missile Range. RCA was systems contractor for ship's electronic gear.*

**THERMO GENERATOR'S FUTURE** lies in increasing efficiency of present power plants, not in replacing them, says Mark W. Cresap, Jr., Westinghouse president. Thermoelectricity has been getting "frantic attention" since semiconductor breakthrough, he reports. Also foreseen: appliances, such as bottle warmers and electric blankets, that will both heat and cool.

**NEW AIRBORNE EARLY WARNING RADAR** system is being produced for the Air Force by Hazeltine Corp. under contracts totaling about \$15 million. Equipment is said to increase protection from surprise attack.

*Soviet post-mortem conference on why Lunik failed to hit the moon reportedly gave greater weight to relative crudeness of third-stage cut-off mechanism than to influence of magnetic fields.*

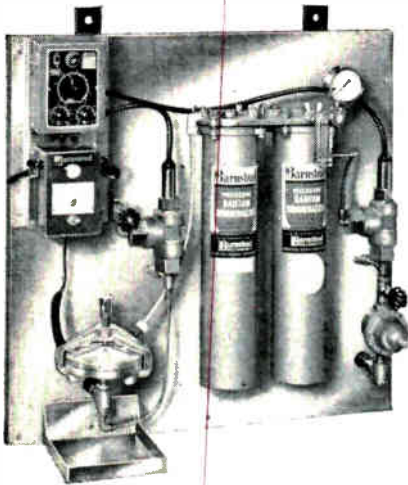
**INTERNATIONAL CONVENTION** on transistors and associated semiconductor devices, sponsored by Britain's Institution of Electrical Engineers, will be held May 21 to 27, a few days earlier than previously announced. Exhibition will be open during convention period.

**JAPANESE ELECTRONICS** industry reported production valued at \$333 million for the first nine months of 1958, 24 percent above the comparable 1957 period. Information comes from a study prepared for the Commerce Department's electronics division by the U. S. embassy in Tokyo. Exports worth \$26 million in the nine months ran about one-third more than for all of 1957.

**BRITISH RADIO EQUIPMENT** exports rose to \$126 million last year, \$4.5 million more than in 1957. Largest hikes were in sales of tubes and sound reproducing gear while components and capital goods exports fell slightly, reports Radio Industry Council of Britain. Council's breakdown of export customers for first nine months of '58 shows U. S. bought about \$11.5 million worth of British radio goods.



# NEW



## **Barnstead** Cooling Water Repurifying System . . .

*adds thousands of hours  
to UHF transmitting  
tube life.*

**PAYS FOR ITSELF OVER AND OVER IN  
REPLACEMENT TUBE SAVINGS . . .  
REQUIRED BY SOME MAKERS BEFORE  
THEY GUARANTEE TRANSMITTING  
TUBES.**

Research by a leading transmitting tube manufacturer shows that the life of UHF transmitting tubes is drastically shortened by impurities in cooling water. Dissolved impurities and suspended particles in the cooling water deposit on the tube anode forming an insulation. This causes overheating, and shortened tube life results. The most damaging of these impurities is copper oxide which is formed when carbon dioxide dissolves copper particles in the cooling water. The Barnstead Cooling Water Repurifying System substantially reduces and sometimes completely eliminates the copper oxide deposits by removing the dissolved copper, carbon dioxide and oxygen. Other dissolved scale-forming impurities are removed at the same time including submicroscopic particles. For the answer to your Pure Water Problems why not write to Barnstead today!

**Barnstead**  
STILL & STERILIZER CO.

84 LANESVILLE TERRACE, BOSTON 31, MASS.

NEW YORK  
Kingsbridge  
8-1557

CLEVELAND  
ACademy  
6-6622

CHICAGO  
MUIberry  
5-8180

BOSTON  
Jamaica  
4-3100

PHILADELPHIA  
LOcust  
8-1796

LOS ANGELES  
RYan  
1-6663

SAN FRANCISCO  
TEmplebar  
2-5391

CIRCLE 8 READERS SERVICE CARD

## WASHINGTON OUTLOOK

ODDS ARE AGAINST passage of Sen. Saltonstall's new bill to revamp military procurement policy. It faces stiff opposition from House Armed Services Committee Democrats and small business supporters.

The Saltonstall bill provides for:

- (1) Increased use of negotiated, fixed-price contracts with special incentives for production cost reductions.
- (2) Wider application of the weapon system management concept under which increased authority is granted to prime contractors.
- (3) Other procurement short cuts.

The bill would allow the military greater latitude to award negotiated—as opposed to advertised—contracts. Under present laws, military award of negotiated contracts involves considerable red tape. Advertised procurement is considered the general rule; negotiated procurement is allowed only under specific exemptions to the law which the Pentagon must justify in detail before signing contracts.

For the most part, defense producer spokesmen are backing the bill. But small business advocates are suspicious of the measure's stress on weapon system management.

Under this system, control over weapon development is centralized in one prime contractor—with a minimum of government interference. The prime has responsibility for the design and production of an entire missile or plane and all its components.

He builds some of this himself, farms out the remainder to subcontractors, assembles the product, even directs crew training and supervises installation and maintenance. The scheme was devised as a means of simplifying and speeding development of complex new weapons.

- A broader scope on challenges to renewals of radio and television station licenses is shaping up.

It appears, after a round of court actions, that the Federal Communications Commission must allow nonbroadcasters who compete with a broadcaster (or its parent) in another business to challenge renewals.

Last June, the Court of Appeals in the District of Columbia reversed FCC's position that the Philco Corp.—as a nonbroadcaster—had no standing to challenge the renewals of NBC's Philadelphia radio and tv station licenses.

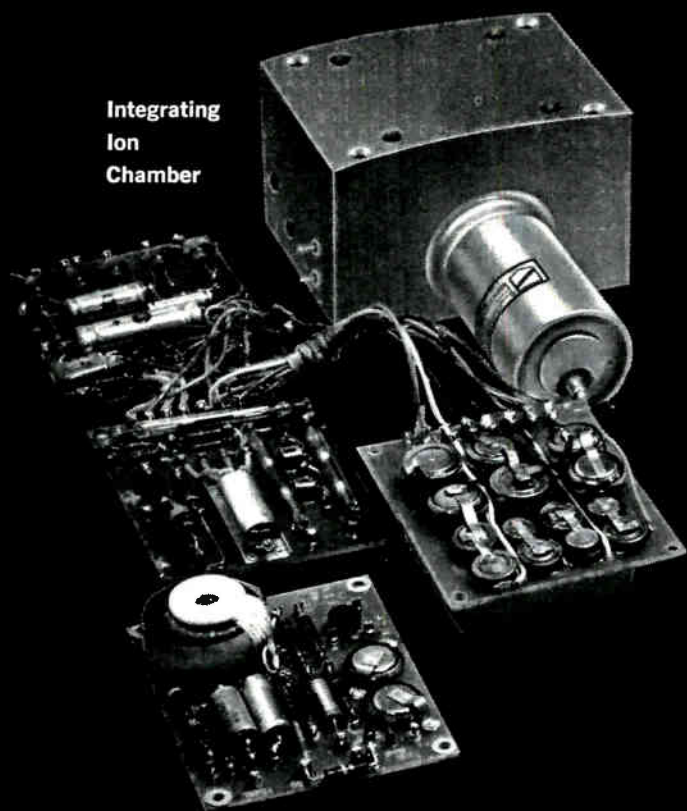
Now, the U. S. Supreme Court has refused to review the Court of Appeals decision. FCC must now consider Philco's protest to the NBC renewals, specifically, that RCA-NBC antitrust troubles should disqualify NBC as a station operator.

- New electronic developments are expected to play a key part in the military's push for a global communications network using space satellites.

Dubbed Project Courier, three such communications experiment shoots are scheduled for 1960, with four more set for 1961. Early versions of the satellites are supposed to be able to receive and transmit messages at the rate of 2,000 words per minute.

The Advanced Research Project Agency is in charge now but the new National Aeronautics and Space Administration will eventually take over.

Integrating  
Ion  
Chamber



## Concerning Radiation Theories in Interplanetary Space

Aptly called **Pioneer**, the terminal stage of **Able-One's** space probe reached into the fringes of the universe to telemeter data that will help solve the problems of interplanetary travel. **Pioneer** successfully carried 39.6 pounds of **Space Technology Laboratories'** developed instrumentation for the gathering and transmission of data.

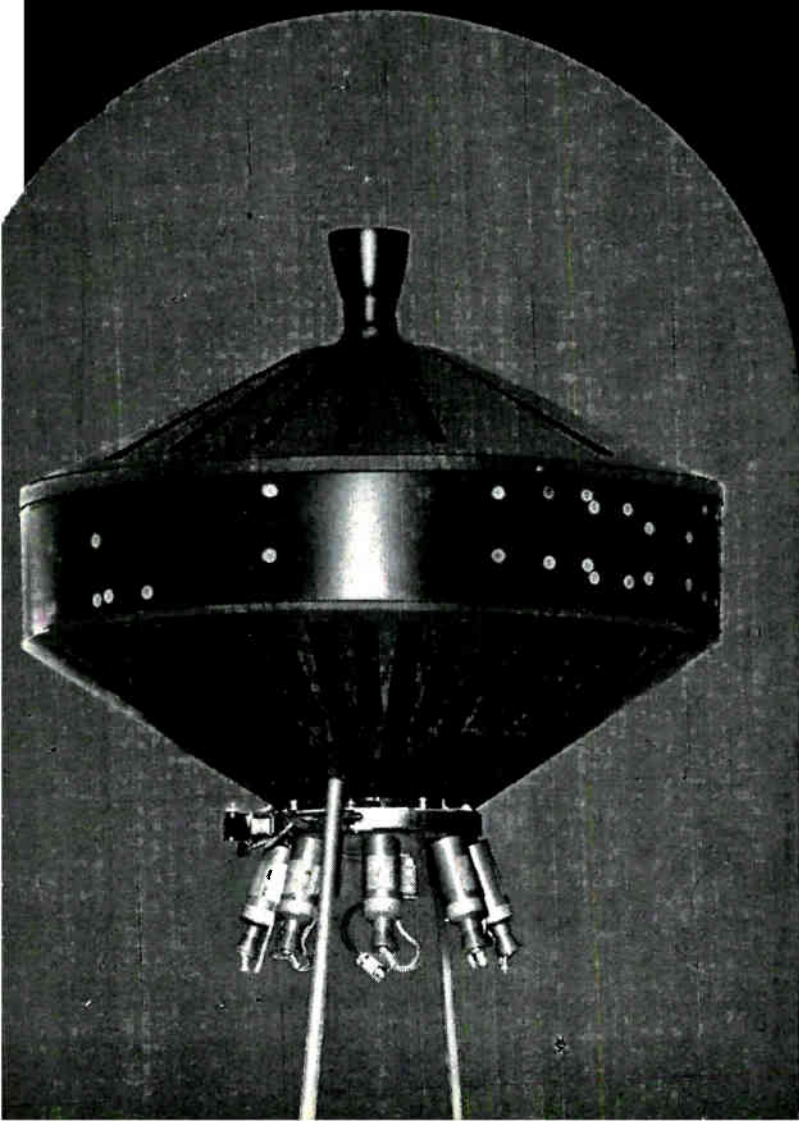
The ion chamber and associated equipment provided information concerning the radiation intensity in space. This experiment was carried on in connection with the Department of Physics, State University of Iowa.

In conjunction with the U. S. Air Force Ballistic Missile Division, and under the sponsorship of the National Aeronautics and Space Administration, **STL's** explorations and developments in seeking energy spectra of the radiation belt are continuing at an accelerated pace. Increased knowledge in the fields of interplanetary magnetism and the distribution of interplanetary matter are being sought. Related fields of astrophysics provide additional areas in which advanced experimentation may be expected to add substantially to man's knowledge of the universe.

These programs at **STL** open a whole new vista in analytical and experimental areas for the advanced technical person whose interests and experience qualify him for work in the following fields: electrodynamics, nuclear physics, communication theory, and the design and execution of physical experiments in interplanetary space. Inquiries are invited.

## Space Technology Laboratories, Inc.

P. O. Box 95001, Los Angeles 45, California  
Telephone: OSborne 5-4677





NORTH RVF ROTARY SWITCH GIVES YOU

# GREATER APPLICATION FLEXIBILITY

30 INPUTS AND 30 OUTPUTS PER LEVEL give you a flexibility in circuit approach unmatched by any other stepping switch! For application to programming, sequence control, routining, impulse counting, tallying, or as a memory device, the completely dust enclosed North RVF Switch is the most versatile, flexible, reliable Stepping Switch on the market!

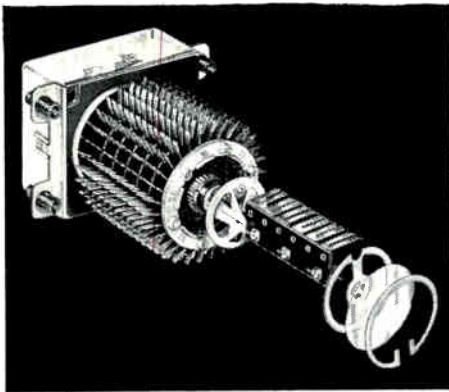
INDUSTRIAL DIVISION

**NORTH ELECTRIC COMPANY**

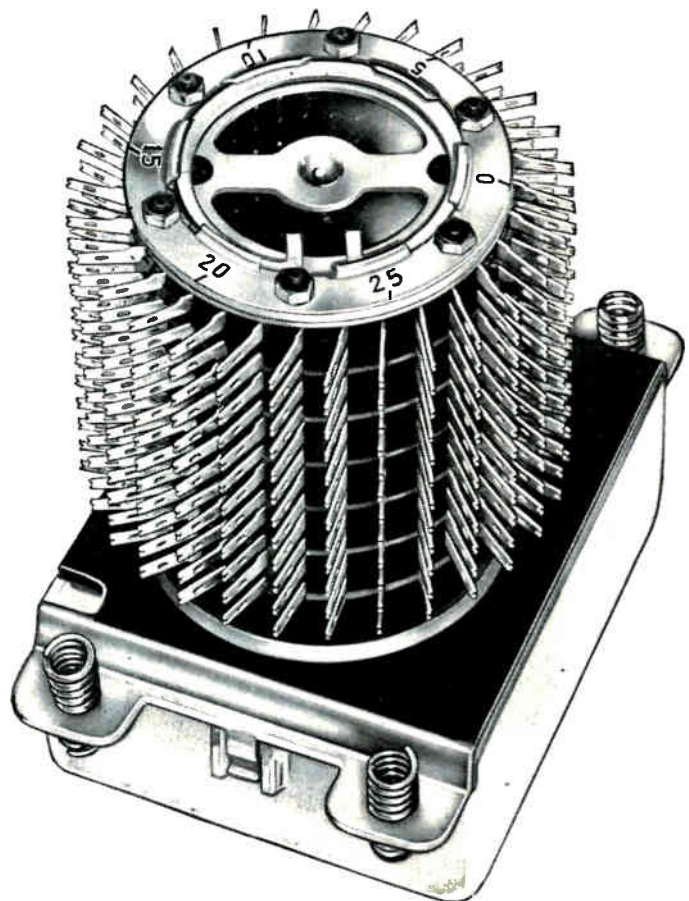
492 SOUTH MARKET STREET • GALION, OHIO



Available in Canada through Ericsson Telephone Sales of Canada, Ltd., Montreal 8, P. Q.



For circuit applications requiring up to 30 points per level, the switch is provided in 2, 4 or 6 levels with single rotor. For circuit applications requiring up to 12 levels with 15 points per level, the switch is furnished with a dual rotor. Bank contact ratings: 1 amp at rest; .2 amp. resistive when stepping. Off normal contact ratings .4 amp. resistive. Switch may be driven self-stepping or externally. Gold plated bank contacts and wipers are available for low level switching. Available with 12, 24, 48, 110 V. D.C. coils. Built-in spark suppression on 24 and 48 volt switches. Mounting dimensions: 1.968" x 3.661" O.C. Overall height: 4 $\frac{3}{4}$ " height above mounting, 3 $\frac{1}{2}$ " (max. dimensions for 6 level switch). Weight: 1.32 lbs.





# New Names Hit 'Big Boards'

LISTING of Ampex Corp. stock on the New York and Pacific Coast Stock Exchanges last week may point the way to increase in electronics firms on the "big boards" of U. S. securities markets.

An official of NYSE told ELECTRONICS that a check of records back to mid-1957 shows that the number of electronics listings has grown steadily.

During the past 19 months, the New York mart's rolls have been increased by eight firms which derive all or part of their income from electronics.

A spokesman for the American Stock Exchange told ELECTRONICS that seven electronics firms have obtained listings there in the same time period.

In order to qualify for listing on the New York exchange, a firm must meet the following requirements:

- It must be one in which there is nationwide interest.
- It must have issued at least 400,000 shares of stock which are owned by at least 1,500 investors.
- It must have demonstrated earning power of at least \$1 million annually in its recent past.
- It must agree to publish quarterly financial statements publicly.
- Stock must have voting privilege.

Stocks listed on the major exchanges generally find a broader market than those sold over the counter. Some market observers say this is because many investors, such as institutions, mutual fund groups and endowment funds, do not buy securities not listed on the big boards. In some cases, such groups are prevented by law or policy from purchasing over-the-counter stocks. Also, listings are more widely published for main exchange stocks.

In addition to Ampex Corp., other newcomers mentioned by officials of the New York Stock Exchange for the period from July 1957 to the present are: Allied Products Corp., Detroit; Bausch & Lomb Optical Co., Rochester, N. Y.; Champion Sparkplug, Detroit; Glading McBean & Co., Los Angeles; Litton Industries, Beverly Hills, Calif.; Sie-

gler Corp., New York; and Thiokol Chemical Corp., Trenton, N. J.

New electronics listings on the American Stock Exchange for the same period were reported as follows: General Transistor Corp., New York; Herold Radio & Electronics Corp., New York; Jetronic Industries Inc., Philadelphia; Philips Electronics, Inc., New York; Stratham Instruments Inc., Los Angeles; Teleprompter Corp., New York; and Victoreen Instrument Co., Cleveland.

## OVER THE COUNTER

1958 LOW	BIDS HIGH	COMMON STOCKS	WEEK ENDING		
			Jan. 16 BID	Jan. 23 BID ASKED	
33 1/2	20 1/2	Acoustica Assocs	19	20	23
15 1/2	3	Advance Industries	27 1/2	31 1/2	41 1/4
31 1/2	6 1/2	Aerovox	6 1/2	6 1/2	8 7/8
20 1/2	33	Amer Res & Dev	37 1/4	37 1/4	39 3/4
16 3/4	24 1/4	AMP Inc	22	23 1/4	25 7/8
5 1/2	15	Appl'd Sci Princet	11	9 1/4	11 1/8
11 1/2	8 7/8	Avion, A	9	10 3/8	11 1/8
6 3/4	24	Baird-Atomic	27 1/2	26 3/4	30 3/8
9 3/4	13 3/8	Burndy	14 3/8	14 3/8	15 1/2
6 3/4	9	Cahu Electronics	6 7/8	6 3/4	7 7/8
11	22 1/2	Collins Radio, A	21 3/8	25 1/4	27 3/4
10 1/4	22 1/4	Collins Radio, B	22 3/4	25 1/4	27 1/2
4	4	Craig Systems	6 3/8	6 3/8	8 1/4
30	50 1/2	Dictaphone	48 1/2	48	52 1/2
17 1/2	25 3/8	Eastern Industries	20	20 1/2	22 1/2
10 1/2	21	Electro Instr	22 1/2	26 1/4	29 3/8
34	49	Electronic Assocs	52	51	56 1/2
5	11	Electronic Res'rch	12	12 1/4	14 1/8
8 1/2	12 3/4	Electronic Spec Co	14	14 1/2	15 3/4
15 1/4	49 1/2	Epsco, Inc	43	41	48 1/4
5 1/2	9 3/8	Eric Resistor	8 3/4	10 1/4	12 1/4
10	17 1/2	Fischer & Porter	16 3/4	16	18
36 3/4	50	Foxboro	48	49 1/2	54 1/2
5 1/2	10 1/2	G-L Electronics	10	11 1/4	13 3/8
12	27	Giannini	29 1/2	31	35 1/8
30	39 1/2	Hewlett-Packard	40 1/2	42 1/2	47 3/8
23 1/4	48	High Voltage Eng	61	57	63 1/2
1 3/4	3	Hycron Mfg	3 1/2	3 3/8	4
1 1/2	5 3/8	Industro Trans'tor	3	2 3/4	4
21	30	Jerrold	4 1/4	4 1/2	5 1/8
3 1/4	29	D. S. Kennedy	28	33 3/4	37 1/2
19 1/4	28	Lab For El'tronics	27 1/4	23 3/4	29 3/8
2	2	Leeds & Northrup	28 1/2	29 1/2	32
5	3 1/8	Leetronics	2	2	2 3/8
16	18 3/4	Ling Electronics	19 1/4	18 3/4	21 1/8
3 1/4	8 1/4	Machlett Labs	22	21 3/4	24 3/8
27 1/2	4 1/2	Magnetic Amplifiers	8	8	8 3/4
49 1/2	12	Magnetics, Inc	3 3/8	3 3/8	4 1/8
10 3/8	29	W. L. Maxson	12 3/4	13 1/2	15 3/4
5 1/4	11 3/4	Microwave Assocs	36 7/8	34	42 1/2
1 1/2	7	Midwestern Instr	11 1/8	13 1/4	15
3 1/2	7 1/4	Monogram Preci's'n	9	8 1/4	9 5/8
9 3/4	16	Narda Microwave	6 7/8	6 1/2	7 1/4
14 1/4	56	National Company	16 3/4	18 1/4	20 3/8
14 1/2	29 3/4	Nuclear Chicago	26	30 1/2	38 3/4
4 1/2	7 3/8	Orradio Industries	29 3/4	28 3/4	32
10 1/8	27 1/2	Pacific Mercury, A	9 1/2	9 1/4	11 1/2
4 1/4	9 3/8	Packard-Bell	28 1/2	30 1/2	33 1/4
21	53 3/4	Panellit, Inc	7 1/4	6 3/4	8 1/8
11 3/8	19 1/2	Perkin-Elmer	52	52 3/4	56 1/2
2 1/2	7 3/8	Radiation, A	18	17 3/4	19 1/2
13	32 1/2	Reeves Soundcraft	6 3/4	7 7/8	9 1/4
7	12	Sanders Associates	34	33	37 1/4
22 3/4	40	SoundScriber	14 1/4	15	20 1/8
26	35	Sprague Electric	41 1/2	41 3/4	45 3/8
5 1/2	15 1/4	Taylor Instruments	34	34 1/2	37 1/4
5 1/2	15 3/4	Technical Operat'ns	15 1/4	16 1/4	18 3/8
3 1/4	7 3/4	Teledyne Mfg	15 1/4	16	21
1 1/2	23 1/4	Telecomputing	8 1/2	8 1/2	9 1/8
8 3/4	16 1/4	Tei-Instrument	2 3/4	2 3/4	3 1/2
3 3/4	10 3/4	Topp Industries	12 7/8	14 3/8	16 3/8
1 1/2	3 3/8	Tracerlab	12	12 1/4	13 7/8
14 1/4	40	Universal Trans'tor	2 3/8	2 3/8	2 7/8
12 1/2	18 1/2	Varian Associates	48 1/2	50	56 1/4
		Vitro Corp. Amer	15 3/8	16 1/4	19 3/8

The above "hid" and "asked" prices prepared by the NATIONAL ASSOCIATION OF SECURITIES DEALERS, INC., do not represent actual transactions. They are a guide to the range within which these securities could have been sold (the "BID" price) or bought (the "ASKED" price) during preceding week.

# NEW



## fast response servo amplifier

transistor-magnetic  
small size • light weight  
"built in" stabilization

Suitable for use where specifications for low-power instrument servos call for small size, high gain, and high performance.

### SPECIFICATIONS — MODEL

	A	B
Rated Power Output: 3.5 watts, 57 volts Mark XIV motor or equivalent	X	X
Input Impedance: 30K ohm	X	X
500K ohm		X
Voltage Gain: 2000 max.	X	
900 max.		X
adjustable by external resistor over 50:1 range		
Response Time: 1 cycle of supply frequency	X	X
Zero drift over ambient Temperature Range (-55°C +100°C): Less than ±5% of rated output voltage	X	X
Inherent servo stabilization at velocity constant of 100-200	X	X
Power Supply: 115 Volts ± 10%, 400 cps ± 5%	X	X

Send for Literature

# AVION

AVION DIVISION

MILITARY • INDUSTRIAL — QCF INDUSTRIES  
Equipment and Components 11 Park Place, Paramus, N. J.

QCF DIVISIONS ADVANCED PRODUCTS, AMERICAN CAR AND FOUNDRY, AVION, NUCLEAR PRODUCTS—ERCO, CARTER CARBURETOR, SHIPPERS' CAR LINE, W.K.M.

CIRCLE TO READERS SERVICE CARD

Engineering  
careers  
grow  
better  
at Link-  
Palo Alto

The climate is right for achievement at Link - Palo Alto...  
for your career, and for your enjoyment of life.

Among the burgeoning projects at Link's attractive new laboratory are those requiring cultivation by engineers who have a green thumb with *digital computers*. If you have such talents, you will want to investigate a career at Link - Palo Alto.

The professional atmosphere at Link is based on a recognition of technical competence and accomplishment. For those interested in advanced university study, Link will arrange tuition.

Salaries are excellent. The Link health, medical, and retirement plans are outstanding.

Palo Alto, a charming suburban community, offers an ideal location for career advancement and for raising a family.

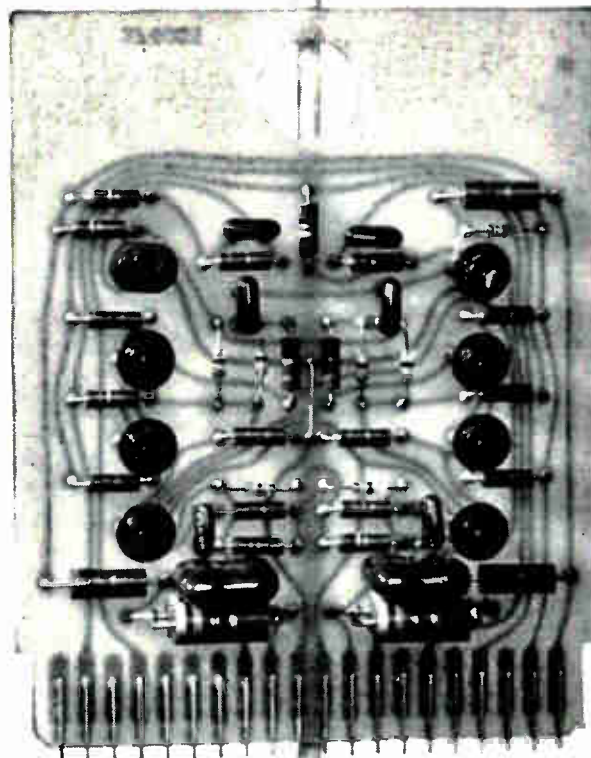
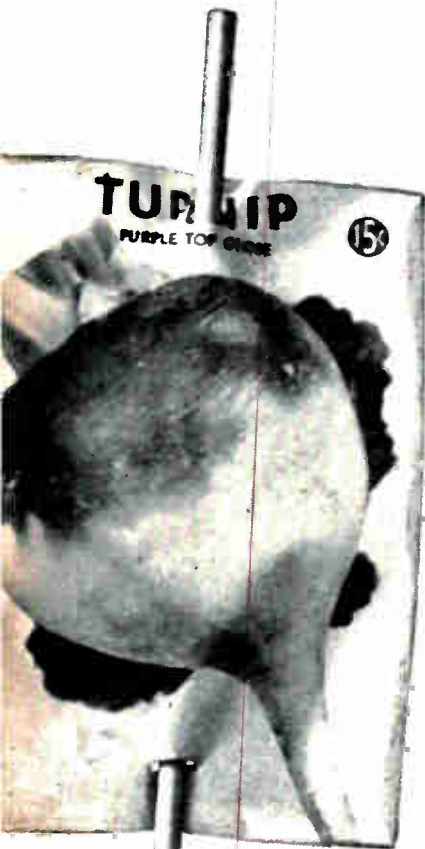
In addition to digital computer engineers, Link has staff openings for people with capabilities in electronic packaging, automatic checkout equipment, optical systems, and radar simulators.

Your engineering career can grow better at Link-Palo Alto. Contact us at once. Write to Mr. N. A. Larko, Link Aviation, Inc., P. O. Box 1318, Palo Alto, California



A subsidiary of  
General Precision  
Equipment  
Corporation

LINK AVIATION, INC.

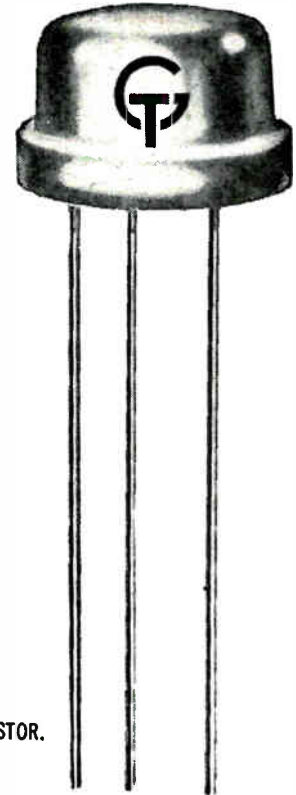
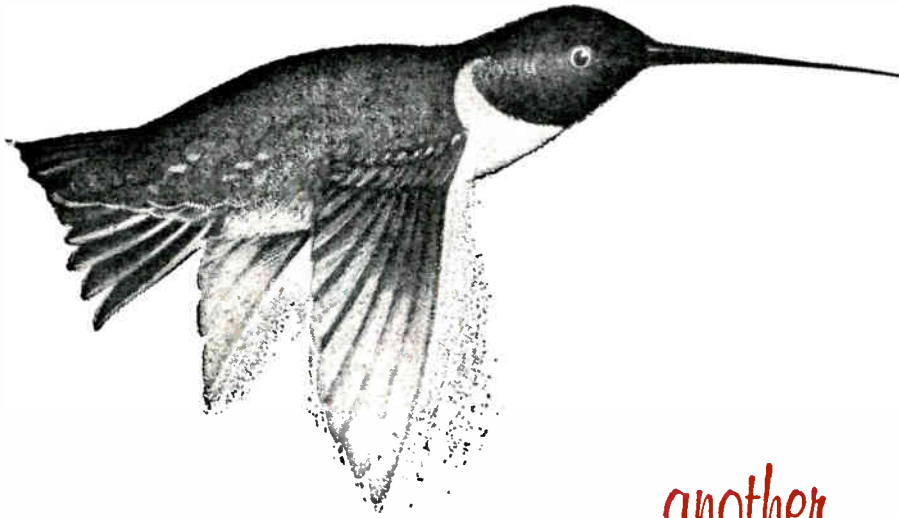




ready to go in



either direction



another

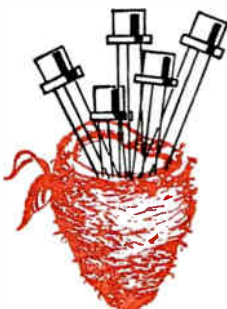
QUALITY PRODUCT FROM GENERAL TRANSISTOR.

**NEW PNP AND NPN  
BILATERAL TRANSISTORS  
HAVE EMITTER  
AND COLLECTOR  
INTERCHANGEABILITY**

General Transistor has developed another new transistor series—the Bilateral PNP 2N592, 2N593 and NPN 2N594, 2N595, 2N596. These germanium alloyed junction transistors have been designed to allow current to flow in either direction—valuable in medium speed switching applications as in computers, communications equipment, multiplexing devices, and for bi-directional switching and phase detection systems.

The characteristics of these transistors are guaranteed in both directions. Their symmetrical design allows extremely low saturation resistances and switching properties. Ordinary uni-directional types lack this advantage. The NPN types have an alpha cutoff frequency range of 1.5 to 10.0 megacycles.

For complete technical specifications write for illustrated brochure G-170.



**GENERAL TRANSISTOR CORPORATION**

91-27 138TH PLACE. JAMAICA 35. NEW YORK

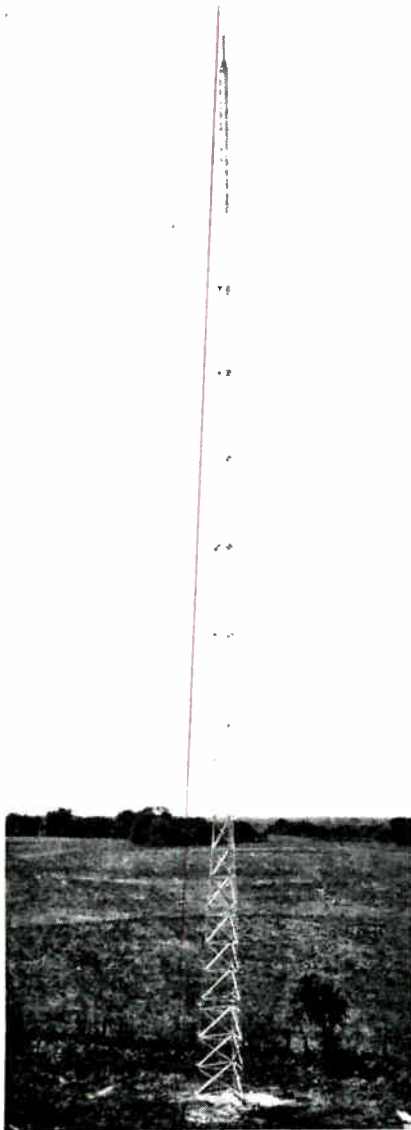
In Canada: Desser E-E Ltd., 441 St. Francis Xavier, Montreal 1, Quebec  
FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED  
GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING  
CORP. 95-27 SUTPHIN BLVD. JAMAICA 35, NEW YORK FOR EXPORT: GENERAL  
TRANSISTOR INTERNATIONAL CORP. 91-27 138TH PLACE JAMAICA 35, NEW YORK

6



# New ROHN

## SELF SUPPORTING COMMUNICATION TOWER



- ★ 120 ft. in height, fully self-supporting!
- ★ Rated a true HEAVY-DUTY steel tower, suitable for communication purposes, such as radio, telephone, broadcasting, etc.
- ★ Complete hot-dipped galvanizing after fabrication.
- ★ Low in cost—does your job with BIG savings—yet has excellent construction and unexcelled design! Easily shipped and quickly installed.

**FREE** details gladly sent on request. Representatives coast-to-coast.

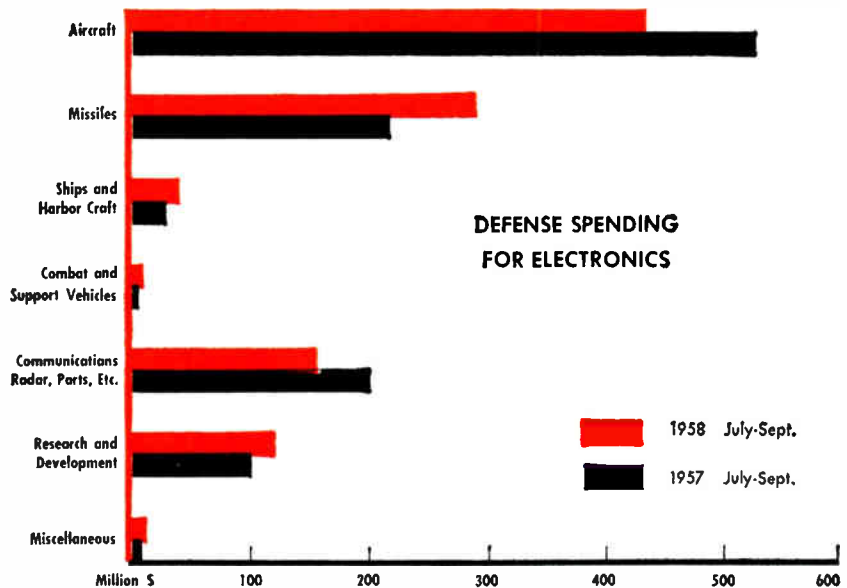
**ROHN Manufacturing Co.**

116 Limestone, Bellevue,  
Peoria, Illinois

"Pioneer Manufacturers of  
Towers of All Kinds"

CIRCLE 12 READERS SERVICE CARD

## MARKET RESEARCH



## Missiles Rise in 3rd Quarter

DEFENSE DEPARTMENT spending for electronics during the months July to September, 1958, showed relatively little overall change from July to September, 1957. Of a total expenditure of \$3.8 billion, electronics industry benefitted by some \$1.06 billion in the third quarter of 1958, versus an outlay of about \$1.09 billion in the third quarter of 1957. But gains were posted in five of seven categories.

Electronics expenditures for aircraft amount to \$446 million during the third quarter of '58. About \$531 million was spent for aircraft electronics in third quarter, '57.

Missile electronics accounted for \$288 million in third quarter '58, \$221 million in third quarter '57.

DOD budgets have lowered expenditures in the aircraft category. Missile electronics, on the other hand, has shown a steady increase—but not enough to compensate for the more severe cuts in aircraft electronics procurement.

Electronics spending in third quarter 1958: \$34 million for ships and harbor craft; \$6 million for combat and support vehicles; \$161 million for communications, radar, parts, etc.; \$120 million for research and development; and \$7 million for miscellaneous electronics.

Electronics spending in third quarter 1957 totaled: \$26 million

for ships and harbor craft; \$3.4 million for combat and support vehicles; \$204 million for communications, radar, parts, etc.; \$102 million for R&D; and \$4 million for miscellaneous electronics.

The electronics portion of total spending for various budget categories is based on following percentages developed by ELECTRONICS research department: Aircraft electronics, 25 percent; missile electronics, 40 percent; ship and harbor craft electronics, 10 percent; combat and support-vehicle electronics, 6 percent; communications, radar, parts, etc., 100 percent; electronics research and development, 25 percent; miscellaneous electronics, 3 percent.

Most controversial of these categories is missiles. Percents for the electronics portion of missile systems have been estimated as low as 30. Other estimates have neared the 50-percent mark.

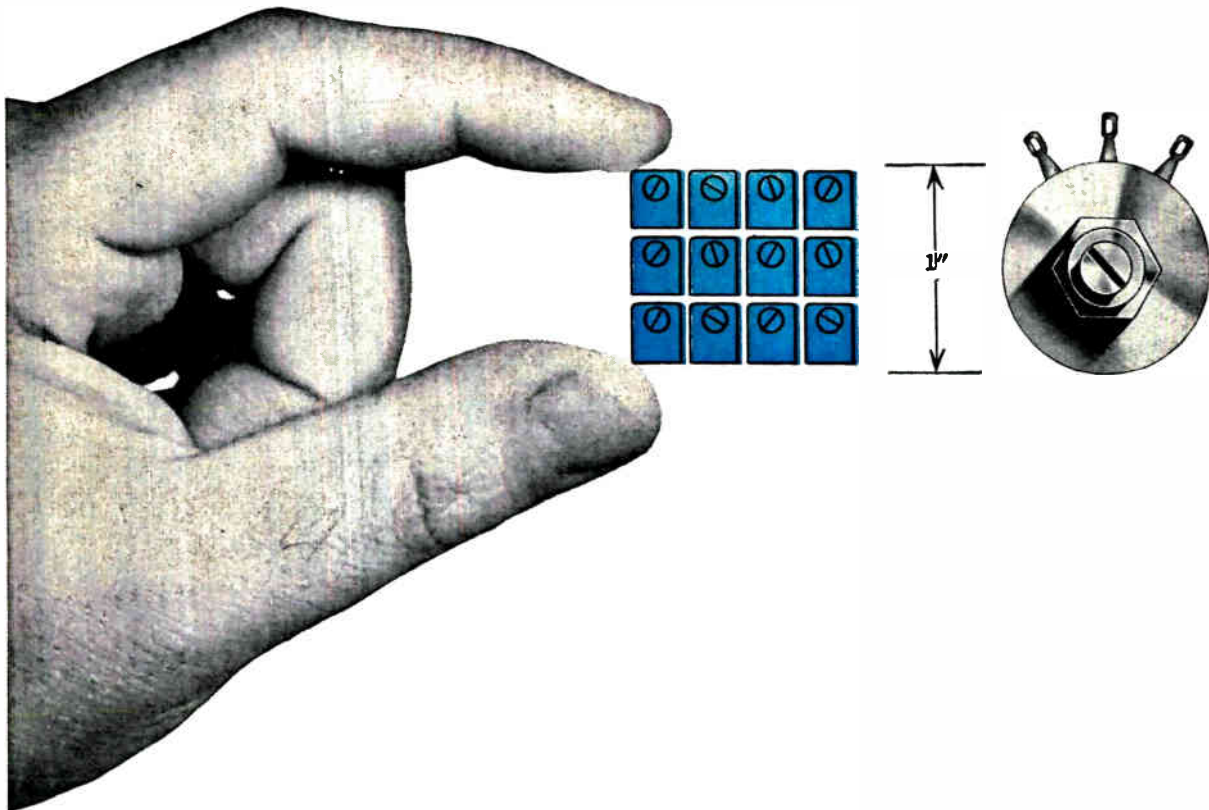
## FIGURES OF THE WEEK

### LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Jan. 16, 1959	Dec. 19, 1958	Change From One Year Ago
Television sets	103,696	110,021	- 4.7%
Radio sets (ex. auto)	279,954	319,478	+17.1%
Auto sets	109,765	124,976	+10.2%

### STOCK PRICE AVERAGES

(Standard & Poor's)	Jan. 21, 1959	Dec. 23, 1958	Change From One Year Ago
Electronic mfrs.	74.56	72.24	+39.1%
Radio & tv mfrs.	82.36	76.19	+83.3%
Broadcasters	79.77	78.07	+36.9%



**FIT 12 OF THESE RECTANGULAR POTENTIOMETERS  
IN A PANEL AREA OF 1 SQUARE INCH!**

You can pack 12 Bourns TRIMPOT® potentiometers in the  
1-square-inch area occupied by the average single-turn rotary.

Fit the TRIMPOT into corners—between components—flat against  
a chassis or printed circuit board. Mount them individually or in stacked  
assemblies. Any way you use them—Bourns potentiometers save space!

You can adjust Bourns potentiometers more accurately, too.

The 25-turn screw-actuated mechanism gives you 9000° of rotation  
instead of 270°. Circuit balancing and adjusting is easier, faster.

Repeatability is assured every time. Furthermore, adjustments are  
self-locking—shock, vibration and acceleration have no effect!

*Write for new Model Summary Brochure*

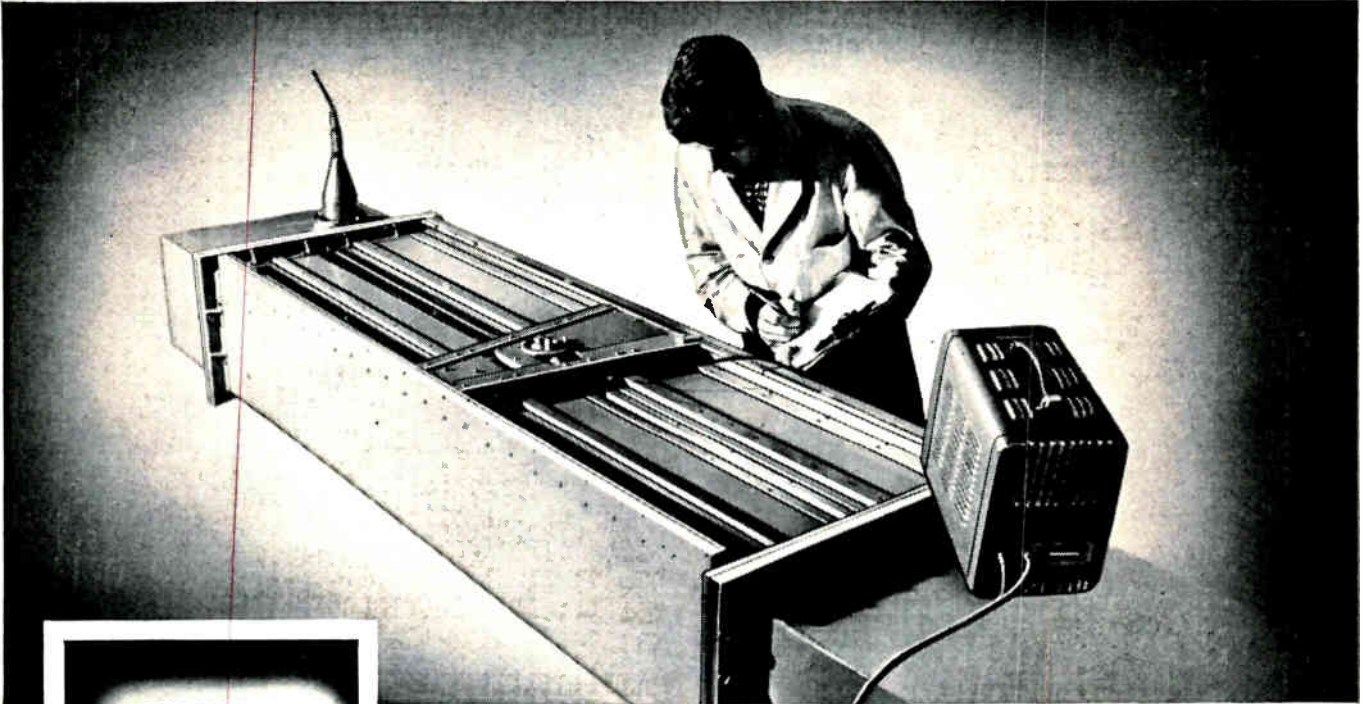
**BOURNS**  
*Laboratories, Inc.*

P. O. Box 2112-A • Riverside, California

ORIGINATORS OF TRIMPOT® AND TRIMIT®  
PIONEERS IN POTENTIOMETER TRANSDUCERS FOR POSITION, PRESSURE AND ACCELERATION



# I-T-E CAN SUPPLY ALL YOUR LARGE WAVEGUIDE TEST EQUIPMENT

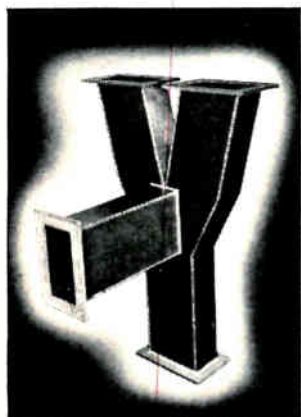


**Slotted lines** are supplied complete with probe and carriage. Residual SWR is less than 1.02:1 over the frequency band. Available in sizes WR770 through WR2300.

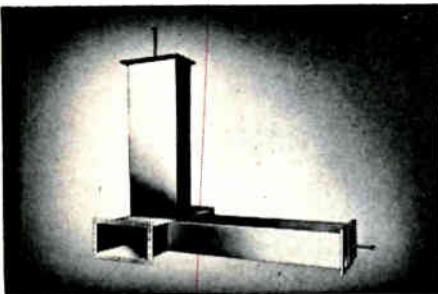
Here are a few examples of the waveguide test equipment and components currently available from I-T-E to meet the testing and operating requirements of multi-megawatt radar and scatter communications systems. This equipment reflects I-T-E's broad experience in all phases of large waveguide design and manufacture.

Take advantage of I-T-E's specialized knowledge of waveguide testing and the precision fabrication capabilities of a specially equipped waveguide shop. Facilities such as these assure you of the highest standards of quality, maximum economy, and excellent delivery—in single or production quantities.

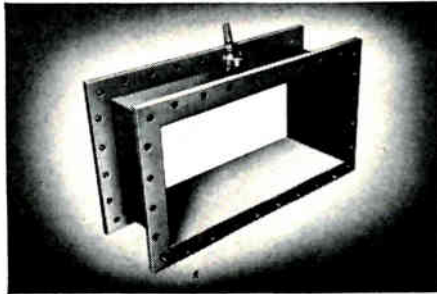
If you have a requirement or problem relating to waveguide test equipment, write I-T-E Special Products Division, 601 E. Erie Ave., Philadelphia 34, Pa. And ask for your copy of free-space wave length vs. guide wave length conversion tables for large waveguide.



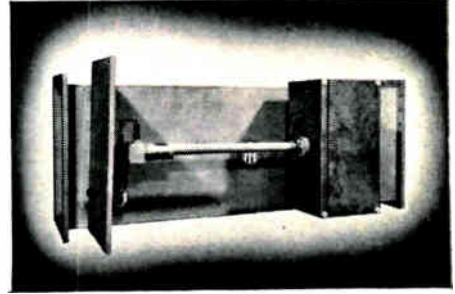
**Folded hybrid tee**



**E-H plane tuner**



**Close-loop directional coupler**

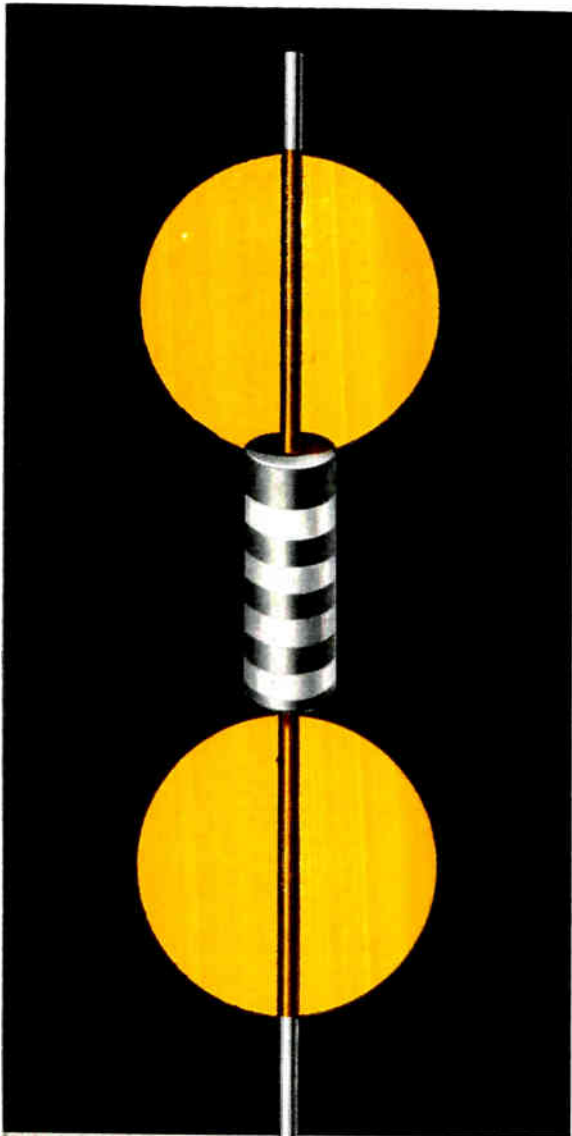


**Motorized short circuit section**



**I-T-E CIRCUIT BREAKER COMPANY**  
Special Products Division • 601 E. Erie Avenue • Philadelphia 34, Pa.





**Coldite 70+ Resistors Save You Money on Assembly Work!**

Stackpole Coldite 70+ resistors solder easier and stay soldered more surely. Thanks to an extra solder coating applied AFTER the usual tin-lead coating, they solder perfectly by ANY method — dip or iron. Moreover, resistance variations from normal soldering heat are negligible.

## Get a head-start on production with "solder-coated" resistors

You can pretty well take for granted that any one of several leading resistor brands will meet or exceed your performance requirements. But there's another factor to be considered too—ease of handling on your assembly lines. Mainly that means ease of soldering — and here Stackpole Coldite 70+ "solder-coated" fixed composition resistors stand head and shoulders above the field. Not only do these famous cold-molded resistors meet today's critical specifications, but they provide unmatched "solderability" on any hand or automatic, open wiring or printed circuit operation. That makes not only for a real saving in assembly work, but also stands to reduce subsequent service costs resulting from poor soldered connections.

