

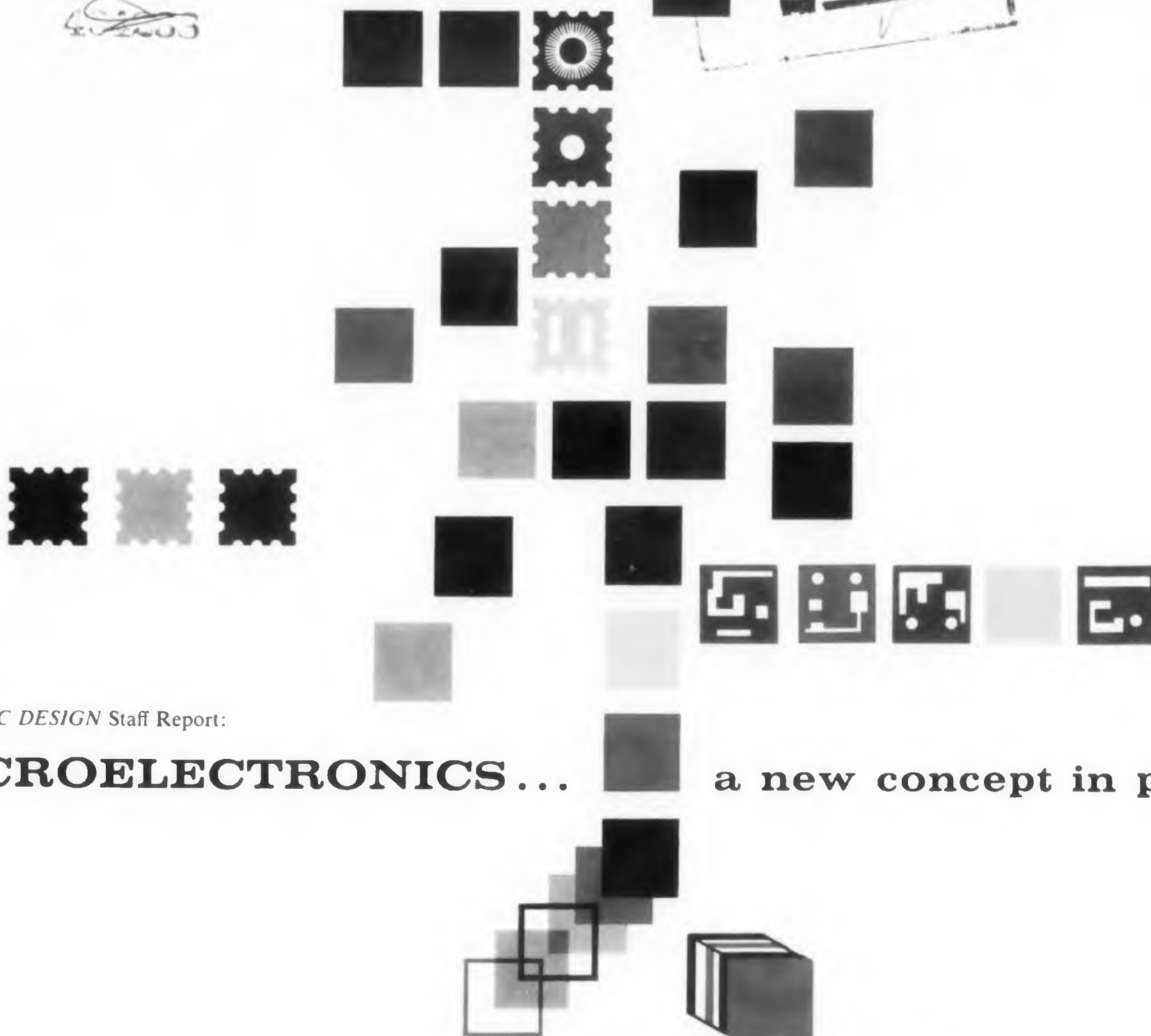
# ELECTRONIC DESIGN

APRIL 29, 1959

B 770268

APR 24 1959

THE LIBRARY OF  
CONGRESS  
SERIAL RECORDS  
MAY 13 1959



An *ELECTRONIC DESIGN* Staff Report:

## MICROELECTRONICS...

a new concept in packaging

**Canadian General Electric Co., Ltd.**

New streamlined transformers, molded in Epon resins, have superior insulation and dielectric strength. Accuracy and over-all performance are greatly improved.



## Specify Epon<sup>®</sup> Resins...



**Good-All Electric Manufacturing Co.**

New Epon resin-molded 600 UE capacitors have superior moisture resistance. Offer rugged, trouble-free performance because Epon resin assures high dielectric strength, low leakage.

## for potting, molding, sealing, encapsulating

SWITCH TO Epon resin-based compounds for potting, molding, sealing, and encapsulating to upgrade the performance of your electrical or electronic units... cut costs through design simplification.

Why? Because the excellent physical properties of Epon resins eliminate the need for conventional containers and housings. Size, weight, and com-

plexity of components are reduced.

To lower costs and speed up production, manufacturers have moved in the direction of automation. In the new mixing, metering and dispensing equipment, even the most heavily filled Epon resin formulations can be used for high-volume, rapid-curing potting, encapsulating, and sealing operations.

Epon resins can be adapted to a wide variety of formulations designed to meet your specific needs. Write now for full information including a list of suppliers of Epon resin-based formulations and manufacturers of automatic mixing, metering, and dispensing equipment.

SHELL CHEMICAL CORPORATION  
50 West 50th St., New York 20, N.Y.

### SHELL CHEMICAL CORPORATION PLASTICS AND RESINS DIVISION

CHICAGO • CLEVELAND • LOS ANGELES • NEW YORK  
IN CANADA: Chemical Division, Shell Oil Company of Canada, Limited, Montreal • Toronto • Vancouver



CIRCLE 1 ON READER-SERVICE CARD

## HIGHLIGHTS OF ISSUE



### Microelectronics (Cover) . . . . 32

Microminiaturization of electronic circuits is one of the most significant developments in electronics today. Extremely broad in scope, its implications excite the imagination of even the most inveterate designer. Radical new forms of conventional components and entirely new processes of making them are here now. Microelectronics presents a new frontier to be conquered for the frustrated designer of conventional components. There are new exciting challenges at every turn. Our staff report summarizes progress to date of the various groups working in this fast-moving area. The report further cites problems that must be solved before the electronics industry can realize the full potential of micro-miniaturization.

### Use two Time Constants . . . . 18

Sometimes it's not safe to assume step input to a circuit. Hughes Richard Muller shows better approximations to use when a square wave input has been rounded.

### New Ripple Reduction . . . . . 30

A quick, clear design procedure for using transistors instead of reactors in ripple reduction. Saves weight and volume.

### Rechargeable "Dry" Cells . . 52

Designed to replace carbon-zinc dry cells, the new nickel-cadmium batteries are gaining popularity. Sonotone's line is one of the most complete.

APR 24 1959

April 29, 1959

Vol. 7

N U M B E R

9

## SUBSCRIPTION POLICY

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

**ANY ADDRESS CHANGES FOR OLD SUBSCRIBERS NECESSITATES A RESTATEMENT OF THESE QUALIFICATIONS.**

Subscription rate for non qualified subscribers—\$15.00 for 1 year only.

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

## CONTENTS

Behind the News	3	Electronics Assists in Picking Astronauts ✓ B-8
Washington Report	14	New Concept in R & D Planning
Editorial	17	Not a Breakthrough But a Revolution
Special Report	32	<b>MICROELECTRONICS . . .</b> A New Concept in Packaging Electronic components are changing shape. Latest developments and trends are covered in this <i>ELECTRONIC DESIGN</i> staff report.
Features	18	How To Determine Circuit Response With Two Time Constants, R. S. Muller
	22	Synchronous Motor
	24	Space Coordinate Transformation, G. H. Steinberg
	28	Cast Silicon I-R Domes
	30	The New Look in Ripple Reduction, B. Daien
Component Design Data	50	Random Reliability Notes
	52	Design Data on Rechargeable Dry Cells
Ideas for Design	90	Radio Frequency Manhole Cover
Russian Translations	100	Nonlinear and Parametric Phenomena in Radio Engineering, Part 17, A. A. Kharkevich
German Abstracts	112	Attenuation in the Passband of Filters Time Delays in P-N Junctions
Departments	54	New Products
	84	New Literature
	88	Patents
	96	Standards & Specs
	98	Careers
	114	Meetings
	116	Report Briefs
	120	Advertisers' Index

NBP

BPA

**ELECTRONIC DESIGN** is published bi-weekly by Hayden Publishing Company, Inc., 830 Third Avenue, New York 22, N.Y., T. Richard Gascoigne, President; James S. Mulholland, Jr., Vice-President & Treasurer; and David B. Landis, Secretary. Printed at Hildreth Press, Bristol, Conn. Accepted as controlled circulation publication at Bristol, Conn. Additional entry, New York, N.Y. Copyright 1959 Hayden Publishing Company, Inc. 32,000 copies this issue.

CIRCLE 2 ON READER-SERVICE CARD &gt;



## G-V Thermal Time Delay Relays... used in Hughes Airborne Armament Control System

The F-102A all weather interceptor and many other planes in the U. S. and Canadian Air Defense Commands are fully equipped with this system developed and manufactured by the Hughes Aircraft Company. G-V thermal time delay relays are relied upon in all of these systems.

In both military and industrial equipment, G-V thermal relays are providing long, dependable, proven service in time delay applications, voltage and current sensing functions and circuit protection.

Write for extensive application data and catalog material.

**G-V CONTROLS INC.**

LIVINGSTON, NEW JERSEY





**RAYTHEON**

# SILICON TRANSISTORS

in quantity production

PNP NPN

Other significant advantages include:

- Low saturation voltage
- Twenty volts BVEBO
- Low noise type available in both PNP and NPN
- Minimum change in characteristics with temperature, current, and voltage
- Suitability for complementary circuits

For both PNP and NPN Silicon Transistors specify **RAYTHEON**

FOR LARGE SIGNAL APPLICATIONS (Temperature Range  $-65^{\circ}\text{C}$  to  $+160^{\circ}\text{C}$ )

Type	$I_{EO}$ or $I_{CO}$ at $V_{CE} = 20\text{ Vdc}$ $\mu\text{A}$	$V_{CE}$ max. volts	$h_{FE}$ ave.	$r_b'$ $f = 1\text{ Mc}$ ohms	$r_c$ kilohms	Noise Figure db (max.)	$C_{ob}$ $f = 100\text{ Kc}$ ave. $\mu\text{mf}$	$I_{ab}$ ave. Kc
<b>2N327A</b>	0.005	-40	15	1200	500	30	65	200
<b>2N328A</b>	0.005	-35	30	1400	500	30	65	300
<b>2N329A</b>	0.005	-30	60	1500	500	30	65	400
<b>2N619</b>	0.005	50	15	2000	500	30	35	200
<b>2N620</b>	0.005	40	30	2500	500	30	35	350
<b>2N621</b>	0.005	30	60	2700	500	30	35	500

†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  $+160^{\circ}\text{C}$ )

Type	$I_{EO}$ or $I_{CO}$ at $V_{CE} = 20\text{ Vdc}$ $\mu\text{A}$	$V_{CE}$ 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. $\mu\text{mf}$	$I_{ab}$ ave. Kc
<b>2N1034</b>	0.005	-40	15	3000	70	30	65	200
<b>2N1035</b>	0.005	-35	30	3000	85	30	65	300
<b>2N1036</b>	0.005	-30	60	3000	100	30	65	400
<b>2N1037</b>	0.005	-35	30	3000	85	15	65	250
<b>2N1074</b>	0.005	50	15	3500	70	30	35	200
<b>2N1075</b>	0.005	40	30	3500	85	30	35	350
<b>2N1076</b>	0.005	30	60	3500	100	30	35	500
<b>2N1077</b>	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 • CIRCUIT PACKAGES  
New York, Plaza 9-3900 • Boston, Hillcrest 4-6700 • Chicago, National 5-4000 • Los Angeles, Normandy 5-4221  
Baltimore, Southfield 1-1237 • Cleveland, Winton 1-7005 • Kansas City, Plaza 3-5330

## STAFF

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

## CO-PUBLISHERS

T. Richard Gascoigne  
James S. Mulholland, Jr.

## ADVERTISING REPRESENTATIVES

Advertising Sales Manager  
Bryce Gray, Jr.

**New York:** Owen A. Kean  
830 Third Avenue  
PLaza 1-5530  
Robert W. Gascoigne  
Richard Parker  
Blair McClenachan  
James P. Quinn

**Chicago:** Thomas P. Kavooras  
664 N. Michigan Ave.  
SUperior 7-8054  
Berry Conner, Jr.  
Fred T. Bruce

**Los Angeles:** Robert E. Ahrens Dorf  
3275 Wilshire Blvd.  
DUmkirk 2-7337  
John V. Quillman  
Stanley I. Ehrenclou

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

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



# BEHIND THE NEWS

## Electronics Assists in Picking Astronauts

**T**HE FINAL seven candidates for Project Mercury were evaluated and selected with the help of electronic transducers. Known as Mercury astronauts, one of the candidates will be chosen in about two years to probe outer space in a manned satellite.

To pick the seven final candidates from a field of 32, the volunteers were put through a rigorous battery of physiological and psychological tests. During many of the tests various electronic transducers were used to detect the men's bodily reactions. General areas of concern were the men's

nervous, respiratory and circulatory systems.

During the tests cardiograms of heart muscle contraction were made. Heart stroke and sounds were also studied. To determine the response of the nerves they were stimulated electrically. And tracings of electric currents produced by the brain were made.

Other tests included making audiograms with and without background noises, and voice tape recordings. Electronic devices were used to measure blood pressure, breathing and air volume rate, and skin temperature and resistance.

These tests went on for seven and a half days and three evenings at the Lovelace Clinic in Albuquerque, N.M. See *ELECTRONIC DESIGN*, Mar. 4, page 20, for data on devices that may be used in these tests.

### Medical Data Sent While Astronaut Orbits

While the chosen astronaut orbits the earth he will be rigged with medical electronic equipment that will telemeter his physiological conditions to ground stations. Estimating the value of medical electronic equipment used during flight, one



**Complete shore-based receiving unit** (above), developed by the U. S. Navy Medical Dept., will permit a constant watch on the physical condition of animal and human occupants of space vehicles. The technique will also enable isolated medical practitioners who need the services of medical specialists located at distant points to transmit all essential data to the specialists by telephone. If a consultant is not available at the time of the call, data can be recorded on magnetic tape for later playback.

**Electrodes** are being attached to a Navy officer (left) in a new technique which will permit a constant watch on the space man's blood pressure, temperature, breath sounds, heart sounds and brain waves. Electrocardiograms are superimposed on carrier waves and transmitted over world-wide radio and telephone circuits.

## NEW MASER CIRCULATOR FOR L-BAND



**\$975.00!**

**AVAILABLE IMMEDIATELY  
FOR YOUR APPLICATION.**

**MINIATURE, THREE-PORT  
DEVICE WITH COAXIAL FITTINGS  
MEASURES ONLY 7½ INCHES,  
WEIGHS 9 POUNDS**

An entirely new Raytheon technique has made possible the design of an extremely small low-frequency circulator. The three-port device has Type N coaxial connections and is designed for use with masers and parametric amplifiers at L-band.

The new circulator, designated CLL1, combines an extremely low insertion loss of 0.3 db with 25 db isolation and VSWR of less than 1.1 centered at any frequency from 900 to 1,600 mc. With a permanent magnet, as illustrated, performance is typically 0.4 db and 20 db with a maximum VSWR of 1.25 over any 50 mc band. However, with a tuned magnetic field, the same performance is obtainable over a 100 mc band.

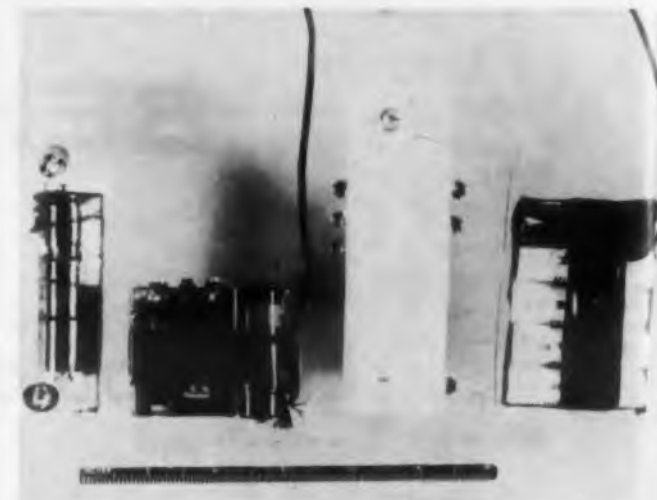
**To learn more about this significant development or other important Raytheon advances in microwave ferrite devices, please write stating your particular area of interest to the address below.**

**RAYTHEON MANUFACTURING COMPANY  
SPECIAL MICROWAVE DEVICES  
WALTHAM 54, MASSACHUSETTS**



EXCELLENCE IN ELECTRONICS

## BEHIND THE NEWS



This subminiature electrocardiogram equipment is being used in experiments conducted for space travel. It was designed for use on ambulatory or exercising patients as a portable electrocardiograph and will enable medical researchers to collect important medical data as man responds to space. From left to right is: electrocardiogram amplifier; transformers; fm oscillator; dry cell batteries.

knowledgeable person said: "If he ever gets in trouble we'll probably know about it before he does."

The National Aeronautics and Space Administration is directing Project Mercury. It will pick and launch one of the seven astronauts into space. The astronaut will circle the earth two or three times at an approximate altitude of 125 miles in a one-ton capsule. Plans are for the satellite to splash-land somewhere in the Atlantic Ocean.

### Space Medicine Interests Navy Too

While the names of the seven Mercury astronauts and data on how they were selected was being released in Washington, D.C., a conclave in San Francisco watched a closed-circuit TV presentation of "Medicine Prepares For The Space Age."

At the meeting many of the medical problems and peculiarities of man's coming flights into space were outlined by Captain Norman L. Barr, USN, Director of Astronautics Div. Dr. Barr has developed systems for gathering physiological information from pilots in air and from animal and human occupants of earth orbiting vehicles. The equipment used in these systems permits transmission of electrocardiograms, electroencephalograms, body temperature and other physiological measurements. Some of the Navy's recent activities in Medical Electronics are shown in the accompanying photographs. ■ ■

## Channeling Millimeter Waves Big Challenge

Being so short, millimeter waves are not only difficult to generate but hard to control—and they remain so, as concluded by those who attended the three day symposium on millimeter waves earlier this month in New York. However the fruits of millimeter wave application continue to tantalize many engineers and scientists, mainly because of the great number of messages that can be transmitted on a single transmission line. It was estimated that at least three hundred thousand telephone messages could be sent at once on a transcontinental transmission line. In addition to radio, telephone and television applications, millimeter waves should prove useful in determining the densities of hot ionized gases created by atomic reactions and calculating the atomic weights of nuclei.

### Getting Strong Signal is Problem

However a number of problems will have to be resolved before millimeter waves can be successfully harnessed. Because of the small tube size needed to generate such waves, it is difficult to obtain a sufficiently high signal level. The problem is one of generation and detection. Second, an efficient means of transmitting the waves must be achieved with minimal losses. Presently waves are transmitted along rectangular or circular waveguides. Because of their low signal power, millimeter waves can not be transmitted readily through the atmosphere, since the elements absorb much of their energy. However in space-platform applications, millimeter waves can be efficiently used for communication because of the rarefied atmosphere.

At the present time 4 mm generation is possible but no one has successfully made for commercial use 1 and 2 mm devices.

### Expect To Transmit TV

Despite the problems that confront the millimeter-wave engineer and scientist, they showed little pessimism at the symposium. All eventually expect to achieve their goals in the not too distant future. One of the possibilities they envision is the ability to handle several hundred television channels at once on a transmission line. This is possible because of the great frequency range of millimeter waves. The spectrum is greater than the combined ranges of radio, television and radar.

Held from April 1st to the 3rd, the symposium was cosponsored by the Office of Naval Research and the Air Force Office of Scientific Research and arranged by the Polytechnic Institute of Brooklyn in conjunction with the Institute of Radio Engineers.



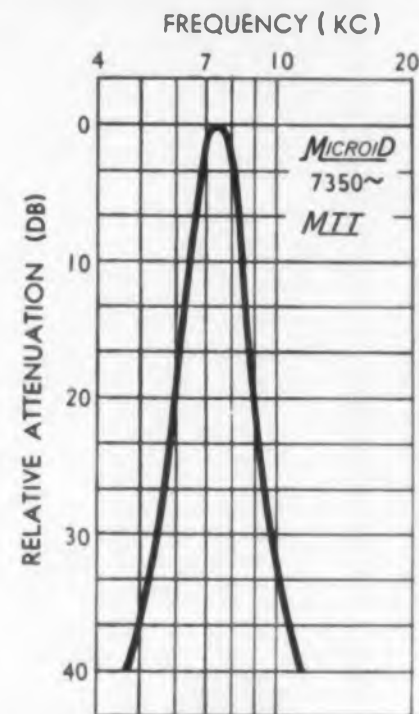
## SHRUNK BY EXPERTS

Burnell & Co. may not be experts in the art of head shrinking. But when it comes to toroids, filters and related networks, Burnell has the know-how to solve an infinite variety of small space problems. The new **MICROID**® filters by Burnell & Co. are a notable achievement in the shrinking of filters which can be designed for low pass or band pass applications.

For example, as a low pass filter, Type **MLP** starts at 400 cps. Physical size is 11/16" x 1-11/16" x 1/2" max. For higher frequencies from 5 kc up to 100 kc, size is 3/4" x 1" x 1/2".

The band pass filter, Type **MTI** pictured here, ranges from 7,350 cycles

up to 100 kc. Physical size is 1/2" x 19/32" x 15/16", weight .3 ounces, band width 15% at 3 db and + 60% — 40% at 40 db. Wherever space and performance are critical requirements, miniaturized **MICROID**® low pass and band pass filters provide utmost reliability as well as more unit surface economy on printed circuit boards. Completely encapsulated, they are ideally suited to withstand high acceleration, shock and vibration environments.



® REGISTERED TRADE MARK

*Burnell & Co., Inc.*

PIONEERS IN TOROIDS, FILTERS AND RELATED NETWORKS

EASTERN DIVISION  
DEPT. D-17  
10 PELHAM PARKWAY  
PELHAM, N. Y.  
PELHAM 8-5000  
TELETYPE PELHAM 3633



PACIFIC DIVISION  
DEPT. D-17  
720 MISSION ST.  
SOUTH PASADENA, CALIF.  
RYAN 1-2841  
TELETYPE PASACAL 7578

CIRCLE 5 ON READER-SERVICE CARD



# another Potter First



**THE  
NEW POTTER '909'**

## Now...

a device that **READS** and  
**STOPS** faster, better

The compact '909' Perforated Tape Strip Reader now makes it possible to process information from perforated tape into digital data computer systems at high speed and low cost. Simple to operate by clerical personnel, the '909' is completely transistorized, and will give maximum performance with complete reliability.

The '909' is a compact unit, suitable for console or rack mounting. Here are some of the performance features, available for the first time in equipment of this type:

- Character reading speeds up to 1000 char/sec.
- Simple In-Line threading
- 3 Millisec starting time
- Stops on STOP Character, (0.2 millisec) and will read next character after start
- 100 x 10<sup>6</sup> operation pinch roll
- Photo Diode Head reads any tape (including oiled yellow teletype tape)
- Reads 5, 6, 7 or 8 level tape with sprocket channel
- Ambient temperature up to 125° F. with 10,000 hour life
- Built to meet requirements of MIL-E-4158A

### Specifications

- Tape Speed:  
10 to 100 ips
- Tape Width:  
Any Standard Width
- Power Requirements:  
115V, 60 Cycle, 1 Phase
- Control:  
Remote/Level Inputs

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



The mark of  
Engineering Quality

**POTTER INSTRUMENT COMPANY, INC.**  
Sunnyside Boulevard, Plainview, N. Y.  
Overbrook 1-3200

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

CIRCLE 6 ON READER-SERVICE CARD

## BEHIND THE NEWS

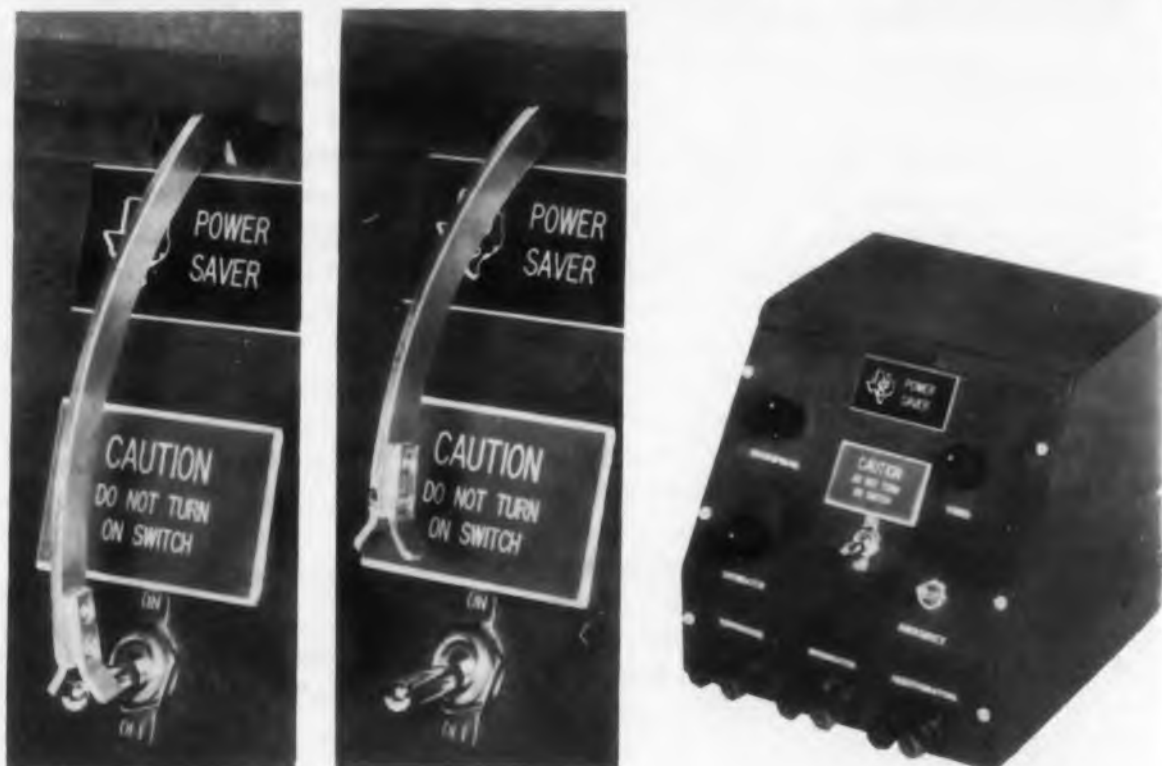
# Can "Power Saver" Alleviate World's Power Shortage



The United States consumed 567 billion kilowatt-hours of electricity last year. This figure will surely skyrocket in the next few years. To meet this problem, engineers at Texas Instruments' Industrial Instrumentation Division in Houston and at the Semiconductor Components Division in Dallas developed the unique "Power Saver" shown in action in the accompanying photos.

What's really unique about this great achievement is that it didn't cost the government a cent. There was no research and development contract—no cost plus fixed fee. The TI engineers did all the necessary work on this project at home—during off hours.

The "Power Saver" operates on Murphy's Law, which deals with the obstinacy of inanimate objects. The sign over the power switch reads: Caution—Do Not Turn On Switch. When the operator turns it on (he always does), a mechanical arm emerges, turns off the switch, then withdraws.



ELECTRONIC DESIGN • April 29, 1959

## U.S. to Play Major Role in Paris Computer Conference

Strong world-wide position of U.S. computer technology has been confirmed in the final program plans for the forthcoming global computer conference sponsored by the United Nations organization in Paris, June 15-20. The formal technical program will feature 23 of 55 papers from United States computer experts.

More than 2500 scientists, engineers, and mathematicians meeting at the Western Joint Computer Conference, March 2-6, heard the first official details of the program just finalized in Paris by consultants to UNESCO from the thirteen participating nations. It also was the first public announcement of the high honors accorded to certain leading computer specialists from the United States in appointing them to official positions for the global event.

A special new session has been added to the formal program which will explore "Computer Techniques of the Future." It was also disclosed that U. S. manufacturers of computer and data control systems would have considerable exhibit space in AUTO-MATH 59, a major equipment exhibit held in conjunction with the conference.

## Electronic Instrument Inside Concrete Mixer

Electronics is helping builders make better concrete. An electronic instrument to measure the water content of damp sand, with an error of only a fifth of one per cent, has been produced by Shaw Moisture Meters, England.

The measuring probe of the "Sandmaster" moisture meter is fixed inside the sand hopper of a concrete-making machine. The gage is located where the operator can see it easily and tell at a glance how much water to add.

The moisture content of the sand is measured by the ease or difficulty with which an electric current passes through it at a frequency of 100 mc.

*From Transistor Center, U.S.A. ...*

# PHILCO®

## announces a new family of LOW COST Medium Power Alloy Junction Transistors








Introducing a completely new family of PNP germanium transistors, especially designed to meet rigid military and industrial specifications... at lowest possible prices.

These transistors are available in production quantities, for use in teletypewriters, control

amplifiers, ignition systems, mobile radios and desk calculators (2N1124); servo amplifiers, voltage regulators and pulse amplifiers (2N1125, 2N1126, 2N1127); medium power audio and switching applications (2N1128, 2N1129, 2N1130).

Also available in quantities 1-99 from your local Philco Industrial Semiconductor Distributor.

Make Philco your prime source of information for all transistor applications. Write to Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa., Dept. ED-459.

TYPE	V <sub>CB</sub> Max. (Volts)	V <sub>CES</sub> Max. (Volts)	Peak I <sub>C</sub> (Amps)	P Max. (Watts)	F <sub>-3dB</sub> (MC)	Beta	Applications	PRICE
 <b>2N1124</b>	40	35	0.5	0.3	0.4 Min	$h_{fe}$ 40 Min	For high voltage general purpose use in amplifier and switching. Small signal beta controlled.	\$ 1.30
 <b>2N1125</b>	40	40	0.5	0.3	1.0 Min	$h_{fe}$ 50-150 @ 0.5 amp	For high voltage, higher frequency industrial amplifier and switching systems. Large signal beta controlled.	\$1.90
 <b>2N1126</b>	40	35	0.5	1.0	0.4 Min	$h_{fe}$ 40 Min	1 watt version of 2N1124 for servo amplifiers and relay actuators. Small signal beta controlled.	\$1.80
 <b>2N1127</b>	40	40	0.5	1.0	1.0 Min	$h_{fe}$ 50-150 @ 0.5 amp	1 watt version of 2N1125 for servo amplifiers and control systems. DC beta controlled.	\$2.40
 <b>2N1128</b>	25	18	0.5	0.15	1.0	$h_{fe}$ 70-150	For low distortion, high level driver and output application. Small signal beta controlled.	\$ .95
 <b>2N1129</b>	25	25	0.5	0.15	0.75	$h_{fe}$ 100-200 @ 0.1 amp	For high gain general purpose amplifier and switching. Typical DC beta 165.	\$1.10
 <b>2N1130</b>	30		0.5	0.15	0.75	$h_{fe}$ 50-165 @ 0.1 amp	For higher voltage, higher level amplifier and switching applications. Typical DC beta 125.	\$ .95

Available in Production Quantities—Also Available from Local Distributors

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





# The right counter for every purpose



100KC, MODEL 7150



1MC, MODEL 7160



10MC, MODEL 7170

## EPUT® METERS

Long considered standard equipment for making rapid, precise frequency measurements, Berkeley EPUT meters are now available with over twenty standard modifications designed for an ever-broadening variety of applications. Most EPUT meters are equipped to make period measurements of low frequency signals.



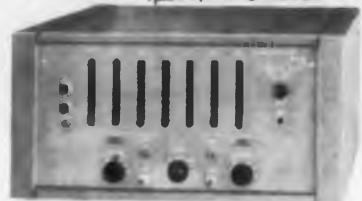
5210 PORTABLE  
100KC



10μSEC, UNITS MODEL 7250



1μSEC, UNITS MODEL 7260



0.1μSEC, UNITS MODEL 7270

## TIME INTERVAL METERS

The full line offers meters of four degrees of precision ranging from a tenth of a millisecond to a tenth of a microsecond. Versatile 7000 Series Instruments feature selectable sensitivity for noise discrimination, trigger level adjustable over a wide range, slope selection and very high input impedance.



5220 PORTABLE, 100μSEC UNITS



100KC, MODEL 7350



1MC, MODEL 7360



10MC, MODEL 7370

## UNIVERSAL EPUT AND TIMERS

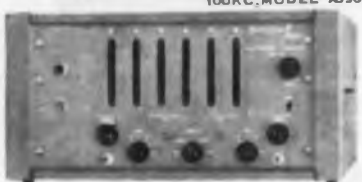
Combining the functions of an EPUT meter and time interval meter in a compact economical package, these instruments are widely preferred as general purpose laboratory equipment for precise frequency and time measurement. Universal instruments feature as many as ten distinct operating functions.



5230 PORTABLE



100KC, MODEL 7050



1MC, MODEL 7060



10MC, MODEL 7070

## GATING COUNTERS

The counting interval of these instruments can be accurately controlled by a broad variety of input signals. Widely useful as a systems building block, several of these units will perform as EPUT meters or time interval meters when operated in conjunction with an independent source of time signals.



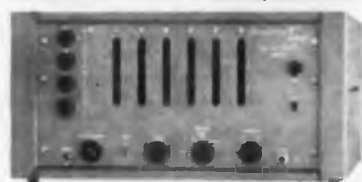
MODEL 5804

## INDUSTRIAL TOTALIZING COUNTERS

Berkeley makes rugged counters with top speeds from 125 cps to 10,000 cps and capacities up to one billion counts. Model 5805 utilizes miniature magnetic amplifiers for long-term trouble-free operation.



100KC, MODEL 7151



1MC, MODEL 7161



1MC UNIV., MODEL 7351

## PRESET EPUT METERS

These instruments will create direct digital indications of rotating speed, flow, pressure, temperature and similar physical quantities in any desired units—for example, rpm, gals/sec, psi, etc. Direct indication is made possible by a counting interval variable over a wide range in small increments.



MODEL 5420 SERIES



MODEL 5440 SERIES

## COUNTER-CONTROLLERS

Counters which deliver output signals when selected numbers are reached are widely used for precise control of diverse operations. Output signals may be relay closures, sharp voltage pulses or changes in dc level. 5400 Series instruments operate at speeds up to 40,000 counts per second and deliver output signals at one or two preset totals. 5800 Series controllers utilize miniature magnetic amplifiers for maximum reliability in industrial control applications. Operable at speeds up to 5000 counts per second, these units are obtainable with from 1 to 12 preset points.



MODEL 5820 SERIES

Write for Catalog C706.

# Beckman

## Berkeley Division

2200 Wright Avenue, Richmond 3, California

a division of Beckman Instruments, Inc.

CIRCLE 8 ON READER-SERVICE CARD

## BEHIND THE NEWS



## "Hotshot" Wind Tunnel

A new 40-in. "hotshot" wind tunnel now being built by Boeing will give the company its seventh operating wind tunnel and the largest privately owned hypersonic tunnel in the country.

Shown is an 8-in. pilot model which has been in operation since mid-1958. This "hotshot" tunnel—often called an "electric-arc-discharge wind tunnel"—gives Boeing testing capabilities in the Mach 10 to 27 range.

A "hotshot" tunnel consists of a capacitor bank for storing electrical energy, an arc-discharge chamber for containing high pressure—high temperature air, a nozzle, a test section to hold the model and a vacuum system for lowering the pressure in the test section. A plastic diaphragm maintains the pressure differential between the arc chamber and the test section until the moment of test.

In a typical test run, the capacitor bank is charged to capacity and compressed air is forced into the arc chamber. When an arc is struck, the air in the arc chamber becomes ionized. This high temperature—high pressure plasma rupture the plastic diaphragm and permits a high-energy shock wave to rush through the nozzle and into the test section. The shock wave is followed by a hypersonic flow of air.

Although the actual test lasts only about 1/25th of a second, ultra-high-speed oscillograph recorders can record data at 160 inches of paper per second on 36 channels.

The new hypersonic tunnel, as well as this pilot model, will enable the testing of models up to satellite Mach numbers.

Don't forget to mail your renewal form to continue receiving **ELECTRONIC DESIGN**.

ELECTRONIC DESIGN • April 29, 1959



## Soviets Claim "World's Most Powerful" Computing Machine

A computing machine the Russians call "the most powerful in the world" is solving scientific puzzles at Kiev University, while another "unique" computer is working out problems of efficient exploitation of Soviet oil fields.

The Kiev computer, a differential analyzer, is described by a Russian writer as "incorporating 24 integrators and characterized by a high degree of automation in all of its units."

The solver of oil-field problems is said to illustrate Soviet mastery in series production of "specialized analog computers capable of investigating dynamic systems and other processes described by differential equations of the order 6 to 32."

The "matrix-type electrointegrator" has a matrix of resistors and capacitors at 20,000 points, a feature said to make it "a unique machine of this class."

One is a universal digital computer which will figure complex scientific and engineering problems at a rate of 20,000 operations per second. Its circuit will contain a series of storage units, one for internal storage of 2047 numbers, one for intermediate storage for 4096 numbers, and a third for external storage of 100,000 numbers.

The Russians describe the second machine as one of the first small-size universal digital computers with circuits using transistors, ferrites, and miniature tubes. Circuits of its control and arithmetic units incorporate transistors and semiconductor diodes.

The computer is designed to operate at a speed of 2000 to 2500 single-address operations a second. Internal ferrite storage will be 2048 forty-column binary digits of 4096 commands. External storage will consist of two magnetic tape units, each holding 70,000 forty-column digits.

## Japanese Interpreter

An experimental electronic computer which can translate English into Japanese has been successfully produced at the Industrial Technology Institute's Electric Laboratory in Tokyo.

The new invention, the first such machine ever made in Japan, was described by Dr. Shigeru Takahashi at the meeting of the Telecommunication Academy's Electronic Computer Research Committee at Osaka University's Department of Technology. The translating machine, christened "Yamato," was completed last December by Dr. Takahashi with collaboration of five other electronic specialists in the electric laboratory.

"Yamato" can translate first year junior high school English to Japanese.

High capacitance for low voltage circuits . . .

# NEW TANTAPAK\* CAPACITORS

**SPRAGUE'S TANTAPAKS** are the newest members of the Tantalex\* family of tantalum electrolytic capacitors. TANTAPAKS have as much as 2400  $\mu$ f at 10 volts d-c or as little as 140  $\mu$ f at 75 volts d-c. Five case sizes—ranging from less than a cubic inch to a mere 3½ cubic inches—are identical to Type CP-90 paper capacitors. Standard footed and spade-lug brackets simplify mounting. All units are dual-voltage rated for operation at both 85°C and 125°C under 2000 hour life tests.

The construction of TANTAPAK Type 200D capacitors assures excellent shock and vibration resistance. Glass-to-metal solder-seal terminals provide positive hermetic sealing. There are no electrolyte leakage problems.

Porous tantalum anodes give better leakage and temperature coefficient characteristics than foil-type capacitor sections of comparable ratings. In addition, the impedance and equivalent series resistance of Type 200D are superior to foil units at high temperatures and frequencies.

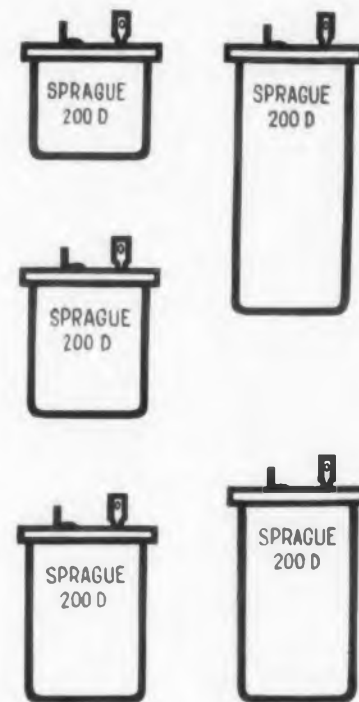
*Get complete information by writing for Engineering Bulletin No. 3705. Address request to Technical Literature Section, Sprague Electric Co., 347 Marshall Street, North Adams, Massachusetts.*

\*Trademark

#### SPRAGUE COMPONENTS:

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

CIRCLE 9 ON READER-SERVICE CARD



One-half actual size.

**SPRAGUE®**  
the mark of reliability



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

Remarkable new design concepts and modern construction features of Cerafil Capacitors make it possible to obtain **extremely high capacities per unit volume**. These ultra-miniature ceramic capacitors offer a logical solution to circuit designers concerned with extremely miniaturized assemblies and equipments.

Cerafil Capacitors are the **smallest** ceramic units manufactured in the electronic industry. They are designed specifically for airborne and space-borne equipments, computer circuits, hearing aids and other critical applications where space and weight requirements are at an absolute premium.

Cerafil capacitors are available in working voltages of 30, 50 and 100 VDC, and in capacities from 10 mmf to 100,000 mmf. Type C80 (100 VDC) of this rugged ceramic unit of **high reliability** is designed for operation at temperatures from  $-55^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ . Type C80T (50 VDC) is rated at  $125^{\circ}\text{C}$ . Types C80 and C80T will meet or surpass all the applicable requirements of MIL-C-11015A.

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



**Hi-Q<sup>®</sup>**  
Division

**AEROVOX  
CORPORATION**

Available at local  
Aerovox Parts Distributors nationally!

Write today for complete technical  
information of these ultra-miniature  
**CERAFIL CAPACITORS...**

OLEAN, NEW YORK

CIRCLE 10 ON READER-SERVICE CARD

## BEHIND THE NEWS

# New Field Effect Semiconductor Tetrode Is Almost "Universal" Component

**F**UNCTIONS of a transformer, gyrator, isolator, non-distorting modulator, or short-circuit stable negative resistance can be duplicated by a new four-terminal semiconductor device developed by Bell Telephone Laboratories. Labeled a "field-effect tetrode," the device has no analog, either in electron tubes or previous transistors.

### Construction

The tetrode, Fig. 2, is composed of a disc of semiconductor with a diffused junction. A circular trench is cut and etched into each face of the disc, to within 1 mil of the junction on either side. Two leads are then attached to each face, one inside the trench, the other outside. When a voltage is applied across the junction, the thickness of the depletion layer adjacent to it is increased or decreased, depending on the direction of the biasing voltage. This in turn increases

or decreases the resistance of each "channel" between the bottom of the trench and the junction.