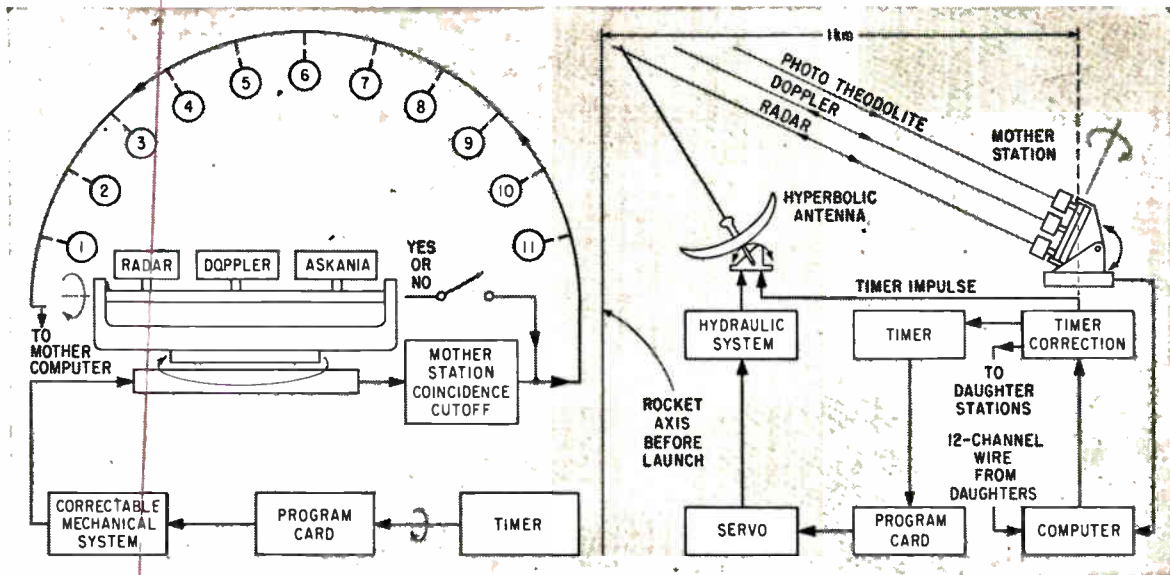
ELECTRONIC COMPONENTS DIVISION  
STACKPOLE CARBON COMPANY, S.T. MARYS, PA.

STACKPOLE

*Coldite 70+*<sup>®</sup>

**FIXED COMPOSITION RESISTORS**

CERAMAG<sup>®</sup> FERROMAGNETIC CORES • SLIDE AND SNAP SWITCHES • VARIABLE COMPOSITION RESISTORS • CERAMAGNET<sup>®</sup> CERAMIC MAGNETS • FIXED COMPOSITION CAPACITORS • ELECTRICAL CONTACTS • BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT • HUNDREDS OF RELATED CARBON, GRAPHITE, AND METAL POWDER PRODUCTS



Tracking station control system (left) and directional-beam missile guidance ground station

# How USSR Guided Lunik

1. Documentation shows she aimed at moon's equator and missed
2. Red China supplied much high-purity germanium for the project
3. All-transistorized gear used two-dimensional printed circuits

BONN—DOCUMENTED information from the USSR makes it clear that the Soviet artificial planet launched Jan. 2 was, in fact, intended to strike near the moon's equator.

McGraw-Hill World News learned that the Russians dispensed with telemetering gear for providing rocket performance data, and made no provision for destruction in flight. Sodium cloud, released by preset timer, provided check data on rocket performance.

Lunik contained essentially the same instruments as Sputnik III to measure magnetic fields, cosmic radiation, radioactivity, interplanetary matter, corpuscular radiation, micrometeorites and temperatures; four intercoupled transmitters were provided to relay data on 19.993, 19.995, 19.997, and 183.6 mc, with a fifth transmitter included as a standby. Transmitters had 6-watt input and average output of 1 watt.

The transmitters, which started operating 10 minutes before firing time, were also interconnected with a magnetic trip system. In the event of transmitter failure prior

to burnout of the last vehicle stage, the fuel system was to be cut off to stop the rocket's journey.

For the first time in a Soviet rocket, McGraw-Hill World News learned, all electronic gear was fully transistorized and two-dimensional printed circuits were used. Much of high-purity germanium came from Red China. Rocket was launched from a point northeast of the Aral Sea on the border of European Russia, and was slated to be tracked by 13 stations sweeping from Prague to Voroshilov, near the Pacific. Chemical batteries, exhausted after 62 hours, enabled continuous transmission of data while the vehicle passed through the earth's shadow.

The rocket used programmed guidance for coarse control and a directional beam for fine control. System is said to have permitted the Russians to come within three degrees of their target. Key to this success was third-stage cut-off with 0.1-second accuracy when Lunik had achieved the desired escape velocity on its planned path.

Guidance and control gear was located in both the third-stage and the ground control station. Though all controls were programmed, additional ground-to-missile fine control was obtained by riding the vehicle on a beam projected by a hyperbolic antenna.

The desired flight path was inscribed on a perforated aluminum card in the rocket. Readout of this data was programmed by a crystal-controlled oscillator. Meanwhile, on the ground, a perforated iridium card with identical commands inscribed on it programmed the movement of the directional-beam antenna. Oscillator in the rocket was pulse synchronized with an identical timer on the ground.

The guidance beam was provided by a 2,500-mc crystal-controlled transmitter feeding an 85.2-ft diameter hyperbolic antenna.

Three liquid-damped gyroscopes in each of Lunik's three stages acted on an inertia stable platform to control roll, pitch and yaw. Gravitational influences were compensated by gyro system; magnetic

influences causing roll or pitch were corrected by two induction coils. A third induction coil coupled directly to an integrating accelerometer governed the pressure of fuel injected into the thrust chamber.

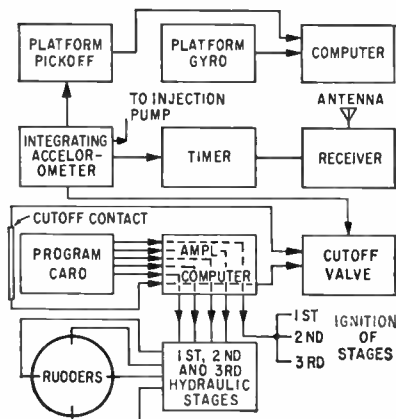
Guidance signals from the rocket's inertial system were sent through a computer to an amplifier, and compared in a second computer with signals from perforated-card program control. The resulting error signal was used to actuate a hydraulic system which positioned four graphite rudders at the end of the rocket nozzle.

The guidance beam was controlled by a ground station. There were 12 identical ground tracking stations, plus the main control station. Each station had a doppler radar, a conventional radar and a phototheodolite in a single turret.

The doppler used a parabolic reflector. The radar operated on 12-cm and used a 9.8-ft diameter reflector. The phototheodolite used an Askania system, some parts of which reportedly came from West Germany.

Correcting time pulses to the missile timer were sent as amplitude modulation on the guidance beam's 2,500-mc carrier frequency.

After launch, each subsidiary station, which was in phase, sent a signal to the main station indicating if it was zeroed in on rocket. Information from main tracker and all reporting subsidiaries was fed into master computer, which provided a correcting time pulse if necessary. Correcting time pulse went to the beam timer, the timer in missile, and the timers at subsidiary tracking stations.



Radio-inertial guidance equipment within missile

## 347 YEARS TO DESIGN A RADAR SYSTEM???

Well, hardly! Not laid end-to-end, anyway. It's simply that the combined radar system experience of Canoga engineers and physicists whose know-how contributed to the development of the AN/MPS-26\* totals 347 years. Know-how isn't the only thing — it's everything.

\* Long range automatic tracking Instrumentation Radar developed for Bureau of Aeronautics, U. S. Navy

### SPECIFICATIONS AND FEATURES

OPERATING FREQUENCY: 5.4 - 5.9 Kmc (C-band)  
 POWER OUTPUT: 250 Kw peak  
 ANTENNA POLARIZATION: Vertical, horizontal, circular (push-button selectable by operator)  
 RANGE TRACKING RATE: 8,000 yd/sec (Mach 22 at sea level) with full velocity memory  
 PULSE REP FREQ: 320 - 1707 cps (in 12 steps)  
 DATA TAKE OFF: Digital, d-c analog and synchro (range, azimuth and elevation)  
 PULSE WIDTHS: 1.0 and 0.25  $\mu$  sec  
 Van or building installation  
 One man operation  
 Multiple pulsing feature  
 Separate receivers and AFC's for simultaneous beacon and skin signal reception and display

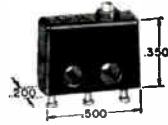


**CANOGA**  
 DIVISION  
 underwood corporation  
 15330 OXNARD STREET  
 VAN NUYS, CALIFORNIA  
 P.O. BOX 550, Phone State 6-9010





# MICRO SWITCH Precision Switches



ACTUAL SIZE

## More news about the "SX" miniaturized subminiature switch

### New actuators add to versatility of "SX" Series

Two of the auxiliary actuators for the "SX" are shown below. Others, not shown, are pivoted lever and pivoted roller lever variations. All are made of stainless steel.



LEAF ACTUATOR



ROLLER LEAF ACTUATOR

The new "SX"—smallest precision snap-action switch—offers a new kind of answer to switching problems involving space, weight, and reliability. Here are some of the reasons:

**SIZE** (of case): .500" x .200" x .350" high—ten to the square inch.

**WEIGHT:** 1 gram . . . 28 switches to the ounce.

**ELECTRICAL RATING:** 28vdc: 7a. resistive, 4a. inductive-sea level; 2.5a inductive-50,000 ft.; 4a. motor load, 24a. max. inrush. 115/230 vac: 5a. resistive, 15a. max. inrush.

Other useful and newsworthy features of this remarkable switch include these:

Mechanical life is in the millions of operations.

The case of the "SX" has two through holes that will accept #2 screws. One hole is slightly elongated to facilitate mounting.

The "SX" operates dependably in temperatures from -65° F. to +250° F.

Operating force is controlled and predictable within 3 oz. to 5 oz. limits.

Terminals are integrally molded.

Special plating on terminals improves ease of soldering.

The normally-open and normally-closed terminal-contact inserts are solid silver and in one piece for maximum conductivity and heat dissipation.

For more information about this important switch, ask for Data Sheet 148.

MICRO SWITCH . . . FREEPORT, ILL.

A division of Honeywell

In Canada: Honeywell Controls Limited, Toronto 17, Ontario



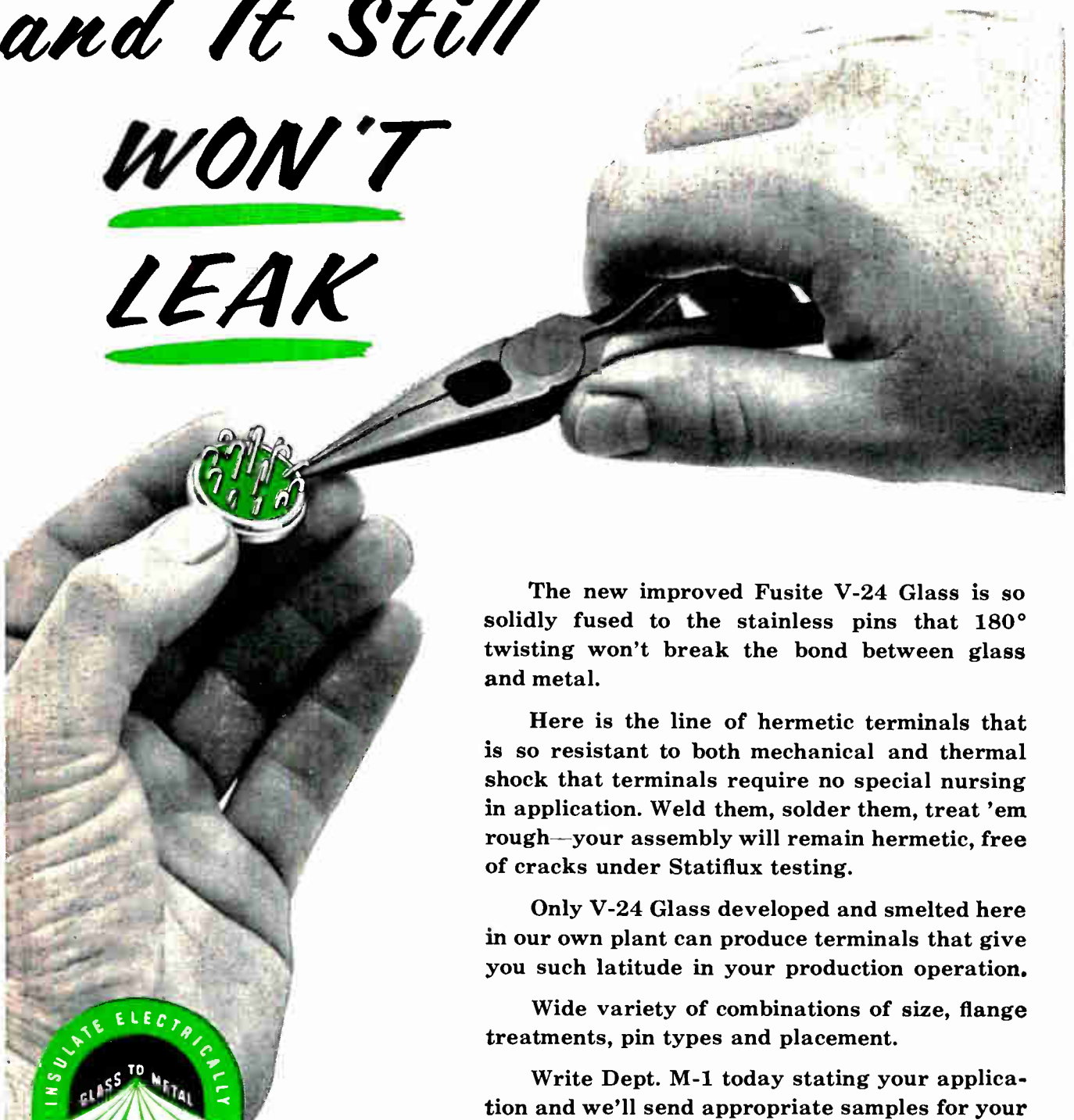
# Honeywell

MICRO SWITCH PRECISION SWITCHES

# Twist It 'til It Snaps and It Still

## WON'T

## LEAK



The new improved Fusite V-24 Glass is so solidly fused to the stainless pins that 180° twisting won't break the bond between glass and metal.

Here is the line of hermetic terminals that is so resistant to both mechanical and thermal shock that terminals require no special nursing in application. Weld them, solder them, treat 'em rough—your assembly will remain hermetic, free of cracks under Statiflux testing.

Only V-24 Glass developed and smelted here in our own plant can produce terminals that give you such latitude in your production operation.

Wide variety of combinations of size, flange treatments, pin types and placement.

Write Dept. M-1 today stating your application and we'll send appropriate samples for your own testing.



THE **FUSITE** CORPORATION

6000 FERNVIEW AVE., CINCINNATI 13, OHIO

In Europe: FUSITE N. V. Königsweg 16, Almelo, Holland

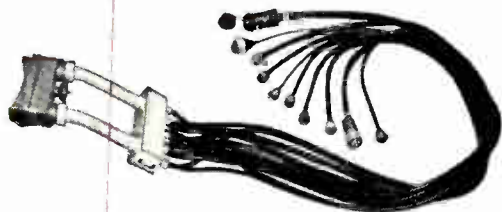
# Cable assemblies by BENDIX

Specialized designs for the most exacting requirements

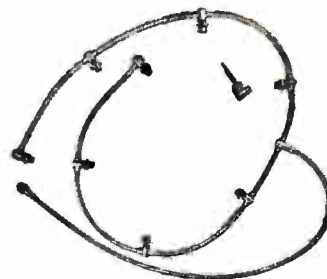
The versatility of design and reliability of performance offered by Bendix\* Cable Assemblies result from over a quarter century of precision manufacturing in this field. Our outstanding research and design facilities are avail-

able for custom designing cable assemblies to meet your specialized requirements on each installation. Cable assemblies shown are typical Scintilla Division developments in cabling for aircraft, electronic and missile applications.

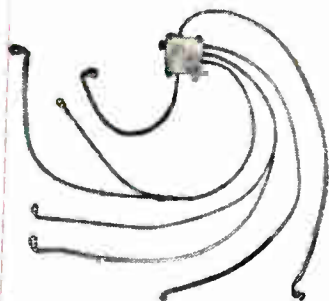
\*REG. U. S. PAT. OFF.



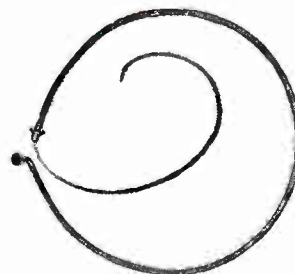
**MISSILE CONTROL CABLE:** This cable is fabricated using both Benseal® (a plastic molded covering) and Bendix electrical connectors. Protects vital circuitry controlling the firing of missiles.



**THERMOCOUPLE HARNESS:** Flexible, completely sealed and suitable for continuous operation in ambient temperatures of  $-65^{\circ}\text{F}$  to  $1500^{\circ}\text{F}$ . Thermocouples are singly detachable and the sealed harness eliminates any chance of trouble from altitude, moisture or other contaminants.



**CONTROL HARNESS:** This configuration, encased and sealed in metal braid and complete with junction box, can safely withstand the adverse effects of engine environment such as heat, vibration, and oils.



**FUEL CELL CABLE:** Safely conducts electricity to fuel control valves, pumps, switches and gaging devices immersed within fuel cells. Features: unbroken stainless steel bellows type conduit, double layer protection between current carrying conductors, stainless steel integral connector shells.



**HEAVY DUTY CABLE:** Ground support cable assembly built and designed for hard usage at missile launching sites. Heavy duty moldings and a tough neoprene tubing combine to resist wear.



**RIBBON CABLE:** Ribbon type cable terminated to both standard MS or Bendix Pygmy® connectors. Advantages offered by this type of wiring include durability, performance, lightness, plus minimum space requirements.

Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N.Y. Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec

SCINTILLA DIVISION  
SIDNEY, NEW YORK





# Small Recorder Sales Climb

Rising sales rate in battery-operated recorders holds promise of brisk component sales, say manufacturers, as consumer interest grows

INDUSTRY EMPHASIS on small size and portability of electronic gear is becoming increasingly evident in the manufacture of tape recorders.

Estimate by one audio manufacturers' group is that slightly more than thirteen percent of all models now on the market are battery operated. About one-third of the battery-operated models are transistorized.

Tape recorders in general are now enjoying what one firm describes as the "steepest sales climb" in tape-recorder history. Predictions by a major tape manufacturer are that yearly sales of tape recorders, amounting to some 600,000 this year, will total 865,000 units by 1960. Dollar volume is expected to hit \$151 million in the next two years, an increase of almost one-half over present figures.

## Performance

Although many battery-operated tape recorders have audio characteristics that leave much to be desired from the hi-fi enthusiast's point of view, a large number of them are capable of response curves extending from 50 to 15,000 cps.

A number of manufacturers are using spring motors to reduce power drain on recorder batteries. The spring motors are used to activate the transit mechanism, while the batteries supply power to the electronic portion of the unit. Some spring motors are designed to allow rewinding while the unit is in use, while others must be switched off to rewind.

Almost without exception, the battery operated models are available with more than one transit speed. A number of models feature speeds of  $3\frac{1}{2}$ ,  $7\frac{1}{2}$ , and 15 inches per second. There are several models that move tape at  $\frac{1}{2}$  ips.

Sizes vary from units as big as briefcases weighing close to 20 pounds, to  $9\frac{1}{2}$ -in. models weighing closer to six pounds.

While following the trend to miniaturization, some tape recorder manufacturers have not forgotten the great interest in stereo now prevalent. A substantial portion of the battery operated models are dual track units equipped for stereo playback.

Some models are available with four-track heads.

## Pricing

Current prices for portable recorders hover at about the \$400 mark although there are exceptions both above and below this price. The beginnings of European competition are being felt in this field.

A number of factors have caused the rise of the battery operated recorder. Some spokesmen for the recorder business say the increase is due to growing demands on broadcasters and record companies for records of events taking place away from conventional power sources.

Many manufacturers are banking on the belief that the tape re-

recorder has, in many cases, become the businessman's working tool.

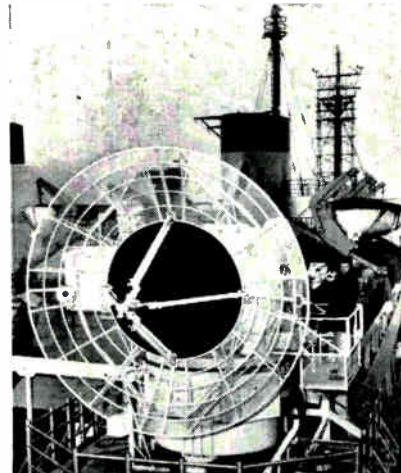
## Business Uses

One example of the way portable sound is used is being demonstrated to good advantage by a manufacturer of retail consumer goods. A major part of the firm's sales campaign hinges on radio and tv commercials.

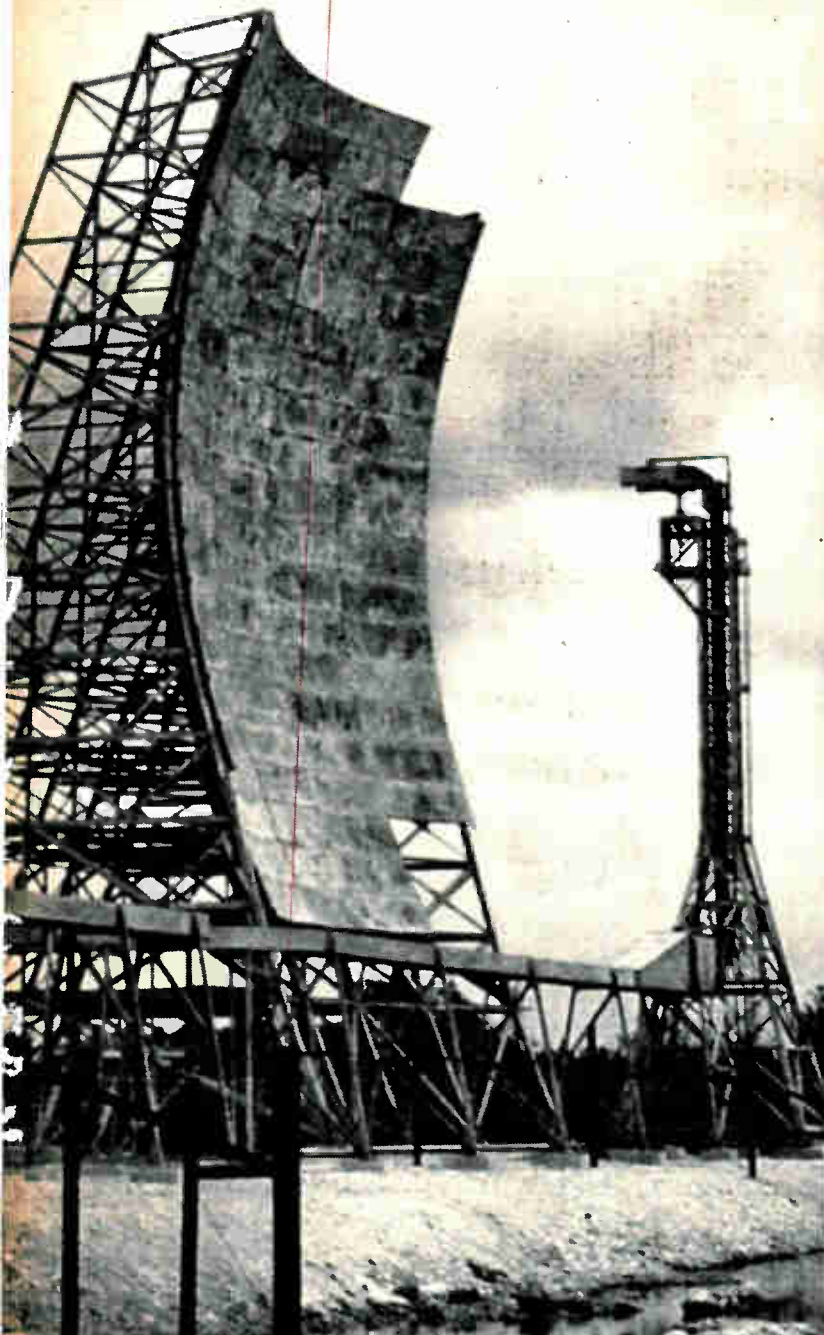
Company salesmen are provided with tapes of the radio-tv message so that they can give the retailer an accurate rundown of what the firm is doing to help him sell the product. In addition to sales demonstration, the salesmen also use the recorders to keep notes and data while on sales trips, and to record consumer comment on the products they are selling.

Another firm is contemplating the use of portable tape recorders for its time-and-motion study personnel. The group would go through the plant equipped with recorders to make verbal notes of changes in procedure, employee comment, and other information.

## Electronic Laboratory Goes to Sea



Plotting and recording gear (left) is among equipment RCA installed and will operate on S. S. American Mariner, new "missile measurement ship" now active on the Atlantic Missile Range. Huge dish is described as largest tracking radar antenna afloat



EIMAC Klystrons are used in most tropo-scatter installations



EIMAC 4KM50,000LQ klystron

## NOW, 400 TO 985 MEGACYCLES SPANNED WITH JUST TWO EIMAC 10KW KLYSTRONS

Exceptionally wide frequency coverage, 400 to 985 megacycles, is now available with just two interchangeable klystron amplifiers using the Eimac 4KM50,000LA and LQ 10 KW klystrons. This important tropo-scatter and UHF-TV range can now be covered with a single transmitter. In addition, both tube types offer exclusive design advantages that have made Eimac klystrons the most widely used power tubes in tropo-scatter networks.

### Field-Proved External Cavity Design

Extra wide tuning range with single set of tuning cavities. Lower original cost. Tube replacement cost much lower since external tuning circuitry need not be replaced.

Uniform bandwidth through inductive tuning plus greater broadbanding by external cavity loading.

### Wide Range Load Coupler

One coupler covers entire frequency range.

### Modulating Anode

Provides simplified overload protection. Protects cathode from internal arc damage.

### EMA Cathode

Combines ruggedness and long life of a pure metal emitter with the high efficiency of an oxide cathode.

Extra large area cathode conservatively rated for exceptional reliability.

Eliminates need for high voltage bombarder power supply, reducing system cost and total power consumption.

### Series Connected Body Magnet Coils

Permits use of single power supply and control for body magnets.

### Performance Proved Reliability

In tropo-scatter service, individual Eimac klystrons have logged more than 25,000 hours air time.

**EITEL-McCULLOUGH, INC.**



San Carlos, California





ultra-miniaturized  
for limited space



**TinyMike**  
ceramic capacitors

**TINY MIKE**®  
"the ceramic with the million dollar body"

**SPECIFICATIONS**

Capacitance Values Available:  
.005, .01, .02, .05, and .1 mfd.

Diameters: .350" to .625"

Working Voltage: 50 VDC

**Immediately available in production quantities!**

Ideal for limited space and low-voltage requirements of portable radios and a variety of other miniature battery-powered and line-powered equipment. Excellent for bypass and coupling. Tough phenolic coating affords excellent insulation while protecting against severe humidity and vibration. For further information, write for Bulletin SEB-2 to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.



**Crimped and Straight-Cut Leads for Automation.** These units are available in 600 and 1000 VDCW units on types C, JA, JB, JC, BYA and other General Purpose capacitors. Leads are accurately spaced on these units for easy insertion into printed wiring boards. Crimped-lead units prevent bottoming on the printed wiring board assuring positive contact for soldering. Straight-cut leads save height off the board and may be inserted to circumference of disc.



**Controlled phenolic dip** avoids "rundown" of the phenolic on straight-cut leads. Assures always-uniform soldered connections.



Consistently Dependable  
**CORNELL-DUBILIER**  
CAPACITORS

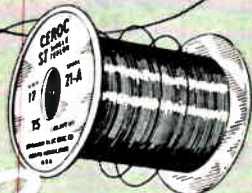


**TWO OUTSTANDING  
HIGH-TEMPERATURE  
MAGNET WIRES**



*Tetroc*

FOR CONTINUOUS OPERATION AT  
HOTTEST SPOT TEMPERATURES  
UP TO 200°C



*Ceroc*

FOR CONTINUOUS OPERATION AT  
HOTTEST SPOT TEMPERATURES  
UP TO 250°C

For continuous operation at hottest spot temperatures up to 200°C (392°F) and up to 250°C (482°F) for short periods of time—depend upon TETROC—an all Teflon-insulated wire available in both single and heavy coatings.

CEROC is Sprague's recommendation for continuous operation at hottest spot temperatures up to 250°C (482°F) and up to 300°C (572°F) for short periods of time. Ceroc has a flexible ceramic base insulation with either single silicone or single or heavy Teflon overlays. The ceramic base stops "cut-through" sometimes found in windings of all-fluorocarbon wire. Both Tetroc and Ceroc magnet wires provide extremely high space factors.

Write for Engineering Bulletins 405 (Tetroc Wires) and 400A (Ceroc Wires).

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

**SPRAGUE**<sup>®</sup>  
THE MARK OF RELIABILITY

CIRCLE 21 READERS SERVICE CARD

# Soviets Reveal Trade



In an exclusive interview, Associate Editor Manoogian (left) chats in Armenian with Soviet First Deputy Premier Anastas J. Mikoyan and an embassy secretary

## Transistorized computers, machine tool controls and other electronic gear are among items Russia wants to sell United States

NEW YORK—Soviet Union is offering as part of a new trade campaign to sell small, transistorized computers and electronic instrumentation to the U. S. and wants to buy other electronic equipment, some of which is now denied to it as strategic material, ELECTRONICS learned exclusively.

Following a private conversation with Soviet Deputy Premier Mikoyan at the Soviet embassy in Washington, our staffer was introduced to N. N. Smeliakov, new chairman of the board and president of Amtorg Trading Corp., USSR's export-import agency in U. S.

In an exclusive interview, Smeliakov said the Soviets believe they have products in "many areas of electronic instrumentation in which

the U. S. does not have commercial equivalents."

He explained that he could not give specific technical product details, but said that Amtorg was planning to publish a quarterly magazine in English that would contain information about products the USSR wants to sell here.

### Items for Sale

Smeliakov arrived unobtrusively in this country as part of Soviet Deputy Premier Mikoyan's party and quietly remained behind to assume his new duties. He said he was formerly chairman of the economic council of the Gorky district.

According to Smeliakov, the "areas" of instrumentation in which the Soviets have products that would interest American firms in-

# Aims

clude: machine tool controls, spectrographic analyzers, and rotational and linear speed indicating devices. The Soviets also want to sell new transistorized computers and cameras with electronic accessories.

The USSR, he said, wants to buy from the U. S. complete chemical factory equipment including all of its electronic instrumentation, equipment for manufacturing synthetic fibers and plastic tubing.

In addition, Smeliakov said the USSR is interested in promoting patent licensing agreements. He said the Soviets are now considering requests from U. S. firms who want Russian licenses covering equipment manufacture. The Soviets, he added, would like to obtain U. S. licenses in electronics, chemistry and metal-working.

An aide to Smeliakov cited radio-sondes used during the International Geophysical Year as an example of electronic items already purchased in the U. S. He said an application to buy replacement radio, tv tubes is pending.

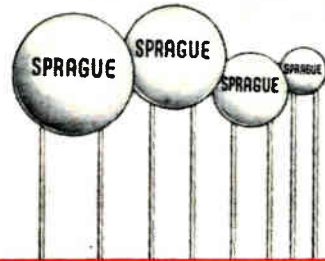
With regard to the proposed sale here of Russian electronic products, Smeliakov stressed that the Soviets want to sell only equipment, not components. Among other items that fit in this category is food processing equipment, some of it apparently controlled electronically. One example is equipment that automatically separates crabs from their shells and packs them.

## X-Ray Sampler



Automatic x-ray fluorescent spectrograph made by North American Phillips is used by Haynes Stellite Co. to test composition of metal alloy batches. Machine compares batch sample with known sample and prints results on tape

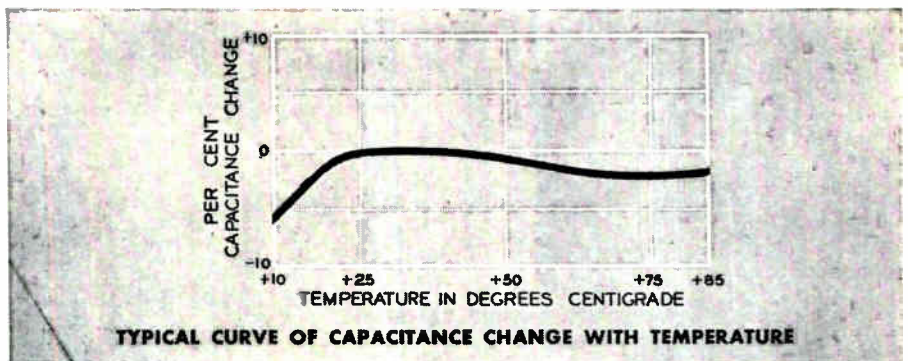
# NEW



## Formulation 40

### flattens temperature-stability curve of *Cera-mite*<sup>®</sup> Disc Capacitors

Cera-Mite Ceramic Capacitors are now *smaller, more stable...* thanks to Sprague's new ceramic body Formulation 40. The increased dielectric constant of this newly developed ceramic body gives Cera-Mite Capacitors *three* times the capacitance per unit size than heretofore possible. Capacitance change with temperature over the operating temperature range is negligible.



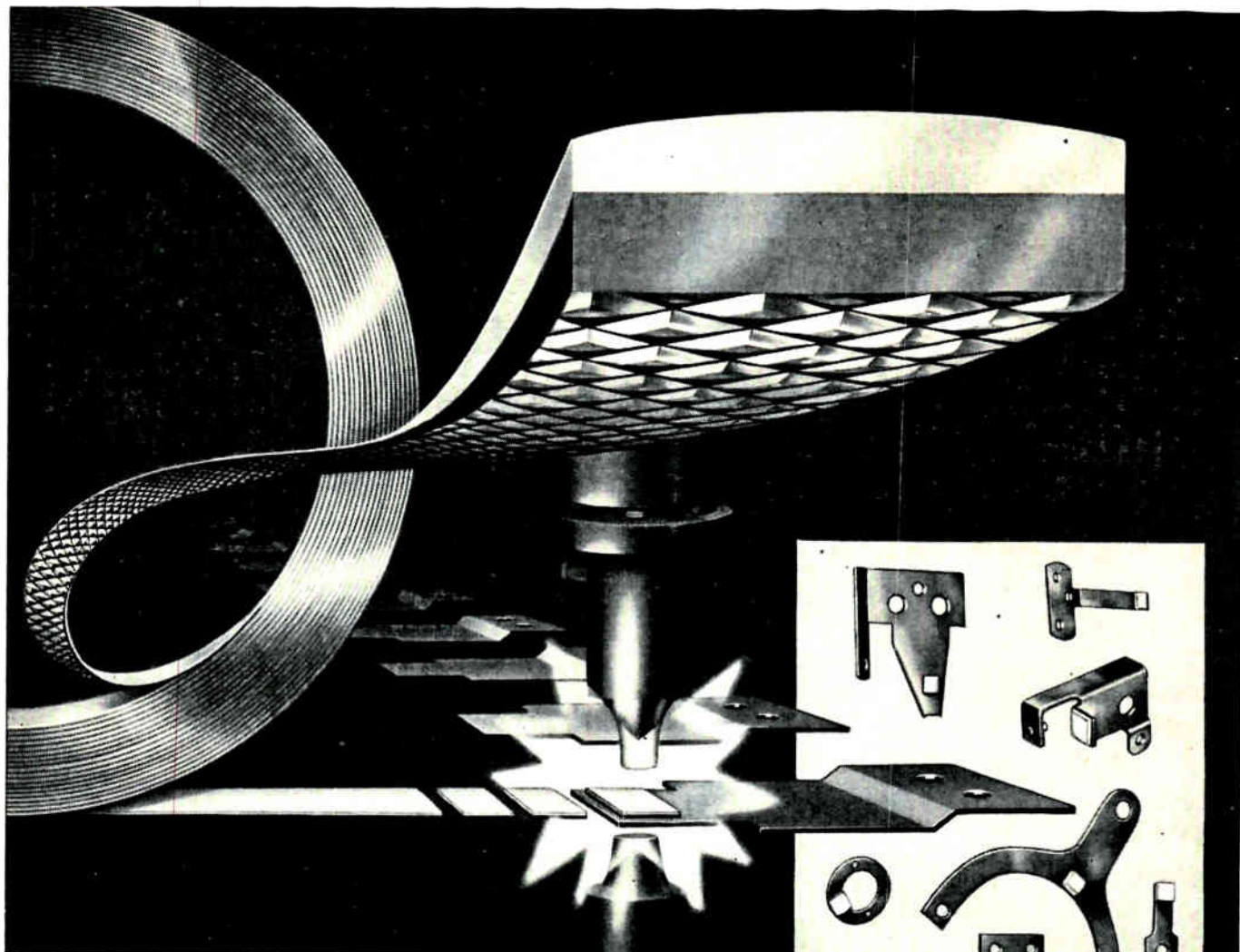
Cera-Mite Capacitors are now available in Formulation 40 from .001 to .02  $\mu$ F, 250, 500 and 1000 volts d-c. Engineering Data Sheets 6106 and 6120 list complete ratings and specifications.

Address literature requests to  
Technical Literature Section,  
Sprague Electric Company, 35  
Marshall St., North Adams,  
Massachusetts.

**SPRAGUE**<sup>®</sup>  
the mark of reliability

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





*Now with General Plate  
Electrical Contact Tape...*  
*You Can*  
**SAVE UP TO 40%**  
*On Contact Cost*

**In addition . . .  
Contact Tape permits:**

- Broader latitude in contact assembly design
- Smaller contacts for same electrical loads
- Weight-saving
- Simpler material handling

General Plate Electrical Contact Tape can be applied to any large-volume contact design, permitting the automatic assembly of two or more parts in a single operation.

Tape contacts are easily attached by spot welding methods. They are self-aligning . . . allow broader assembly tolerances. Because of this, tape contacts reduce assembly costs and eliminate or reduce adjustment time.

Tape contact material is supplied in long continuous lengths which simplify material handling.

In addition to supplying clad electrical contact tape material, General Plate is equipped to weld contact tape sub-assemblies for you.

Design engineers are invited to make use of General Plate contact engineering services . . . for material selection . . . parts design . . . samples.

Let us make an electrical contact cost analysis on products you want to automate. Find out how General Plate electrical contact tapes, as well as other clad contacts, can be put to work for you.

**METALS & CONTROLS**  
*General Plate Division*



**CORPORATION**  
1302 Forest St., Attleboro, Mass.

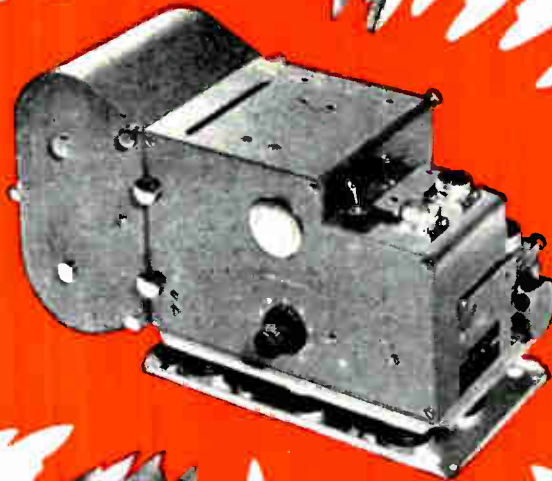
FIELD OFFICES: NEW YORK • CHICAGO • DETROIT • INDIANAPOLIS • MILWAUKEE • PASADENA



# TOTAL DESTRUCTION EXPECTED!

## YET RECORDS REMAIN INTACT

LET US TELL  
YOU THE  
DRAMATIC  
409 STORY



Century Oscillograph

Century can tell you of dramatic incidents where little has remained of either the vehicle or its instrumentation but complete accurate — permanent — reproducible test records have been salvaged from even totally mutilated 409 Century Oscillographs!

*Today's* 409 Series of Century Oscillographs Have Features Usually Only Found In Large Laboratory Units.

- 13 - lbs. weight — Size 12" x 6 - 15/16" x 5"
- Permanent - Reproducible High Contrast Record
- 12 Recording Channels
- Up to 40 hours continuous recording
- Easy Trace Identification
- Provision for remote operation



### CENTURY ELECTRONICS & INSTRUMENTS, INC.

1353 N. UTICA ● TULSA, OKLAHOMA



# Announcing **BEN-HAR** "1258"

**the most flexible Silicone Rubber Insulating  
Tubing ever developed . . . and the toughest**

Never before has there been an insulating tubing with the remarkable flexibility of Ben-Har "1258" Extruded Silicone Rubber Tubing . . . and it's actually less expensive than conventional Class H tubings and sleeveings, with higher rated temperature performance.

**300% more flexible than silicone varnished glass.**

**700% more flexible than Teflon.**

Ben-Har "1258" retains its flexibility after continuous service at 250°C. Equally serviceable at -85°C temperatures encountered in high altitude operation.

Ben-Har "1258" uses a new silicone rubber formula. It is highly resistant to abrasion and cut-through. It is especially designed for resistance to corona attack and harmful radiation effects.

Ben-Har "1258" conforms to wires and connections being covered. Its expandability assures snug fit and minimizes vibration.

Ben-Har "1258" is made by a new (patent pending) extrusion process which permits substantially more accurate dimensional control than required by ASTM — D — 922.

Available in standard wall thicknesses of .015" and .035" and in a complete range of colors. Special dimensions can be custom-engineered. Write for samples and data or ask to see a Bentley, Harris representative.



**BENTLEY, HARRIS  
FLEXIBLE SLEEVINGS**

**BENTLEY, HARRIS MANUFACTURING CO.**  
200 BARCLAY STREET  
CONSHOHOCKEN 4, PA. • Telephone, Norristown, Pa.: Taylor 8-7600



Receivers mounted on both fenders of tank during maneuvers amplify electromagnetic signals from mines. Cable carries signals to stopping mechanism in engine compartment, simulating a tank being destroyed during combat

## Electronic 'Mine' Halts Tank

War games device now undergoing tests employs a completely transistorized circuit

**ELECTRONICALLY-OPERATED** antitank mine simulator system developed by Army's Combat Operations Research Group is slated for extensive use in tests, training and maneuvers.

When a tank runs over a practice mine during maneuvers, the system puts the tank out of action temporarily, simulating a tank being destroyed by a real mine during combat.

System was developed and tested at Fort Monroe, Va., by civilian scientists of Technical Operations,

Inc., Burlington, Mass., and officers of Continental Army Command.

When tank runs over mine pressure plate, mine emits electromagnetic signal which is picked up by one of two receiver coils mounted on tank's belly. Signal is carried to receiver on tank fender, where it is amplified and carried by cable to stopping mechanism in engine compartment. Mechanical linkage actuated by receiver signal shifts tank transmission into neutral. Army says entire circuit is transistorized.

## Environmental Testing Expands

A NEW torture chamber for electronic equipment and components went to work at the U. S. Army's Environmental Test Division, Frankford Arsenal, Philadelphia.

The giant rain and sunshine chamber, duplicates practically every extreme and characteristic of rain and sunshine found in nature. Size of raindrops, their velocity, rainfall per square inch along with accompanying air temperature and wind velocity can be controlled. Sunshine can be varied from sunrise at the pole to

high noon on the equator.

Another new environmental chamber at the arsenal is a humidity and ozone test room which for the first time simulates the corrosive effect of ozone.

These units and other new environmental equipment recently installed at the arsenal add up to \$1½ million in value. The arsenal's test division has blossomed under growing military recognition of the importance of environmental testing. It now has \$5 million worth of testing equipment.

# need high vacuum components?



Stokes Series H Microvacs were designed by vacuum specialists . . . are industry engineered to meet your needs . . . give you more pumping capacity per dollar. The integral construction includes dynamic balancing, valves, motor, belt guard, and automatic lubrication—there are no extras to buy. A complete line of Microvacs include capacities from 17 to 500 cfm. For fast, efficient pump-down—you can depend on an Stokes Microvac Series H Pumps.

**S**TOKES makes a complete line of vacuum components . . . advance-designed and engineered to help make your vacuum systems more productive. Each unit reflects Stokes' unparalleled experience, pioneering leadership and wealth of basic vacuum technology.

The product list includes: Diffusion Pumps, Vapor Booster Pumps, Mechanical Pumps, Mechanical Booster Pumps, Vacuum Gages, and Valves.

Send for technical data on any or all . . . without obligation.

*High Vacuum Division*  
F. J. STOKES CORP.  
5565 Tabor Road, Phila. 20, Pa.

# STOKES

CIRCLE 42 READERS SERVICE CARD



A giant step has been taken in the U.S. military development program with contracts for the creation of an unprecedented primary strategic weapon system. It is the Air Force DYNA-SOAR, now in Phase-I design stage by a six-company project team under Martin direction.

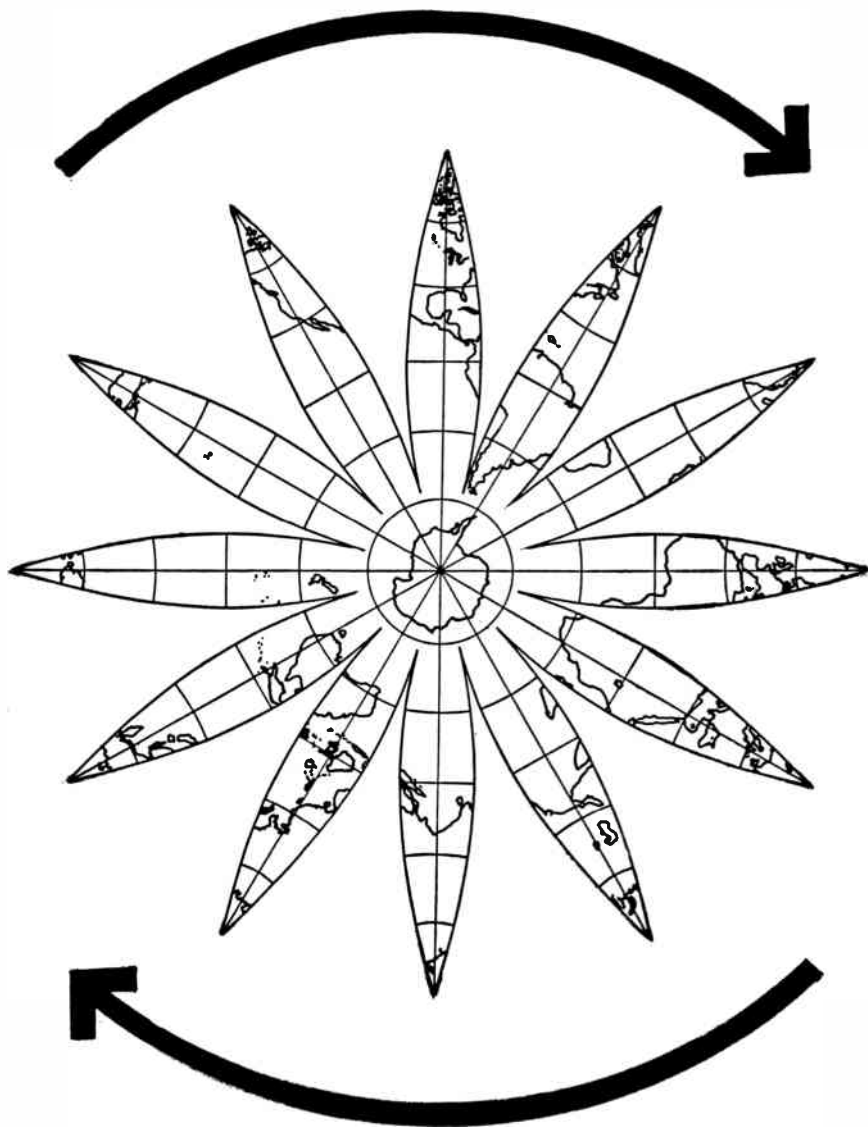
DYNA-SOAR—the most advanced military weapon system now in development—is a pilot-controlled bomber-reconnaissance space vehicle, its mission being to circle the earth at orbital velocity, with controlled aircraft landing capabilities. It will be propelled by several stages of rocket boosters, enabling it to operate from ground level to the ionosphere at hypersonic speeds.

In an entirely new and advanced concept of integrated industry coordination, the six companies teamed in this No. 1 military program constitute top capabilities in the basic areas of airframe, propulsion and radar guidance system development.

Bell, a pioneer in the boost-glide field, will design and build the airframe of the vehicle ...Bendix will develop communication, telemetry, hydraulic and electrical power conversion systems...Goodyear will produce the crew-escape capsule and the radar systems ...Minneapolis-Honeywell will be responsible for guidance and navigation to keep DYNA-SOAR on course and supply position and velocity information to the crew. American Machine & Foundry's responsibility is an advanced system of ground handling and launching equipment...And Martin will establish the configuration and design of the rocket boosters, carry out an experimental aerodynamic program for the complete vehicle, and assemble a full-scale mockup of the system.

Because of the challenging technical problems involved, the presidents of the six companies — aggregating assets of over \$2 billion — comprise an active advisory panel, with their top engineering teams participating.

Never before in military history has so formidable a task force of specialized industrial capabilities been applied against such an advanced concept.



**MARTIN**  
BALTIMORE · DENVER · ORLANDO

## MEETINGS AHEAD

- Feb. 1-6:** American Institute of Electrical Engineers, Winter General Meeting, Statler Hotel, N. Y. C.
- Feb. 12-13:** Transistor & Solid-State Circuit Conf., AIEE, PGCT of IRE, Univ. of Penn., Philadelphia.
- Feb. 12-13:** Electronics Conference, AIEE, IRE, ISA, CPS, Eng. Soc. Bldg., Cleveland.
- Feb. 16-20:** Western Audio Convention, Audio Eng. Soc., Biltmore Hotel, Los Angeles.
- Mar. 3-5:** Western Joint Computer Conf., AIEE, ACM, IRE, Fairmont Hotel, Los Angeles.
- Mar. 5-7:** Western Space Age Conf. and Exhibit, L. A. Chamber of Commerce, Great Western Exhibit Center, Los Angeles.
- Mar. 15-18:** National Assoc. of Broadcasters, Annual Convention, Conrad Hilton Hotel, Chicago.
- Mar. 23-25:** Flight Testing Conf., ARS, Daytona Beach, Fla.
- Mar. 23-26:** Institute of Radio Engineers, IRE National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.
- Mar. 31-Apr. 2:** Millimeter Waves Symposium, Polytechnic Inst. of Brooklyn, USAF, ONR, IRE, USA Signal Research, Engineering Societies Bldg., N. Y. C.
- Apr. 5-10:** Nuclear Congress, sponsored by over 25 major engineering and scientific societies, Public Auditorium, Cleveland.
- Apr. 6-9:** British Radio and Electronic Components Show, Great Hall, Grosvenor House, Park Lane, London, W.I.
- Apr. 13-15:** Protective Relay Conf., A & M College of Texas, College Station, Tex.
- Apr. 14-15:** Industrial Instrumentation & Control Conf., PGIE of IRE, Armour Research Foundation, Illinois Inst. of Tech., Chicago.
- Apr. 16-18:** Southwestern IRE Conf. and Electronics Show, SWIRECO, Dallas Memorial Auditorium & Baker Hotel, Dallas.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 74.

# He's getting results...

## WITH THE NEW BRUSH RECORDER MARK II

So can you. The versatile Mark II is an integrated oscillograph package—a readout tool for engineers and technicians everywhere . . . in the shop . . . in the lab . . . or in the field.

*Just plug it in . . . put it to writing . . . anywhere.*

### PERFORMANCE SPECIFICATIONS

**Recordings**—Uniform, crisp, easily reproduced. Trouble-free ink writing on precision chart paper.

**Channels**—Two analog, plus two event markers.

**Sensitivity**—Maximum of 10 mv/chart line (mm); range, 10 mv to 400 v.

**Input**—Differential; impedance 5 megs each side to ground.

**Frequency Response**—D.C. to 100 cps.

Write for free booklet 2521A for complete specifications. Immediately available from stock. Price \$1350.



**brush** INSTRUMENTS  
DIVISION OF

37TH AND PERKINS

**CLEVITE**  
CORPORATION

CLEVELAND 14, OHIO



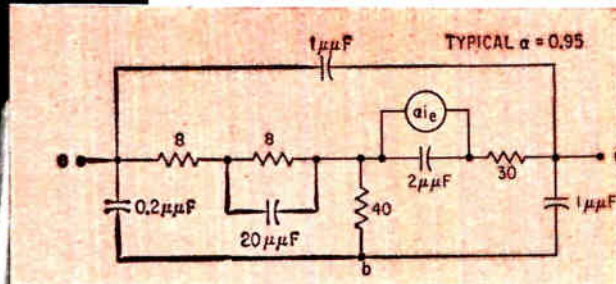
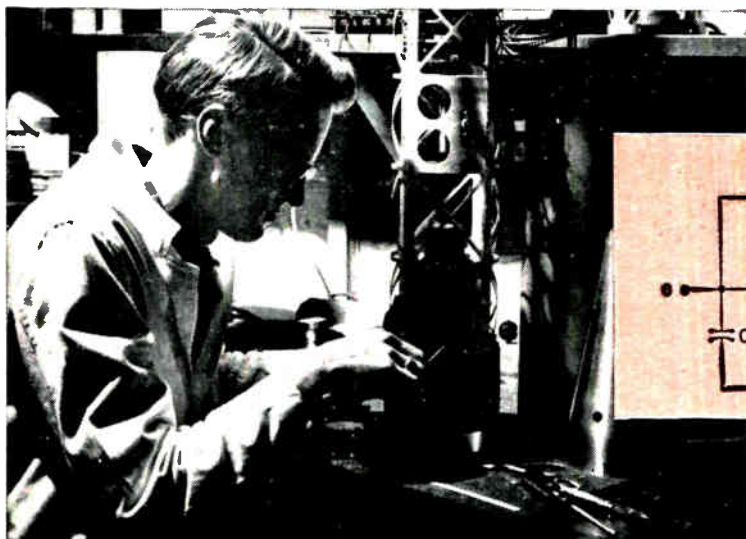


FIG. 1—Installing electronic instrumentation inside lattice sleeve prior to insertion inside satellite (left), and equivalent circuit of transistor used (right)

## Instrumenting the Explorer I Satellite

Design philosophy employed prior to successful launching of the Explorer I satellite was to achieve maximum reliability within the predicted environment. Here are the results of design decisions based on estimated effects

By HENRY L. RICHTER, Jr., WILLIAM PILKINGTON, JOHN P. EYRAUD,  
WILLIAM S. SHIPLEY and LEE W. RANDOLPH,

Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Cal.

RESEARCH LEADING to the instrumenting of the Explorer I satellite (1958 Alpha) ranged from consideration of the basic physics which determines the environment of a satellite to the final environmental testing of the entire satellite itself. A philosophy of instrumentation of minimal-weight satellites was evolved and will be set forth in the matériel that follows.

Several of the characteristics of the payload were determined by the characteristics of the launching vehicle. The allowable weight of the payload section (including all structure forward of the fourth-stage motor case) was set at under 20 lb. The physical dimensions of this section were indicated by the vehicle configuration; the spin stabilizing of the high-speed stages imposed an addi-

tional restraint on the design of the payload.

The desire to provide a maximum operating life of the payload along with the transmission of sufficient data to insure the success of the experiment led to the development of the Microlock<sup>1</sup> communications system.

**OBJECTIVES**—Concisely stated, the objectives met in equipment design were high reliability, sufficient receiver sensitivity consistent with minimum power levels to insure continuous tracking, development of telemetry techniques to insure wide geographical coverage and maximum lifetime, and the application of methods to keep the information bandwidth to a minimum.

Two completely independent radio transmitters

are used in the Explorer, each with its own power supply and antenna. This arrangement provides reliability in the form of redundancy. One transmitter operated at 108.03 mc with an output of 60 mw. The low-power unit operated at 108 mc at 10 mw.

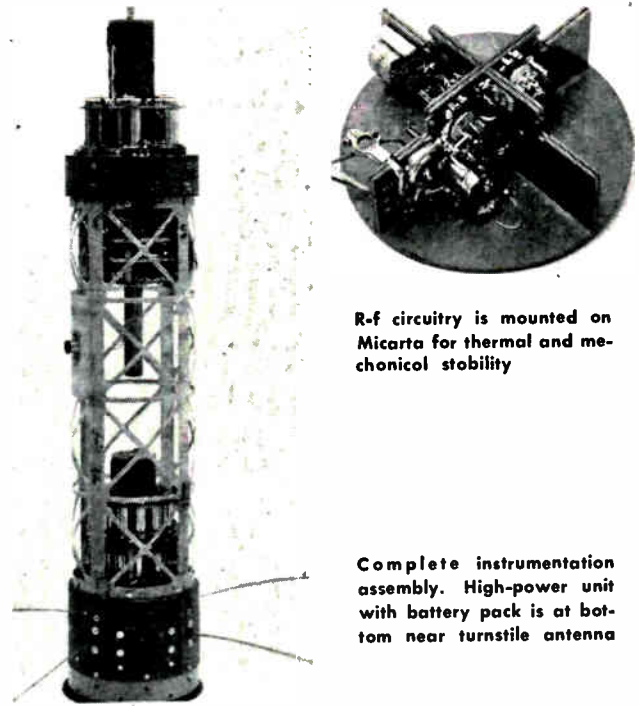
The high-power unit, using amplitude modulation, insured the recording of telemetry signals by nonprofessional equipment all over the earth. Because of the higher power, this transmitter operated for only a 2-week period. The 10-mw transmitter provided tracking data for two months, which was the calculated operating lifetime of this unit. Small-deviation phase modulation, which is compatible with the low power level, was used as the telemetry system.

**TRANSMITTERS**—In Explorer I there were two similar transmitters, each one separate and self-sufficient. They were not interconnected in any way except through radiative couplings between two separate antennas and through the sharing of an input to one telemetering channel.

The 10-mw unit was heard continuously for as long as 35 min during a pass (near apogee). This probably established a distance record for such a low-power transmitter, as the satellite traveled approximately 10,000 miles in 35 min and was a minimum of 5,000 miles from the receiver at the most distant point.

Transistors used in these units are a selected version of the WE 53194 which itself is a version of the original BTL 2039 transistor. The 2039 is a germanium diffused-base transistor with excellent characteristics for high-frequency operation. The use of these transistors in the r-f circuitry of the Explorer satellite made it possible to have an overall efficiency of better than 25 percent including power used by the oscillator, doubler buffer, and modulator. This does not include the power used by the cosmic-ray package.

An equivalent circuit for the 2039-type transistor is shown in Fig. 1. It can be seen that the output impedance of this transistor is low at frequencies



R-f circuitry is mounted on Micarta for thermal and mechanical stability

Complete instrumentation assembly. High-power unit with battery pack is at bottom near turnstile antenna

of the order of 100 mc and that at these frequencies the input impedance is also low in the grounded-base configuration. Both qualities are advantageous for low-voltage, low-power oscillators and amplifiers. It is difficult to obtain reasonable efficiencies at the low powers desired in beacons of this sort using vacuum tubes.

**BLOCK DIAGRAM**—Figure 2 shows a block diagram of both transmitters. Figure 2A shows the low-power transmitter which consists of a 54-mc crystal-controlled oscillator with a modulator producing phase modulation at 54 mc. A second r-f stage acts as a doubler and buffer amplifier with a total output of approximately 10 mw. This output is phase-modulated with four channels of telemetry to approximately 14-deg phase deviation per channel. The output from this transmitter is radiated

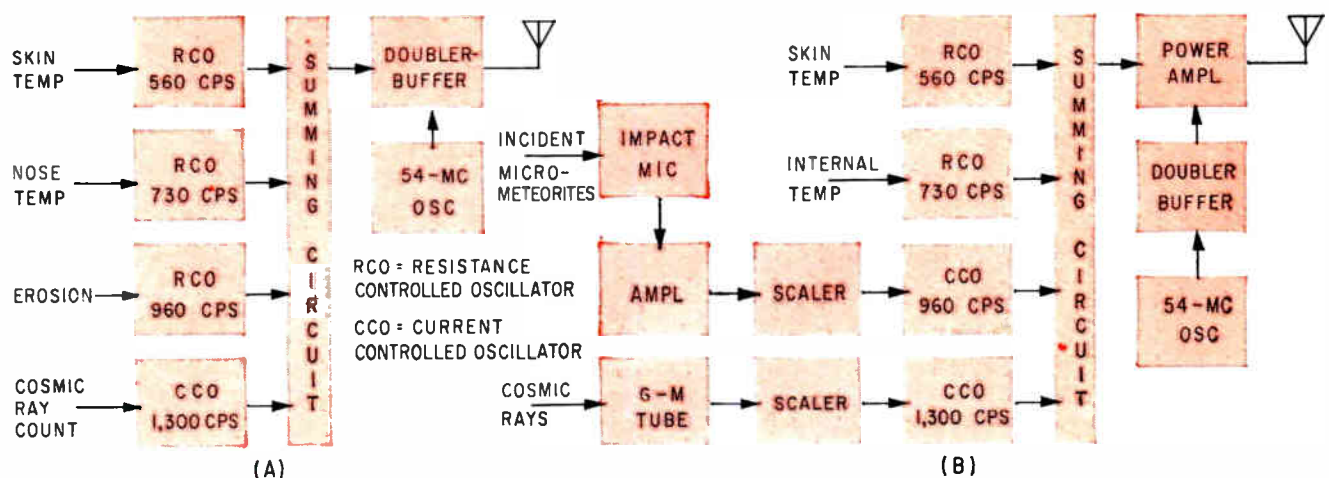


FIG. 2—Block diagram of the telemetry transmitters. The phase modulated low-power unit (A) operates at 108 mc. Amplitude-modulated high-power unit has output of 60 mw at 108.03 mc

by an unsymmetrical dipole antenna produced by electrically separating the nose cone of the vehicle from the shell and driving the nose cone against the shell as a dipole. The pattern of such an antenna is similar to that of a dipole, but with the main lobes bent slightly to the rear of the vehicle.

The high-power transmitter of Fig. 2B is similar. The battery pack supplies a slightly higher voltage; the oscillator generates 54.015 mc and is not modulated as is the low-power transmitter. The second transistor acts as a doubler and buffer. Amplitude modulation is produced by varying the voltage applied to the collector of the doubler-buffer transistor. The r-f power output with modulation applied is approximately linear from 20 to approximately 5 v.

**ANTENNA**—Output of this transmitter goes through an antenna phasing and matching network into a turnstile antenna which is made up of four whip antennas. These antennas are perpendicular to and spaced at 90-deg intervals about the body of the missile, forming a circularly polarized antenna pattern.

Figure 3A shows a schematic diagram of the low-power transmitter. The transmitter is powered by a series of six mercury batteries from which it draws approximately 5 ma current at about 8 v d-c. Crystal-controlled oscillator  $Q_1$  uses a WE 53194 transistor and oscillates at 54 mc. The oscillator is a grounded-base type with feedback from a small turn on the tank coil through capacitor  $C_1$  to the fifth-harmonic 54-mc crystal. Inductor  $L_1$  is wound on resistor  $R_1$  and placed in parallel with the crystal. The inductor resonates the capacitance of the crystal.

**PHASE MODULATION**—In Fig. 3A resistor  $R_2$  stabilizes the feedback loop by reducing the effect of transistor input impedance changes. Capacitor  $C_2$  is used as a d-c blocking capacitor in the feedback circuit.

Phase modulation is produced by varying the voltage applied to the collector of oscillator  $Q_1$ . One side of the tank is bypassed through capacitor  $C_3$  which effectively grounds that side to r-f but allows the a-f sum voltage from the telemetry oscillators to be applied in series with the d-c supply. The collector of a transistor of this type is equivalent to a back-biased diode and has a capacitance which is voltage-dependent; thus, the voltage applied to the tank circuit produces a proportional variation in the tank tuning. This produces in the stable crystal-controlled oscillator a small-angle phase modulation.

A tap on the battery supply brought to the base of the transistor with resistor  $R_3$  in the emitter circuit provides fixed bias. There is some loss of efficiency with this type of bias but it has a high degree of stability.

**CONVERSION**—Output from the oscillator is coupled by a small turn around the tank coil at fairly low impedance to the emitter of doubler-

buffer  $Q_2$ . The output desired is a 108-mc signal. It is also desirable to have the conversion as efficient as possible, which calls for approximately class-C operation.

For maximum efficiency, the angle of conduction in the emitter of  $Q_2$  must be fairly small producing short pulses at a 54-mc rate. The amplified pulses appear as 108-mc energy in the resonant tank circuit. Bias for the doubler-amplifier is provided by r-f from the oscillator across resistor  $R_4$ .

An antenna-matching network is used between the 50-ohm output connector and the nonsymmetrical dipole from which the power is radiated into space.

**HIGH-POWER TRANSMITTER**—R-f circuitry of the 60-mw transmitter is shown in Fig. 3B. Oscil-

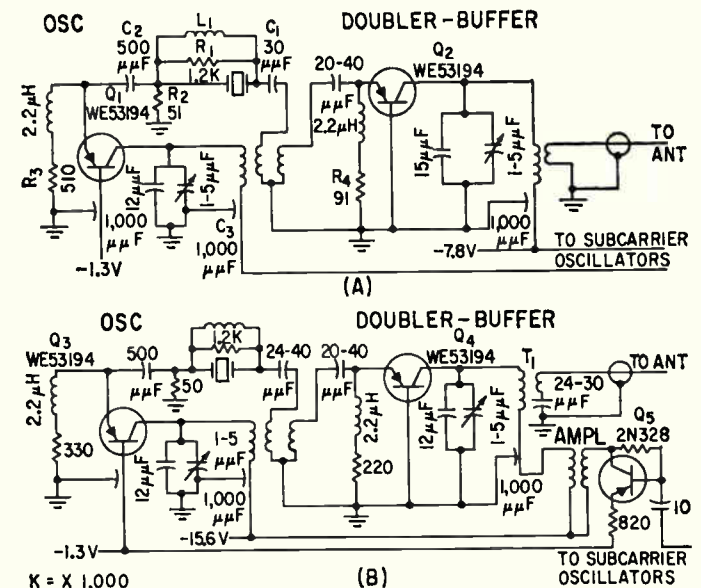


FIG. 3—In (A), phase modulation of the r-f unit is achieved by utilizing voltage-dependent capacitance of  $Q_1$  collector. In (B) amplitude modulation is accomplished conventionally

lator  $Q_3$  is almost identical to the low-power version. This unit does not have phase modulation applied in the manner described for the low-power beacon, but power from the oscillator  $Q_3$  is coupled into an amplifier-doubler stage  $Q_4$  and the modulation applied at the collector of the doubler in a manner similar to plate modulation of a vacuum tube.

Because of the resistance of the transformer  $T_1$ , the 15-v battery voltage is dropped to approximately 14 v at the collector of buffer  $Q_4$ . To this is added an audio voltage of approximately 8-v peak which produces about 50 percent amplitude modulation of the carrier.

Output of this transmitter is coupled through a matching system consisting of lengths of miniature 50-ohm cable, cut to produce approximately 90-deg phase rotation from each antenna to the next. Actually, the circular pattern was designed to have



some elasticity so that spin could easily be measured from the r-f signal-strength records of the ground receivers.

**AMPLITUDE MODULATION**—Amplitude modulation of the high-power beacon is accompanied by some phase modulation which is convenient for telemetry when using phase-locked receivers.

The basic structural material used to support the electronic components was micarta because it is a good thermal insulator with excellent mechanical properties.

A thermal time constant of several hours was desired for the internal electronics so that external temperature extremes would not cause malfunctions. All the electronics including batteries were thermally connected to produce the longest reasonable time constant.

The telemetering subcarrier oscillators incorporated in the Explorer I satellite are of two basic design configurations. One type is a resistance-controlled oscillator (rco) wherein the subcarrier frequency varies as a function of the change in input resistance. The second type is a current-controlled oscillator (cco) whose frequency is varied by a change in input current.

The telemetry channels used are 2, 3, 4, and 5, whose frequency ranges are 518-602, 675-785, 888-1,032, and 1,202-1,398 cps, respectively.

The two telemetering systems are completely self-contained in that each system has its own power supply consisting of 4 mercury-cell batteries. The total power consumption for each system is approximately 2.5 mw. The telemetry systems for the two transmitters are arranged as indicated in Table I.

For phase modulation of the low-power trans-



At left, engineer prepares part of instrument package for shake table test. During power phase of launching period, payload was exposed to a force of approximately 100 gravities. At right, assembled payload is lowered onto fourth-stage rocket motor, the culmination of 80 days of intensive effort

mitter the low-impedance winding on each subcarrier-oscillator transformer is connected in series to form the modulation transformer.

The amplitude-modulated high-power transmitter requires only the addition of a class-A amplifier-modulator stage in the transmitter section. The telemetering system utilizes the same low-impedance output windings as in the low-power transmitter but is capacitively coupled to the class-A amplifier.

**RESISTANCE-CONTROL**—The type of resistance-controlled oscillator used in Explorer I is shown in Fig. 4A. The simplicity of the circuit and operation made this oscillator configuration most advantageous.

The frequency limit of this circuit is related directly to the tuning capacitance ratio of  $C_1$  and  $C_2$ . For the case of a high  $C_1/C_2$  ratio, the frequency deviation obtainable is limited to less than the  $\pm 7.5$  percent necessary in telemetering subcarrier channels. In the case of a low  $C_1/C_2$  ratio, the Q of the tuned circuit drops to an impractical value. Actual limits are approximately  $1 \leq C_1/C_2 \leq 3$ . When used with telemetering subcarrier oscillators, a  $C_1/C_2$  ratio of 1.5 is about optimum.

**CURRENT-CONTROL**—The typical current-controlled oscillator shown in Fig. 4B uses a relatively new method<sup>2</sup> for controlling oscillator frequency: time-controlled reactance modulation.

This method is made possible by the characteristics of the transistor. The operating frequency of a conventional L-C oscillator can be altered by introducing an alternating current that is of the same frequency but is 90 deg out of phase with the oscillator voltage. The frequency shift thus produced is proportional to the amount of additional current introduced into the tuned circuit.

Oscillator frequency shift can be obtained using a transistor employed as a time-controlled reactance modulator. The portion of the cycle during which this reactive current is introduced can be

### WHAT EXPLORER I REVEALED

Temperatures on various parts of the satellite shell ranged between  $-25$  and  $75^\circ\text{C}$ ; temperatures inside the cylindrical section ranged from  $0$  to  $35^\circ\text{C}$ ; nose cone temperature varied from  $5$  to  $40^\circ\text{C}$ .

Data from the high-power transmitter indicated 38 impacts from micrometeorites were detected. The average influx of particles 4 microns or larger in diameter was therefore approximately  $0.02$  particles/sq m/sec averaged over the time period of January 31 to February 12. The low-power unit indicated that no more than one and possibly none of the wire gauges was broken on the grid-type micrometeorite detector. This information permits an upper limit to be established for the influx of particles 10 microns or more in diameter. This limit is  $0.001$  particles/sq m/sec from January 31 to April 14.

At altitudes below 1,000 km the radiation detection gear indicated a cosmic-ray intensity in general agreement with results from balloons and high-altitude rockets. However above this altitude a suddenly anomalous behaviour of the circuitry was encountered.

It is believed that at altitudes above 1,000 km, for regions between  $30^\circ\text{N}$  and  $30^\circ\text{S}$  latitude, there is an intense field of low energy electrons. On impact with the satellite shell, these electrons with energies ranging from about 50 to 90 kev produce x-radiation, resulting in an indicated count 1,000 times greater than that expected from primary cosmic radiation alone.

**Table 1—Explorer Telemetry System**

Channel	Measurement	Subcarrier Type	
		10 mw	60 mw
2	Skin Temp.	rco	rco
3	Nose Cone Temp.	rco	rco
4	Meteorite Impact	rco	—
4	Meteorite Count	—	cco
5	Cosmic Ray Count	cco	cco

controlled by d-c current introduced into the control transistor. By this new method, frequency modulation is achieved with minimum dependence upon temperature-sensitive parameters.

**TESTING AND CALIBRATION**—Environmental test specifications for the Explorer satellite prescribed two complete testing procedures: flight-acceptance and type-approval tests. Flight-acceptance tests, applied to all units prepared for flight, including spares, were designed to subject the units to an environment simulating that encountered in flight. The type-approval tests, applied to a sample payload, were designed to verify that the payload design was capable of surviving an environment more severe than that expected, as well as surviving the flight-acceptance test and then the flight.

The use of 100-percent flight-acceptance testing in the Explorer program, in preference to any sampling or test-to-failure plan, was dictated by the complete lack of statistical information concerning the reliability of the units and by the high reliability desired. Furthermore, flight-acceptance

testing was the only conceivable technique which would provide assurance that custom-made r-f transmitters, such as the Microlock beacons, would provide satisfactory signals for low-power reception while subjected to the severe environmental conditions expected in the launch and orbiting phases of the Explorer's operating life.

Basically the program was broken into two parts: thorough and accurate calibration of the telemetering equipment; and testing to assure that the equipment not only performed satisfactorily over the expected temperature environment but also during the initial launch-phase environment.

**MICROMETEORITES**—Two types of micrometeorite detectors are used in Explorer I: a parallel combination of twelve wire-grid detectors; and an impact microphone and its associated amplifier.

In the grid type, a severed wire in one of the grid structures caused by a micrometeorite of sufficient size and velocity produces a small step increase in resistance. This change of resistance, when sensed by the rco, results in a step increase in subcarrier frequency. To assure accuracy, a flight erosion gauge with a multiple-switching network is used for calibration.

Frequency against temperature data for the impact microphone is obtained by subjecting both the beacon and the microphone equipment to the applied temperature. Thus, if the scaler output voltage varied with temperature, it is automatically included in the frequency calibration.

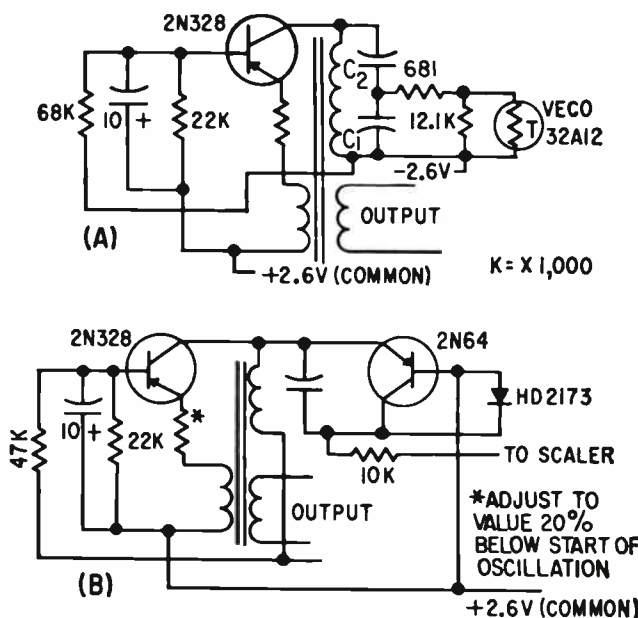
**PARTICLE MASS**—Determination of microphone sensitivity is made by dropping glass beads of known size and density on the satellite shell from various heights. Knowing the height necessary to actuate the scaler and the size of the glass bead, the required momentum averaged over the entire shell was found to be 0.012 gm-cm/sec. Therefore, if a velocity of 40 km/sec is assumed for a micrometeorite, the minimum detectable particle mass is found to be  $3 \times 10^{-9}$  gm.

The second phase of the testing program consisted of subjecting the payload to an environment similar to that expected during flight. The remainder of the environmental testing was carried out in the following order: noise vibration to simulate the firing of the fourth-stage motor; centrifuge test to simulate the linear acceleration due to the firing of the fourth-stage motor; spin test at 750 rpm; and altitude test to check out the high-voltage circuitry.

**PERFORMANCE**—The performance of the payload during environmental testing proved to be extremely satisfactory. The only major problem encountered was in the altitude test. It was found necessary to provide more adequate high-voltage breakdown protection.

**REFERENCES**

- (1) H. L. Richter, Jr., W. F. Sampson, and R. Stevens, Microlock: A Minimum-Weight Radio Instrumentation System for a Satellite, to be published in *Jet Propulsion*.
- (2) F. M. Riddle, Patent No. 2,728,049, assigned to California Institute of Technology.



**FIG. 4—Schematics of typical subcarrier oscillators. (A) is resistance-controlled type; (B) is current-controlled**

# Magnetic Drum Provides

Drum recording system developed to make analog simulations in designing continuous-processing system provides time delay. Precision of 0.1 percent between recorded and played-back low-frequency analog voltages is exceeded in highly stable system applicable also to tape

By H. L. DANIELS and D. K. SAMPSON, Remington Rand Univac, Division of Sperry Rand Corp., St. Paul, Minn.

**P**RECISION of 0.1 percent in a magnetic-recording system was required for analog simulation of transport delays in designing a continuous-processing system. A relatively uncomplicated recording technique is described that achieves such precision with a high degree of stability.

A typical transport delay is the temperature-time function of a fluid flowing at a variable rate through a long insulated pipe. The delay is the time displacement of the temperature function between points of intake and discharge.

Continuously variable delay was required over a wide range without interruption or degradation of the function. This requirement made conventional electrical delay lines unfeasible.

The application required delays of 5 to 20 sec for analog signals ranging between  $-50$  and  $+50$  volts. Accuracy within 0.1 percent was specified for frequency components from zero to one cps. Gradual degradation of accuracy was allowable above one cps, with response signal not down more than 3 db at 30 cps.

Noncontact magnetic recording on the surface of a rotating drum was selected as the basic delay mechanism because of its freedom from considerations of head and surface wear. Control of delay could be provided by adjustment of rotational speed or of angular displacement between recording and playback stations.

The magnetic record form in Fig. 1A is a plot of the analog signal using a transversely magnetized line on the surface of a strip-form recording medium. The time axis is represented by coordinates along the length, and instantaneous values are represented by coordinates across the strip.

## Playback Principle

The playback method in Fig. 1A uses a conventional but thin ring-form playback head that crosses the record at constant velocity. Its gap remains parallel to the direction of motion of the medium and perpendicular to the direction of magnetization of the recorded line.

Time between  $T_1$  of crossing a fixed reference line and  $T_2$  of crossing the recorded function line is translated into a proportional volt-

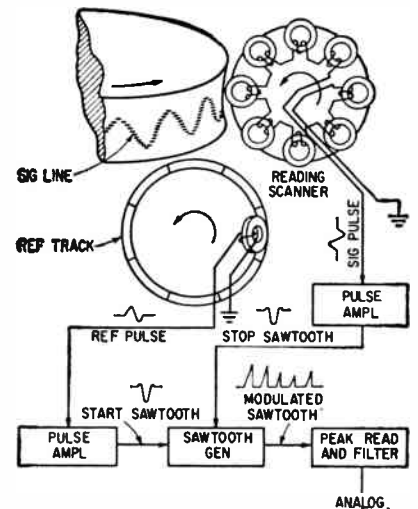


FIG. 2—Block diagram shows how reference and signal pulses initiate and stop sawtooth generator

age, as shown in Fig. 1B. A linearly rising voltage is initiated at  $T_1$  and abruptly returned to zero at  $T_2$ .

If the record is scanned at a rate sufficiently high relative to the velocity of the medium, the composite of the peaks of the resulting modulated sawtooth becomes the desired electrical playback.

The playback head, shown in Fig. 2, comprises a rotating structure carrying eight ring-form heads with their gaps uniformly spaced around a cylindrical surface. The series-connected coils are connected to the electronic circuits through slip rings.

The peripheral spacing between gaps is made at least equal to the active width of the recording medium to avoid ambiguity. The surface of the recording medium is

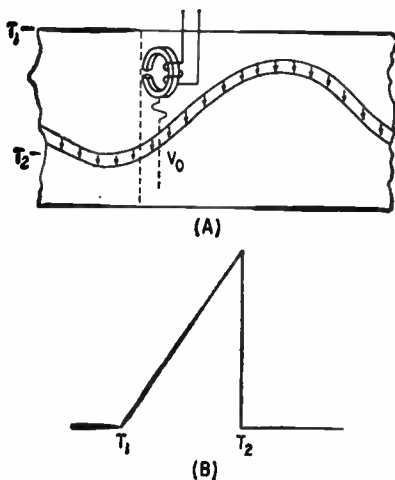


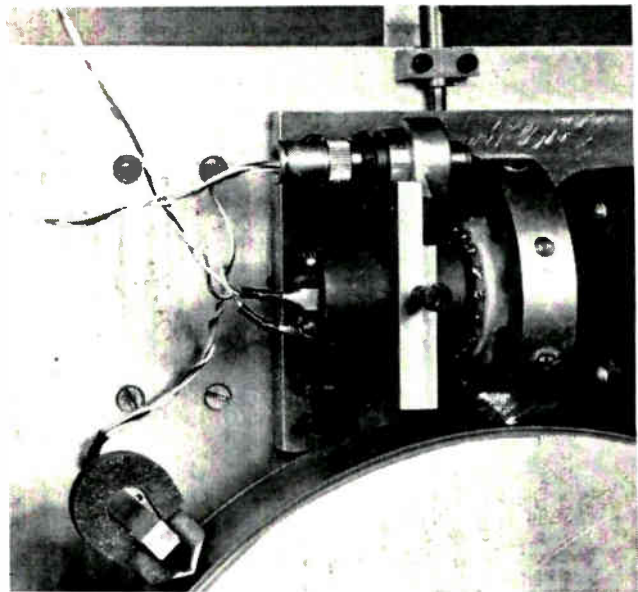
FIG. 1—Magnetized line at (A) is plot of analog voltage. Sawtooth at (B) is initiated when head crosses reference line and ended when head crosses analog



# Analog Time Delay



Adjustment of two potentiometers is required to zero system. Because there is little interaction between the two settings, system can be adjusted with one repetition of the two steps



Permanent magnet at left erases drum before it rotates to recording scanner. Curvature of drum assures that recording gaps are at constant distance from drum

curved to maintain constant spacing to the gaps.

A rotating reference track of magnetic oxide has a permanent recorded pulse for each active gap. A fixed playback head reads this track to supply reference pulses, which are generated just before

each rotating head enters the active area of the medium.

## Recording Principle

The recording arrangement shown in Fig. 3 is substantially a reversal of the playback method. The analog voltage and the sawtooth are fed to a voltage comparator. At the instant they are equal, the comparator generates a write signal that initiates a pulse of current in the head and records a mark on the medium. A series of these marks represent, by their composite pattern, the wave form of the input voltage.

The powdered-iron transfers shown in Fig. 4 were made from several actual recordings. They were obtained by dusting the surface of the medium with finely divided iron powder and transferring the powder adhering to the magnetic discontinuities of the medium to pressure-sensitive cellophane tape.

In the prototype equipment, the medium was erased by a longitudinally saturating d-c wipe prior to recording. The resulting magnetic discontinuity formed between the uniformly saturated area and

the transversely magnetized line is readily readable with adequate resolution.

## Inherent Errors

One source of error inherent in the system involves the relative velocities of the medium and the transverse scanning gaps. If the medium velocity is  $v_m$  and the gap velocity is  $v_g$ , the crossing line of the gap is inclined at an angle  $\tan^{-1}(v_g/v_m)$  to the longitudinal axis of the medium. This source of difficulty is eliminated by making the ratio  $v_g/v_m$  in playback equal to that in recording.

Another source of distortion stems from the effective dimension of the gap across the head and normal to the direction of scan. Even if gap width were reduced to zero, the gap would have an effective dimension along the length of the medium of perhaps 15 to 20 mils under noncontact conditions.

The result of this type distortion is shown in Fig. 5. It vanishes when the recorded line is parallel to the axis of the medium and becomes increasingly serious with increasing inclination of the line.

Two types of deterioration may

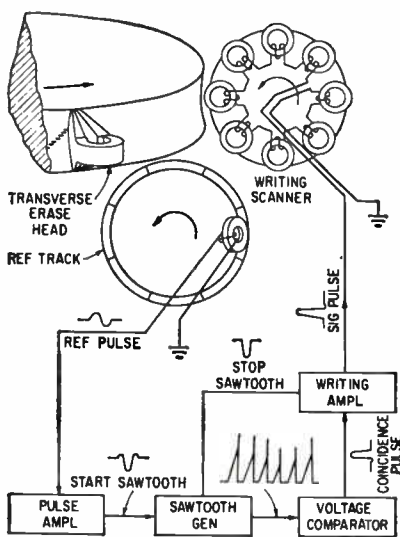


FIG. 3—Recording system is similar to playback system. When sawtooth reaches analog value, a write pulse is delivered to writing scanner



FIG. 4—Powdered-iron transfers were made from actual recordings. Composite of individual marks is analogous to input

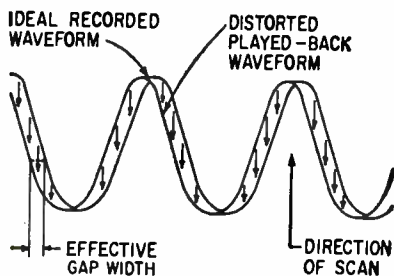


FIG. 5—Distortion resulting from limitations in resolving ability of head are aggravated with increased inclination of recorded mark

be caused by the continuous-line recording of a series of discrete marks. One involves a relationship between medium velocity, scanning rate and effective width of recording and playback gaps such that successive marks overlap along the axis of the medium, as in Fig. 4. The other involves having the marks physically separated longitudinally.

Longitudinal overlap yields non-harmonic distortion in a manner similar to that shown in Fig. 5. Longitudinal separation, on the other hand, is entirely free from such distortion provided playback scanning is so synchronized that the scanning gaps are properly centered on the recorded marks.

### Prototype Construction

The reading and recording scanners are mounted so that the gaps of the two units are separated by 180 degrees of arc around the aluminum drum. The drum can be driven either synchronously or with controlled variable speed. Drum and scanners are mounted on a normalized cast-aluminum base. The scan-

ners are adjusted so that spacing between gaps of the read-record heads and the medium are between 0.0015 and 0.002 in.

The scanner disk is mounted directly on the shaft of a 3,600-rpm hysteresis synchronous motor. The heads were roughly positioned radially in fabrication with set-screws. They are held in place permanently after wiring by embedment in a resin whose thermal expansion coefficient approximates that of the aluminum disk.

Longitudinal erase is achieved with a permanent magnet with properly shaped pole pieces.

### Generation of Reference Pulses

A single line of pulses is written on the drum by rotating the drum with the scanner stationary, as shown in Fig. 6. One read-record head is energized and its gap positioned near the edge of the drum. The drum is then stopped and each scanner is rotated.

The played-back and amplified pulse from each scanner is used to trigger a writing circuit connected to its reference head. Thus pulses are permanently written on the reference track at the exact spacing of the read-record heads.

Two sawtooth-control flip-flops such as shown in Fig. 7 are used, one for the recording and the other for the reading sawtooth generator. When flip-flop output is negative with respect to the reference voltage shown as zero set in Fig. 7B, sawtooth output is dropped through the diode gate to the reference voltage. A start-sawtooth pulse

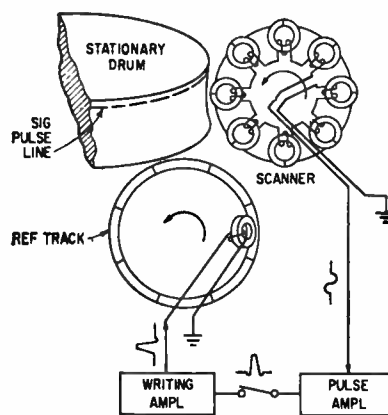


FIG. 6—Using this arrangement, reference pulses are recorded so that sawtooth is initiated just as gaps reach active area of drum

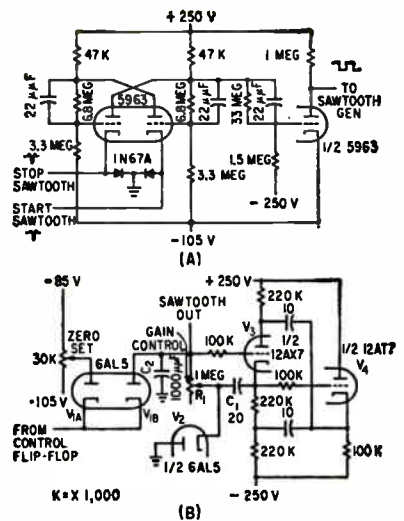


FIG. 7—Negative output from flip-flop at (A) returns sawtooth output at (B) to reference level established by zero-set potentiometer. Positive flip-flop output permits sawtooth voltage to rise

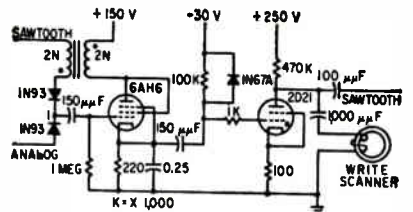


FIG. 8—When sawtooth amplitude reaches analog level, blocking oscillator causes thyatron to fire

makes flip-flop output positive. Voltage at the sawtooth output in Fig. 7B begins to rise toward ground potential.

### Sawtooth Output

Sawtooth output is returned to reference level by switching the flip-flop back with a writing or a played-back signal pulse.

Extreme linearity of the sawtooth circuit is obtained by the reflexing arrangement shown in Fig. 7B. When sawtooth output is clamped to the reference voltage because of negative output from the flip-flop, voltage at the left of C<sub>1</sub> is returned to ground through the 6AL5 clamp.

At the right of C<sub>1</sub>, voltage is essentially that appearing at the cathode of V<sub>2</sub>. When output voltage is allowed to rise, the cathode voltage of V<sub>2</sub> follows closely. Because C<sub>1</sub> is large, the drop across R<sub>1</sub> is maintained nearly constant. This ensures a linearly rising voltage at the sawtooth output.



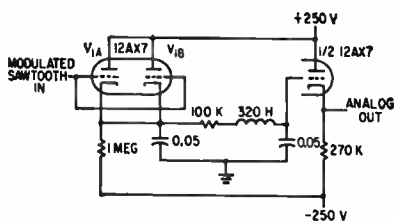


FIG. 9—Peak-reading circuit recovers analog voltage from modulated sawtooth

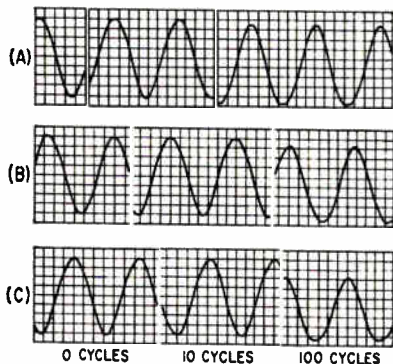


FIG. 10—Oscillograms show effects when sine wave is recorded and played back 0, 10 and 100 times. Plot at (A) was made immediately after zeroing, and plots at (B) and (C) were made at succeeding one-hour intervals without further adjustment

Measured linearities of such a circuit have been within 0.05 percent.

### Adjustment

Gain control is achieved with a slope control on one sawtooth generator. Zero set is obtained by variation of the reference voltage of one sawtooth generator.

Zeroing the system and adjusting for unity gain requires adjusting two potentiometers. First, a  $-50$ -v signal is recorded and the zero-set potentiometer turned until a zero-center microammeter connected directly between input and output indicates balance. Then a  $+50$ -v signal is recorded and the gain-control potentiometer turned until the meter is again centered. Because

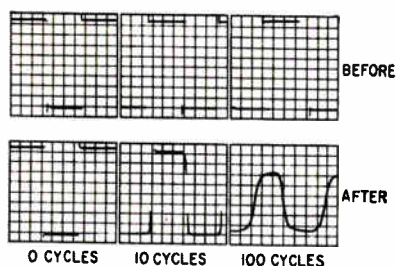


FIG. 11—Oscillograms show square waves before and after recirculation

there is little interaction between the two settings, the system can be adjusted by one repetition of the two steps.

The voltage comparator shown in Fig. 8 is similar to the multiar circuit. When amplitude of the sawtooth exceeds analog voltage, the positive feedback loop of a blocking oscillator is completed through a conducting diode. The blocking oscillator conducts, triggering a thyatron writing circuit.

### Peak-Reading Circuit

The peak-reading and filter circuit used to recover the analog waveform from a modulated sawtooth is shown in Fig. 9. Charging current for the  $0.05$ - $\mu$ f capacitor in the cathode circuit of  $V_{1A}$  exists when instantaneous voltage of the modulated sawtooth appearing at the grid exceeds cutoff, as referenced to the instantaneous voltage of the recovered analog appearing at the cathode. When cutoff does exist, the capacitor discharges through the one-megohm resistor. Discharge rate is equal to the maximum rate of change of voltage for the highest possible analog frequency.

A conventional RLC filter follows the peak-reading circuit.

Desired performance of the recorder is a condition in which overall gain is exactly unity, a-c signal variations of the input are exactly reproduced at the output and there is no d-c voltage shift between input and output.

Because departures from ideal performance under continuous record-playback operation were too small to measure, a recirculation technique was adopted. Output was connected directly to input after a function had been initially recorded on the drum. Recirculating the

function through the recorder progressively exaggerated systematic errors. Output was then recorded with a direct-writing pen recorder.

### Performance

A played-back,  $40$ -v peak-to-peak,  $0.75$ -cps sine wave is shown in Fig. 10 after zero, 10 and 100 cycles of recirculation. Peak-to-peak amplitude is virtually unchanged after 100 cycles, but the signal has drifted  $3$  v in the negative direction.

Assuming constant drift rate, a d-c shift of  $0.03$  v/cycle of record and playback is indicated. Since peak-to-peak recording and playback amplitude is  $100$  v, precision is  $0.03$  percent of full scale immediately after zeroing.

The oscillograms in Fig. 10B and 10C were taken at one-hour intervals after those of Fig. 10A with no further adjustments. In Fig. 10B, after 100 cycles of recirculation, d-c level has drifted  $3$  v and amplitude has diminished about one v. In Fig. 10C, after 100 cycles, d-c level has drifted  $5.6$  v and amplitude has diminished  $7.25$  v.

After 100 cycles of recirculation, positive peaks of the sinusoid are narrowed in the time direction and negative peaks are broadened. Also progressive attenuation of peak-to-peak amplitude results because higher frequency components are generated in the positive peaks than the low-pass output filter will accommodate.

Inherent distortion and the resultant filtering action is even more evident with square and triangular waves, as is shown in Fig. 11 and 12.

A one-cps sine wave of  $0.3$  v peak-to-peak was recorded, read back and reproduced on a direct-writing recorder. Input voltage was then reduced to zero and noise level recorded. Noise did not exceed  $0.1$  peak-to-peak. Since the linear range of the recorder exceeds  $100$  v peak-to-peak, dynamic range is in excess of  $60$  db.

Frequency response is essentially flat from zero to  $20$  cps, with  $3$ -db attenuation at about  $30$  cps.

There appears to be no serious obstacle to adapting the principle used here to tape to provide extended records for permanent storage.

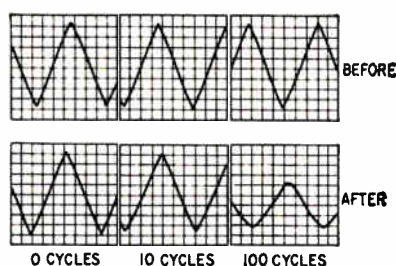


FIG. 12—Oscillograms show triangular waves before and after recirculation



# Wideband Amplifier Design Data

Circuits, relationships and equations are presented to help the circuit designer confronted with the problem of securing both high gain and wide bandwidth

By RICHARD H. ENGELMANN,

Associate Professor of Electrical Engineering, Univ. of Cincinnati

TWO BASIC VARIABLES of wideband-amplifier circuits are the tube and the type of configuration used. The tube determines transconductance and, in part, total capacity from plate to ground. The type of circuit determines the advantage factor and the bandwidth narrowing function for each stage.

Three basic maximally flat wideband-amplifier circuits and their equivalents are given in Fig. 1. These circuits may be compared readily with data in Table I.

The maximum voltage gain per stage and the overall gain of these and other amplifiers are calculated from Eq. 1 and 2.

TABLE I—Formulas and Parameter

Voltage Gain Per Stage

$$G_S = \frac{g_m K F_N}{B_T} = g_m R_{BQ} \quad (1)$$

Overall Gain

$$G_T = G_S^N = \left[ \frac{g_m K F_N}{B_T} \right]^N \quad (2)$$

- $B_S$  = bandwidth of one stage
  - $B_T$  = overall bandwidth in rad/sec  
=  $B_S F_N$
  - $C$  = total cap, plate to ground  
=  $C_{in} + C_{out} + C_{stray}$
  - $F_N$  = bandwidth narrowing factor for  $N$  stages
  - $g_m$  = tube transconductance
  - $G_S$  = voltage gain per stage
  - $G_T^{**}$  = overall gain of ampl
  - $K^{***}$  = advantage factor  
= ratio of gain bandwidth product of any stage to the gain-bandwidth product of a single stage ampl with a resistance load only, using the same tube
  - $R_{BQ}$  = an equiv load resist
- \*\*solve for  $G_T$  for enough values of  $N$  until  $G_T$  is sufficiently large  
\*\*\*effect of  $K$  should be kept in mind when comparisons are made

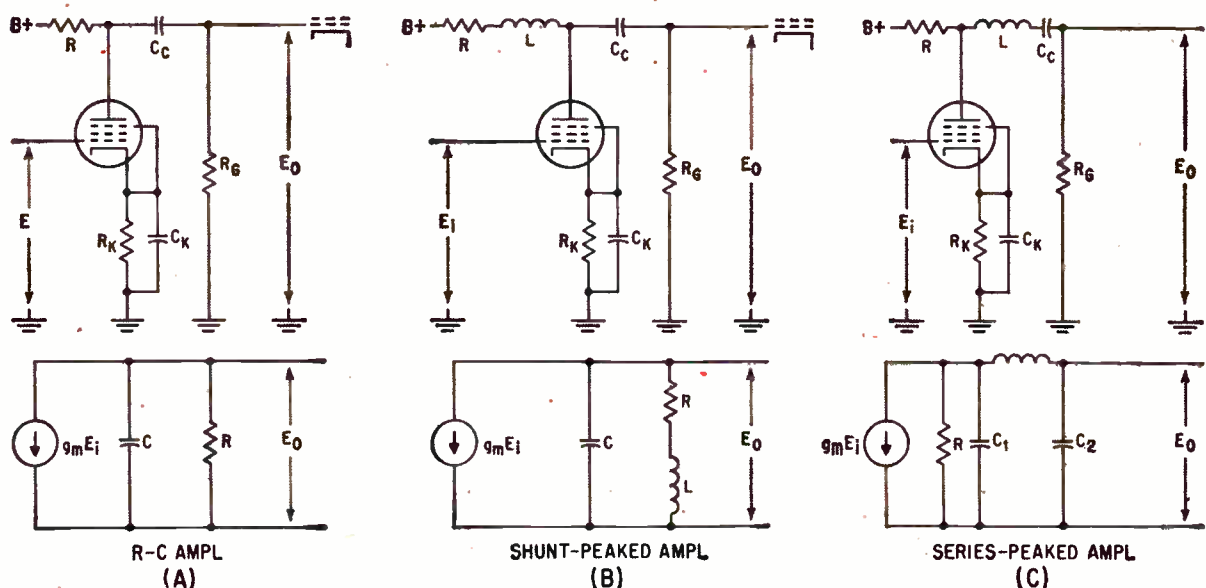


FIG. 1—Basic wideband-amplifier circuits and their equivalents

## Relations Used in Amplifier Design

Screen grid supplies have been ignored. Equiv circuits in Fig. 1 are based on assumptions that  $C_c$ ,  $R_G$ ,  $R_K$  and  $C_K$  will have effects only at low frequencies and that  $R_G$  and  $r_p$  are much larger than other impedances encountered in the circuits. Capacitor  $C_1$  is output capacitance of the tube plus stray capacitance in parallel with it:  $C_1 = C_{out} + C_{stray}$ .  $C_2$  is input capacitance of next stage plus its parallel stray capacitance:  $C_2 = C_{in} + C_{stray2}$ . All these capacitors may be augmented artificially, and must be in some cases.

Ampl Circuit	K	Bandwidth Narrowing Factor, $F_N$	Parameter Relations	Values of $F_N$ for N stages									
				1	2	3	4	5	6	7	8	9	10
(A) R-C Ampl	1	$\sqrt{2^{1/N} - 1}$	$R = R_{EQ}$	1	0.643	0.51	0.435	0.386	0.35	0.323	0.301	0.283	0.268
(B) Shunt Peaked	1.722	$\frac{\sqrt{(2^{1/N} - 1) \left(1 + \sqrt{1 + \frac{23.3}{2^{1/N} - 1}}\right)}}{2.435}$	$R = R_{EQ}$ $L = 0.414 R^2 C$	1	0.773	0.679	0.622	0.583	0.554	0.53	0.511	0.494	0.48
(C) Shunt Peaked Plus R-C	1.1	$\frac{\sqrt{2^{1/N} - 1}}{N \text{ even only}}$	$R = \sqrt{2} R_{EQ}$ $L = 0.500 R^2 C$	—	1	—	0.802	—	0.714	—	0.66	—	0.621
(D) Feedback Pair	1.1	$\frac{\sqrt{2^{1/N} - 1}}{N \text{ even only}}$	$R = \sqrt{2} R_{EQ}$ $R_1 = g_m R^2$ $>> R$	—	1	—	0.802	—	0.714	—	0.66	—	0.621
(E) Series-Peaked	$C^*/2C_1$ or $3C/2C_2$	$\sqrt{2^{1/N} - 1}$	$R = R_{EQ}$ $C_2 = 3 C_1$ $L = 2.67 R^2 C_1$	1	0.863	0.799	0.758	0.728	0.705	0.686	0.67	0.657	0.645

\*  $C = C_1 + C_2$ . Advantage factor is = to or  $< 2$ . Use the form which yields the value less than 2 using the original values of  $C_1$  and  $C_2$ . Note from relationship between  $C_1$  and  $C_2$  that one element in general must be augmented. The augmented value is used in the parameter-relationship equations.

In the following examples, a 12BV7 tube is used throughout. For this tube,  $g_m$  is 13,000  $\mu\text{mhos}$ ;  $C_{out}$  is 3  $\mu\text{f}$ ;  $C_{in}$  is 11  $\mu\text{f}$ . Stray capacitances  $C_{stray1}$  and  $C_{stray2}$  are assumed equal, each having a value of 5  $\mu\text{f}$ . Therefore,  $C_1$  is 8  $\mu\text{f}$ ;  $C_2$  is 16  $\mu\text{f}$ ; and  $C$  is 24  $\mu\text{f}$ . Radical  $g_m/C$  is  $542 \times 10^6$  rad/sec, which is the gain-bandwidth product for a single R-C stage.

**DESIGNING THE CIRCUIT**—As an example, assume that the circuit calls for an overall bandwidth of 10 mc and overall gain of 5,000. How many stages are required and what are the circuit parameters using (A) resistance-capacity stages, (B) shunt-peaked stages, (C) series-peaked stages?

To solve (A), convert 10 mc to rad/sec and obtain  $62.8 \times 10^6$  rad/sec for  $B_T$ . For the R-C amplifier,  $K$  equals 1. The maximum value of  $G_n$  possible is calculated from equation (1), taking  $F_N = 1$ . This yields 8.63.

To avoid extra work, calculate the minimum number of stages required under this ideal condition of no bandwidth narrowing from  $8.63^N$  equal to 5,000. In this case find the  $G_n$  and  $G_T$  values beginning with  $N$  equal to 4. For each value of  $N$  above 4,  $G_n$  is calculated using Eq. 1; and  $G_T$  is calculated using Eq. 2.

For this problem 10 stages yield insufficient gain. Using the equation  $\sqrt{2^{1/N} - 1}$  for the R-C amplifier, in Table I find that  $N$  equal to 11 yields a gain of 5,900, which is adequate. Under this condition,  $G_n$  equals 2.2 and consequently  $R$  equals  $G_n/g_m$  equals 169 ohms from Eq. 1.

To solve part (B): If shunt-peaked stages are used,  $K$  equals 1.722, and the maximum value of  $G_n$  is equal to 14.9. Using the ideal case of no bandwidth narrowing, calculate  $N$  greater than 3 from  $14.9^N$  equal to 5,000. Again  $G_n$  and  $G_T$  are calculated for each value of  $N$ . For  $N$  equal to 4,  $G_n$  equals 9.25 and  $G_T$  equals 9.25' or 7,200.

We now calculate components from the parameter relationship equation and Eq. 1 in Table I:  $R$  equals 712 ohms; and  $L$  equals 5.03  $\mu\text{H}$ .

To solve part (C): If series-peaked stages are used, first calculate the advantage factor. This will be the smaller of the two forms  $K$  equals  $C/2C_1$  equals 1.5 and  $K$  equals  $3C/2C_2$  or 2.25.

Use the 1.5 for  $K$ , and  $C_2$  must be augmented by 8  $\mu\text{f}$  to satisfy the required relationship between  $C_1$  and  $C_2$ . Note that the use of the augmented value of  $C_2$  in the second form for  $K$  yields  $K$  equals 1.5 again. Because  $C_2$  must equal  $3C_1$ , the advantage factor in many cases is reduced below the ideal of 2.

From Eq. 1, the maximum value of  $G_n$  is 12.95 and the minimum number of stages possible is  $N > 3$  from  $12.95^N = 5,000$ . Beginning calculations with  $N$  equal to 4, find  $G_n$  equal to  $12.95 \times F_N$  equal to  $12.95 \times 0.758$  equal to 9.8; and  $G_T$  equal to 9.8' or 9,100.

The parameters are calculated as before:  $R$  equals 754 ohms;  $L$  equals 12.1  $\mu\text{H}$ . Capacitance  $C_s$  is increased by 8  $\mu\text{f}$ .

Solutions can be obtained for combinations of these circuits using the data in Table 1.

Compact one-mc transistorized oscillator yields a frequency stability of one part in  $10^9$  per day at normal room temperature. Total weight of oven and oscillator is 2.5 lb. A 12-lb, 45-v battery can furnish both oven and circuit power for 72 hours at room temperature

By **JOSEPH F. MERCURIO, JR.**,

Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Mass.

# Stable, Low-Cost

**M**ODERN communication and radar systems place stringent requirements on stability of oscillators. The oscillator to be described exhibits a stability of one part in  $10^9$  per day at a frequency of one mc for operation at  $25\text{ C} \pm 10\text{ C}$ . A normal slow variation of ambient temperature from 25 to 50 C yields a frequency change of two parts in  $10^9$ .