### Unusual Applications

Depending on the polarity of the biasing voltage, the tetrode will function either as a transformer or a gyrator. As a transformer, it has a very decided size advantage for low frequency use, although it does not afford dc isolation. As a gyrator, it should be of considerable circuit interest. (A gyrator is a non-reciprocal four terminal network which behaves similarly to a transformer, while exhibiting a 180 deg difference in phase shift depending on the direction of transmission.) One important gyrator function is impedance inversion. For example, it should be possible to use the new device to convert the reactance of a miniature capacitor into that of a high-Q inductor.

If the device is biased properly, it will



Fig. 1. Inventors R. M. Warner Jr. and H. A. Stone, Jr. inspect model of field-effect tetrode



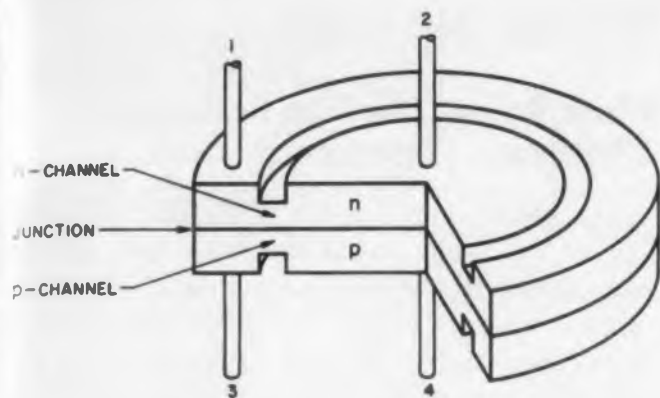


Fig. 2. Note circular trench etched into face of upper and lower section of field effect tetrode.

function as an isolator, allowing passage of alternating current in one direction only.

#### Distortionless Modulator

According to its inventors, H. A. Stone, Jr. and R. M. Warner, Jr., one of the most important applications for the new device may be as a distortionless modulator, or electronically controlled resistor for large signals. In this use, a relatively low frequency control-voltage varies the width of the depletion layer, and thus the resistance of the device. Simple capacitors act as high-pass filters to isolate the control-voltage from the signal, if the frequency ratio is maintained at a high level. The signal voltage does not appear across the junction and has no effect on the depletion layer. Therefore, it can be magnitudes higher than the control voltage, without being distorted by self-modulation. For the same reason, it is not limited by junction capacitance.

#### Stable Negative Resistance

If a direct connection is made between the inner lead on one face and the outer lead on the other, the device will function as a two-terminal a-c short-circuit stable negative resistance. In the experimental models produced at Bell Laboratories, this performance has been achieved over a range of about 30 to 250 v, at 0.6 to 0.1 ma, in a boron-doped silicon crystal with a phosphorous diffused junction.

While the practical development of the field effect tetrode is still in a very early stage, it shows potential characteristics in a single device which previously either could not be obtained at all, or only through extensive circuitry. ■ ■

Have you sent us your subscription renewal form?

**ON-TARGET**  
*dependability*

with.....  
**BREW DELAY LINES**

**LUMPED CONSTANT**

- Delay Time 10 millimicroseconds - 100 milliseconds
- Impedance 50 - 3000 ohms
- Delay to Rise Time Ratio up to 50 - 1
- Low attenuation characteristics

**SOLID DELAY LINES**

- Delay Time 3 - 4000 microseconds
- Impedance 50 - 2000 ohms
- Center Frequency 5 - 100 megacycles
- Spurious to 60 db
- Low attenuation characteristics
- Band width to 50% of Carrier Frequency

- Modern production facilities
- Complete quality control
- Packaging to Military specifications
- Minimum size and weight is prime design factor
- Trained Personnel
- Prototypes

**BREW DELAY LINES**

Richard D. Brew and Company, Inc.  
90 Airport Rd. • Concord, N. H.

Brochures Available On Request

CIRCLE 11 ON READER-SERVICE CARD





FOR COMMUNICATIONS  
AND CW RADAR

## VARIAN KLYSTRONS

VA-802  
1.7 to 2.4 kMc  
1 kW cw

### WIDE TUNING RANGE • AIR COOLED

The highly efficient VA-802 has been designed to meet the rigid demands of both fixed station installations and transportable service. Simple to install and operate, it provides rugged reliability at low operating cost — with power output of 1 Kw, tuning range of 1.7 to 2.4 kMc. Features of this 18" Klystron with permanent magnet include: Trouble-free internal cavities, low noise and long life.

Varian makes a wide variety of Klystrons and Wave Tubes for use in Radar, Communications, Test and Instrumentation, and for Severe Environmental Service Applications. Over 100 are described and pictured in our new catalog. Write for your copy — address, Tube Division.



**VARIAN associates**  
PALO ALTO 21, CALIFORNIA  
Representatives throughout the world

VA-800	1.7 to 2.4 kMc	10kW cw
VA-802	1.7 to 2.4 kMc	1kW cw
VA-804	4.4 to 5.875 kMc	10kW cw
VA-805	5.875 to 6.425 kMc	2kW cw
VA-806	7.125 to 8.5 kMc	2kW cw
VA-822	9.9 to 10.8 kMc	1kW cw
VA-833A, B	.47 to .965 kMc	10kW cw



KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, HIGH VACUUM PUMPS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, R. F. SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALDS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

CIRCLE 12 ON READER-SERVICE CARD

## BEHIND THE NEWS

### Moon Relay Link Ties Pentagon to 50th State Outpost

Communications between Washington and Pearl Harbor will make use of the moon as a passive relay station in the coming year. After nine years of research work by the Naval Research Labs., a feasible system for reflecting radio and radar signals off the moon has been developed. Known as the Communication Moon Relay Project, the system theoretically could handle all military communications between Washington and the military command center of the Pacific.

Two and one-half seconds will be required for the uhf signals to complete the trip to the moon and back; about 4500 miles lie between Washington and Pearl Harbor. Signals will be transmitted from 84 ft. diam. parabolic antennas at Annapolis, Md., and received by similar antennas at Cheltenham, Md., about 15 miles from Washington. Two similar stations will be located at Wakiawa and Opana in the Pacific.

The fact that the moon must be in sight of both links poses the obvious limitation to the system. Radio contact can vary from four to fourteen hours daily depending on the orbit of the moon. This disadvantage is outweighed, say Navy officials, by the improved reliability of message transmission. Noise interference and ionosphere-caused blackouts will not mar system operation.

In addition, the system is virtually jam-proof—an important military consideration. In order to jam the moon circuit, an enemy would require a station located within several miles of the main sites. Theoretically, the enemy could bounce signals off the moon at the same frequency, but this attempt could easily be thwarted by switching frequency at predetermined intervals.

### Ultra-High Speed Flash

Flash X-ray equipment for use in recording explosion processes and measuring the speed of hyper-velocity objects has been announced by Zenith Radio Research Corporation. Utilizing a newly developed air-core pulse transformer and special "triggering" circuits, the equipment performs with a degree of reliability and accuracy which has never before been achieved by flash X-ray systems.

Unlike other flash X-ray equipment in which capacitors apply the full accelerating voltage directly to the flash X-ray tube, Zenith's equipment stores the energy at a relatively low potential. The pulse transformer, steps it up to the required peak accelerating voltage only when the tube's operation is desired. Full accelerating voltage is within the range of 60-120 kv.

ELECTRONIC DESIGN • April 29, 1959

## NEWS BRIEFS . . .

• • • **LONG DISTANCE COMMUNICATION** employing man-made clouds which reflect radio signals has been patented by Henri Busignies, president of the ITT Laboratories of International Telephone and Telegraph Corporation. The system utilizes clouds of metallic chaff or ionized materials off which the radio signals, transmitted from earth, are reflected back to earth at distant points and picked up by radio receivers. The materials are sent aloft by various methods such as guns, aircraft including guided missiles, balloons, and rockets. They also can be expelled as ionized gas in the exhaust of aircraft such as rockets.

• • • **MANUFACTURERS OF PERMANENT MAGNETS** recently organized the Permanent Magnet Producers' Association, a national trade association designed to promote the progress and development of this industry. The basic program for the PMPA is to expand the program of magnet standardization with respect to magnetic and physical properties for the benefit of industries utilizing permanent magnets. In addition, it will collect and disseminate reliable technical information, from domestic and foreign sources, as an aid for the designer using permanent magnets.

Headquarters for the PMPA have been established at 27 East Monroe Street, Chicago 3, Ill.

• • • **ESTABLISHMENT OF THE NUCLEAR INSTRUMENTATION ASSOCIATION** has been jointly announced by a group of prominent nuclear instrument manufacturers. Creation resulted from the increased importance of nucleonics and nuclear instrumentation within the field of electronics.

Purpose of the Nuclear Instrumentation Association is to give industry support to research, development and production in the U. S. The new national trade organization will be expanded to represent major manufacturing segments of the nucleonics industry.

• • • **A NEW METHOD IN THE THEORY OF SUPERCONDUCTIVITY** by N. N. Bogoliubov, V. V. Tolmachev, and D. V. Shirkov, will be published in April by Consultants Bureau, Inc., 227 W. 17th St., New York 11, N.Y. The book, a complete English translation of the recent Russian work, will be cloth bound and priced at \$5.75.

**Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.**

GENERAL INSTRUMENT SEMICONDUCTOR DIVISION

*Radio Receptor* *silicon diodes*

# IN ANY COMBINATION OF CHARACTERISTICS

*high speed • high conductance • high temperature  
high voltage • high back resistance*

Including the industry's most versatile diode with uniform excellence in all parameters

## 1N658

General Instrument semiconductor engineering has made possible these Radio Receptor diodes with a range of characteristics never before available to the industry.

The types listed here are just a small sampling of the complete line which can be supplied in volume quantities for prompt delivery. Write today for full information.

GENERAL PURPOSE TYPES		FAST RECOVERY TYPES	HIGH CONDUCTANCE TYPES	
1N456	1N461	1N625	1N482	1N484A
1N457*	1N462	1N626	1N482A	1N484B
1N458*	1N463	1N627	1N482B	1N485
1N459*	1N464	1N628	1N483	1N485A
		1N629	1N483A	1N485B
			1N483B	1N486
			1N484	1N486A

\* JAN Types

PLUS a large group of special DR numbers developed by General Instrument Corporation with characteristics that far exceed any of the standard types listed above!

**G**

Semiconductor Division

**GENERAL INSTRUMENT CORPORATION**

65 Gouverneur Street, Newark 4, N. J.

GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION  
AUTOMATIC MANUFACTURING DIVISION, RADIO RECEPTOR COMPANY, INC.  
AND MICAMOLD ELECTRONICS MANUFACTURING CORPORATION (SUBSIDIARIES)

GENERAL INSTRUMENT DISTRIBUTORS: Baltimore: D & H Distributing Co. • Chicago: Merquip Co. • Cleveland: Pioneer Electronic Supply • Los Angeles: Valley Electronics Supply Co. • Burbank: Milwaukee: Radio Parts Co., Inc. • New York City: Hudson Radio & Television Corp. • San Radio & Electronic Co. • Philadelphia: Herbach & Rademan, Inc. • San Diego: Shanks & Wright Inc. • San Francisco: Pacific Wholesale Co. • Seattle: Seattle Radio Supply • Tulsa: Oil Capitol Electronics

CIRCLE 13 ON READER-SERVICE CARD





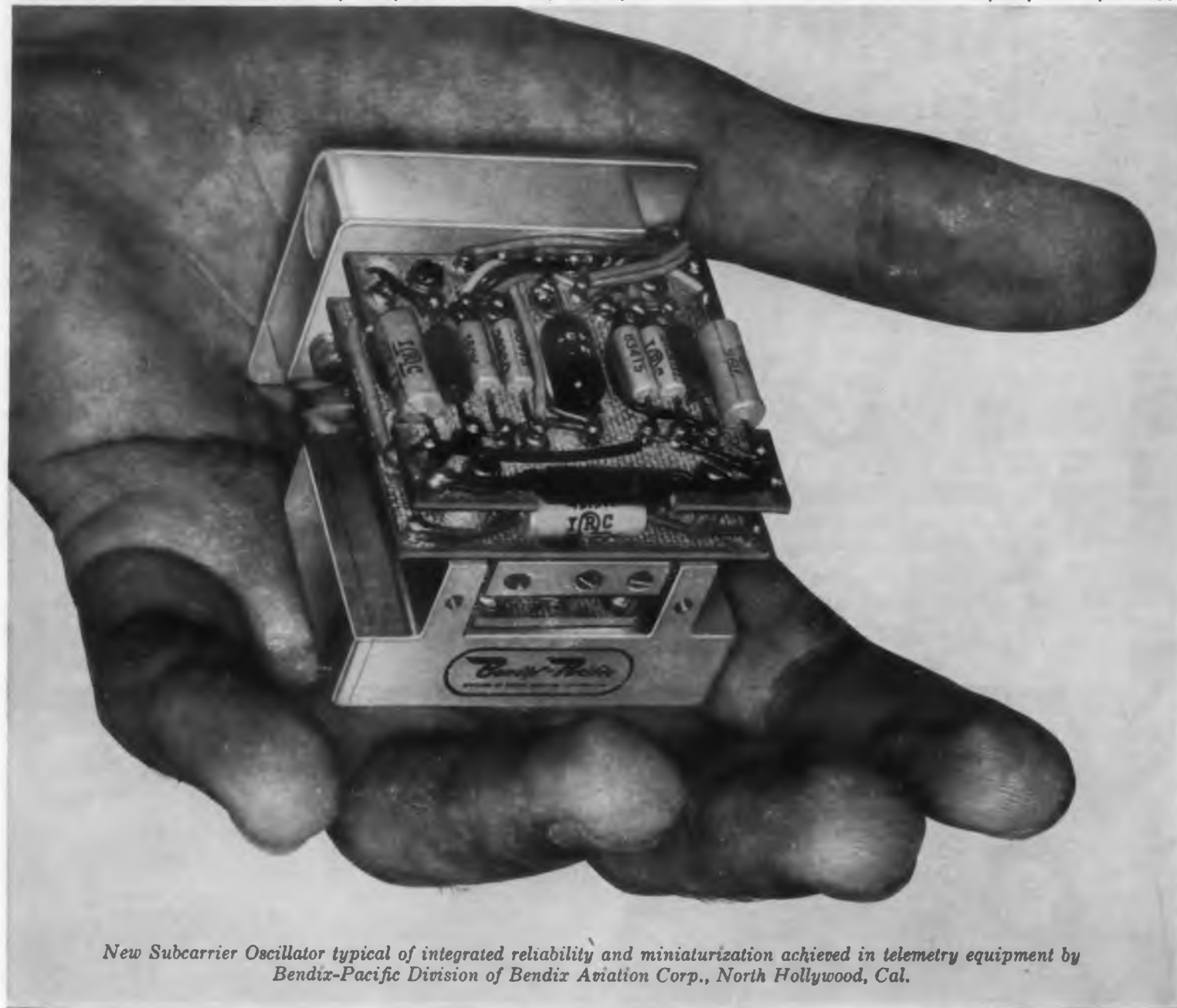
## Small-World Resistors with out-of-this-world Reliability

Miniaturization is a severe test of performance, for reliability tends to shrink faster than size. Here, where critical equipment had to be made smaller, yet more reliable, Bendix-Pacific pinned performance to the reliability of IRC precision film resistors.

IRC Molded Metal Film Resistors combine excellent stability on load with a low, controlled temperature coefficient that is far superior to other precision film resistors. They exceed requirements for extremely close design tolerances and have excellent high frequency characteristics. Where these superior characteristics are not required, IRC Molded Deposited Carbon Resistors offer excellent all-around performance and economy. Both types available in  $\frac{1}{8}$ ,  $\frac{1}{4}$ , 1 and 2 watt sizes . . . and exceed MIL-R-10509B specifications. For design data, write for Bulletins B-3 and B-9.



INTERNATIONAL RESISTANCE CO. • Dept 333, 401 N. Broad St., Phila. 8, Pa. In Canada: International Resistance Co., Ltd., Toronto, Licensee



*New Subcarrier Oscillator typical of integrated reliability and miniaturization achieved in telemetry equipment by Bendix-Pacific Division of Bendix Aviation Corp., North Hollywood, Cal.*

CIRCLE 14 ON READER-SERVICE CARD

## WASHINGTON REPORT



Ephraim Kahn

### New Concept in R & D Planning

Present concepts of research and development would be vastly changed if the military adopt a proposal that has been suggested by Dr. William H. Martin, Director of R & D for the Army. As he sees it, R & D should continue through the first stage of the production cycle. If major production changes are needed, they should be worked into the design before the pilot run has been completed.

#### Leadtime Could be Halved

Furthermore, Dr. Martin believes that the agency sponsoring the development program should be held responsible for all work until the "bugs" have been worked out of any new device. Object of this extensive change in R & D responsibility is to shorten leadtime to about four years from the eight now customary.

Increased automation must necessarily go along with the greater complexity of modern weapons. States Dr. Martin: "This applies especially in the microminiaturization of electronic components, where the designs of the device to be made by automatic machinery have to be compatible and concurrent with the designs of this machinery, and consequently must be able to react on each other."

Industry support for this change in R & D concept is solicited. The Army, for example, wants and needs "more organizations which are proficient in both development and production and whose management has the concept and the experience of handling as a prime contractor the over-all job from the systems point of view."

Some aspects of Dr. Martin's plan for R & D acceleration are bound to create a stir in Congress. The Armed Services have, in the past, come in for sharp criticism from both the House and Senate Small Business Committees for alleged over-emphasis on the use of negotiated contracts in military buying—particularly those involving larger firms. Nevertheless, Dr. Martin implies that competitive bidding is not appropriate for new and untried products that are still basically in the development stage. It is only after this period is over that the military is "ready to break into the systems concept of responsibility by the primary contractor and 'peel off' direct purchasing of some of the supporting equipment.



As Dr. Martin sees it, the four-year development cycle would require the services of a "project manager," and provision for funds for the entire cycle would have to be made at the time the program was set up. Though these are "objectives and not regulations to be applied to every project regardless of its magnitude or urgency," he believes that they "should be valid for the more important projects."

#### Possible Approaches

Guidelines for putting this proposal into practice would include:

- Adequate basic research and development programs to provide a reservoir of new concepts, knowledge, and components, and that each project be backed by a well-drawn plan prior to its authorization.

- Development cycle end only after acceptable and tested items have been produced in the course of the first production run.

- Responsibility by a single contractor for development, preparation for production, initial production, and support materials.

- Maximum stress be placed on the Qualitative Military Characteristics of the product throughout the development cycle, with the R & D agency primarily responsible for seeing to it that QMC are properly adjusted to available technology, economical quality production, reliability, and timely availability.

- Close relations with the contractor and the development agency be maintained by the logistics and user agencies to insure that their interests are properly effective in the development of the design.

- Designation, by the development agency, of an employee as project manager, responsible for the progress of the venture and for coordinating the participation of other government agencies.

- No more than a four year lead-time be planned from inception of a project to operational availability of its end-product, and that the availability of funds be geared to this rate of progress.

#### EIA Group to Visit USSR

Ray C. Ellis, Vice President of Raytheon Manufacturing Co. and Chairman of the International Department of the Electronic Industries Association (EIA) will head a six-man delegation of American electronics specialists leaving shortly for a three-week visit to the USSR. The group will meet with its Soviet counterpart and visit electronics laboratories and plants.

This is the time of our annual subscription renewal.

ELECTRONIC DESIGN • April 29, 1959

## Feeds, stakes and fuses Eyelets in PRINTED CIRCUIT Boards WITH 100% RELIABILITY



in every environmental test!

**EDWARD SEGAL  
MODEL NR-ESSM  
automatic eyelet  
attaching machine**

\* Some of the plants using Edward Segal Model NR-ESSM eyeletting machines—in many cases, batteries of them, include:

Bendix Aviation Co., Kansas City, Mo.  
Federal Telephone & Radio Division of  
I.T.T., Clifton, N. J.

Bell Telephone Laboratories,  
Whippany, N. J.

Laboratory of Electronics,  
Boston, Mass.

Melpar, Inc., Arlington, Va.

Sandia Corp., Albuquerque,  
New Mexico

Western Electric Co., Greensboro, N. C.  
... and many others.

Economical, too. They frequently pay  
for themselves in a few months or less.

This revolutionary development in printed circuit board production is obsoleting manual eyelet attaching and soldering. Many of the leading manufacturers in America\* find that Segal's new Model NR-ESSM is a completely dependable automatic method of making continuous electrical circuits of the printed elements on opposite sides of a board — or a single side if desired.

This unique machine stakes and solders simultaneously, sets up to 30 eyelets a minute, top and bottom, with never a reject.

Model NR-ESSM is just one of many efficient Edward Segal machines. There's Model NRLT for example, for cold staking flat and funnel type eyelets, and Model LSD that automatically feeds and stakes tube pins and turret terminals with equal reliability. For full details on these or any other machine to improve your eyelet attaching production, write Section ED-4

*Edward Segal engineers can recommend and supply you with eyelets for every phase of printed circuit work.*



MANUFACTURERS OF EYELETING MACHINERY, SPECIAL HOPPERS AND FEEDING DEVICES

132 Lafayette Street, New York 13, N. Y. Telephone: WOrth 6-3935

Chicago 22: A. J. Horne, Inc., 1958 West North Avenue

California: Dolliver & Bro., 5108 East Washington Blvd., Los Angeles 22;  
619 Mission Street, San Francisco 5

CIRCLE 15 ON READER-SERVICE CARD

# COAX HYFEN CONNECTORS

with crimp-type  
snap-locked contacts



Snap-lock action of Burndy coax HYFEN connectors recommends them for many applications. Contacts may be installed on cable wherever convenient and then snapped in or out as required. These connectors are now in use in critical circuits

**ME7X**  
...Rack-and-panel Coax HYFEN with one-piece die-cast shell and one-piece block. Mates with existing solder types.

**COAX MODULOK**  
...Modular terminal block. Modules snap together or apart and are mounted on cadmium-plated steel track.



**CONNECT QUICKLY**  
...high speed tooling for volume production results in low installed costs.

**CONNECT EASILY**  
...snap-lock action and simple design with few parts make installation easy—tool crimps contacts in any circumferential position.

**CONNECT RELIABLY**  
...tool-controlled crimp provides strain relief for conductors, guarantees a uniform indent for measurable quality control. There is no heat to damage insulation.

FOR OTHER REQUIREMENTS OR APPLICATIONS, CONTACT OMATON DIVISION

# BURNDY

59-7

Norwalk, Connect.

In Europe: Antwerp, Belgium  
CIRCLE 16 ON READER-SERVICE CARD

Toronto, Canada

## Burndy Hyliner Coming Your Way Vehicle To Demonstrate Latest in Connections

The Burndy "Hyliner," a mobile demonstration unit, recently left Burndy's Norwalk headquarters for its second transcontinental tour. The Hyliner is a deluxe bus which was converted into a traveling demonstration and display vehicle to introduce Burndy's Omaton Division and its products to the nation's manufacturers of electrical and electronic products.



The Hyliner began its first tour in August 1956 after being dedicated by Connecticut's Governor Abraham Ribicoff. Since then nearly 80,000 engineers have visited the Hyliner during its 70,000 miles of crisscrossing the U. S. and Canada.

After completing its initial tour the Hyliner returned to Burndy headquarters for outfitting with the latest displays and demonstration equipment. Alan E. Aune, OEM Sales Manager, states that heavy emphasis is being placed on connections for electronic equipment, such as new HYFEN® and STAPIN® methods. During the current tour, he added, smaller, more intimate groups from each plant visited will tour the Hyliner.

During the Hyliner's first tour, many new lines of HYFEN connectors were perfected including the new coax HYFEN which has already been adopted by several large manufacturers of computers as well as military missile guidance control equipment manufacturers.

Samples of all the latest connectors and connection techniques, including all types of installation tooling, will be demonstrated.

CIRCLE 240 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1957



# EDITORIAL

## Not a Breakthrough But a Revolution

There is a revolution going on in the components industry. Microcircuitry, or more generally, microelectronics, is no longer simply a blue-sky topic for luncheon speakers. The cover story of the last issue of *ELECTRONIC DESIGN* and special report in this issue, "Microelectronics . . . a new concept in Packaging", bears witness to the fact.

It is not easy to describe the transformation going on but the 18 pages that follow will give you an "operational definition" in the P. W. Bridgman sense. A study of the report will show the work of not one or two government labs but the results of at least 60 organizations. If you were at the IRE National Convention, you saw the Army's micro-modules at the RCA booth and the solid circuits at the Texas Instrument booth—the same solid circuits predicted as coming but at least five years away.

RCA's micro-modules are for sale. Texas Instrument says theirs will be available shortly. This means that in two years operational equipment using microelectronics will be available. Since at least 85% of today's electronics equipment can be built the micro-module way, today's engineer is witnessing the beginning of a revolution.

Whether the conversion will take depends on a number of factors. There will be of course widespread passive resistance if the owners of production machinery do not invest in new machinery. Currently, the components portion of the electronics industry, excluding tubes and transistors, produces products having a value of only \$1.3 billion, but the practices of this small group determine the form factor of the product of a \$7.9 million original equipment market.

There will be changes, therefore, only as production machinery for the new techniques is funded. We see this coming. The stakes are worth it: smaller size, greater reliability, lower costs. If the military finances but one company, the rest will follow as no one can afford not to be prepared to share in the new market. If components manufacturers do not rise to the challenge, weapon system contractors will take the lead. Once they do, the revolution will come to pass. Since microelectronics by automation is economical, producers can control not only the military market but the consumer and industrial market as well. Microelectronics products produced by automation will be cheaper than the coolie-labor products and the world market, too, will belong to the victors.

*James G. Kipp*



## 7

DECADES  
of accurate

# VOLTAGE DIVISION

IN THE

## NEW Model DT-72

# DEKATRAN

## Decade Transformer

*Featuring*

**EXCEPTIONAL ACCURACY—**  
Better than 0.0001% (1 part per million) linearity; 50-1000 cps.

**HIGH RESOLUTION—**7 place readings in steps of 0.00001% (1/10 part per million).

**TRANSIENT SUPPRESSION—**  
Switching transients minimized by unique circuit design.

**EASE OF OPERATION—**Human engineering features simplify dial setting and permit in-line reading.

**DECADE OVERLAP—**Each decade except the first has 12 useful positions - 1 to +10.

**CONVENIENT SIZE—**Mounts in standard 5 1/4 x 19 inch rack space.

★ The Northwest is a great place to raise a family! Don't hold out on them. Write today and tell us about yourself — we may have just the right job for you.



**ELECTRO-MEASUREMENTS, INC.**  
7524 S. W. MACADAM • PORTLAND 19, OREGON

CIRCLE 17 ON READER-SERVICE CARD



# How To Determine Circuit Response With Two Time Constants

The simplifying assumption is perhaps one of the most useful tools in the design engineer's arsenal. But it can be a treacherous one.

"Let us assume a step input," is one of the most popular of these tools. It is extremely convenient, but unless used carefully, it can lead to unexpected circuit response.

Richard Muller, a Fellow of the National Science Foundation, shows when the assumption is "safe," and what "safer" assumptions can be made when necessary.

Richard S. Muller

Hughes Aircraft Co.  
Culver City, Calif.

**T**HOUGH no real waveforms can have zero rise time, practical calculations of network response usually assume that driving waveforms are square. This approximation is often valid, often not. When the approximation leads to troublesome errors, it is profitable to consider simplifications which may permit more accurate calculations while still avoiding the laborious, exact approach.

The step response of a single time constant network consists of a single exponential term which can be easily manipulated to yield an explicit solution for time. But if the driving waveform is rounded so it has a finite rise time, the response equation has two exponential terms. The driving wave's rise time contributes the second time constant.

In this case, an explicit solution for time is not attainable. An exact approach demands a laborious graphical technique.

## A Transistor's Step Response

To illustrate the problem, consider a network which has a transformed response to a step input which takes the form

$$\frac{A}{s(s + D)}$$

Such an equation is, for example, characteristic of the transistor step response derived by Easely.<sup>1</sup> In the common emitter configuration, for in-

stance, the form of the equation is

$$I_c = \frac{A I_{b1}}{s(s + D)}$$

where  $I_{b1}$  is the magnitude of the base current step and  $I_c$  is the output (collector) current.

If the driving waveform is not square, but rounded as by capacitive shunting, it is likely to be of the form

$$I_b = I_{b1} (1 - e^{-Gt})$$

instead of the simple step  $I = I_{b1}$ .

Such a driving waveform would yield a transformed response equation of the form

$$I_c = I_{b1} \left[ \frac{A}{s(s + D)} - \frac{A}{(s + G)(s + D)} \right]$$

since

$$L[I_b(t)] = \frac{1}{s} - \frac{1}{(s + G)} I_{b1}$$

which implies that

$$I_c = I_{b1} \left\{ \left[ \frac{A}{D} (1 - e^{-Dt}) \right] - \left[ \left( \frac{A}{D - G} \right) (e^{-Gt} - e^{-Dt}) \right] \right\} \quad (1)$$

Eq (1) is the type under consideration. The first term is the step response of a network with a single time constant  $1/D$ . The second is due to

the finite rise time of the driving waveform. As its time constant  $1/G$  approaches zero, the rise time of the driving wave approaches zero and the output approaches the step response.

## How Accurate Is The Single Time Constant Approximation

The important question that arises with this example is "What is the relative magnitude of  $G$  with respect to  $D$ , which would allow considering the step response alone with negligible error?" If one thinks in terms of time constants, the consideration is of the ratio of the circuit time constant  $1/D$ , to the driving waveform's time constant  $1/G$ .

For negligible error, the second term in Eq (1) must be negligible compared with the first. If, for example, the ratio of these two terms is set at 0.1, it should be interesting to see what restriction this places on the magnitude of  $G$  with respect to  $D$ .

Accordingly, set

$$\left( \frac{D}{D - G} \right) \frac{(e^{-Gt} - e^{-Dt})}{(1 - e^{-Dt})} < 0.1 \quad (2)$$

Probably  $G$  will have to be significantly larger than  $D$  to make  $e^{-Gt} \ll e^{-Dt}$  at all but very small  $t$ 's. Hence, the effective requirement is

$$\left( \frac{D}{G - D} \right) \left( \frac{1}{e^{Dt} - 1} \right) < 0.1$$

which leads to

$$\epsilon^{Dt} > \frac{9D + G}{G - D} \quad (3)$$

Eq (3) gives a quantitative statement to the evident fact, that as consideration is extended to smaller and smaller response times, the approximation demands greater and greater disparity in the exponential time constants. The expression also indicates that the error decreases with time since the inequality becomes easier to fulfill with increasing  $t$ .

At this juncture, the designer must decide in what time range his interest lies. Then, using Eq (3), he can determine the required  $G$  to  $D$  ratio.

Continuing with the example of transistor step response equations, and specifying that response times of interest will be less than  $1/2$  the time constant of the dominant exponential, insert  $t = 1/2 \times 1/D$  in Eq (3).

Thus

$$\epsilon^{1/2} > \frac{9D + G}{G - D}$$

which leads to a required  $G = 16.4 D$ . If the 10 per cent error point had been set at  $t = 1/D$ , the required  $G$  would be  $6.25 D$ . These values justify the neglect of  $\epsilon^{-Gt}$  when compared with  $\epsilon^{-Dt}$  in Eq (2).

From this example, it is evident that a large deviation of one time constant from another may be necessary to permit neglect of the effect of one with respect to the effect of the other. In this instance, recognition of the finite rise time of the forcing function is necessary unless this wave is characterized by an exponential with about  $1/15$  the rise time of the response.

### Two Time Constant Consideration

When the first order approximation becomes too inaccurate, some recognition of both time constants becomes imperative.

It is helpful to examine plots of the actual response of the system of Eq (1) for different ratios of the two time constants. A careful inspection may point out a simplified approach that would bypass graphical techniques and yield a readily calculable explicit solution for response time.

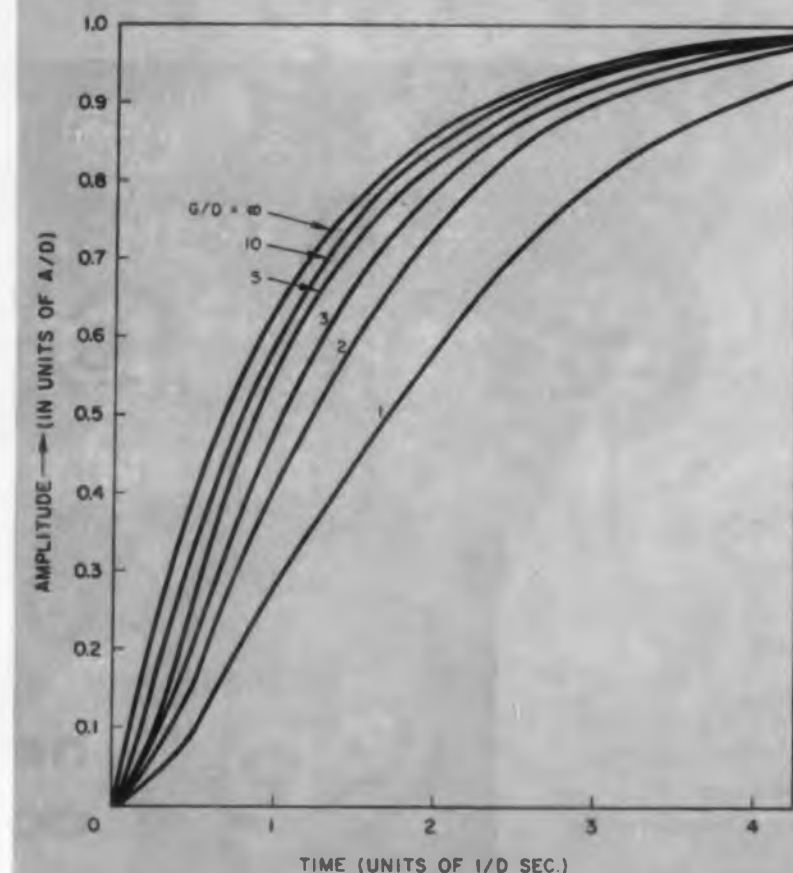
Fig. 1 is a family of such curves for various values of  $G$ . As  $G$  approaches  $D$ , the response approaches the form

$$\frac{I_e(t)}{I_b} = \frac{A}{D} (1 - \epsilon^{-Dt} - Dt \epsilon^{-Dt})$$

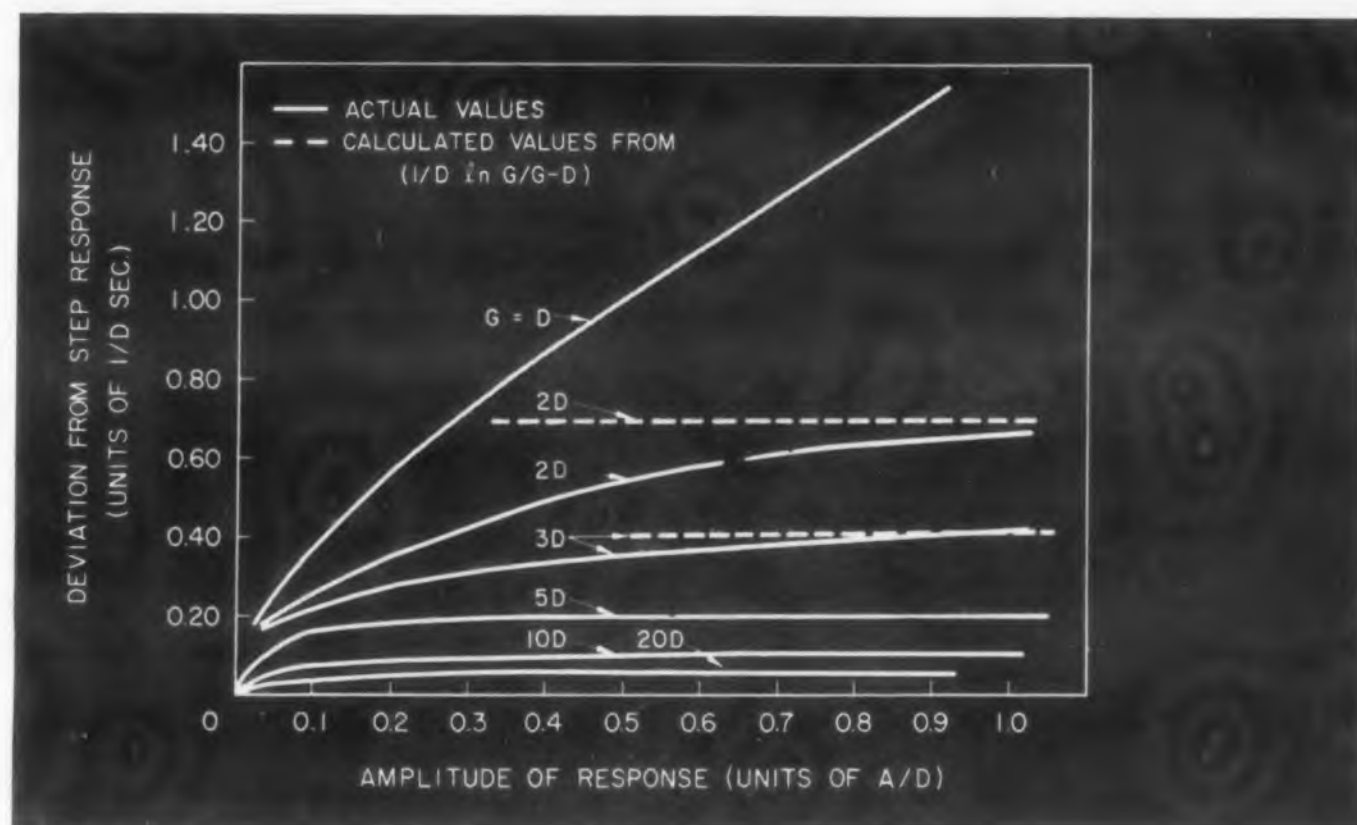
From this graph, a second plot, more useful to the circuit designer, may be obtained.

If the time lag between the step response and the actual response is plotted, (Fig. 2) as a func-

**Fig. 1.** The actual response of a system compared with the estimated response assuming a square driving waveform for various ratios of system time constants  $1/D$  to driving-wave time constants  $1/G$ .



**Fig. 2.** Deviations of actual network response from step input response.



tion of the amplitude, an interesting fact appears. For  $G/D$  ratios of three or more, the time deviation of the actual response from the step response rapidly approaches a constant, independent of the response amplitude.

As  $G$  becomes greater than  $D$ , the term in  $\epsilon^{-Gt}$  rapidly tends to become negligible compared with  $\epsilon^{-Dt}$ . Hence, the correction term to the step response approaches

$$- \frac{A}{G - D} \epsilon^{-Dt} \quad (4)$$

Now, for any given amplitude  $C$ , the step response equation determines a value  $t'$  as follows:

$$t' = \frac{1}{D} \ln \left( \frac{A}{A - DC} \right) \quad (5)$$

Using the correction approximation of Eq (4),



# GENERAL TRANSISTOR



QUALITY PRODUCT  
FROM GENERAL TRANSISTOR.

**new  
complete line of**

**GERMANIUM  
GOLD BONDED DIODES**

## GENERAL TRANSISTOR IS NOW MAKING GERMANIUM SUBMINIATURE GOLD BONDED DIODES

You may be assured that this new product line has the same high quality and reliability that has made General Transistor the Fastest Growing Name in Transistors. Experienced design engineers, quality materials, proven production techniques, and strictly enforced quality controls are your guarantees.

These diodes have been designed for computer, industrial and military applications where high reliability is of prime importance. They are hermetically sealed in a glass case with tinned leads. Their rugged construction makes them resistant to humidity, shock and vibration, and impervious to extreme environmental conditions.

Write today for Bulletin GD-10 showing complete specifications, diagrams and other engineering data.



**GENERAL TRANSISTOR  
CORPORATION**

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

91-27 138th Place  
Jamaica 35, N. Y.

CIRCLE 18 ON READER-SERVICE CARD

the true response is closely approximated by

$$C = \frac{A}{D} \left[ 1 - \frac{G}{G-D} e^{-Dt} \right]$$

which yields

$$t = \frac{1}{D} \left[ \ln \left( \frac{A}{A-DC} \right) + \ln \left( \frac{G}{G-D} \right) \right] \quad (6)$$

Hence, the time added to the step response approaches the difference between Eq (6) and Eq (5), or

$$\frac{1}{D} \ln \left( \frac{G}{G-D} \right) \quad (7)$$

The dotted family of curves on Fig. 2 is calculated from this equation. For  $G = 5D$  and higher, at amplitudes greater than two tenths of the final value, they nearly overlay the true curves. Even for  $G = 2D$ , the calculated curve, which is the true curve's asymptote, is a fair correction above about half the final amplitude.

### Simplified Calculations

This fact simplifies calculations for the two time constant case a great deal. It allows consideration of the second exponential via a simple additive term to the explicit solution for time, achieved by considering one time constant equal to zero.

Consider a specific application. From Easely's calculations (which add the effect of collector capacity to the transistor response equations, and were derived first by Ebers and Moll<sup>2</sup>), explicit solutions for "turn-on" and "turn-off" time were derived.

Since they are explicit for a single time constant, these same expressions can be modified by the correction term given in Eq (7) to account for a nonsquare input to a transistor amplifier. The following sample problem illustrates a typical design situation in which these observations apply.

### Sample Problem

It is desired to "turn on" a common emitter transistor with a current pulse which has a rise time (to  $1/\epsilon$  of the final value) of  $0.06 \mu\text{sec}$ .

What magnitude should the base current have to achieve a "turn on" time of  $0.43 \mu\text{sec}$ , if the transistor has the following properties?

$$f_{\alpha \min} = 15.9 \text{ mc } (\omega_{\alpha \min} = 100 \times 10^6)$$

$$C_{c \max} = 10 \mu\text{f}$$

$$r_{c \min} = 200 \text{ K}$$

$$\alpha_{\theta \min} = 0.95$$

The final current required is  $I_{c1} = 10 \text{ ma}$  into a  $1 \text{ K}$  load  $R_L$ .

### Design Procedure

From the input wave rise time of 0.06  $\mu$ sec, one may determine  $G$ . Thus

$$G = \frac{1}{t_r} [1 - \ln(\epsilon - 1)]$$

$$= \frac{0.46}{0.06 \times 10^{-6}} = 7.67 \times 10^6$$

From Easely's paper

$$D = \frac{(1 - \alpha_0 + R_L/r_c)(\omega_a)}{(1 + R_L C_c \omega_a)}$$

$$= \frac{(1 - 0.95 + 1/200)(100 \times 10^6)}{(1 + 10^3 \times 10 \times 10^{-12} \times 100 \times 10^6)} = 2.75 \times 10^6$$

$$G = \frac{7.67}{2.75} D = 2.79 D$$

Hence, the step response is  $(1/D) \ln(2.79/1.79) = 0.44/D$  shorter than the actual response.

Since  $1/D$  equals 0.364  $\mu$ sec, the actual response is  $0.44 \times 0.364 = 0.16 \mu$ sec longer than the step response. Thus, for an overall "turn on" time of 0.43  $\mu$ sec, the time to be inserted in the step response equation is 0.43-0.16, or 0.27  $\mu$ sec.

Thus, by Eq (3)

$$0.27 \times 10^{-6} = \left( \frac{2}{0.055 \times 100 \times 10^6} \right)$$

$$\ln \left( \frac{I_{b1}}{I_{b1} - 0.9(10 \times 10^{-3}) \left( \frac{0.055}{0.95} \right)} \right)$$

and the required base "turn on" current is

$$I_{b1} = \frac{2.1(0.521 \times 10^{-3})}{1.1} = 1.0 \text{ ma}$$

### Approximations Are "Safe"

The correction embodied in Eq (7) tends to be undefined as  $G$  approaches  $D$ . This is to be expected since the approximation which leads to this term, through Eq (4), becomes further and further removed from reality. However, Fig. 2 shows that the correction term is quite accurate for values of  $G$  three or four times the value of  $D$ , and may be helpful as a first order calculation for  $G$  as small as two times the magnitude of  $D$ .

In any case, the correction term always exceeds the actual error. Hence, any design based on calculated response time will be on the "safe" side. ■ ■

### References

1. The Effect of Collector Capacity on the Transient Response of Junction Transistors, J. W. Easely, *IRE Transactions on Electron Devices*, Vol. ED-4, No. 1, pg. 6.
2. Large Signal Behavior of Junction Transistors, J. J. Ebers and J. L. Moll, *Proc. IRE*, Vol. 42, Dec. 1954, pp. 1761-1772.

the first real "BREAK" for airborne harnesses

## THE ALL NEW A-MP HELICON CONNECTOR



### FEATURES

- helical construction imparts a connection so firm that a special A-MP tool is required to connect and disconnect.
- "O" ring and metal wire-insulation ring make moisture-tight seal
- wiping action cleans pin and socket for assured maximum conductivity
- positive wire-stops prevent over-insertion of stripped conductor

### FEATURES

- serrations inside barrel assure maximum crimp-contact between barrel and conductor
- inspection ports permit examination of conductors in barrel
- environmental proofing: moisture resistant, corrosion resistant, vibration and shock resistant

Never before has such a unit been available—a reliable, pre-insulated "manufacturing break" for aircraft and missile harnesses. Designed as a quick connect/disconnect for all high-reliability circuits, the all new A-MP HELICON Connector is completely environmental-proofed and fully pre-insulated. Equally important, it requires a special A-MP tool to connect and disconnect, thereby preventing tampering and unintentional breaks in circuits.

The HELICON Connector can be attached to airborne circuit wires with remarkable speed and ease... permits multiple connect/disconnects without harm to unit... offers the highest reliability.



This is the product that the Avionics Industry has needed for years. There is nothing else on the market like it. Write for more information.

# AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan  
CIRCLE 19 ON READER-SERVICE CARD



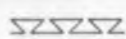
# NOW DROP TUBE TEMPERATURES

AS MUCH AS 130°C

prolong tube life—increase reliability

**atlee** FULL-CONTACT TUBE COOLING SHIELDS  
provide MAXIMUM tube cooling through

- FULL CONTACT with tube
- FULL CONTACT with shield
- FULL CONTACT with chassis

The new **atlee** FULL-CONTACT tube-cooling shield, with exclusive "delta-wave"  insert and flat-mounting shield base, provides a spectacular reduction of envelope temperatures even under extreme operating conditions. Tests prove a drop of 130°C below bare-bulb temperatures, and 80°C below levels reached with JAN shields and standard N.E.L. inserts.

Here is a significant advance in the fight against equipment failure even under conservative operating conditions. Further, where tubes must operate close to maximum ratings, it means a real reduction in the inevitable penalty of shorter tube life.

DESIGN FOR RELIABILITY WITH **atlee** — a complete line of dependable heat-dissipating holders and shields of all types, plus the experience and skill to help you solve unusual problems of holding and cooling electronic components.

## ATLAS E-E

CORPORATION

47 PROSPECT STREET • WOBURN, MASS.

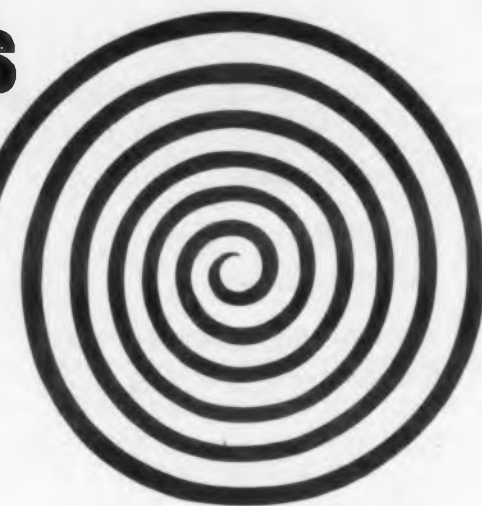
CIRCLE 20 ON READER-SERVICE CARD



Get the complete story  
in your free copy of  
this fact-filled Bulletin!

# Synchronous Motor

starts, stops,  
reverses  
almost instantly



**D**ESIGNED for electronic control systems, this synchronous motor can start, stop, and reverse itself almost instantly. The small, maintenance-free unit operates at constant speed and produces a high torque.

Applications of the motor, called Slo-Syn and made by The Superior Electric Co., Bristol, Conn., include: remote control systems; numerical control systems; and automatic machines and apparatus. It is an enclosed, permanent-magnet type synchronous ac motor.

### Electrical Characteristics

The motor combines a speed of 72 rpm with a 150 oz-in. torque. Speed is synchronous with line frequency and at 60 cps it remains at a constant 72 rpm without gear reduction. Because the motor is

self-starting, no additional starting means are necessary.

Spinning the motor forward, instantly reversing or stopping it can be done with a single-pole, three-position switch since the unit has but three leads. The motor will start or stop in less than 0.025 sec, or about 1.5 cycles. Electrical or mechanical braking is not needed because it will stop in less than 5 deg of motor shaft rotation.

There is no excessive inrush current when the motor is turned on because the starting current is nearly identical to the operating current (0.3 amp max at 60 cps). The correct set of phase-shifting components is specified for nominal 60 cps duty. And with these components the motor will operate satisfactorily at any frequency between 40 and 70 cps. Rated for 50 C temperature rise at 40 C maximum



**Fig. 1.** This exploded view shows the various parts of the synchronous motor. No lubrication of the bearings is required for the life of the motor since the shaft is mounted on two prelubricated ball bearings.

Originality in design concepts...

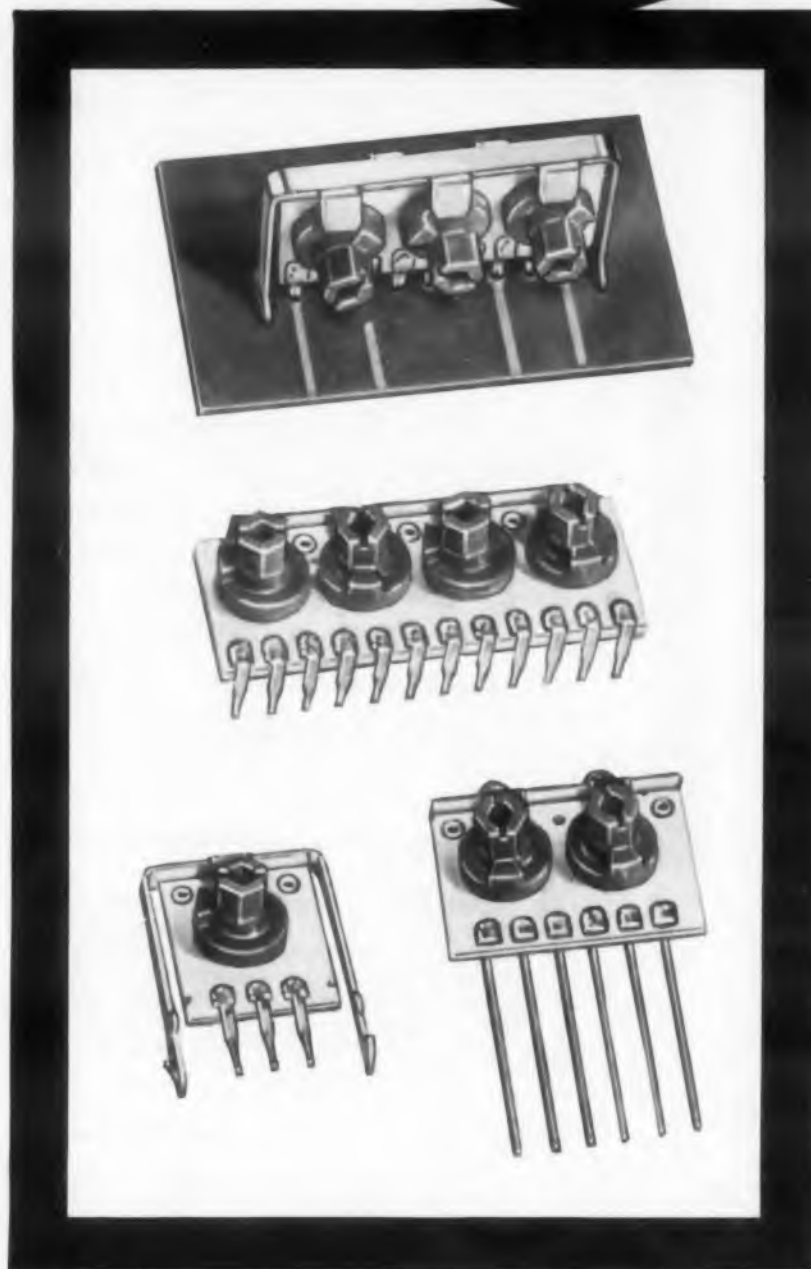
your job...and **Centralab's**

**Economical  
Versatile  
Reliable...**

**MODEL 5  
RADIOHM®**

**1/4 WATT  
MULTIPLE MINIATURE  
VARIABLE RESISTOR**

(Component Density: 16.2 per cu. in.)\*



The Model 5 is a new proven design concept, not merely an improvement of an existing component. This is typical of CENTRALAB's approach to product design. It is available with up to 4 variable and 9 fixed resistors on a single steatite plate measuring 2 1/4" x 3/4" x 1 5/32", including knobs... proportionally smaller when fewer variable resistors are required. This remarkable increase in component density is another CENTRALAB "first," setting the example for the electronics industry.

#### A WIDE RANGE OF MOUNTING STYLES AND TYPES

Model 5 Radiohms® are available with horizontal or vertical mounting brackets, plug-in terminals for printed circuit boards or wire leads for metal chassis.

#### 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

**Initial Torque:** 2 inch ounces average

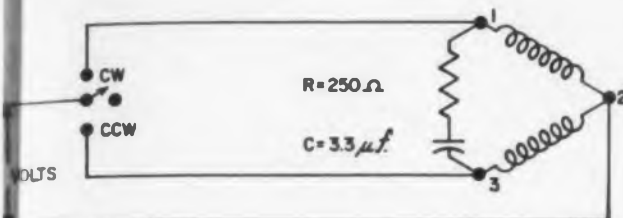
Complete specifications and design data are given in CENTRALAB Bulletin EP-539; write for your copy today.

\* Cubic inch, rather than cubic foot, is used to provide a more realistic and more readily visualized standard of comparison.

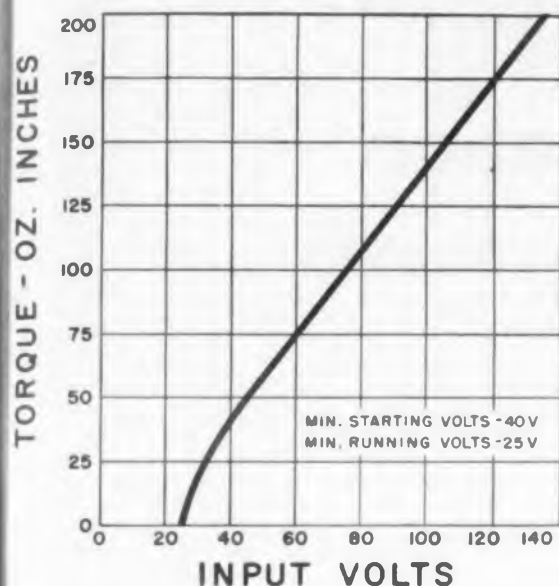
**Centralab** 

VARIABLE RESISTORS • ELECTRONIC SWITCHES • PACKAGED ELECTRONIC CIRCUITS • CERAMIC CAPACITORS • ENGINEERED CERAMICS  
CIRCLE 21 ON READER-SERVICE CARD

A Division of Globe-Union Inc.  
960E E. KEEFE AVE. • MILWAUKEE 1, WIS.  
In Canada: 669 Bayview Ave., Toronto 17, Ont.



**Fig. 2.** This graph shows the motor's torque at various input voltages, 60 cps.



**Fig. 3.** A phase-shifting network, as shown, must be used to operate the motor when the power source is a single phase.

ambient under continuous operation, the unit weighs 6.5 lb.

#### Physical Dimensions

Shaft diameter of the motor is 3/8 in. and its length is 1 x 3/16 in. The motor has a 4.25 in. diameter and a 4.75 in. depth.

When the synchronous motor is adapted for use as an incremental positioning device, dc electrical pulses are converted into either 200 or 400 precise increments for one revolution of the motor shaft. The motor will maintain its rated torque for any stepping position. And since no ratchets are used, each step is made instantly without slip or clatter.

A phase-shifting network, required when the motor operates from a single phase source, can be had in an enclosure that is mounted on the end of the motor.

For more information on this synchronous motor, turn to the Reader-Service card and circle 101.



# 26 NEW TYPES ADDED TO BENDIX NOISE SOURCE TUBE LINE!

Freq. Range KMC	Band	Waveguide Number	Bendix Type Number	RETMA Type No.	Mount Type	Recommended Mode of Operation (Note 2)	Anode Current Ma (Note 1)	Tube Drop Volts (Note 1)	Tune Excess Noise Ratio DB (Note 3)
1.12-1.70	L	RG-69/U	RXB103085 TD-21 TD-29 TD-33	6881 7101	10°E 90°H 90°H 90°H	D.C. D.C. A.C. and D.C. A.C. and D.C.	250 250 250 250	130 65 130 75	15.2 15.2 18.0 15.2
2.6-3.95	S	RG-48/U	TD-12 TD-22 TD-31 TD-32 TD-34 TD-35 TD-38	6358 6782	10°E 90°H 10°E 10°E 10°E 90°H 10°E	D.C. A.C. and D.C. A.C. and D.C. A.C. and D.C. D.C. A.C. and D.C. PULSE*	250 250 250 250 250 250 (250)	80 45 85 140 155 80 (90)	15.2 15.2 15.2 18.0 18.0 18.0 15.2
3.30-4.90	S	WR-229	TD-24 TD-30	6852	10°E 10°E	A.C. and D.C. A.C. and D.C.	250 250	65 110	15.2 18.0
3.95-5.85	C	RG-49/U	TD-10 TD-39 RXB103422	6356	10°E 10°E 10°E	D.C. PULSE* D.C.	250 (250) 250	70 (80) (110)	15.2 15.2 18.0
5.85-8.20	X	RG-50/U	TD-10 TD-39 RXB103422	6356	10°E 10°E 10°E	D.C. PULSE* D.C.	250 (250) 250	70 (80) (110)	15.2 15.2 18.0
8.20-12.40	X	RG-52/U	TD-11 TD-23 TD-40 RXB103093 RXB103394	6357 6882	10°E 10°E 10°E 90°H 90°H	D.C. D.C. PULSE* D.C. A.C. and D.C.	200 200 (200) 200 (100)	75 115 (85) (35) (50)	15.2 18.0 15.2 15.2 15.2
12.4-18.00	K	RG-91/U	TD-18 RXB103399 RXB103400 TD-41 RXB103411 RXB103254	6684	10°E 10°E 10°E 10°E 90°H 90°H	D.C. D.C. A.C. and D.C. PULSE* A.C. and D.C. D.C.	200 200 (100) 200 (100) 200	70 (110) (65) (80) (50) (40)	15.2 18.0 15.2 15.2 15.2 15.2
18.0-26.5	K	RG-53/U	TD-13 RXB103423 TD-42 RXB103411	6359	10°E 10°E 10°E 90°H	D.C. D.C. PULSE* A.C. and D.C.	200 200 (200) (100)	65 (100) (75) (50)	15.2 18.0 15.2 15.2
26.5-40.0	K	RG-96/U	RXB103251		10°E	D.C.	(150)	(120)	15.2

NOTE 1: Anode current and tube drop are D.C. values. Values in parentheses are tentative.

NOTE 2: D.C. operation—Cathode at one end only.  
A.C. and D.C. operation—Cathodes at both ends.  
Pulse operation—Cathode at one end specially designed for pulse operation.

NOTE 3: The Excess Noise Ratio in DB is  $10 \log \left( \frac{T_{eff}}{290} - 1 \right)$

\*If the anode current during the "on time" of a square pulse (of greater than 100 micro sec. duration) is nominally the same as the rated D.C. anode current, the tube drop during this period will be approximately the same as the rated D.C. tube drop.

Expanding its line from 9 types to 35 types, Bendix Red Bank now offers a great variety of noise source tubes.

But great variety is only one advantage. Noise source tubes that are free from ambient temperature corrections are the result of making tubes so that no correction in noise figures is necessary from  $-55^{\circ}\text{C.}$  to  $+85^{\circ}\text{C.}$  What's more, long life and unusual stability result from precise quality control—far beyond the usually accepted tolerances for such products.

Whatever your applications, whether for  $10^{\circ}$  or  $90^{\circ}$  angle mounting, check with our specialists for the most efficient solution. Write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATON-TOWN, NEW JERSEY.

West Coast Sales & Service: 117 E. Providencia Ave., Burbank, Calif.

Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

Canadian Distributor: Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ontario

**Red Bank** Division



CIRCLE 22 ON READER-SERVICE CARD

## Space Coordinate Transformation

*Using High-Precision Resolvers*

Gilbert H. Steinberg

Reeves Instrument Corp.  
Garden City, N. Y.

Problems in space navigation require detection of the vehicle's attitude in reference to fixed space coordinates. This article shows how resolvers are combined to transform velocity vectors and angles from one coordinate system to another.

Gil Steinberg is manager for resolver and gyro products for Reeves. He's interested in educating engineers on the capabilities of resolvers in coordinate transformation and wrote this article as a step in that direction. Current and future trends, he says, indicate more and more use of "amplifierless" chains.

MODERN computer techniques for navigation and guidance usually involve linear transformations of vectors and angular relationships between two or more coordinate systems. Many aircraft and ships are supplied with a central inertial space reference system to and from which all guidance and fire control data are referred. The most convenient and efficient method presently available for solving transformation is through the use of high precision resolver chains.

Simplified representation of a resolver, Fig. 2(a), shows essentially a rotatable transformer with two windings in space quadrature on both primary and secondary. Fig. 2(b) illustrates the standard schematic representation of a resolver. The output equations are:

$$\begin{aligned} C &= A \cos \theta - B \sin \theta \\ D &= B \cos \theta + A \sin \theta \end{aligned} \quad (1)$$

These equations describe a simple two dimen-

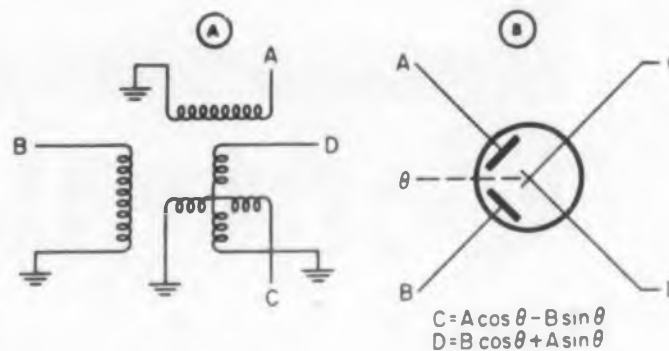
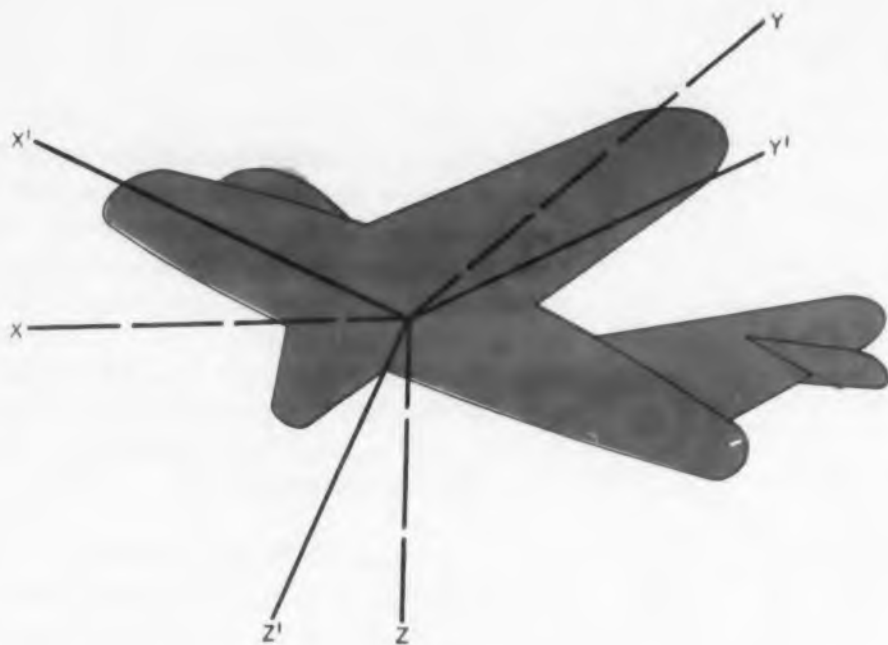


Fig. 2. Simplified circuit of resolver (a) and standard symbol (b).



**Fig. 1.** Typical coordinate transformation problem  $x$ ,  $y$  and  $z$  are fixed space coordinates;  $x'$ ,  $y'$  and  $z'$  are aircraft coordinates.

ional coordinate rotation. As shown in Fig. 3,  $A$  and  $B$  are the  $(x, y)$  components of the vector  $V$  in the original coordinate system and  $C$  and  $D$  are the  $(x', y')$  components in the new coordinate system, rotated through an angle  $\theta$  with respect to the original coordinates. In matrix notation these equations can be represented as:

$$\begin{bmatrix} C \\ D \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} A \\ B \end{bmatrix} \quad (2)$$

Since both coordinate systems are orthogonal, the inverse of the transposition matrix is equal to the transposed matrix and therefore:

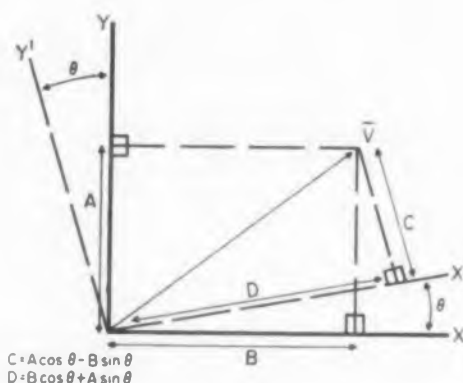
$$\begin{bmatrix} A \\ B \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} C \\ D \end{bmatrix} \quad (3)$$

Equation (3) describes a coordinate rotation from the new coordinate system  $(x', y')$  back to the original system.

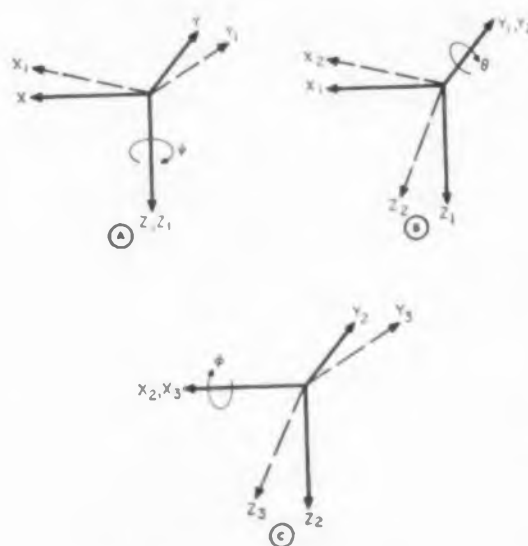
Equations 2 and 3 describe a coordinate rotation through one degree of freedom. This can be instrumented using only one resolver. The same basic techniques can be expanded to cover coordinate rotation through 3 degrees of freedom.

### Three Possible Rotations

Assume (Fig. 1) that the aircraft is in level flight; that is, the aircraft coordinates coincide with the space coordinates. Three coordinate ro-

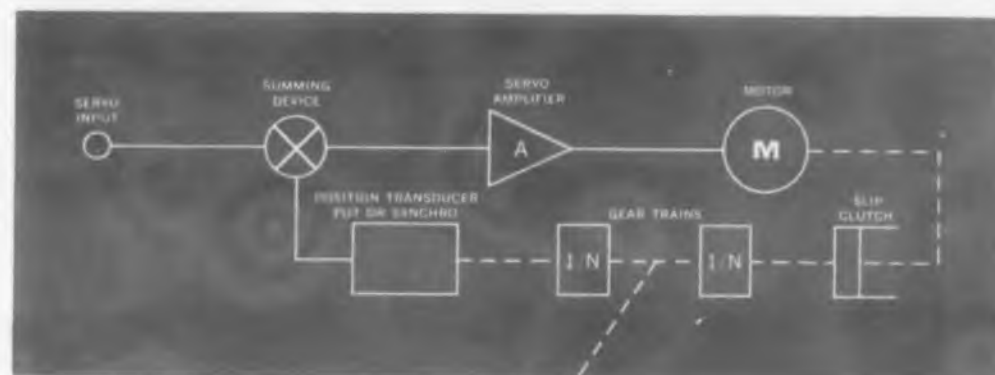


**Fig. 3.** Simple two-dimensional rotation.



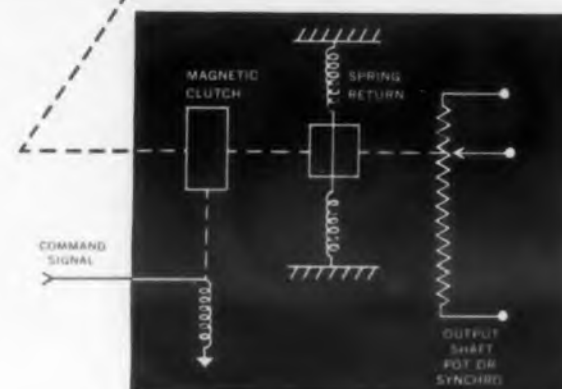
**Fig. 4.** Transformation from space coordinates to aircraft coordinates, around  $z$  axis (a),  $y_1$  axis (b) and  $x_2$  axis (c).

**PROBLEM:** To provide an output Potentiometer-Transducer which can be readily engaged with a minimum angular error to a servomechanisms gear train when energized by an external command signal. The transducer must accurately return to a specified null position when the command signal is removed.



### A SOLUTION:

Provide an electro-magnetic clutch, spring return mechanism and rotary potentiometer. Assemble these parts into the required package with the resultant difficulties brought about by the mounting and coupling problems with a consequent increase in cost.



### THE OPTIMUM SOLUTION:

Technology Instrument Corporation's west coast engineering facilities developed and offer a unitized package consisting of an electro-magnetic clutch, spring return mechanism and rotary potentiometer as one compact assembly. The clutch will transmit high torque without slippage and has negligible angular engagement error. TIC's unique spring return mechanism will accurately return the output transducer to the desired null, yet requires low driving torque. TIC's unitized assembly replaces three (3) individual components with their inherent assembly difficulties.

**TIC**  
unitized  
package

### GENERAL INFORMATION:

Shaft Position Transducers can be linear or nonlinear potentiometers, synchros, linear transformers or digitizers. Spring return mechanism can be supplied designed to return to any desired point. A built-in slip clutch can also be furnished if the input torque can exceed the rating of the clutch.

### TIC UNITIZED PACKAGE HAS MANY APPLICATIONS,

**SUCH AS:** Auto pilots, altitude controllers, machine controllers, measurement and control problems, speed control, process control of temperature and flow, differential measurement, expanded scale servos, or any other problem requiring an output, commencing at some specified servo position determined by an external command signal.



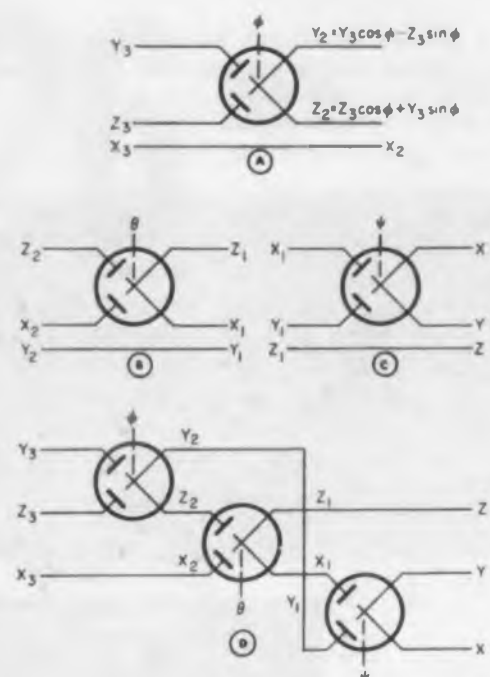
### TECHNOLOGY INSTRUMENT CORPORATION

Subsidiaries: Technology Instrument Corp. of Calif.  
North Hollywood, Calif.  
Acton Laboratories, Inc., Acton, Mass.  
Tucson Instrument Corp., Tucson, Ariz.  
Servotrol, Inc., Chicago, Ill.  
Altomac Corp., Canton, Mass.

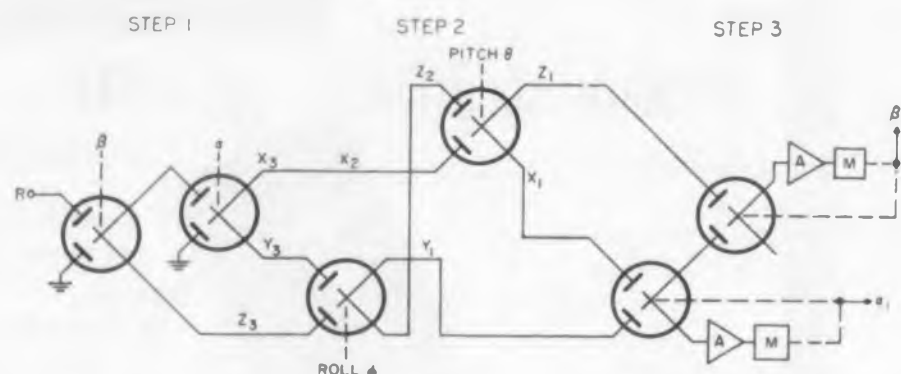
555 Main Street  
Acton, Massachusetts

CIRCLE 23 ON READER-SERVICE CARD





**Fig. 5.** To determine the vector in terms of space coordinates, three rotations are instrumented as in (a), (b) and (c), and tied together to complete the system (d).



**Fig. 7.** Solution to antenna stabilization problem is instrumented like this.

tations are possible: (1) a rotation about the  $z'$  axis (yaw), (2) rotation  $\theta$  about the  $y'$  axis (pitch), and (3) rotation  $\phi$  about the  $x'$  axis (roll). It is apparent that space coordinates can be transformed to aircraft coordinates through successive coordinate rotations about each of the three axes.

The converse is also true: aircraft coordinates can be transformed to space coordinates by three successive rotations about fixed axes. The order in which the rotations are made will determine the final form of the transformation equations. While any order is correct and will give the same final results, to be consistent with current practice in the aircraft industry the angles will be taken in the order  $\psi$ ,  $\theta$ ,  $\phi$ , when transforming from space coordinates to airplane coordinates.

First rotation, Fig. 4(a), is taken about the  $z$  axis. The equations of this transformation are:

$$X_1 = X \cos \psi + Y \sin \psi \quad X = X_1 \cos \psi - Y_1 \sin \psi$$

$$Y_1 = Y \cos \psi - X \sin \psi \quad Y = Y_1 \cos \psi + X_1 \sin \psi$$

$$Z_1 = Z \quad Z = Z_1 \quad (4)$$

Second rotation, Fig. 4(b), is taken about the  $y_1$  axis. The equations of this transformation are:

$$x_2 = x_1 \cos \theta + z_1 \sin \theta \quad x_1 = x_2 \cos \theta + z_2 \sin \theta$$

$$Y_2 = Y_1 \quad Y_1 = Y_2$$

$$Z_2 = Z_1 \cos \theta + X_1 \sin \theta \quad Z_1 = Z_2 \cos \theta - X_2 \sin \theta \quad (5)$$

Third rotation, Fig. 4(c), is taken about the  $x_2$  axis. The equations are:

$$X_3 = X_2 \quad X_2 = X_3$$

$$Y_3 = Y_2 \cos \phi + Z_2 \sin \phi \quad Y_2 = Y_3 \cos \phi - Z_3 \sin \phi$$

$$Z_3 = Z_2 \cos \phi - Y_2 \sin \phi \quad Z_2 = Z_3 \cos \phi + Y_3 \sin \phi \quad (6)$$

To illustrate the use of resolvers in this type of coordinate transformation let us assume we are given a vector  $(x_3, y_3, z_3)$  in the aircraft coordinate system. We are also given the angle information, which is supplied by gyros. We wish to determine the vector in terms of the space coordinates  $(x, y, z)$ . This involves a successive ro-

tation through the angles  $\phi$ ,  $\theta$ ,  $\psi$ . The first rotation is into the  $(x_2, y_2, z_2)$  coordinate system using the equations:

$$X_2 = X_3$$

$$Y_2 = Y_3 \cos \phi - Z_3 \sin \phi$$

$$Z_2 = Z_3 \cos \phi + Y_3 \sin \phi \quad (7)$$

The  $Y_2, Z_2$  equations are similar to the simple case of a two dimensional rotation. This is because each of the three rotations keeps one axis fixed. Therefore, we can instrument the set of Equations 7 as shown in Fig. 5(a). In like manner the other two rotations can be instrumented as shown in Fig. 5(b) and 5(c). All that remains is to tie together the proper terminals as shown in Fig. 5(d) and we have mechanized the complete solution to our problem.

### Convert Angular Systems

It is frequently necessary to transform angles, instead of vectors, from one coordinate system to another. A typical example of this type of transformation is an antenna stabilization problem. We have a target at bearing angle  $\alpha_3$  and depression angle  $\beta_3$  with respect to the aircraft coordinates and wish to stabilize the antenna with respect to the pitch and roll of the aircraft. Pitch and roll angles are supplied by a gyro reference system. We can stabilize the antenna by deriving angles  $\alpha_1, \beta_1$  in the  $(x, y, z)$  coordinate system.  $\alpha_1$  and  $\beta_1$  are called respectively the antenna train and antenna depression angles. In this case we can neglect the yaw angle. In order to convert these angles we assume a vector  $R$  with a bearing angle  $\alpha_3$  and a depression angle  $\beta_3$ . Then:

$$X_3 = R \cos \beta_3 \cos \alpha_3$$

$$Y_3 = R \cos \beta_3 \sin \alpha_3$$

$$Z_3 = R \sin \beta_3$$

Also:

$$\alpha_3 = \tan^{-1} \frac{y_3}{x_3}, \quad \beta_3 = \tan^{-1} \frac{z_3}{\sqrt{x_3^2 + y_3^2}} \quad (8)$$

And, in general:

$$\alpha_n = \tan^{-1} \frac{y_n}{x_n}$$

$$\beta_n = \tan^{-1} \frac{z_n}{\sqrt{x_n^2 + y_n^2}} \quad (9)$$

Using this analysis we break our problem into three steps:

- (1) Given angles  $\alpha_3$  and  $\beta_3$  and a reference voltage  $R$  we first instrument Equations (8) to put the problem in terms of the vector coordinates  $(x_3, y_3, z_3)$ .
- (2) The coordinates must be rotated back through

the roll and pitch angles to give us the coordinates  $(x_1, y_1, z_1)$ .

(3) Using Equations (9) we derive the antenna bearing angle  $\alpha_1$  and the antenna train angle  $\beta_1$ .

To solve Equations (8), consider the output equations of a resolver with one input grounded, as shown in Fig. 6(a). The equations are:

$$C = A \cos \theta$$

$$D_s = A \sin \theta$$

By combining 2 resolvers with one input of each grounded, Fig. 6(b), we have solved Equation (8) as required in Step 1.

Step 2 is similar to the three axis problem except that we eliminate the yaw angle resolver. The schematic is shown in Fig. 6(c).

Step 3 involves finding the arc tangents using the coordinates derived in Step 2. This can be instrumented using the circuit shown in Fig. 6(d). The servo drives the rotor of the resolver until there is a zero output on the servo input winding. At this position the other winding has maximum coupling with the flux vector formed by the two inputs. Therefore, the outputs are  $\theta = \tan^{-1} B/A$  and  $\sqrt{A^2 + B^2}$  as shown. Using this technique we can instrument Step 3 as shown in Fig. 6(e).

Combining the proper terminals of Steps 1, 2 and 3, we have the solution as shown in Fig. 7.

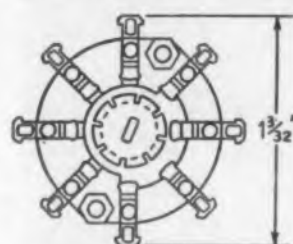
Note from Fig. 7 that one of the outputs of the resolver which is driven to  $\beta_1$  is  $R$ . A rough check of the accuracy of the chain could be made by comparing this  $R$  voltage with the original reference voltage. Since lengths of vectors do not change during coordinate transformations these voltages should be equal.

#### Practical Applications Vary

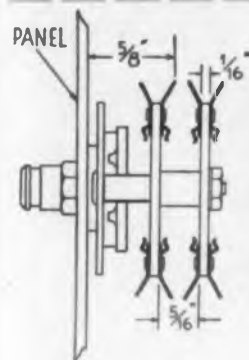
In actual system applications, the output of one resolver cannot be fed directly into a second resolver without introducing some loading errors into the system. The accepted method of avoiding these loading effects is through the use of isolation amplifiers, with one amplifier being used for each winding. When used in conjunction with resolvers having special feedback windings, compensation for temperature and frequency changes can also be made. Overall accuracies of better than 6 minutes have been achieved in chains when compensated resolvers and isolation amplifiers were employed.

By using special loading networks and thermistors in place of the amplifiers, resolver chains can be simplified. While this method has the virtue of convenience and simplified circuitry, it is gained at the expense of some loss in system accuracy. ■ ■

## 8, 10, 12 pos. miniature switch



FITS IN 1-3/32" CIRCLE



MINIMUM DEPTH BEHIND PANEL—  
ONLY 1/16" FOR A  
SINGLE-SECTION SWITCH

SWITCH SECTION IS ONLY 1/16" THICK

MINIMUM SPACE BETWEEN SECTIONS—  
5/16" WITH CLIPS ON FRONT AND BACK



### OAK SERIES "A"

#### LOW-CURRENT ROTARY SWITCH

- ▶ UP TO 18 CONTACTS PER SECTION
- ▶ 1/4" SHAFT, STANDARD
- ▶ LOW CAPACITANCE
- ▶ SAME HIGH QUALITY AND RELIABILITY AS LARGER OAK SWITCHES

Here's new help in the battle of miniaturization. This tiny switch can pare critical space and weight from your designs. The large number of contacts it provides enables you to handle complex circuits, too. The clips on the Series "A" are a miniature version of the famous Oak double-wiping design—long accepted as the standard of the industry for reliability and long life. Oak engineers will be glad to furnish complete information, and work with you in developing the exact variation you need.



Write on Company Letterhead for  
a Copy of the Oak Switch Catalog

#### SPECIFICATIONS

**Index**—Double ball bearing, hill and valley type with stainless steel spring. Fixed and adjustable stops, and locating key available.

**Shafts and Bushings**—1/4" shaft with 3/8-32 bushing is standard; 5/32" shaft with 3/8-32 bushing and 1/8" shaft with 1/4-32 bushing can be supplied also. Water seal bushings optional.

**Sections**—8, 10, or 12-position, stacked in any number up to a total depth of three inches. The 12-position section provides up to 18 insulated contacts—12 on front, 6 on back. No insulating blocks are needed on back.

Poles	8-Position (45° throw)	10-Position (36° throw)	12-Position (30° throw)
1 pole	2 to 8	2 to 10	2 to 12
2 poles	2 to 4	2 to 5	2 to 6
3 poles	2 to 3	2 to 4	2 to 5
4 poles	2	2 to 3	2 to 3
5 poles	...	2	2
6 poles	...	...	2

**Clips**—Solid spring-silver alloy or silver-plated spring brass, fastened by solid rivets.

**Insulation**—Stator is silicone fiber glass, meeting specification MIL-P-997 type GSG; rotor is KEL-F®, known for its excellent mechanical and electrical properties.

**Finish**—Commercial or 50 and 200-hour salt spray.



1260 Clybourn Avenue, Dept. D, Chicago 10, Illinois  
Phone: MOhawk 4-2222

SWITCHES • ROTARY SOLENOIDS • CHOPPERS • SPECIAL ASSEMBLIES • VIBRATORS • TUNERS

CIRCLE 24 ON READER-SERVICE CARD



Now from **CLEVITE** ...

# HIGH POWER TRANSISTORS



*Clevite offers new types with improved reliability and power handling capacity.*

#### EIA REGISTERED TYPES WITH:

- Improved seal for long life.
- Saturation voltage less than 1 Volt at increased maximum rated current of 15 amperes.
- Average thermal resistance 0.7°C per watt.
- Current gain controls: 60-150 at 5 amperes.
- 100% test for resistance to transient burn out.
- Either standard pins or solder lugs.