Figure 1 illustrates the effect of varying the oven temperature at the rate of 8 C per hour from 0 to 50 C. Figure 2 shows the transient response of the oven and oscillator to a temperature change of 5 deg

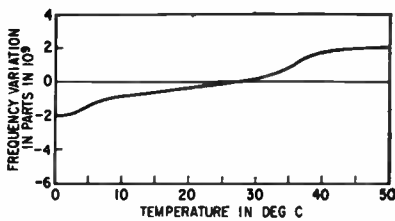


FIG. 1—Frequency characteristics of the one-mc oscillator when ambient temperature is varied at a rate of 8 C per hour

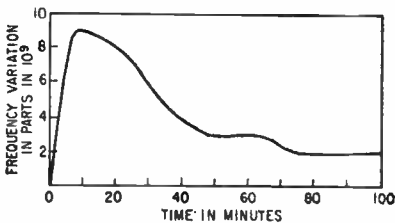


FIG. 2—Frequency characteristic when ambient changes rapidly from 27.5 to 50 C

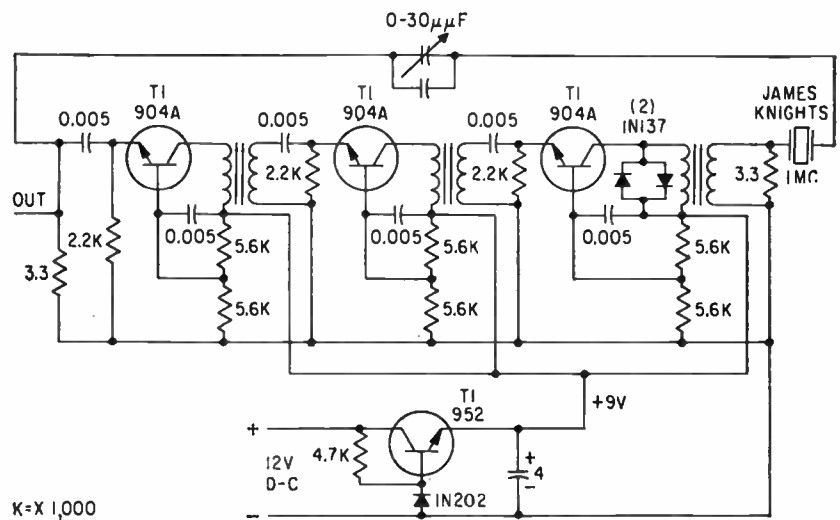


FIG. 3—Schematic diagram of the crystal oscillator

per minute from 27.5 to 50 C. Major factors related to the stability are the crystal, the oven, the circuit configuration and selection of components.

## Crystal Units

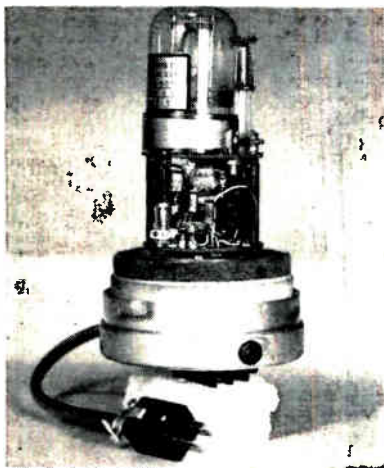
The one-mc crystal is an AT-cut crystal with a Q of 1.6 million. It is designed for operation at 60 C. In the operating range, the temperature coefficient of the crystal is 0.146 cycle per deg C. Series impedance at resonance is about six ohms. A 20-g shock for eight millisecond results in a frequency change of 15 parts in  $10^9$ . A new design of crystal mounting is said to reduce the effect of shock considerably.

The James Knights crystal is mounted in the horizontal plane and is supported by a spring structure.

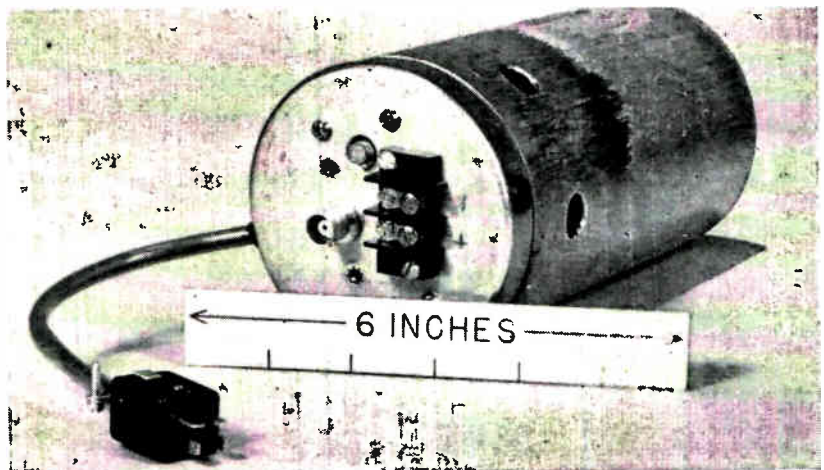
Insulating medium for the General Radio oven is a vacuum flask. At a room temperature of 25 C, an average power of two watts maintains the oven at a temperature of 60 C. Oven temperature remains constant within a few hundredths of one deg with normal slow changes in ambient temperature. A heavy-duty 45-v battery can act as a power source for the oven for a 72-hour period. A transistor serves as a switching device to deliver power to the heating element.

If a-c power is available, the





Front view of the oscillator



Complete oven and oscillator assembly

# One-Mc Oscillator

heating element can be controlled by a thyatron through the same power connector used with the battery. In both methods of oven control, the control circuit is not troubled by contact resistance of the thermostat. Since the oven was made for use in a tv transmitter monitor, it was necessary to modify it considerably to package the oscillator. However, the thermal time constant was not changed appreciably. A roughing oven enclosing the oven described would improve the instability caused by thermal shock.

## Circuit Description

Basic aim of the circuit is to reduce undesirable phase shift in the amplifier portion of the oscillator and to maximize the phase-angle change across the feedback network as a function of frequency. Variations in temperature and supply voltage can introduce a change in phase angle of the amplifier.

To alleviate temperature and voltage effects, the entire oscillator circuit and a transistor voltage regulator were placed in the oven. Since tuned amplifiers could introduce phase problems, the amplifier was designed to be of broad bandwidth. Because crystal impedance is six ohms, the crystal must be terminated in a low impedance to provide a high-Q feedback network.

Figure 3 shows the oscillator and voltage-regulator circuits. A three-

stage grounded-base transistor amplifier delivers the necessary power gain. The output transformer requires a 23 to 1 turns ratio to drive the three-ohm termination of the crystal from a grounded-base stage. A turns ratio of 3 to 1 is used for the interstage transformers. Amplitude limiting in the final amplifier is accomplished with two diodes placed in opposite polarity across the output transformer. Since the circuit operates at 60 C, silicon

within the resolving power of the measuring equipment (parts in  $10^9$ ) were introduced.

The 100-mc signal produced by the multiplier was mixed with a 100-mc signal from a National Radio Atomichron. This latter unit has a five-mc source stable to one part in  $10^{11}$ . By offsetting the frequency of the one-mc transistor oscillator so that it was 3.9 cps below one mc, a beat note of 390 cps appeared at the mixer output. This audio frequency was delivered to a 400-cps frequency meter having a direct output voltage proportional to frequency. A recorder displayed variations in the d-c output of the frequency meter.

Figure 4 is a block diagram of the measuring equipment. Maximum deviation over a 24-hour period was one part in  $10^9$ . Similar results were obtained by using the same technique to measure drift between two of the transistor oscillators. Another method of measurement involved the Lissajous pattern produced by two of the transistor oscillators. By introducing distortion in one of the oscilloscope inputs to distort the Lissajous pattern, one can measure the number of minutes required for the phase difference between the two oscillators to shift by 360 deg. Research on this project was supported by the Army, Navy and Air Force under contract with MIT.

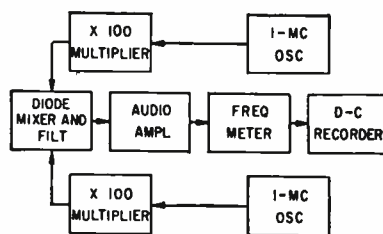


FIG. 4—Block diagram of the measuring equipment

transistors are used. It is possible to change frequency of the oscillator slightly by adjusting the trimmer capacitor in parallel with the feedback capacitor. A change of 30  $\mu\text{f}$  varies the frequency by 0.4 cycle. The rms voltage output of the oscillator is 3 mv.

Stability of the oscillator was measured by multiplying the one-mc output to 100 mc. Tests were made to determine effects of the multiplier chain. No variations

# F-M Tuner Adapter for

Four-tube unit separates subcarrier signal from output of standard f-m tuners and, after demodulation, matrixes it with main signal to provide two stereophonic channels. Though designed for Crosby system of multiplex transmission, provision is made for use with other systems

By **LEONARD FELDMAN**, President, Madison Fielding Corporation, Brooklyn, N. Y.

**S**TEREOPHONIC BROADCASTS attempted to date have had various shortcomings.

Simultaneous a-m/f-m stereo broadcasts, using one of the two media for each channel, result in one good channel and one relatively inferior channel; also, the listener equipped with only one type of receiver hears a highly unbalanced program which favors the left or the right. Twin f-m stations pooling their efforts for stereo eliminate the first of these shortcomings, but they retain the second and also reduce the number of programs that can be transmitted on the f-m band in any given area.

Development of the Crosby f-m multiplex stereophonic system affords two channels which together are as good as the single channel used in conventional f-m transmissions. In addition, the listener to a stereo transmission with a conventional f-m receiver hears a complete and balanced monophonic signal.

This article describes an inexpensive converter that, when used in conjunction with a conventional f-m tuner or receiver, will separate the two stereo channels. The unit requires no tuning or other periodic

adjustments and its circuits are effective only during periods of stereo transmission.

## Transmission System

Figure 1 shows the transmission setup for the Crosby system. A two-channel signal is supplied from a stereo tape or disk, or two properly positioned microphones. The two channels, *A* and *B*, are added in-phase in a mixing network to obtain an output signal that is the sum of *A* + *B*. This sum signal is used to modulate the f-m transmitter in the usual way. It is therefore this total-program signal that the listener equipped with only a conventional f-m receiver will hear.

The *B*-channel signal is also passed through a phase inverter; the  $-B$  output signal is added to the *A* signal in another mixing network to obtain an output signal which is *A*-*B*, the difference between the two channels. This signal may be thought of as the stereo-content signal.

The *A*-*B* signal is used to modulate a 50-kc generator to a maximum deviation of  $\pm 25$  kc. Thus, the frequency limits of this subsidiary generator are 25 kc and 75

kc. This f-m is used to further modulate the f-m transmitter.

Since the total permissible deviation per f-m channel is  $\pm 75$  kc, equal deviation is assigned to the main carrier and the 50-kc subcarrier, or a  $37\frac{1}{2}$  kc maximum deviation for each. Subcarrier modulation will always be constant at  $37\frac{1}{2}$  kc whereas the main *A* + *B* modulation will vary in accordance with audio content as always. In any case, the total bandwidth requirement will never exceed the allowed 75 kc on each side of the r-f carrier.

For the monophonic listener, the reduced primary audio modulation (to  $37\frac{1}{2}$  kc) will result in a 6-db reduction of audio amplitude. Advances in f-m tuner signal-to-noise and quieting sensitivity design are such that this slight decrease in sound level can be deemed unimportant.

In the case of stereo listening, no reduction in sound level results. Both the *A* + *B* and *A* - *B* signals are preemphasized in accordance with standard practice.

## Reception System

Figure 2 is a block diagram of the system needed to receive the

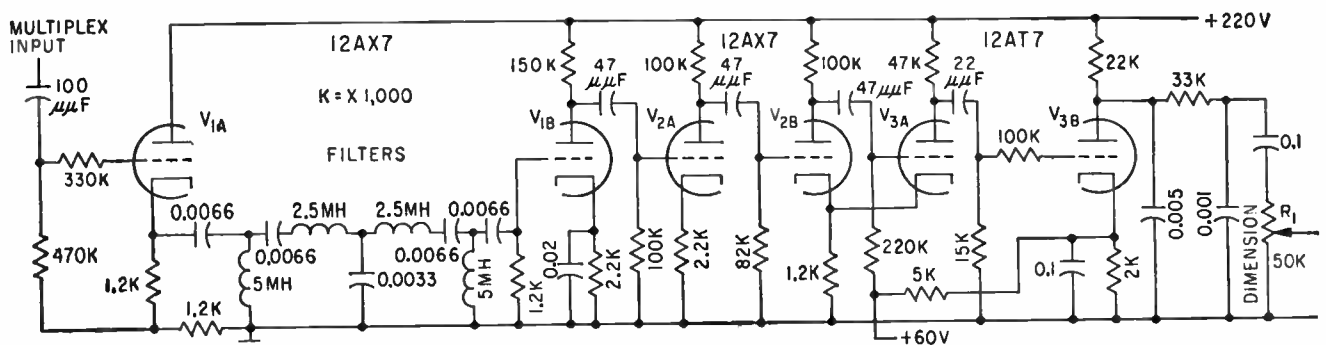


FIG. 3—Complete circuit for separation of sum-and-difference signals of Crosby system into original two-channel signals, S<sub>1</sub> permits unit to be

# Multiplexed Stereo

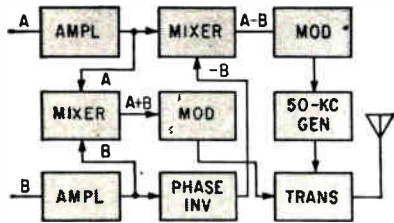


FIG. 1—Basic Crosby multiplex transmission system for two stereophonic channels

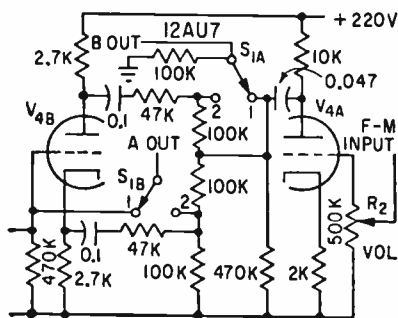
stereophonic broadcasts. The blocks enclosed in the dashed line comprise the converter circuits. This is the only additional piece of equipment needed, assuming that the listener is already equipped for other stereo media.

The main output of an f-m tuner is connected to one of the inputs of the converter. A second connection is made from the multiplex output of the tuner.

## Multiplex Output

The multiplex output is taken ahead of the deemphasis network, at the output of the discriminator or ratio detector. As the pertinent signal at this output is the 50-kc subcarrier, the length of cable must be kept minimal, usually no more than 3 ft.

The multiplex signal is stripped of primary audio content by sharp high-pass filters having a cut-off point of 20 kc. The subcarrier is then amplified, limited and demodulated. After demodulation, the  $A - B$  signal is recovered and mixed, in phase, with the  $A + B$  signal from the main output of the tuner. The resultant output is  $(A + B) + (A - B)$  or  $2A$ ,



used with other multiplex transmission systems

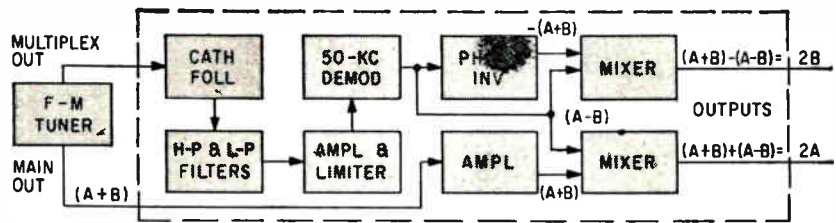


FIG. 2—System necessary to receive stereophonic transmissions; encircled blocks comprise converter circuits

The  $A - B$  signal also undergoes phase inversion to produce a  $-(A - B)$  signal that is added to the main  $A + B$  signal to produce  $(A + B) - (A - B)$  or  $2B$ .

## Noise Figure

The factor of two in each case is relative, depending upon the amplification in the particular circuits; it substantiates the earlier hypothesis that no signal-to-noise deterioration results when listening to stereo.

The subcarrier noise figure is somewhat better than the main-carrier noise figure, so when the two are remixed, the noise figure of each channel ( $A$  and  $B$ ) is actually better than that of an equivalent monophonic transmission.

The complete circuit diagram of the converter unit is shown in Fig. 3.

Amplifier  $V_{4A}$  equates the level of the primary ( $A + B$ ) audio with subsequently demodulated ( $A - B$ ) components.

The signal from the multiplex output of the f-m tuner is passed through cathode follower  $V_{4A}$  to provide isolation and a proper source impedance for the filters to follow. While the circuit parameters used suggest nonlinear operation of this stage, sinusoidal reproduction at this point is not necessary as only frequency variations of the subcarrier contribute to the final demodulated output. Maximum gain (minimum loss) was the governing factor, rather than minimum distortion.

As both the main audio and the subcarrier are available at the multiplex output of any standard f-m tuner, it would have been pos-

sible to provide only one input on the converter, with subsequent separation taking place in the converter itself. This was avoided for two reasons: (1) the main audio signal derived at the discriminator or ratio detector of an f-m tuner lacks the necessary high-frequency deemphasis characteristic. While a deemphasis network could have been built into the converter this would have duplicated parts already present in the tuner and increased cost. (2) Many jacks of present-day tuners have an isolating capacitor that is adequate for passing the subcarrier but hardly adequate for coupling audio to the high-impedance input of the converter.

## Filters

The filters that follow  $V_{4A}$  are necessary to completely eliminate all audible frequencies thus far accompanying the subcarrier. Since these frequencies extend to 15 kc, the cut-off point of both high-pass sections is 20-kc.

The single low-pass section has a cut-off frequency of 75 kc, to restrict demodulated noise of the bandwidth necessary for proper functioning of the rest of the circuit and no more. Terminating and source impedances are 1,200 ohms.

It was found that 10-percent resistors and 5-percent capacitors and inductors were satisfactory.

For the high-pass sections, a leeway of  $\pm 3$  kc for the 3-db attenuation point will not deteriorate performance, as the highest audio frequency transmitted is 15 kc, fully 5 kc removed from the beginning of the nominal passband.

In a positive direction, 25 kc is the first frequency of interest in



the subcarrier. This frequency is attained only under conditions of 100-percent (25 kc) modulation of the subcarrier; with the amplitude available from most tuners, an attenuation of as great as 6 db at 25 kc will not affect limiting, demodulation or noise figure.

The low and high-pass characteristics of the filter sections are shown in Fig. 4.

The f-m subcarrier is amplified by  $V_{1n}$  and  $V_{2A}$ ; the latter also affords partial saturation limiting because of the large voltage swings in its plate circuit.

### Detection

At this point in the circuit, the classic approach would have been to provide further limiting and subsequent f-m detection by any one of the several techniques available. Anticipated variations in sub-carrier level because of different tuners used, cable lengths and other factors discouraged this approach, as full limiting could not be relied on unless more stages were incorporated. Also, as it has been decided to employ pulse or counter detection, waveshapes had to be consistent and fixed for proper pulse differentiation and minimum distortion in the recovered audio signal.

For these reasons, the actual subcarrier is abandoned at this point and is used merely to generate or trigger a series of square waves utilizing the monostable multivibrator consisting of  $V_{2n}$  and  $V_{2A}$ . The time constants were chosen to produce consistently shaped wave trains at any frequency from 25 kc to 75 kc. Thus, any amplitude of subcarrier of about 0.1 or more at the multiplex input jack will produce a steep, high-amplitude square-wave train suitable for differentiation in the network in the grid circuit of counter detector  $V_{2n}$ .

### Parameter Choice

The choice of the parameters in the differentiation network involved a classic compromise, that of gain versus distortion. A time constant of  $1\mu\text{sec}$  or three times that of  $0.33\mu\text{sec}$ , as finally chosen, would have yielded an audio output in the plate circuit more than twice as great. Unfortunately, the lowest frequen-

cies of pulse trains would also undergo severe amplitude and shape distortion, which would in turn manifest itself as high-order second-harmonic distortion in the recovered ( $A - B$ ) audio.

Properly designed, the counter detector is extremely linear and highly suitable at the frequencies under consideration. The r-c networks in the plate circuit of  $V_{2n}$  remove residual subcarrier components and the necessary  $75\text{-}\mu\text{sec}$  deemphasis.

### Matrixing

The recovered ( $A - B$ ) signal is fed to  $V_{1n}$  and derived in phase at its cathode and out of phase,  $-(A - B)$ , in its plate circuit. The two signals are then mixed in

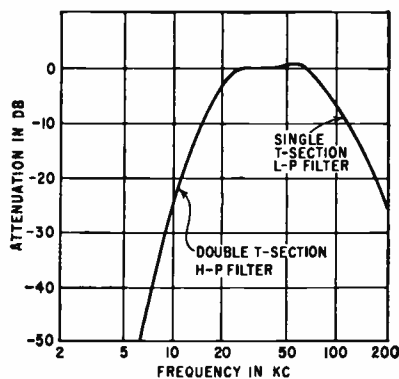


FIG. 4—Characteristics of filter networks used in circuit of FIG. 3

proper proportion with the  $A + B$  signals to complete the electrical algebra necessary for the ultimate recovery of the individual  $A$  and  $B$  channels.

Fixed proportions of mixing could have been preset at a considerable reduction in cost. However, potentiometer  $R$ , that governs the percentage or proportion of  $A - B$  signal provides an excellent customer feature. With this control set at minimum, conventional monophonic f-m is received, even when stereo is being broadcast since only  $A + B$  is supplied at the outputs of the converter.

When stereo is desired, the user adjusts this dimension control to introduce as much or as little stereo effect as he pleases. This flexibility enables too closely spaced speakers to create the illusion of being further apart and visa versa.

Volume control  $R$ , provides a

means for adjusting the level of the monophonic  $A + B$  signal from tuners of different manufacturers.

Switch  $S_1$  is shown in the position required for Crosby-system stereo transmissions. If this system gains universal approval,  $S_1$  will probably be eliminated. Until that time, it is conceivable that some stations may wish to transmit other types of f-m stereo signals, in which channel  $A$  may be broadcast through regular f-m and channel  $B$  through the f-m subcarrier. In that event,  $S_1$  will enable the user to extract subcarrier audio from one output jack and main audio from the other.

In either case, connection is made from the two output jacks to high-level high-impedance inputs of two single-channel amplifiers or a dual-channel stereophonic amplifier. In the absence of stereo broadcasting, the dimension control may be adjusted for normal f-m reception from both speaker systems. Under these conditions, amplifier volumes would be adjusted to provide equal volume from each of the speaker systems. Then, when the dimension control is used on the occasion of stereo broadcasting, perfect spatial balance will be automatically achieved.

### Performance

For the main channel, the gain is  $-3\text{ db}$  with a frequency response of 20 to 18,000 cps  $\pm 1\text{ db}$ . Harmonic distortion is less than 0.3 percent for the 0.4-v output obtained with 37.5-kc maximum deviation when fed from a ratio-detector type tuner.

The subchannel has a response of  $-11\text{ db}$  at 8 kc and is flat from 20 to 15,000 cps  $\pm 1\text{ db}$  when fed with a signal having standard  $75\text{-}\mu\text{sec}$  preemphasis. Full limiting of the subcarrier channel is obtained with as little as 60 mv input; up to several volts input can be handled without overload.

Output of the adapter is 0.4 v for 25-kc (maximum) deviation of the subcarrier and the harmonic distortion is less than 1 percent over-all for full deviation of the sub and main carriers.

Up to 6,000-cps, phase error between the  $A + B$  and  $A - B$  channels is less than  $15\text{ deg}$ .

# Soft Magnets for Amplifiers

Choice of magnetic amplifier core materials broadens as new square-loop and high-permeability alloys are added to the old standbys

By GEORGE SIDERIS, Associate Editor

TABLE I—Properties of Representative Magnetic Amplifier Core Materials

Typical Trade Names	Composition (balance Fe)	Initial Permeability ( $\times 10^3$ )	Maximum Permeability ( $\times 10^3$ )	Saturation Induction (kilo-gauss)	Saturation Hysteresis (erg/cm <sup>2</sup> /~)	Residual Flux Density (kilo-gauss)	Coercive Force (oersted)	Electrical Resistivity ( $\mu\text{ohm-cm}$ )	Curie Temp (°C)
Deltamax, Hipernik V Orthonol, Orthonik Permeron, etc.	45-50 Ni grain-oriented }	0.4-1.7	30-150	13.5-20	200-700	8.3-15	0.15-0.5	40-50	475
High Perm 49	49 Ni	5	50	16	.....	6.5	0.075	43	475
Hipernik, H <sub>2</sub> ann.	50 Ni	4	70	16	220	.....	0.05	45	500
45 Permalloy	45 Ni	2.5-2.7	23-25	16	1,200	8	0.3	45	400
45 Permalloy, H <sub>2</sub> ann.	45 Ni	4	50	16	.....	.....	0.07	45	...
65 Permalloy	65-68 Ni	1.5	250-600	13	.....	13	0.03	20	600
4750 Allegheny	47-50 Ni	3-9	50	16	.....	6-6.2	0.07-0.08	52	430
4-79 Permalloy	79 Ni, 4 Mo	20-22	72-100	8-8.7	200	5-5.5	0.05	55-60	460
Supermalloy	79 Ni, 5 Mo	55-150	500-1,000	6.8-8	8	.....	0.002-0.05	60-65	400
Hy Mu 80	80 Ni, bal Mo-Fe	10-20	90-100	7-9	.....	2.5	0.05-0.07	55-58	460
Dynamax	65 Ni, 2 Mo	.....	1,750	12.5	.....	12	0.0053	.....	...
Mumetal	77 Ni, 5 Cu, 2 Cr	20	100	6.5-8	200	6	0.05	60-62	400
1040 Alloy	72 Ni, 14 Cu, 3 Mo	40	100	6	200	2.5	0.014-0.02	55	290
Supermendur	49 Co, 2 V	.....	92.5	24	2,000	21.5	0.2	26	980
Hipersil, Silectron Magnesil, Alphasil Tran-Cor 3X, etc.	3-3.5 Si grain-oriented }	a	17.5-55	18-20	700	8.3-14	0.1-3.3	45-50	735
Ferranic H	Ni-Zn+Cu	0.850 <sup>b</sup>	4.3	3.4 <sup>c</sup>	.....	1.47 <sup>c</sup>	0.18	10 <sup>10</sup>	150
Ferranic H-1	ferrites	0.550 <sup>b</sup>	3.8	2.8 <sup>c</sup>	.....	1.5 <sup>c</sup>	0.35	2 $\times 10^{10}$	125

<sup>a</sup> Uncertain; value at 100 gauss induction reported as 7,500

<sup>b</sup> At 1 mc

<sup>c</sup> Induction at field strength of 25 oersteds

TABLE II—D-C Magnetic Properties of Cube-oriented and Grain-oriented 3% Silicon Steels<sup>a</sup>

Direction of Measurement	Maximum Permeability	Residual Induction	Energy Loss <sup>b</sup>	Coercive Force	
Measured Parallel to Rolling Direction	Cube-oriented	116,000	12,200	0.56	0.07
	Grain-oriented	55,000	9,500	0.60	0.08
Measured Perpendicular to Rolling Direction	Cube-oriented	65,000	11,500	0.65	0.08
	Grain-oriented	8,000	1,750	1.6	0.27

<sup>a</sup> Source: report in *Jour App Phys*, March, 1958

<sup>b</sup> Watts/pound at 15,000 gauss induction and 60 cps

PERMEABILITY ( $B/H$ ) of an ideal magnetic amplifier core material is infinite to the saturation point on its hysteresis loop. A rectangular loop material is generally preferred in the output stages of the amplifier, but an alloy with high permeability may do the job in an input stage. Choice of materials is wide.

High resistivity reduces core losses. Losses can also be minimized by using thin laminations or, at high frequencies, by using ferrites. Silicon steels perform well at high power. Permalloy types give high sensitivity. Supermalloy features low magnetizing currents and Mumetal, low saturation induction.

Properties of typical materials are given in Table I. Properties of the alloys will vary widely according to production methods and post-annealing care.

NEW MATERIALS—New materials include Supermendur, Dynamax and cube-oriented steel, table II, which is being tried in transformers.

# Tape Recording System

Pulse duration recording technique and 31-channel block format give large information content, minimum dead space and effect from tape skew plus ability to selectively rerecord on individual blocks. Unique electronically controlled pneumatic tape transport permits high rate of information transfer

By **WAY DONG WOO**, DATAmatic Div., Minneapolis-Honeywell Regulator Co., Newton Highlands, Mass.

**N**OVEL RECORDING TECHNIQUES are enabling a data processing system to handle information at a rate of 60,000 digits or 40,000 alpha-numeric characters a second. This article describes the information format, read and write circuits, and tape transport mechanism which give the system the required speed and capacity.

## Information Format

Magnetic tape is the common medium of information transfer throughout the system. A 3-inch wide tape capable of accommodating 36 magnetic channels is used. Three channels control and position the tape, 31 contain recorded information, and two are spares.

Information is recorded in blocks of 62 words, 2 words in each of the 31 information channels. Start and finish of each block is indicated by marks on the control and position

channels. An interlace recording technique minimizes the dead spaces between blocks required to accelerate the tape and eliminates the need for rewinding.

Interlacing is done by recording on every other block while the tape is moving in the forward direction, then recording in reverse to fill in unused blocks as shown in Fig. 1A. A full reel of tape contains 50,000 blocks: blocks numbered 1 through 25,000 are used during the forward cycle and 25,001 through 50,000 during the reverse cycle.

Magnetization of the block mark channels and the signal as it appears when the tape is played back are shown in Fig. 1B, 1C and 1D. To assure that recording begins at the proper point, the positive pulse appearing in the forward or reverse mark channels must occur with the check pulse in the check mark channel. Positive and negative pulses in the forward or reverse mark channels indicate the respective beginning and end of reading.

## Recording Technique

A pulse-width-modulation technique is used for magnetically recording binary digits on the tape information channels. Binary digits are represented by the interval of time between two successive reversals of magnetization of the tape. An example magnetic pattern is shown in Fig. 2.

During playback, peak output voltages are obtained when the head passes through a reversal of magnetization. Alternate peak voltages are generated every 31 or 62  $\mu$ sec. Information is conveyed by

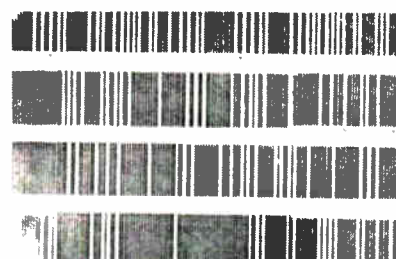


FIG. 2—Magnetic flux pattern of four information channels

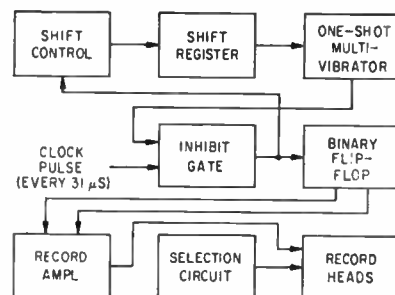


FIG. 3—Writing circuits convert 62-word information block in shift register to magnetization pulses in recording head

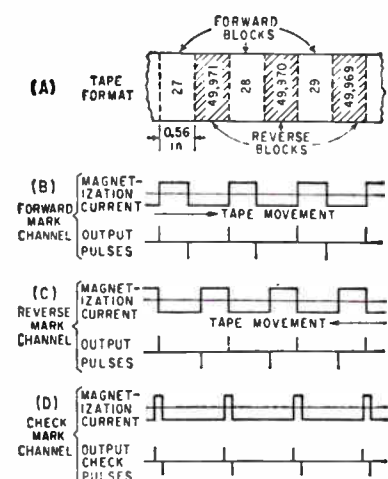


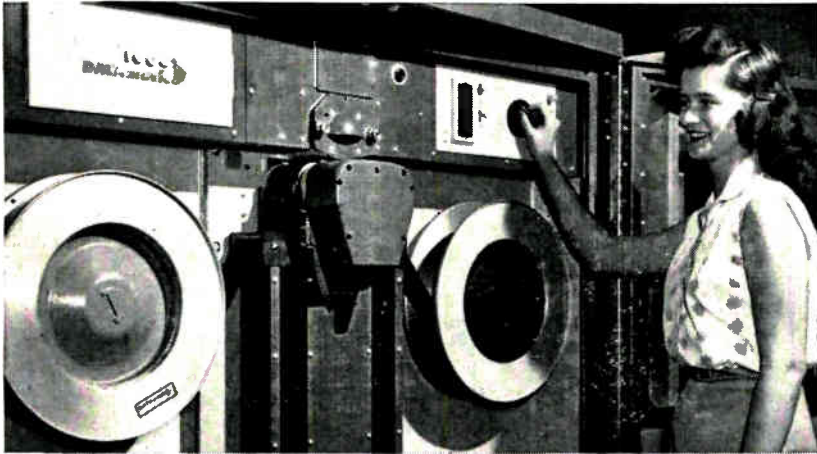
FIG. 1—Tape format (A) and corresponding block mark waveforms (B, C and D)

frequency deviation of the carrier and not by variation of amplitude. Since noise causes fluctuation of amplitude, a lower signal-to-noise ratio can be tolerated than in conventional recording systems.

Erasing of previous recording is not necessary when new words are recorded. Since the magnetic medium is subjected to saturation of one polarity or the other, the resultant magnetization of the tape is completely independent of its history. This feature allows information blocks to be selectively altered without disturbing adjacent blocks. Also, need for synchronization of pulses in different channels



# Speeds Data Processing



Operator starts DATAmatic 1000 magnetic file unit. Reel holds 2,700 feet of 3-in. wide tape containing over 37 million decimal digits

is eliminated thereby removing skew as the limiting factor in obtaining maximum pulse density.

## Writing Circuits

A block diagram of the magnetic tape writing circuits is shown in Fig. 3. The 106 bits of the two words to be written in each channel are stored in the shift register and are read out serially during recording. A ZERO output permits clock pulses to be applied to the binary flip-flop every 31  $\mu\text{sec}$ . A ONE output, however, energizes a one-shot multivibrator which actuates the inhibit gate for 44  $\mu\text{sec}$ . This action permits only the second, or 62- $\mu\text{sec}$ , clock pulse to be fed to the binary flip-flop. After being amplified, the flip-flop output is applied to the head selected by the selection circuit. Writing current is reversed

in the selected head in 31  $\mu\text{sec}$  for a ZERO and in 62  $\mu\text{sec}$  for a ONE.

The circuit used to apply the output of the binary flip-flop to a selected head in the remotely located magnetic file unit is shown in Fig. 4. Magnetic recording transformers  $T_1$  and  $T_2$  associated with the selected head are connected to +190 v; transformers of all unselected heads are connected to +160 v. Since the voltage applied to the selected head transformers exceeds the amplifier B + voltage, plate currents from tubes  $V_1$  and  $V_2$  flow in the transformer primary generating +60 ma of magnetization current in the head winding.

Diodes  $D_1$  and  $D_2$  clamp the amplifier end of all head transformer primaries at the plate supply voltage, while voltage  $E_1$  on the other end of unselected head transformer primaries is held at +160 v. Since the back resistance of series diodes  $D_3$  and  $D_4$  is high, current cannot flow in unselected heads.

Pulse-width modulation results in different length words in different channels thus, signals are necessary to indicate where information begins and ends. Writing starts when the beginning mark from the block mark channel is detected. A few ZEROES followed by a ONE, which are not information bits, are then written. After the 106 information bits are re-

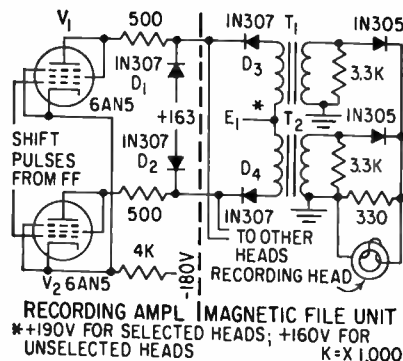


FIG. 4—Recording amplifier and record head circuits

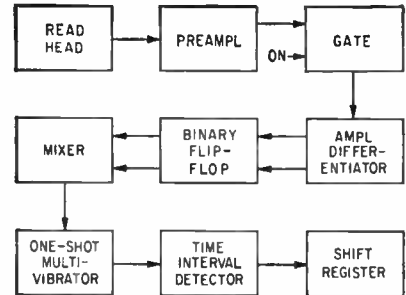


FIG. 5—Reading circuits convert signals from read head to digital information in shift register

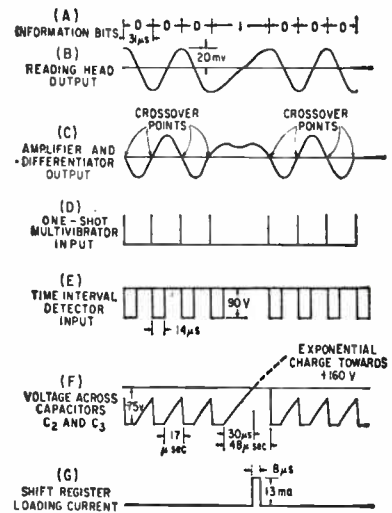


FIG. 6—Waveforms at various points in reading circuit

corded, another ONE and a few ZEROES are written.

The noninformation ONE bits, called sentinals, serve to signal the start and finish of the information bit recording. The ZERO bits preceding and following the sentinel bits are used to make certain that at least one ZERO is read in spite of tape skew, delays and the like.

## Reading Circuits

A block diagram of the tape reading circuits is shown in Fig. 5. Information bit content and corresponding read head output waveform are shown in Fig. 6A and 6B.

Signals from a head are amplified and gated on when the associated channel is read. The gated signal is again amplified, differentiated and phase split to give the

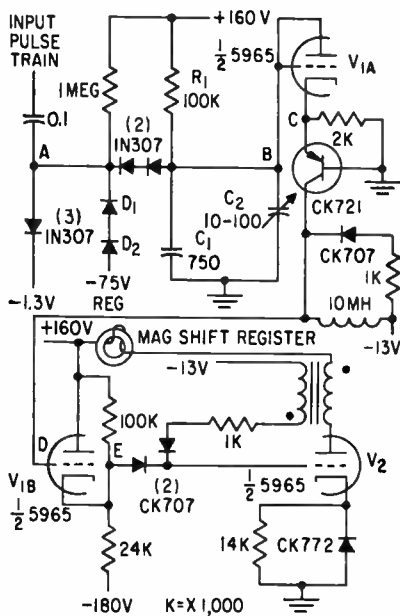


FIG. 7—Time interval detector in writing circuit

waveform shown in Fig. 6C. Since the signal is differentiated, cross-over points occur through the base lines at the positive and negative peaks of the original head signal.

The outputs of the amplifier and differentiator are fed into the opposite inputs of the binary flip-flop. The two flip-flop outputs are then differentiated, mixed and fed to a one-shot multivibrator. The multivibrator output signal, shown in Fig. 6D, contains a 14  $\mu$ sec negative pulse for every change in polarity of tape magnetization.

The train of pulses is now applied to the time interval detector circuit shown in Fig. 7. In the

quiescent state, point A is at +1.3 v while B and C are at ground potential. If a large negative pulse arrives, the potential of points A and B is driven down to -75v and clamped there by diodes  $D_1$  and  $D_2$ . When the input pulse disappears, the potential at points A and B rises exponentially towards +160 v with a time constant  $R_1(C_1 + C_2)$ . As soon as point B rises to ground potential,  $V_{1A}$  conducts driving the potential of point D from -13 v to ground. Tube  $V_{1B}$  then conducts raising the potential of point E to ground triggering blocking oscillator  $V_2$  which delivers a 13-ma pulse to the core winding in the magnetic shift register.

Time constant  $R_1(C_1 + C_2)$  is set to raise points B and C from -75 v to ground in 30  $\mu$ sec. If a ZERO bit is read, time delay between successive pulses is only 17  $\mu$ sec; therefore, no magnetization pulse is generated. However, if a ONE bit is read, time delay between successive pulses is 48  $\mu$ sec and a pulse is delivered to the shift register.

### Tape Transport Mechanism

Two continuously counter rotating capstans driven by a synchronous motor and traveling at circumferential speeds of 100 ips move the tape. Capstan surfaces contain a number of small holes which are connected to a pneumatic suction system through electrically operated valves. To stop the tape, the suction is removed from the capstan and applied to brake surfaces

located under the chosen head.

A schematic diagram of the driving circuits is shown in Fig. 8. The two capstans and brakes are connected to the vacuum and the low pressure compressed air reservoirs through a valve system containing three control vanes; one for the brake surfaces, and one each for the counter rotating capstans'. Each vane together with its air passage forms a bistable pneumatic flip-flop. In one state the capstan or brake surface is connected to the vacuum, in the other to the pressure reservoir.

The vanes are set at one of the two positions when pulses are applied to the two actuators. When a GO FORWARD pulse is received, it is amplified by  $V_{1A}$  and used to energize the one-shot delay tube  $V_2$  which delivers a 3.5 millisecc positive pulse. Through cathode follower  $V_{1B}$ , the vacuum actuator is energized with a current of 1.5 amp through the plate circuit of  $V_{1B}$ , thereby connecting the forward capstan to the vacuum. The output of  $V_{1B}$  also energizes the low pressure actuator which removes the brake. Similarly when a STOP FORWARD pulse is received, the one-shot-delay tube  $V_7$  becomes operative delivering a pulse of 2.5 millisecc to the low-pressure actuator which disconnects the forward moving capstan from the vacuum and connects it to the low pressure air line. Output of  $V_{7B}$  also energizes the vacuum actuator which brakes the tape to a stop.

In cases where a GO FORWARD command is received before 2.5 millisecc has elapsed from the last STOP FORWARD command, the effect of the stop command is immediately overridden by a cancel circuit consisting of coupling capacitor  $C_1$ . The negative pulse on  $V_{2A}$  cuts off  $V_{1A}$  under all circumstances, thereby causing the output of  $V_2$  to immediately return to a negative value. This action cuts off tubes  $V_7$  and  $V_8$ , with the result that low pressure and vacuum actuators immediately energize moving the tape forward. A similar circuit is used for the reverse drive.

### REFERENCE

- (1) R. B. Lawrence, R. E. Wilkins and R. A. Pendleton, Apparatus for Magnetic Storage on Three-Inch Wide Tapes, Proc IJCC, 1957.

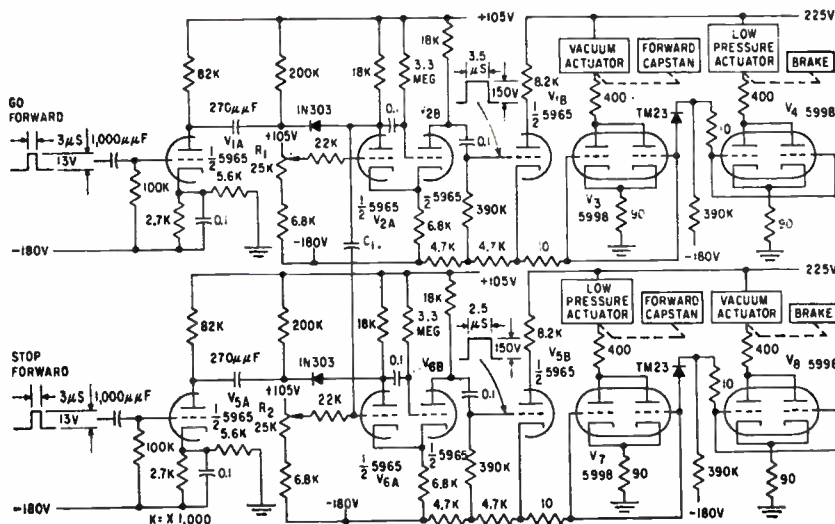


FIG. 8—Electronic control circuit enables tape transport mechanism to start, stop and reverse in a few milliseconds



## *MEN AND IDEAS IN MOTION: AERONUTRONIC*

This is Aeronutronic—men, ideas, and the tools for research. Aeronutronic—a dynamic new name in science—created by the Ford Motor Company to meet the demanding technological needs of a nation on the move.

Aeronutronic is moving into the future and moving fast. Space sciences, missile technology and space vehicles...computers, electronics...tactical weapon systems...these are major research,

development and manufacturing activities conducted at ASI's modern 200-acre Research Center under construction at Newport Beach, California.

Exceptional engineers and scientists are needed now. If you are forward-looking and want to be an important part of a forward-moving organization, you'll find a new challenge and rewarding future at Aeronutronic—*where men set ideas in motion.*

*For information regarding positions, interests, facilities or products, write to Mr. K. A. Dunn, Aeronutronic Systems, Inc., Bldg. 5, 123 1/2 Air Way, Glendale, California, or call CHapman 5-6651.*

## **AERONUTRONIC**

*a subsidiary of FORD MOTOR COMPANY*

NEWPORT BEACH, GLENDALE, SANTA ANA AND MAYWOOD, CALIFORNIA

OFFICE OF ADVANCED RESEARCH • SPACE TECHNOLOGY DIVISION • COMPUTER DIVISION • TACTICAL WEAPON SYSTEMS DIVISION



# Waveguide Data Charts

Double and triple-post susceptance data charts permit design of X-band waveguide filters with high precision

By **ELIO SION\***, Airborne Instruments Lab., Div. of Cutler-Hammer, Inc., Mineola, N. Y.

**I**NDUCTIVE POSTS offer one of the simplest and most economical ways of designing multiple-cavity X-band waveguide filters.

These charts can be used to design filters with a bandwidth as narrow as 0.8 percent. Constructed ten-cavity one-percent bandwidth filters had insertion losses of less than 0.75 db at

midband. The low susceptance sections of the filter employed two-post structures, while the high-susceptance cavities used the three-post structure.

In actual filter design, the cavity sections are made slightly shorter than calculated. The filter sections are tuned by capacitive screws or capacitive dimpling.

For triple posts, cavity Q's

in the order of 6,300 were obtained, and Q's of 5,000 were obtained for double posts. Cavity designs consisted of silver posts in silver-lined X-band waveguide. A silver plated hemispherically tipped tuning screw was used for tuning.

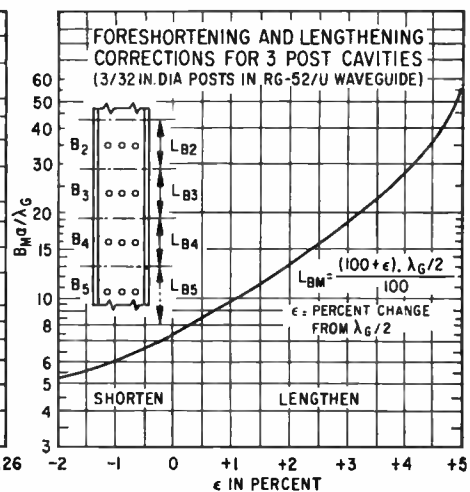
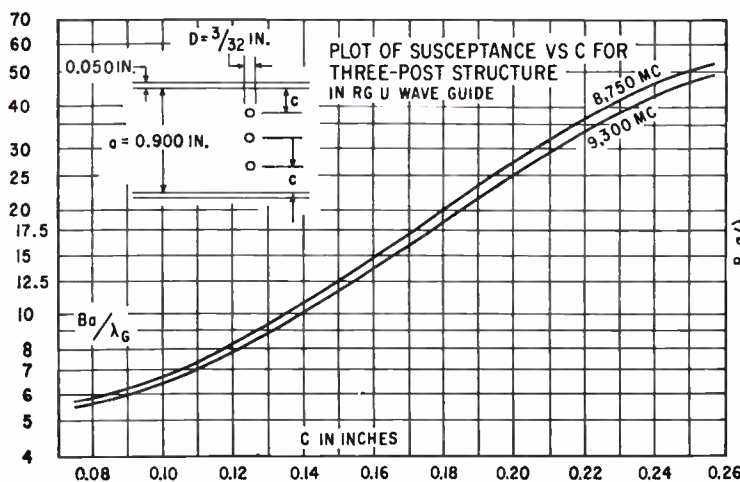
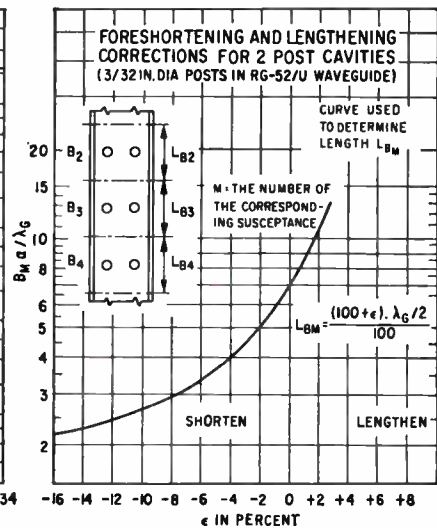
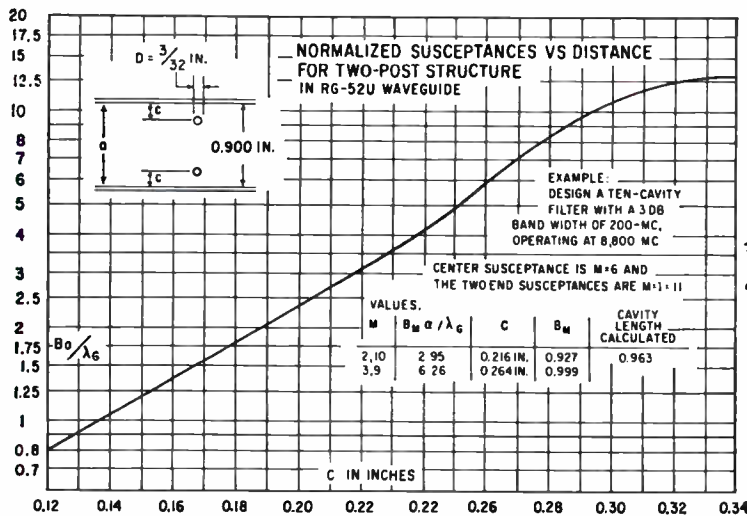
Length  $L_{RM}$  is determined using the correction curves.

In the example given on the chart, the calculated length of the second cavity, namely the distance between  $B_2$  and  $B_3$ , is,

$$\frac{1}{2}L_{B_2} + \frac{1}{2}L_{B_3},$$

hence this is equal to 0.963 inch.

\* Now with Hughes Systems Development Labs.

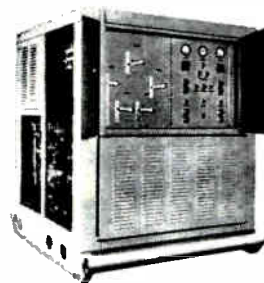




SYVERSON  
FOR LEACH/INET

## NEXT TIME...LOOK TO LEACH/INET FOR PRECISE GROUND POWER

This INET 400-cycle ground power unit was tailor-made for the Atlas. The unit operates in parallel with the missile's power system and provides remote control regulation. Frequency regulation is  $\pm 0.2\%$ . With shock load equal to a third of rated output, frequency recovers to  $\pm 0.2\%$  in 0.15 seconds. Voltage regulation is  $\pm 0.5\%$  with recovery time at 0.30 seconds.



# LOOK TO LEACH

INET DIVISION  
LEACH CORPORATION

18435 SUSANA ROAD, COMPTON, CALIFORNIA

DISTRICT OFFICES AND FIELD REPRESENTATIVES IN PRINCIPAL CITIES OF U.S. AND CANADA • EXPORT: LEACH CORPORATION, INTERNATIONAL DIVISION

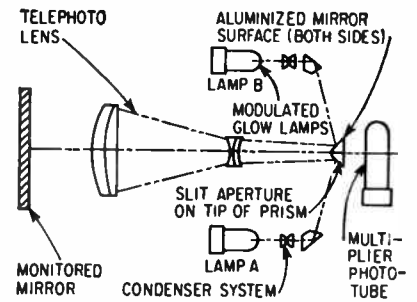


FIG. 1—If monitored mirror is not perpendicular to line of sight, modulated light reaches multiplier phototube

THE FRONT COVER—Tie-in to geographical reference is achieved with a survey theodolite incorporating an accurate azimuth circle and sighting telescope. Perkin-Elmer system provides reference for Ford Instrument inertial guidance in Jupiter

# Theodolite References Jupiter Guidance

AZIMUTH orientation of inertially guided missiles before launch establishes a frame of reference without which the missile could not navigate to its target. The irrevocable nature of inertial guidance after blast off spurred development of a highly accurate azimuth theodolite by Perkin-Elmer. The prototype and operational requirements have been supplied for the Redstone Arsenal for use with the Jupiter missile.

Optical and electronic techniques are combined in the theodolite to form a closed servo loop. Accuracy is characterized by the systems ability to detect deviations within the angle subtended by a dime placed a mile away.

### Operation

The theodolite detects discrepancies in alignment of basic monitored equipment by continuous observation of reflections from a mirror mounted on the stable platform of the guidance package. Rotational discrepancies cause error signals that are applied as corrective signals to drive elements of the monitored equipment via a closed loop between theodolite and missile.

The monitoring optical system consists of two modulated light sources, a telephoto lens as the ob-

jective, a beam dividing vee prism and a multiplier phototube. The system is shown in Fig. 1.

Light from the sources is reflected from a mirror or prism mounted on the stable platform. Two glow discharge lamps used as sources are modulated at 400 cps in phase opposition. The two lamps are each imaged at the focal plane of the telephoto objective by separate condenser systems.

A prism-shaped mirror reflects the beams along the optical axis of the objective lens. The resultant signal produced by the multiplier phototube is a function of the angular displacement of the monitored mirror from the squared-on position. This 400-cps signal is in phase or 180 degrees out of phase with the reference voltage, depending on the direction of deviation.

If the monitored mirror is squared on with the optical axis, reflected light will re-enter the objective, fall on the opposite side of the prism and be lost in the source. Thus by being perpendicular to the line of sight, a null results.

Tie-in to the geographical reference is achieved with a survey theodolite incorporating an accurate azimuth circle and sighting telescope. Desired angle between reference and monitoring line of

sight is set off using the azimuth circle. The zero setting is determined by autocollimating both systems from a common test mirror.

### Error Signal

If the monitored mirror is rotated in azimuth even slightly, returning beams will not be centered on the optical axis and will pass through a slit (which is ground and polished on the apex of the

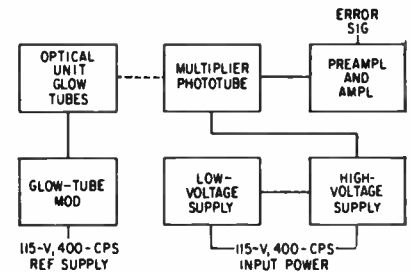


FIG. 2—Modulation of glow lamps is 180 degrees out of phase, so that light reaching multiplier produces signal indicating direction of error

prism) and strike the multiplier phototube, shown in Fig. 2. An error signal is produced which, by its phase, represents direction of azimuth deviation and, by its magnitude, the amount of error.

Error signals drive the stable



*first in  
Performance  
Reliability  
and Quality*

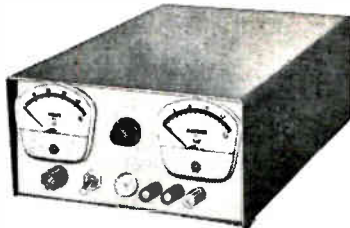
# Kepeco

## TRANSISTORIZED V.R.P.S.\*

\*VOLTAGE  
REGULATED  
POWER  
SUPPLIES



Model SC-32-2.5



Model  
SC-18-2M

**0.1% REGULATION  
STABILITY**

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

the most  
complete  
line of  
POWER  
SUPPLIES

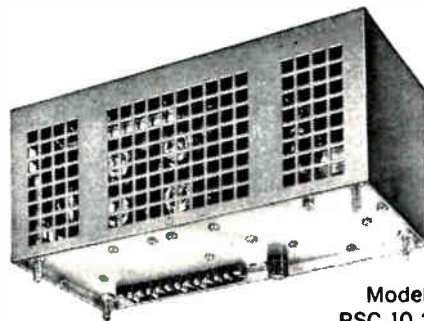
**0.01% REGULATION  
STABILITY**

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.
SC-32-0.5	0-32	0-0.5
SC-32-1	0-32	0-1
SC-32-1.5	0-32	0-1.5
2SC-32-1.5	0-32	0-1.5
DUAL OUTPUT	0-32	0-1.5
SC-32-2.5	0-32	0-2.5
SC-32-5	0-32	0-5
SC-32-10	0-32	0-10
SC-32-15	0-32	0-15
SC-60-2	0-60	0-2
SC-60-5	0-60	0-5
2SC-100-0.2	0-100	0-0.2
DUAL OUTPUT	0-100	0-0.2
SC-150-1	0-150	0-1
SC-300-1	0-300	0-1

**Kepeco**

offers more than  
120 standard voltage  
regulated power supplies  
covering a wide range  
of transistor, tube  
and magnetic types.

For complete specifications,  
write for Brochure B-591



Model  
PSC-10-2

**0.02% REGULATION  
STABILITY**

**COMPACT PACKAGE TYPE**

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



# Kepeco INC.

131-38 SANFORD AVENUE • FLUSHING 55, N.Y. • INDEPENDENCE 1-7000

*A story without an ending!*



## The Versatility of TAYLOR Vulcanized Fibre

### *What this material is . . .*

Vulcanized fibre is truly one of the wonder materials of all times. It is hard and dense, with excellent physical, mechanical and electrical properties. It is tough and resilient—has high resistance to impact, abrasion, wear, organic solvents, oils and gasoline. It is attractive and light in weight.

### *What can be done with it . . .*

Vulcanized fibre can be machined, turned, stamped and punched. It can be formed, sawed, drilled, planed, milled and chiseled. It can be hammered, shaved, threaded, buffed and sanded. It can be decorated by lacquering, painting, printing and engraving. It can be laminated.

### *How it can be used . . .*

Vulcanized fibre can be used for welders' helmets, golf club face inserts, carrying cases, track and motor insulation, and abrasive discs. It can be used for switch parts, gears, sliding door guides, shuttles, bobbin heads, labels and tags; for facings, table tops, partitions and kitchen utensils. There is no end to the things that can be done with it and the applications for which it is suited.

For more complete information on the forms and grades available, contact TAYLOR FIBRE CO., Norristown 40, Pa.

**Taylor**  
LAMINATED PLASTICS VULCANIZED FIBRE

platform back to correct azimuth heading. Error signals generated by the theodolite may also be recorded to obtain longterm data for making corrective adjustments.

Alignment using long-range theodolites is generally performed with the missile upright. In this position, its nose section is susceptible to sway of greater magnitude than the monitored prism width. Thus the long-range model incorporates a sway compensating system.

### **Short-Range Model**

Two theodolites are used with the Jupiter. The model described is supplemented by a short-range model. The short-range unit is stationed 3 to 4 feet from the foot of the missile and sends beams to an auxiliary prism monitoring unit (with same heading as top prism) in the Jupiter base.

This monitoring unit is directly connected to the launching ring on which the missile is positioned. A second auxiliary monitoring prism is also attached to the launching ring at an angle representing a second target point.

The short-range theodolite takes over alignment in the event of poor weather conditions that might distort the beam path to the nose section.

## Thyratron Used for Bistable Circuit

DEVELOPMENT of a tester for checking out repaired dial telephones led to an experimental bistable circuit. It uses a triode, a thyratron and only three other components.

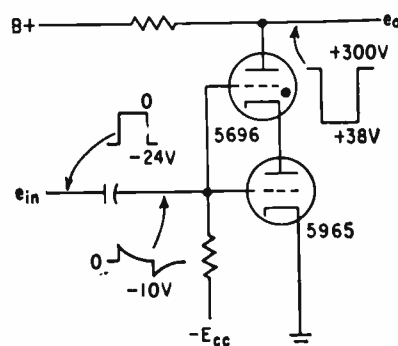


FIG. 1—Triode-thyratron bistable circuit delivers large pulses without being sensitive to changes in load

Conventional flip-flops were unsuitable for the particular application because they are sensitive to changes in load characteristics when handling large pulses. A thyatron was used because its plate-to-cathode voltage does not change with changes in current.

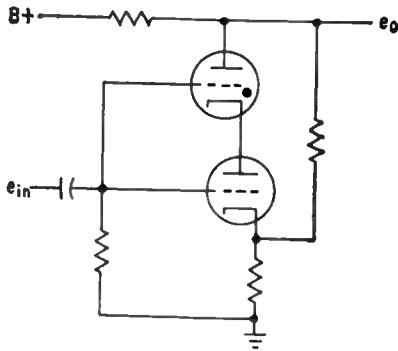


FIG. 2—Normal condition of monostable circuit is the ON state

The load can be entirely in the plate or cathode circuit of the flip-flop shown in Fig. 1, and an external load may be directly coupled. Triggering is unaffected by changes in plate current. Since the circuit does not have regenerative feedback, somewhat larger triggering pulses are required.

Time required for transition from OFF to ON state depends on breakdown time of the thyatron (about 5  $\mu$ sec). Transition from ON to OFF state is about equal to the rise time of the trigger waveform.

#### Operation

In the OFF state, both tubes are cutoff. An external positive pulse fires the thyatron and causes the triode to conduct. Because the triode grid is positive with respect to its cathode, it draws grid current. However, the thyatron grid is at a lower potential than its cathode so it delivers current. The circuit therefore locks in a stable condition.

An external negative pulse cuts off the triode, opening the thyatron cathode circuit and returning the circuit to its OFF state.

Other vacuum tube-thyatron circuits can be derived from the basic circuit. A monostable circuit is shown in Fig. 2.

This material was abstracted from The Western Electric Engineer, Oct. 1958, p 21-24.

# NEW Development!

## HICKOK

### 250° Arc

## LONG SCALE METERS

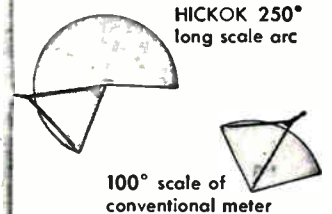
Save Valuable Panel Space

The scale in these new instruments is 2½ times as long as conventional meters. A 3½" HICKOK 250° meter has a scale length equal to a conventional 6" instrument.



These exclusive panel style 250° meters fit a smaller space though still provide easier, more accurate readings.

Available in all popular AC or DC ranges. Square, semi-flush or round flush cases. 2½" thru 5½" sizes.



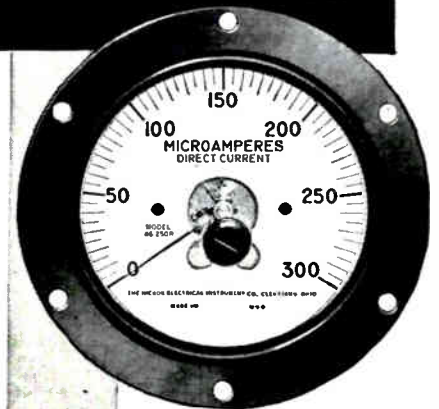
UNIFORM SCALE  
Evenly Spaced Scale Divisions

## RUGGEDIZED and SEALED

AC rectifier or DC types

The highly efficient HICKOK shock mount construction permits pointer and scale divisions to be easily read when meter is under vibration. The DC movement is a precise and rugged type.

The AC movement is of the AC rectifier type with unusually efficient magnetic damping for ruggedized purposes. Case is permanently sealed at the factory, however, may be opened and resealed.

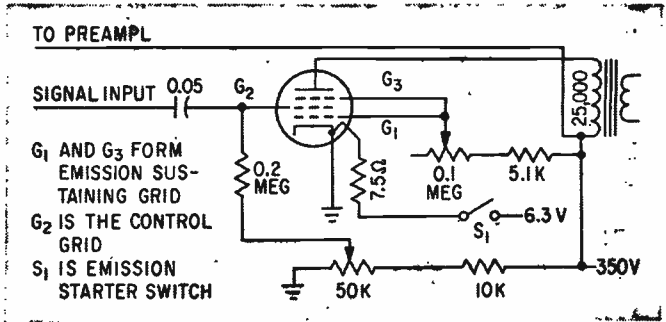
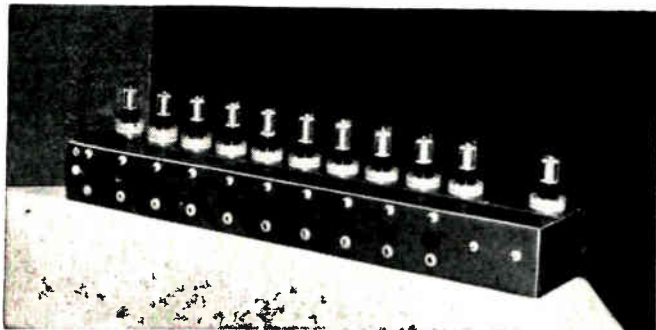


These instruments meet military specifications and are in volume production. Your inquiry is invited. Kindly list details of your requirements or request Catalog No. 39

### THE HICKOK ELECTRICAL INSTRUMENT CO.

10514 DuPont Avenue • Cleveland 8, Ohio





One conventional tube uses as much power as 10 cold-cathode tubes FIG. 1—Audio output amplifier using cold-cathode tube

## New Self-Sustained Emission Tube

MAGNESIUM OXIDE cold cathodes are a new electron source discovered at the Signal Corps Research and Development Laboratory, in the course of a study of the self-sustained secondary emission. Use of this cathode in a pre-production model of an audio output tube was recently demonstrated jointly by Tung-Sol Electric and the Army.

The cathodes were first discovered when thin MgO layers were deposited on a nickel base and bombarded with electrons possessing sufficient energy to produce secondary electron emission from the MgO. When the bombarding beam was turned off, the MgO layer continued to emit electrons without external stimulus. Neither heat, nor external light was necessary to keep alive the emission current. By varying the voltage at the collector electrode, this self-sustained current could be easily controlled for many hours from a few microamps to several tens of milliamperes.

A simple technique was finally developed which was suitable for large scale production of efficient and reproducible MgO cathodes. The resulting cathodes were successfully employed in electron tubes under a Signal Corps contract with Tung-Sol Electric Inc.

### Mechanism Of SSE

When emission starts from MgO a positive charge is developed at the surface of the MgO layer. Since the cathode coatings are thin, a high electrical field is created across the coatings. It is assumed that

under the influence of this field, electrons multiply by an avalanche process, and gain sufficient energy to enter the vacuum. The avalanche of electrons is assumed to be the result of a photoelectric effect in which photons are ejected during the recombination of positive ions with electrons. This concept can be considered only as a first approximation at present.

### The Tube

The first pre-production tube developed was an audio output amplifier (see Fig. 1). It develops 900 mw of power to drive a loudspeaker. Outwardly it looks exactly like a hot cathode tube since it is made of similar parts.

The power required to run one hot cathode of the conventional type is sufficient to run ten magnesium oxide cold cathodes. The cold cathodes require only three quarters of a watt per cathode totalling seven and a half (7.50) watts for the ten of them. This refers to cathode power only, not to plate or total power. The plate power is the same for one cold cathode tube as for one thermionic tube.

It is not necessary to have a filament transformer or separate battery to run the cathode in a cold cathode tube. The cathode itself can be run on a small portion of the direct current supply used for total operation of the tube. This applies also to the filament used momentarily for starting emission.

Advantages of the cold-cathode

tube are: less cathode power required for operation, quick starting, longer life, and no trouble from faulty heater operation.

The disadvantages are: even though the overall power is substantially less, a minimum voltage of about 300 volts is necessary for operation at present; the present tubes are not self starting; a starting means must be provided; the tubes are slightly more complex internally. The two types are about equal with respect to cost and noise level.

One of the early tubes has been in continuous operation for 14,000 hours without any decrease in the emission.

### Applications

Development work now is concentrated on other types of cold-cathode tubes. One is a preamplifier that will produce more amplification than any commercial hot-cathode tube. Sample tubes of this kind have already been produced successfully.

Another development presently under way is a cold cathode electron gun for use in cathode ray tubes for television, and in klystrons, travelling wave tubes and the like.

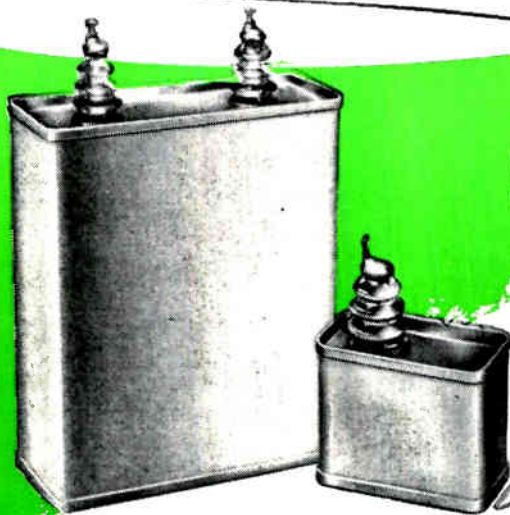
In the design stage is a flat, picture-on-the-wall display device for television or radar. It appears to be possible to produce brightness in such a device greater than that of any present picture tube.

Other applications include garage door openers, electronic computers where the elimination of the heater

For **HIGH** Insulation Resistance  
and Low Power Factor

**AEROVOX** Polystyrene Capacitors  
are wound with

**NATVAR**  
**Styroflex**®



Aerovox Polystyrene Capacitors are designed for applications where stability and low dielectric absorption are essential—such as computing devices, tuned circuits demanding highest Q standards, capacitance bridges, and laboratory standards. They are available in many case styles and in capacities from 0.001 mfd to 25. mfd. and in voltage ratings from 100 VDC to 1600 VDC.

**A**EROVOX Corporation, with ten plants from coast to coast, have been manufacturing capacitors since 1922. As leaders in the field, they have been quick to take advantage of new and better materials, and to anticipate the demands of the fastest growing industry—electronics.

They use Natvar Styroflex because it has all of the outstanding properties of polystyrene, plus complete flexibility, toughness and uniformity.

Natvar Styroflex is available in standard thicknesses from .0004" to .006" in rolls from 1/2" to approximately 10" in width. Ask for data sheet St-1.



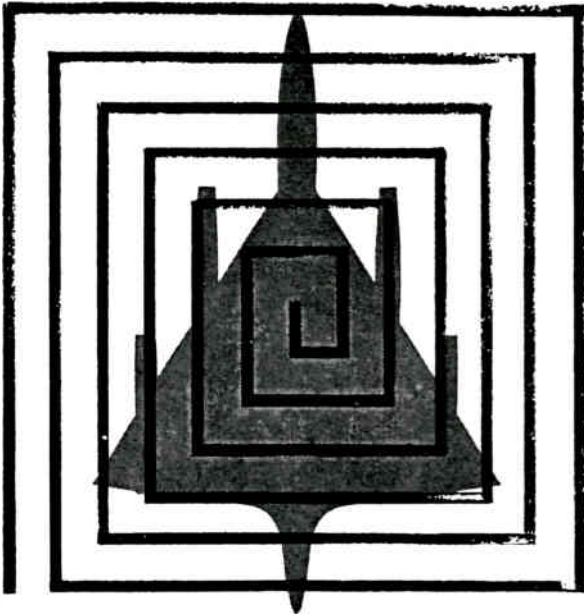
#### Natvar Products

- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fiberglas
- Varnished papers—rope and kraft
- Slot cell combinations, Aboglas®
- Isoglas® sheet and tape
- Isolastane® sheet, tape, tubing and sleeving
- Vinyl coated—varnished tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

We will be very happy to supply information on any of our products on request.

**NATVAR CORPORATION**

FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION  
TELEPHONE  
FULTON 8-8800  
CABLE ADDRESS  
NATVAR: RAHWAY, N. J.  
201 RANDOLPH AVENUE • WOODBRIDGE, NEW JERSEY



For Engineers & Scientists:

**THE PROBLEM:**

**Detection...  
Resolution...  
Identification**

Today we rely on devices hardly dreamed of a few short years ago. The limits of man's theoretical knowledge are being pushed farther almost daily. Between the theory and the device lies the exciting zone of applied research and development—the application of new concepts, and the development of new products. This is the fascinating challenge of creative engineering.

Radar Ambiguity is just one example, but typical, of the problems under intensive examination at Melpar. Important as the problems of radar are, they comprise but one part of the 110 different electronic research, development and production projects at Melpar.

**Rewarding positions are presently available in the following areas of Melpar's activities:**

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>Reconnaissance Systems Engineering Department</li> <li>Airborne Equipment</li> <li>Ground Data Handling Equipment</li> <li>Ground Support Equipment</li> <li>Simulation &amp; Training Systems</li> </ul> | <ul style="list-style-type: none"> <li>Communication &amp; Navigation Systems</li> <li>Detection &amp; Identification Systems</li> <li>Chemistry Laboratory</li> <li>Antenna &amp; Radiation Systems</li> <li>Applied Physics Laboratory</li> <li>Analysis &amp; Computation Laboratory</li> </ul> |
|--|--|

Positions are also available in our Production Division and our Quality Control Department.

For details about opportunities at Melpar, address your inquiry to:

TECHNICAL PERSONNEL REPRESENTATIVE



**MELPAR** Incorporated

A Subsidiary of Westinghouse Air Brake Company  
3377 Arlington Boulevard, Falls Church, Virginia  
10 miles from Washington, D.C.

would pay dividends in reliability and in total power drain, industrial and automation control circuits for the same reasons, telephone cables buried at the bottom of the sea where the unlimited life would be advantageous and in earth satellites where the low power drain would make operation on solar batteries feasible and where the long life and resistance to radiation from outer space would provide reliable functioning for years of orbiting.

An interesting feature of the cold cathode is its ability to sustain emission continuously at extremely low currents without danger of going out, and to start up again instantly. This offers a decided advantage when a small "keep-alive" current at adequate voltage is available. Restarting times have been measured as fast as one thousandth of a second.

**Semiconductors for Strain Gages**

Most commonly used metal-wire strain gages have gage factors ( $dR/RS$  where  $R$  is resistance of the unstrained element and  $dR$  is change of resistance with strain  $S$ ) between two and four. But germanium and silicon used in strain gages give gage factors of up to 150 and 175, respectively, according to the January 1959 issue of *Bell Laboratories Record*.

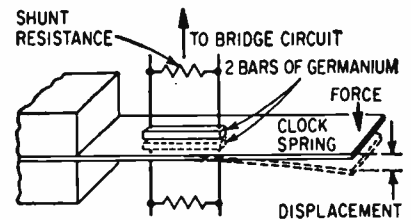


FIG. 1—Semiconductor strain gage for measuring displacement

With semiconductor gages, stress forces can be large since semiconductors are strong materials. They respond to torsional and shearing forces which wire-type gages do not.

Figures 1 and 2 show two versions of the semiconductor gages. Figure 1 is a drawing of a displacement gage while Fig. 2 shows the configuration of a torsional gage.



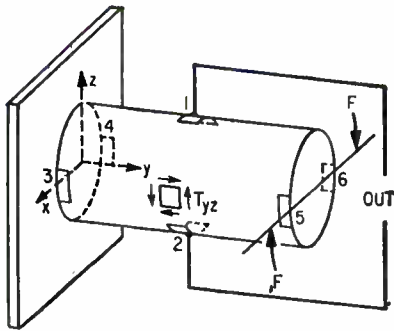


FIG. 2—Torsional transducer incorporating semiconductor cylinder

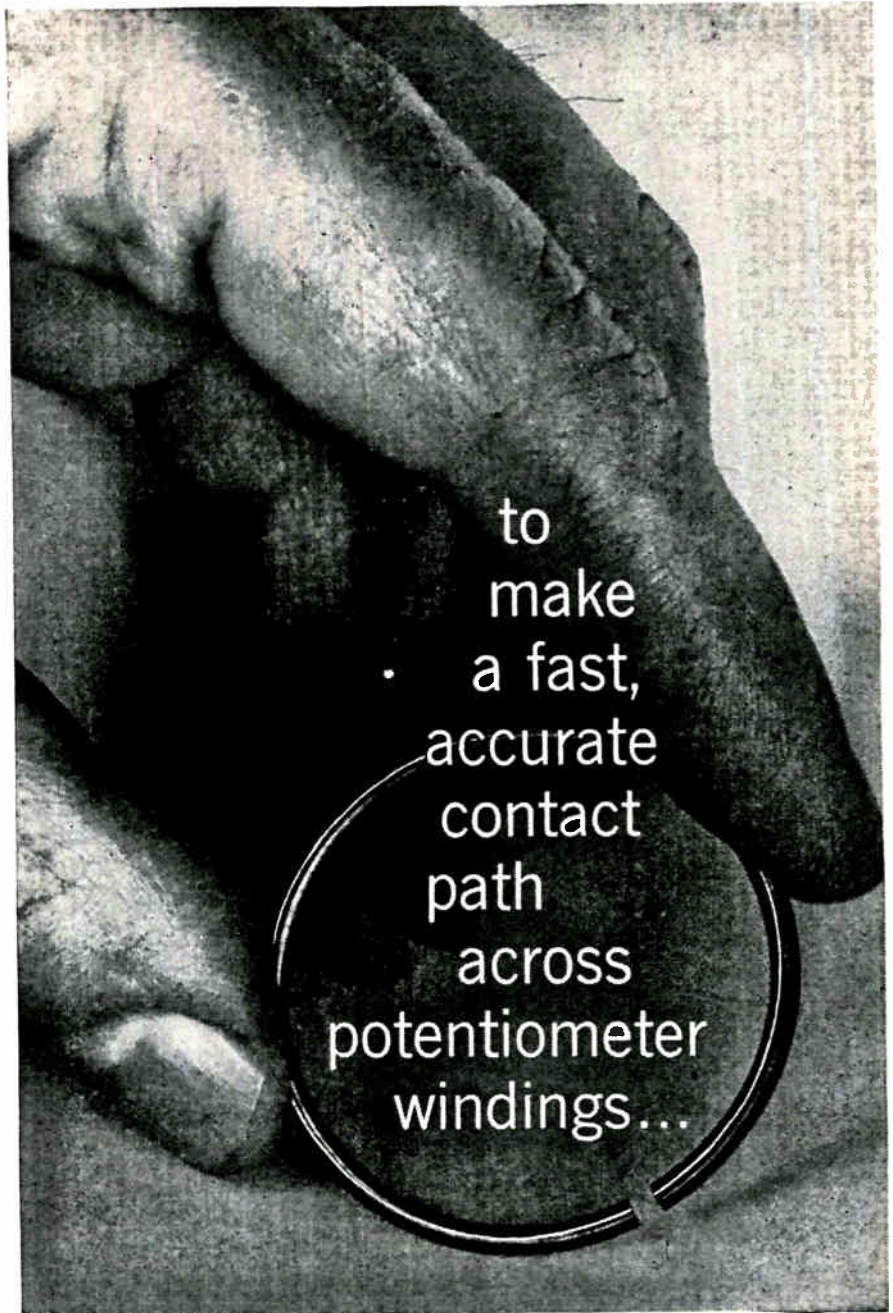
The torsional unit consists of a cylindrical crystal of germanium cemented to a solid support at one end. Electrodes one to six are attached as shown. With the proper biasing voltage, current flows from electrode three to five and from six to four. Electrodes one and two are normally neutral. But when a torque is applied to the free end of the cylinder, a voltage is generated across them. The voltage is directly proportional to torque and no balancing bridge is required.

### Stripline Resistors Have Mica Base

AVAILABLE as matched loads, fixed pads, variable attenuator elements, and terminations, Stripline resistors developed by Filmohm Corp. exactly match the shape and configuration of the Stripline circuit.

A thin film of specially selected natural mica is used for the base. The resistance film is an alloy of pure metals about 50 millionths of an inch thick and sealed with a thin coating of quartz. The mica base is made as thick as the height of the copper conductor (2-mil mica for 1.8-mil copper and 3-mil mica for 2.8-mil copper). Width is equal to width of the copper and length is determined by electrical match, power and resistance.

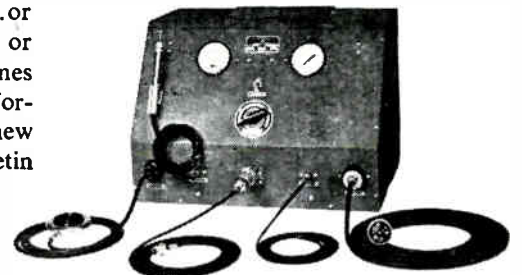
To install the resistor, a section of Stripline is etched out. The resistor is placed on the plastic dielectric between the copper conductors. Electrical contact is achieved by using conductive silver epoxy cement to join the silver tab on the resistor to the copper strip. The final step is to adhesive varnish the resistor and contact areas.



to  
make  
a fast,  
accurate  
contact  
path  
across  
potentiometer  
windings...

Cut potentiometer contact paths 6 to 10 times FASTER with the S.S. WHITE Airabrasive Unit. It gas-propels a fine stream of abrasives to give fast, uniform, perfectly controlled cutting action. The cutting action will not affect even the finest wires...or create heat to damage wires or surrounding varnish. Cuts lines as fine as .008"! For more information about this amazing new industrial tool, ask for Bulletin 5705A.

*S.S. White*  
INDUSTRIAL  
AIRBRASIVE®  
UNIT



S. S. WHITE INDUSTRIAL DIVISION, Dept.-EU, 10 E. 40th St., New York 16, N.Y.  
Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

# Kitting Smooths Production Flow



Subassembly kit is prepared at kitting table

Assembling a kit. Completed subassemblies, placed back in their plastic bags, are in box at assembler's right

TIGHTER CONTROL and coordination among purchasing requirements, inventory, production schedules and quality control has been gained by Magnetic Amplifiers, Inc., New York, N. Y., with an uncomplicated procedure which the firm calls kitting.

Component parts for each subassembly and major assembly are gathered together before the assembly reaches the production floor. Parts for small assemblies are placed in clear plastic bags. Parts and subassemblies for major assemblies are boxed. The parts are delivered to production personnel in numbered and sealed kits.

Cost of the procedure, the firm reports, is at most slight. In many cases, it leads to substantial sav-

ings by smoothing work flow. It has worked as well for large and small lot production.

Since all parts shortages are discovered prior to assembly, downtime while assemblers hunt for parts or go to the stockroom is negligible. Production personnel get all materials for each unit at one time and can make no mistakes in parts selection. Records are kept on a unit basis, giving preproduction quality control history of each assembly and its parts.

### Shortages Noted

Two cards are placed in each kit. One is an identification and quality control routing ticket. The other is a shortage card, listing any parts missing from the kit. These eliminate any confusion on the production line.

Production control personnel determine whether incomplete kits are to be released for assembly. Normally, kits are not released unless the parts can be readily added late in assembly. The cards give added flexibility to production scheduling.

If parts of the assemblies are to be changed after the kits are released, this can be done all at once on kits still unassembled.

First step in kitting is to obtain, inspect and accumulate parts for a production run. When a reasonable inventory of open stock and specially-ordered parts is on hand, the kits are made up. Materials in the stockroom are preassigned to particular jobs, but are stored by type as well as job for inventory control purposes.

Kitting areas and tables are set up adjacent to prekitting storage areas. Kitters are guided by parts lists. The shortage cards are filled out and are also used to make up shortage lists which are referred to purchasing for a followup.

Subassemblies are kitted first because often sufficient subassembly parts are on hand before final assembly materials are received. After assembly and testing, these are routed back into final assembly kits.

### Assembly Guides

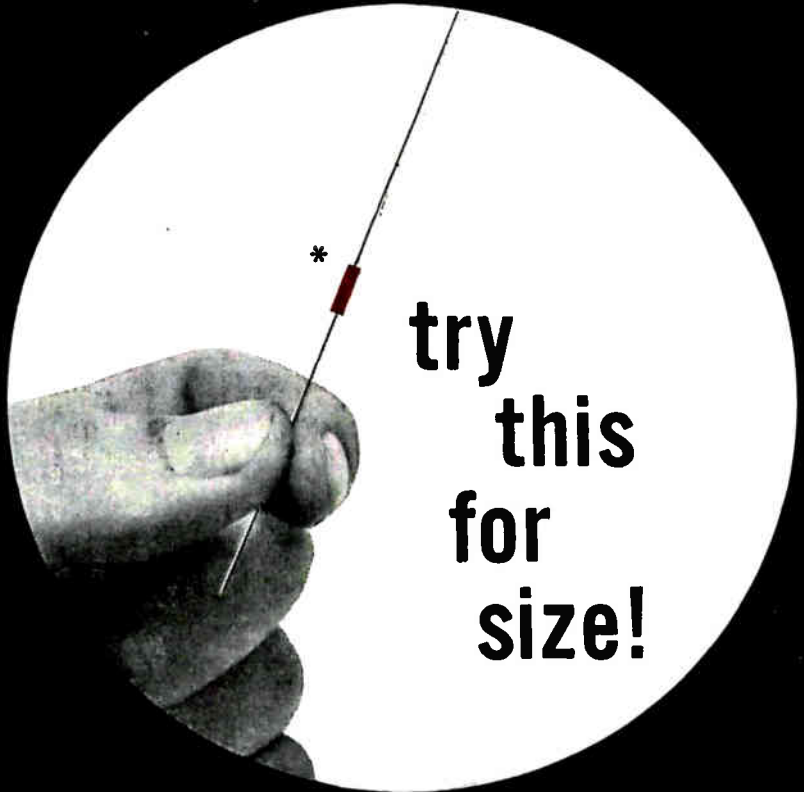
Assemblers are instructed in proper assembly techniques when they receive the kits. In addition, models, assembly drawings, color photos or black and white photos are provided as guides. The models have been previously tested and approved.

Photos are used when models are



Kit is placed in bag with quality control routing ticket





try  
this  
for  
size!

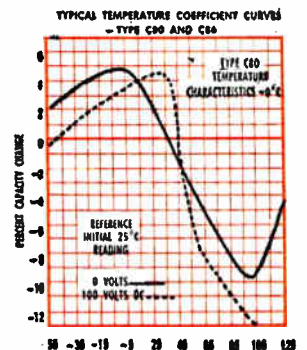
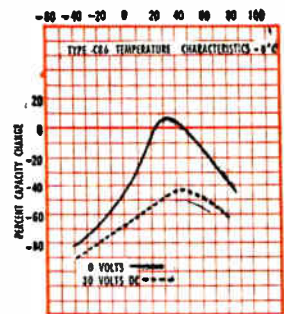
\* Actual size of a 1000 mmf. unit @ 100 vdc.

# Aerovox CERAFIL<sup>®</sup> Capacitors

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

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

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



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

OLEAN, NEW YORK





## Speaking of service . . . have you heard what PRICE is doing?

Price Electric has created a new service department within their sales organization . . . to give you fast, personalized service from inquiry to delivery.

As you know, Price has always had an enviable reputation for quality and reliability. Their relays are everywhere . . . flashing across the sky in our satellites, in missiles, telephones, car radios, business equipment, and a thousand other precision uses. Now . . . Price offers you reliability AND improved service.

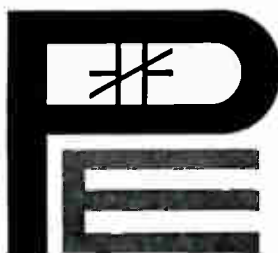
Why not give Price Electric a try on your next relay requirement?



**SEE THE NEW 1959 LINE  
OF PRICE RELAYS**

Write or Call

**PRICE ELECTRIC CORPORATION**  
Frederick, Maryland      MOument 3-5141



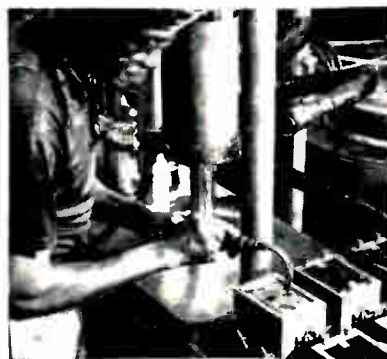
Subassemblies placed in box form major assembly kit

not available or when the lot is too small to warrant preparation of a model. The firm has a photo file covering every type of unit previously made by the firm.

## Skates Roll Potted Parts to Cure Oven

SKATE CONVEYORS are used to deliver a steady supply of encapsulated assemblies to the curing oven at Reliance Electric and Engineering Co., Cleveland, Ohio.

Subassemblies are interconnected in a bird cage frame. After test, the assemblies are locked in a



Encapsulant is pumped into mold through hose



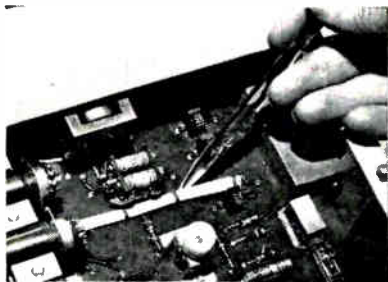
Tanks in background agitate compound

2-part aluminum mold. The molds go, 4 at a time, into a frame which rides on the wheels of a double-decked skate conveyor.

The conveyor holds 100 units. Thermosetting compound is poured into the molds at one end of the conveyor and the units are cured in an oven at the other end. The technique is used in the production of up to 2,000 motor control building blocks monthly.

## Wrap-Around Rubber "Tails" Hold Wiring

WIRING BUNDLES in the Bomarc missile, made by Boeing Airplane Co., Seattle, Wash., are secured with rubber "mouse tails", tapered at one end and with a button on the other end. The tapered end of the tail is passed through a small hole in the chassis, looped around the bundle and reinserted in an adjacent hole. The button acts as a



Painter shows "mouse tail" snugging wiring to chassis



Cutaway view of bundle secured by "mouse tail"

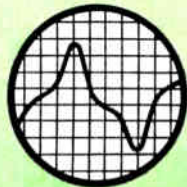
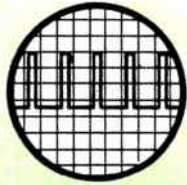
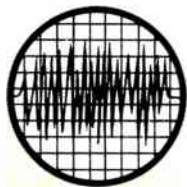
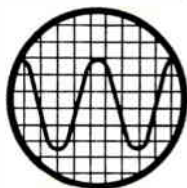
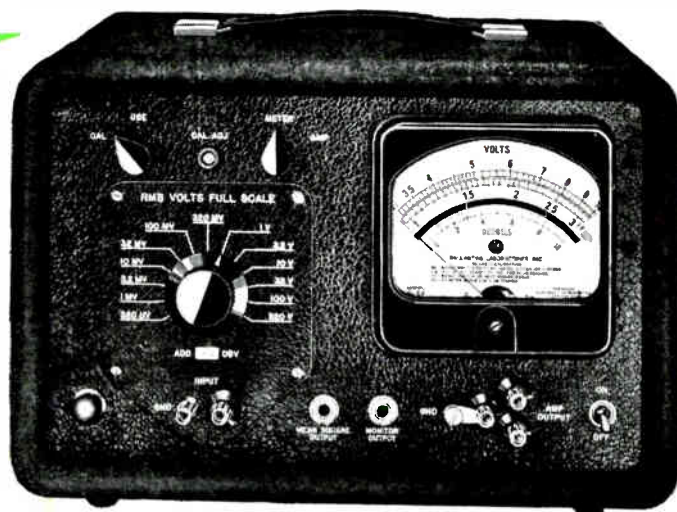
stop so the tough rubber can be cinched up tight. Elasticity permits the tapered end to be pulled through the hole. The rubber expands when tension is released, so the rubber becomes its own stopper. Boeing reports the tails are quicker to install and hold the bundles more securely than waxed string formerly used.

## Now Measure

# TRUE RMS

from 100 microvolts to 320 volts  
REGARDLESS OF WAVEFORM

with the Ballantine Model 320 Voltmeter



### REPRESENTING:

A distinctly new departure in VTVM design.

### FEATURING:

A built-in calibrator; — easily read 5-inch log meter; — immunity to severe overload; — useful auxiliary functions.

### BRIEF SPECIFICATIONS:

VOLTAGE RANGE:.....100 microvolts to 320 volts  
DECIBEL RANGE:..... — 80 dbv to +50 dbv  
FREQUENCY RANGE:.....5 to 500,000 cycles per second  
ACCURACY:.....3% from 15 cps to 150KC; 5% elsewhere  
Figures apply to all meter readings  
MAXIMUM CREST FACTORS: 5 at full scale; 15 at bottom scale  
CALIBRATOR STABILITY: .05% for line variation 105-125 volts  
INPUT IMPEDANCE: . . . 10 M $\Omega$  and 25  $\mu$ f, below 10 millivolts  
10 M $\Omega$  and 8  $\mu$ f, above 10 millivolts  
POWER SUPPLY:..... 105-125 volts; 50-420 cps, 75 watt  
Provision for 210-250 volt operation  
DIMENSIONS: (Portable Model) . . . . .14 $\frac{3}{8}$ " wide, 10 $\frac{1}{8}$ " high,  
12 $\frac{3}{8}$ " deep—Relay Rack Model is available  
WEIGHT:.....21 lbs., approximately  
PRICE: \$425

Write for the New Ballantine Catalog describing this and other instruments in greater details.

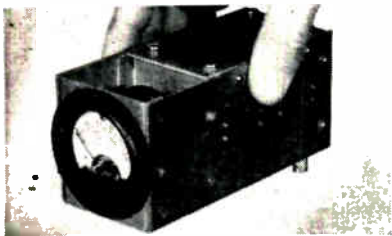
BALLANTINE LABORATORIES, INC.

Boonton, New Jersey





# ON THE MARKET



## VTVM small size

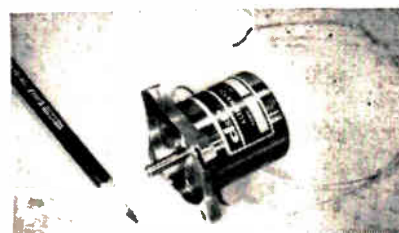
METRONIX, INC., Chesterland, Ohio. Designed to meet MIL-T-945A, model SPD-25 electronic voltmeter is especially suitable for use in aircraft, missiles and ground sup-

port equipment. It occupies panel space of only  $2\frac{1}{4}$  by  $2\frac{1}{2}$  in. and is less than 6 in. deep. Unit is available in any range from 0-30 mv to 0-300 v. Frequency response is 40 cps to 50 kc. Input impedance is 1 megohm, 15  $\mu\text{mf}$ . **Circle 200 on Reader Service Card.**

## H-F Generators light weight

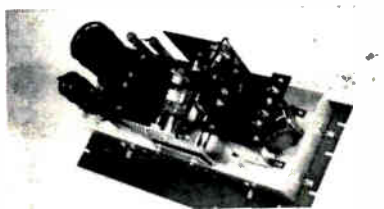
D&R LTD., 402 E. Gutierrez, Santa Barbara, Calif., has developed a small light weight generator suitable for a missile power supply. Capable of being driven by a hot

gas turbine or other suitable means, the model D-1309 develops 100 w of power at 6,000 cps with shaft speeds up to 60,000 rpm. Featured in the design are low internal impedance, low starting torque, low inertia, reliability. **Circle 201 on Reader Service Card.**



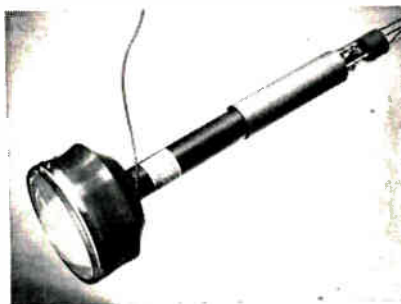
## D-C Power Supply silicon rectifier

GATES ELECTRONIC CO., 2090 Barnes Ave., Bronx 62, N. Y., announces a new line of silicon power rectifiers. Operating entirely without electronic tubes, the units consist of a double wound varnish impregnated step-down transformer,



full wave silicon rectifier, a varnish impregnated reactor and fil-

tering network. A unique protection circuit on models 15GX and 20GX indicates when continuous ratings are exceeded by flashing overload warning light on front panel. The units are designed for rack mount, but may also be used for bench testing at slightly additional cost. **Circle 202 on Reader Service Card.**



## Cathode-Ray Tube for airborne uses

FERRANTI, LTD., Hollinwood, Manchester, Lancs., England. A new micro-spot crt is capable of resolving 5,000 lines. Measuring 5 in. across, the 5/71 CM tube has been developed for airborne applications. The spot size is less

than 0.001 in. in diameter. The high resolution has been made possible by the use of an exceedingly fine screen and an entirely novel design of electron gun using two focusing elements, one of which is electromagnetic and external to the tube, while the other is electrostatic and of fixed focal length. **Circle 203 on Reader Service Card.**

## Converter analog/digital

RADIATION, INC., P. O. Box 37, Melbourne, Fla. The 12-bit Radicon converts analog information to digital (and digital to analog) for



use in modular data systems. It provides visual display and six selectable output codes compatible with most commercial digital computers. It features asynchronous operation at up to 24 kc word rate, accuracy to  $\pm 0.025$  percent full-



# ONE INTEGRATED SOURCE for Ceramic-to-Metal Seals



Standard types of Alite high voltage bushings are available in various sizes and configurations.

In *all* phases of planning for ceramic-to-metal seals—from design to finished assembly—you can rely on ALITE for the know-how and “do-how” required to produce highest quality ceramic-metal components for critical applications.

High alumina Alite is the ideal material for making rugged, high performance hermetic seals and bushings. It has superior mechanical strength, high temperature and thermal shock resistance, plus reliable electrical characteristics. Our complete high temperature metalizing and bonding facilities assure delivery of the finest seals available—mass-spectrometer tested for vacuum-tightness.

Please contact us for valuable performance data and information regarding ceramic-to-metal applications . . . no obligation.

## INSIDE LOOK AT ALITE—



Fact-packed, illustrated Bulletins A-20 and A-7R just off the press. Give vital technical data and product information. Write today.

ALITE DIVISION

**U. S. STONEWARE**

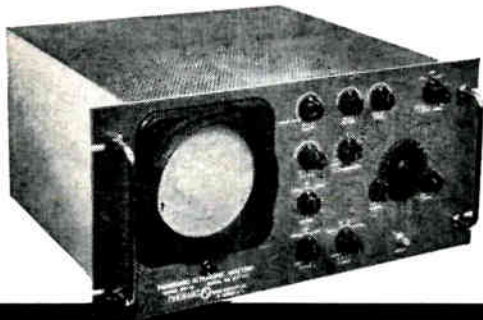
Orrville, Ohio

New York Office  
60 East 42nd St.

12F

# NOW 0.1 to 525 KC

in **one** compact  
reliable **ultrasonic**  
**spectrum analyzer**



## PANORAMIC'S NEW SB-15

... designed for maximum  
application utility, reli-  
ability and automaticity for

- Ultrasonic Spectrum Analyses
- Harmonic and Cross Modulation Investigations
- Ultrasonic Vibration and Noise Measurements
- Telemetering
- Monitoring
- Attenuation Measurements of Filters and Transmission Lines

In the all-new, precisely developed SB-15, you get expanded frequency coverage ... all the way to 525 kc! With a single, complete unit, only 8¾" high.

For a low-cost, highly stable Spectrum Analyzer 1-300 kc for the 300 kc range,



PANORAMIC'S  
**SB-7bZ**  
is the proven  
pace-setter



dependable  
**CERTIFIED**  
SPECIFICATIONS  
for accurate  
data

**PANORAMIC**  
RADIO PRODUCTS, INC.

530 South Fulton Ave. • Mount Vernon, N. Y.  
Phone: OWens 9-4600 Cables: Panoramic, Mount Vernon, N. Y. State

Check these specifications for the SB-15:

- Continuously calibrated sweep width from 200 KC to 1 KC
- Exceptional stability at reduced sweep widths
- 100 cps resolution capability
- Independently variable resolution or automatically optimized resolution to suit your needs
- Continuously variable sweep rate from 1 cps to 60 cps

For Single Line Frequency Response Curve Tracing



... just add the  
PANORAMIC  
**G-15**

... highly selective ... discriminates against noise and hum ... virtually unlimited dynamic range. Valuable for analyzing telemetering and carrier current system components, transformers, filters, transducers, amplifiers, receivers and various networks and devices.

GET the full story on the many other uses of the SB-15. WRITE, WIRE, OR PHONE for detailed specification bulletin; and ask to be put on our regular mailing list for The PANORAMIC ANALYZER featuring application data.

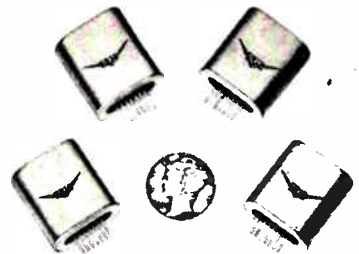


scale, and miniaturized solid-state construction. With companion modular blocks, it performs many on-line computation functions. Circle 204 on Reader Service Card.



### Microwave Equipment for 6 kmc band

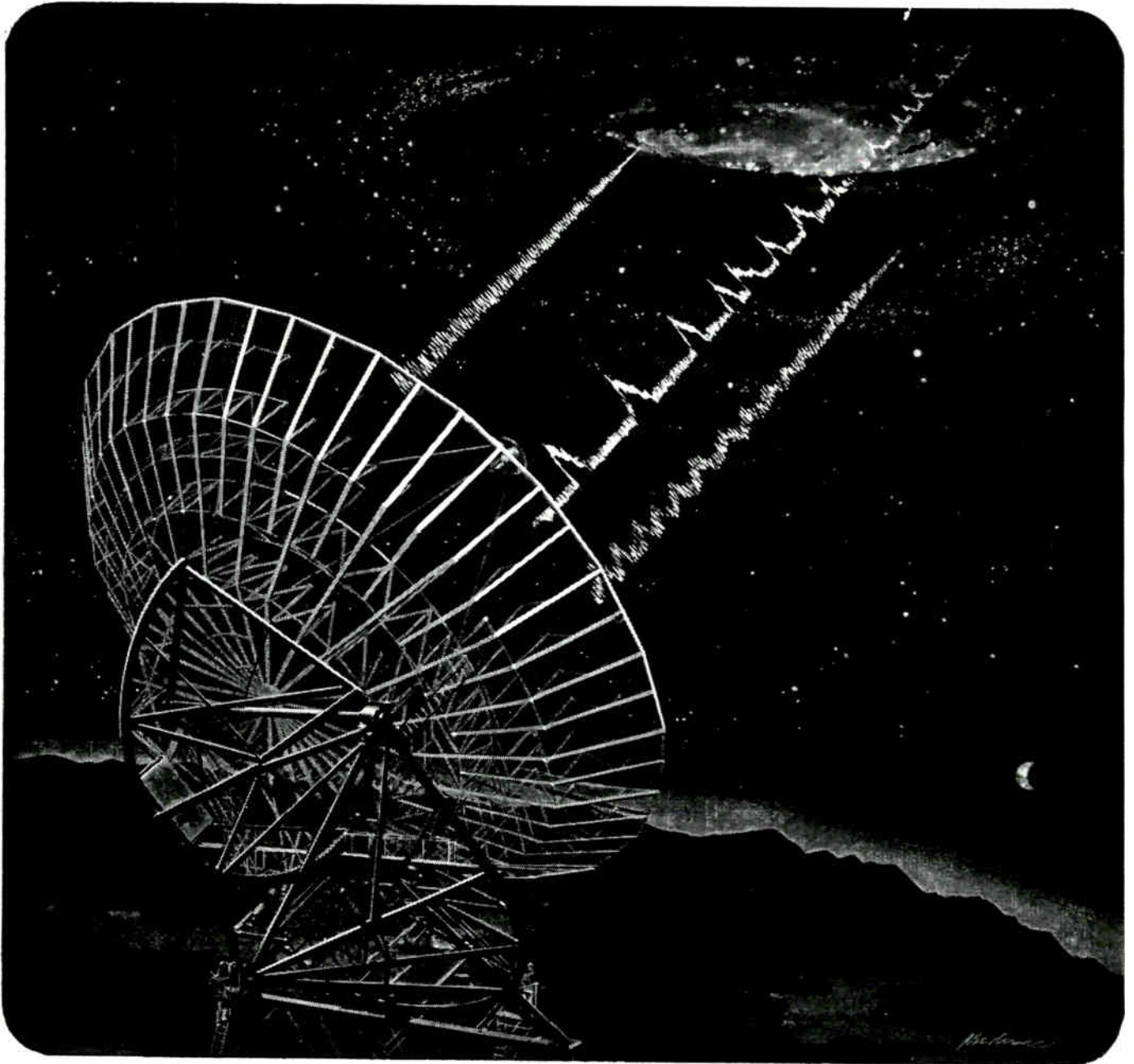
GENERAL ELECTRIC Co., Syracuse, N. Y., has introduced a new series of microwave equipment designed to operate in the 6 kmc band. This addition to the existing 2 kmc line places GE in a position to offer the communication industry a microwave line operating in both frequency bands. The 6 kmc line offers 120 channels to microwave users. The company will now offer both time division and frequency division multiplexing with its 6 kmc products and will continue to supply time division with its 2 kmc equipment. Circle 205 on Reader Service Card.



### Logic Circuits transistorized

ERIE RESISTOR CORP., Erie, Pa., announces the first of a line of high speed transistorized plug-in modules for digital equipment and system construction based primarily upon the NOR logic. These units are designed to work at speeds in excess of 2 mc under typical loading conditions. The module is designed to fit a standard 7 pin inline subminiature tube socket. Up to 144 units may be mounted on a standard 3½-in. by

## IMPORTANT DEVELOPMENTS AT JPL



### SIGNALS FROM VEHICLES IN SPACE

The exploration of outer space has taken a new step forward with the completion of the new giant radio antenna which has recently been installed by JPL at Goldstone near Barstow, California. This huge "dish," 85 ft. in diameter, enables the Laboratory scientists to probe still farther into space problems.

The Goldstone antenna is presently tracking rocket probes far out in space. Information thus obtained from Explorer satellites and Pioneer space probes is being

reduced and studied to provide invaluable basic data for future space programs.