#### TECHNICAL DATA

##### Typical Electrical Characteristics at 25°C

2N1147 Series has solder lugs 2N1146 Series has standard pins	2N1147 2N1146	2N1147A 2N1146A	2N1147B 2N1146B	2N1147C 2N1146C
Collector to Emitter Voltage Shorted Base (IC = 1 amp)	30V (Min)	40V (Min)	60V (Min)	75V (Min)
Saturation Voltage (IC = 15 amps)	1.0V (Max)	1.0V (Max)	1.0V (Max)	1.0V (Max)
DC Current Gain (IC = 5 amps)	60-150	60-150	60-150	60-150
DC Current Gain (IC = 15 amps)	35	35	35	35
<b>Absolute Maximum Ratings</b>				
Collector Current	15 amps	15 amps	15 amps	15 amps
Collector to Base Voltage	40V	60V	80V	100V
Collector to Emitter Voltage	40V	60V	80V	100V
Power Dissipation at 70°C Case Temperature	25W	25W	25W	25W
Junction Temperature	95°C	95°C	95°C	95°C

#### OTHER CLEVITE DIVISIONS:

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

## CLEVITE

### TRANSISTOR PRODUCTS

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

A DIVISION OF  
**CLEVITE**

CIRCLE 25 ON READER-SERVICE CARD

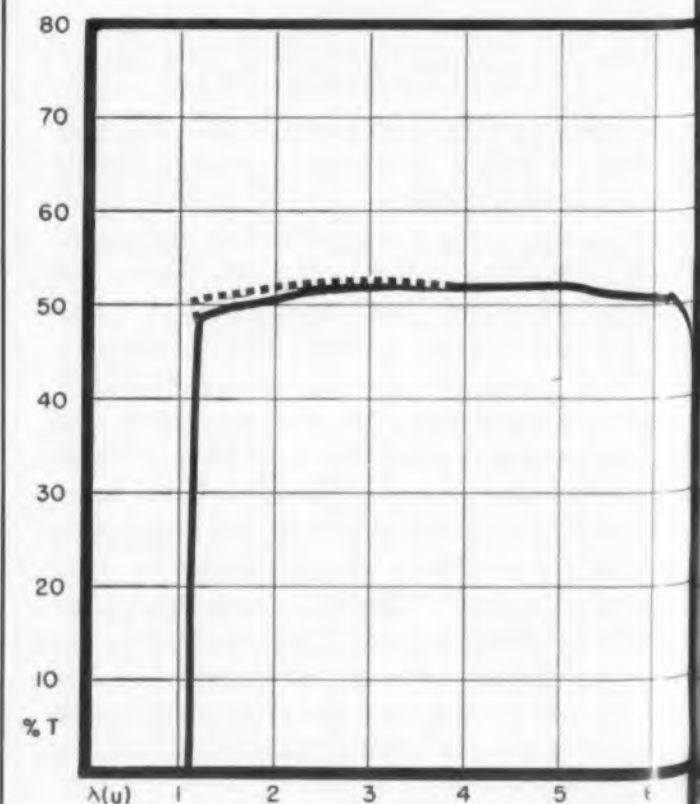
Ballistically spherical castings of polycrystalline silicon shown at the IRE Show. In the foreground is a crude casting. After etching, the dome looks like one at the rear—note the mosaic polycrystal pattern. To right and left are polished domes.

## Cast Silicon I-R Domes

**B**LANKS, DOMES, flats and prisms of polycrystalline silicon for infrared systems are available in production quantities. Cast from polycrystalline silicon instead of being ground, laboriously, from a large single crystal, the new material shows optical transmission and scatter characteristics almost identical to the single-crystal parts.

Manufactured by Hughes Products Semiconductor Division, Newport Beach, Calif., the polycrystalline material is cast and polished with

**Fig. 1.** (below) Comparison of transmission and emissivity of cast polycrystalline and single-crystal silicon over a 1-14 micron wavelength range.



very little waste of raw silicon. The design of infrared optics for military and commercial systems becomes considerably more economical than heretofore.

Casting, as a practical, in-production method for making infrared missile domes, was revealed for the first time at the IRE show in late March. The shiny, bluish domes shown above are ballistically spherical, pass infrared wavelengths, are opaque to light. In an infrared system an aspheric silicon lens would be protected by the dome, focus infrared radiation on a cooled or uncooled detector. Cooled detectors, which work in the three to five micron range, operate in an ambient on the order of 30 K and might consist of PbSe, InSb or GeAu. Environment ambient detectors work at 25 C, might consist of PbSe or PbTe.

A comparison graph of transmission characteristics shows no significant difference between the cast material and grown single-crystal silicon. See Fig. 1.

Scattering was compared, again showed no significant difference, within the  $\pm 5$  per cent accuracy of the test. In the test, a single crystal aspheric lens focused a collimated beam on a pinhole in front of a band-pass filter (3.0 to 4.2 micron) and a cooled PbSe detector. The beam, from an 800 K source, was chopped at 90 cps. Sample domes were placed in front of the lens.

Density of cast polycrystalline silicon is the same as single-crystal—it is apparently entirely free of voids. It has approximately 80 per cent of the breaking stress and modulus of elasticity of the single-crystal silicon.

For further information on cast polycrystalline silicon infrared components, turn to the Reader's Service card and circle 102.

Sample: Cut from Dome DB23, Polycrystalline

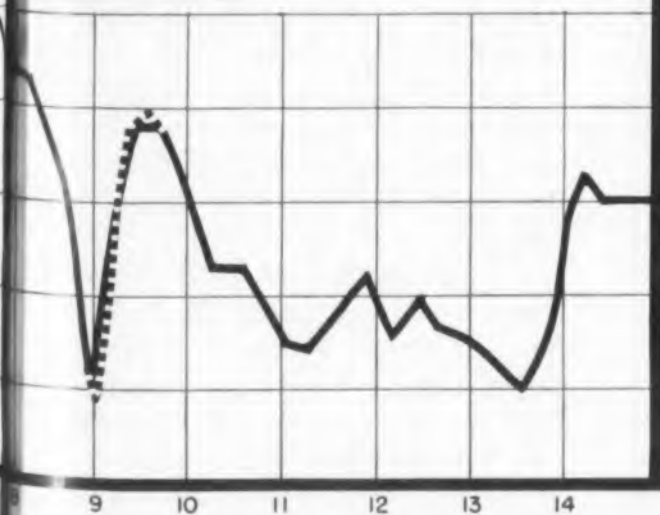
Slit .04/3 $\mu$ -0.5  $\mu$ /min-1  $\mu$ /min-DB

Thickness 0.483 cm

Sample: S-3466 Single Crystal Silicon  $\rho$ 40-45 $\Omega$ -cm

Slit .04/3 $\mu$ -0.5  $\mu$ /min-1  $\mu$ /min-DB

Thickness: 0.51 cm



The Mark  
of Reliability

# in GLASS-TO-METAL SEALS



Compression End Seals

Diode Closures



Threaded End Seals

Miniature Closures



Transistor Closures

Single Lead Terminals



Plug-in Connectors

Color Coded Terminals



Multiple Headers

Custom Sealing Service



Consult E-I for  
Complete Design-  
Engineering Service  
on your next  
Sealing Problem...  
Sales Engineers  
Located in all  
Principal Cities

The E-I line provides designers with the versatility of the most complete selection of standard seals in the industry. Proof of their dependable performance is the fact that E-I Seals were employed on the Atlas Missile Program... are specified for critical assignments industry-wide on both commercial and military equipment.

Select your seals from the E-I standard line or ask E-I for quotations on custom sealing components of your own manufacture. Either way, E-I engineers will work with you in meeting your sealing requirements, quickly and economically!



**ELECTRICAL INDUSTRIES**

A Division of Philips Electronics, Inc. • MURRAY HILL, NEW JERSEY

PATENTED IN CANADA, NO. 523,390; IN UNITED KINGDOM, NO. 734,583; LICENSED IN U. S. UNDER NO. 2561520  
CIRCLE 26 ON READER-SERVICE CARD





**ARMA** relies  
on Photocircuits  
plated-thru holes

#### Heart of TITAN ICBM Inertial Guidance System

When the Titan's electronic umbilical cords are severed, the giant missile begins life. With no ground contact, its unjammable inertial guidance system must work...there's no second chance.

Arma Division of American Bosch Arma Corporation, maker of the Titan's computer brain, demands printed circuit boards that must function the first time...every time. A defect, at any assembly point, means discarding the board and the costly components mounted on it.

That's why Arma relies on PHOTOCIRCUITS printed circuit boards with *plated-thru holes* to do the job.

PHOTOCIRCUITS pioneered *plated-thru holes*...manufactures them with built-in reliability for military and industrial applications.

*Plated-thru hole* reliability is based on PHOTOCIRCUITS' unequalled experience in every phase of printed circuitry. Consistent dependability is the result of proper design, precision production and advanced quality control techniques.

Check the advantages of *plated-thru holes* by PHOTOCIRCUITS...the largest and most experienced manufacturer in printed circuitry. For complete information, write our Engineering Department PS-2 today.

PHONES  
GLEN COVE 4-8000  
FLUSHING 7-8100  
CABLE  
PHOCIRCO



CIRCLE 27 ON READER-SERVICE CARD

## The New Look In Ripple Reduction

**Bernard Daien**

Kearfott Company, Inc.  
Clifton, N. J.

Engineers often use voltage regulators—not for regulation—but for ripple reduction. They pay for this in size, weight, and transistor dissipation. They don't have to.

**L**ARGE ripple reductions are possible with substantial weight and volume savings when transistors replace reactors.

The cascaded emitter follower shown in the figure offers lower impedance and better stability than many previous circuits that performed essentially the same function. The divider across the input provides a constant fraction of the supply voltage to the base of the driver transistor. A capacitor filters this base voltage, leaving only the dc component.

The output voltage depends on this filtered dc, and is relatively independent of the collector ripple.

Several important differences distinguish this circuit from the series voltage regulator, which it resembles.

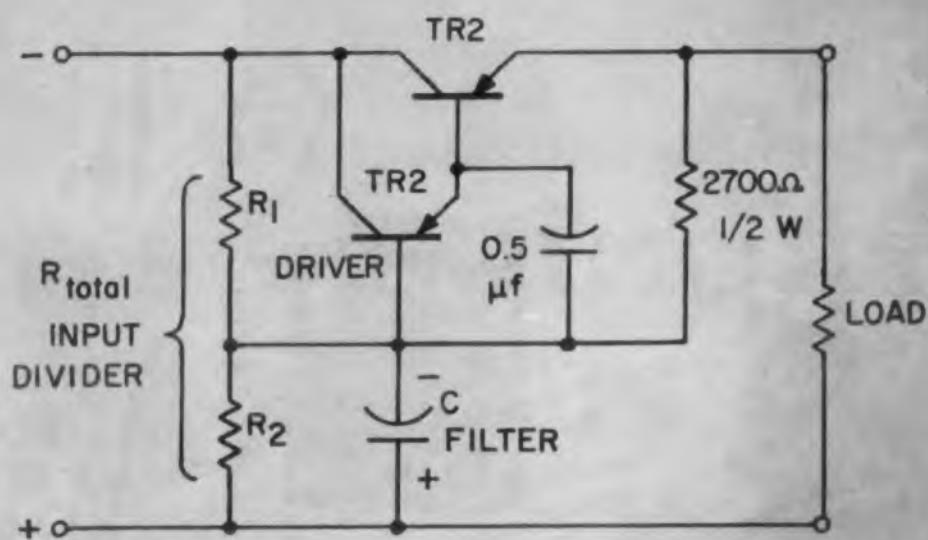
- The output is a constant fraction of the dc input. Hence a change in input level appears at the output. This eliminates

the rapid increase in transistor dissipation which occurs in the series regulator as the input rises and the transistor must absorb the difference between the rising input and the fixed output voltage. Since dissipation is reduced, the de-ripleper handles heavy currents with a smaller heat sink, resulting in compact design.

- In the de-ripleper the output is always less than the input. In a regulator, the input may fall below the fixed reference, in which case the circuit drops out of regulation and the output ripple rises sharply.

To prevent dropout, an LC filter must precede the regulator. It must have enough energy storage to maintain the input voltage during an undervoltage period. The ripple reducer does not drop out during undervoltage.

- Dc overvoltage will destroy a true reg-



This circuit can knock down ripple by a factor of 200. (Tr 2 can be several transistors in parallel for high load currents.)

ulator long before it would even overload the ripple reducer. Since the de-riple's output follows the input, it is quite difficult to develop sufficient voltage across the transistors to punch through.

#### Quick Design Procedure

Values for the components in the figure are calculated as follows:

$$R_{total} = \frac{\beta_1 \beta_2 E_r}{10 I}$$

$$R_1 \cong \frac{R_{total} (1 + 0.5 E_r)}{1.1 E_{in}}$$

where  $E_r$  is the peak to peak input ripple,  $E_{in}$  is the nominal dc input voltage,  $\beta_1$  and  $\beta_2$  are the dc beta's of transistors 1 and 2, and  $I$  is the maximum load current.

The capacitor C is best chosen by substitution. Increasing its value will reduce the ripple till the desired reduction is obtained. Ripple reduction by factors of more than 200 are quite realistic.

The final step is to choose suitable transistors and heat sinks. The dissipation required of the transistors is approximated by the following expressions.

For transistor 1

$$P_d = I \frac{(1.5 + 0.5 E_r)}{\beta_2}$$

For transistor 2

$$P_d = I (1.5 + 0.5 E_r)$$

The maximum voltage across transistors should be held to about 1.5 plus the peak to peak input ripple.

The maximum voltage across transistors is

$$E_{max} \cong E_r + 1.5$$

#### A Typical Design

A 28 v bench supply, operating from the 60 cycle line, had a 2.8 v peak to peak ripple. The ripple reducer had to provide a 24 v output with no more than 15 mv peak to peak ripple. Output current was 1 amp.

An equivalent filter would have required a 0.8 henry choke with a 4 ohm resistance. It would have weighed 2 lb. and taken up 2-1/2 x 3 x 2-1/2 in. In addition it would have required filter capacitors and mountings.

The de-riple, in a can no larger than the choke alone, weighed 1-1/4 lb. Net saving was four cubic inches and one pound with no attempt at miniaturization.

#### For Higher Temperatures

The formulas given here apply when the transistors are germanium. Where higher temperatures call for silicon transistors, which are less efficient, the dissipation and voltages will be somewhat higher. ■ ■

## WHY ENCAPSULATED?

Up to 250 KVA and no bulky case! Electro builds high reliability high power into half the size...half the weight. But this is no ordinary open coil construction—the coils are thin and solid...100% encapsulated with epoxy inside and out...sealed completely against dirt, damp and damage. One result: Fast cooling with high overload capacity for built-in reliability... temperature rise is 50% less! Another: Less size and weight simplifies equipment packaging...permits smaller cabinets and more efficient layout. Get the whole story of *Electro* encapsulateds for heavy-duty industrial applications (Class A or B); or on *HR/Epseal* ultracapsulateds for extreme environments (Mil-T-27A Grade 5 Class T). Electro engineers to your requirements... from microwatt to megawatt.



# ENCAPSULATED HIGH POWER TRANSFORMERS

**ELECTRO**  
high reliability transformers

ELECTRO ENGINEERING WORKS, 401 PRED A STREET, SAN LEANDRO, CALIFORNIA

CIRCLE 28 ON READER-SERVICE CARD





# MICROELECTRONICS —

## a new concept in packaging

Laurence D. Shergalis

Associate Editor

Less than two years ago, the flat-wafer concept of making ultraminiature electronic circuits was still in the laboratory. Since that time, with a boost from the Signal Corps and Diamond Ordnance Fuze Laboratories, the concept has developed rapidly. Industry is becoming more aware that a revolution in electronics packaging is taking place. To bring our readers up to date, *ELECTRONIC DESIGN* presents in this special report the latest techniques, processes and the current status of the work in microminiaturization.

**M**ICROMINIATURIZATION or microelectronics has never been clearly defined. But basically, it means making an electronic circuit as small as possible. Advantages of microcircuits are:

- Lower weight. They require little or no support and will withstand more g's.
- Better reliability. Microminature devices will perform through a wider temperature range at reliabilities about 50 per cent higher than standard units.
- Less space. Eliminating bulk and weight permits higher density packaging, thus permitting better systems for aircraft and missiles with greater fuel and payloads.

Assembly of electronics circuits has followed the classical method of hooking together a group of components with wires. Each resistor, capacitor, transformer, etc. is complete in itself and provided with leads, terminals or other forms of connecting devices.

These components are placed on a chassis and connected together with wires. More recently, they have been connected with printed wiring. But

the classical form factor remains the same. For example, resistors are generally round with axial leads. Their general shape has not changed much in the past 40 years.

New materials and methods of production have resulted in making these devices somewhat smaller (Fig. 1). This decrease in size has been called miniaturization. The common hearing aid is a good example. But the degree of miniaturization has been limited by the relatively poor utilization of space by these classically-shaped components.

With the advent of printed wiring, engineers began printing conductors, resistors and capacitors. Concentrated effort toward improving techniques of making these flat-type components and flat-type circuits has led to different approaches to microminiaturization.

### Two Basic Philosophies

One approach to the problem is concerned with putting an entire circuit on one small flat plate. The other approach is that of placing one com-

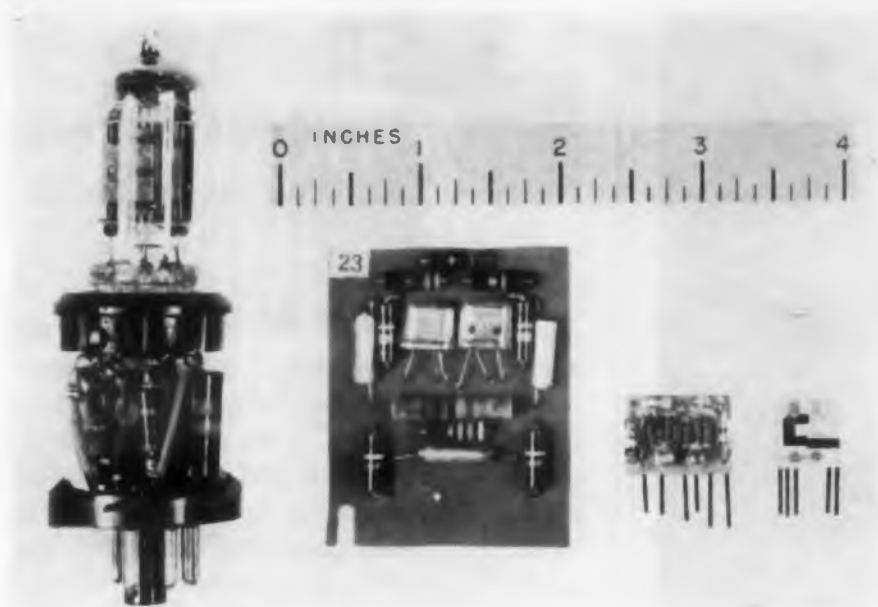
ponent on an extremely small flat plate and combining these plates to form a circuit (Fig. 2).

Both of these philosophies have valid reasons for their existence and are not in competition with each other. Each has its advantages and disadvantages for particular applications.

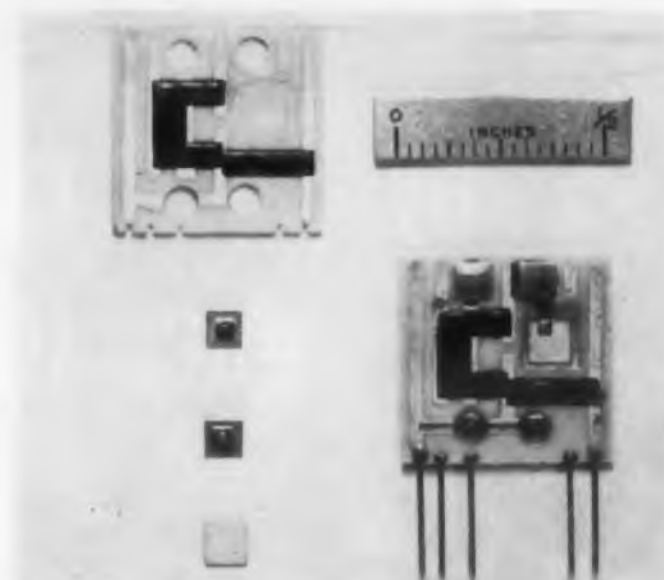
Diamond Ordnance Fuze Laboratories, Washington, D. C. is one center of activity of work by the military in utilizing the concept of placing the entire circuit on one plate (Fig. 3). Their 2D program (2D for two-dimensional) is aimed at putting as much circuitry as possible on one flat plate. But the method is economical only where a great number of these plates bearing the identical circuit must be reproduced. It will not pay if a relatively small number of these units are to be produced. A great deal of independent research by private industry is also in progress.

To gain the advantage of economical production for almost any number of units, the U. S. Army Signal Corps has initiated an extensive research, design and development program based upon the concept of micro-modular construction. Here, Fig. 4, components are constructed on 0.3-in. sq wafers and assembled in standard-size modules of standard shapes. Each module is a complete circuit assembly. But they are generally larger than the 2D units.

Defense Electronic Products of RCA is leader contractor on this project for the Signal Corps. Their objective is to provide a production oriented microminiaturization concept. Over 25 companies are actively engaged in various phases of this pro-



**Fig. 1.** Module using a standard miniature tube (left) compared to a transistor version (second from left), a "hearing aid" form of the same circuit (second from right) and the flat-wafer version (right).

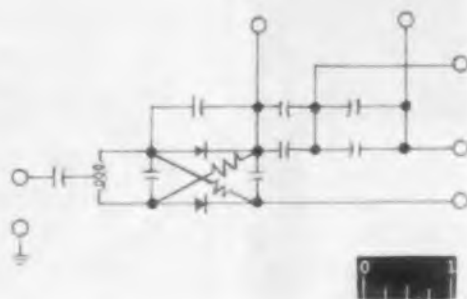


**Fig. 3.** Typical circuit assembly on one wafer using the DOFL approach. Complete module, lower right, has a component density of 2800 components per cu in.

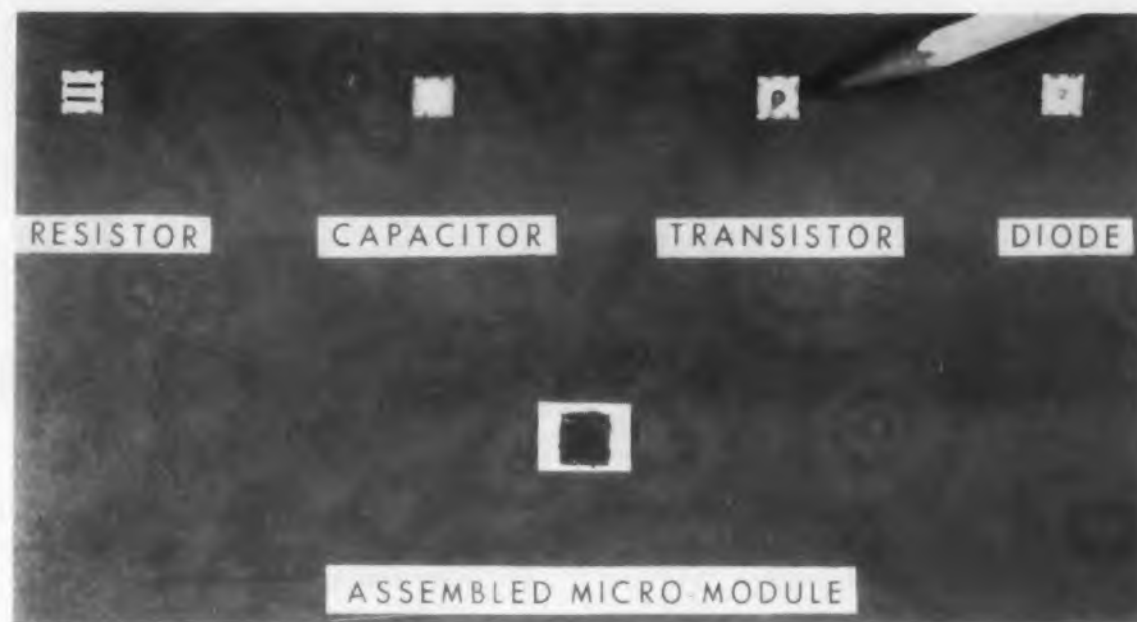
## CONVENTIONAL MINATURE PARTS



## MICROMODULE EQUIVALENT

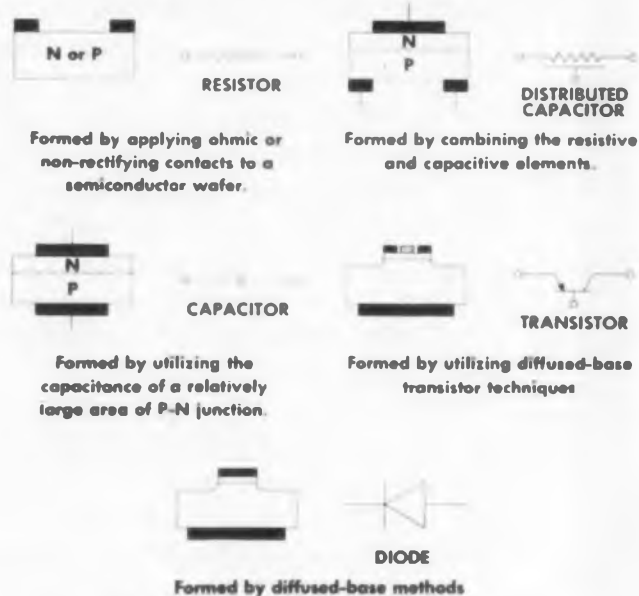


**Fig. 2.** Discriminator Micro-Module (right) contains the same number of components shown at the left.



**Fig. 4.** Component parts of a typical micro-module.

## Ultramicroscopic Circuits



Forms of Texas Instruments, Inc. components that are integrated into solid circuits.

Last month Texas Instruments Inc. announced a major advance in microcircuitry. Complete working circuits have been made, each measuring less than  $1/4 \times 1/8 \times 1/32$ -in. They have a theoretical packaging potential of over 25 million parts per cubic foot as compared to the Micro-Module's packing density of about 500,000 parts per cubic foot.

So far TI has succeeded in making development models incorporating only transistors, diodes, resistors and capacitors. Inductors still present a problem, however.

Two working circuits have been completed. One is a multivibrator circuit containing as integral parts the equivalent of 12 components—two transistors, two capacitors and eight resistors.

The other is a phase shift oscillator containing five resistors, three capacitors and one transistor.

All these components are integral parts of one piece of solid semiconductor material. Either silicon or germanium may be used. Manufacturing techniques used involved controlled masking, etching and diffusion.

Greatest potential for these solid circuits is in applications where large numbers of repetitive circuits are required. The computer field would use units of this type to great advantage.

Samples or production units of the solid-circuit type will not be available for about a year, TI says. And then probably only a limited number of circuit types.

RCA announced last month their version of the solid circuit. Dr. Irving Wolff, vp, research, RCA Laboratories, said that their development of a computer logic circuit makes possible packaging densities up to 100 million parts per cubic foot. An important element in this development is the utilization of the uni-polar transistor.

Both active and passive elements can be built into a small piece of silicon as small as 0.000016 cubic in. To date, RCA has built only the computer logic circuit in this form. Investigation of other base materials such as gallium arsenide and indium phosphide is continuing.

RCA also recently announced the availability of their micro-modules (*ELECTRONIC DESIGN*, April 15, page 28). Sample quantities are available for sale to designers of military equipment.



# flyweight champ goes the limit....

## New SUBMINIATURE RELAY SHOWS UNVARYING HIGH PERFORMANCE UNDER VIOLENT ENVIRONMENTAL ASSAULT.

Wheelock Signals, Inc. has successfully packaged high performance and superior environmental stability in an unprecedented relay design of exciting import to airborne electronics designers. In fit and fighting trim, the new Crystal Case Relay (weight 0.4 oz.) is designed for a minimum of 100,000 functional operations in ambients from  $-65^{\circ}$  to  $+125^{\circ}\text{C}$ . Shock, vibration and acceleration immunity exceed MIL spec demands.

Now, spatial requirements are eased significantly in your guidance electronics package — telemetering transmitter — radar "black box" — mobile communications equipment — modulators, amplifiers, power supplies.

Available with standard terminations for plug-in, solder or printed circuit use. Write for descriptive literature: Bulletin 160-1.



### SPECIFICATIONS

Shock .....	50g per MIL-R-5757C
Vibration .....	10-55 cps, $\frac{1}{8}$ " excursion 55-2000 cps at 20g
Ambient Temperature .....	$-65^{\circ}\text{C}$ to $+125^{\circ}\text{C}$
Dielectric strength .....	1000 volts rms
Dielectric strength across open contacts .....	500 volts rms
Contact life, operations .....	100,000 min. @ rated load
Contact material .....	Palladium-to-gold flashed silver — other material available
Contact resistance .....	.05 ohms max.
Pickup time, nominal voltage .....	5.0 millisecs max.
Drop out time .....	5.0 millisecs
Insulation resistance at $125^{\circ}\text{C}$ .....	100 megohms
Contact arrangement .....	DPDT (SPDT on request)
Contact rating, 28v d-c or 115v a-c .....	2 amperes — resistive
Coil power, for min. operate .....	350 milliwatts
Coil resistance, 26.5 volt DC winding* .....	580 ohms
Relay weight .....	0.4 oz.

\*Coils available for other voltages.

*In this corner! the most reliable fractional ounce in your guidance package!*

Wheelock SIGNALS

W S

CIRCLE 29 ON READER-SERVICE CARD

## MICROELECTRONICS PROGRESS

gram with RCA and the Signal Corps with well over 100 others interested in participating.

As a result of the present micro-programs, the industry is expected to see increased use of digital equipment. In aircraft and missiles, the digital approach to instrumentation is becoming more common. This means packaging densities going up to a possible million components per cubic ft. And automatic machinery is being developed to handle the microcomponents which will result in greatly decreased production costs.

### Resistors

Several methods of making resistors are now in use. RCA, in their Micro-Module program have prepared resistors using a duPont metal glass frit-ink. The properties of this new type ink provide a temperature coefficient of the order of 150 ppm/C.

Several inks have been used with resistivity from 100 ohms per square to 35 K ohms per square. Firing is done in a continuous belt tunnel kiln at about 1300 F.

Resistors of the type shown in Fig. 5 are being used because they allow some adjustment. Resistor elements of this type are being supplied by Corning Glass and have tin oxide as the resistive material. Thus, resistors are available to the program with resistances ranging from 47 ohms to 100 K ohms.

Both Glass Products Co. and Mallory are supplying tin oxide type resistors in the Micro-Module program. Weston Electrical Instrument Co. is supplying 250 metal film resistor elements. The Weston process consists of metallizing the whole wafer first and then scribing the required resistors and dividing lines. Temperature coefficient of these units has been found to be less than 50 ppm/C. Value of the resistance changed about half a per cent during handling, but work is in progress to determine if this change can be prevented by suitable coating.

Weston, now Daystrom-Weston Instruments Div. of Daystrom Inc., is making wafer-type resistors commercially available in small quantities. They expect to go into production in about 6 months. Units now offered have resistance range from 100 ohms to  $1/4$  megohm, with four resistors on a wafer. Obviously these four can be connected in series. Power rating is  $1/8$  w at  $70^{\circ}\text{C}$  or  $1/6$  w at  $125^{\circ}\text{C}$ . Later, units ranging from 10 ohms to

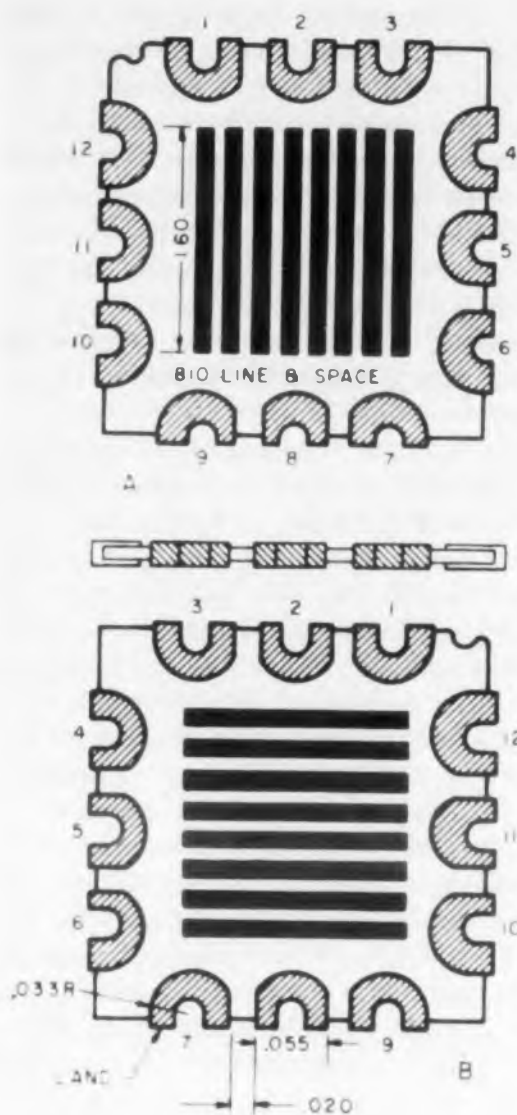


Fig. 5. How the resistor pattern is laid out on both sides of the micro-module wafer.

1 megohm will be available. These Weston units fulfill the requirements of MIL-R-10509C.

Allen Bradley and Chicago Telephone Supply Co. are also working on metal film resistors in conjunction with the program. Centralab is providing some carbon composition type resistors for evaluation.

Nichrome film resistors are also being made at RCA for the program. The metal film is applied by vacuum deposition through an organic film mask previously applied to the wafer. The organic film, Kodak photo resist, is applied as a solution by brushing, is air dried and then baked at 100 C for 15 minutes. The coated wafers are placed on a photographic plate having the resistive pattern design and exposed to an ultraviolet light. Then they are developed, the result being a positive photographic plate containing the open lines of the resistive pattern. The resistive film is deposited by vacuum deposition. Nichrome alloy (80 Ni:20 Cr) is deposited to give a resistive value of 50 ohms per square.

Resistor patterns are made from a drawing to determine line length and configuration based on the 50 ohms per square value. The design is then

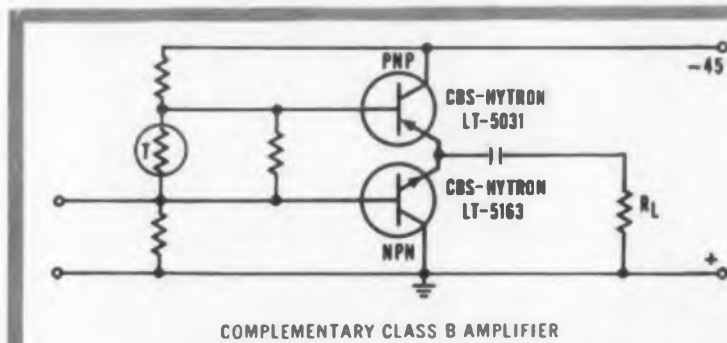
## NEW ECONOMY OF CIRCUIT DESIGN with new NPN power transistors



### ... in complementary push-pull circuits

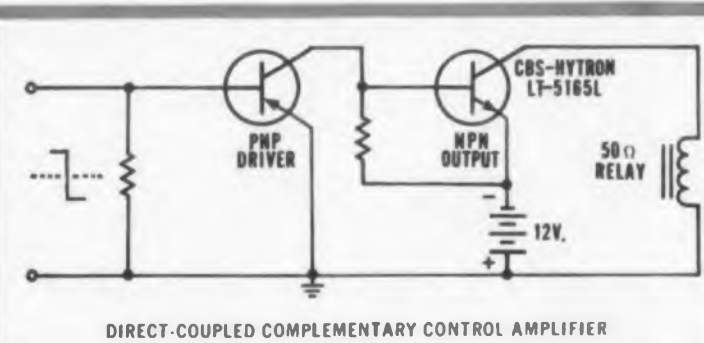
These new NPN transistors in the complementary push-pull circuit eliminate input and output transformers with many resulting advantages:

1. Economy. 2. Miniaturization. 3. Improved frequency response. 4. Ease of applying negative feedback.



### ... in complementary cascade circuits

CBS-Hytron NPN power transistors are also intended for single-ended cascade output circuits, and three types are designed for use with inductive loads such as output transformers, motors and relays. The simplified direct-coupled circuits permit economies through elimination of components.



### FIRST COMPREHENSIVE LINE OF NPN POWER TRANSISTORS

Type	Max. W Diss. (25°C Ambient*)	Max. V <sub>CE0</sub>	Max. V <sub>CEs</sub>	Min. h <sub>FE</sub> (I <sub>C</sub> = 0.5A)	Max. Thermal Res. °C/W	Similar PNP Types
FOR RESISTIVE-LOAD CIRCUITS						
2N326	7	35	35†	30	8	LT-5025
LT-5165	12	35	30‡	30	5	LT-5025
LT-5163	12	60	45‡	30	5	LT-5031
LT-5164	12	80	60‡	30	5	LT-5039
FOR INDUCTIVE-LOAD CIRCUITS						
LT-5165L	12	35	30‡	30	5	LT-5031
LT-5163L	12	60	45‡	30	5	LT-5039
LT-5164L	12	80	60‡	30	5	LT-5048

All seven types have: Max. collector current, 3 amps; storage temperature, -65 to +85°C; min. cutoff frequency, 150 kc. \*Adequate heat sink required. †I<sub>CEs</sub> = 1 ma. max. ‡I<sub>CEs</sub> = 10 ma. ‡φ<sub>CEs</sub> = 300 ma.

New design economies in complementary push-pull and cascade circuits are made possible by these CBS-Hytron NPN power transistors. They feature high voltages . . . up to 80 volts. Their proven reliability (they meet the MIL-19500A specification) is what you might expect from specialists in reliable NPN switching and PNP power transistors. Check the typical circuits and abbreviated data for this versatile and comprehensive line. Write for complete technical Bulletin E-332 . . . and, if you wish, for Bulletin E-288 on CBS-Hytron PNP power transistors for complementary circuits.

More reliable products  
through Advanced-Engineering



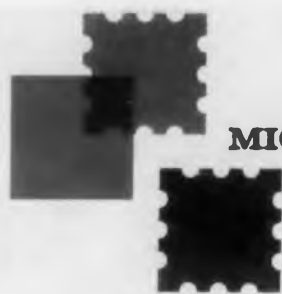
semiconductors

CBS-HYTRON, Semiconductor Operations  
A Division of Columbia Broadcasting System, Inc.

Sales Offices: Lowell, Mass., 900 Chelmsford Street, Glenview 4-0446 • Newark, N. J., 32 Green St., Market 3-5832 • Melrose Park, Ill., 1990 N. Mannheim Rd., EStebrook 9-2100  
Los Angeles, Calif., 2120 S. Garfield Ave., Raymond 3-9081

CIRCLE 30 ON READER-SERVICE CARD





## MICROELECTRONICS' PROGRESS

produced on Mylar film using black photographic tape to form the proper configuration. Master patterns have been worked out to provide resistor values ranging from 1 ohm to 33 K ohms.

Problems have been encountered in obtaining fine lines using the photo resist. Feathery edges were noticed and these are believed to be a result of internal reflection of light in the glass wafers. Ceramics also show a similar lack of sharpness due to their rough surfaces.

Tin oxide film resistors have also been produced. Resistance values of 25 to 1000 ohms per square have been obtained. Coatings prepared on glass plates were found to be easily reproducible. Steatite and Fotoceram are also being used as substrate material.

Practical resistors of platinum-gold alloy have been produced by the Royal Radar Establishment, England. They are in production and are reported to have excellent temperature characteristics. An alloy of 80 per cent gold and 20 per cent platinum gives a resistivity of 60 microhms per cm in a thickness of 100 Angstroms. Temperature coefficient is 0.025 per cent. An alloy of 60/40 gold-platinum has been found to have a resistivity of 75 microhms per cm in the same thickness with a temperature coefficient of 0.06 per cent.

This same group is also engaged in making high resistance units from films of nickel chromium. Problems have arisen in making the extremely fine

lines required. Meanwhile, engineers at the Royal Radar Establishment are continuing their search for alloys offering much higher resistance. This group has been engaged in work similar to that of the Diamond Ordnance Fuze Labs. They report that their work in making actual resistors can be adapted to making an entire circuit. The necessary resolution required for units of this type can be obtained by photomechanical processes.

Recent research at Bell Telephone Laboratories promises some interesting results in this area using the old technique of cathode metal sputtering. In this process, ionized gas molecules bombard a cathode, dislodging atoms of metal which then re-deposit on nearby surfaces.

A plate of the metal to be deposited is used as a cathode. The substrate on which the film is to be deposited is placed near it. After evacuation, argon or other suitable gas is introduced and maintained at a pressure of about 40 microns. When a voltage is applied, ionized atoms of gas bombard the cathode dislodging metal atoms or clusters of atoms which then deposit on the substrate.

Sputtering is one of the most convenient methods available for the production of thin films of the high-melting point metals. Thickness of the films may be controlled within narrow tolerances.

Tantalum and titanium, melting at 3000 C and 1670 C respectively have been laid down. These films show sufficiently high resistivity to be useful as resistors.

### Need Fine Lines

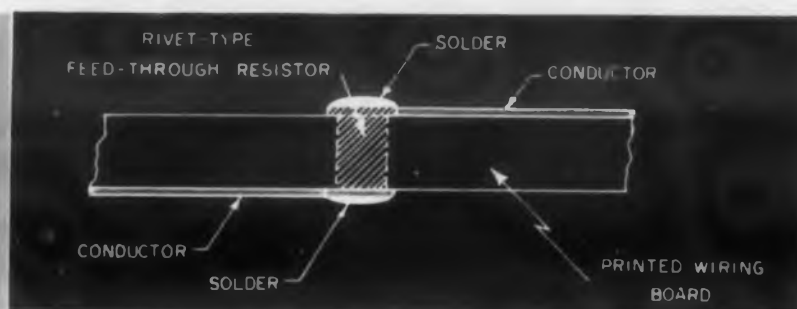
Being able to produce extremely fine lines is important in the production of precision resistors suitable for microminiature circuitry. Bell Labs has been successful through the sputtering technique in making lines only 1 mil wide. At Diamond Ordnance Fuze Labs., lines 2.5 mils wide with 2.5 mil spacing have been successfully reproduced.

At Bell Labs another development possibly more suited to the DOFL 2D approach rather than the Micro-Module approach is the "rivet type" resistor shown in Fig. 6. Length of the resistor is equal to the thickness of the printed wiring board or the substrate on which it will be used. The resistor then, acts as a feedthrough connection between the two sides of the board. Since the ends are flush with the board surface, the connections occupy no space and the resistor is completely hidden within the thickness of the board. International Resistance Co. is also reported to be developing a resistor of the same type.

### Capacitors

Diamond Ordnance Fuze Laboratories has done some work on vacuum deposition of silicon monoxide dielectric capacitors. This material has

Fig. 6. Cross section of Bell Lab's rivet-type resistor mounted in the thickness of a printed-wiring board.



## PRESENT CAPABILITIES

### CAPACITY

6 VOLT 0.22-6 MFD

20 VOLT 0.1-2.2 MFD

TEMP. RANGE - 55 to +85 °C

### BASIC MICRO-PART SHAPE

Fig. 7. Solid tantalum electrolytic capacitor of the current type (top). The sintered slug, bottom, has been adapted for the micro-module wafer.

Fig. 8. Bell Telephone Labs used a sputtering technique to make these miniature tantalum-oxide capacitors.

received a great deal of attention because of its ease of deposition. Using outer layers of various metals, it was found possible to obtain a wide range of capacitance per unit area, breakdown voltage, insulation resistance, dielectric constant and dissipation factor. The best values found were those using gold as the electrode film. It has high conductivity, resists oxidation and is easy to deposit.