The Goldstone link from space to earth will be extended from the present range of 500,000 miles to many times that figure, bringing the planets Mars and Venus within its reach.

This activity is part of the research and development program operated by JPL for the National Aeronautics and Space Administration.



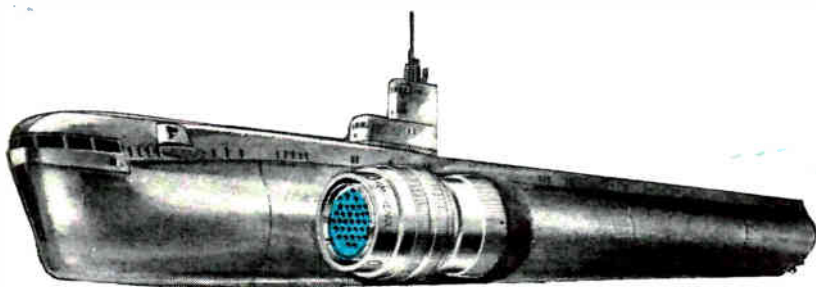
### JET PROPULSION LABORATORY

A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY  
PASADENA • CALIFORNIA

OPPORTUNITIES NOW OPEN IN THESE CLASSIFICATIONS ▶ APPLIED MATHEMATICIANS • ENGINEERING PHYSICISTS • COMPUTER ANALYSTS • IBM-704 PROGRAMMERS  
FIELD ELECTRONIC ENGINEERS • SENIOR R.F. DESIGN ENGINEERS • STRUCTURES AND DEVELOPMENT ENGINEERS

ELECTRONICS — February 6, 1959





## THE FLYING SUBMARINE

"Flying Submarine" describes AMPHENOL's new *MINNIE* 67 series connector; it may seem a large and unlikely name to fasten on such a small connector, but it's quite accurate. Here's why: The performance conditions under which these miniature "E" connectors will operate reliably are exactly like those encountered by a submerged submarine—flying at 80,000 feet altitude.

"Flying Submarine" also means *altitude-moisture resistant*. Under a test recently devised by industry and the armed services, wired *MINNIE*'s are completely submerged in salt water, altitude cycled to 80,000 feet for one minute, 65,000 feet for one half hour and then returned to ambient pressure for another half hour. Following this test, the minimum insulation resistance of *MINNIE* connectors is 1000 megohms, well in excess of the 100 megohms required by MIL-C-5015 after moisture exposure.

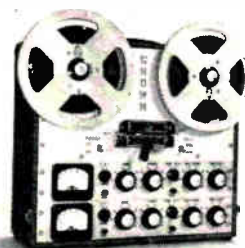
What can a "Flying Submarine" do for you? If you use electrical connectors in aircraft, missile or naval applications (including non-flying submarines), *MINNIE* connectors provide *assured environmental resistance to moisture* at sea level and at high altitudes. Write for complete information on AMPHENOL's *MINNIE* connectors!

AMPHENOL's Authorized Industrial Distributors stock *Minnie*'s and other standard AMPHENOL components—and provide on-the-spot delivery.

**AMPHENOL** connector division

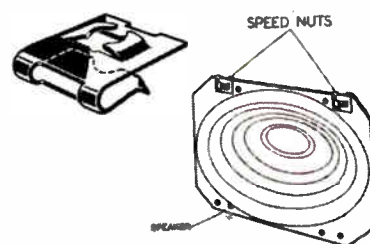
AMPHENOL-BORG ELECTRONICS CORPORATION  
chicago 50, illinois

19-in. rack panel. Each module measures 0.750 in. high, 0.687 in. wide and 0.297 in. thick. Alternative packaging for other uses is available. The standard unit contains 4 inputs. Circle 206 on Reader Service Card.



### Stereo Recorder professional type

INTERNATIONAL RADIO & ELECTRONICS CORP., Elkhart, Ind., is now marketing a stereo tape recorder for satellite tracking. The machine has 14 in. reels. Speeds include 1 $\frac{1}{2}$ , 3 $\frac{3}{4}$ , 7 $\frac{1}{2}$  and 15 ips. Signal to noise ratio is claimed to be outstanding. Price is \$805. Circle 207 on Reader Service Card.



### Fasteners dual-purpose

TINNERMAN PRODUCTS, INC., Cleveland, Ohio. Four spring steel J-type Speed Nuts provide both the fasteners and the grounding of the loudspeaker to the chassis in portable tv sets. One of the new dual-purpose fasteners is quickly and easily snapped on each corner of the speaker flange. Once positioned, the fastener retains itself firmly in screw-receiving position providing an "extra hand" for the final assembly of the speaker to the chassis. The speaker is then positioned and the screws driven, completing the assembly in a matter of seconds. One corner of the lower leg of the new fastener is



CONTINENTAL OPTICAL COMPANY

SPERRY

MET-L-ROL

GALLAGHER COTTON MILLS

THE AEROSONIC INSTRUMENT CORP.



CREST DIVISION OF JACQUES KREISLER CO

RADER AND ASSOCIATES ENGINEERS AND ARCHITECTS

THE BABY BUTLER ELEVATORIZED

A-M-P

Hood

BABCOCK & WILCOX BOILER DIVISION



Glace Engineering Corporation

FLORIDA FISHING TACKLE Mfg. Co. Inc.

Barracuda BRAND

Carnaval Fashions

BEE BEE TOGS, Inc.

Metal Industries, Inc.

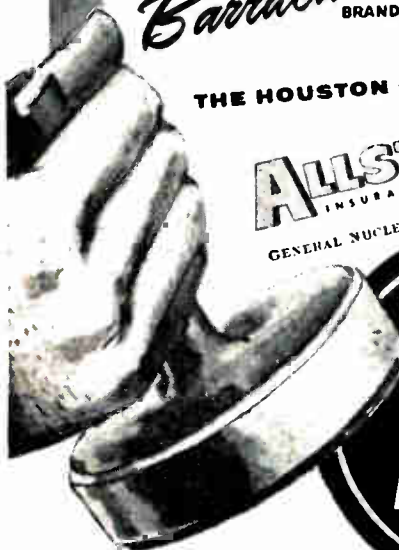


THE HOUSTON CORPORATION

Milton Roy CONTROLLED VOLUME PAPER

ALLSTATE INSURANCE COMPANY GENERAL NUCLEAR ENGINEERING CORPORATION

Smith and Gillespie "TAPECO" ELECTRONIC COMMUNICATIONS INC.

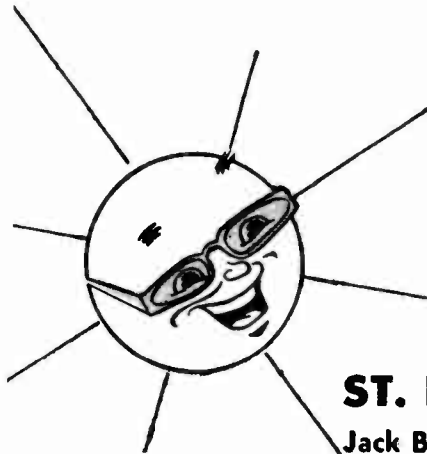


MAKE YOUR MARK

in greater St. Petersburg

Where work and play are combined—profitably! This fast-growing electronics, nucleonics and mechanical engineering and research center of Florida invites you to join these major business firms who have located in this area. Available skilled workers, excellent schools, fine transportation make an ideal community in which to live, work and play where most people dream of retiring. Write on your letter-head today for informative literature.

Note: Persons seeking positions with St. Petersburg industries, please write Florida State Employment Service, 1004 First Avenue North.



ST. PETERSBURG CHAMBER OF COMMERCE

Jack Bryan, Industrial Director

Dept. SA

St. Petersburg, Florida

### TUBE PROBLEM:

An amplifier manufacturer was plagued by noise, microphonics and hum that developed in the high gain stages of his amplifiers. Sonotone engineers were consulted on the problem.

### SONOTONE SOLVES IT:

Sonotone engineers discovered that they could correct *all three* complaints by redesigning just *one* tube.

### RESULTS:

The heater element was changed to a coil heater, eliminating the hum. And rigid controls on the mount structure and processing reduced microphonics and noise. This resulted in the Sonotone reliable type 7025. It's now available for initial equipment and replacement purposes.

Let Sonotone help solve *your* tube problem, too.

## Sonotone

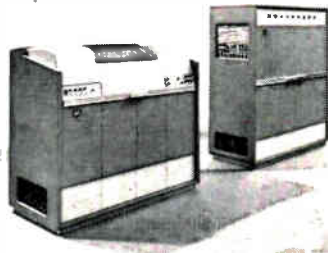
Electronic Applications Division, Dept. TRR-29  
ELMSFORD, NEW YORK

Leading makers of fine ceramic cartridges, speakers, microphones, tape heads, electron tubes.

In Canada, contact Atlas Radio Corp., Ltd., Toronto

CIRCLE 39 READERS SERVICE CARD

turned down. This not only facilitates mounting, but as the screws are tightened these corners bite hard into the chassis to provide four positive grounding points. Circle 208 on Reader Service Card.



### Line Printer transistorized

BURROUGHS CORP., 460 Sierra Madre Villa, Pasadena, Calif., has developed a transistorized line printer which will select, edit and print out data from a computer or magnetic tape at rates up to 1,500 lines per minute. The high-speed printer is integrated with the new Burroughs 220 electronic data processing system. It features on-line or off-line operation, buffer data storage and automatic editing—all under plugboard control. Used on-line, the printer system takes advantage of the computer's electronic speed to produce up-to-the-second reports directly from the data processor. Off-line, it edits and transcribes data from Burroughs 220 magnetic tape storage units, freeing the computer for other processing jobs. Circle 209 on Reader Service Card.

### Servo Multiplier miniaturized

INDUSTRIAL CONTROL Co., 805 Albin Ave., Lindenhurst, L. I., N. Y. The SL-1024 is a high performance, miniaturized servo multiplier driven by d-c data. It consists of a servo loop that positions a shaft to follow a  $\pm$  d-c signal, and a multisection pot for computation. Unit uses a high reliability transistor-magnetic amplifier, with all circuits sealed for maximum life. The only power required is 117 v  
(Continued on p 84)

## LACING TAPE PROBLEMS? GUDEBROD CHARTS THE ANSWER

	GUIDE-GLASS	TEMP-LACE H	STUR-D-LACE H	GUIDELACE H	GUIDELACE
MAX. TEMP. °C	375°	220°	160°	125°	90°
WAXED FINISH					X
RUBBER FINISH		X	X	X	
NON-TOXIC	X	X	X	X	X
INERT	X	X	X	X	X
FLEXIBLE TO °C	-40°	-40°	-40°	-40°	-20°
FUNGUS RESIST.	X	X	X	X	X
SIZES AVAILABLE	4	5	7	5	7
SLIP RESISTANCE COMPLIANCE	X	X	X	X	X

Only a few Gudebrod flat-braided Lacing Tapes are included in this chart. Many are available with silicone finish, with vinyl finish... many are available pre-shrunk with controlled shrinkage characteristics. We will be glad to engineer a tape to meet your needs.

Gudebrod Lacing Tapes and Drive Cords are used with signal success in communications, utilities and the critical field of defense electronics. Write for new Data Book with complete specifications of ALL Gudebrod Lacing Tapes.

## GUDEBROD BROS. SILK CO., INC.

ELECTRONIC DIVISION  
225 West 34th Street, New York 1, N.Y.  
EXECUTIVE OFFICES  
12 South 12th Street, Philadelphia 7, Pa.

CIRCLE 40 READERS SERVICE CARD

February 6, 1959 — ELECTRONICS



# PRESENT SUBSCRIBERS

## — Please Note!

This subscription coupon is for NEW subscribers. It is not intended as a renewal notice. If you are already personally subscribing, we shall appreciate your passing the form to one of your associates. Thank you.

Mail Reply to: McGraw-Hill Pub. Co., Electronics, 330 W. 42nd St., N. Y. 36, N. Y.



### NEW Subscription ORDER FORM

O.K. — put me down for a personal subscription to "electronics" . . . giving me benefit of your weekly editorial service . . .

Check here  for 1 year, \$6     for 2 years, \$9     for three years, \$12

- Please  One
- Send bill to home address
  - Send bill to Company address
  - Payment Attached

Name \_\_\_\_\_ Dept. \_\_\_\_\_

Company Name \_\_\_\_\_

Street \_\_\_\_\_ City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

Products Mfrd. \_\_\_\_\_ Number of Employees \_\_\_\_\_

Or Service \_\_\_\_\_

Street \_\_\_\_\_ City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

Please fill out card completely for best service

Check here if you want Publication sent to your home

Foreign Rates (1 year) Canada \$10, Other Foreign \$20

Now...

# DIALCO Pilot Lights

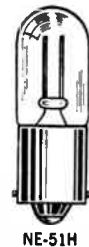
with **Built-in Resistor** (18,000 ohms)  
(a patented DIALCO feature)

and the **NEW High Brightness Neon Glow Lamp NE-51H**



### A New Advance in Pilot Light Design by DIALCO:

Three basic advantages are incorporated in this series of DIALCO assemblies: (1) *Built-in resistor* for direct use on 125 to 250 volt circuits . . . (2) *New plastic lens* designed to give attractive "halo" effect . . . (3) *New High Brightness Neon Glow Lamp NE-51H*. This lamp may be operated at about 3 times the level of current



Catalog No. 132-408-991H

NE-51H

that may be applied to the standard lamp, and it will produce 8 times as much light—with long life! Very low power is required, less than 1 watt on 250 volt circuit. Recommended for AC service only.

In the DIALCO assembly, the built-in current limiting (ballast) resistor (18,000 ohms) is *completely insulated in moulded bakelite* and sealed in metal (U. S. Patent No. 2,421,321) . . . Small space required—units are available for mounting in 9/16" or 11/16" clearance holes . . . A wide choice of optional features includes lens styles, shapes, and colors; terminal types; metal finishes, etc. . . Meet applicable MIL Spec and UL and CSA requirements.

**All Assemblies Are Available Complete with Lamp  
SAMPLES ON REQUEST—AT ONCE—NO CHARGE**

DIALIGHT CORP., 58 Stewart Ave., Brooklyn 37, N. Y.

Send brochures on Pilot Lights  for NE-51H Neon lamp  Sub-Miniatures  Oil-Tight

Name \_\_\_\_\_ Position \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

Foremost Manufacturer of Pilot Lights

# DIALIGHT

CORPORATION

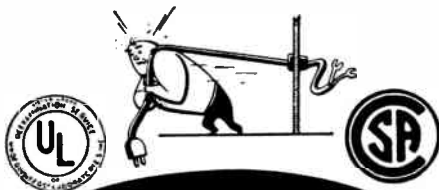
58 STEWART AVE., BROOKLYN 37, N. Y. • HYacinth 7-7600

CIRCLE 43 READERS SERVICE CARD



The Approved  
Standard for  
Insulating and  
Anchoring  
**ELECTRICAL  
CORDS & CABLES**

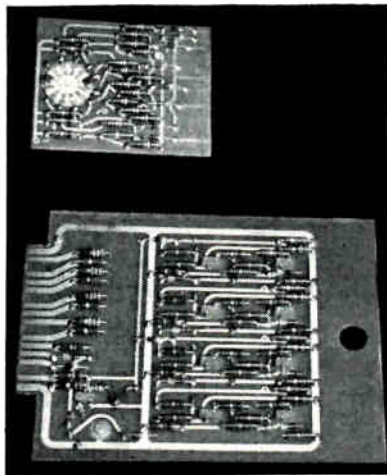
**FREE TEST SAMPLES** will be sent on the receipt of the sizes of the wires you are using.



**HEYMAN  
MANUFACTURING CO.**  
KENILWORTH 2, NEW JERSEY  
HEY MAN!—SAY HEYMAN

CIRCLE 44 READERS SERVICE CARD

400 cps. Typical input signals are within  $\pm 100$  v d-c, with static error under 0.25 percent and full scale travel within 0.5 sec. Output position is indicated on a calibrated dial. Circle 210 on Reader Service Card.



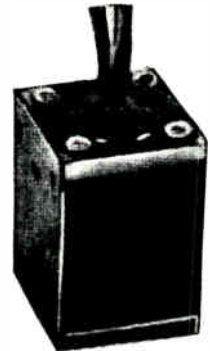
**Decimal Selector  
for counter use**

NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa., announces a new decimal to four line binary code converting switch, model 319C, which can be used to preset the "complement nine" binary code directly into their model 190A or 312 transistorized binary decimal counters. The selected decimal number is converted into four line binary code and is controlled by four diode "gates" at the output points. With "complement nine" presetting, the carry pulse from the last decade can be used as a "stop" pulse in a counting operation and no resetting is needed. Circle 211 on Reader Service Card.

**TWT Amplifier  
for modern radar**

VARIAN ASSOCIATES, 611 Hansen Way, Palo Alto, Calif. The VA-125 is a one megawatt, 2.7-3.0 kmc, twt amplifier for modern radar. It gives systems engineers greater freedom in radar design. A broad-band, high gain, liquid cooled twt pulse amplifier, it is intended to cover a large portion of the S-band without tuning and is for use in coherent high power radar appli-

**Acme  
2002  
POTTING  
COMPOUND**



*Recommended  
For All  
MINIATURIZED  
UNITS*

ACME 2002 POTTING COMPOUND is unaffected by climatic changes and assures 100% protection against extremes of temperature ranging from  $-100^{\circ}$  F. to  $+185^{\circ}$  F.

Developed to withstand elevated and subzero conditions, ACME 2002 forms a hard, moisture-proof seal that will not crack or become brittle when subjected even to sudden changes in temperature. Exterior casings are not necessary.

There are many Acme Compounds for various applications. Let us help you.

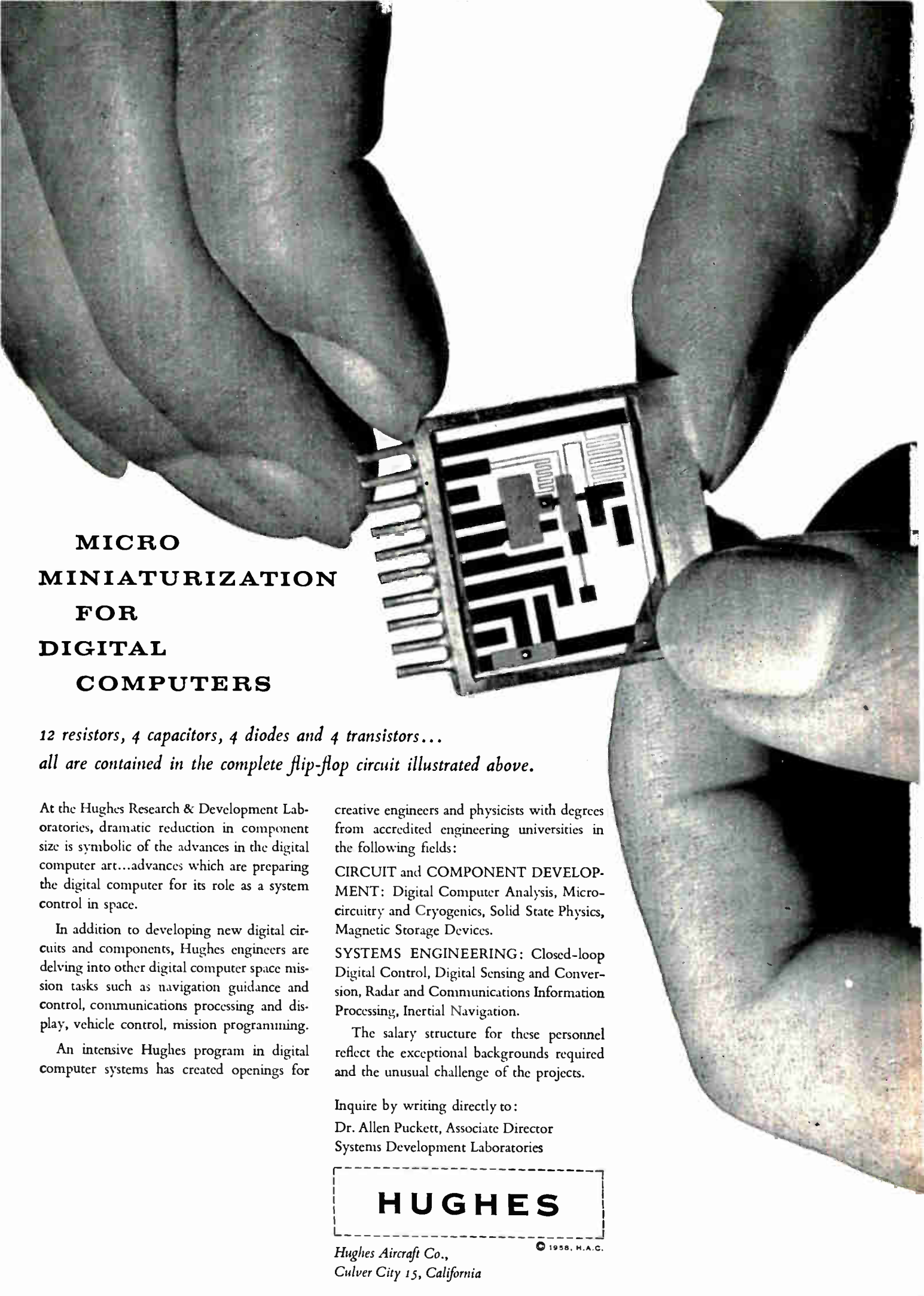
Integrated Electrical Products  
of Highest Quality for  
Over Fifty Years

**ACME WIRE CO.**  
NEW HAVEN, CONN.

MAGNET WIRE • COILS  
VARNISHED INSULATIONS  
INSULATING VARNISHES  
AND COMPOUNDS



CIRCLE 66 READERS SERVICE CARD  
February 6, 1959 — ELECTRONICS



**MICRO  
MINIATURIZATION  
FOR  
DIGITAL  
COMPUTERS**

*12 resistors, 4 capacitors, 4 diodes and 4 transistors...  
all are contained in the complete flip-flop circuit illustrated above.*

At the Hughes Research & Development Laboratories, dramatic reduction in component size is symbolic of the advances in the digital computer art...advances which are preparing the digital computer for its role as a system control in space.

In addition to developing new digital circuits and components, Hughes engineers are delving into other digital computer space mission tasks such as navigation guidance and control, communications processing and display, vehicle control, mission programming.

An intensive Hughes program in digital computer systems has created openings for

creative engineers and physicists with degrees from accredited engineering universities in the following fields:

**CIRCUIT and COMPONENT DEVELOPMENT:** Digital Computer Analysis, Micro-circuitry and Cryogenics, Solid State Physics, Magnetic Storage Devices.

**SYSTEMS ENGINEERING:** Closed-loop Digital Control, Digital Sensing and Conversion, Radar and Communications Information Processing, Inertial Navigation.

The salary structure for these personnel reflect the exceptional backgrounds required and the unusual challenge of the projects.

Inquire by writing directly to:  
Dr. Allen Puckett, Associate Director  
Systems Development Laboratories

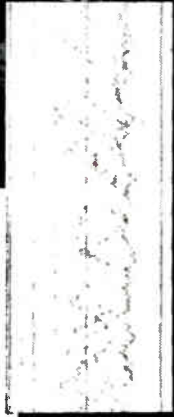
**HUGHES**

Hughes Aircraft Co.,  
Culver City 15, California

© 1958, H.A.C.



**Test:**  
*in progress*  
**Readout:**  
*instantaneous*



Immediately evaluate your test results, using new, *extra-thin* Kodak Linagraph Direct Print Paper in suitable moving-mirror galvanometer oscillographs.

No wet processing! Records can be read as they're being made. And you get sharp, legible traces to 30,000 i.p.s.

New Kodak Linagraph Direct Print Paper on *extra-thin* base provides *extra footage* for longer runs. Sizes on request. For complete details, write to:

**EASTMAN KODAK COMPANY**

Photo Recording Methods Division

Rochester 4, N. Y.

CIRCLE 67 READERS SERVICE CARD

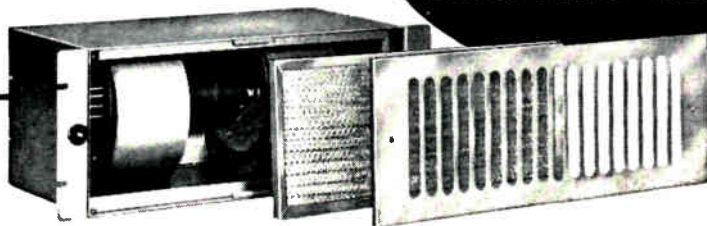
*Now available on extra-thin base*

Rack-Mounted • Compact

Ready-To-Use • Low Cost

High Efficiency • Quiet

The  
**WORLD'S  
Most Practical  
COOLING UNIT**



McLean

**From the World Leader in Packaged Cooling!**

McLean's Model 2E408A popular cooling units are the industry's standard . . . there are no better packaged blowers available. Over 10,000 of them are in use, cooling transistors, power supplies, and electronic tubes in systems all over the world! They provide high velocity, and fast cooling in a minimum of space (7 inches x 19 inches, 300 CFM.) McLean has a complete line of fans and blowers in every size for every cooling application. Mil. Spec. equipment for packaged cooling also available.

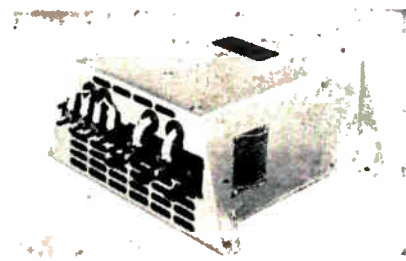
**McLEAN ENGINEERING LABORATORIES**  
World Leader in Packaged Cooling  
Princeton, New Jersey — WALnut 4-4440  
Twx Princeton, New Jersey 636



**FREE TECHNICAL DATA**

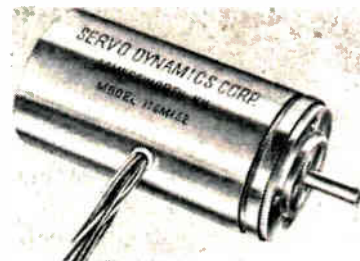
- 24 Page Catalog
- 12 Page Article Forced Convection Cooling
- Specification Sheet on Reversible Fans

cations. The x-ray shielding is provided as an integral part of the VA-125 and its accompanying VA-1503B focusing electromagnet. Useful bandwidth is 375 mc and power gain, 28 db. Pulse beam voltage is 110 kv and pulse beam current, 60 amperes. Circle 212 on Reader Service Card.



**Converter  
transistorized**

ELECTROSOLIDS CORP., 13745 Saticoy St., Panorama City, Calif., announces a new transistorized converter. The transformer-rectifier unit is constructed of PN-junction type diodes to effect a weight saving that results in a 200-ampere unit weighing only 17 lb. The 28-v unit accepts three phase input power at 400 cps, 115/200 v. Model W-1328 converter uses solid state components throughout, with operating life expectancy in excess of 50,000 hr. Circle 213 on Reader Service Card.

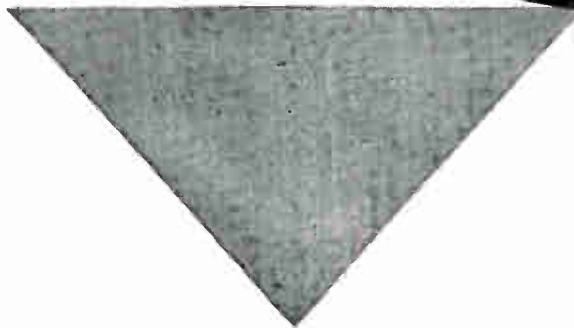


**Motor Generator  
size 11**

SERVO DYNAMICS CORP., Somersworth, N. H. Manufactured in 400 cycles, the model 11GM152 motor generator is designed to operate between 6 and 200 v. The no load speed is 6,000 rpm with a power input of 3.5 w at 0.053 ampere. Effective resistance is 3,780 ohms. Output shafts are designed to customer requirements. Linearity is



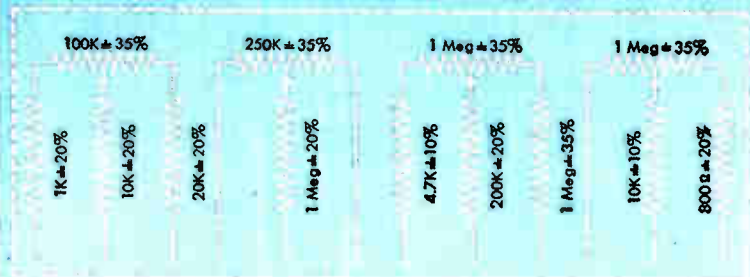
**Cost Savings  
Higher Reliability  
your job...  
and Centralab's**



**Model 5 Radiohm®**  
1/4 watt multiple miniature  
variable resistor  
(Component Density=16.2 per cu. in.)\*

\*Cubic inch, rather than cubic foot, is used to provide a more realistic and more readily visualized standard of comparison.

**TYPICAL MODEL 5**



up to 4 variable and 9 fixed resistors on a single steatite plate measuring 2 1/4" x 3/4" x 15/32", including knobs . . . proportionally smaller when fewer variable resistors are required.

**ECONOMY:** Installed cost is considerably lower than larger variable resistors and separate fixed resistors. Substantial savings result from reduced production assembly costs.

**RELIABILITY:** Steatite bonded resistance elements assure high stability and noise-free operation. Conservative ratings provide an extra margin of safety under maximum load or severe environmental conditions.

**VERSATILITY:** The Model 5 Radiohm® is available with one to four variable resistors, with horizontal or vertical mounting brackets, plug-in terminals for printed circuit boards or wire leads for metal chassis.

**SUPERIOR KNOB CONSTRUCTION:** Unusual design permits adjustment with internal or external hexagon wrench, screwdriver, or by fingertip.

**SPECIFICATIONS:**

Resistance Range: 1000 ohms to 5 megohms, linear taper.  
Wattage Rating: 1/4 watt at 70° C. ambient.

Breakdown Voltage: 1250 Volts RMS, between adjacent sections and to bracket.

End Resistance: Less than 1% of total.

Rotational Life: Less than 5% resistance change after 250 rotations.

Initial Torque: 2 inch ounces average.

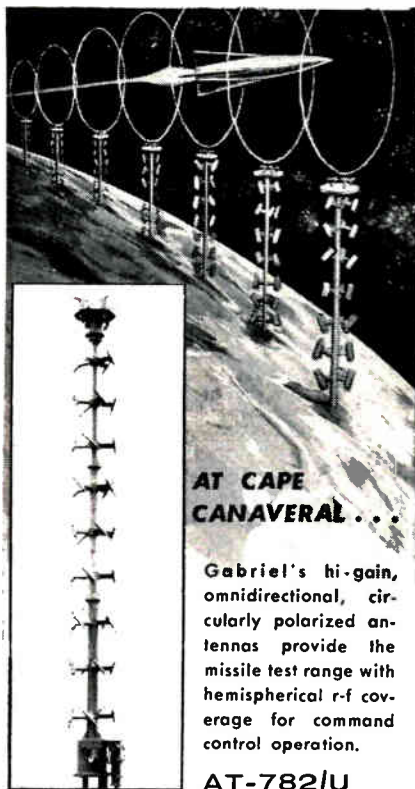
Write for Centralab Bulletin EP-539 giving full specifications on the Model 5 Radiohm® series.

**Centralab** 

A DIVISION OF GLOBE-UNION INC.  
914B EAST KEEFE AVE. • MILWAUKEE 1, WIS.  
In Canada: 804 Mt. Pleasant Rd., Toronto 12, Ont.

VARIABLE RESISTORS • ELECTRONIC SWITCHES • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS





**AT CAPE  
CANAVERAL . . .**

Gabriel's hi-gain, omnidirectional, circularly polarized antennas provide the missile test range with hemispherical r-f coverage for command control operation.

**AT-782/U**

The AT-782/U antennas manufactured and designed by Gabriel provide null-free spatial coverage along the 5000 mile range. Part of the Ground Support Equipment (G.S.E.) at this missile test center, the all aluminum AT-782/U has increased directivity in the vertical plane and has a turnstile of dipoles for overhead coverage.

**Other features:**

- Frequency . . . . .400 to 500 mc
- VSWR . . . . .1.4 over bond
- Gain . . . . .10 db
- Power . . . . .2 kw
- Wind Loading . . . . .120 knots
- Pressurization . . . . .3 psi
- Input . . . . .1/2" coax line
- Weight . . . . .300 lbs.

**. . . AND POINT MUGU**

**DRONE CONTROL  
ANTENNA**

**AT-781/U**

Gabriel's smaller version of the AT-782/U for application where gain requirements are not as great. It has proven a very reliable drone command antenna because of its hi-gain, hi-power and null-fill-in characteristics.



Write for complete Data Sheets  
L5-A, L5-B

**Gabriel**

**ELECTRONICS DIVISION**  
135 Crescent Road  
Needham Heights 94, Mass.

CIRCLE 46 READERS SERVICE CARD

0.5 percent. Ambient operating range is -65 C to +200 C. Body length is 1.875 in. Circle 214 on Reader Service Card.



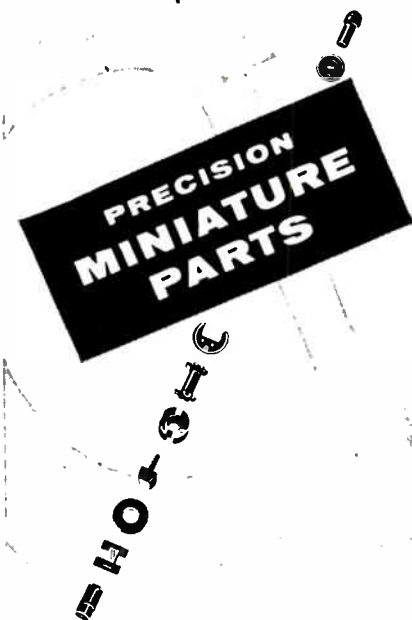
**VOM Analyzer  
highly sensitive**

WESTON INSTRUMENTS, Division of Daystrom, Inc., Newark 12, N. J. Model 980 Mark II analyzer, a highly sensitive and extremely sturdy volt - ohm - milliammeter, was engineered to provide for a wide range of test measurement applications in the electrical and electronic fields. It has a d-c sensitivity of 20,000 ohms v, and an a-c sensitivity of 1,000 ohms/v. It offers accuracy within 2 percent full scale d-c and 3 percent a-c. Range and function-switching is greatly simplified by use of a single dial control. The Cormag mechanism protects the instrument against magnetic disturbances, and electrostatic shielding assures accurate measurements at high d-c voltage. Circle 215 on Reader Service Card.

**Analog Computer  
all solid-state**

SOUTHWESTERN INDUSTRIAL ELECTRONICS Co., 2831 Post Oak Road, Houston 19, Texas. The CM-2 analog computer is an all solid-state unit which can reliably perform all-purpose mathematical computations. It consists of operational amplifiers, logarithmic networks and scaling potentiometers. Use of transistors and magnetic amplifiers in place of vacuum

Booker & Wallestad is a plastics molder especially equipped for low-cost production of



*Substantial savings and  
precision quality . . .*

These are the two advantages Booker & Wallestad are delivering to some of the best-known names in industry.

They are the reasons why Booker & Wallestad is probably the nation's foremost custom molder of miniature plastic parts.

Exacting specifications are met in any quantity, using any molding compound. Unique production processes sharply reduce mold costs and set-up charges. Unit costs are dropped. Short runs can be justified, even very limited quantities for model testing or sales samples.

To see exactly how these benefits apply to your requirements, submit prints to Booker & Wallestad for quotation.

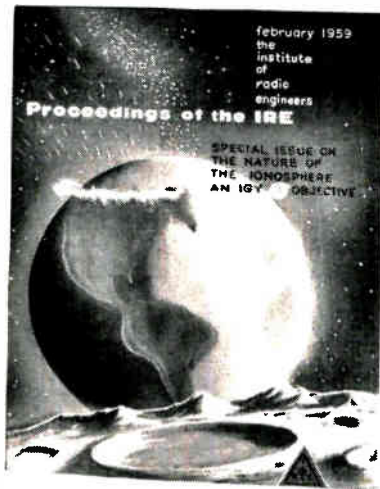
**booker &  
wallestad, inc.**

*Unusual SKILL and ECONOMY  
in custom plastics molding . . .*

3332 Gorham Ave. • Minneapolis 26, Minn.

CIRCLE 47 READERS SERVICE CARD  
February 6, 1959 — ELECTRONICS





# KNOW YOUR

# NEW WORLD

*by reserving your copy*

*of THE NATURE OF THE IONOSPHERE—AN IGY OBJECTIVE, special February issue of PROCEEDINGS OF THE IRE. On these pages you will find a distillation of 18 months of an intensive international effort. Set against a background of earlier work, here is a new compendium of engineering knowledge edited to your special interests. Here is your new frontier.*



## PARTIAL CONTENTS OF IONOSPHERE-IGY ISSUE

"The Earth and its Environment" by S. Chapman, U of Colorado

"The Constitution and Composition of the Upper Atmosphere" by M. Nicolet, Radio and Meteorology Institute, Belgium

"The Normal F-Region of the Ionosphere" by D. F. Martyn, Radio Research Labs. CSIRO, Australia

"The Normal E-Region of the Ionosphere" by E. V. Appleton, U of Edinburgh, Scotland

"The D-Region of the Undisturbed Ionosphere" by J. J. Gibbons & A. H. Waynick, Penn State U

"The Distribution of Electrons in the Ionosphere" by J. O. Thomas, U of Cambridge, England

"Motions in the Ionosphere" by C. O. Hines, Defense Research Board, Canada

"Meteors in the Ionosphere" by L. A. Manning & V. R. Eshleman, Stanford U

"Atmospheric Whistlers" by R. A. Helliwell, Stanford U & M. G. Morgan, Dartmouth U

"Radiation and Particle Precipitation upon the Earth from Solar Flares" by L. G. B. Biermann & R. Lust, Max Planck Institute for Physics and Astrophysics, Germany

"The Very-Low-Frequency Emissions Generated in The Earth's Atmosphere" by R. M. Gallet, National Bureau of Standards

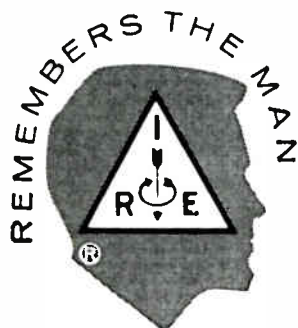
"The F-Region During Magnetic Storms" by K. Maeda, Kyoto U & T. Sato, Shiga U, Japan

"Aurora Phenomena" by E. N. Parker, U of Chicago

"Rocket Observations of the Ionosphere" by H. Friedman, U. S. Naval Research Lab.

"Earth Satellite Observations of the Ionosphere" by W. W. Berning, Aberdeen Proving Grounds

"Exploration of the Upper Atmosphere with the help of the 3rd Soviet Sputnik" by V. I. Krassovsky, Institute for Atmospheric Physics, Moscow



## THE INSTITUTE OF RADIO ENGINEERS

1 East 79th St., New York 21, N. Y.

△ Enclosed is \$3.00

△ Enclosed is company purchase order for the February 1959 issue on I.G.Y. and Ionosphere.

Send this special issue of THE NATURE OF THE IONOSPHERE—AN IGY OBJECTIVE to:

NAME \_\_\_\_\_

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY & STATE \_\_\_\_\_

All IRE members will receive this February issue as usual.

Extra copies to members, \$1.25 each (only one to a member)

THE LEGENDARY FIREBIRD, the Phoenix, rose young and strong again and again from flames . . . This is the new Norton Firebird—symbol for the exciting new fused materials made in Norton's electric furnaces.



## New booklet on TITANIUM compounds and other electrochemicals

Born in flames, like the legendary Phoenix, Norton electrochemicals gain new power to perform new wonders. Titanium, a basic metallic element discovered in 1789, is now revitalized in Norton electric furnaces. Results are titanium di-boride, titanium carbide, titanium nitride, titanates and other compounds.

These high-melting compounds have already proved their value as source materials, components of cermets, metallurgical additives and electrical conductors. Like all Norton electrochemicals they have definite potentials for many new applications.

The new booklet brings you important facts on how Norton electrochemical developments may benefit your own processing. Write for it to NORTON COMPANY, Electro-Chemical Division, 946 New Bond Street, Worcester 6, Massachusetts.



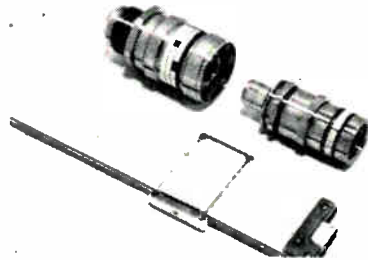
GIFTS OF THE FIREBIRD: compounds of silicon zirconium • boron • aluminum • magnesium titanium • chromium . . . including many borides carbides • nitrides • oxides

**MAKING BETTER PRODUCTS  
TO MAKE**

**YOUR PRODUCTS BETTER  
CIRCLE 49 READERS SERVICE CARD**

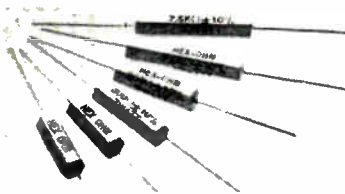
90

tubes provides the reliability and ruggedness needed for industrial applications. An integral programming board inside the cabinet facilitates programming of functions. Circle 216 on Reader Service Card.



### Quick Connector light in weight

E. B. WIGGINS OIL TOOL Co., INC., 3424 E. Olympic Blvd., Los Angeles 23, Calif., has developed a new Inst-O-Matic connector compatible with existing exotic and cryogenic fluids in the missile and rocket field. It has an expanded temperature range of  $-320$  to  $\pm 650$  F due to the development of a new sealing design. Circle 217 on Reader Service Card.



### Wire Wound Resistors hexagonal case

BRADFORD COMPONENTS, INC., 65 South Ave., Salamanca, N. Y. A new ceramic wire wound resistor series, Hex-Ohms, are precision resistors with efficiencies equal to many of the high priced units. The resistance wire is uniformly wound on a fiber glass core and sealed into the hexagonal ceramic case with a special moisture resistant silicone cement. The ceramic case is an excellent insulator capable of withstanding 1,250 v break-down tests. The new hexagonal design provides very good heat dissipation so that the

## PRECISION DEFLECTION WITH COSSOR YOKES



### Component Development Engineering at its BEST!

- ADVANCED ELECTRICAL DESIGN
- PRECISION MECHANICAL DESIGN
- ACCURATE PRODUCTION METHODS

Custom Built to the most  
Exacting Specifications  
by Cossor Engineers

In Mumetal Cores for Optimum Geometry  
In Ferrite Cores for Speed and Sensitivity  
In Non-magnetic Cores for Perfection of Response

Any of Cossor's Three Core Types can be made in single or double axis with single or push-pull windings, and encapsulated for fixed or slip ring (rotating) use.

Normal characteristics of yokes for 1-1/2 in. neck tubes are:

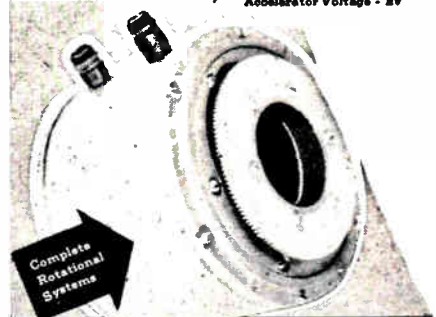
Positional accuracy - the spot position will conform to the yoke current co-ordinates within 0.25% of tube diameter. For deflection angles less than  $25^\circ$  better accuracy can easily be achieved.

Memory - 0.5% max. without over-swing;  
0.1% or less with controlled over-swing.

Complete encapsulation in epoxy (stycast) or silicone resins is standard for all Cossor deflection yokes, and is done with special moulding tools ensuring accurate alignment of the yoke axis. When slip rings are added, solid silver rings are mounted in encapsulating resin. The finished slip ring yoke is precision turned to centre bore, and can include bearing mounting surfaces with dimensional tolerances approaching those associated with high quality metal parts.

Settling Time (Micro sec.) =  $120 \sqrt{\text{Inductance in Henries}}$

Sensitivity degrees/milliamperes =  $0.008 \sqrt{\frac{\text{Inductance} \cdot \text{millihenries}}{\text{Accelerator Voltage} \cdot \text{kV}}}$



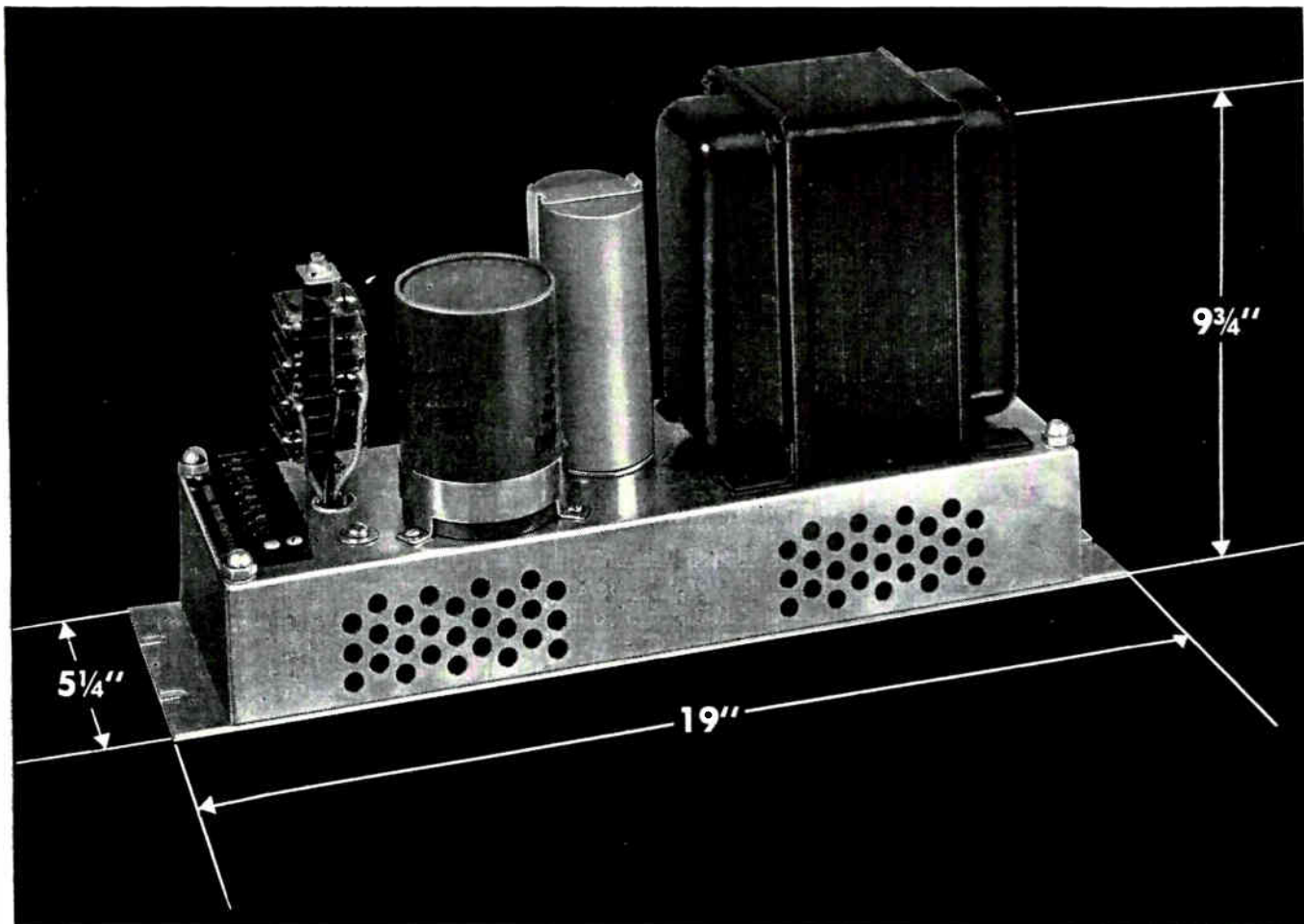
COMPONENTS DIVISION

**COSSOR  
CANADA LIMITED**

301 Windsor St., Halifax, N. S.  
8230 Mayrand St., Montreal, Que.  
648A Yonge St., Toronto, Ont.  
Corporation House, 160 Laurier West, Ottawa, Ont.

CIRCLE 50 READERS SERVICE CARD  
February 6, 1959 — ELECTRONICS





*Sola Constant Voltage DC Power Supplies are designed for intermittent, variable, pulse or high-amperage loads.*

## Sola packs 6 amps of 300-watt regulated dc power into 5<sup>1</sup>/<sub>4</sub> inches of relay-rack space

Looking for a source of regulated dc power that fits into a small space? You'll probably find that the Sola Constant Voltage DC Power Supply offers what you want.

This compact unit has exceptional performance characteristics, too — it delivers current in the "ampere range," regulates within  $\pm 1\%$  even under a  $\pm 10\%$  variation in line voltage, has less than 1% rms ripple, and even tolerates dead shorts. It is 80% efficient and has a very low static output impedance.


How's it done? Sola managed it through a balanced assembly of three complementary components . . . a special Sola Constant Voltage Transformer is teamed up with a semiconductor rectifier and a high-capacitance


filter. Electrical characteristics of the transformer maximize most of the advantages of the rectifier and filter, while virtually eliminating all their disadvantages. The resulting regulated dc power supply is simple, highly reliable, compact and moderately priced.

These benefits are exhibited by the entire line of Sola dc power supplies. Sola has designed and produced hundreds of ratings to meet requirements of equipment manufacturers. The company is set up to handle specific needs for custom-designed units in production quantities. A Sola sales engineer can supply all the facts. In addition to this custom service, Sola currently stocks six models ranging from 24 volts at six amps to 250 volts at one amp.

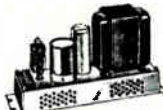
**For complete data write for Bulletin 7B-CV-235**

Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., Bishop 2-1414 • Offices in principal cities • In Canada, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 18, Ont.







CONSTANT VOLTAGE TRANSFORMERS



REGULATED DC POWER SUPPLIES



MERCURY LAMP TRANSFORMERS



FLUORESCENT LAMP BALLASTS

**A DIVISION OF BASIC PRODUCTS CORPORATION**



**Lepel**  
**HIGH FREQUENCY**  
INDUCTION  
**HEATING**  
**UNITS**

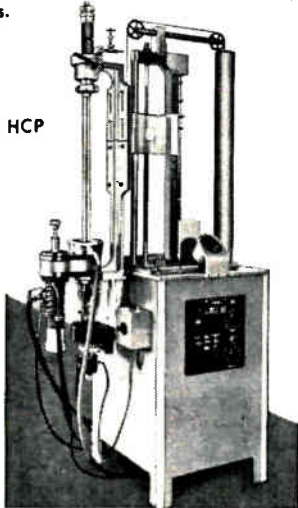
SPARKING BOMBARDING SOLDERING MELTING HARDENING ANNEALING

Lepel induction heating equipment represents the most advanced thought in the field of electronics — the most practical and efficient source of heat developed for numerous industrial applications. You are invited to send samples of work with specifications. Our engineers will process and return the completed job with full data and recommendations without cost or obligations.

**FLOATING ZONE UNIT FOR METAL REFINING AND CRYSTAL GROWING**

A new floating zone fixture for the production of ultra-high purity metals and semi-conductor materials. Purification or crystal growing is achieved by traversing a narrow molten zone along the length of the process bar while it is being supported vertically in vacuum or inert gas. Designed primarily for production purposes, Model HCP also provides great flexibility for laboratory studies.

Model HCP



**Features**

- A smooth, positive mechanical drive system with continuously variable up, down and rotational speeds, all independently controlled.
- An arrangement to rapidly center the process bar within a straight walled quartz tube supported between gas-tight, water-cooled end plates. Placement of the quartz tube is rather simple and adapters can be used to accommodate larger diameter tubes for larger process bars.
- Continuous water cooling for the outside of the quartz tube during operation.
- Assembly and dis-assembly of this system including removal of the completed process bar is simple and rapid.

Electronic Tube Generators from 1 kw to 100 kw.  
 Spark Gap Converters from 2 kw to 30 kw.

WRITE FOR THE NEW LEPEL CATALOG



All Lepel equipment is certified to comply with the requirements of the F.C.C.

LEPEL HIGH FREQUENCY LABORATORIES, INC.  
 55th STREET and 37th AVENUE, WOODSIDE 77, N. Y.

CIRCLE 52 READERS SERVICE CARD

units operate at lower temperatures than other type resistors. They are made in 4, 5, 7, 10 and 12 w sizes within 10 percent tolerance. Circle 218 on Reader Service Card.



**Electronic Counters solid-state units**

THE REDFORD CORP., Lake Luzerne, N. Y., has available electronic counters for both laboratory and production control service. Taking advantage of the newest developments in semiconductor circuitry, the line assures highly reliable operation. Other features are compact size, low current usage, easy installation and silent performance. Counting rate is 500 pps or less. Circle 219 on Reader Service Card.



**Servo System Analyzer for rack or bench**

SERVO CORP. OF AMERICA, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y. Measuring phase, transient response and gain, the new model H Servoscope facilitates fast, accurate plotting of Nyquist, Bode or Nichols diagrams. It covers frequency ranges 0.1 to 2.0 cps and 1.0 to 20 cps, and provides phase measurements to  $\pm 1$  deg accuracy. Direct reading of both amplitude and frequency plus direct readout of phase log simplify operation. Frequency accuracy is  $\pm 5$  percent of setting, rather than

**ATTENTION!**

From February 20  
 to  
 February 24, 1959

will be held the

**SECOND  
 INTERNATIONAL  
 EXPOSITION  
 of ELECTRONIC  
 SPARE PARTS  
 in Paris**

PARC DES EXPOSITIONS  
 PORTE DE VERSAILLES

the world's largest  
 display in the field  
 of Electronics

FOR INFORMATION:

FEDERATION NATIONALE  
 DES INDUSTRIES ELECTRONIQUES  
 (S.D.S.A.) 23 RUE DE LUBECK,

PARIS 16<sup>e</sup>—PAS.01.16

CIRCLE 53 READERS SERVICE CARD  
 February 6, 1959 — ELECTRONICS

**For HEAVY DUTY  
WORK! Severest Electrical  
Services!**



P-506-CE  
Plug with Cap



S-506-DS  
Socket with  
deep brackets

**JONES  
PLUGS &  
SOCKETS**

500 SERIES

*Proven  
Quality*

For 5,000 Volts 25  
Amperes per Contact Alterable by  
circuit Characteristics.

Socket contacts phosphor bronze knife-switch type, cadmium plated. Plug contacts hard brass cadmium plated 2, 4, 6, 8, 10, and 12 contacts. Plugs and sockets polarized. Long leakage path from terminal, and terminal to ground. Caps and brackets, steel parkerized (rust-proofed). Plug and socket blocks interchangeable in caps and brackets. Terminal connections most accessible. Cap insulated with canvas bakelite.

Write for Jones BULLETIN 22  
for full details on line.



**HOWARD B. JONES DIVISION**

CINCH MANUFACTURING CORPORATION  
CHICAGO 24, ILLINOIS  
SUBSIDIARY OF UNITED-CARR FASTENER CORP.

CIRCLE 54 READERS SERVICE CARD

## Insulation Resistance High Voltage Breakdown

Non-Destructive Testing  
Leakage Current • Shorts

### HYPOT®



Over-potential tests of motors, cables and components at 150 kv and up, o-c or d-c. Breakdown and excess leakage current indicated by meter, audibly or lights for automated production.

HYPOT® Model 412 provides 1500 v o-c test in a portable instrument for production and maintenance. Insulation breakdown and excess leakage current indicated on separate lamps. Complete... \$137.50. Write for bulletin "Practical High Potential Testing".

### VIBROTEST® Megohmmeter

Measurement of insulation resistance to 50,000 megohms is easy with this modern megohmmeter.

VIBROTEST® Model 201 reads resistance to 200 megohms at 500 v d-c. Also has 0-2000 ohm and 0-150-300-600 v a-c and d-c ranges. Direct reading, no computations. Complete \$136.50. Write for bulletin "VIBROTEST".

10-35.8



**ASSOCIATED RESEARCH, Incorporated**

3781 W. Belmont Avenue • Chicago 18, Illinois

CIRCLE 55 READERS SERVICE CARD

ELECTRONICS — February 6, 1959

of full scale. Model H generates sine wave and modulated carrier waveforms. Weight is 30 lb. Price is \$1,785. Circle 220 on Reader Service Card.

## Composite Metal fully preplated

AMERICAN SILVER Co., 36-07 Prince St., Flushing 54, N. Y., has available a new composite metal possessing all the superior qualities of conventional clad metal strip, yet priced substantially lower than clad metals. Thermo-Lay strip is a hard, dense layer of metal electrolytically deposited, then heat-treated to achieve a metallurgical bond to a base metal strip, and finally rolled to finished thickness and temper. It is of especial use to the electronics-electrical industry for such applications as contact wiping arms, switches, contact points and springs, flexible wave guides, terminals, and tuners. Circle 221 on Reader Service Card.

## Pulse Transformers encapsulated

TECHNITROL ENGINEERING Co., 1952 E. Allegheny Ave., Philadelphia 34, Pa., announces a new series of miniature encapsulated pulse transformers wound on high permeability ferromagnetic cores. The T series have a range of pulse widths from 0.1 to 25  $\mu$ sec for vacuum tube or transistor blocking oscillator and interstage coupling applications. Circle 222 on Reader Service Card.



## Servo Amplifier fully potted

BULOVA WATCH Co., Woodside 77, N. Y. For continuous operation in a temperature range of  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ , the AMP-298 servo amplifier utilizes all silicon resistors. Fully potted, the new amplifier of-

# ENGINEERS

for expanding  
Electronics Division

(located in Carlstadt, N. J. 5 miles south of Hackensack on Newark-Hackensack line)

### PROJECT ENGINEERS

**Industrial TV:** Two or more years in industrial television, design and development of TV cameras, projectors, monitors. To design video equipment that requires familiarity with image orthicon and vidicon TV cameras.

**Electrical Systems:** M.S. in E.E. or equivalent. Minimum 5 years experience. Heavy background in circuit theory and design, servo mechanisms, pulse and switch circuits. Proven record of supervision in systems design, test and calibration.

**Digital Computer:** Minimum 5 years technical experience beyond engineering or allied degree. Minimum 3 years in digital computer techniques with special ability in systems design.

**Electronic Components:** Minimum 10 years experience. Must have a heavy background in components, reliability, quality production. Prefer experience in radiation and/or instruments.

**Radar Systems:** To design and develop unique circuitry for simulating radar signals from stationary and moving targets, including cultural and geographic features. Design circuitry for utilizing these radar returns in the same manner as in airborne tactical radar and/or fire control systems or ground based radar. Knowledge of pulse and sweep circuitry techniques, video amplifiers, servo mechanisms, analog computers, and military specifications.

Send detailed resume including salary requirements to: T. W. Cozine, Mgr., Executive & Technical Placement, Curtiss-Wright Corporation, Dept. ED-37, Wood-Ridge, N. J.

All replies confidential

**CURTISS-WRIGHT**  
CORPORATION • WOOD-RIDGE, N. J.



Save Half  
**ASSEMBLING**  
 ONE OF THESE TWO  
*Schober*  
**ELECTRONIC  
 ORGANS** in KIT form

"CONCERT" "CONSOLETTA"



NO SPECIAL SKILLS  
 PAY KIT-BY-KIT

CONSOLETTA MODEL  
 Occupies only 2' x 3'2"  
 Floor Space

- HANDSOME ASSEMBLED CONSOLES
  - DOUBLE KEYBOARDS — 122 KEYS
  - ABOVE-KEYBOARD TABS
  - CONCERT MODEL CONFORMS TO A G O SPECIFICATIONS. Occupies 3'5" x 4'7" Floor Space
  - BUILT-IN SPEAKERS OPTIONAL (For Console Model only)
  - COMPLETE DETAILED INSTRUCTIONS
  - FREE—NEW 1959 EDITION of 16-page BOOKLET DESCRIBING BOTH MODELS
  - 10" LP RECORD DEMONSTRATING BOTH MODELS available for \$2, refundable on receipt of order
- Write today—see what fine instruments you can have at such great savings.

**The SCHOBEL ORGAN CORP.**  
 2248-M Broadway, New York 24, New York

CIRCLE 56 READERS SERVICE CARD

I Bought My Wife a Sports Car with the  
**EXTRA MONEY**



I earned in  
**Mobile-Radio  
 Maintenance!**

Sure, an engineer's pay is good—but mine just wouldn't stretch far enough to give my family all the nice things they deserve. So in my spare time I'm servicing commercial mobile-radios in my home town. And I'm mighty proud to think of my wife driving that new Thunderbird!

This can be your story, too. Send coupon for your free copy of "HOW TO MAKE MONEY IN MOBILE-RADIO MAINTENANCE." Published by Lampkin Laboratories, Inc., manufacturers of the 105-B Micrometer Frequency Meter & 205-A FM Modulation meter.



105-B



205-A

**LAMPKIN LABORATORIES, INC.**  
 Instruments Div., Bradenton, Fla.

At no obligation to me please send "HOW TO MAKE MONEY IN MOBILE-RADIO MAINTENANCE."

Name \_\_\_\_\_  
 Address \_\_\_\_\_  
 City \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 57 READERS SERVICE CARD

fers: (1) maximum power output of 12 w, (2) 40 v rms into a 160 ohm center-tapped load, (3) voltage gain of 1,000 at a constant input impedance of 50,000 ohms, and this gain can be easily adjusted by an external resistor. Unit requires only 28 v d-c power, operates from a carrier of 400 cps  $\pm 20$  cps and meets MIL-E-5400 and MIL-E-5272A. Circle 223 on Reader Service Card.



**Oscilloscope**  
 large screen

EASTERN PRECISION RESISTOR CORP., 675 Barby St., Brooklyn 7, N. Y. Designed for use with telemetering and data processing equipment, this large screen oscilloscope features a 17-in. crt. Component parts can be removed and mounted in any standard 19-in. rack. Both the X and Y axis have 1 percent linearity. Other features include: magnetic deflection, constant deflection sensitivity, hand calibrated controls, small spot size and high resolution. Amplifier response is rated at 10 mv sensitivity up to 500 kc, with accurately calibrated time base system for both driven and recurrent operations. Circle 224 on Reader Service Card.

**Toroidal Inductors**  
 hermetically sealed

ARNOLD MAGNETICS CORP., 4613 W. Jefferson Blvd., Los Angeles 16, Calif., announces the series 782 miniature toroidal inductors. Units have an inductance value from 0.1 millihenry to 500 millihenries, with a useful frequency range of from 10 kc to 100 kc. Circle 225 on Reader Service Card.

- NOW AVAILABLE
- OFF-THE-SHELF DELIVERY



**WINCHESTER  
 ELECTRONICS  
 INCORPORATED**

- CONNECTORS
- TERMINALS
- ACCESSORIES

**GREENE SHAW**  
 COMPANY, INC.  
 341 WATERTOWN ST., NEWTON 58, MASS.  
 DEatur 2-9300 — DEatur 2-6500

CIRCLE 58 READERS SERVICE CARD



Now Available  
 at  
**LEADING  
 DISTRIBUTORS**  
 throughout  
 the country.



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

—In Canada:  
 700 WESTON RD., TORONTO

CIRCLE 59 READERS SERVICE CARD  
 February 6, 1959 — ELECTRONICS





### Delay Timer plug-in type

G. C. WILSON & Co., Huntington, W. Va., announces an electronic delay timer completely self-contained in a steel can with octal radio type plug for mounting and wiring connections. The timer employs a unique circuit to control the breakdown of gas tubes and to provide timing delays from 0.003 to 300 sec unaffected by variations in line voltage. It requires no warmup and consumes less than 2 w. Unit can be provided with either a spdt relay or 3 pdt relay, or can be furnished to operate a relay external to the timer. Circle 226 on Reader Service Card.

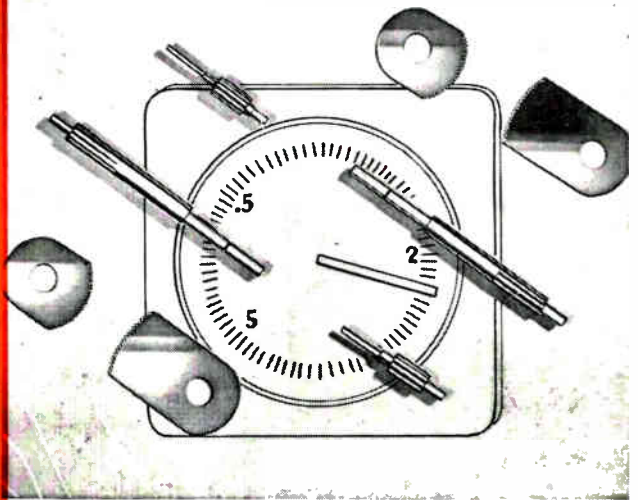


### A-C VTVM 10 cps to 4 mc

REPUBLIC ELECTRONIC INDUSTRIES CORP., 111 Gazza Blvd., Farmingdale, L. I., N. Y. Model VA-104 a-c vtm incorporates such features as long life electrolytic capacitors as well as output jacks permitting the use of the instrument as a high gain, 4 mc wide-band amplifier with a maximum gain of 50 db. Voltage range is 0.001 v to 300 v in 12 ranges. Overall accuracy is  $\pm 2$  percent. Circle 227 on Reader Service Card.

20  
TO  
200 D.P.

SEND YOUR  
PRINTS FOR  
QUOTATION



SPURS • HELICALS • WORM AND WORM GEARS • STRAIGHT BEVELS  
LEAD SCREWS • RATCHETS • CLUSTER GEARS • RACKS • INTERNALS • ODD SHAPES

THE *Finest*



IN GEARS

*Beaver Gear Works Inc.*

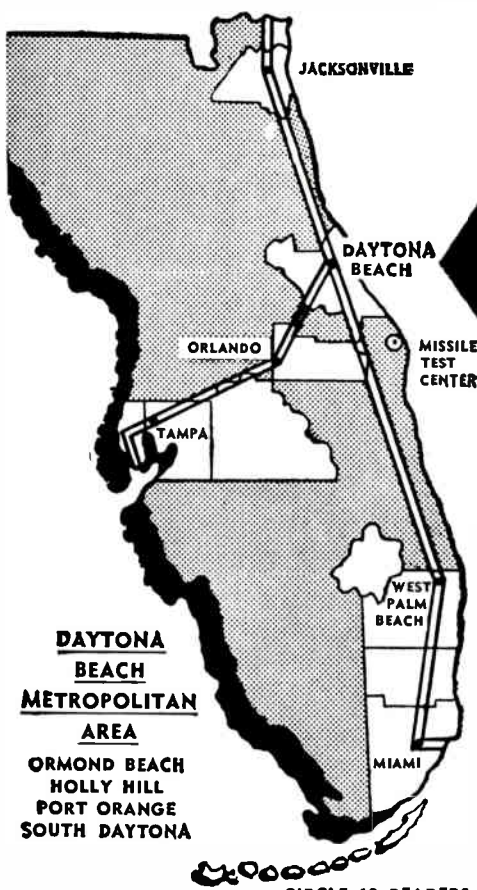
1021 PARMELE STREET, ROCKFORD, ILLINOIS

CIRCLE 60 READERS SERVICE CARD

Your Inquiries  
to Advertisers  
Will Have  
Special Value . . .

—for you— the advertiser—and the publisher, if you mention this publication. Advertisers value highly this evidence of the publication you read. Satisfied advertisers enable the publisher to secure more advertisers and—more advertisers mean more information on more products or better service—more value—to YOU.

## ATTRACT AND HOLD TECHNICAL PERSONNEL



**STRATEGIC  
LOCATION FOR  
GROWTH INDUSTRIES**  
**DAYTONA BEACH  
FLORIDA**  
**Metropolitan Area  
Industrial Sites**

**DAYTONA  
BEACH  
METROPOLITAN  
AREA**  
ORMOND BEACH  
HOLLY HILL  
PORT ORANGE  
SOUTH DAYTONA

Daytona Beach, the east-to-west terminal on the north-to-south route of the projected Federal Limited Access Freeway System, gives industry a plus for the future.

Write for new 101 page  
Industrial Brochure  
**R. H. MILES, MGR.,  
INDUSTRIAL DEPARTMENT  
CHAMBER OF COMMERCE  
DAYTONA BEACH, FLORIDA**

CIRCLE 62 READERS SERVICE CARD

## Literature of

### MATERIALS

**Paper-Base Laminate.** Synthane Corp., Oaks, Pa., has prepared a new engineering bulletin on grade EP-22, a paper-base, epoxy resin laminate and one of its latest products especially designed for printed circuit and other electronic applications. Circle 230 on Reader Service Card.

### COMPONENTS

**Deposited Carbon Resistors.** The Kidder Co., 24 So. Springfield Road, Clifton Heights, Pa. Bulletin 100 describes computer-type  $\frac{1}{2}$  w deposited carbon resistors which are designed to combine accuracy, long stability and economy for close tolerance application. Circle 231 on Reader Service Card.

**Magnetic Circuits.** The Indiana Steel Products Co., Valparaiso, Ind. A recent issue of *Applied Magnetism* presents a detailed discussion of permanent magnetic circuits. Circle 232 on Reader Service Card.

**Transistor Types.** Philco Corp., Lansdale Tube Co. Division, Lansdale, Pa., has published a brochure giving a brief description of the company's transistor types designed for reliable performance, stability of operation and long life. Circle 233 on Reader Service Card.

**Delay Lines.** Control Electronics Co., Inc., Huntington Station, N. Y., is now offering a handy form for the specification of lumped and distributed constant delay lines. Circle 234 on Reader Service Card.

### EQUIPMENT

**Bobbin Winder.** Boesch Mfg. Co., Inc., 45 River St., Danbury, Conn. Bulletin BW2 covers the design, operation, standard and optional equipment and outstanding features of a fast, versatile and completely automatic winder for bobbins, solenoids, resistors, re-

You can reduce **GERMANIUM WASTE**

with these new paper-thin **Felker Diamond Blades!**

Here's good news to all crystal cutters, germanium, quartz, silicon, barium titanate, etc.! Felker DI-MET metal bonded diamond blades are exceedingly thin, *greatly reducing amount of expensive crystal lost in the cut!* Special blades are supplied for either wafering or dicing insuring maximum efficiency and savings of material!

Fast cutting, smooth finishes, long blade life, utmost reliability...you get them all in Felker DI-MET...originators of the first commercial diamond abrasive cut-off blades!

Available from your Felker Distributor...or write direct.

**FELKER DI-MET**  
Torrance, California

*First in Diamond Cut-Off Blades!*

*Above:*  
**FOR DICING  
TYPE DIT**  
Available as  
thin as .006"

*Below:*  
**FOR WAFERING  
TYPE DITR**  
Available as  
thin as .015"





## the Week

lays and similar coils. Circle 235 on Reader Service Card.

**Radar Data Processing.** Burroughs Corp., 6071 Second Ave., Detroit 32, Mich. A recent brochure contains descriptions of the function, capabilities, performance and future possibilities of the AN/FST-2 SAGE coordinate data processing system. Circle 236 on Reader Service Card.

**Fans and Blowers.** McLean Engineering Laboratories, Box 228, Princeton, N. J. A new 36-page catalog features packaged fans, blowers, and accessory equipment used in conjunction with the cooling of electronic or electrical apparatus. Circle 237 on Reader Service Card.

**Power Supplies.** Lambda Electronics Corp., 11-11 131 St., College Point 56, N. Y. A 34-page catalog covers a line of power supplies for laboratory and industry. Units described are guaranteed by the company for five full years. Circle 238 on Reader Service Card.

### FACILITIES

**Testing Facilities.** United States Testing Co., Inc., 1415 Park Ave., Hoboken, N. J. Included in bulletin 5801 is a detailed description of the company's engineering facilities and services, which cover a broad range of subjects, from environmental studies to electronics, instrument calibration, and reliability testing and failure analysis. Circle 239 on Reader Service Card.

**Cryogenics.** Stearns-Roger Mfg. Co., 660 Bannock St., Denver 17, Colo. A 12-page brochure covers in text and pictures the extensive activities and services of the company in the specialized fields of ground support facilities for missiles, cryogenic engineering and handling equipment, and nuclear engineering and manufacturing. Circle 240 on Reader Service Card.



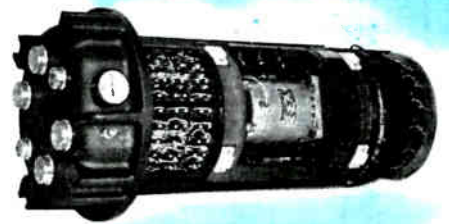
**noise-free**

**response**

*on 90 low-level*

*PDM channels*

*...with CEC's* **PLEXICODER**



*Rocketdyne, a division of North American Aviation, Inc.*

Noise problems and signal distortion, always solid obstacles to the use of sensitive *low-level* pickups for PDM, are *now eliminated* by CEC's PLEXICODER. Providing PDM conversion and commutation of the signals from flux and strain gages, resistance thermometers, thermocouples, and other low-level pickups, the PLEXICODER employs no troublesome filters, amplifiers or mechanical wiper arms. Operation is based on a noise-free galvanometer optical system with inherent filtering characteristics. The PLEXICODER is ideally suited for use with data handling systems, engine test stands, and missile ground-checkout equipment. Operating at speeds up to 900 samples per second, it easily accommodates 90 low- or high-level inputs in any combination.

The PLEXICODER utilizes simple oscillograph-proved techniques for adjustment and calibration. It is designed for a minimum of 1000 service-free hours of operation. Call your nearest CEC sales and service office for full information, or write for Bulletin CEC 1599-X11.

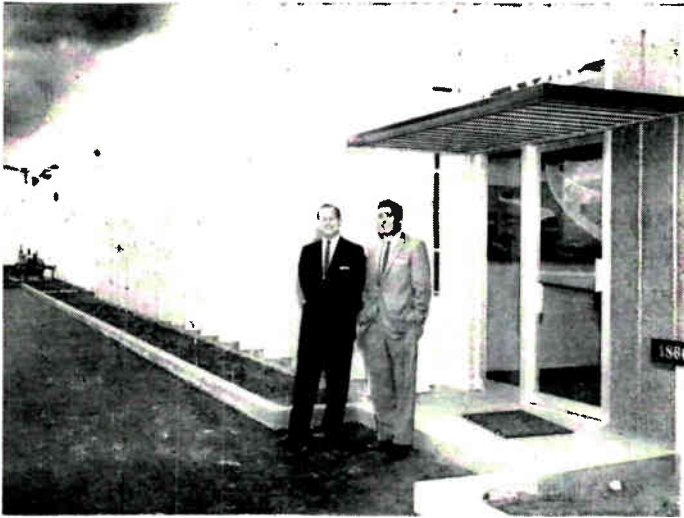
*Transducer Division*

**CEC**

**CONSOLIDATED ELECTRODYNAMICS** / 300 N. Sierra Madre Villa, Pasadena, Calif.

FOR EMPLOYMENT OPPORTUNITIES WITH THIS PROGRESSIVE COMPANY, WRITE DIRECTOR OF PERSONNEL





## Directors Head Departments

AN UNUSUAL management feature is paying off for Calvideo, independent West Coast tv picture tube producer. It's this: Each member of the closed corporation's board is also a department head.

With annual sales approaching \$5 million, Calvideo recently moved into a new 40,000 sq ft building in Compton, Calif. Firm's optimistic business outlook as a producer of tubes for monitoring, radar, camera pickup, etc., is evident in plans for a 20,000 sq ft wing to the building on the 2.5 acre lot. Construction of the new addition will probably occur in 1960.

President Steve Tidick, 37, (at left in picture) started business in '51 with 15 employees making 35 cathode ray tubes daily. Now his hand-picked youthful management staff (average age 36), all of whom got their early training with major tube companies, supervise 200 workers. By end of 1959's first quarter, production will be 1,000 crt's daily, not counting special-purpose tubes.

Sales manager Gil Sherman (shown at right) reports Calvideo has its own truck fleet (prominently displaying the company's emblem) for distribution of its goods. Calvideo serves 16 states. Though sales are now mostly in the West and for export, the company is prepared to branch out nationally.

Sixty-five carts on a 136-ft track, controlled by a timer, convey tubes to and through the baking oven, greatly cutting down on manual labor. The oven operates on a treadmill and permits automatic cycling of tubes. Tubes are fired face down, neck up, allowing freer escape of gases to make a clear tube. Plant also has an overhead conveyor belt, saving both time and space.

Calvideo Electronics Corp. of Hawthorne, Calif., founded in 1958, will continue functioning as a separate entity. This plant makes components and test equipment for guidance and detection systems for the radar industry.

## Dolberg Advances at Philco Corp.

CHARLES E. DOLBERG has been named manager-systems management planning for Philco Corporation's Government and Industrial

Division. He will report directly to S. C. Spielman, director of engineering, and continue in his present capacity as manager of air traffic control engineering.

Since joining Philco in 1942, Dolberg has been engaged in research, development and management of such projects as microwave com-

munications, airborne and ground radar systems, video data processing, military television, underwater devices and missile fusing. He also holds eight patents dealing with radar equipment.

## Ampex Promotes William T. Frost

WILLIAM T. FROST, engineer with the video development unit of Ampex Corporation's Instrumentation Engineering Department, has been promoted to staff engineer.

Frost joined Ampex in July, 1958, after 10 years with the British Broadcasting Corp. in London. While there his research work contributed significantly to the science of magnetic recording, particularly with respect to high frequency signals.

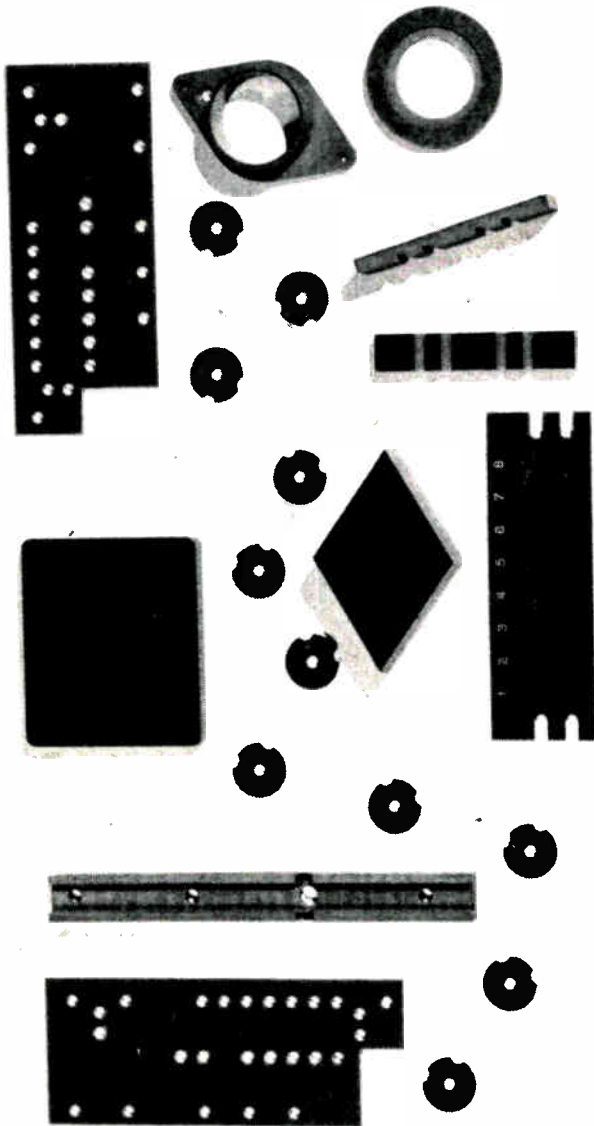


## Mark Products Hires Mueller

ANDREW A. MUELLER recently joined Mark Products Co., Morton Grove, Ill., as plant manager. In this capacity he will direct the production and engineering departments of the firm.

Mark Products specializes in the design and manufacture of antenna systems for communications services including parabolas for microwave point to point and heliwhips for mobile use.

Mueller has previously been em-



# CDF Dilecto<sup>®</sup> paper-base laminates for the workhorse insulation jobs

For everyday mechanical-electrical parts that receive tough punishment and must have excellent physical and dielectric properties at low cost, the CDF phenolic paper-base line is outstanding.

**Economy.** CDF paper-base grades machine readily into intricate parts. Some are flame-retardant. Others are especially adaptable for punching. All are economical for the value delivered.

**Fabrication Facilities.** CDF has excellent and extensive plastics-fabrication facilities for turning out finished Dilecto parts to your specifications—better and more economically than you can do it yourself. Save the time and trouble of intricate fabrication by using CDF's specialized facilities.

See Sweet's, Electronics Buyers' Guide, and the other directories for the phone number of the CDF sales engineer nearest you. Or send us your print or problem direct, and we'll return a recommendation of the right Dilecto grade for your need.

CDF makes Di-Clad\* printed-circuit laminates, Diamond<sup>2</sup> Vulcanized Fibre, CDF products of Teflon<sup>2</sup>, flexible insulating tapes, Dilecto<sup>2</sup> laminated plastics, Celoron<sup>2</sup> molded products, Micabond<sup>2</sup> mica products, Spiral Tubing, Vulcoid<sup>2</sup>.

\*Trademark of Continental-Diamond Fibre Corporation

†Du Pont trademark for its TFE-fluorocarbon resin

Fabricated by CDF. Near the presses that produced the Dilecto laminates, these paper-base parts were machined to close tolerances by CDF specialists . . . quickly, accurately, economically for the purchasers. This is a random selection from the five grades described in the table below.



## CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE *Build* COMPANY • NEWARK 16, DEL.

Typical Property Values—Dilecto Paper-Base Laminates in Sheet Form

	X-13 (NEMA X)	XP-13 (NEMA P)	XX-13 (NEMA XX)	XX-13 FR (Fire-retardant) (NEMA XX)	XXXX-28 (NEMA XXXP)
ROCKWELL HARDNESS (M SCALE)	100	95	110	108	90
TENSILE STRENGTH <i>l</i> w (1000 psi.)	20	12	16	17	12
FLEXURAL STRENGTH <i>l</i> w (1000 psi.)	27	16	17	20	18
COMPRESSIVE STRENGTH (1000 psi.)	40	25	35	41	22
WATER ABSORPTION (% in 24 hrs.) 1/16" thickness	3.5	3.0	1.4	1.2	0.6
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (°C.)	120	120	120	120	120
DIELECTRIC STRENGTH perp. to lam. (VPM)	800	800	650	700	800
DIELECTRIC STRENGTH parallel to lam. (Kv.)	50	50	60	70	75
DISSIPATION FACTOR at 1 mc, Cond. A	0.042	0.038	0.034	0.038	0.027
DIELECTRIC CONSTANT at 1 mc, Cond. A	5.5	4.6	4.7	4.8	3.6
ARC-RESISTANCE (seconds)	8	4	4	10	10
INSULATION RESISTANCE (megohms) ASTM D-257, Fig. 3	100	100	1,000	1,000	600,000
AIEE insulation class	A	A	A	A	A

*Operate your...*

- tape recorder
- P. A. system
- portable TV set
- hand tools

FROM YOUR CAR, Boat or Plane!

with



## INVERTERS

FOR CHANGING YOUR STORAGE BATTERY CURRENT TO

A.C. HOUSEHOLD ELECTRICITY ANYWHERE...in your own CAR, Boat or Plane!



OPERATES PORTABLE TV SET directly from your car!

### OPERATES

- TAPE RECORDERS
- DICTATING MACHINES
- PUBLIC ADDRESS SYSTEMS
- ELECTRIC SHAVERS



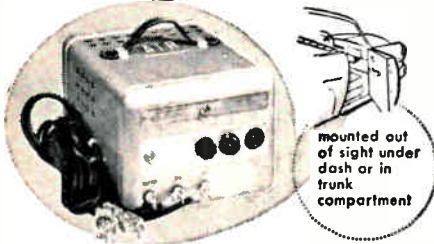
MAKE YOUR CAR, BOAT OR PLANE "A ROLLING OFFICE!"



### OPERATES

- RADIOS
- RECORD PLAYERS
- MIXMASTERS, ETC.

directly from your car!



mounted out of sight under dash or in trunk compartment

## ATR UNIVERSAL INVERTERS

Especially designed to change 6 or 12 volt D.C. to 110 volt A.C. 60 cycles. for...

- EXECUTIVES
- SALESMEN
- OUTDOOR MEN
- PUBLIC OFFICIALS
- POLICEMEN
- REPORTERS
- FIREMEN

MODELS 6U-RHG (6 volts) 125 to 150 watts. Shipping weight 27 lbs. List price.....\$89.95

DEALER NET PRICE.....\$59.97

12U-RHG (12 volts) 150 to 175 watts. Shipping weight 27 lbs. List price.....\$89.95

DEALER NET PRICE.....\$59.97

Write for literature on other Sizes and Models of ATR INVERTERS, priced as low as \$9.95 list.

### SEE YOUR JOBBER OR WRITE FACTORY

- ✓ NEW MODELS ✓ NEW DESIGNS ✓ NEW LITERATURE
- "A" Battery Eliminators • DC-AC Inverters • Auto Radio Vibrators



AMERICAN TELEVISION & RADIO CO.

Quality Products Since 1931

SAINT PAUL 1, MINNESOTA, U. S. A.

CIRCLE 69 READERS SERVICE CARD

played by the Glenn L. Martin Co., Baltimore, Md.; A. C. Nielson Co., Chicago, Ill.; and Chicago Aerial Industries, Chicago, Ill., as chief, Engineering Laboratories.



## TI Moves Region Sales Office

TEXAS INSTRUMENTS INC. has moved its eastern region sales office from New York City to Elizabeth, N. J.

This region office will coordinate the efforts of its own staff of TI sales engineers and those headquartered in district offices—one in Garden City, Long Island, N. Y., headed by J. F. Hegarty (picture), and another in Camden, N. J.



## R/S Electronics Names Isabeau

APPOINTMENT of John Isabeau as senior project engineer at R/S Electronics Corp., Palo Alto, Calif., was recently announced.

Isabeau specializes in the engi-

## IN THIS SUB-MINIATURE RELAY



## SUB-MINIATURE COILS

Designed and Built by Forbes and Wagner in Co-operation with One of the World's Largest Electrical Manufacturers

TO reduce the size of this sub-miniature relay, the single coil common to most relay designs was divided into two, and the two halves were connected in series. In this way the ratio of the number of turns to the total ohmic value was kept to a maximum. The magnetic cores were used as coil retaining members as well as flux carrying members.

Ordinary wire insulations are inadequate for the high temperatures encountered in many relay designs. Research is currently going on to find correct insulating materials for magnet wire. Important also is the selection of coil spool materials and coil wrappings for they can seriously effect the reliability of operation.

### Let us help YOU with YOUR Electronic Problems

We design and produce both simple and complex components and assemblies, Electronic, Electro-Mechanical and Mechanical for Commercial and Military applications in Radio, Television, Tele-communications, Computers, Radar, Guided Missiles and allied fields; also, Pulse Amplifiers, Triggered Circuits, Wide Band Circuits, Toroidal Windings and Transformers. Write for brochure giving complete information.

**Growth Opportunity for Electrical Engineers.** To meet the growing demand for our services, we offer steady employment, high base salary plus profit sharing, paid vacation, group life and hospitalization insurance, sick leave policy, retirement program, etc. Located on shore of Lake Erie. Fishing, boating, swimming at your doorstep. Ideal community life. Thirty minutes from Buffalo via thruway. Replies held in strict confidence.



*forbes and wagner, inc.*

SILVER CREEK, N. Y. • TELEPHONE 650

CIRCLE 70 READERS SERVICE CARD

February 6, 1959 — ELECTRONICS



neering of both conventional and transistorized models of high-frequency electronic devices and will be assigned to the company's Electronics Division. He was formerly associated with the Zenith Radio Corp., Chicago, Ill., as a research engineer.

## News of Reps

**Snelling-Bogossian Co.** of Hamburg, N. Y., is the new selling agent for DuMont scientific instruments in upper New York State. Rep firm replaces Edward A. Ossmann and Associates in all upstate N. Y. except Putnam and Rockland counties. These two counties have been transferred to **Gawler-Knoop Co.**, of Roseland, N. J., DuMont instrument rep for the greater New York, northern New Jersey, greater Philadelphia, and the District of Columbia areas.

**General Transistor Corp.**, Jamaica, N. Y., recently named two sales rep organizations to handle its products. **Charles W. Lienau & Co.**, of Silver Spring, Md., will cover Virginia, Maryland and the District of Columbia; and **McLoud & Raymond Co.** will serve in Colorado, Wyoming, Utah, New Mexico, southeastern Idaho and El Paso County in Texas.

The line of wave filters, toroidal and magnetic components and lumped-constant delay lines of **Wahlgren Magnetics**, Pasadena, Calif., will be represented by the **G. S. Marshall Co.**, of San Marino, Calif.

**Radiation Counter Laboratories, Inc.**, Skokie, Ill., has appointed the **Hyde Electronics Co.** of Denver, Col., as representative in Montana; Wyoming; Idaho, south of Idaho County; Colorado; Utah; New Mexico; western Kansas; and in El Paso, Texas.

**Aerol Associates** of Beverly Hills, Calif., are now the sales reps in thirteen western and southwestern states for electronic connector manufacturer, **H. H. Buggie, Inc.**, Toledo, Ohio.




# expecting a check?



You'll get it quicker if you gave your postal delivery zone number with your address.

The Post Office has divided 106 cities into postal delivery zones to speed mail delivery.

Be sure to include zone number when writing to these cities; be sure to include your zone number in your return address—after the city, before the state.





**fci**  
Stabilized  
Precision  
Capacitors

TYPE	CAP. RANGE	V.D.C.	TEMP.	P.F.	T.C.	I.R. 25°C	MIN. TOL.	SOAK-AGE
A	.001—20MF	100—30KV	-55°C +85°C	.02% 1KC	-100 PPM/C	10 <sup>6</sup> MEG	0.1—	0.01%
B	.001—20MF	600—20KV	-55°C +70°C	.02% 1KC	+800 PPM	10 <sup>6</sup> MEG	1.0%	3.00%
C	.001—20MF	100—30KV	-55°C +200°C	.02% 1KC	-50 PPM/C	10 <sup>6</sup> MEG	0.1—	0.01%
D	.0001—20MF	100—60KV	-55°C +125°C	5% 1KC	+500 PPM	10 <sup>6</sup> MEG	1.0%	0.10%

ALSO MANUFACTURERS OF:

LOW CURRENT  
POWER SUPPLIES  
2 KVDC—30 KVDC  
METALLIZED  
PAPER & MYLAR  
CAPACITORS



WRITE FOR FURTHER INFORMATION  
AND OUR COMPLETE CATALOG

**Film Capacitors, Inc.**

3400 PARK AVENUE • NEW YORK 56, N. Y.

CIRCLE 71 READERS SERVICE CARD



**ELECTRICAL  
COIL WINDINGS**

- Encapsulated
- Bobbin
- Paper Interleave
- Cotton Interweave
- Form Wound
- High Temperature

Send us your coil specifications for quotation.

TRANSFORMERS MADE TO ORDER

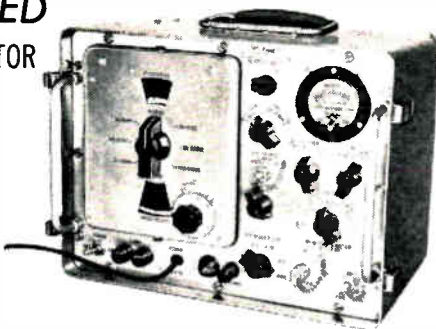
**THE DANO ELECTRIC  
COMPANY**

MAIN STREET • WINSTED, CONN.

CIRCLE 72 READERS SERVICE CARD

## UNIVERSALLY APPROVED SG-25 RF STANDARD SIGNAL GENERATOR

The SG-25 is in use all over the World. Thousands have been furnished to the Armed Forces alone (as Military AN/URM-250) — and they keep coming back for more! The reason? — PROVEN Accuracy, Reliability and Stability. The SG-25 covers the frequency range 10kc to 50mc and features a 3-Stage (MO-BUFFER-PA) RF section, enclosed in an aluminum casting. Precision quality in a portable instrument — ideal for both laboratory and field use.



Write for details and specifications

**TRAD** ELECTRONICS CORPORATION • ASBURY PARK, N. J.

CIRCLE 73 READERS SERVICE CARD

## sending a bill?

It'll get there quicker if you give your postal delivery zone number with your address.

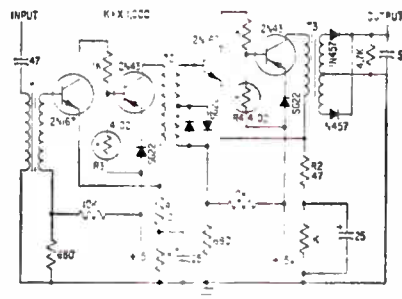
The Post Office has divided 106 cities into postal delivery zones to speed mail delivery. Be sure to include zone number when writing to these cities, be sure to include your zone number in your return address—after the city, before the state.

## COMMENT

### Case of a Substitute Amplifier

Since the article ("Voltage Comparator With High-Speed Switches," p 56, Jan. 30) was sent to your magazine, the authors, J. W. Higgenbotham and H. H. Douglass, have begun using a different and better a-c amplifier. They feel that the article does not properly reflect this advancement in the state of the art unless a diagram of the new a-c amplifier is substituted in place of the one you now have, Fig. 3.

Accordingly, I am sending you a quick drawing of the new diagram which we would like to substitute for Fig. 3.



The amplifier consists of a pair of 2-transistor complementary-coupled stages, coupled by a transformer. Each stage employs heavy d-c feedback to control the d-c operating point, plus a smaller amount of a-c feedback to control gain.

The problem of leakage-current amplification, common to all d-c amplifiers, has been eliminated by placing a diode in the emitter of the 2N43 transistor and connecting a thermistor from the supply voltage to its base. This technique ensures that the second transistor can be completely cut off by the first transistor, even at maximum rated junction temperature.

Experience has shown this configuration to be exceptionally stable and flexible. Wide variations in input impedance and voltage gain are possible merely by changing the value of feedback resistors  $R_1$  and  $R_2$ .

WILLIAM B. WELLING

THE MARTIN CO.  
BALTIMORE

# AN INVITATION TO JOIN ORO

## Pioneer In Operations Research

Operations Research is a young science, earning recognition rapidly as a significant aid to decision-making. It employs the services of mathematicians, physicists, economists, engineers, political scientists, psychologists, and others working on teams to synthesize all phases of a problem.

At ORO, a civilian and non-governmental organization, you will become one of a team assigned to vital military problems in the area of tactics, strategy, logistics, weapons systems analysis and communications.

No other Operations Research organization has the broad experience of ORO. Founded in 1948 by Dr. Ellis A. Johnson, pioneer of U. S. Opsearch, ORO's research findings have influenced decision-making on the highest military levels.

ORO's professional atmosphere encourages those with initiative and imagination to broaden their scientific capabilities. For example, staff members are taught to "program" their own material for the Univac computer so that they can use its services at any time they so desire.

ORO starting salaries are competitive with those of industry and other private research organizations. Promotions are based solely on merit. The "fringe" benefits offered are ahead of those given by many companies.

The cultural and historical features which attract visitors to Washington, D. C. are but a short drive from the pleasant Bethesda suburb in which ORO is located. Attractive homes and apartments are within walking distance and readily available in all price ranges. Schools are excellent.

For further information write:  
Professional Appointments

## OPERATIONS RESEARCH OFFICE **ORO**

The Johns Hopkins University

8935 ARLINGTON ROAD  
BETHESDA 14, MARYLAND

### One Best Bet in 1959

... I would like to take this opportunity to add my congratulations to all the others you have received on the revised format of **ELECTRONICS**.

DONALD T. WORTHINGTON  
ROME AIR DEVELOPMENT CENTER  
ROME, N. Y.

### A Confusion of Corporations

We have noted with pleasure your mention of Narda Ultrasonics stock on p 19 of your Jan. 16 issue (**Financial Roundup**).

You now list the stock quotations on the common stock of Narda Microwave, and since there seems to be some confusion between the two companies, we feel it would be of interest for you to list the common stock quotations on Narda Ultrasonics, which are entirely separate and distinct quotations from Narda Microwave.

GERALD B. VEGA

NARDA MICROWAVE  
NARDA ULTRASONICS  
MINEOLA, N. Y.

Reader Vega's point is well taken, and the editor of our financial pages assures us that we will start carrying listings for both stocks in the near future.

### Kudo

I would like to compliment you on the accurate and quite readable condensation of my paper ("Storage Tube Has Symmetrical Guns," p 60, Jan. 2).

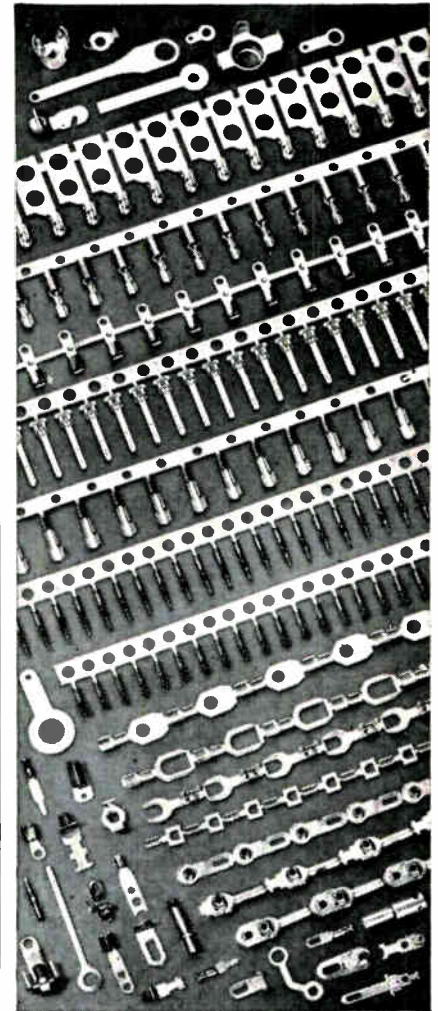
I would also like to thank you for the opportunity to publish the results of our development, and for the speed with which the article was published.

MICHAEL F. TOOHIG  
ITT LABORATORIES  
FORT WAYNE, IND.

The thanks are ours, and bounce right back to author Toohig for having provided us with an article of great interest, articulately presented in the first place, and accompanied by the finest in cooperation.

The pleasure was ours . . .

## ANY TYPE TERMINAL for RADIO, TELEVISION, COMMUNICATIONS and ELECTRONIC APPLICATIONS



Malco supplies terminals for all standard and special requirements. Send blueprint or specifications for specific information and prompt quotation.

REQUEST  
BULLETIN  
552



**Malco** TOOL and MANUFACTURING CO.

4023 W. LAKE ST. • CHICAGO 24, ILL.  
CIRCLE 74 READERS SERVICE CARD



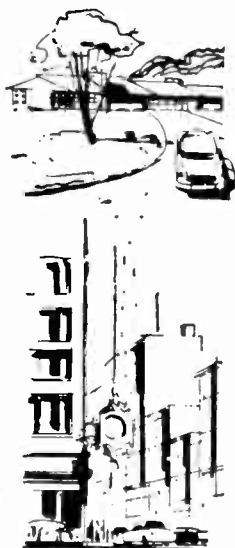
ENGINEERS...PHYSICISTS

**NEW** opportunities at  
Motorola in Chicago

give yourself and your family  
all the big city advantages at a  
relaxed midwest pace, while you  
**ADVANCE YOUR CAREER**

Outstanding career opportunities are waiting at the many Motorola research and development laboratories in the Chicago area. This is your opportunity to advance your career with a swiftly expanding company, working in the most modern and well instrumented laboratories . . . with liberal employee benefits, including an attractive profit sharing plan and association with men of the highest technical competence.

You'll like living in one of the beautiful suburbs of the playground of the midwest, where there are endless social, cultural, and educational activities to choose from the year-round. Exciting life or quiet life—Chicago offers either.



**MILITARY  
POSITIONS OPEN**

- Radar transmitters and receivers
- Radar circuit design
- Antenna design
- Electronic countermeasure systems
- Military communications equipment design
- Pulse circuit design
- IF strip design
- Device using kylstron, traveling wave tube and backward wave oscillator
- Display and storage devices

**CIVILIAN  
POSITIONS OPEN**

**2-WAY RADIO COMMUNICATIONS**

- VHF & UHF Receiver • Transmitter design & development • Power supply
- Systems Engineering • Selective Signaling • Transistor Applications • Crystal Engineering • Sales Engineers

**PORTABLE COMMUNICATIONS**

- Design of VHF & UHF FM Communications in portable or subminiature development.

**MICROWAVE FIELD ENGINEERS**

Write to:

Mr. L. B. Wrenn Dept. D  
MOTOROLA, INC.  
4501 Augusta Blvd., Chicago 51, Ill.



ALSO . . . there are excellent opportunities in  
**PHOENIX, ARIZONA • RIVERSIDE, CALIFORNIA**



**MOTOROLA**

ENGINEERS—BSEE, MSEE, PhD

**HIGH-LEVEL  
OPENINGS**

for

**SPECIALISTS**

in

**HYPERSONIC**

**VEHICLE**

**COMMUNICATIONS**

The Missile and Space Vehicle Dept. of General Electric has *immediate* positions in the design and development of systems for communication through ionized media and infrared. Maximum personal contribution is assured by working in small study groups on:

- Coding, multipath and associated signal propagation problems.
- Research and Development of electronic, optical and infrared systems applicable to advanced missiles and space vehicles.
- Theory and analysis of operational requirements for design and development of missile and space vehicle communications.

These high level positions require a background in advanced systems development, high order of creativity and analytical ability. Advanced degrees are preferred.

Please submit your qualifications in complete confidence to:

Mr. R. L. Eddy, Dept. 702-2  
Professional Placement

**GENERAL  ELECTRIC**

Missile and Space  
Vehicle Department  
3198 Chestnut St.  
Philadelphia 4, Pa.



complete systems

**missile tracking**  
**ground-space communications**  
**airborne instrumentation**  
**range design and operations**  
**data processing**

these are the pursuits of

PHILCO  
**WESTERN  
 DEVELOPMENT  
 LABORATORIES**  
 PALO ALTO



For industry, for the military . . . for ground, air or space . . .  
 electronic and electromechanical systems designed and de-  
 veloped in superb new Palo Alto facilities . . . by the world's  
 finest new team of senior specialists.

A rewarding share in this can be yours; your confidential in-  
 quiry is invited. Urgently needed:

*Ph.D., MS, BS in*

**ELECTRONIC ENGINEERING    ENGINEERING PHYSICS**  
**MECHANICAL ENGINEERING    MATHEMATICS**

experienced in any of our basic pursuits in military electronic  
 systems. Please write H. C. Horsley, Dept. E.

**PHILCO WESTERN DEVELOPMENT LABORATORIES**

3875 Fabian Way, Palo Alto, California

A part of the Government and Industrial Division of Philco Corporation

5184



Measuring phase stability vs.  
 temperature during prototype  
 equipment development



Developmental helical  
 antenna, part of sophisticated  
 new direction-finder system



Pattern measurements—vital  
 to development of microwave  
 dish antennas



60' parabolic receiving  
 antenna for missile telemetry  
 and tracking



# ENGINEERS SCIENTISTS ERCO

A pioneer and one of the leading producers of electronic flight simulators, is increasing its engineering activity to include volume engineering programs in the fields of analog and digital computer techniques, telemetry, transistor applications and light/optical scanners. It is also rapidly expanding its research and development operations in the fields of ionospheric propagation & UHF communications.

Challenging and diversified assignments in product design and research and development are offered by this constantly growing organization to the career-minded engineer or scientist who wishes to combine stability with the latitude necessary for rapid professional and financial growth.

Immediate openings exist for qualified, professional personnel whose areas of experience coincide with the following requirements:

## DESIGN AND DEVELOPMENT PROGRAMS

### CIRCUIT DESIGN (ALL LEVELS)

BSEE, for transistor circuitry, application, analog and digital computer techniques, DC amplifiers, simulation, telemetry and design of systems and components.

BS in Physics, plus experience in one or more of the following: optics, hydraulic instrumentation, human engineering, numerical analysis, computer techniques.

### AERODYNAMICIST

BS in Aero E, plus 3 years' experience in aerodynamics, preferably in airplane stability control, power plants, performance or simulation.

### TECHNICAL WRITERS

BS in EE or Physics, or equivalent, plus 2 years' experience in the preparation of operational and maintenance, manuals and engineering reports concerning electronic systems and components.

**EXCELLENT SALARIES**  
*commensurate with education and experience*

**MODERN COMPANY BENEFITS**  
*including educational assistance plan*

**RELOCATION ASSISTANCE**

**IDEAL LIVING CONDITIONS**  
*in suburban Washington, D. C.*

**EXPENSE-PAID INTERVIEWS WITH SELECTED APPLICANTS**

*Send Resume Stating Education & Experience to:*

Mr. R. J. REID, Technical Employment Manager

## ERCO PLANT

Nuclear Products — Erco  
DIVISION OF ACF INDUSTRIES INCORPORATED  
RIVERDALE, MARYLAND WARFIELD 7-4444

## RESEARCH AND DEVELOPMENT PROGRAMS

### IONOSPHERE PHYSICIST

BS degree plus 3 to 5 years' experience in the study of ionospheric phenomena. Familiar with present state-of-the-art of upper atmosphere and have an understanding of present programs using rockets and satellites for studies in E & F regions and beyond. Will work with radiation problems spanning VLF to VHF region of spectrum with emphasis on HF backscatter techniques and their applications to communications. Will design and conduct field experiments.