Fused silica was also used as a capacitor dielectric in experimental work at DOFL. It has excellent stability and its dielectric breakdown strength is 15,000 v per mil, the highest known.

So far, the best experimental capacitors using vacuum evaporation techniques were made using dielectrics of silicon oxide and aluminum oxide. Values given for these units show a capacitance of 0.005 microfarads per square cm and an insulation resistance of 100 kilomegohms. Loss factor was less than 1 per cent.

Thin-film ceramic capacitors promising to fulfill the needs of the Signal Corps Micro-Module program were developed at RCA's Advanced Development Laboratories. Initial work produced samples in the range of 150  $\mu$ f and 300  $\mu$ f. The 150  $\mu$ f capacitors contain a 0.001 layer of dielectric material while the 300  $\mu$ f units contained twice that amount. Gold was the electrode material; film was a silica-titanate compound on a ceramic base. All the units had a Q greater than 1000 measured at 100 kc. Temperature coefficient was less than plus or minus 100 ppm/C between 25 and 300 C. Breakdown strength was better than 600 v dc below 85 C.

#### Making Miniature Dielectrics

Both Mallory and Magnavox are supplying tantalum capacitor elements to the Micro-Module program. RCA has also been engaged in the development of dry electrolytics for the program. Work has been directed toward the development of tantalum capacitors made with sintered tantalum slugs to achieve the extremely small size necessary. A capacitance range of 1 to 50  $\mu$ f is being incorporated into the module structure. An example is illustrated in Fig. 7.

R. W. Berry of Bell Labs has produced printed capacitors, Fig. 8, by a combination of cathode sputtering and chemical methods. A tantalum film of proper shape and size is first sputtered on to the substrate. Then it is anodically oxidized to form a tantalum oxide dielectric film. The counter electrode, a gold film, is then evaporated onto the dielectric to form the complete capacitor sandwich.

Aerovox Corp. has done some development work in the Micro-Module program. One of their new designs and techniques developed is exemplified in their Cerafil capacitors announced recently.

(Continued on page 38)

## BROWN CONVERTERS

put stable performance in your measuring and servo loops



These synchronously-driven choppers handle d-c signals as small as 10<sup>-8</sup> volt. SPDT switching action. Sensitive, stable performance. Ideal for computers, servomechanisms, balancing circuits. Available with special features such as fungus proofing, grounded housing, mica-filled base, various contact percentages. Weight: 10 ounces. Prices from \$36.

Driving coils in 60-50, 40 and 25-cycle converters are energized by 6.3 volt a-c. 400-cycle converters use 18 volts. Other specifications on chart at right.

MINNEAPOLIS - HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

ELECTRICAL CHARACTERISTICS					
Part No.	354210-2	354210-3	354210-1	354210-4	355081
Modulation Frequency	20-30 cycles	40-45 cycles	50-65 cycles	50-65 cycles	360-440 cycles
Switching Action (SPDT)	(Make-before-break) Each contact closed 55% of each cycle ( $\pm 2\%$ ) Other actions, as specified			(Break-before-make). Each contact closed 47% of each cycle	Each contact closed 57% of each cycle ( $\pm 7\%$ )
Driving Coil Requirements	6.3 v, 60 ma at rated frequency				18 v, 94 ma at rated frequency
Contact Rating	100 microwatts at 6 v max.; 1.0 ma max.				
Electrostatic Stray Pickup	$2 \times 10^{-10}$ volts per ohm of input circuit impedance				$2 \times 10^{-10}$
Electromagnetic Stray Pickup	Less than $2 \times 10^{-6}$ volts, constant to within $2 \times 10^{-7}$				$2 \times 10^{-5}$ volts constant to $2 \times 10^{-6}$
Phase Shift	Output voltage lags driving phase by $17^\circ \pm 5^\circ$				Lags driving phase by $45^\circ$ to $50^\circ$
Symmetry	Within 2%				Within 7%
Shielding	Frame and coil shield, grounded through pin No. 2				Shell and coil shield, grounded through pin No. 2
Load Characteristics	Resistive or Inductive				
Vibration Resistance	Output voltage varies less than 2% with rates of vibration from 0 to 10g				
Weight	10 oz.				8.5 oz.
Special Features	Specify SS-8816-A for anti-fungus treated, vibration resistant wiring, hermetically sealed case. Also available with side plug for exciter coil connection.				All 400-cycle converters are treated as shown at left

# Honeywell



*First in Control*

CIRCLE 31 ON READER-SERVICE CARD





One of the most promising developments in the field of microcapacitors is the monolithic structure for ceramic capacitors. Developed by Sprague Electric Co., these units are currently being incorporated into the Signal Corps Micro-Module program.

Sprague's capacitors are high-dielectric constant barium titanate units made by a layering process, Fig. 9. This capacitor consists of five active dielectrics. An early model, for example, consisted of layers each 0.0025-in. thick, occupying a volume of 0.620 by 0.355 by 0.018 in. Capacitance of a unit this size is 0.4  $\mu$ f.

Sprague manufactures two groups of capacitors by this process. One group utilizes a high dielectric constant material for bypass and coupling applications, and the other utilizes low dielectric constant materials for resonant circuits and other applications requiring high stability. Lead configuration of these units may be modified for particular applications.

Erie Resistor Corp. is marketing the Corning WL-4 miniature fixed capacitor. It is especially designed for printed-circuit applications.

Summing up the problems involved in making these extremely small units, industry must find a way to obtain high stability and low temperature coefficient. Very thin films are not practical if they are unstable. Stability will then be the dominant factor in developing a readily reproducible microcapacitor.

## Inductors

For the Micro-Module program, inductors for rf filters, both fixed and variable, and inductors to be used as transformers must meet the require-

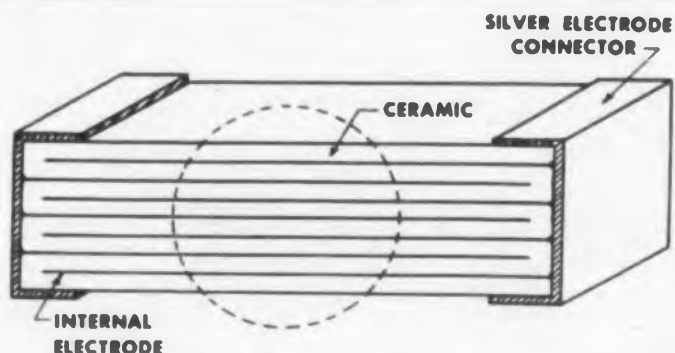


Fig. 9. Construction of the Sprague Monolithic capacitor.

Table 1—Characteristics of Ferrite and Metal Magnetic Films

	Metal	Ferrite
Operating Speed	30 m $\mu$ sec	1 $\mu$ sec
Drive Power	400 ma into 5 ohms (transistor)	800 ma into 50 ohms (tube)
Repetition Rate	5 mc	500 kc

ments of MIL-C-15305A. Miniature ferrite core inductors are also undergoing development to be compatible with the program (Fig. 10). Variable inductors are being considered for tuning applications, although the Signal Corps has found electric tuning particularly attractive for certain applications.

Audio, power, and pulse transformers and inductors are also under development for the Micro-Module program. These units will be required to meet MIL-T-27A.

A zero temperature coefficient is required for most inductor applications. Ferrite material with NPO (zero temperature coefficient) characteristic was investigated to determine the effects of various protective coatings. Some coatings tried seemed to subject the ferrite core to undue stress and strain under varying temperatures. This, of course, nullified the NPO characteristic of the ferrite. A foam coating avoids the problem, and further investigation may reveal other suitable coatings.

RCA and the Signal Corps are looking for cores of higher permeability. They have studied results of adding molybdenum, cobalt, barium and yttrium to nickel-zinc ferrites. Ferrites with low temperature coefficients and high Q (greater than 100) for operation at 50 mc have been prepared. Inductance ranges up to 1.5 mh.

Coil impregnants are also being sought in connection with the Micro-Module program. Some epoxy resins have been tested, but no definite conclusions have yet been reached.

Properties of the impregnant must include corrosion resistance, moisture resistance, resistance to



Fig. 10. Possible method of mounting a toroid on a micro-module wafer.

thermal shock, and the necessary electrical properties. It must also be nonreacting with the adhesive used in bonding the coil or with the wire insulation. Work in this area is continuing.

At the Royal Radar Establishment, experiments show that metal is preferable to ferrite as a magnetic film, Table 1. Metal films have superior properties and are easier to evaporate as an alloy. Both metal and ferrite films have rectangular hysteresis loops and are suitable for use in memory planes.

These films consist of nickel-iron in the ratio of 8 to 1. Thickness must be limited to less than a micron or so because of excessive eddy current losses.

Varo Mfg. Co. has made inductors by vacuum evaporation techniques. In a simple rf or i-f transformer, a mask was used to deposit a spiral of pure metal on each side of a substrate. The inductance is controlled by the shape of the mask. The thickness of the substrate, which is the separation of the primary and secondary coils, controls the mutual inductance. Thus bandwidth can be controlled.

Inductors made by vacuum deposition possess the advantage of small size and, more important, reproducibility. By careful control of the substrate thickness and by using the same mask, these vacuum evaporated transformers come out the same.

## Semiconductors

Conventional semiconductor components are relatively large because of their cases. Actually the working material is a very small percentage of the total volume. To overcome the problem of the large transistor package, several techniques have been investigated at Diamond Ordnance Fuze Laboratories for working with caseless transistors. These techniques allow the active element of the transistors to be incorporated as an integral part of a ceramic printed plate, as shown in Fig. 11.

One of the most impressive developments in this area is the extension of photolithographic techniques for the fabrication of transistors. An-

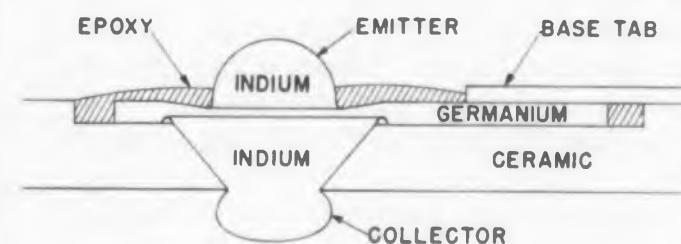


Fig. 11. Transistor integrated into a printed-wiring board.

other method is to mask the transistor on the ceramic plate so that the leads may be vacuum deposited to connect the base and emitter contacts to the printed wiring.

In addition, two methods of encapsulating transistors have been developed, one nonhermetic and the other hermetic. The sealed units have been subject to various environments with no change in transistor characteristics.

Two methods have been developed by RCA for microminiature transistors for the Micro-Module program. One method consists of sealing the transistor element between two wafers. Each wafer is recessed to accommodate the transistor.

In the second method, the transistor is placed in a recess in the wafer and covered with a metal lid. This circular lid is sealed to the wafer. Several methods of rf heating are being tried to effect the seals.

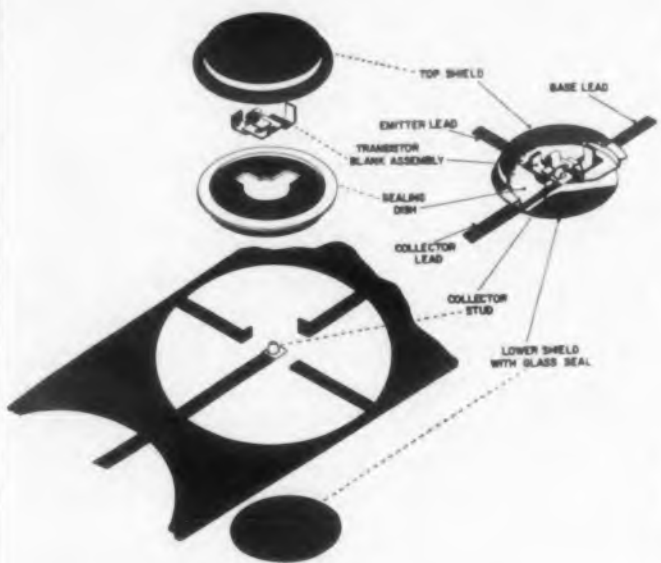


Fig. 12. Parts of Philco's micro-module transistor.

Philco's Advanced Research and Development group of the Lansdale Tube Co. is developing semiconductor devices for the Micro-Module program. These devices are expected to afford size and weight reductions of about 10 times that of current components, and may achieve packing densities of 500,000 to 600,000 components per cubic foot. Packing density of current equipment at best is about one-tenth that.

Basic components of a microminiature high-frequency transistor are shown in Fig. 12. The strip for electrode forming is 0.002-in. thick copper.

Hermetic sealing was a problem here, too. A minimum seal length of 0.05-in. is necessary for a reliable seal. This amount of seal length was obtained in the design shown.

An automatic production technique (Fig. 13) was worked out by Philco. Transistor elements

## 3-D Radar Tells Distance, Altitude

(Pictures on Page 3)  
A revolutionary new 3-D radar capable of detecting enemy air attackers at extreme range and revealing their distance, bearing and altitude to military ground units was revealed today by the Army. The new system, called Frescanar and developed by Hughes Aircraft Company, also sees its target clearly than ordinary radar.

## Army Shows Radar With 3d Dimension

By JACK RAYMOND  
Special to The New York Times  
WASHINGTON, Oct. 14.—The Army demonstrated a new "three-dimensional" radar device today and called it "one of the most important advances made in electronic detection." The new radar gives simultaneous readings of bearing, distance and altitude; it is designed to be hauled on truck trailers.

## Army Unveils Hughes Radar

Electronically, 'Frescanar' Can 50% Further Than Previous  
WASHINGTON, Oct. 14.—The Army Tuesday unveiled a field radar system that simultaneously computes distance, bearing and altitude. It employs a single antenna housed in an inflatable container and is designed to become the electronic eyes of ground defenses.

## New Radar Improves Air Defense for Army

WASHINGTON.—Field armies have a truly effective missile defense against any kind of attack except that from ballistic missiles within a year, Army officials said last week. An additional statement came at the unveiling of a new type of radar as a key element of the Monitor system, will save men, training time, and ease of air defense in tactical operations. The new radar is a mobile unit that can be moved at good speed off set up and be ready in minutes. KEY to the thing known...



## Army Unveils A Faster Radar System

WASHINGTON.—A radar system that is faster, more reliable and more rugged than present equipment was unveiled by the Army here Tuesday. Nicholas A. Bezovich, of Hughes Aircraft Co., said a single antenna does the work of three.

## U.S. Reveals New Radar Instrument

A "3-D" radar that for the first time automatically computes distance, bearing and altitude of far-away targets was unveiled today by the Army in Washington. The unit is a new radar instrument that can detect enemy aircraft at extreme range and reveal their distance, bearing and altitude to military ground units.

## Army Unveils Revolutionary Radar Device

BY VERNON...  
The Army unveiled a revolutionary new radar device today that can detect enemy aircraft at extreme range and reveal their distance, bearing and altitude to military ground units.

## Hughes Radar

THE WALL STREET JOURNAL  
Wednesday, October 15, 1958  
Army Tests Improved Radar Device Originally Developed for Navy

## A new field... a new future... for the forward-looking engineer!

The first radar system capable of simultaneously detecting range, bearing and altitude from a single antenna, transmitter, and receiving channel...Frescanar is a major breakthrough in radar technology.

Developed by Hughes Fullerton, the Frescanar antenna operates on a new electronic principle called *frequency scanning*: The position of the radar beam is changed by varying the frequency of electromagnetic energy applied to the antenna. Thus the beam can move at lightning speed to handle more targets with greater accuracy than with conventional radar.

This unique concept opens entirely new fields for radar... including a great many as yet unexploited. Hughes Fullerton needs creative engineers who can step in and help develop these new military and civilian applications.

While Hughes Fullerton places emphasis on advanced development, it is a completely integrated engineering and manufacturing organization...whose activities cover a wide range of electronic and electromechanical applications.

Now expanding rapidly, Hughes is offering imaginative engineers a number of new positions. If you are interested in stimulating work with solid opportunity for personal and professional growth, we invite your inquiry. Please contact Mr. L. V. Wike at address below.

HUGHES

GROUND SYSTEMS DIVISION  
PERSONNEL SELECTION AND PLACEMENT  
HUGHES AIRCRAFT COMPANY  
FULLERTON, ORANGE COUNTY, CALIFORNIA

## 3-D Radar Developed by Hughes

Computes Bearing, Range, Altitude in Single Operation

Three-dimensional, hemispheric radar detection developed by Hughes Aircraft is now in use on Navy ships.

## Army Gets Improved Field Radar

WASHINGTON, Oct. 14.—The Army today unveiled a new field radar system that simultaneously computes distance, bearing and altitude. It employs a single antenna housed in an inflatable container and is designed to become the electronic eyes of ground defenses.

## 3-Dimensional Radar Is Displayed by Army

By JAMES W. BRADY  
Special to...  
The Army today unveiled a new field radar system that simultaneously computes distance, bearing and altitude. It employs a single antenna housed in an inflatable container and is designed to become the electronic eyes of ground defenses.





## REFUELLING MISSION ACCOMPLISHED WITH BENDIX-PACIFIC RADAR BEACONS

All-weather refuelling of B-58 bombers by KC-135 tankers will soon become Standard Operating Procedure through the electronic teamwork of such products as the Bendix-Pacific Rendezvous Beacons. Bendix-Pacific has developed these beacons in cooperation with the Fort Worth Division of Convair, the Transport Division of Boeing Airplane Company and Wright Air Development Center, and will shortly be producing these rendezvous beacons in quantity.

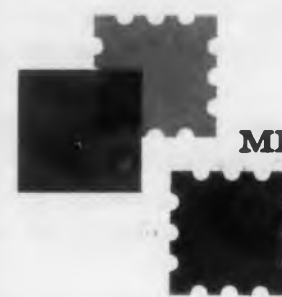
Bendix-Pacific maintains a complete staff of airborne radar personnel to assist you in the solution of your problems.



NORTH HOLLYWOOD, CALIFORNIA

East Coast: (Eastern Representative) Rockefeller Plaza, New York City; Dayton, Ohio: 120 West 2nd; Washington, D.C.: Suite 803, 1701 "K" Street, N.W.  
Canadian Distributors: Computing Devices of Canada, Ottawa 4, Ontario. Export Division: Bendix International, 205 East 42nd Street, New York 20, N.Y.

CIRCLE 33 ON READER-SERVICE CARD



## MICROELECTRONICS' PROGRESS

are dropped into the proper holes provided in the continuous strip. A cutter then slices the strip into individual wafers. Because the transistors are hermetically sealed, no special method of insertion is required.

### Other Components

Selenium rectifiers, diodes, crystals, relays, switches, miniature lamps, batteries are among the many other components now being developed in the microminiature size. Midland Mfg. is developing microminiature crystals for the Micro-Module program. These are to operate at frequencies of 7, 10, 20, 45.1, and 70 mc. Other companies also involved in the design of similar units include Bulova, Hycon Eastern and McCoy Electronics. Union Thermoelectric has also submitted a proposal in connection with the Signal Corps program.

Both Varo Mfg. and Servomechanisms, Inc. have reported work on thin film diodes using vacuum evaporation techniques. They feel that field-effect transistors may be possible using this technique also.

Miniature lamps have been developed at Diamond Ordnance Fuze Labs. Smallest of these, Fig. 14, is 0.1-in. long and consumes only 25 ma at about 1 volt. They are designed to operate on the limited currents available in most transistor circuits. They provide a very small source of il-

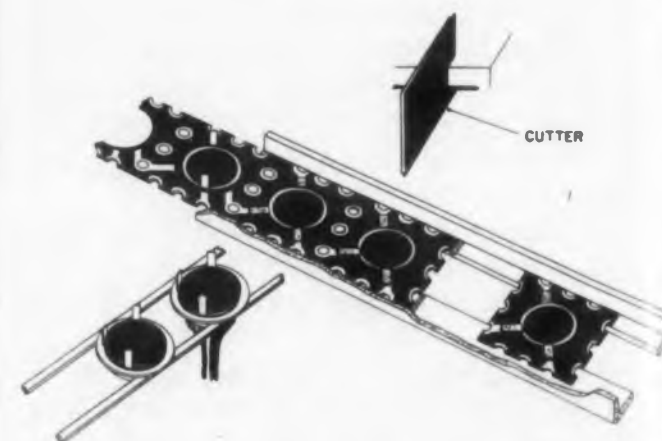


Fig. 13. Production of Philco's micro-transistors. Transistors are dropped into holes on the strip (left), then the leads are soldered and the wafers cut from the strip.

ICS'

in the  
p into  
e her-  
tion is

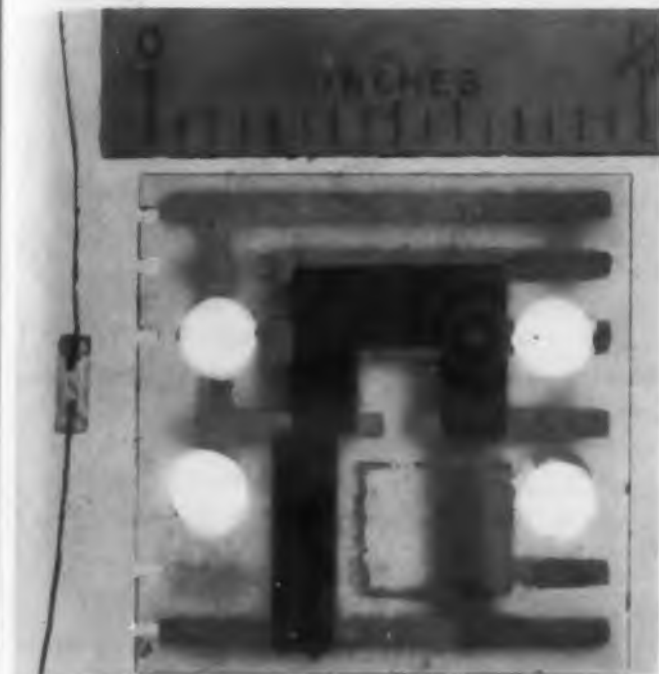
relays,  
ng the  
ed in  
devel-  
Micro-  
t fre-  
Other  
imilar  
McCoy  
sub-  
Signal

Inc.  
g vac-  
field-  
tech-

Dia-  
these,  
25 ma  
ate on  
istor  
of il-

Tron-  
, then  
e strip.

1959



**Fig. 14.** Microminiature lamp is 0.1-in. long, draws about 25 ma at 1 v.

lumination that has been found to be visible from any point in a normally lighted room.

Batteries for microminiature applications are not yet in existence. RCA and the Signal Corps report that no work has been done in this area yet. However, the tentative specifications require batteries to have a nominal voltage of 15 volts with taps at 1.5, 3, 6, 9, and 12 volts also. Their energy yield shall not be less than 6500 milliwatt hours per cubic inch for the first 20 per cent drop. There will be a minimum of eight microminiature cell sizes with capacity ratings ranging from 10 milliwatt hours to 2000 mwh. Further, the batteries will be required to deliver at least 90 per cent of their rated performance at the end of 12 months storage at 70 F.

Switching and relay operations for all types of microminiature circuits will have to be carried out by transistors and other static means wherever possible. Other than that, the mechanical relays will have to be miniaturized as much as possible.

### Assembled Units

Both Diamond Ordnance Fuze Laboratories and the Signal Corps are doing a great deal of development work to find the best means to assemble all of these microminiature components to the best advantage. Besides these two groups, many independent laboratories and industry groups have been engaged in the problem. Some of them are working in conjunction with these groups; others are working independently.

Among the private firms working on micro-miniaturization programs, one, Cleveland Metal Specialties Co. is already offering a microminiature computer circuit for sale. They have been

**No stoop, no squint,  
no painful nagging  
backache\***



**Buy this Testmobile and tilt  
your 'scope so you can read it!**

Obsoleting all previous concepts in one brilliant breakthrough, -hp- engineers have achieved the *ultimate device*—the revolutionary 115A Oscilloscope Testmobile. Employing the radical Supermarket Cart principle (first described 1906 by A. and P.) -hp- 115A *actually tilts an oscilloscope so you can read it, and lets you push it from place to place!* Scope may be tilted up to 30° in 7½° increments; heavy chromed tube steel construction; big, locking, rubber-tired wheels; removable bottom basket; size 40" high x 23" wide x 29" deep, folds for shipment or storage; lightweight, only 28 lbs., \$80.

\*with thanks to our friends at Philco and Anacin

Still further probing the Unknown, -hp- engineers achieved the -hp- 116A Storage Unit and 117A Storage Drawers. The 116A is a sophisticated cube known as a "box." It holds up to 3 plug-in units for -hp- 150A/AR 'scopes; prevents dust and elbows in the circuitry. Yours for \$22.50. The 116A also holds up to three 117A drawers which in turn hold tools, solder, components and bubble gum. -hp- 117A, a modest \$10.

### HEWLETT-PACKARD COMPANY

4959K Page Mill Road • Palo Alto, California, U.S.A.  
Cable "HEWPACK" • DAvenport 5-4451  
Field engineers in all principal areas



**over 300 instruments for measuring speed and accuracy**

**Besides Testmobiles,  
-hp- makes  
oscilloscopes, too!**



**-hp- 150A/AR - to 10 MC**  
Automatic trigger, direct-reading; plug-ins providing dual trace or differential input; or high amplification. -hp- 150AR (rack) \$1,200. -hp- 150A (cabinets) \$1,100.



**-hp- 130B/BR - to 300 KC**  
1 mv sensitivity, similar X/Y amplifiers, direct reading, automatic trigger, X5 magnifier, balanced on 6 most sensitive ranges. -hp- 130B (cabinet) or 130BR (rack), \$650.



**-hp- 120A/AR - to 200 KC**  
Sweeps 1 μsec/cm to 0.5 sec/cm; X5 sweep magnifier, automatic trigger, high sensitivity calibrated vertical amplifiers, regulated power supplies. -hp- 120AR (rack mount, 7" high) or 120A (cabinet) \$435.

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

CIRCLE 34 ON READER-SERVICE CARD



## MICROELECTRONICS' PROGRESS

engaged with work for Diamond Ordnance Fuze Labs, and their approach follows that of building an entire circuit of one printed-wiring wafer (Fig. 15). A binary counter made up of these commercially available units is shown in Fig. 16.

Denver Research Institute of the University of Denver has been active in all phases of micro-miniaturization in use today. W. A. Alford, R. W. Buchanan, and R. D. Seibel are generally responsible for work at DRI and have been concerned with design of conventional tube circuitry to achieve maximum packaging density and printed circuitry with tube and/or transistor components.

An internally sponsored microcircuitry program was started at DRI with a multivibrator chosen as the test circuit. This circuit has been realized by two techniques: 1. Resistive and conductive inks and 2. Vapor deposition. Fig. 17 illustrates the multivibrator made with resistive and conductive inks. Passive elements made with vacuum deposition techniques are shown in Fig. 18. In both cases, Raytheon CK-28 transistors were used for the active elements. An operating range of from 30 to 100 kc has been obtained by variation of the RC parameters.

One of the potted multivibrators is shown in Fig. 19 with a conventional circuit beside it for comparison. The final size of the potted unit is 3/8-in. in diameter and 5/16-in. tall. Resistor elements used in this circuit are representative of high and low values required in this circuitry. Deposits of manganese can apparently be used for resistances from 20 to about 500 ohms. Tellurium is also a good resistor material for the range between 1000 and 200,000 ohms. These materials have been vacuum deposited and a 5 per cent tolerance was obtained.

In the work to date, a disk of 0.020 thick barium titanate has been used for the dielectric base. Much difficulty was encountered in the mechanical processing of the barium. Other methods are being investigated.

One possible technique for obtaining the required dielectric involves the use of aluminum foil anodized on one side followed by vacuum deposition of an aluminum or silver layer on top of the oxide. Thus, capacitor plates are formed by the original foil and the deposited material with an aluminum oxide dielectric.

Work at Denver Research Institute also covers the problem of removing the case from transistor

and diode elements. One method merely involves getting the commercial units from the manufacturer without the cases and putting the active elements into the proper place in the circuit.

The other technique would use microcircuitry approaches. Coupled with this are investigations of vacuum deposition and special heat treating processes. Effects of aging and potting of circuit components is also being studied.

### Black-Box Circuits

Varo Mfg. Co. has been concerned with fabrication of a functionally complete circuit rather than an assembly of components. These circuits are achieved by the alternate deposition of the con-

necting materials on a suitable substrate in the proper configuration and sequence.

Varo started on this project in 1956, the objective was to perform research and development in this field for use in the Army-Navy Instrumentation program. Their work has resulted in a concept that translates a lumped-constant circuit into one of distributed constants.

For example, a substrate of a high dielectric constant is used with a deposited film of conducting material on one side and a resistive film on the other. The result is a distributed-constant RC network of much smaller size than its lumped-constant equivalent.

Other circuitry made experimentally by Varo

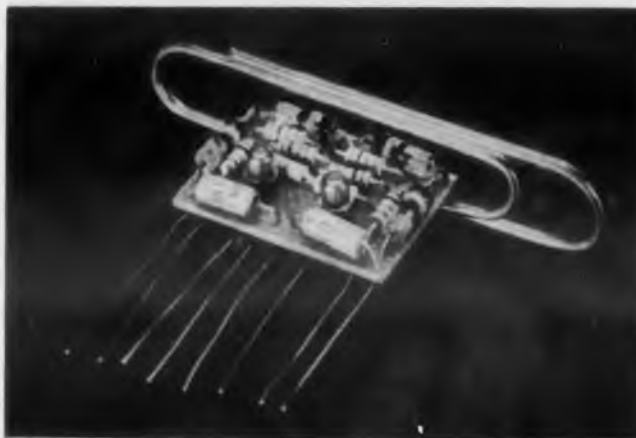


Fig. 15. Commercially available wafer-type circuit for a binary counter, being produced by Cleveland Metal Specialties Co.

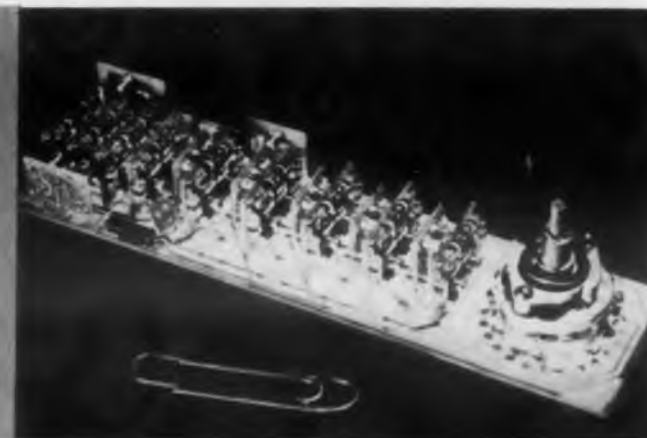


Fig. 16. Complete binary counter made of wafer-mounted circuits patterned after the DOFL technique.

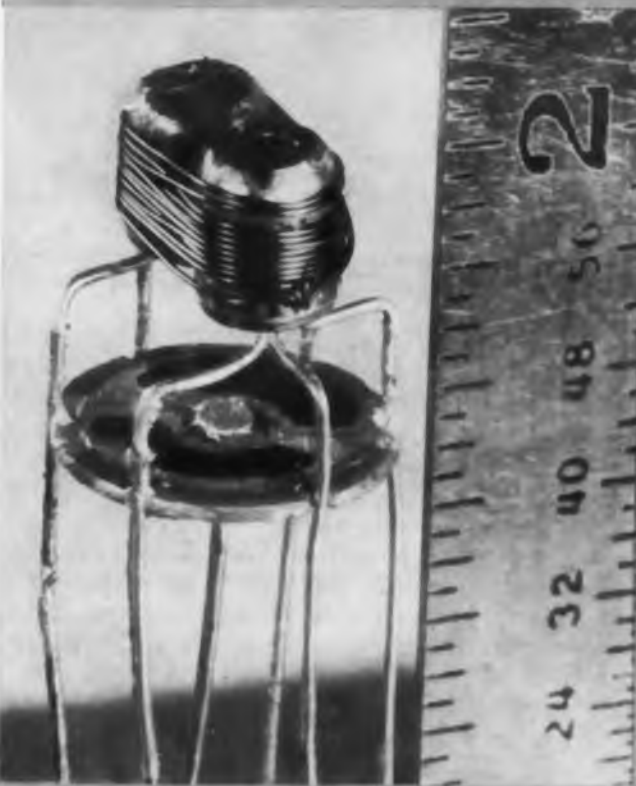
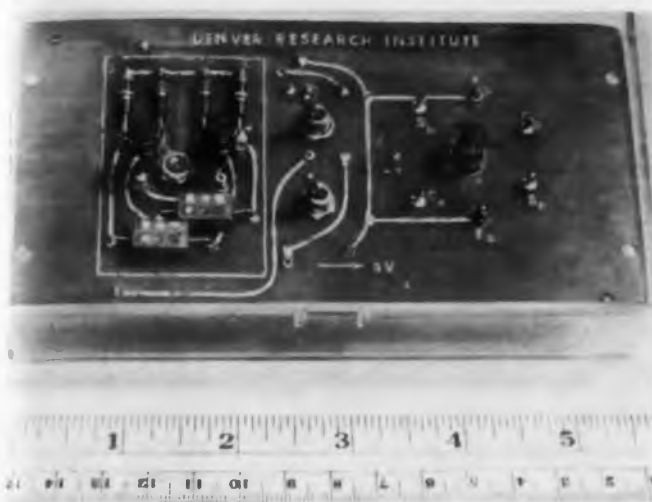


Fig. 17. Microminiaturized multivibrator made with resistive and conductive inks. Denver Research Institute made this unit.



Fig. 18. Passive elements of a multivibrator circuit made by vacuum deposition techniques.



**Fig. 19.** Standard multivibrator unit (left) mounted on same printed-wiring board with Denver Research Institute's potted unit (right).

using their microcircuitry on parallel fabrication technique includes carrier generators, dc amplifiers, multivibrators as well as potentiometers, strain gauges, thermocouples and thin film magnetic memory elements.

Bell Telephone Laboratory has also been developing some concepts in microminature circuits. Their approach, like DOFL's and Varo's is to make one circuit per wafer. They prefer to think of wafers in many sizes. For example, circuits are being built on wafers 1, 2, and 3 in. square. As many components as is necessary should go on one board, they feel. And this depends entirely on the circuit subfunction rather than how many components could be jammed into that space.

International Resistance Co. is examining the microminature problem from the production versus unit cost approach. In other words, they are more concerned with problems of reproducibility, testing, packaging, production machinery and yield factor. There must be an interaction between the production process and the product to achieve microelectronic packages that are worth making at all.

About 16 circuits made up of the Signal Corps Micro-Modules have been assembled and checked. These include rf and if amplifiers, signal generators, oscillators and others. Up to ten wafers are used in the assembly.

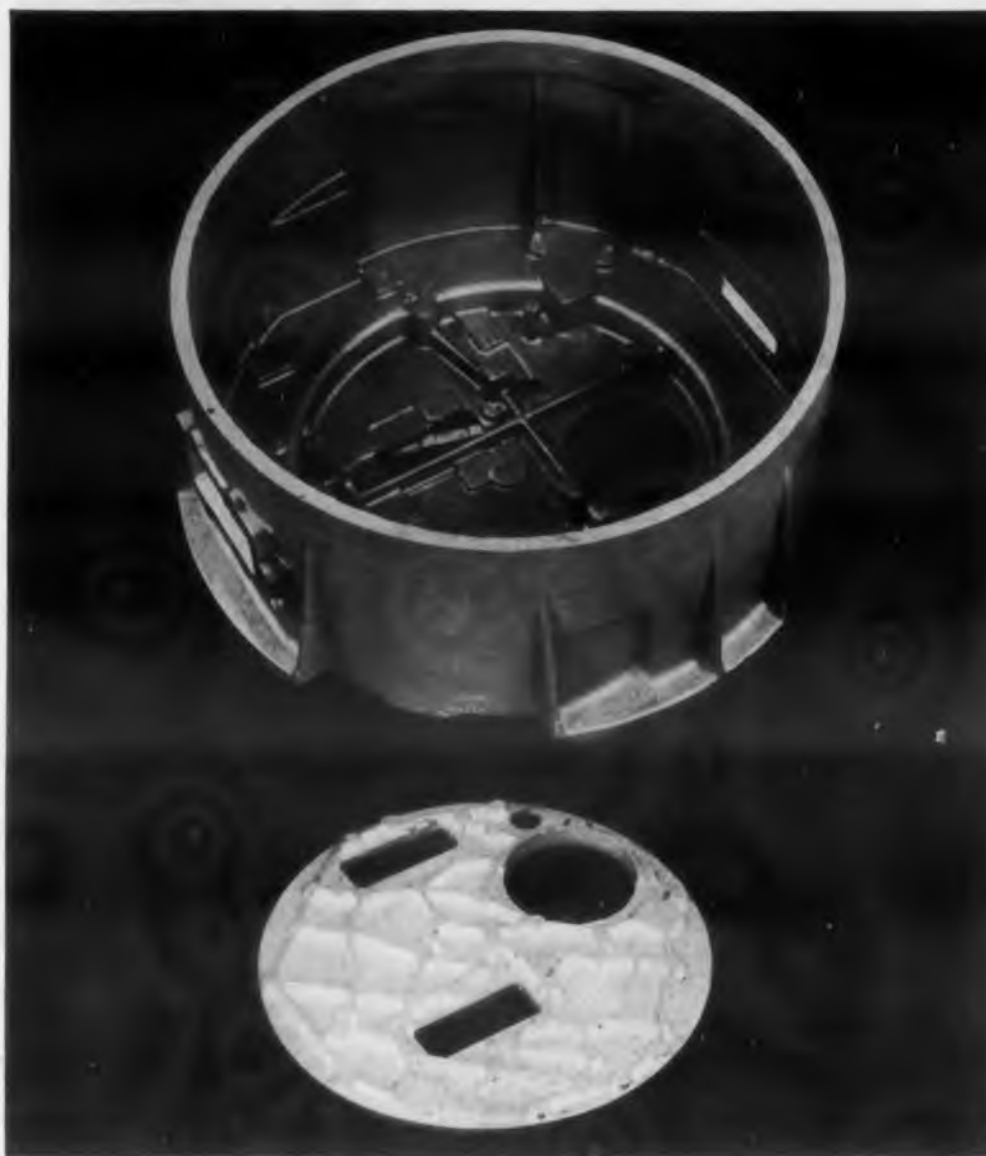
Several experimental units have also been built for demonstration recently. One is the RCA fountain pen radio. Also, RCA engineers have assembled various pieces of military communications equipment for demonstration.

Work in microelectronics at Wright Air Development Center Components Laboratory and the Air Force Cambridge Research Center has been underway for over a year. ARDC programs lean more toward basic research of existing physical phenomena and their possible application to microminiaturization.

(Continued on page 44)

**DOW**

**MAGNESIUM**



**K1A CASTINGS** used on Nike Hercules guidance control system. Large sand casting is a housing for electronic guidance components. Small die casting is a mounting plate used within housing.

Damping capacity—the ability of a material to reduce vibration by absorbing energy—is a highly important factor in electronic equipment used in missiles and aircraft. The performance of sensitive instruments can be severely affected by high energy vibrations generated in missiles in take-off and flight.

A big step forward in solving this increasingly critical problem is the development of K1A, a new magnesium alloy. Used in electronic bases and housings, this lightweight alloy eliminates complex mounting and suspension systems that often take up precious weight and space in missiles.

This new magnesium alloy has vibration damping characteristics much better than cast iron, aluminum or other magnesium alloys. Its heat conductivity and diffusivity are approximately twice that of standard magnesium alloys, thus making possible substantially reduced environmental temperatures for electronic instruments. Welding and machining have no adverse effect on the damping properties of K1A.

Bell Telephone Laboratories has done extensive work in determining properties and characteristics for the alloy, and in establishing its suitability for Western Electric's work on the guidance control system of the Nike Hercules. K1A is now available in the form of sand and die castings.

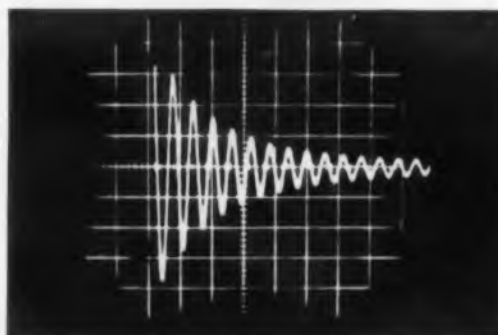


**NEW BROCHURE** on damping characteristics of magnesium discusses K1A, other mag alloys. Contact the Dow sales office or **THE DOW CHEMICAL COMPANY**, Midland, Michigan, Magnesium Sales Dept. 1310BC4-29.

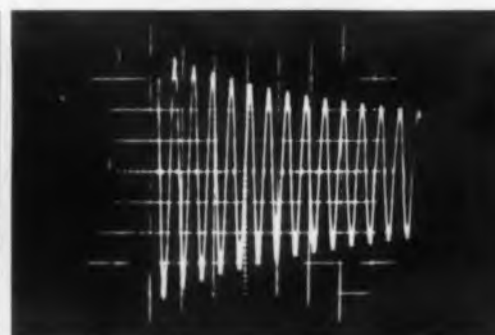
## NEW ALLOY DAMPS VIBRATIONS IN U.S. ARMY NIKE HERCULES

Dow announces a new lightweight magnesium alloy with superior damping capacity for electronic bases, housings.

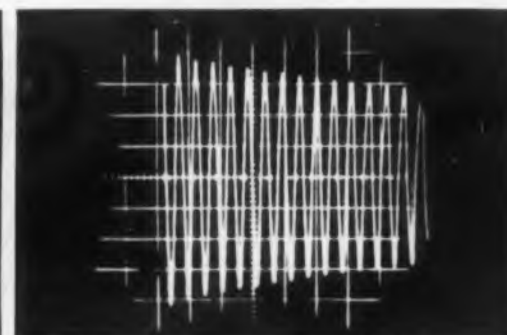
**K1A MAGNESIUM**



**AZ81A MAGNESIUM**



**355 ALUMINUM**



**OSCILLOSCOPE PATTERNS**, taken under identical test conditions, demonstrate high damping capacity of K1A compared to other magnesium and

aluminum alloys. The superiority of K1A is evidenced by rapid absorption of energy as shown by the sudden reduction in amplitude of the vibration.