### GLOBAL COMMUNICATIONS SPECIALISTS

BS degree plus 5 to 10 years' experience embracing theoretical as well as practical knowledge of communications systems design involving F-layer ionospheric propagation techniques. Working knowledge of modern high-power HF transmitters and HF receiving Systems.

### ELECTRONIC PHYSICIST

BS degree with 3 to 5 years' experience in diffusion pump high-vacuum techniques and have an understanding of classical gas discharge physical phenomena. Will conduct laboratory investigations of simulated upper atmosphere experiments.

ADVANCED ELECTRONICS CENTER AT CORNELL UNIVERSITY

## DISPLAY DEVICES AND TECHNIQUES

Several unusual openings for Electrical Engineers with 3 to 5 years' advanced engineering experience and the ability and initiative to make individual contributions. These engineers will work on research programs leading to advanced developments in:

*Display devices for airborne weapons systems — flight control, fire control, IR, radar and CIC — CRT circuits, computer read-in and read-out and solid state, color and 3-D display techniques.*

Located at Cornell University in beautiful Ithaca, New York, the Advanced Electronics Center affords you unrivalled opportunity for extending your professional education on the tuition refund program.

*Write in complete confidence to:  
Dr. Paul Doigan, Div. 27-WE  
ADVANCED ELECTRONICS CENTER  
AT CORNELL UNIVERSITY*

**GENERAL ELECTRIC**  
Ithaca, New York

## ELECTRONIC and ACOUSTICAL ENGINEERS WANTED

By Electro-Voice, Inc.

For research, development and design. Excellent opportunity for advancement and interesting work in rapidly expanding company. Write: Vice President for Engineering, Electro-Voice, Inc., Buchanan, Michigan

## NEED ENGINEERS

Place an "Engineers Wanted" advertisement in this EMPLOYMENT OPPORTUNITIES section. It's an inexpensive, time saving method of selecting competent personnel for every engineering job in the Electronics industry. The selective circulation of ELECTRONICS offers you an opportunity to choose the best qualified men available throughout the industry.



# NUCLEAR PHYSICISTS

**THEORETICAL PHYSICIST** to evaluate radiation effects on complex electronic airborne systems and components and perform theoretical experiments in nuclear physics, cosmic radiation, astrophysics, magnetic phenomena, tropospheric properties. Goal of assignment: To further understanding of basic physical environment encountered by advanced weapons systems. Must have advanced degree in Physics and three years' experience in nuclear radiation physics. Knowledge of reactor testing techniques essential.

**704 PROGRAMMER ANALYST** to study data flow diagrams and write the differential equations of a circuit diagram. Should be familiar with transforms, numerical analysis, nuclear shielding techniques, and construction of a mathematical model of a nuclear reactor. Assignment entails: investigating analog and digital real-time control systems using high-speed electronic digital and/or analog computer; shielding of components from nuclear radiation. Must have M.S. in Physics and at least two years' experience in control systems analysis and/or nuclear shielding techniques.

### ADVANTAGES OF IBM

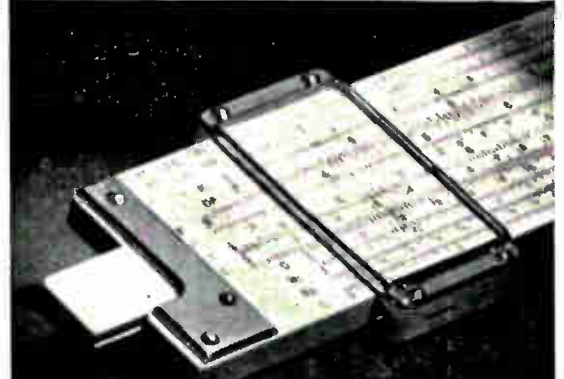
A recognized leader in the electronic systems field . . . products used for both military and commercial work . . . advancement on merit . . . company-paid relocation expenses . . . liberal company benefits . . . salary commensurate with ability and experience.

WRITE, outlining your qualifications and experience, to:

Mr. P. E. Strohm  
Dept. 554B  
IBM Corp.  
Owego, New York

# IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION



## Scope and adventure in RCA BMEWS engineering positions

On the Ballistic Missile Early Warning System, you work with equipments which are largest in their fields . . . the most complex project in military electronics . . . exploring interesting areas of scientific unknowns.

*Immediate openings include positions for:*

**PROJECT ENGINEERS**—assume systems responsibility during installation, checkout and integration and provide engineering leadership thereafter. EE, plus advanced theoretical knowledge.

**DESIGN ENGINEERS**—association with equipments through initial design and responsibility for checkout, integration and redesign. EE or ME, circuit design and field experience desirable.

Work at desirable New Jersey locations . . . or on field assignments (temporary or permanent) in Alaska and other areas. Excellent salaries, plus added compensation for field assignment. Unusual opportunities for rapid advancement. Complete RCA benefit program for you and your family.

For details, act today!

Mr. Robert Vincent  
RCA, Dept. BM-4B  
1809 Bannard St., Riverton, N. J.



Have \_\_\_\_\_ Project Engineer \_\_\_\_\_ Design Engineer  
experience you need on BMEWS.

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

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



**RCA SERVICE COMPANY**  
A DIVISION OF RADIO CORPORATION OF AMERICA

**ENGINEERS**

*Which Facts About*  
**SANDERS ASSOCIATES, INC.**

*Are Important to You in a Career?*

**THE WORK:**

Diversified systems and components. Missile, space vehicle, radar, Panar, surveillance, ECM, computer, servo systems and circuitry development and study. Gyro, hydraulic servo valves, vacuum tube and microwave components development.

**SALARIES:**

Open. More than competitive nationally, based on the individual.

**COST-OF-LIVING:**

Low. No state income tax, no sales tax; low housing and living costs.

**THE COMPANY:**

Growth based on technical excellence—from 12 to 900 employees on own capital in only 7 years.

**LOCATION:**

Ideal. Less than an hour from downtown Boston, mountains and ocean beaches. Nashua, New Hampshire is an attractive city of 40,000 surrounded by picturesque small communities. Shopping facilities, schools and residential districts are excellent, and Nashua provides a safe, wholesome and friendly environment for your family.

**Continued Growth Creates Immediate Openings:**

1. **STUDY & SYSTEMS.** Senior & Doctorate. Weapons Systems.
2. **RELIABILITY.** Junior thru Senior. Circuitry Background.
3. **SPECIFICATION & STANDARDS.** Section Head. Circuitry Background.
4. **SYSTEMS.** Senior. Countermeasures, Radar, Missile, Electronics.
5. **GYROS.** Senior. Theoretical Analysis & Development.
6. **SALES.** Senior. Rate gyros, hydraulic, components & systems.
7. **RECEIVERS.** Senior. Front ends, IF's.
8. **ELECTRONIC PACKAGING.** Senior Mechanical.
9. **MICROWAVE.** Junior thru Section Head. Systems or Components.
10. **CIRCUIT DESIGN.** Junior thru Senior. Transistor or Tube.
11. **ELECTRONIC PRODUCT DESIGN.** Junior thru Senior. BSEE.
12. **TEST EQUIPMENT.** (Circuits). Junior thru Senior. Transistor or Tube.

*Please send resume, including salary desired, to Lloyd R. Ware, Staff Engineer.*



Nashua, New Hampshire

**E N G I N E E R S**

*Senior Project & Staff Positions in Development of*  
**ADVANCED CELESTIAL NAVIGATION SYSTEMS**

Qualifications should include previous responsible experience in analog and digital computers, advanced electronic techniques and navigation concepts.

**FIELD ENGINEERS**

*For Development and Flight Evaluation Work.*

**PRODUCT ENGINEERS**

*For Design of Field Test Equipment for Electromechanical Systems.*

Enjoy unusual opportunity for growth . . . a stimulating professional environment . . . with one of America's finest developers and manufacturers of flight instrumentation. Send resume, in confidence, to  
**T. A. DeLuca.**



**kollsman** INSTRUMENT CORPORATION

80-08 45th AVENUE, ELMHURST, NEW YORK • SUBSIDIARY OF *Standard* COIL PRODUCTS CO., INC.

**PROFESSIONAL SERVICES**

**CROSBY LABORATORIES, INC.**

*Murray G. Crosby & Staff*

Radio - Electronics  
 Research Development & Manufacturing  
 Communications, FM & TV

299 Robbins Lane, Syosset, New York  
 WElls 1-3181

**ERCO RADIO LABORATORIES, INC.**

*Radio Communications Equipment*  
 Engineering - Design - Development - Production  
 Our 30th Year in Air to Ground  
 Communication and Radio Beacons  
 Garden City • Long Island • New York

**ALBERT PREISMAN**

*Consulting Engineer*

Television, Pulse Techniques, Video

Amplifiers, Patent technical consultation.

616 St. Andrews Lane, Silver Spring, Maryland

RESEARCH & DEVELOPMENT

**ELECTRONIC ENGINEERS**

**Unusual Career Openings**

in RAPIDLY growing company for

**PROJECT ENGINEERS  
SR. ENGINEERS & ENGRS.**

**BS-EE or PHYSICS**

Several years or more experience in circuitry and equipment design or applicable background—to work on UHF and VHF systems. Wide band knowledge desirable for challenging assignments on electronic countermeasures systems for military application and electronic instruments for commercial use.

Excellent salary range at all levels. Close association with acknowledged leaders who will aid your professional growth and develop your engineering abilities.

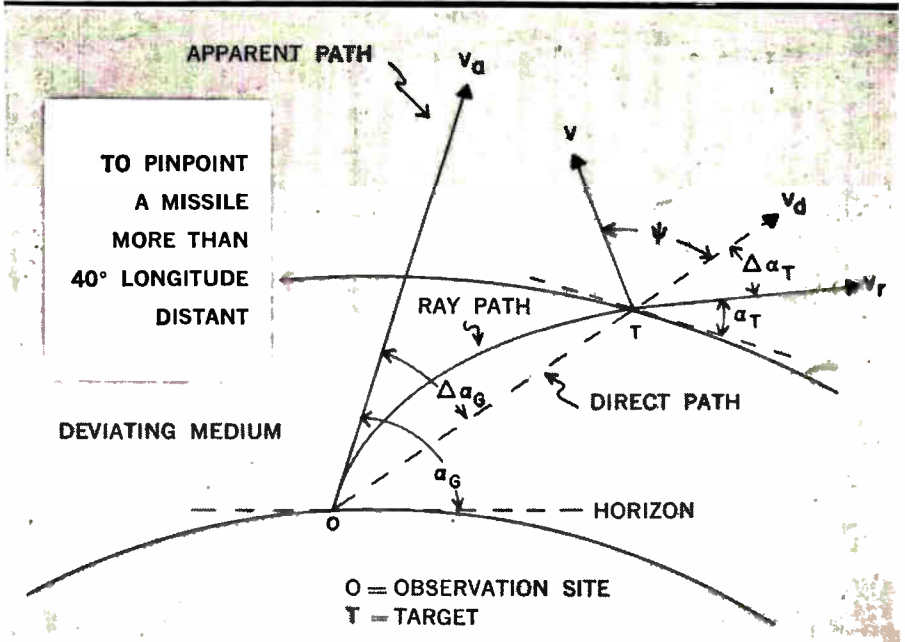
Profit Sharing Retirement Plan  
Many other Benefits.



Call for interview  
J. V. Hicks  
OVerbrook 1-7100  
or send resume  
in confidence to:

**INSTRUMENTS FOR  
INDUSTRY, INC.**

101 New South Rd. Hicksville, L. I.



**Engineering Opportunities  
of a High Order in Creating Complex  
Identification & Tracking Equipments  
at General Electric's Missile  
Detection Systems Section**

To locate a 15,000-mph missile despite complicating factors such as the varying refractive index of the troposphere and ionosphere, a high degree of systems sophistication is of paramount importance.

Growth opportunities commensurate with the creative and analytical demands implicit in such requirements are open now for experienced electronic engineers at G.E.'s Missile Detection Systems Section in these areas:

- Research & Development of New Detection Techniques
- Initiation & Development of Proposals
- Definition and Direction of Equipment Design
- Engineering Liaison with Military & Engineering-Manufacturing Sub-Contractors

Salaries fully competitive, commensurate with experience  
Write in confidence to Mr. James P. Kinsella, Div. 27-WF

**Missile Detection Systems Section  
HEAVY MILITARY ELECTRONICS DEPT.**

**Positions at Several Levels  
for Electronic Engineers**

**SYSTEMS DEVELOPMENT ENGINEERING**  
(At least 4 years' experience)

- RADAR SYSTEMS
- SYSTEMS ANALYSIS
- DATA ANALYSIS
- ELECTRONIC COUNTERMEASURES SYSTEMS

**SYSTEMS EQUIPMENT ENGINEERING**  
ANTENNA DESIGN AND DEVELOPMENT

- RF COMPONENTS DEVELOPMENT
- UHF AND MICROWAVE RECEIVER DEVELOPMENT

- DATA REDUCTION EQUIPMENT D & D
- VIDEO DISPLAY DEVELOPMENT
- COMPUTER APPLICATIONS

ice fishing can be fun, but ..



...even the fish like the Florida sunshine. Engineer fishermen at Radiation, Inc. can enjoy their sport the year around.

We have many openings for challenging and rewarding work in design and development. Radiation is well known in DATA PROCESSING, TELEMETRY, ANTENNAS, and other areas of MISSILE ELECTRONICS. Our stable growth pattern indicates a secure future with professional growth for engineers with ideas and energy.

Write today for complete details on opportunities available. If you qualify, you too can live and work where living is pleasant and work a challenge.

Technical Personnel Dept. 22

**RADIATION, Inc.**

MELBOURNE, FLORIDA

**GENERAL ELECTRIC**

Court Street, Syracuse, New York



*This is one of a series of informative messages to acquaint engineers and scientists with the projects of RCA Moorestown.*

## RCA MOORESTOWN AND ATLAS

Responsibility for the development, design and production of an advanced launch control system for the Atlas missile is one of the charters of RCA Moorestown. The system is designed to perform two primary functions: To determine the operational readiness of the missile and to control the actual launching of the ICBM into space.

The Atlas launch control system complex requires over 200 cabinets of relay logic and newly developed transistorized digital and analog computer circuitry. Of critical significance in the development of the complex are the problems of reliability and accuracy, necessitating the use of advanced transistorized techniques. The challenge of the project is increased by the need for obtaining and integrating information from many associate contractors and by the problems of concurrent research, development and production. The breadth and complexity of the Atlas launch control system are creating stimulating assignments in systems, projects and development engineering.

Engineers, scientists and managers interested in contributing to this program—or to other challenging weapon system projects—are invited to address inquiries to Mr. W. J. Henry, Box V-10-B.



**RADIO CORPORATION of AMERICA**

MISSILE AND SURFACE RADAR DEPARTMENT  
MOORESTOWN, N. J.

## ENGINEERING SALES MANAGER

### ABOUT THE POSITION:

Work with top echelon, blue-chip corporation executives and engineers on some of the most advanced electronic and electrical projects of our time. Complete responsibility for sales programming, execution and evaluation.

### ABOUT THE COMPANY:

World's largest manufacturer of specialized high temperature insulation materials. World's first producer of a vital synthetic mineral. Leader in high reliability, mechanical switches. Located in metropolitan New York area.

### ABOUT YOU:

EE degree or strong electronics engineering background. Familiarity with insulation materials and telemetering experience desirable.

*If you can fill the challenging requirements of this executive position, please write immediately giving full details and salary desired*

P-9757 Electronics  
Class. Adv. Div.,  
P. O. Box 12, N. Y. 36, N. Y.

## ENGINEERS

Progressive research and development concern in the Chicago area is in need of several capable engineers to complete their expansion program. E. E. or Physicist with a good mathematical background will have an excellent opportunity for advancement. Will consider recent grads. Profit sharing plus usual fringe benefits. Reply in confidence.

P-9736 Electronics  
520 N. Michigan Ave., Chicago 11, Ill.

## ENGINEER, RESEARCH

Must have degree in physics or electric or mechanical engineering. Challenging opportunity for young man beginning his career to carry out projects on his own, with supervisory guidance, from design through testing and installation stages. Please send resume to Personnel.

**GREAT LAKES PIPE LINE COMPANY**  
P. O. Drawer 2239, Kansas City 42, Missouri

ADDRESS BOX NO. REPLIES TO: Box No.  
Classified Adv. Div. of this publication.  
Send to office nearest you.  
NEW YORK 36: P. O. BOX 12  
CHICAGO 11: 520 N. Michigan Ave.  
SAN FRANCISCO 4: 68 Post St.

### POSITIONS WANTED

**Wanted—Concern needing top-quality engineering—BME and BEE degrees—10 years experience in industrial, military, ad missile fields—prefer Mid-West location. PW-9626. Electronics.**

**Sales Engineer—successful record of accomplishment with components in electronic and electro-mechanical field in N. Y., desires affiliation with concern in Los Angeles area. Graduate Engineer, age 38, with ability to carry on preliminary discussions on engineering level. Have highest recommendations. Five figure compensation. Available for interview at Los Angeles in February, or at I.R.E. Show in N. Y. Position must be exceptional opportunity or not interested. PW-9752. Electronics.**

### DON'T FORGET

the box number when answering advertisements. It is the only way we can identify the advertiser to whom you are writing.

Immediate Openings at ELECTRIC BOAT DIVISION OF GENERAL DYNAMICS CORPORATION

## Birthplace of the Atomic Submarine

### Now Building first 2 Ballistic Missile POLARIS Subs



#### RESEARCH & DEVELOPMENT DEPARTMENT

**ELECTRICAL SYSTEMS** EE, ME or Physics degree required. Responsible for conceptual engineering and system analysis of large complex devices employing a combination of electrical, electronic, electromechanical, hydraulic and pneumatic systems. Should be familiar with servomechanisms theory, experienced in use of analog or digital computers as a design tool, and have a good grasp of mathematics. Will work on proposal preparation, feasibility studies and execution of hardware contracts.

**CIRCUITS—BSEE OR PHYSICS** Responsible for conceptual and engineering production of electronic equipment. Familiar with servomechanisms and analog computer theory. Experienced in use of semiconductors, magnetic amplifiers, and vacuum tube circuit elements; good grasp of mathematics.

**SERVOMECHANISMS** For engineering design of servomechanisms in both the instrument and multiple horsepower class. Will interpret performance specifications and be responsible for design of a system including stability studies and the calculation of other performance criteria.

#### ENGINEERING SECTION—DESIGN DEPARTMENT

Circuit Development and Systems Installation assignments concerning application of missile fire control and shipboard navigation systems. Requires EE degree and minimum of 2 years missile or navigation system experience.

Development of Circuits and Equipment in conjunction with missile and navigation systems installations aboard submarines. Requires EE degree with advanced courses and experience in servomechanisms.

*The professional development offered engineers at Electric Boat—largest and most highly trained engineering and design staff of any private shipyard in the United States—is outstanding in every way.*

*Electric Boat's location, in the New England community of Groton on the Connecticut shore near New London, provides excellent living and working conditions—just half way between New York and Boston. To arrange interview appointment, send resume to James P. O'Brien, Technical Employment Supervisor.*

**GENERAL DYNAMICS CORPORATION**  
**ELECTRIC BOAT DIVISION**  
Groton, Connecticut

## NEW ENGLAND OPPORTUNITIES

for ELECTRONIC ENGINEERS

- SYSTEMS
- COMMUNICATIONS
- INSTRUMENTATION
- CIRCUIT DESIGN
- SEMI-CONDUCTORS
- MICROWAVE

Your Resume is assured PROMPT and CAREFUL CONSIDERATION for these RESPONSIBLE FEE PAID POSITIONS.

**SOS PERSONNEL BUREAU**

127 TREMONT STREET • BOSTON 8, MASS.

## SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES      EQUIPMENT - USED or RESALE

### • LEASE OR PURCHASE CONTRACT •



30,000 square feet of floor space—brick, tile & concrete. Available for immediate occupancy. Located on two national highways and two state highways, in city, with Santa Fe and M K & T Railroads. Inquire—

**WOODWARD INDUSTRIAL CORPORATION**

BOX 129

WOODWARD, OKLAHOMA

## FOR ADDITIONAL INFORMATION

About Classified Advertising

Contact

*The McGraw-Hill  
Office Nearest You.*

ATLANTA, 3—1301 Rhodes-Haverty Bldg.  
JACKSON 3-6951  
M. H. MILLER

BOSTON, 16—350 Park Square  
HUBBARD 2-7160  
D. J. CASSIDY

CHICAGO, 11—520 No. Michigan Ave.  
MOHAWK 4-5800  
W. J. HIGGINS—D. C. JACKMAN

CLEVELAND, 13—1164 Illuminating Bldg.  
SUPERIOR 1-7000  
W. B. SULLIVAN

DALLAS, 1—1712 Commerce St., Vaughn Bldg.  
RIVERSIDE 7-5117  
GORDON JONES—F. E. HOLLAND

DETROIT, 26—856 Penobscot Bldg.  
WOODWARD 2-1793  
D. M. WATSON

LOS ANGELES, 17—1125 W. 6 St.  
HUNTERLEY 2-5450  
R. L. YOCOM

NEW YORK, 63—500 Fifth Ave.  
OXFORD 5-5959  
D. T. COSTER—R. P. LAWLESS

PHILADELPHIA, 3—Six Penn Center Plaza  
LOCUST 8-4330  
T. W. McCLURE—H. W. BOZARTH

ST. LOUIS, 8—3615 Olive St.  
JEFFERSON 5-4867

SAN FRANCISCO, 4—68 Post St.  
DOUGLAS 2-4600  
R. C. ALCORN

# - CAPACITORS -

**4 mfd.—600 V ..... \$ .58**

Inverted cylindrical cap. single term. Mount through 3/4" hole in chassis. Hardware included. Factory cartons. Qua. disc.  
 .4 mfd.—600 V Mica ..... \$1.98  
 25 Amps @ 1 Mc

## HIGH KVA MICA CAPS B 'tub & Channel

Mfd	Volts	Price	Mfd	Volts	Price	Mfd	Volts	Price
.001	10KV	4.95	.5	4000	3.25	1	15KV	PUR
.001	50KV	24.95	.5	5000	3.05	5	220VAC	.98
.0025	10KV	5.25	.5	7500	4.25	5	330VAC	1.19
.0025	15KV	5.95	.5	25KV	38.50	5	600	.95
.005	25KV	21.95				5-5	400	.89
.012	25KV	10.95				1	115 VAC	.44
.015	16KV	5.95				6	330VAC	1.29
.02	8000	4.50				6	600	1.29
.02	10KV	5.25				6	1000	1.95
.02	20KV	8.25				6	1500	2.95
.025	50KV	32.95				6	2000	4.50
.03	7500	4.25				7	800	1.25
.04	17KV	6.50				8	330VAC	1.50
.05	2500	.65				8	600	.75
.05	7500	4.50				8	600	1.29
.05	16KV	7.95				8	660VAC	2.40
.05-.05	12KV	8.95				8	1000	2.15
.05-.05	40KV	60.00				8	1500	3.65
.075	7000	3.25				8	2000	6.95
.1	1500	.25				8	9500*	19.50
.1	2000	.65				8-8	600	1.89
.1	2500	.69				3x8	600	2.25
.1	3000	.50				1x8	600	2.98
.1	3000	1.19				9	10KV	PUR
.1	4000	1.29				10	600	1.10
.1	5000	1.30				10	1000	3.45
.1	5000	3.25				10	1400	2.25
.1	7500	.89				10	1500	4.35
.1	7500	3.95				10	2000	6.50
.1	12KV	6.95				10	2500	10.95
.1	15KV	8.95				10	2500*	6.25
.1	20KV	9.95				10	3000	20.95
.1	25KV	24.95				10	5000	PUR
.1	25	27.5				10	6000	52.50
.125	10KV	8.50				12	660VAC	4.25
.125	100KV	PUR				12	1000	2.95
.1-1	7000	1.35				12	2000	6.75
.2	10KV	8.50				13.5	4000	21.25
.2	13KV	9.50				14	660VAC	4.25
.2	15KV	10.75				15	600	3.25
.2	50KV	69.50				15	1000	2.95
.25	2000	.89				15	1500	6.35
.25	3000	1.25				15	5000	PUR
.25	4000	1.75				20	330VAC	3.25
.25	6000	.89				20	400VAC	3.25
.25	15KV	15.95				25	600	4.25
.25	20KV	19.95				25	2500*	10.95
.25	25KV	49.50				28	1000	5.50
.25	50KV	69.50				30	2500	13.50
.3	2000	.25				32	600	2.98
.4	10KV	10.95				32	600	5.85
.4-4	7500	3.75				50	100	4.10
.5	40VAC	.49				50	100	4.10
.5	600	.45				50	330VAC	6.50
.5	1500	.59				120	3000	49.25
.5	2000	1.19						*Photo Flash
.5	2500	1.21						
.5	3000	1.25						

## TRANS. MICA CAPACITORS

Mfd	Wvdc	Price	Mfd	Wvdc	Price	Mfd	Wvdc	Price
.00001	600	.20	.00017	2500	.40	.005	3000	1.65
.000024	2500	.35	.0005	600	.23	.006	600	.36
.000025	1200	.29	.0005	1200	.29	.006	1200	.55
.00003	600	.24	.0005	2500	.40	.006	3500	1.65
.00003	1200	.28	.0005	3000	1.25	.0062	2500	.94
.00003	2000	1.25	.0005	5000	2.45	.0075	3000	1.75
.00003	2500	.35	.0005	7500	2.95	.008	600	.35
.000047	2500	.30	.0062	3000	1.25	.008	1200	.57
.00005	600	.23	.0068	2500	.28	.01	1000	.50
.00005	1200	.29	.0089	1200	.28	.01	1200	.69
.00005	2500	.33	.001	600	.23	.01	1200	.69
.00005	3000	1.25	.001	1200	.32	.01	1250	.69
.000051	5000	1.75	.001	2500	.49	.01	2500	.94
.00007	2500	.26	.001	4500	1.65	.01	800	6.95
.000075	5000	1.45	.001	5000	2.25	.012	1200	.64
.0001	600	.24	.001	8000	3.98	.014	600	.45
.0001	1200	.27	.0015	600	.23	.014	1200	.64
.0001	2500	.36	.0015	2500	.53	.015	600	.55
.0001	5000	1.95	.0015	5000	2.25	.015	2000	1.75
.00015	600	.23	.002	600	.27	.02	600	.21
.00015	2500	.33	.002	1200	.33	.02	1200	.99
.00015	5000	1.95	.002	2500	.63	.02	5000	.55
.0002	600	.23	.002	5000	2.25	.025	600V	.55
.0002	1200	.29	.002	6000	2.40	.02	2000	.98
.0002	2500	.34	.0024	5000	2.25			
.0002	5000	1.95	.0025	600	.28	.024	2500	1.10
.00025	600	.23	.0025	1200	.43	.03	2000	1.50
.00025	1200	.29	.0025	2500	.65	.03	600	.65
.00025	2500	.34	.003	600	.31	.03	1200	1.18
.00025	5000	1.95	.003	1200	.52	.03	2000	1.50
.00027	1200	.27	.003	2500	.73	.039	600	.67
.00027	2500	.36	.003	3000	1.65	.25	250	1.95
.0003	600	.23	.003	5000	2.25	.05	1500	1.95
.0003	2500	.36	.004	600	.29			
.0004	600	.23	.004	1200	.49	.065	1800	.89
.0004	1200	.29	.004	2500	.91	.1	600	1.98
.0004	2500	.39	.005	600	.35			
.0004	5000	1.95	.005	2500	.45	.2x.1	250	1.98
			.005	5000	.98	.115	2000	4.65

## MONMOUTH RADIO LABS.

Box 159  
 Capitol 2-0121 Oakhurst, N. J.  
 ART HANKINS, Owner



AN/ART-13, 100 watt transmitter designed to provide radio communication by voice, (MCW) or CW telegraphy. Class "B" audio modulator system capable of modulating the carrier at least 90% on voice or MCW. Incorporates automatic tuning mechanism which may be used to select any one of 11 frequencies, range 2000 KC to 18,100 KC. Frequencies 200 KC to 1500 KC range is provided by addition of oscillator 0-16/ART-13A. Excellent—\$59.50. 0-16 Low frequency oscillator coil for ART-13. Excellent—\$9.95. 24 Volt dynamotor for ART-13 \$14.95.

## VHF UHF AN/APR-4 38-4000 mc RECEIVER

This is a precision receiver covering 38-4000 mc. The set utilizes 5 tuning units with direct reading dials in megacycles. The receiver has a wide and narrow band-width 30 mc I.F. strip which may be selected at will.

An output meter is provided to measure signal strength. Outputs are provided for a pulse analyzer and pan adaptor 110-v AC, 60-2600 cycle. With 3 tuning units 38 to 1000 mc. Excellent. \$159.50.

TN-19/APR-4 Tuning Unit 1000 to 2200 mc. Excellent. \$159.50

LM-20 Frequency meter heterodyne, crystal calibrated. Modulated covering frequencies from 125KC to 20,000KC continuously. This equipment provides accuracies of .02% in the 125 to 2000KC band and .01% in the 2000 to 20,000KC band. With original calib. book and crystal. Brand New .....\$79.50

LM-13 Frequency meter. Excellent \$59.50  
 AN/APR5A—Airborne superhet radar search rec. Freq. range 1000 to 6100 MC. Rec. has a 10 MC IF band width operating from 80/115V AC, single phase 60 to 2600 cps. and one amp. at 26V DC—complete with tubes.....\$89.50

Measurements Corp Pulse Generator Model 79B-60 to 100,000 pulses per second, which can be locked with a sine wave or other external source when frequency accuracy is needed. Pulse width 0.5 microseconds & delay time not more than 25% pulse width (at 70% peak). Output voltage is approx. 150 volts to 200 volts peak positive with respect to ground. Cathode follower output with 1000 ohm impedance. Sync. output is 35 volt displaced by 1/2 period from pulse output. Sync. input may be as little as 2 volts. 110 volts, 60 cycle, 115 watts. Excellent.....\$69.50

MD4 - RT - 15  
 3 cm radar modulator, rec. and trans. complete with all tubes, Magnetron 725 A, 2 ea. 723/AB, 829B, 715B, etc. Excellent .....\$39.50

## R W ELECTRONICS

Dept. I  
 2430 S. Michigan Ave.  
 Chicago 16, Ill.

## NEED METERS? STANDARD or SPECIALS ANY QUANTITY—NEW—MILITARY

**FOR** ELECTRONIC—MILITARY  
 AIRCRAFT—HAMS  
**ALL** MAKES—MODELS  
 RANGES—SIZES  
**METERS** REPAIRED  
 RESCALED  
 RECALIBRATED

WRITE - PHONE - WIRE

## A & M INSTRUMENT SERVICE INC.

76-14 Woodside Ave.  
 Elmhurst 73, N. Y.  
 CAA No. 4264 Ltd. HA 9-2925

## WE BUY ALLEN-BRADLEY POTENTIOMETERS

in all values and combinations

## LEGRI S COMPANY

391 Riverdale Ave.  
 Yonkers 5, N. Y.

## INVENTORY CLEARANCE

All items & quantities new & unused  
 18—Hi-volt power supply, Condenser Products, Model PN25E-1M400-1. 115v-400 cycle to 2.5 Kv DC @ 1 ma. @ \$19.00 Lot \$700.00  
 28—Stevens Arnold Millisee relays, Cat. No. B-42. Coil 6v & 57 ohms. @ \$12.95 Lot \$325.00  
 2—Kellogg Crossbar switches, D313007. 12 Horizontals, 13 Verticals. @ \$550.00 Lot \$1000.00  
 JOHN M. HEINRICH  
 2016 W. 58 St. Cleveland 2, Ohio

## TYPE J-JJ-JJJ POTENTIOMETERS

From stock in all values  
 LEGRI S COMPANY  
 391 Riverdale Ave. Yonkers 5, N. Y.

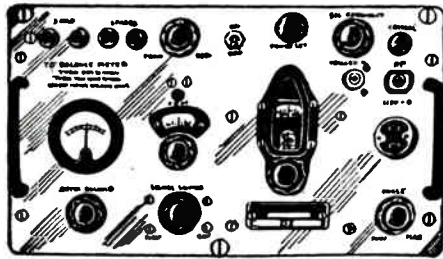
## Electronic LABORATORY SUPPLY COMPANY

FAR BELOW REGULAR FACTORY PRICE  
 LOW-LEVEL DC-AC CHOPPERS—6 Volt 60 CPS Coil, Octal Plug-in base  
 STEVENS-ARNOLD TYPE 248—Special Price \$9.95 ea. 6 for \$54.00  
 Prices for larger quantities on request.

7208 GERMANTOWN AVENUE • PHILADELPHIA 19, PENNSYLVANIA • Chestnut Hill 8-2700



# THIS MONTH ONLY! NEVER BEFORE! 50% DISCOUNT ON OUR REGULAR PRICES.

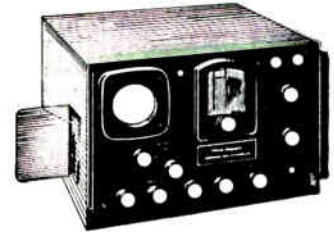


**TS-147 X TEST SET**  
Hard-to-get X-Band Signal Generator  
Now Available

Test Set TS 147 UP is a portable Micro-wave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.

**\$895.00**

**OTHER TEST EQUIPMENT**  
Laboratory Used, Checked Out, Surplus



**TS148/UP SPECTRUM ANALYZER**  
Write for Price

TS3A S-Band Power & Freq. Meter	\$59.00
TS RF-1 S-Band Fanthom Target	25.00
TS10 Callibrator	25.00
TS11 Meter	22.50
TS12 VSWR X-Band Meter	449.50
TS13 X-Band Signal Generator	128.00
TS14 S-Band Signal Generator	125.00
TS15 Gauss Meter	55.00
TS16 Callibrator	20.00
TS10 Callibrator	100.00
TS28	115.00
TS33 X-Band Freq. Meter	75.00
TS34 Synchroscope	125.00
TS35 X-Band Signal Generator	149.50
TS35A X-Band Signal Generator	99.00
TS36 X-Band Power Meter	125.00
TS45 X-Band Signal Source	75.00
TS47 40-500 MC Signal Generator	50.00
TS48 S-Band Echo Box	145.00
TS49 S-Band Echo Box	99.00
TS62 X-Band Echo Box	125.00
TS66 Meter and Plumbing	20.00
1-96 Signal Generator	125.00
TS100 Synchroscope	75.00

TS102A Callibrator	\$125.00
TS108 Dummy Load	75.00
TS110 S-Band Echo Box	35.00
TS117 Freq. Meter	200.00
TS125 Power Meter	195.00
TS126 Synchroscope	75.00
TS127 Freq. Meter	25.00
TS146 X-Band Signal Generator	99.00
TS147 X-Band Signal Generator	895.00
TS148 X-Band Spec. Analyzer	?
TS173 Freq. Meter	125.00
TS174 Freq. Meter	150.00
TS175 Freq. Meter	225.00
TS182 Freq. Meter High Frequency	50.00
TS186 Freq. Meter 1000-10000 MC	700.00
TS226 Callibrator	75.00
TS239 Synchroscope	795.00
TS251 Callibrator	125.00
TS258 X-Band Signal Generator	125.00
TS259 K-Band Signal Generator	895.00
TS268 Crystal Tester	45.00
TS270 S-Band Echo Box	175.00
TS419	795.00
TS545 L-Band Echo Box	55.00

**SURPLUS EQUIPMENT**

- UPM1 Test Analyzer
- UPM7 S-Band Analyzer
- UPM33
- APA10 Panoramic Receiver
- APA38 Panoramic Receiver
- APA62 Panoramic Receiver
- APS4 Radar Transmitter
- S08 Radar Transmitter
- Radar Magnetron Pulsers
- APR4 Radar Receiver
- APR 5 Radar Receiver
- APR 10 Radar Receiver
- APS 23 Radar Receiver
- Transmitter
- APT2 Radar Jammer
- APT5 Radar Jammer
- Marcony Spectrum Analyzer
- X band type TF890/1
- SCR718C Altimeters

**OTHER MATERIAL**

- 400 lbs. III-Temp Teflon Wire No. 36 at 4.50 per lb.
- 10,000 pounds Alnico V magnetron magnets.
- Vibrators, 2, 6, 12, 24, 110 Volt.
- Ask us for quantities of Transistors and Diodes
- We have the hard to get old type tubes not manufactured at present, like: 6A3, 6A5G, and many, many others.

Minimum Order, **\$25.00**



Phone: ORegon 4-7070

**LIBERTY ELECTRONICS, INC.**

119 PRINCE ST.  
NEW YORK 12, N. Y.  
Cables: TELSERUP

**BEST OFFER**

- 6000 IN34A Sylvania
- 6000 IN67A Hughes
- 6000 IN116 Hughes

All Clean—Jobber Boxed

FN-9732, Electronics

Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

## SEARCHLIGHT Equipment Spotting Service

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) No charge or obligation.

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 company letterhead to:

**Searchlight Equipment Spotting 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 Spotting 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 ...../2/6/59

## RADIO RESEARCH INSTRUMENT CO.

550 FIFTH AVE.  
NEW YORK  
JUDSON  
6-4691

**F-28/APN-19 FILTER CAVITY**

Jan. spec: Tunable 2700-2900mc, 1.5db max. loss at ctr. freq. over band. New, \$37.50 each.

**SCR 584—SKYSWEEP ANTENNA PEDESTAL**

Full azimuth and elevation sweeps, 360 degree azimuth, 205 degree elevation. Accuracy ± one mill or better in angle, 6 ft. dish, fully desc. MIT. Radiation Lab series Vol. 1 pg 284 and 209. Vol. 2, pg 223. For full tracking response. Includes pedestal drives solenoids, etc. Excellent used condition. First time these pedestals have been available for purchase. Control consoles also in stock.

**COMPLETE RADAR SYSTEMS**

**SCR-584** 30 ft. trailer Skysweep antenna system PPI indicator + RHI 10 cm. High power for airway control missile-satellite tracking, radio astronomy R & D. As new. Complete.

**SCR 784** Complete 10 cm. Sky Sweep System.

**AN/APS-10** Complete airborne Radar Mfg. by G.E. 3cm. using 2432 Magnetron for Navigation, Mapping, Weather, Collision Avoidance. Like New.

**AN/MPN-1A** (GCA) Ground Control Approach Radar, 30 ft. trailer with 5cm precision and 10cm Search Radars as used by CAA. Full desc. Vol. 11 MIT Rad Lab Series Sec. 8.1E.

**WEATHER RADAR** 275 kw. 10 cm. Compact wt. 488 lbs. rotating yoke PPI 1, 20, 80 mile ranges, ideal for weather forecasting. Lab. Brand new. FCC approved \$950.

**ADDITIONAL "SEARCHLIGHT" ADVERTISING**

on pages 111 & 112

## TEST SETS—RADAR COMMUNICATION EQUIP.

- AN/URM-61 1800-4000MC SIG. GENERATOR
  - AN/URM-64 900-2100MC SIG. GENERATOR
  - AN/UPM-12 X-BAND VSWR TEST SET
  - AN/UPM-17 10MC TO 11,000MC SPECTRUM ANALYZER
  - AN/UPM-33 8500-9600MC SPECTRUM ANALYZER
  - TS-186 100-10,000MC HETERODYNE FREQ. METER .02 ACCURACY
  - TS-600-606-608 COVERING 85KC-1000MC MIN. OF 5 WATTS OUTPUT
  - LAE 520-1300MC SIG. GEN.
  - LAF 90-600MC SIG. GEN.
  - LAG 1200-4000MC SIG. GEN.
- MANY OTHERS, LATE SETS WRITE

AN/TPS-1B  
200 MILE SEARCH RADAR WITH MTI

RECEIVERS—TRANSMITTERS  
FIELD RADIOS—RADARS  
COUNTERMEASURES—SHORAN ETC.

SCR-784  
10CM SEARCH-AUTOMATIC TRACKING RADAR

## TELEVISION — AM-FM BROADCAST STATIONS

- 250W - 50,000 WATTS
- COMPLETE STATIONS + TRANSMITTERS
- STUDIO - TERMINAL EQUIPMENT
- CAMERAS - MICROWAVE RELAY
- PROJECTORS - TEST SETS
- DUMONT - GE - RCA - RAYTHEON GATES

WE MAINTAIN A RECONDITIONING LAB.

WRITE FOR OUR CATALOG

## TECHNICAL SYSTEMS CORP.

12-01 43rd Ave., L. I. C. 1, N. Y.  
RA 9-0652

# KLYSTRON POWER SUPPLY



with a

# MEMORY

No more fiddling with reflector voltage adjustments when you switch between cw and square wave... because of just one of the typically advanced features of this low-medium voltage Klystron Power Supply.

Ever double-mode a Klystron? Not with our model 809! Again, the *thoughtful* engineering that goes into every PRD product assures the user of self-protection against errors.

Even little things like the built-in beam voltage and current meter prevent guessing and doubt during runs. And when it comes to 'scoping the Klystron... compare the CRT display of a tube powered by the 809 and you'll see for the first time what a really sharp trace looks like!

For complete details, send for our data sheet F-10.

*P.S. In case you don't have our latest catalog, E-8...160 pages, chock-full of useful data... dash off a note on your company letterhead.*



**POLYTECHNIC RESEARCH  
& DEVELOPMENT CO., INC.**  
202 Tillary St., Brooklyn 1, N.Y.  
ULster 2-6800

CIRCLE 75 READERS SERVICE CARD

## INDEX TO ADVERTISERS

*Acme Wire .....	84	*Natvar Corporation .....	67
Addo-X .....	6	*North Electric Company.....	14
Aeronutronic, a Subsidiary of Ford Motor Company .....	59	Norton Company-Electro-Chemical Div.	90
Aerovox Corporation .....	71	Operations Research Office (ORO).....	103
*American Television & Radio Co.....	100	*Packard Bell Electronics.....	7
*Amphenol-Borg Electronics Corp.....	78	*Panoramic Radio Products Inc.....	76
*Associated Research Inc.....	93	Polytechnic Research & Development Co., Inc. ....	114
Avion Division—A.C.F. Industries.....	15	*Price Electric Corp.....	72
*Ballantine Laboratories, Inc.....	73	*Radio Corporation of America, Electron Tube Div. ....	4th Cover
*Barnstead Still & Sterilizer Co.....	12	*Raytheon Mfg., Co. ....	5
Beaver Gear Works Inc.....	95	*Rohn Mfg., Co.....	18
*Bendix Aviation Corp. Schnitella Division .....	26	St. Petersburg Chamber of Commerce..	79
*Bentley, Harris Mfg., Co.....	34	Schober Organ Corp., The.....	94
Booker & Wallestad, Inc. ....	88	*Sola Electric Co.....	91
Bourns Laboratories, Inc.....	19	Sonotone Corp. ....	80
*Brush Instruments Division of Clevite Corp. ....	38	Space Technology Laboratories, Inc....	13
Canoga-Division Underwood Corp.....	23	Sprague Electric Company.....	80, 81
*Centradub, A Division of Globe-Union Inc. ....	87	Stackpole Carbon Co.....	21
Century Electronics & Instruments, Inc.	33	Stokes Corp., F. J.....	85
Consolidated Electrodynamics .....	97	Taylor Fibre Co.....	64
*Continental-Diamond Fibre Div., of the Budd Company, Inc. ....	99	*Texas Instruments Incorporated.....	10
*Cornell-Dubiller .....	29	Trud Electronics Corp.....	102
Cossor Canada Limited .....	90	U. S. Stoneware, Alite Division.....	75
*Curtiss-Wright Corp. ....	93	White S. S., Industrial Division.....	69
*Dano Electric Co.....	102	Professional Services .....	114
Daytona Beach Chamber of Commerce.	96	CLASSIFIED ADVERTISING	
*Dialight Corporation .....	83	F. J. Eberle, Business Mgr.	
Eastman Kodak Company.....	86	EMPLOYMENT OPPORTUNITIES.104-111	
*Eitel McCullough, Inc.....	28	EQUIPMENT	
Federation Nationale Des Industries Electroniques .....	92	(Used or Surplus New)	
Felker Mfg., Co. ....	96	For Sale .....	111-113
*Film Capacitors Inc.....	102	ADVERTISERS INDEX	
Forbes & Wagner Inc.....	100	A & M Instrument Service Inc.....	112
*Fusite Corp., The.....	25	Electro-Voice Inc.....	106
*Gabriel Electronics Division.....	88	Electronic Laboratory Supply Co.....	112
*General Electric, Semiconductor Prod. Dept. ....	9	Erco Plant Nuclear Products, Erco Div. of ACF Industries Inc.....	106
*General Transistor Corporation.....	17	General Dynamics, Electro Boat Div.....	111
Good-all Electric Mfg. Co.....	94	General Electric Co.....	104-106-109
Greene-Shaw Co., Inc.....	94	Great Lakes Pipe Line Company.....	110
*Gudebrod Bros., Silk Co., Inc.....	80	Heinrich, John M.....	112
*Hewlett-Packard Company .....	2nd Cover	Instruments for Industry Inc.....	109
*Heyman Mfg. Co.....	84	International Business Machines Corp....	107
Hickok Electrical Instrument, Co. The..	65	Kollsman Instrument Corp.....	108
*Hughes Aircraft Corp.....	85	Legri S. Company.....	112
I-T-E Circuit Breaker Company.....	20	Liberty Electronics Inc.....	113
Institute of Radio Engineers, The.....	89	Monmouth Radio Laboratories.....	112
Jet Propulsion Laboratories.....	77	Motorola Inc. ....	104
*Jones, Howard B. Division Cinch Mfg., Corp. ....	93	Philco Western Development Laboratories.	105
*Kennedy & Co., D. S.....	3	Radiation Inc. ....	109
*Kepeo Inc.....	63	Radio Corporation of America.....	110
*Klntel—A Division of Cohu Electronics Inc. ....	3rd Cover	Radio Research Instrument Company.....	113
*Lampkin Laboratories, Inc.....	94	RCA Service Company, Div. of Radio Corp. of America.....	107
*Leach Corp., Inet Division.....	61	R. W. Electronics.....	112
Lepel High Frequency Laboratories, Inc.	92	Sanders Associates Inc.....	108
Link Aviation, Inc.....	16	S O S Personnel Bureau.....	111
*Malco Tool & Mfg. Co.....	103	Technical Systems Corp.....	113
Martin Company .....	36, 37	Woodward Chamber of Commerce.....	111
*McLean Engineering Laboratories.....	86	* See advertisement in the June, 1958 Mid-Month ELECTRONICS BUYERS GUIDE for complete line of products or services.	
Melpar Inc. ....	68		
Metals & Controls Corp.....	32		
Microswitch, A Division of Honeywell..	24		

This index is published as a service. Every care is taken to make it accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.

# ONLY KIN TEL DIGITAL VOLTMETERS GIVE YOU ALL THESE ADVANTAGES

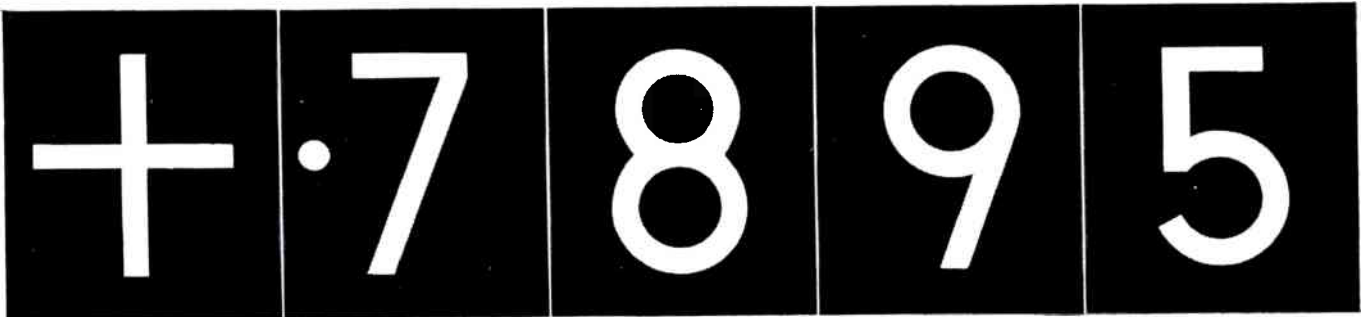
**1. SINGLE-PLANE READOUT:** KIN TEL digital voltmeters employ a simple projection system to present numbers on a readable single plane... no superimposed outlines of "off" digits... reduced possibility of error. Standard pilot lamps give extra long life.

**2. ADVANCED CIRCUIT DESIGN:** Transistors employed where they contribute to performance and reliability... relay drive coils energized with DC as in telephone type service to provide long, trouble-free operation... automatic, continuous standard cell calibration. No electronic circuitry in readout allows easy remote mounting. Sensitivity control permits stable reading of noisy signals.

**3. MANUFACTURING EXPERIENCE:** KIN TEL has manufactured over 10,000 "standard cell accuracy" DC instruments on a true production line basis. Only by this method, by years of repeated manufacturing experience, by an over-all awareness of the accuracies and tolerances involved, is it possible to guarantee consistent accuracy and reliability... to assure real value for every dollar you invest.

**4. NATIONWIDE APPLICATION ENGINEERING FACILITIES:** KIN TEL has engineering representatives in every major city. An experienced staff of over 200 field engineers is always immediately available to help solve your application problems, provide technical data, or prepare a detailed proposal. Factory level service is available in all areas.

**5. DESIDERATE SPECIFICATIONS (MODEL 401B DC DIGITAL VOLTMETER):** *Display*... 4 digit with automatic polarity indication and decimal placement. Total display area 2" high x 7½" long, internally illuminated. Each digit 1½" high. *Automatic Ranges*... .0001 to 999.9 volts covered in 4 automatic ranges. Sensitivity control provides gain ÷10 setting and least digit sensitivities of .1, 1, and 10 mv. *Accuracy*... 0.01% ±1 digit. *Counting Rate*... 20 counts per sec., providing average balance (reading) time of 1 sec. *Reference Voltage*... Chopper-stabilized supply, referenced to an unsaturated mercury-cadmium standard cell. *Input Impedance*... 10 megohms, on all ranges. *Output*... Visual display, plus print control. Automatic print impulse when the meter assumes balance. No accessories required to drive parallel input printers. *Input*... 115 volt, 60 cycle, single phase, approx. 75 VA. *Dimensions*... Control unit, 5¼" high x 19" wide x 18" deep. Readout display, 3½" high x 19" wide x 9" deep. *Weight*... Approx. 40 lb. *Price*... \$2,450.



Model 402B AC/DC 4-digit



Model 401B DC 4-digit



Model 501 DC 5-digit

**6. WIDE RANGE OF MODELS—ACCESSORIES—SPECIAL SYSTEMS:** Versatile "digital building blocks" permit measurement of AC, ohms, ratios of AC and DC, automatic scanning of multiple inputs... 4- or 5-digit models. Preamplifiers increase digital voltmeter sensitivity to 1 microvolt DC, 10 microvolts AC. Buffers permit driving typewriters, tape punches and printers. KIN TEL's Special Products Department can design and manufacture digital instruments to meet special requirements... complete digital systems for data logging, missile checkout and automatic production line testing.



Write today for descriptive literature or demonstration. 5725 Kearny Villa Road, San Diego 11, California





# GOING STEADY!

## ...DESIGNERS AND RCA-6AU6, A PREFERRED TUBE TYPE



Thumb through any stack of entertainment-equipment circuits. Go back a dozen years. Note the rf, if, af, and limiter stages and you'll find one thing especially common to a large number of the circuits... the 6AU6, an RCA original. As the result of continuing efforts to offer quality typical of all Preferred Tube Types, the RCA-6AU6 is still a steady design favorite. Here are some of the latest reasons why.

*RCA-6AU6 is rugged...* larger-than-usual cathode diameter and rigid fit of the mica supports to the cage assembly increase sturdiness and reduce microphonics.

*RCA-6AU6 is reliable...* offers "reserve

power" because of enlarged emissive-cathode area. Cathode is of special alloy that reduces interface and grid loading, substantially extends useful tube life. A built-in shield completely surrounding the cage assembly and connected to grid #3 minimizes intertube coupling and adds to structural rigidity. A double helical-wound heater reduces magnetic hum.

*RCA-6AU6 is 100% tested* for rf noise, shorts and continuity, transconductance, gas, plate current and static emission.

Little wonder designers have been "going steady" with the RCA-6AU6. Ask your RCA Field Representative for further information. He'll be glad to help.

### RCA FIELD OFFICES

#### EAST

744 Brood St.  
Newark 2, N. J.  
Humboldt 5-3900

#### MIDWEST

Suite 1154  
Merchandise Mart Plaza  
Chicago 54, Ill.  
Whitehall 4-2900

#### WEST

6355 E. Washington Blvd.  
Los Angeles 22, Calif.  
RAymond 3-8361



**RADIO CORPORATION OF AMERICA**

*Electron Tube Division*

*Harrison, N. J.*