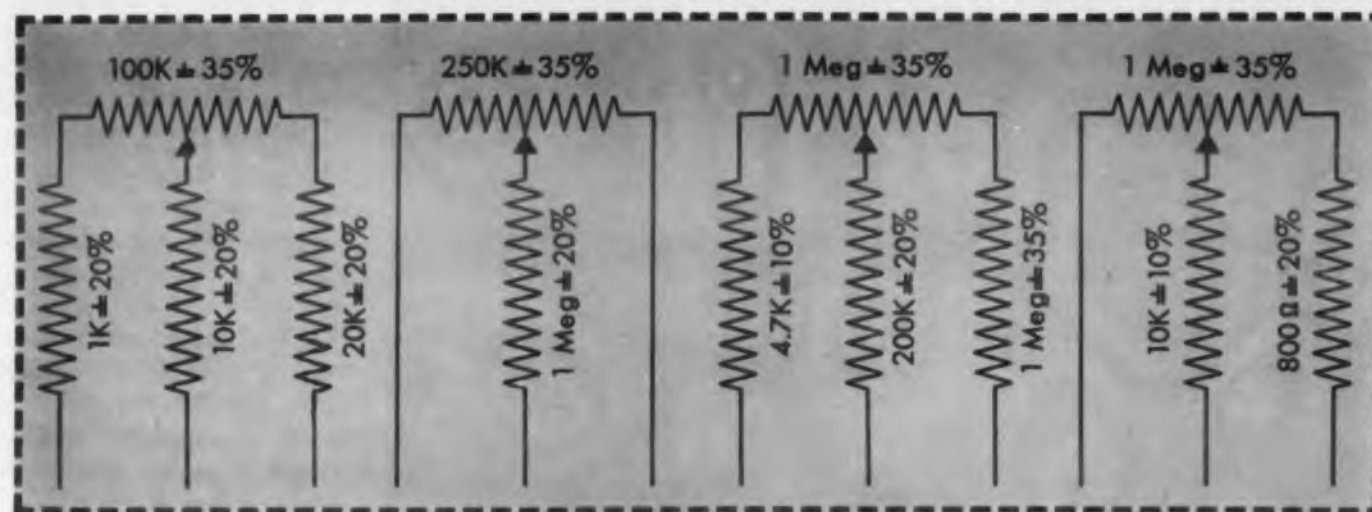
**THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN**

CIRCLE 35 ON READER-SERVICE CARD



## MICROELECTRONICS' PROGRESS

**Fig. 20.** Typical wafer-mounted flip-flop made by MF Electronics Inc. Pencil points to transistor leads. Generous allowance after bending puts more strain on the board rather than the leads. (Right)



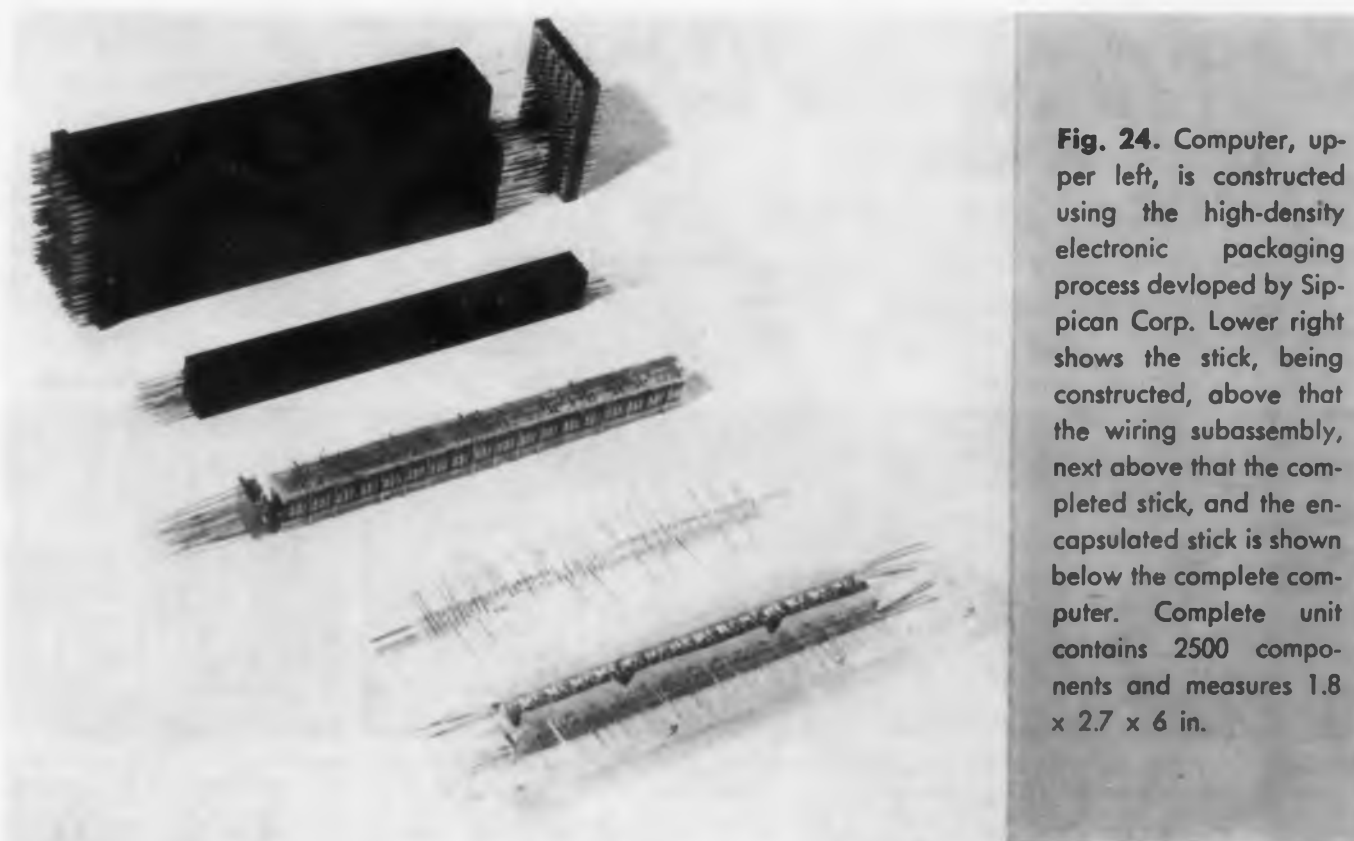
**Fig. 22.** Typical circuit for the variable-resistor assembly shown in Fig. 21.



**Fig. 21.** Miniature variable resistors. This Centralab plate is 2-1/4 in. long. Capacitors and fixed resistors may be screened on the other side.



**Fig. 23.** Centralab's four-stage transistor amplifier, below, compared to wafer-type assembly of the same circuit, top. Single stage amplifier made by layering techniques is at the right.



**Fig. 24.** Computer, upper left, is constructed using the high-density electronic packaging process developed by Sipican Corp. Lower right shows the stick, being constructed, above that the wiring subassembly, next above that the completed stick, and the encapsulated stick is shown below the complete computer. Complete unit contains 2500 components and measures 1.8 x 2.7 x 6 in.

Modules about the size of a postage stamp have been produced by M F Electronics Co. These units are in the form of flip-flops, multivibrators, oscillators and others. They are about 5/16-in. thick and have a components density up to 125,000 parts per cubic foot.

A typical flip-flop made by M F Electronics Co. (Fig. 20) shows on method for mounting transistors in tight places. Here the transistors have been inserted into the board through hole placed so that when the leads are bent, the strain will be taken by the board. This relieves the strain on the glass header and special bending tools are not required.

Centralab introduced the concept of packaged circuits in connection with military devices manufactured during World War II. Their basic philosophy of their approach has been to develop packaging methods of maximum flexibility that can be adapted to the specific requirements of a given product or circuit.

The objective on their standard PEC Couplates has been to design a package that is essentially

two dimensional, eliminating thickness as a dimension of the circuit. A thin ceramic plate with wiring, resistors, capacitors and other components, printed or screened on it, is the basic form. Many times, however, to achieve maximum component density and take advantage of the space available, custom built shapes are used. The plate also serves as a base for the attachment of other components, such as variable resistors, transistors, diodes, etc., that cannot readily be reduced to a two dimensional form.

A typical example of this technique is illustrated in the multiple miniature variable resistor shown in Fig. 21. In addition to the four variable resistors, as many as nine fixed resistors can be screened on the same ceramic plate. Fig. 22 is its schematic. Fixed capacitors, transistors and other components can be attached to the reverse side of the ceramic base plate and, where fewer variable resistors are required, the entire package can be made proportionally smaller.

In some applications, Centralab found that the two dimensional concept results in a package that requires a larger area than might be available in the equipment. Under these circumstances a layering technique (not to be confused with module construction), utilizing several ceramic plates, is used. Under certain circumstances this might result in a package of greater thickness, but of such a shape (Fig. 23) as to be better adapted to the available space. Here, the Centralab TA-11 unit contains a transistorized four stage amplifier constructed on a ceramic plate. This same four stage amplifier constructed by a layering technique is shown directly above the TA-11.

#### Packaging with Standard Parts

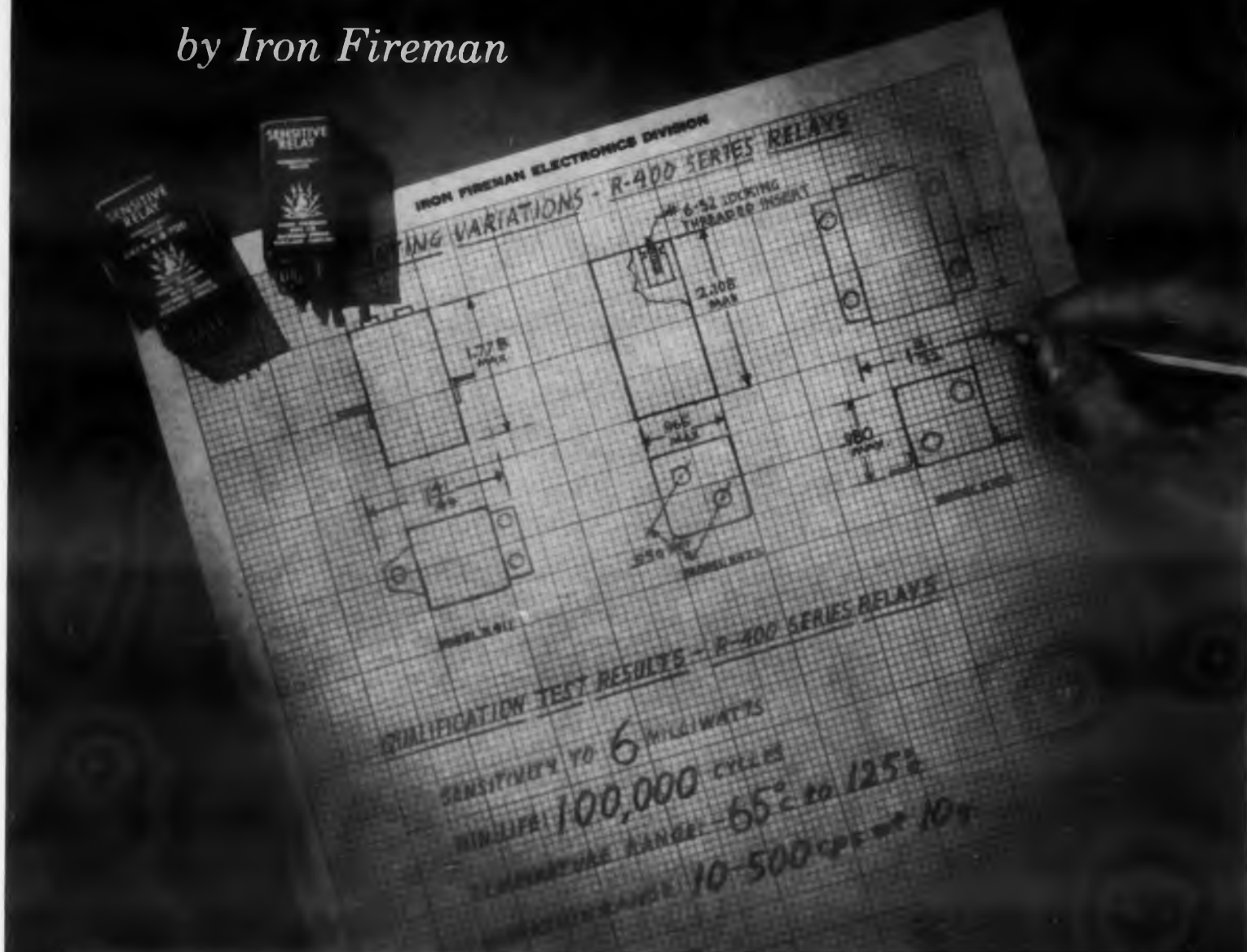
High Density Electronic Packaging is the name used by Sippican Corp. to describe their method of assembly. Their objective has been to develop an economic process for improving packaging density by more than one order of magnitude over the best density obtainable with printed circuit techniques. This has resulted in a series of developments in layout technique and positioning devices which use photographic processes.

Sippican uses spot welding for making most of the connections and have developed ways of achieving totally "hard" cabling systems which eliminate the "haywire" needed for conventional assemblies. They are using a variety of techniques for heat removal with considerable success.

High Density Electronic Packaging is complementary rather than competitive with both major Micro-Module programs. The standardized modules contemplated in the Signal Corps program will demand interconnections, and the module groups so developed will need cabling systems of one sort or another. High Density Electronic Packaging is a process involving a depth

# SENSITIVE RELAYS

by Iron Fireman



## Tested to and exceed MIL-R-5757C

These balanced armature relays meet or exceed rigid military specifications. They combine extreme sensitivities with rugged resistance to a wide range of shock, vibration and temperature.

Available in four header styles: dual 4 pin loop, 8 pin loop, standard octal socket and 9 pin plug-in for printed circuit applications,

these may be ordered in various combinations of resistance current and power.

As shown in the diagrams above, the R400 series is adaptable to a wide variety of mounting configurations for special applications. Specifications and performance data may be obtained by writing to the address below.



MICRO. MIN. RELAYS



HIGH SPEED RELAYS



SLIP RINGS & BRUSHES



FREE AND VERTICAL GYROS

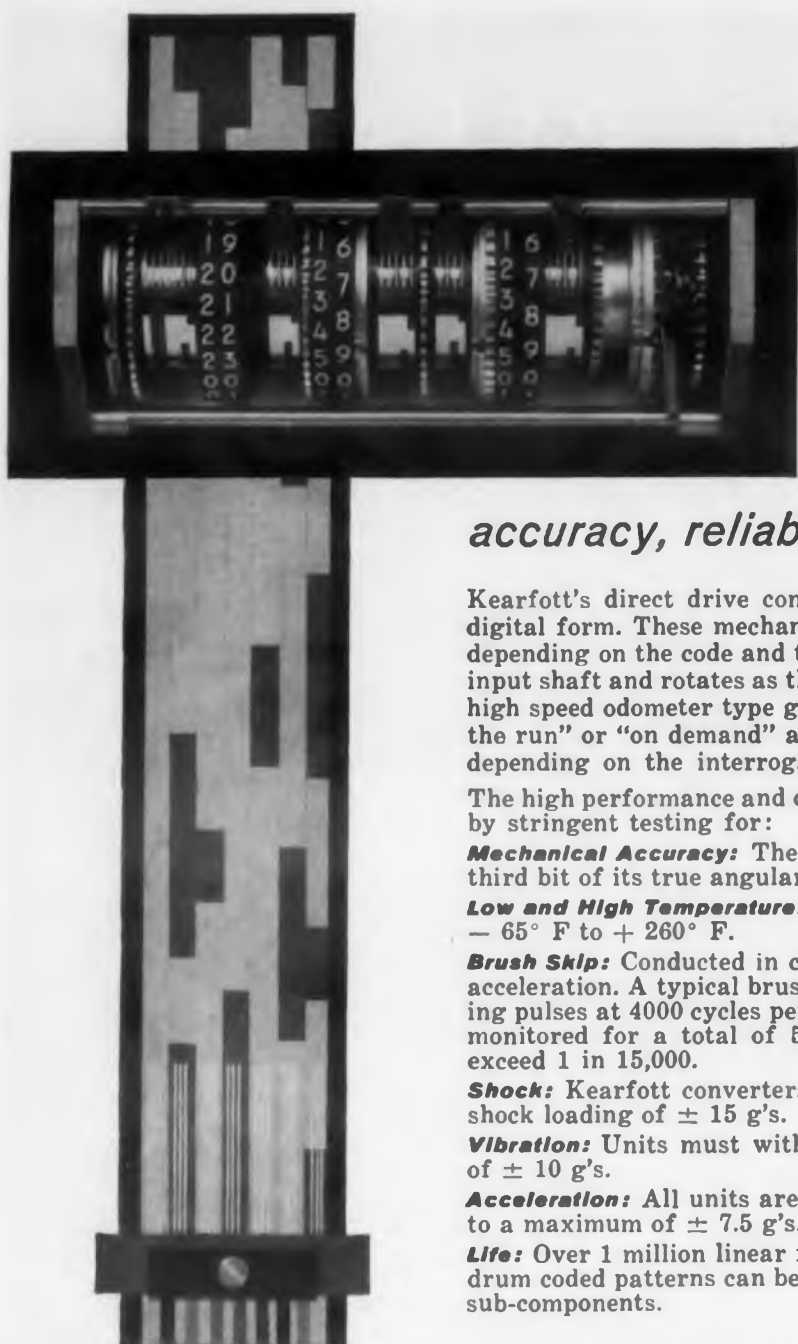


IRON FIREMAN *Electronics* DIVISION

2838 S. E. NINTH AVENUE, PORTLAND 2, OREGON

CIRCLE 36 ON READER-SERVICE CARD





## ... Kearfott analog-to-digital converters

*accuracy, reliability, varied capacities and codings*

Kearfott's direct drive converters translate shaft rotation into electrical and visual digital form. These mechanically positioned units consist of coded drums, the number depending on the code and total count. The first, or units drum, connects directly to the input shaft and rotates as the shaft turns. On models where more than one drum is used, high speed odometer type gearing provides interconnection. All models can be read "on the run" or "on demand" and all tracks may produce simultaneous or serial readings, depending on the interrogating pulse.

The high performance and quality of Kearfott's analog-to-digital converters are assured by stringent testing for:

**Mechanical Accuracy:** The location of any code transition point must fall within one-third bit of its true angular position.

**Low and High Temperature:** All units operate efficiently at temperatures ranging from  $-65^{\circ}\text{F}$  to  $+260^{\circ}\text{F}$ .

**Brush Skip:** Conducted in conjunction with tests for temperature, vibration, shock and acceleration. A typical brush skip test employs  $200\ \mu\text{sec.}$ ,  $23\text{V}$  DC amplitude interrogating pulses at 4000 cycles per second. With the shaft rotating, each output drum track is monitored for a total of 500,000 pulses, in which "lost" counts or "skips" will not exceed 1 in 15,000.

**Shock:** Kearfott converters are subjected to 18 shocks in three different planes with shock loading of  $\pm 15\text{ g's}$ .

**Vibration:** Units must withstand vibrations between 5 and 500 cps with applied load of  $\pm 10\text{ g's}$ .

**Acceleration:** All units are subjected to radial accelerations of varying magnitudes up to a maximum of  $\pm 7.5\text{ g's}$ .

**Life:** Over 1 million linear feet (1000 hours at 82 RPM) of continuous brush travel on drum coded patterns can be achieved without excessive wear to drums, brushes or other sub-components.

Write for new ADAC brochure.

### ANALOG-TO-DIGITAL CONVERTER CHARACTERISTICS

Kearfott Unit No. Code (1)	423830-1 B.D.	423607-1 B.D.	Y1241-11A B.D.	P1240-11A B.D.	Y1240-11A B.D.	U1240-11 B.D.	P1241-11A C.B. (Gray)
No. of Drums	1	1	2	3	3	4	5
Range	0 to 84 in 348.5° of arc. 11.5° dead spot coded 0	-19 to 0 to + 19	0 to 359	(+) 0 to (+) 999 (-) 999 to (-) 0	0 to 359.9	0 to 359.9	0-32,768 (2 <sup>15</sup> )
Bits per Revolution	85	39	40	20	40	40	16
Revolutions for Total Range	1	1	9	100	90	90	2,048
Volts D.C.	23	12	23	23	23	23	10.5
Current (ma.)	20	20	20	20	20	20	20
Inertia (gm. cm. <sup>2</sup> ) (2)	158	48	104	28	158	100	20
Unit Diameter (in.)	2 1/8	1 3/4	1 5/8	1 7/8	1 5/8	1.875	1 1/8
Unit Length (in.)	31/32	1 1/8	1-43/64	1 1/8	2 1/8	2.8125	3
Life (3)	10 <sup>6</sup> revolutions or 10 <sup>3</sup> hours						2 (break) 1 (running)
Static Torque (in.-oz.) (4)	0.5	0.1	1.0	.5	1.0	1.0	2 (break) 1 (running)
Weight (oz.)	5	3.5	5.75	4	7.75	6.5	5
Maximum Speed (RPM)	1100	250	300	400	300	700	600
Dielectric (Volts DC)	500	500	500	500	500	500	500

(1) B.D. (Binary Decimal), C.B. (Cyclic Binary).

(2) Inertia measured at maximum trip.

(3) Under recommended conditions.

(4) At room temperature.

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

**Kearfott**

A  
**GENERAL  
PRECISION  
COMPANY**

**KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.**

A subsidiary of General Precision Equipment Corporation  
Sales and Engineering Offices: 1500 Main Ave., Clifton, N. J.  
Midwest Office: 23 W. Calendar Ave., La Grange, Ill.  
South Central Office: 6211 Denton Drive, Dallas, Texas  
West Coast Office: 253 N. Vineland Avenue, Pasadena, Calif.

CIRCLE 37 ON READER-SERVICE CARD

## MICROELECTRONICS PROGRESS

of techniques, but two of its major features are a system for highly compact intramodular wiring and a number of techniques for "hard" inter-module cabling. These techniques, which are themselves in a state of rapid evolution, support the Micro-Module program.

High Density Electronic Packaging (Fig. 24) results in a density of well beyond one order magnitude improvement over printed circuit techniques, the typical 30x reduction in space being approximately 1.5 orders of magnitude. The density figure obtainable over a complete system with High Density Packaging, using currently available and well-proven components, runs in the region of  $1$  or  $2 \times 10^5$  components per cubic foot. Announced objectives of the micro-module program are considerably below this density level; 600,000 components per cubic foot being a figure which is often mentioned in relation to parts of systems, with 250,000 per cubic foot mentioned for complete systems.

### Variable Components

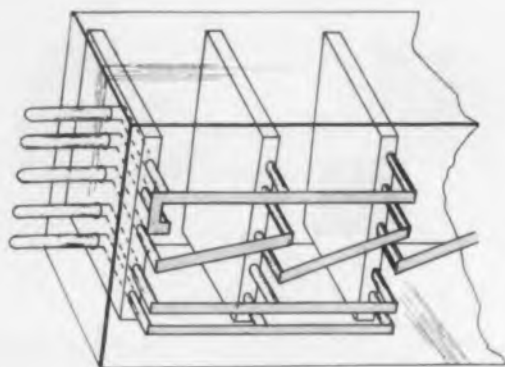
It is generally agreed that variable components should not be used. Variable capacitors are too bulky and may be replaced with a few smaller components. Electric tuning by means of Pacific Semiconductor's Varicap is one possible way to eliminate variable capacitors.

RCA and the Signal Corps eliminate the usual variable tuning of if transformers by using a deposited metal capacitor which is tuned by eating part of one electrode away with an abrasive spray. Thus, an if amplifier is tuned by "sanblasting" the capacitors until the right value is reached.

While rotating, or adjustable components can be made very small, the limiting factor is the size of the operator's hand or fingers that has to turn the knob. There is little problem when the adjustment is made by means of a screwdriver. But a continuously tunable radio receiver or a device requiring manual switching or operation of any kind cannot be made so small that the controls cannot be operated.

### Interconnection of Modules

Interconnection of microminiature devices is of great concern to everyone working in the field. Here reliability becomes a problem. More important is the fact that the connections between modules



**Fig. 25.** How a stack of DOFL's 2D wafers can be interconnected. Interconnection wires are deposited by copper reduction.

ules or components may become larger than the assembly itself.

Methods for connecting extremely small wafers having volumes of about 0.005 cu in. have been under investigation at Diamond Ordnance Fuze Labs. Their basic technique involves stacking the wafers so that all leads protrude from one side of the assembly (Fig. 25).

The assembly is then encapsulated and the side containing the leads is faces off to expose the cross-sections of the wires. These are the interconnecting points. Interconnecting these points was accomplished using chemically deposited copper or by printed silver wiring.

Finer connections were produced using the deposited metal method than with the screened silver method. In the latter method, ink flows through the stencil, resulting in wider lines than desired. It should be noted also that interconnecting lines have a finite resistance and must be taken into account in the circuit.

Interconnections of the Signal Corps Micro-Modules are made between the wafers by conductors placed in the groove cut into the edges. By properly positioning the wafers and locating component leads, an entire circuit can be wired using the 12 connecting wires.

To interconnect the modules, RCA and the Signal Corps are investigating the use of Flexprint, a flexible printed-wire cable made by Sanders Associates.

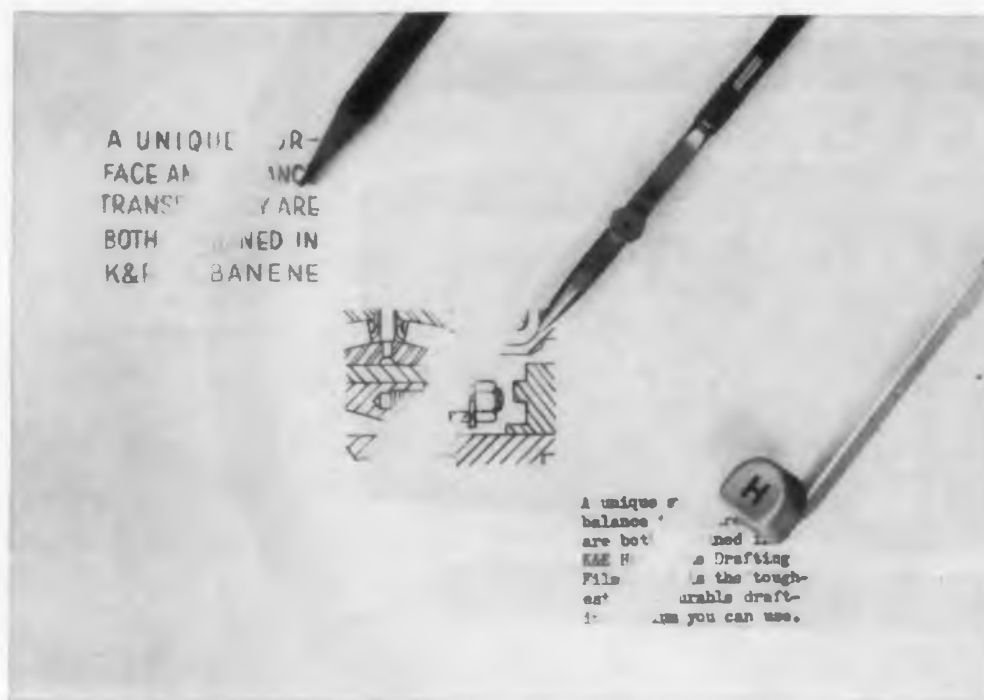
According to Sanders, a Flexprint wiring system provides a degree of space conservation proportional to that offered by the module itself, while affording the production uniformity characteristic of its photo-mechanical manufacturing process. Sanders' chief efforts have been directed toward increasing the density of interconnecting wiring within and between assemblies of both conventional and micro-size. The ultimate size of a functional cluster or train of modules depends to a great extent, they feel, on the physical characteristics of the wiring system used to interconnect its individual units.

(Continued on page 48)

## Some Ideas

for your file of practical information on drafting and reproduction from

KEUFFEL & ESSER CO.



Now you see it . . . now you don't. Pencil, ink and typing all register sharply, erase completely on the K&E "engineered surface."

### The K&E "Engineered Surface"

All K&E paper, cloth and film has one extremely individual characteristic. It's what K&E calls its "engineered surface" . . . a unique surface designed and applied by K&E, right in its own plant, to every roll and sheet of prepared tracing paper, cloth and film. It means controlled drafting qualities far beyond anything the base material alone can normally provide, with a surface tooth that's exactly right and uniform. Whatever's penciled, inked or typed onto it goes on crisply and sharply . . . shows up clearly and stays that way. Furthermore, the "engineered surface" lets you erase if you want to, easily and quickly and without any of those leftover ghost lines that drive you crazy when they show up in reproductions. And remember, only with K&E do you get all the advantages of an "engineered surface," no matter which paper, cloth or film you're interested in.

### About HERCULENE (TM) The Newest of Films

Frankly, we think K&E Herculene Drafting Film is a real discovery. It has all the properties of the K&E "engineered surface" . . . exceptional "take," adhesion and erasability . . . plus the toughness and durability of its Mylar® base. What's the latter? It's a polyester film, developed by DuPont, that's uncommonly strong and virtually indestructible . . . waterproof and almost immune to the effects of age, heat, ultraviolet exposure and handling. With our K&E "engineered surface" added, it becomes K&E Herculene Drafting Film . . .

the toughest, most durable drafting medium yet to reach the drafting room. And the surface will last indefinitely, without flaking off or chipping off.

### Some Points About Paper...

K&E Albanene® Tracing Paper is the largest selling tracing paper in the world today. Why? Because Albanene is the *only* prepared tracing paper which has an "engineered surface." All other brands depend for their pencil tooth solely on the natural surface texture of the paper itself, which varies from fine to coarse . . . often on the same sheet.

Albanene invariably gives you sharp, clear pencil lines, superb reproductions. It has a solid transparentizer that is chemically stable and can't leak out, ever. This permanent transparentizing means that you'll never get white, opaque spots, even from contact with drafting tape. Try the drafting tape test yourself.

### ... and its package

And now, all Albanene paper in rolls is packaged in the new square carton for better protection and easier storage. Your rolls stay neat and clean while in use, and the cartons will do double duty in helping you to store finished tracings. In fact, some companies are rearranging their filing systems by using Albanene cartons, which hold large numbers of rolled-up drawings and stack simply and neatly.

### Some Facts About Cloth

When you want cloth, think first of K&E Phoenix® Tracing Cloth. Besides the K&E "engineered surface" with the superb "take," adhesion and erasability for pencil, ink or typing, K&E Phoenix has all the advantages of a water-resistant, chemically-inert coating that won't soften even under high heat and won't discolor, become brittle or flake off the base. You can even clean both sides with a damp cloth, without worrying about moisture stains.

### And Some Tips On Erasing

All K&E drafting media give you excellent erasability, but there's a right way to erase on each one. On cloth and film, harsh, gritty erasers can destroy the surface. You'll get the best results with plastic erasers, such as the Richard Best "Tad" and the Eberhard Faber "Race Kleen." Moisten them for removing ink and stubborn typing; use them as they are for removing pencil lines. Large areas of ink can be removed completely without damage by using a moist cloth and Bon Ami cleanser. On Albanene, electric erasing machines are fine if used with a soft eraser.

### The Choice Is Up To You

When it comes to selecting K&E paper, cloth or film for the job at hand, we have to leave the choice to you. We're not being indecisive . . . it's just that you're the only one who knows the particular problem you have and which product solves it best. But remember . . . K&E has a *complete* line of paper, cloth and film . . . and only K&E puts a special "engineered surface" on all three media to provide a well-balanced, uniform surface suited to the base material.

KEUFFEL & ESSER CO., Dept. ED-4, Hoboken, N. J.

Please send me more information and samples on the following:

☐ K&E Herculene ☐ K&E Albanene ☐ K&E Phoenix

Name & Title \_\_\_\_\_

Company & Address \_\_\_\_\_

1277

CIRCLE 38 ON READER-SERVICE CARD





**JERROLD'S**

versatile new

## 900A Sweep Generator Covers The Range of Three Regular Instruments!

It's the most versatile Sweep Generator in the electronics industry... this one instrument covers all your needs from 1/2 MC to 1200 MCS, for IF's, radar, video, telemetering and communications!

**Specifications:** In two ranges—0.5 MC to 400 MC and 275 MC to 1200 MC—the instrument supplies a sweep signal with center at any frequency from 500 KC to 1000 MC and with sweep widths as broad as 400 MC and as narrow as 100 KC. The RF output—carefully monitored by matched, crystal diodes feeding a two-stage, push-pull AGC amplifier—is flat within  $\pm 0.5$  db at full sweep width up to 800 MCS and  $\pm 1.5$  db from 800 MCS to 1200 MCS. When using sweep widths as narrow as 20 MCS flatness at any center frequency is approximately  $\pm 0.15$  db.

**\$1260<sup>00</sup>**

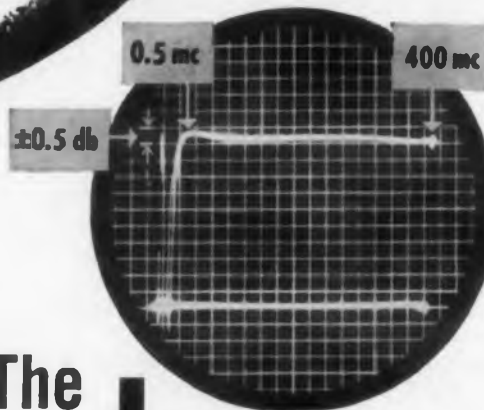
**MODEL 900A IS NOW IN QUANTITY PRODUCTION!**

Write today for on the spot demonstration of this versatile instrument!

**JERROLD**

**ELECTRONICS CORPORATION** Industrial Products Division

The Jerrold Building Dept. TED 31 Philadelphia 32, Pa.  
CIRCLE 39 ON READER-SERVICE CARD



### • HIGH OUTPUT!

.25 volt RMS on VHF—  
.5 volt RMS on UHF!

### • WIDE SWEEP WIDTHS!

From 100 KC up  
to 400 MCS!

### • FLAT OUTPUT!

Flat to  $\pm .5$  db on  
widest sweep width!



**MICROELECTRONICS<sup>®</sup>**  
**PROGRESS**

Bending radius is the most significant figure in terms of volume saving if the full potential of the micromodule concept is to be realized, and the amount of space occupied by each bend in the wiring system must be held to a minimum if the overall group is to be packaged in the most effective manner. Sanders' experiments indicate flexible printed wiring interconnection of two micromodules at a volume penalty of only 0.014-in. This is the thickness of copper conductor that can be bent back on itself while still providing adequate (0.0012-in.) insulation at the outside radius of the 180 deg bend. One form of flexible interconnection is shown in Fig. 26.

Sanders estimates a volume saving of 50 per cent achieved by making interconnections on a flat layer of flexible circuitry and post-forming the layer around a module grouping, Fig. 27, instead of making wire interconnections. The saving is 90 per cent compared with conventional printed circuit techniques at a standard center-to-center distance of 0.4-in.

Complex wiring harnesses have also been constructed using a new matrix-forming technique which permits feeder connections to be attached at any point along a main conductor by either spot welding or soldering, with complete insulation of the joint from both atmosphere and adjoining circuits. Investigations in the area of sonic welding indicate that this method of joining conductors is also capable of development, with the possibility of permitting further reductions in the size of both micromodules and interconnections.

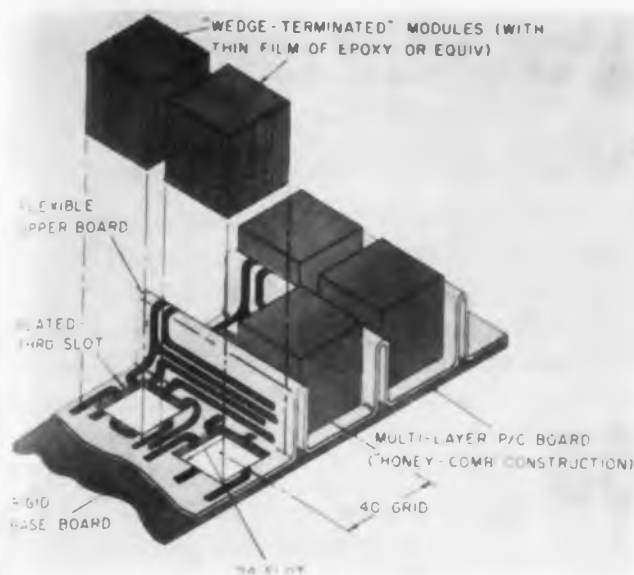
### Production

Saving space and weight is not the only advantage of microminiature devices. Since the parts are generally uniform, they lend themselves easily to automatic production methods.

Micro-Module wafers were designed with production in mind, and equipment has been de-



**Fig. 26.** Flexible printed wiring harness developed by Sanders Assoc. for interconnection of micro-modules.



**Fig. 27.** How Sander's Flexprint wiring can be formed to make the interconnections between modules.

signed for automatic assembly of the wafers. While this is preliminary equipment, the final phase of the program will involve the design and construction of prototype production machinery. All phases from production of the components, their assembly and their integration into equipment subassemblies is part of the program.

Diamond Ordnance Fuze Laboratories has conducted a survey of equipment now available or adaptable to production of these units. Their survey covers all types of circuit elements, discusses their properties as related to physical handling, and some equipment that might do the job.

### For the Future

Engineering samples of Micro-Modules will be available to the military for prototype development late this year. Copies of 17 types of components currently under development will be supplied to equipment manufacturers. They will familiarize themselves with a few working models. Status of the Signal Corps Micro-Module program will be detailed in the May 13th issue of *ELECTRONIC DESIGN* in an article by Vincent Kublin.

Circuit designers will have a major role in the future of microelectronics. Their job will be to design circuits to eliminate large volume components. Almost every branch of science will be involved in microminiaturization.

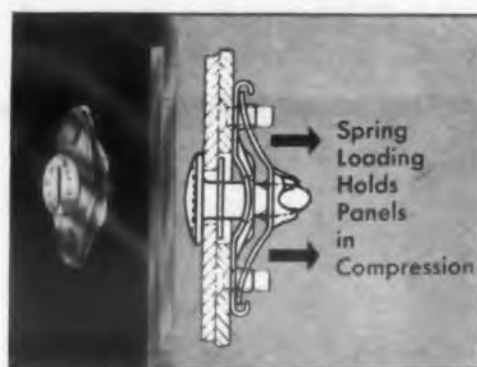
And the importance of the concept is well illustrated by a statement made recently by W. Walter Watts, Group Executive Vice President of RCA. He said, "At the risk of appearing brash, I want to make clear at the outset my belief that the revolution now taking place in materials, devices and techniques in what we call electronic components will reshape the entire electronics industry in the next few years." ■ ■

# Quick-Opening Fasteners

## Selecting Small Fastenings for Metal Closures

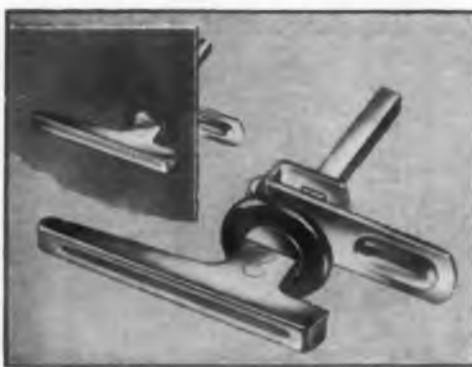
*"Use captive fasteners wherever feasible . . . Avoid the use of loose washers and loose nuts . . . Fasteners on equipment covers should be operable either with no tools or with standard hand tools"\**

(John D. Folley, Jr. & James W. Altman, Research Scientists, American Institute for Research)



### Quarter-Turn Fastener

Lion Fasteners open and close with a  $\frac{1}{4}$  turn, hold sheets tightly under the compression of a rugged spring. Quickly operated and fully retained in the outer panel, they are approved under U. S. Government military specifications. Stud and receptacle float for easy alignment and simplified hole preparation. Flush, oval, wing, knurled, ring, and key head styles available. Sizes—No. 2, No. 5, and High Strength for extra heavy duty.

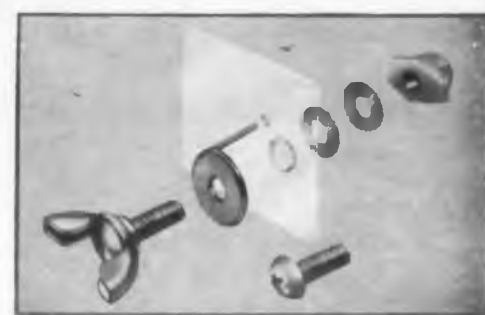


### Cabinet Latch

Just drill a hole, push the fastener stem through, and slide the special push-on

clip into place. No welds, screws, bolts or rivets; the fastener is permanently installed in seconds!

Adjustable to any grip length or panel thickness, the pawl is fixed in place by a single set screw. The fastener's brightly finished knob is set off by a plated washer. Also furnished with screwdriver operated flush head.



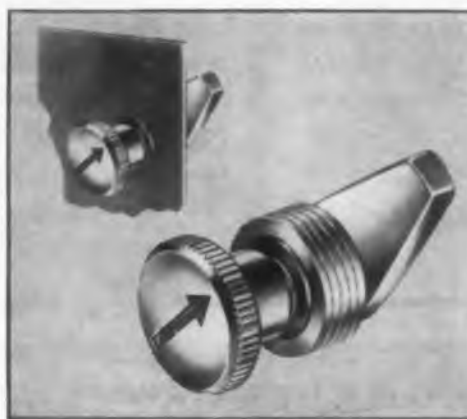
### Adjustable Panel Latch

Small doors and panels can be fastened with greatest speed and lowest cost with the Southco Adjustable Latch.

The entire fastener is quickly installed through two holes punched in the door; no bolts or rivets are needed.

It operates with a quarter turn, requires no striker plate. An extra twist after the nylon pawl is engaged pulls up the door to form a seal and eliminate vibration.

Available with wing, knurled, or Phillips head.



### Spring Tension Latch

For fastening slide-out drawers and hinged panels the Southco Arrowhead Latch is recommended. It locks or opens with a quarter turn yet occupies less than  $\frac{1}{2}$ " inside space.

Doors are held under spring tension—a push against the arrowhead knob relaxes this tension, allows operation with fingertip ease. Drill a single hole for installation—no fastening to the door is necessary. No striker plate is needed.

Pawl stop is eliminated—arrowhead shows at a glance exact position of pawl.



### Free Fastener Handbook

Send for your free copy of Fastener Handbook No. 9, just released. Gives complete engineering data on these and many other special fasteners. Forty-eight pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 235 Industrial Highway, Lester, Pa.



CIRCLE 40 ON READER-SERVICE CARD

\* Quotation from "Designing Electronic Equipment for Maintainability"; *Machine Design*, July 12, 1956.



# Random Reliability Notes

**D**ESPITE the plethora of papers written on Reliability In Electronics, the topic continues to provoke discussions and disputes. The final chapter on the subject has not been written, and there is still much talk on such related matters as cost and methods of achievement. That reliability is desirable is one of the few areas where agreement exists.

Explaining why unreliability exists, H. T. Hallowell, president of the Standard Pressed Steel Co., told the Franklin Institute recently that in satellites, in missiles and even in consumer appliances, performance criteria are being set on the basis of price in an attempt to save "pennies." He said that the consumer repair bill was 20 billion dollars annually.

More reasons behind unreliability: Equipment and part manufacturers compete with each other on the basis of design, price, delivery, and more recently, reliability or trouble-free operation. So explained R. F. Edwards in a paper called "The Reliability Game" at this year's IRE Convention.

"The control system in use by these groups is a democratic one that sets the punishment level for poor reliability at that of the manufacturer of the parts with the most marginal reliability.

"The solution is simply to alter the wording of the purchase contracts all down the line to reflect the true value of reliability. This will automatically change the structure of the organizations to those more suited to produce reliable products."

Failure Rate in a Typical Electronic System

Element	Population Density Ratio	Quantity Per System	Failure Rate Per 1,000,000 Hrs.	System Failure Rate 1,000,000 Hrs.	Failure Rate %
Tubes, Transistors	1	100	1	100	2.71
Connectors	1.01	101	.8	80.8	2.2
Diodes	1.1	110	4.5	495	13.4
Gyros	.01	1	50	50	1.35
Inductors	.02	2	2	4	.1
Motors	.03	3	50	150	4.06
Potentiometers	.26	26	40	1040	28.25
Relays	.15	15	25	375	10.23
Resistors (fixed)	4.4	440	1.4	616	16.76
Switches	.11	11	10	110	2.9
Transformers	.09	9	10	90	2.44
Choppers	.01	1	5	5	.13
Printed Ckt. Board	.2	20	1	20	.54
Soldered Connection	10	1000	.4	400	10.84
Capacitors	1.8	180	.84	151.2	4.09
				Total 3687.0	

This data was extracted from inherent reliability studies made at Autotechnics, Division of North American Aviation, Inc. In the typical system 3687 failures occurred during an operating period of one million hours. The Mean-Time-To-Failure, the reciprocal of the failure rate, is 271.2 hours. The data was in a paper presented by I. G. Rabbin at the recent EIA Conference on Reliable Electrical Connections.

ing pieces against our standard document." This letter cheering the merits of standardization came from C. H. Tuttle, Jr., of Vitramon, Inc.

#### Milspecs Reduce Costs Says One Reader

High reliability military specifications are not raising costs writes another one of our readers. "... Every large manufacturer of capacitors has made application for Q.P.L. testing under Mil-C-26244 (USAF). Within several months one of the largest capacitor companies was able to reduce prices approximately 25%." So says F. J. Ruther of Dayton, Ohio.

Mil-C-26244 specifies both a failure rate and limits on confidence numbers.

#### Milspecs Confuse Says Another

Speaking of Milspecs in general and mentioning Mil-C-26244 in particular, a representative of a capacitor company we recently interviewed said: "Milspecs sometimes hinder. In Mil-C-25, the bible, tab construction is called for. This is unreliable, compared to extended-foil construction, though somewhat smaller and cheaper. Mil-C-25 doesn't recognize today's high vibration requirements, calling for only 55 vps.

"Other specs attempt to supplement this spec. Mil-C-14157 and Mil-C-26244 are two of them. They create confusion and havoc in the field. To get a high reliability product, which 14157 and 26244 call for, we have to charge for the production process because more quality control is involved. But many companies demand high reliability and are unwilling to pay for it." He said that Mil-C-14157 and Mil-C-26244 should be combined and used as a universal spec because they are very similar.

And so the debate continues.

#### Computers Will Play Bigger Part

"Future military performance requirements may preclude important selections of alternate solutions to tradeoff problems by informal means," said D. Ehrenpreis at an IRE Long Island Chapter Meeting, speaking on Reliability. He is a consulting engineer serving the Countermeasures Division of the Sperry Gyroscope Co.

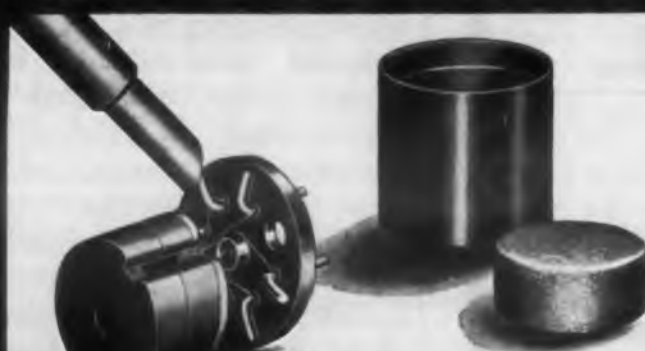
"Formal calculations with mathematical relationships will provide a more logical engineering-like approach to decision-making.

"It is predicted that one major aid in meeting the challenge of today for developing future military electronic equipment will be the greater use of high-speed digital computers.

"Organizations must become aware of the types of problems which lend themselves ideally to solution by analog or digital computers. The next step is to set up and arrange the analytical format for minimum computer programming and rental time." ■ ■

## New all-epoxy E-PAK<sup>®</sup> system drastically cuts encapsulation costs!

Assembly Time and  
Reject Rate Greatly Reduced



Soldering of leads is quick, simple, safe—never a cracked glass or broken seal because it's all epoxy. And with rugged epoxy covers, your lead wires can be made of any metal. No coefficient-of-expansion problem.

②

The E-Pak System consists of an all-epoxy header with embedded lead wires, a cured epoxy shell and a premetered epoxy pellet. The three may be custom-made for your component and are available from one source.

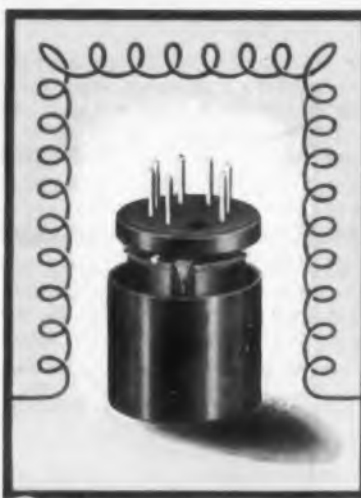


①



After the component is soldered to the epoxy header, a premetered pellet is dropped into the cured epoxy shell. The cover and component are then inserted into the shell.

③



The entire package is then heated; the pellet automatically melts and cures, embedding the component and sealing the cover. In cases where encapsulation is desired without embedment, a self-sealing epoxy cover is available.

④



You now have a solid, chemically-inert seal from within; there is no solder, no flux, no acid to endanger component reliability. Your component is hermetically sealed and embedded in cured epoxy forever.

⑤

Write today for complete information and samples.

# EPOXY PRODUCTS, INC.

A Division of Joseph Waldman & Sons

137 Coit Street, Irvington, New Jersey

ESsex 5-6000

CIRCLE 41 ON READER-SERVICE CARD



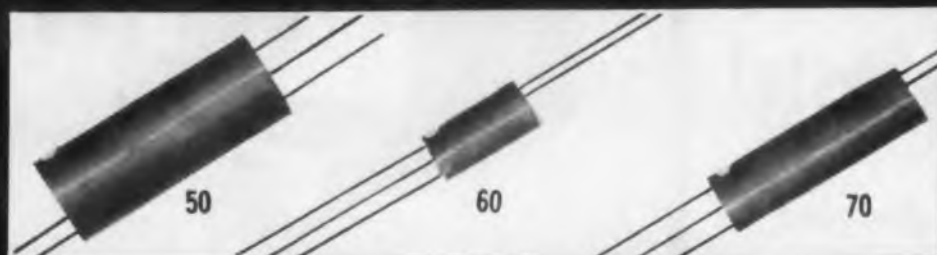
# TRANSISTORIZED CHOPPERS

MICROMINIATURE  
LIGHTWEIGHT  
NONMECHANICAL

INERTIALESS  
LOW POWER  
LOW LEVEL

STABLE  
RUGGED  
LONG LIFE

LINEAR  
HIGH SPEED  
HIGH EFFICIENCY



ACTUAL SIZE

Model: Type:	50 Germanium	60 Germanium	70 Silicon
Temperature Range:	-55° C. to +85° C	-55° C to +90° C	-55° C to +130° C
Sq. Wave Drive Volt.:	1 to 10v. p-p	1 to 15 v. p-p	5 to 20 v. p-p
DC Input Voltage:	to 12 v	to 15 v	to 20 v
Chopping Freq.:	DC to 100 kcps	DC to 100 kcps	DC to 200 kcps
Alpha Cutoff Freq.:	900 kilocycles	One megacycle	5 megacycles
Temperature Drift:	.04% per °C	.02% per °C	.03% per °C
Random Noise:	25uv rms	10uv rms	50uv rms
Weight:	3 grams	1 gram	2 grams

## DESCRIPTION

The transistor chopper (or modulator) is a solidly encapsulated unit designed to alternately connect and disconnect a load from a signal source. It may also be used as a demodulator to convert an a.c. signal to d.c. It is capable of linearly switching or chopping voltages over a wide dynamic range which extends down to a fraction of a millivolt and up to 10 volts. Unlike mechanical choppers which can only be designed to operate over a narrow and comparatively low frequency range due to mechanical limitations, this transistorized chopper is an inertialess device that can be driven from d.c. to hundreds of kilocycles.

The switching circuitry used operates the transistors in a manner which provides stability and freedom from drift over a wide temperature range. Only carefully selected transistors are utilized.

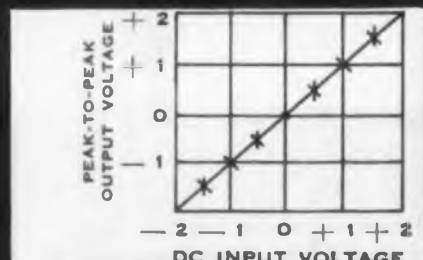
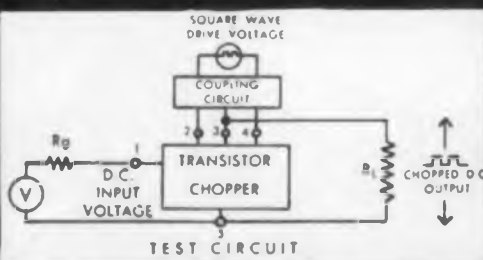
The noise figure of the transistor chopper is competitive with mechanical choppers for many uses. Furthermore, the noise level will not increase with usage.

This unit is practically immune to the effects of shock and vibration making it ideal for military, missile, and portable applications; or where power conservation, miniaturization and elimination or maintenance are a necessity. The transistor chopper has an inherently long life and is not subject to contact bounce, wear, pitting or burning.

## TYPICAL APPLICATIONS

Chopper (modulator).  
Demodulator.  
Low, medium level switching.  
D.C. amplifier stabilization.  
High speed servomechanisms.  
Replace less sensitive diode modulators.  
Thermocouple instrumentation.  
Low, medium level D.C. instruments.

Low level commutators for telemetering.  
Carrier for lower frequency signals.  
Digital meters.  
Portable equipment.  
Low power source equipment.  
Minimum maintenance equipment.  
Multiplex switching equipment.



# SOLID STATE ELECTRONICS CO.

8158 ORION AVE., VAN NUYS, CALIF. • ST. 2-6059

CIRCLE 42 ON READER-SERVICE CARD

## COMPONENT DESIGN DATA

# Design Data on Rechargeable Dry Cells

**N**ICKEL-CADMIUM sealed cells have achieved extremely high interest among design engineers in the past few months, with the advent of lines of standard dry-cell replacements. We review here some of the later developments in rechargeable dry cells.

Sealed nickel-cadmium batteries of French design, distributed and partly manufactured by Gulton Industries, Metuchen, N. J., cover a wide range of sizes, the most popular being a button cell and a D cell. Capacities range from 100 mah to 1750 mah.

D-Ac, a pressed powder type of nickel-cadmium battery from Germany has been marketed to some extent in the United States by Burdgett Battery Co., Freeport, Ill., and Gould National Batteries, Nicad Div., Easthampton, Mass.

Of entirely American manufacture, a very complete line of dry-cell replacements is being marketed by Sonotone Corp., Elmsford, N. Y. It includes the

1/3-C, 1/2-C, 1 x 0.225, 1 x 1/4, 1/4-D, D and F sizes, as well as the very popular "pencil light" AA size used in meters and portable test equipment. Employed in equipment drawing 360 ma, the Model S101 AA battery should last an hour before recharging; at 90 ma, about 4-1/2 hours; at 20 ma, some 21 hours. Discharge curves for the Sonotone Model S103 D Cell are shown in Fig. 1. This battery is designed to replace the D-size dry cell. Note the relative flatness of the curves. During continuous use until discharge, little deterioration of performance is observed in equipment using the battery.

An outgrowth of work in reliable space platform batteries, the rechargeable sealed sintered-plate Ni-Cd cells are claimed to last "for the life of the product" in which they are used. Life tests to 10,000 cycles have been made, and 20,000 cycles without deterioration is hoped for.

Any of the batteries can be stored without deterioration at temperatures of -65 to 160 F. A standard recharging will bring the cell back to full operating charge. A cell will maintain a usable charge for six months without recharging.

Sealed sintered-plate construction, claims Sonotone, is the key to the batteries' long life.

Each cell is made up of plates which have a foundation of nickel wire mesh. Sintered to the mesh is a carbonyl nickel powder which forms a porous surface, giving a larger area than would be possible using a flat plate.

Nickel oxide is the active material in the positive plate, cadmium in the negative. The electrolyte is a 30 per cent by weight solution of potassium hydroxide in distilled water. The entire construction is sealed.

The low internal resistance of the sintered plates allows a high discharge rate—limited only by the short circuit peak. Pulse discharges as high as 40 times capacity are possible.

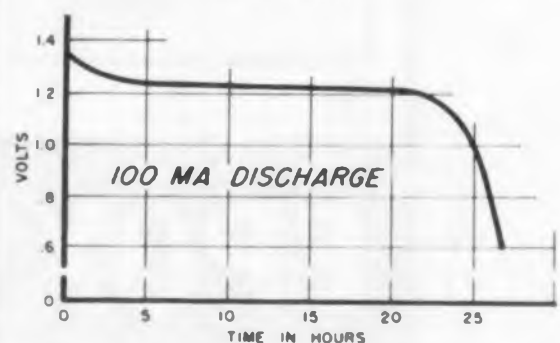
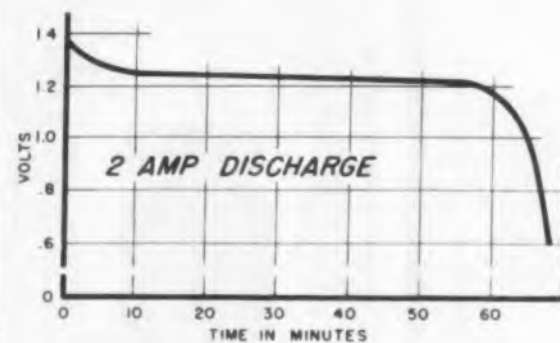


Fig. 1. Typical discharge curves showing constant current output.

# CUT COSTS OF TEST EQUIPMENT BY 20% WITH Technical Information Service

Case histories have shown that companies waste up to 20% of their annual expenditures for test equipment.

A prime cause is the failure to make the best buy obtainable because each company did not know the full range of available equipment. Collecting and maintaining complete, timely, and accurate product information is difficult—could cost as much as \$25,000 a year to service—and yet could be incomplete and inaccurate.

A prodigious number of crucial engineering and purchasing man-hours are squandered in test equipment procurement. Tracking down sources of supply takes days and, often, weeks. Key personnel are trapped by protracted correspondence and sales interviews while obtaining full specifications and prices. When modifications are involved, workloads increase geometrically. This costly routine must be repeated every time new purchases are made.

*Now, for the first time, you can plug these hidden profit leaks through the use of a completely new concept in instrument evaluation for procurement.*

Technical Information Service (TIS) provides you with complete, timely product information about all available electronic test equipment. In a matter of minutes you can possess detailed descriptions of equipment produced by every manufacturer in the business, from the largest to the smallest, without bias in favor of either. What's more, the descriptions include the full specifications, price, and the names and addresses of local sales representatives—all you need to initiate procurement.

Consider the benefits enjoyed by clients of Technical Information Service.

## SINGLE SOURCE OF SUPPLY INFORMATION

Clients have the only central source of supply information designed specifically for their electronic test equipment requirements. Completely categorized, up-to-the-minute information makes the user a technical expert capable of quickly evaluating complete spec-by-spec comparisons of competitive equipment. Since TIS maintains accurate files by constant check of all sources for additions and changes in specifications and prices, clients may make inquiry by phone or letter on any test instrument problem at any time.

With such information at their fingertips, clients can make their purchases with total awareness of what the market has to offer. Procurement is made with minimal demands on key personnel and their time. Many clients find that this accelerated purchasing procedure has earned an extra bonus in expediting tight-schedule projects for which the test equipment is needed.

## COMPLETE, ACCURATE INFORMATION

Clients receive detailed data on more than 4,500 separate instruments manufactured by some 400 different companies. Constant review of the entire instrument field by graduate engineers keeps data on specifications, prices, and models up to date at all times.



VOL. I—Sources • VOL. II—Modifiers • VOL. III—Scalars  
VOL. IV—Index of Manufacturers and Representatives



Suppliers are queried on incomplete or dubious information, if necessary, before their products are included in any TIS release.

Since all products are described without charge and without advertising claims, small and large manufacturers are on equal footing. Their instruments speak for themselves with bald facts, free of slanted claims or persuasive case histories. Clients make their own evaluations from complete, factual information.

## SUPPLIER RESEARCH SERVICE LOCATES "CUSTOM" INSTRUMENTS

Often, seemingly built-to-order requirements can be satisfied by minor modification to standard instruments. The complete listing of all large and small manufacturers of stock items provides a ready reference for such inquiry, either directly by the client or through the efforts of TIS.

In those cases where unique equipment is a necessity, TIS Supplier Research surveys the market for the client, collecting all the pertinent information he requires to initiate serious negotiations with suppliers.

## COMPLETE PRIVACY

Whether TIS is locating sources for unique requirements or providing information on standard equipment, clients maintain a cloaked identity during all stages of inquiry. The Client conducts negotiations with the suppliers in whom he is interested.

## FOUR-VOLUME DIRECTORY

Clients of the tax-deductible Technical Information Service receive a free, four-volume, handsomely bound encyclopedia of standard equipment and sources published twice a year and supplemented constantly. Three volumes are devoted to descriptions of equipment. The fourth volume is an extensive cross-index of manufacturers and their representatives. Completely free of advertising, the directories give clients a complete, factual picture of all standard electronic test instruments. Clients of Technical Information Service receive both the Directories and Supplier Research Service.

## PROVEN IN USE

For the past two years TIS has served such clients as General Electric, M.I.T., Lincoln Labs., General Motors, NASA, Litton Industries, Naval Ordnance Lab., Hewlett-Packard, Lockheed Aircraft, Western Electric, RCA, Marconi Instruments, Eglin AFB, American Bosch Arma, and hundreds of others. The merit of TIS is proven by the fact that many clients have contracted additional service for other departments and projects.

## FREE BROCHURE GIVES KEY TO SAVINGS

One subscriber saved more than three times the cost of TIS within a week! You will have the key to how it was done when you go through the TIS brochure which tells all . . . shows how TIS reduces even the hidden, seldom-counted costs of the old-fashioned way of instrument procurement. Send for your copy of this FREE brochure today. No obligation. Use the convenient coupon below.

## Technical Information Corporation

41 Union Square, New York 3, New York, WAtkins 4-2111

I am interested in knowing more about Technical Information Service. Please send me your free brochure immediately, at no obligation.

NAME \_\_\_\_\_ TITLE \_\_\_\_\_

DEPARTMENT \_\_\_\_\_ COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

CIRCLE 43 ON READER-SERVICE CARD

Fig. 2. Sonotone rechargeable battery has built in charger.

Sealed Ni-Cd cells can be discharged over a temperature range of  $-40$  to  $160$  F. At  $-40$  F the cell delivers 50 to 70 per cent of the room temperature capacity, while at  $125$  F it delivers from 80 to 95 per cent.

So far the only battery package containing a built-in charger is the flashlight cell of Fig. 2. It is the size of two end-to-end D cells. Per-cycle use in a flashlight is about two continuous hours. To recharge, the top is unscrewed and the cell is plugged into a standard 110 vac wall receptacle. A built-in transformer steps down the voltage; and a silicon diode rectifies it. Optimum charging rate is 16 hours—at this rate the cell can be left plugged in for months without any damage. It will last at least 10,000 charging cycles.

Cost of the flashlight battery is on the order of \$5.00 for small orders, less than half that for large orders. For batteries without the internal charging mechanism, an inexpensive charger can be purchased from Sonotone.

For further information on these rechargeable sealed sintered-plate Ni-Cd cells, turn to the Reader's-Service card and circle 103.



# NEW PRODUCTS

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



## MULTI-WIRE FABRIC

Depending on the diameter of the wires used, this flat belt of interwoven copper wires can pass through a clearing of less than 1/32 in. high. The teflon-coated wires are run side by side in perfect alignment. These are woven together by cross threads of nylon, fiber glass or teflon yarn. Wires are of different colors to provide immediate identification for each individual wire from either end. Designed for aircraft or missile applications, the wire fabric can be made any width, the number of wires per inch being determined by the diameter of the coated wire used.

The Fletcher Works, Inc., Dept. ED, Philadelphia, Pa.

CIRCLE 44 ON READER-SERVICE CARD

## ROTARY SWITCH

Any wafer of this rotary switch lifts out instantly without unsoldering or disassembling for fast, easy cleaning or instant replacement. Switches are available in sizes approximately 2 x 2 in., 3 x 3 in., and 4 x 4 in. with lengths to accommodate up to 36 wafers. There is an almost unlimited choice of switch circuit configurations. All connections are to a single bank of receptacles and are accessible from one side of the aluminum housing. Contacts are silver, gold or rhodium plated on a copper base.

Chicago Dynamic Industries, Inc., Precision Products Div., Dept. ED, 1725 Diversey Blvd., Chicago 14, Ill.

CIRCLE 45 ON READER-SERVICE CARD



## CIRCUIT PACKAGES

These circuit packages can be used to simplify equipment assembly, reduce production errors, and increase reliability. They contain semiconductor devices and other components connected to provide the desired circuit. Many different types of circuit packages are available, including: bridge rectifiers; phase comparators; diode switches; amplifiers; and flip-flops. The final assembly is light weight and free from atmospheric effects.

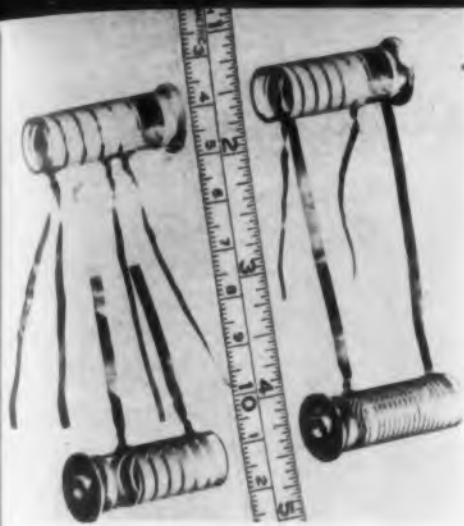
Raytheon Mfg. Co., Semiconductor Div., Dept. ED, 215 First Ave., Needham Heights 94, Mass.

CIRCLE 46 ON READER-SERVICE CARD

# Creative Microwave Technology

Published by Microwave and Power Tube Division, Raytheon Manufacturing Company, Waltham 54, Mass., Vol. 1, No. 4

## NEW KILO-LINE RECORDING STORAGE TUBES SPECIALLY DESIGNED FOR SCAN CONVERSION



### INDUCTORS

These metallized glass inductors are designed for tuned circuit applications at frequencies above 30 mc. Operating temperature range: from  $-55$  to  $+125$  C. The temperature coefficient ranges from 8 to 16 ppm per deg C for an inductor without cores or tuning devices. Inductance values for the standard units range from 0.05 to 0.1  $\mu$ h in increments of 0.01  $\mu$ h, and from 0.1 to 1.3  $\mu$ h in increments of approximately 0.1  $\mu$ h.

Corning Glass Works, Electronic Components Dept., Dept. ED, Bradford, Pa.

CIRCLE 47 ON READER-SERVICE CARD



### MAGNETIC AMPLIFIER

Engineered to perform as an AND, OR or NOT gate, or as a bi-stable memory device, this magnetic amplifier has all-static construction. Called the PMC-785 logic type magnetic amplifier, the unit is made primarily for missile control and checkout applications. It operates from a 70 v center-tapped transformer on a 115 v line at 400 cps, has a 2.5 msec response, and accepts a minimum input signal of only 3 mw.

Pacific Magnetic Corp., Electronic Center, Dept. ED, Romoland, Calif.

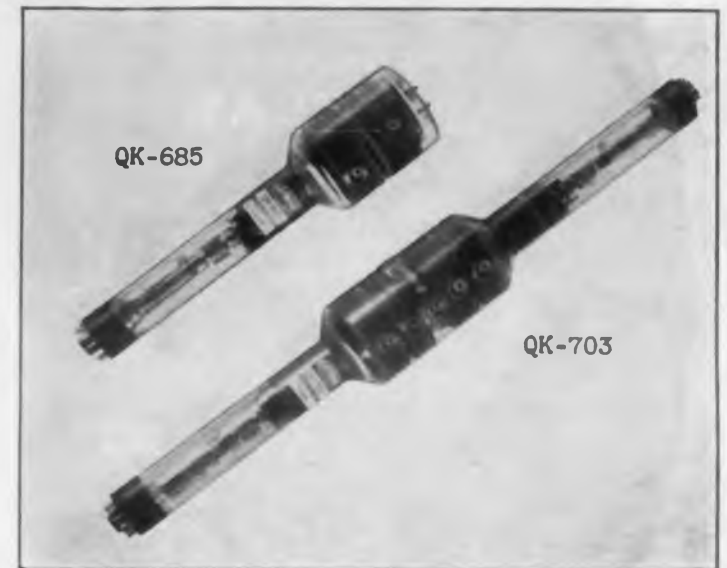
CIRCLE 48 ON READER-SERVICE CARD

CIRCLE 49 ON READER-SERVICE CARD ➤

To meet the need for low-noise, high-resolution devices for frequency and scan conversion, Raytheon scientists and engineers have developed two new storage tubes: the single-gun QK-685 and the dual-gun QK-703. These tubes are now available in production quantities.

Both types incorporate a specially designed tetrode electron gun for higher resolutions — 1,000 TV lines at 50% modulation — and better control over beam cut-off than conventional triode guns. A new multiple collimating lens improves background uniformity and results in shading-to-signal ratios of less than 10%.

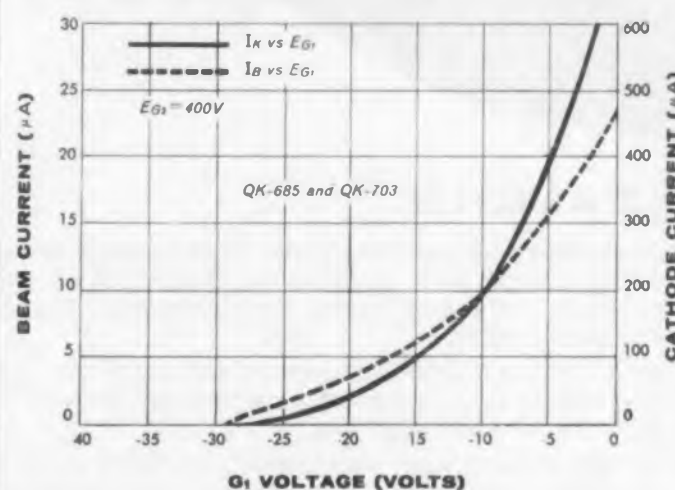
The ability of the dual-gun type to read and write simultaneously makes this tube particularly applicable to slow-down video and conversion from PPI to TV scan patterns for "Bright Display."



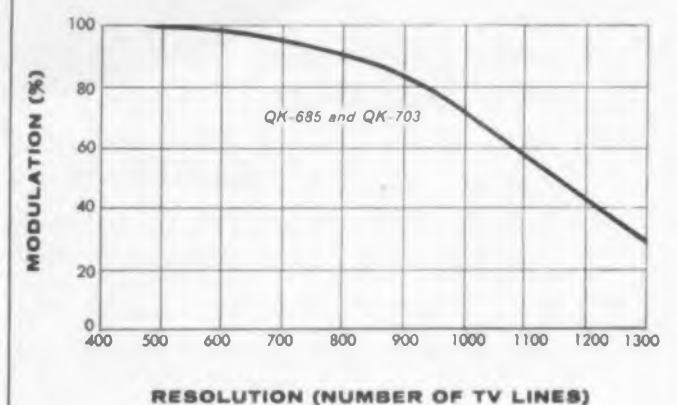
### Typical Operating Characteristics

	QK-685 and QK-703
Anode Voltage	4,000 Vdc (Max.)
Resolving Power	1,000 Lines (Nom.)
Magnetic Focus	700 Lines (Nom.)
Electrostatic Focus	QK-685—10 $\mu$ f (Nom.)
Output Capacitance	QK-703—20 $\mu$ f (Nom.)
Maximum Deflection Angle	30°

### GRID TRANSFER CHARACTERISTICS



### TYPICAL RESOLUTION CURVE



Excellence in Electronics



You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Manufacturing Company, Waltham 54, Massachusetts

A LEADER IN CREATIVE MICROWAVE TECHNOLOGY



FIRST  
IN  
CLASS

## GAR-3 *Super* FALCON

Playing follow-the-leader at 50 millisecond intervals, three *Super* Falcon missiles rocket ahead of their diamond-shaped supersonic shock waves. Homing in on radar, these deadly air-to-air missiles locate, track, and destroy their prey, with the same killer instinct of the birds they're named after.

Hughes Aircraft, the developer and manufacturer of these missiles and the Armament Control System that triggers them, specified Hitemp magnet and Teflon\* wire for their missile, and Teflon wire for its control system.

Hitemp Wires, Inc., the leading specialist in high temperature insulated wires and cables, proudly answers roll call with those developers and manufacturers enlisted in defending our American birthright—*Freedom*.

## HITEMP WIRES, INC.

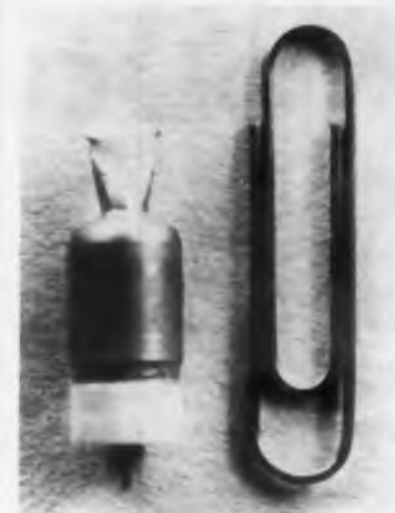
1200 SHAMES DRIVE, WESTBURY, NEW YORK

\*Registered trademark for Du Pont fluorocarbon resins.

CIRCLE 50 ON READER-SERVICE CARD



## NEW PRODUCTS



### Voltage Regulator Tubes

Provide 1%  
regulation

These metal ceramic, corona discharge voltage regulator tubes cover a range from 400 to 4000 v. Regulation is better than 1% from  $10^{-11}$  to  $10^{-12}$  amp, and the prebreakdown current is less than  $10^{-12}$  amp at room temperature. The units are resistant to shock and vibration and operate from  $-55$  to  $+200$  C. Overall length is under 1 in. and OD is 0.3 in.

Radiation Research Corp., Dept. ED, 1114 First Ave., New York 21, N.Y.

CIRCLE 51 ON READER-SERVICE CARD

### Frequency Counter

Limit indicating



Frequency meter model 7153 indicates whether metered frequency is below, within, or above two selected limits by lighting one of three panel lamps. Relay contact closures, occurring at the same time the panel lamps are lit, may be used to actuate audible alarms or to control the source of the input frequency. The unit has a range of dc to 100 kc and a sensitivity of 0.1 v rms into 10 meg.

Beckman Instruments, Inc., Berkeley Div., Dept. ED, 2200 Wright Ave., Richmond 3, Calif.

CIRCLE 52 ON READER-SERVICE CARD

This is the time of our annual subscription renewal.

ELECTRONIC DESIGN • April 29, 1959

## Rotary Positioning Controls

For loads to 200 in.-lb



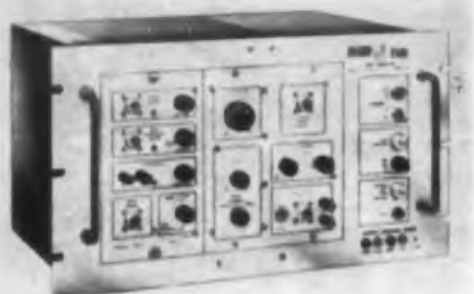
Loads from inch ounces to 200 in.-lb can be positively and accurately held in an infinite number of positions for clockwise or counterclockwise rotation by these rotary positioning controls. Diameters are 3/4 and 1-1/4 in. with a depth of 5/16 in., and 1-3/4 in. with a depth of 5/8 in. The 3/4 in. model is rated for loads to 50 in.-oz, the 1-1/4 in. for loads to 50 in.-lb, and the 1-3/4 in. for loads to 200 in.-lb. Designed for applications as no-back devices, valve and potentiometer positioners, dial controls, clutches, and couplings, the units have zero backlash, low breakaway torques, and rotating speeds to 3800 rpm.

Reid Controls, Reid Metal Products, Inc., Dept. ED, 2021 N. Lincoln St., Burbank, Calif.

CIRCLE 53 ON READER-SERVICE CARD

## Pulse Generator

Uses plug-in adaptors



Model MPG-4A pulse generator is designed to solve a variety of pulse problems with a series of plug-in trigger generators. The pulses it generates are readily adaptable to the measurement of magnetic material saturation properties, circuit step function response, precise time delays, and other factors. The plug-in trigger generators permit the separation of trigger and pulse forming circuitry, making available a variety of triggering modes for specialized needs. Any pulse width from 0.3 to 200  $\mu$ sec may be obtained, and any pulse amplitude from 10 to 175 v may be achieved in a 93 ohm resistive load. Rise time is 0.02  $\mu$ sec, decay time is 0.08  $\mu$ sec, and pulse top is flat within 5% of total amplitude.

PCA Electronics, Inc., Dept. ED, 16799 Schoenborn St., Sepulveda, Calif.

CIRCLE 54 ON READER-SERVICE CARD

# ESC advances the art of delay lines ...

*by design!*



# 145 to 1

## delay time / rise time ratio

At one time the 145 to 1 delay time/rise time ratio of ESC's Model 51-43 was considered impossible—today this unit is revolutionizing delay line applications and providing greater design freedom for America's electronics industry. Such advances in the art of delay lines could come from only ESC—America's leading manufacturer devoted to the design, development and production of custom-built and stock delay lines.



# ESC

**CORPORATION**

WRITE TODAY FOR COMPLETE TECHNICAL DATA.

*exceptional employment opportunities for engineers experienced in computer components...excellent profit-sharing plan.*

534 Bergen Boulevard, Palisades Park, New Jersey

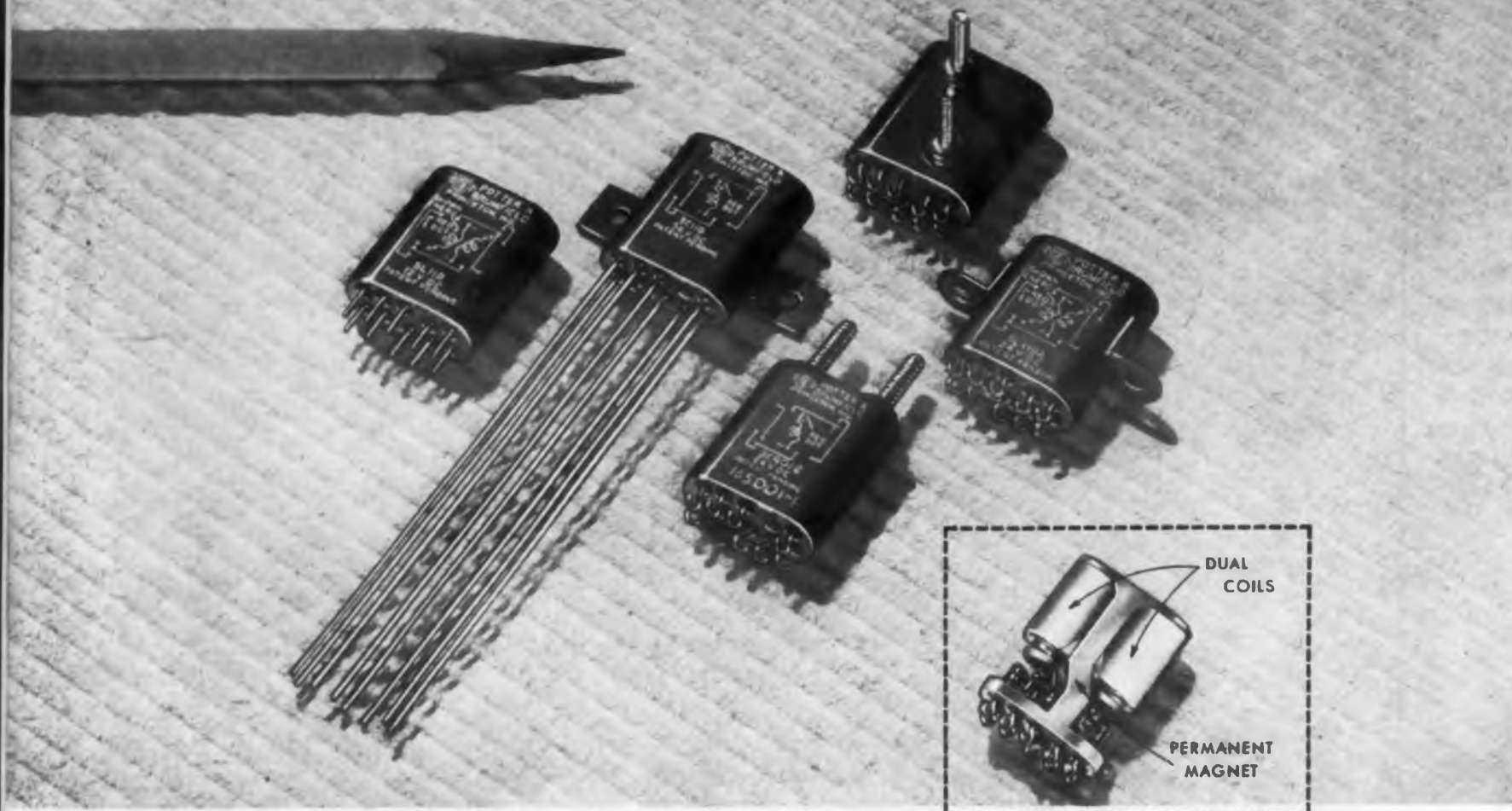
Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines • Shift registers • Pulse transformers • Medium and low-power transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

CIRCLE 55 ON READER-SERVICE CARD



# P&B MICRO-MINIATURE RELAYS LEAD IN performance

**SHOCK: 100g\* VIBRATION: 30g to 2000 cps\***

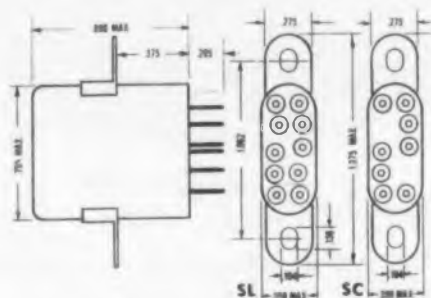


**\*NO CONTACT OPENING**

New P&B crystal-case size relays, the SC and the SL (magnetic latching), show amazing shock and vibration capabilities. They absorb shocks of 100g and vibrations 30g to 2000 cps. without contact openings!

A highly efficient magnetic structure utilizing a permanent magnet makes possible at least twice the contact pressure found in DPDT relays of comparable size. One watt of power for three milliseconds operates either relay. Transfer time is unusually fast—0.5 milliseconds maximum.

For more information, contact your P&B sales engineer, or write Potter & Brumfield, Princeton, Indiana.



**SL**—dual coil latching relay. Operates on a 1 watt, 3 ms. pulse at nominal voltage. Permanent magnet latch locks the armature in either position.  
**SC**—non-latching relay with series-connected dual coils. Operates on approximately 1 watt at nominal voltage. Coils must remain energized to hold the armature in the operate position.

#### SC and SL Series Engineering Data

##### GENERAL:

Insulation Resistance: 10,000 megohms, min.  
Breakdown Voltage: 1,000 V. RMS.  
Shock: 100g.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

Vibration: 30g 55 to 2000 cps.; 0.195" max. excursions from 10-55 cps.  
Temperature Range:  $-65^{\circ}\text{C.}$  to  $+125^{\circ}\text{C.}$   
Weight: 15 grams without mounting bracket.  
Operate Time: 3 MS. max. with 550 ohm coil @ 24 V. DC. (SL: 630 ohm coil at 24 V. DC).  
Transfer Time: 0.5 MS max.  
Terminals: (1) Plug-in for microminiature receptacle of printed circuit board.  
(2) Hook end solder for 2 #24 AWG wires.  
(3) 3" flexible leads.

Enclosure: Hermetically sealed.

##### CONTACTS:

Arrangement: 2 Form C.

Material: Optional

Load: 2 amps. @ 28 V. DC, resistive; 1 amp @ 115 V. 60 cycles AC, resistive.

Pressure: SC—16 grams min.; SL—20 grams min.

##### COIL:

Power: Approx. 1.0 watt at Nominal Voltage.

Resistance: SL—40 to 10,000 ohms; SC—35 to 20,000 ohms.

Duty: Continuous.

##### MOUNTINGS:

Bracket, stud and plug-in.

## NEW PRODUCTS

### Axial Blower

Delivers up to 169 cfm

This axial blower will deliver up to 169 cfm and can deliver 100 cfm against a static pressure of 3.5 in. of  $\text{H}_2\text{O}$ . It is powered by the company's type FC motor and operates at 115 v or 200 v ac, 400 cps, three phase. Power input at peak air volume is 120 w. The unit is 2-3/8 in. long and 2.812 in. in diameter with the 3-in. servo ring attached.

Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton 4, Ohio.

CIRCLE 109 ON READER-SERVICE CARD

### FM-FM Telemetry Transmitter

Meets IRIG requirements

Available in two models which cover 215 to 235 and 235 to 260 mc, the type 86600 fm-fm telemetry transmitter meets all IRIG requirements. Spurious and harmonic output are 60 db down from the carrier level and power output is 2 w minimum at a plate supply of 125 v dc,  $\pm 5\%$  at 130 ma. The carrier frequency adjusts to within  $\pm 0.001\%$  of the assigned frequency, and frequency stability is  $\pm 0.01\%$  from  $-25$  to  $+85^{\circ}\text{C.}$

Gilfillan Bros., Inc., Dept. ED, 1815 Venice Blvd., Los Angeles 6, Calif.

CIRCLE 110 ON READER-SERVICE CARD

### Flexible Printed Circuits

Single or multiple layers

These flexible printed circuits consist of etched copper patterns bonded between thin flexible sheets of plastic insulating materials such as Kel-F, Teflon, and epoxy. Available in single or multiple layers, the circuits are low cost, space and weight saving, and reliable.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

CIRCLE 111 ON READER-SERVICE CARD



# POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

CIRCLE 112 ON READER-SERVICE CARD



(above) Setting up a diffraction image for a research study in near-infrared optics

(left) Nation's first successful re-entry tests were conducted with the Lockheed X-17

(bottom right) Research and Development facility in the Stanford Industrial Park at Palo Alto, California, provides the latest in technical equipment



## RECONNAISSANCE

### EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Lockheed Missiles and Space activities in reconnaissance are among the most advanced in industry. They include such areas as radar, optics, infrared and TV. Work in the fields of radar and data link is concerned with research, design and development of systems and equipment for missile tracking, command guidance, detection and relay of information. Noise modulation techniques are under study as part of statistical communication theory and implementation of automatic space communication systems. Of special significance is the development of a radar firing error indicator that measures the intercept trajectory between target and attacking missile.

Solid state work in infrared embraces the development of new systems and sub-systems for long range infrared communications, surveillance, range findings and target tracking.

Considerable work is being conducted in optical devices and systems employing optics. Capability in this area also extends to scanners, encoders, detectors, read-out devices, and analytics of information processing.

Opportunities exist for engineers and scientists of inquiring mind to contribute to the solution of new problems in these fields. If you are experienced in physics, mathematics, chemistry, or one of the engineering sciences, we invite your inquiry. Write: Research and Development Staff, Dept. D3-21, 962 W. El Camino Real, Sunnyvale, California. U.S. Citizenship required.

*"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics,"*  
NATIONAL MISSILE INDUSTRY CONFERENCE AWARD

**Lockheed / MISSILES AND SPACE DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS,  
SANTA CRUZ, SANTA MARIA, CALIFORNIA  
CAPE CANAVERAL, FLORIDA  
ALAMOGORDO, NEW MEXICO • HAWAII

*Weapons Systems Manager for the Navy POLARIS FBM; DISCOVERER SATELLITE; Army KINGFISHER; Air Force Q-5 and X-7*





Unusual career opportunities for qualified scientists and engineers... write Avco/Crosley today.

**Avco** // **Crosley**

## ***From Crosley...*** **Command Receivers** **for Drones** **and Missiles**

**Designed** and manufactured by Avco's Crosley Division, Command Receivers are standard equipment aboard most of the nation's missiles. Their job: To receive and act upon instructions from the ground to destroy the missile when its flight path indicates the missile has gone awry.

**In a missile configuration**, the Command Receiver weighs only 12 pounds, has three channels and incorporates a decoder and power supply in a simple pressurized package.

**A second version** of the Command Receiver, employing 12 channels for radio communication, is used in high-performance drones and decoys. In such applications, the Command Receiver actuates control surfaces, directs engine operation and opens the recovery parachute—all by radio-conveyed instructions from the ground.

**A Product of Crosley Engineering**, the Command Receiver has proven itself for the future by the job it is doing in the missiles and drones of today.

*For more information, write to:*  
*Vice-President, Marketing-Defense Products,*  
*Dept. L-49, Crosley Division, Avco Corporation,*  
*1329 Arlington Street, Cincinnati 25, Ohio.*

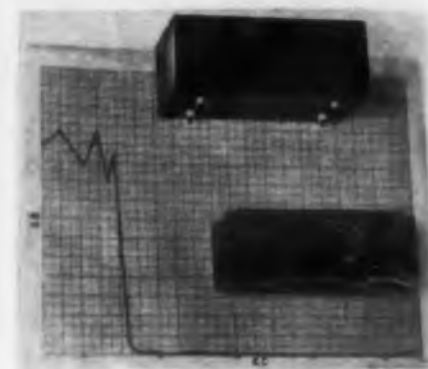


**Weighing only 12 pounds**, Crosley Command Receivers direct destruction of off-course missiles, control drone recovery.

## **NEW PRODUCTS**

### **SSB Crystal Filters**

**10 to 500 kc range**



Ranging from 10 to 500 kc, these SSB filters have high bandwidth ratios and good shape factors. With a carrier frequency of 85 kc, an upper side band unit has a 3 db bandwidth of 3.4 kc and an attenuation band over 40 db. A shape factor of 1.08 is obtained in the slope region. Using a more complex design, a 60 db attenuation can be achieved with a similar shape factor. Insertion loss is about 9 db. Dimensions of this unit are 5 x 2 x 2 in. Bandwidth ratios of better than 10% may be reached with side band crystal filters from 60 to 200 kc, and ratios of 2 to 3% are obtainable from 10 to 60 and 200 to 500 kc.

Bulova Watch Co., Electronic Div., Dept. ED, Woodside 77, N.Y.

**CIRCLE 60 ON READER-SERVICE CARD**

### **Precision Potentiometer**

**Watertight**

A 1/2 in. watertight potentiometer, the model APW 1/2 has a glass-to-metal solder sealed header and terminal lugs that are installed with a glass-to-metal seal and positioned for easy wiring. It has an O ring shaft seal per Mil-E-5272A specifications, and the terminal board is solder sealed to the case. Suited for high temperature use, the unit is available with mechanical rotation stops, special winding angles, and resistance values to 100 K.

Waters Mfg., Inc., Dept. ED, Boston Post Rd., Wayland, Mass.

**CIRCLE 61 ON READER-SERVICE CARD**  
**◀ CIRCLE 62 ON READER-SERVICE CARD**  
**CIRCLE 63 ON READER-SERVICE CARD ▶**

ADVANCED  
SEMICONDUCTOR PRODUCTS  
FROM

PSI





## Very High Frequency Silicon Power Transistors *N-P-N Triple-diffused silicon mesa*

### VHF POWER AMPLIFIER TYPES

- XT-518** TYPICAL 70 MC POWER GAIN 10 db WITH 75 mw POWER OUTPUT; 4 db WITH 250 mw POWER OUTPUT.  
 $V_{CB} = 75V$ ,  $I_C = 30$  mA.
- XT-519** TYPICAL 70 MC POWER GAIN 10 db WITH 250 mw POWER OUTPUT; 4 db WITH 500 mw POWER OUTPUT.  
 $V_{CB} = 75V$ ,  $I_C = 30$  mA.
- XT-520** TYPICAL 70 MC POWER GAIN 10 db WITH 500 mw POWER OUTPUT; 4 db WITH 750 mw POWER OUTPUT.  
 $V_{CB} = 75V$ ,  $I_C = 30$  mA.

See Footnotes 1 and 2.

#### ABSOLUTE MAXIMUM RATINGS (25° ± 3°C except as noted)

Collector-Base Voltage	$V_{CB}$	160 Vac Peak
Collector Current	$I_C$	75 mA dc
Emitter-Base Voltage	$V_{EB}$	4 Vdc
Junction Temperature	$T_J$	150°C
Collector Dissipation	$P_C$	2.8 W @ 25°C case temp. 2.25 W @ 50°C case temp. 1.1 W @ 100°C case temp.

#### OTHER ELECTRICAL CHARACTERISTICS (25° ± 3°C except as noted)

Symbol	Characteristics	Test Conditions	Min.	Typical	Max.	Unit
$I_{EBO}$	Emitter Cutoff Current	$V_{EB} = 2V$ , $I_C = 0$			100	$\mu A$
$I_{CBO}$	Collector Cutoff Current	$V_{CB} = 10V$ , $I_E = 0$			1.5	$\mu A$
$I_{CBO}$	Collector Cutoff Current	$V_{CB} = 100V$ , $I_E = 0$			1.0	mA
$h_{FE}$	HF Current Gain	$V_{CB} = 50V$ , $I_C = 30$ mA, $f = 70$ mc	1.0	1.5		
$h_{FE}$	LF Current Gain	$V_{CB} = 50V$ , $I_C = 30$ mA, $f = 1$ kc		13		
$r_b'$	HF Base Resistance	$V_{CB} = 12V$ , $I_E = -10$ mA, $f = 150$ mc			100	ohm
$C_{ob}$	Output Capacitance <sup>1</sup>	$V_{CB} = 50V$ , $I_E = 0$ , $f = 140$ kc			7.5	$\mu f$
$r_e + r_e'$	Emitter Resistance	$I_E = -10$ mA, $I_C = 0$ , $f = 1$ kc		7		ohm
$r_c'$	Collector Series Resistance	$I_E = -20$ mA, $I_C = 10$ mA, $f = 1$ kc		15		ohm

#### Footnotes:

- Case temperature 50°C maximum.
- Neutralized common emitter power gain with input and output conjugate matching.
- Includes approximately 1.5  $\mu f$  header capacitance.

### VHF POWER OSCILLATOR TYPES

- XT-515** OSCILLATOR POWER OUTPUT 250 mw MIN. @ 70 mc.  
 $V_{CB} = 80V$ ,  $I_C = 30$  mA.
- XT-518** OSCILLATOR POWER OUTPUT 500 mw MIN. @ 70 mc.  
 $V_{CB} = 90V$ ,  $I_C = 30$  mA.
- XT-517** OSCILLATOR POWER OUTPUT 750 mw MIN. @ 70 mc.  
 $V_{CB} = 100V$ ,  $I_C = 30$  mA.

See Footnotes 1 and 2.

#### ABSOLUTE MAXIMUM RATINGS (25° ± 3°C except as noted)

Collector-Base Voltage	$V_{CB}$	160 Vac Peak
Collector Current	$I_C$	75 mA dc
Emitter-Base Voltage	$V_{EB}$	3 Vdc
Junction Temperature	$T_J$	150°C
Collector Dissipation	$P_C$	2.8 W @ 25°C case temp. 2.25 W @ 50°C case temp. 1.1 W @ 100°C case temp.

#### OTHER ELECTRICAL CHARACTERISTICS (25° ± 3°C except as noted)

Symbol	Characteristics	Test Conditions	Typical	Max.	Unit
$I_{EBO}$	Emitter Cutoff Current	$V_{EB} = 1V$ , $I_C = 0$		100	$\mu A$
$I_{CBO}$	Collector Cutoff Current	$V_{CB} = 10V$ , $I_E = 0$		1.5	$\mu A$
$I_{CBO}$	Collector Cutoff Current	$V_{CB} = 100V$ , $I_E = 0$		1.0	mA
$h_{FE}$	LF Current Gain	$V_{CB} = 50V$ , $I_C = 30$ mA, $f = 1$ kc	6		
$r_b'$	HF Base Resistance	$V_{CB} = 12V$ , $I_E = -10$ mA, $f = 150$ mc	60		ohm
$C_{ob}$	Output Capacitance <sup>1</sup>	$V_{CB} = 50V$ , $I_E = 0$ , $f = 140$ kc	4.0		$\mu f$
$r_e + r_e'$	Emitter Resistance	$I_E = -10$ mA, $I_C = 0$ , $f = 1$ kc	7		ohm
$r_c'$	Collector Series Resistance	$I_E = -20$ mA, $I_C = 10$ mA, $f = 1$ kc	15		ohm

#### Footnotes:

- Case temperature 50°C maximum.
- Power output in parallel line oscillator.
- Includes approximately 1.5  $\mu f$  header capacitance.

## Eight new EIA types Fast Recovery Silicon Diffusion Computer Diodes

 ACTUAL SIZE

Type Number	Min. Sat. Voltage (V) @ 100 $\mu A$	Min. Fwd. Current (A) @ 1.0V	Maximum Reverse Current ( $\mu A$ )		Reverse Recovery Characteristics	
			25°C	100°C	Reverse Res. (ohms)	Max. Recov. Time ( $\mu s$ )
1N789	30	10	1 (20V)	30 (20V)	200K	0.5
1N791	30	50	5 (20V)	30 (20V)	200K	0.5
1N792	30	100	5 (20V)	30 (20V)	100K	0.5
1N793	60	10	1 (50V)	30 (50V)	200K	0.5
1N795	60	50	5 (50V)	30 (50V)	200K	0.5
1N801	150	10	1 (125V)	30 (125V)	200K	0.5
1N802	150	50	5 (125V)	50 (125V)	200K	0.5
1N804	200	50	10 (175V)	50 (175V)	200K	0.5

...added to the broadest  
line of Fast Recovery  
Silicon Computer Diodes  
in the industry!

#### MILITARY TYPES

Type Number	Min. Sat. Voltage (V) @ 100 $\mu A$	Min. Fwd. Current (A) @ 1.0V	Maximum Reverse Current ( $\mu A$ )		Reverse Recovery Characteristics	
			25°C	100°C	Reverse Res. (ohms)	Max. Recov. Time ( $\mu s$ )
*1N643	200	10	0.25 (10V)	5 (10V)	200K	0.3
*1N662	100	10	1 (100V)	15 (100V)	100K	0.5
†1N663	100	100	20 (50V)	100 (50V)	200K	0.5
			5 (75V)	50 (75V)		

\*Mil-E-1/1171 (SigC), †Mil-E-1/1139 (SigC), ‡Mil-E-1/1140 (SigC)

#### HIGH CONDUCTANCE TYPES

Type Number	Min. Sat. Voltage (V) @ 100 $\mu A$	Min. Fwd. Current (A) @ 1.0V	25°C	100°C	Reverse Res. (ohms)	Max. Recov. Time ( $\mu s$ )
PS700	30	100	5 (20V)	25 (20V)	100K	1.0
PS701	60	50	5 (45V)	50 (45V)	100K	0.5
PS702	100	75	20 (75V)	50 (75V)	200K	1.0
PS703	100	50	5 (75V)	50 (75V)	100K	0.5
PS704	150	50	5 (75V)	50 (75V)	100K	0.5
PS705	200	50	5 (75V)	50 (75V)	100K	0.5

#### MEDIUM CONDUCTANCE TYPES

Type Number	Min. Sat. Voltage (V) @ 100 $\mu A$	Min. Fwd. Current (A) @ 1.0V	25°C	100°C	Reverse Res. (ohms)	Max. Recov. Time ( $\mu s$ )
PS720	30	3	5 (20V)	25 (20V)	100K	0.5
PS721	60	5	5 (45V)	50 (45V)	100K	0.3
PS722	100	5	5 (75V)	50 (75V)	100K	0.3
PS723	200	3	20 (175V)	100 (175V)	100K	0.3
PS724	150	4	20 (125V)	100 (125V)	100K	0.3

#### LOW CONDUCTANCE TYPES


Type Number	Min. Sat. Voltage (V) @ 100 $\mu A$	Min. Fwd. Current (A) @ 1.0V	25°C	100°C	Reverse Res. (ohms)	Max. Recov. Time ( $\mu s$ )
1N625	30	4 @ 1.5V	1 (20V)	30 (20V)	400K	1 $\mu$ sec
1N626	50	4 @ 1.5V	1 (35V)	30 (35V)	400K	1 $\mu$ sec
1N627	100	4 @ 1.5V	1 (75V)	30 (75V)	400K	1 $\mu$ sec
1N628	150	4 @ 1.5V	1 (125V)	30 (125V)	400K	1 $\mu$ sec
1N629	200	4 @ 1.5V	1 (175V)	30 (175V)	400K	1 $\mu$ sec

## Please Note:

All specifications and information contained herein are current as of:

*April 28, 1959*

## Zener Diodes 500 mW Power Dissipation

 ACTUAL SIZE

#### LOW VOLTAGE GROUP

PSI Type Number	Elect. Equiv.	Zener Voltage @ 5 mA @ 25°C		Maximum Dynamic Resistance (ohms) I	Maximum Inverse Current		At Inverse Voltage (V)
		E. Min. (V)	E. Max. (V)		I <sub>Z</sub> @ 25°C ( $\mu A$ )	I <sub>Z</sub> @ 100°C ( $\mu A$ )	
PS6465	1N465	2.0	3.2	60	75	100	1
PS6466	1N466	3.0	3.9	55	50	100	1
PS6467	1N467	3.7	4.5	45	5	100	1
PS6468	1N468	4.3	5.4	35	5	100	1.5
PS6469	1N469	5.2	6.4	20	5	100	1.5
PS6470	1N470	6.2	8.0	10	5	50	3.5

I. Measured at 10mA DC Zener current with 1mA RMS signal superposed.

#### MEDIUM VOLTAGE GROUP

PSI Type Number	Elect. Equiv.	Zener Voltage @ 200 $\mu A$ @ 25°C		Maximum Dynamic Resistance (ohms) I	Maximum Inverse Current		At Inverse Voltage (V)
		E. Min. (V)	E. Max. (V)		I <sub>Z</sub> @ 25°C ( $\mu A$ )	I <sub>Z</sub> @ 100°C ( $\mu A$ )	
PS6313	1N1313	7.5	10	5	5	5	6.8
PS6314	1N1314	9	12	5	5	5	8.2
PS6315	1N1315	11	14.5	5	5	5	10.0
PS6316	1N1316	13.5	18	5	5	5	12.0
PS6317	1N1317	17	21	5	5	5	15.0
PS6318	1N1318	20	27	1	10	10	18.0

#### HIGH VOLTAGE GROUP

PSI Type Number	Elect. Equiv.	Zener Voltage @ 200 $\mu A$ @ 25°C		Maximum Dynamic Resistance (ohms) I	Maximum Inverse Current		At Inverse Voltage (V)
		E. Min. (V)	E. Max. (V)		I <sub>Z</sub> @ 25°C ( $\mu A$ )	I <sub>Z</sub> @ 100°C ( $\mu A$ )	
PS6319	1N1319	25	32	1	10	10	22
PS6320	1N1320	30	39	1	10	10	27
PS6321	1N1321	37	45	1	10	10	33
PS6322	1N1322	43	54	1	10	10	39
PS6323	1N1323	52	64	1	10	10	47
PS6324	1N1324	62	80	1.0	50	50	56
PS6325	1N1325	75	100	1.0	50	50	68
PS6326	1N1326	90	120	1.0	50	50	82
PS6327	1N1327	110	145	1.0	50	50	100

MAXIMUM Power Dissipation 500 mW @ 25°C  
Operating Range - 65°C to 200°C

### • For Employment Opportunities

Write PSI Technical Staff Placement, 10451 West Jefferson Blvd., Culver City, Calif.

*Pacific Semiconductors, Inc.*

A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.

PSI

## Standard Encapsulations

A variety of assemblies can be furnished for matched pairs and quads, ring modulators, full wave and bridge rectifiers and many other applications.

Numerous lead arrangements are possible in these three basic configurations. Up to four diodes or rectifiers can be encapsulated in the "S" or "T" packages. Up to 12 units can be contained in the "R" package. The number of units contained determines its maximum length.

Leads .020" diameter,  
1" minimum length.  
Spaced on .1" grid centers.



DIMENSIONS

	"R" Package	"S" Package	"T" Package
Length	375" to 1.75"	.45"	.50"
Width	.25"	.39"	—
Height	.50"	.40"	—
Diameter	—	—	.375"

## Non-Linear Resistors

PSI Type	E / $\rho$ 1mA volts	I / $\rho$ 1VDC min mA	Max Dyn Res $\rho$ 1mA ohm	I <sub>h</sub> @ 25°C $\mu$ A Max.
PS594	0.62 $\pm$ 10%	100	60	1.0 @ -5v
PS594G	0.62 $\pm$ 5%	100	60	1.0 @ -5v
PS595	0.62 $\pm$ 10%	250	60	5.0 @ -5v
PS595G	0.62 $\pm$ 5%	250	60	5.0 @ -5v

## Silicon

## General Purpose Diodes

EIA TYPE NUMBER	Minimum Saturation Voltage ( $\rho$ 100 $\mu$ A @ 25°C volts)	Minimum Forward Current ( $\rho$ 1.0 VDC @ 25°C mA)	Maximum Inverse Current at Maximum DC Operating Voltage ( $\mu$ A @ volts)	Maximum Average Rectified Current (mA)
1N456	.80	80	.025 @ 25 .025 @ 25	5 @ 25 5 @ 25
1N456A	.80	100	.025 @ 25 .025 @ 25	5 @ 25 5 @ 25
1N457	.70	70	.025 @ 60 .025 @ 60	5 @ 60 5 @ 60
1N457A	.70	100	.025 @ 60 .025 @ 60	5 @ 60 5 @ 60
1N458	.150	7	.025 @ 125 .025 @ 125	5 @ 125 5 @ 125
1N458A	.150	100	.025 @ 125 .025 @ 125	5 @ 125 5 @ 125
1N459	.200	3	.025 @ 175 .025 @ 175	5 @ 175 5 @ 175
1N459A	.200	100	.025 @ 175 .025 @ 175	5 @ 175 5 @ 175
1N461	.30	15	5 @ 25 5 @ 25	30 @ 25 30 @ 25
1N461A	.30	100	5 @ 25 5 @ 25	30 @ 25 30 @ 25
1N462	.70	5	5 @ 60 5 @ 60	30 @ 60 30 @ 60
1N462A	.70	100	5 @ 60 5 @ 60	30 @ 60 30 @ 60
1N463	.200	1	5 @ 175 5 @ 175	30 @ 175 30 @ 175
1N463A	.200	100	5 @ 175 5 @ 175	30 @ 175 30 @ 175
1N464	.150	3	5 @ 125 5 @ 125	30 @ 125 30 @ 125
1N464A	.150	100	5 @ 125 5 @ 125	30 @ 125 30 @ 125

\*JAN Types

OTHER ABSOLUTE MAXIMUM RATINGS:  
Power Dissipation 0.5 Watts @ 25°C. Power Dissipation 0.25 Watts @ 150°C. 1 Second Surge Current 1.5 Amperes 25°C. Storage and Operating Temperature Range -80°C to 200°C.

## Silicon

## High Conductance Diodes

PSI or EIA TYPE NUMBER	Minimum Saturation Voltage ( $\rho$ 100 $\mu$ A @ 25°C volts)	Maximum Forward Voltage DC @ 25°C (volts)	Maximum Inverse Current Maximum DC Operating Voltage ( $\mu$ A @ volts)	Maximum Average Rectified Current (mA)
1N482	.40	1.1	250 @ -30v 025 @ -30v	30 15
1N482A	.40	1.0	250 @ -30v 025 @ -30v	30 15
1N482B	.40	1.0	250 @ -30v 025 @ -30v	30 15
PS603	.40	1.0	250 @ -30v 025 @ -30v	30 15
PS604	.40	1.0	250 @ -30v 025 @ -30v	30 15
PS605	.40	1.0	250 @ -30v 025 @ -30v	30 15
1N483	.80	1.1	250 @ -60v 025 @ -60v	30 15
1N483A	.80	1.0	250 @ -60v 025 @ -60v	30 15
1N483B	.80	1.0	250 @ -60v 025 @ -60v	30 15
PS609	.80	1.0	250 @ -60v 025 @ -60v	30 15
PS610	.80	1.0	250 @ -60v 025 @ -60v	30 15
PS611	.80	1.0	250 @ -60v 025 @ -60v	30 15
1N484	.150	1.1	250 @ -125v 025 @ -125v	30 15
1N484A	.150	1.0	250 @ -125v 025 @ -125v	30 15
1N484B	.150	1.0	250 @ -125v 025 @ -125v	30 15
PS615	.150	1.0	250 @ -125v 025 @ -125v	30 15
PS616	.150	1.0	250 @ -125v 025 @ -125v	30 15
PS617	.150	1.0	250 @ -125v 025 @ -125v	30 15
1N485	.200	1.1	250 @ -175v 025 @ -175v	30 15
1N485A	.200	1.0	250 @ -175v 025 @ -175v	30 15
1N485B	.200	1.0	250 @ -175v 025 @ -175v	30 15
PS621	.200	1.0	250 @ -175v 025 @ -175v	30 15
PS622	.200	1.0	250 @ -175v 025 @ -175v	30 15
PS623	.200	1.0	250 @ -175v 025 @ -175v	30 15
1N486	.250	1.1	250 @ -225v 050 @ -225v	50 25
1N486A	.250	1.0	250 @ -225v 050 @ -225v	50 25
1N486B	.250	1.0	250 @ -225v 050 @ -225v	50 25
PS627	.250	1.0	250 @ -225v 050 @ -225v	50 25
PS628	.250	1.0	250 @ -225v 050 @ -225v	50 25
PS629	.250	1.0	250 @ -225v 050 @ -225v	50 25
1N487	.330	1.1	250 @ -300v 100 @ -300v	50 25
1N487A	.330	1.0	250 @ -300v 100 @ -300v	50 25
PS632	.330	1.0	250 @ -300v 100 @ -300v	50 25
PS633	.330	1.0	250 @ -300v 100 @ -300v	50 25
1N488	.420	1.1	250 @ -380v 100 @ -380v	50 25
1N488A	.420	1.0	250 @ -380v 100 @ -380v	50 25
PS636	.420	1.0	250 @ -380v 100 @ -380v	50 25
PS637	.420	1.0	250 @ -380v 100 @ -380v	50 25

OTHER ABSOLUTE MAXIMUM RATINGS:  
Maximum Power Dissipation 0.5 Watts @ 25°C. Maximum Power Dissipation 0.25 Watts @ 150°C.  
Maximum 1 Second Surge Current 1.5 Amperes @ 25°C. Storage and Operating Temperature Range -80°C to 200°C.

Varicap®

## Voltage-Variable Capacitor

Varicap Type	Capacitance		Quality Factor Q @ 50 mc.			Maximum Working Voltage MWV Volts D.C
	@ 4VDC <i>μmf</i>	Approx. Range <i>μmf</i> *	Typical			
			@ 4VDC	@ 4VDC	@ MWV	
MODULATION, AFC AND OTHER APPLICATIONS						
V-7	7	3.0-18	13	18	43	25
V-10	10	4.3-26	13	18	43	25
V-12	12	5.2-31	13	18	43	25
V-15	15	6.5-39	13	18	43	25
V-20	20	10-50	7.0	18.7	40.2	20
V-27	27	14-70	7.0	15.7	33.8	20
V-33	33	17-85	7.0	14.6	31.4	20
V-39	35	20-100	7.0	15.1	32.4	20
V-47	47	24-120	7.0	15.4	32.4	20
V-56	56	32-145	7.0	15.5	24.8	15
V-68	68	39-175	9.0	14.0	25.8	15
V-82	82	47-210	9.0	13.0	23.9	15
V-100	100	57-260	8.0	11.0	20.2	15
HIGH VOLTAGE TYPES TUNING AND OTHER APPLICATIONS						
V-7L	7	1.5-18.0	3.0	4.5	22.5	100
V-10E	10	2.2-26.0	3.5	5.5	27.5	100
V-12L	12	2.7-31.0	4.0	6.5	32.5	100
V-15L	15	3.3-39.0	4.5	7.5	37.5	100
V-20E	20	5.0-50.0	7.0	18.7	78.5	70
V-27E	27	7.0-70.0	7.0	15.7	63.5	65
V-33E	33	9.0-85.0	7.0	14.6	56.5	60
V-39E	39	11.0-100.0	7.0	15.1	55.8	55
V-47E	47	14.0-120.0	7.0	15.4	53.8	50
V-56E	56	20.0-145.0	7.0	15.5	41.4	30

\*Q range specified from 0.1 volts to maximum working voltage.

"VARICAP" is the registered trade mark of silicon voltage-variable capacitors manufactured by Pacific Semiconductors, Inc.

# NEW!

Now available! Two new semiconductor devices which may revolutionize present concepts of Micro-Miniaturization and Electrical circuitry!

## 1. PSI microdiode

A major advance in micro-miniaturization. Volume and weight of these new PSI types are approximately 1/20th of present subminiature diodes. Six Fast Recovery Silicon Computer Microdiodes are now available.

actual size!   
Pacific Semiconductors, Inc.

## 2. PSI High Q Varicap

A complete new approach to advanced circuit design is possible with these new High Q Varicap voltage-variable capacitors. Six types with Q Factors of 50 and 100 and 10, 22, 47 mmf. capacitance are available in standard subminiature package.

Phone, wire or write for complete specifications, delivery schedules and prices.



## Silicon

### Subminiature Rectifiers

ACTUAL SIZE

#### MEDIUM POWER TYPES

EIA TYPE NUMBER	MAXIMUM RATINGS			ELECTRICAL CHARACTERISTICS		
	Peak Inv. Voltage (V)	Maximum Avg. Rectified Current (mA) <sup>1</sup>	Minimum Saturation Voltage @ 100°C	Maximum Reverse Current ( $\mu$ A)	Max. Avg. Voltage Drop @ 10 mA @ 25°C (V) <sup>1</sup>	
1N645	225	400	150	275	0.2	15
1N646	300	400	150	360	0.2	15
1N647	400	400	150	480	0.2	20
1N648	500	400	150	600	0.2	20
1N649	600	400	150	720	0.2	25

#### 400 MILLIAMPERE PSI TYPES

PSI TYPE NUMBER	MAXIMUM RATINGS @ 100°C			ELECTRICAL CHARACTERISTICS		
	Peak Recurr. Inverse Voltage (volts)	Maximum RMS Input Voltage <sup>1</sup> (volts)	Maximum Average Rectified Current <sup>1</sup> (mA)	DC Forward Voltage (% Specified Current @ 25°C (volts @ mA)	Maximum Average Inverse Current <sup>1</sup> ( $\mu$ A) @ 100°C	
PS 405	50	35	150	1.5 @ 500	500	
PS 410	100	70	150	1.5 @ 500	500	
PS 415	150	105	150	1.5 @ 500	500	
PS 420	200	140	150	1.5 @ 500	500	
PS 425	250	175	150	1.5 @ 500	500	
PS 430	300	210	150	1.5 @ 500	500	
PS 435	350	245	150	1.5 @ 500	500	
PS 440	400	280	150	1.5 @ 500	500	
PS 450	500	350	125	1.5 @ 500	500	
PS 460	600	420	125	1.5 @ 500	500	

#### 250 MILLIAMPERE PSI TYPES

PSI TYPE NUMBER	MAXIMUM RATINGS @ 100°C			ELECTRICAL CHARACTERISTICS		
	Peak Recurr. Inverse Voltage (volts)	Maximum RMS Input Voltage <sup>1</sup> (volts)	Maximum Average Rectified Current <sup>1</sup> (mA)	DC Forward Voltage (% Specified Current @ 25°C (volts @ mA)	Maximum Average Inverse Current <sup>1</sup> ( $\mu$ A) @ 100°C	
PS 005	50	35	140	1 @ 100	100	
PS 010	100	70	140	1 @ 100	100	
PS 015	150	105	140	1 @ 100	100	
PS 020	200	140	140	1 @ 100	100	
PS 025	250	175	140	1 @ 100	100	
PS 030	300	210	140	1 @ 100	100	
PS 035	350	245	140	1 @ 100	100	
PS 040	400	280	140	1 @ 100	100	
PS 050	500	350	140	1 @ 100	100	
PS 060	600	420	140	1 @ 100	100	

1. Resistive or inductive load
2. Averaged over one cycle for half wave resistive or choke input circuit with rectifier operating at full rated current and maximum RMS input

Storage and Operating Temperature Range -65°C to 200°C

500 MA TYPES IN MINIATURE PACKAGE ALSO AVAILABLE.

## Silicon

### High Voltage Rectifiers

3/4 ACTUAL SIZE

EIA TYPE NUMBER	Peak Inverse Voltage (@ 25 & 100°C (volts)	Continuous DC Voltage (@ 25 & 100°C (volts)	Average Rectified Current (mA) (@ 25°C @ 100°C	RMS Input Voltage (@ 25 & 100°C (volts)	Max. DC Fwd. Voltage Drop (@ 100mA DC 25°C
1N1730	1000	1000	200	100	700
1N1731	1500	1500	200	100	1050
1N1732	2000	2000	200	100	1400
1N1733	3000	3000	150	75	2100
1N1734	5000	5000	100	50	3500

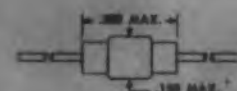
Maximum DC Reverse Current @ Rated PIV -25°C 10 $\mu$ A 100°C 100 $\mu$ A  
Maximum Surge Current (8msec.) @ 25 & 100°C -2.5 Amps.  
Length -1N1730 and 1N1731 .50", 1N1732, 1N1733 and 1N1734 .1.0"  
Diameter -375" (1N1734 .50")  
Leads .030" diam., 1 1/4" long on all units.

## Silicon Very High Voltage Cartridge Rectifiers

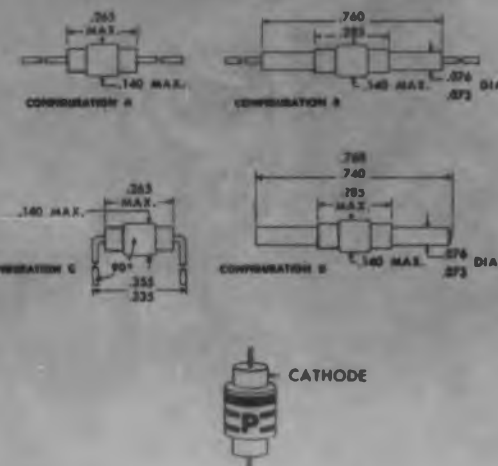


EIA Type	Length Inches	Absolute Max. Rigs. H W Res. Load at 75°C Ambient		Electrical Characteristics at 25°C Ambient	
		Peak Inverse Voltage Volts	Max. Rectified DC Output Current MA	Forward DC Volt Drop at Rated DC Current Volts	Reverse DC Current at Rated PIV MA
1N1139	4 1/4	3600	65	27.0	.025
1N1140	2 1/2	3600	65	18.0	.025
1N1141	4 1/4	4800	60	36.0	.025
1N1142	2 1/2	4800	50	24.0	.025
1N1143	4 1/4	6000	50	45.0	.025
1N1143A	4 1/4	6000	65	30.0	.025
1N1144	6 1/4	7200	50	54.0	.025
1N1145	4 1/4	7200	60	36.0	.025
1N1146	6 1/4	8000	45	60.0	.025
1N1147	6 1/4	12000	45	60.0	.025
1N1148	6 1/4	14000	50	52.0	.025
1N1149	6 1/4	16000	45	60.0	.025

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



Normally supplied in the MIL Specification dimensions shown above. On special request dimensions shown below can be supplied.



## Physical Characteristics

**HERMETICALLY SEALED** - Glass-to-metal fused and metal-to-metal welded seals.

**TERMINALS** - Tinned copper leads .020 inches diameter. Lead length 1 1/4 inch minimum.

**MARKING** - Wide color band indicates cathode end. (Wide band indicates positive bias on Vari-caps.) Type number designated by color bands reading from cathode.

**ALL DIMENSIONS SHOWN IN INCHES** - Patented under one or more of the following United States Patents: No. 2815474, No. 2827403. Other patents pending.



# PSI

## Pacific Semiconductors, Inc.

10451 West Jefferson Boulevard, Culver City, California  
TEXAS 0-4881, TEXAS 0-6113 • TWX: CULVER CITY CAL 7135

### SALES OFFICES

**NEW YORK** - 2079 Wantagh Ave., Wantagh, L.I., N.Y.  
• SUNset 1-7470 • TWX: WANTAGH NY 2320

**Boston** - 471 Washington St., Wellesley 81 • CEDar 5-0171

**Philadelphia** - 320 Huntingdon Pike, Rockledge • PILgrim 2-8089

**Madeira Beach, Fla.** - P.O. Box 8215 • Phone 7-6126

**Ottawa** - 227 Laurier Ave. West • CE 2-8504

**DISTRIBUTORS:** BALTIMORE - Wholesale Radio Parts Company  
• BOSTON - Cramer Electronics, Inc. • BUFFALO - Genesee  
Radio & Parts Co. • MELBOURNE and ST. PETERSBURG -  
Electronic Supply • NEW YORK - Peerless Radio Distributors  
and Terminal Radio Corporation • PHILADELPHIA - Almo Radio  
Company • ROCHESTER - Rochester Radio Supply Company  
• SYRACUSE - Syracuse Radio Supply Company • TORONTO  
- Electro Sonic Supply Company, Ltd. • WASHINGTON, D.C. -  
Electronic Industrial Sales.

**ILLINOIS** - 6957 W. North Avenue, Oak Park, Illinois •  
Village 8-9750 • TWX: OKP 1547

**Dallas** - P.O. Box 4793 • RIVERSIDE 7-1258

**DISTRIBUTORS:** CHICAGO - Allied Radio • CLEVELAND -  
Pioneer Electronic Supply Co. • DALLAS - Wholesale Electronic  
Supply • DAYTON - Srepc, Inc. • DETROIT - Ferguson  
Electronic Supply Co. • HOUSTON - Sterling Radio Products,  
Inc. • MINNEAPOLIS - Lew Bonn Co.

**CALIFORNIA** - 8271 Melrose Ave., Los Angeles 46, Calif.  
• OLIVE 3-7850

**Palo Alto** - 701 Welch Road, Suite 305 • DAVenport 1-2240

**DISTRIBUTORS:** ALAMOGORDO - Radio Specialties Company •  
DENVER - Denver Electronic Supply Co. • LOS ANGELES -  
Electronic Supply Corporation and Kierulff Electronics, Inc. •  
OAKLAND - Elmar Electronic Supply, Inc. • PHOENIX - Radio  
Specialties Corporation • SALT LAKE CITY - Standard Supply  
Company • SEATTLE - C & H Supply Company.

## Four Layer Diodes

Switch 30 to 200 v



A high power four layer diode, type AD is a self-actuated silicon switch similar in function to a relay or gas tube. It is turned on by a voltage pulse and turned off by dropping the current or reversing the voltage. To match circuit requirements, it is available with switching voltages of 30, 40, 50, and 200 v and holding currents of 5 to 45 ma. Compact and rugged, it can handle 300 ma steady dc or a 20 amp pulse current. A string of four in series will switch 800 v, resulting in a peak power of 16 kw for magnetron pulsing, radar beacons, and other modulator applications. The unit can also be used for pulse generator circuits, detonator firing circuits, and dc to dc power conversion.

Shockley Transistor Corp., Dept. ED, Stanford Industrial Park, Palo Alto, Calif.

CIRCLE 64 ON READER-SERVICE CARD

## Noise Figure Test Set

For 200 mc operation

The NF-200 noise figure test set checks tube performance in rf tuners or preamplifiers at 200 mc. It uses a GE ceramic 7077 tube and a 200 mc amplifier of 100 db gain. An integral 3 db attenuator, an output meter, and a separate filtered detector output are included. The unit is designed to JETEC 5.4 subcommittee specifications and may also be supplied for other frequencies in the hf, vhf, and uhf ranges.

LEL, Inc., Dept. ED, 380 Oak St., Copiague, N.Y.

CIRCLE 65 ON READER-SERVICE CARD

CIRCLE 66 ON READER-SERVICE CARD ➤

◀ CIRCLE 63 ON READER-SERVICE CARD



## 50% lighter . . . 40% Smaller . . . Daven's new miniature Egg Crate LC Filters

Now, for airborne and missile applications, Daven offers a miniature version of the popular Egg Crate LC Filter; 50% lighter and 40% smaller than any previous filter!

Frequency range is 0.4 MC to 60.0 megacycles . . . temperature range is  $-55^{\circ}\text{C}.$  to  $+125^{\circ}\text{C}.$  . . . different physical configurations are available depending on allowable space.

The new Filter is suitable for pulse-type circuits and those where the phase shift characteristics must be uniform. It can be pre-tuned in the actual circuit, thus eliminating additional adjustment during assembly. With new production facilities,

these Filters are available in quantity, and each unit is identical in performance to the prototype.

Utilizing no critical materials, the LC Filter is also excellent for medium and wide band-width filters. It can be used for bandwidths down to 0.5%, if under-coupled response is permitted.

Daven's extensive engineering staff, also producing other types of filters extending into the low audio range, is ready to assist you in your filter problems. Just send details of your specific requirement.

THE **DAVEN** CO.



LIVINGSTON, NEW JERSEY

TODAY, MORE THAN EVER, THE DAVEN © STANDS FOR DEPENDABILITY

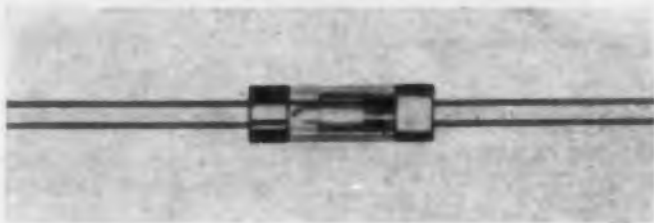




## NEW PRODUCTS

### Current Sensitive Switch

Operates continuously at 750 F



The Pyristor switch is a single shot, current sensitive unit for testing circuitry, bypassing squibs, and protecting devices against surge currents. It is also applicable in current operated triggering devices. Hermetically sealed, the unit is spst, normally open or closed. It operates continuously from  $-100$  to  $+750$  F and for 30 min at 1000 F. It meets MIL-E-5272B humidity requirements and withstands 250 g, 2 to 4 msec shocks and 20 to 20,000 cps, 40 g vibration. It can be used at any altitude.

Thermocal, Inc., Dept. ED, 1627 Colorado St., Santa Monica, Calif.

CIRCLE 67 ON READER-SERVICE CARD

### Precision Strain Indicator

Tests strain gage transducers

For strain gage transducer testing and production line quality control, the model LC-261 automatic strain indicator has 0.005% resolution, 0.02% linearity, 0.01% repeatability, and 0.05% absolute accuracy. The unit is a true mv per v indicator. Instrument calibration is continuously adjustable from 1 to 15 mv per v and is independent of input and output impedance from 60 to 1000 ohms. Input power to the transducer is regulated dc voltage, continuously adjustable from 5 to 15 v, and instrument calibration is independent of transducer supply voltage and zero balance adjustment.

Bytrex Corp., Dept. ED, 294 Centre St., Newton 58, Mass.

CIRCLE 68 ON READER-SERVICE CARD

### High Voltage Resins

Withstand high temperatures

Impregnating and encapsulating Aritemp 215 and 221 epoxy resins pass the requirements for class H insulating compounds. Transformer coils impregnated with 221 and encapsulated in 215 will resist 8 kv for more than 1000 hr at temperatures to 200 C. Both resins are one component systems that require no mixing of catalyst and resin.

Aries Labs, Inc., Dept. ED, 45-33 Davis St., Long Island City 1, N.Y.

CIRCLE 69 ON READER-SERVICE CARD

# NOW!

A HIGH TEMPERATURE FILM WIRE DEVELOPED BY PH

APPLIED RESEARCH TO MEET  $155^{\circ}\text{C}$  (CLASS "F") PE

# THERMAL



BY PHELPS DODGE  
"F" PERFORMANCE...

# TERMALEZE® F 155°C

- Dielectric twist performance establishes Thermaleze F as *exceeding* (155° C) Class "F".
- Better factor of safety because of improved "heat shock" characteristics.
- Good film flexibility under Class "F" conditions.
- Good balance of electrical, chemical and physical properties.
- Ideal for Class "F" stator windings and high temperature layer or random wound coils.
- Presently available in square and rectangular wire; also in round wire, sizes #8-40.

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

FIRST FOR  
LASTING QUALITY  
—FROM MINE  
TO MARKET!

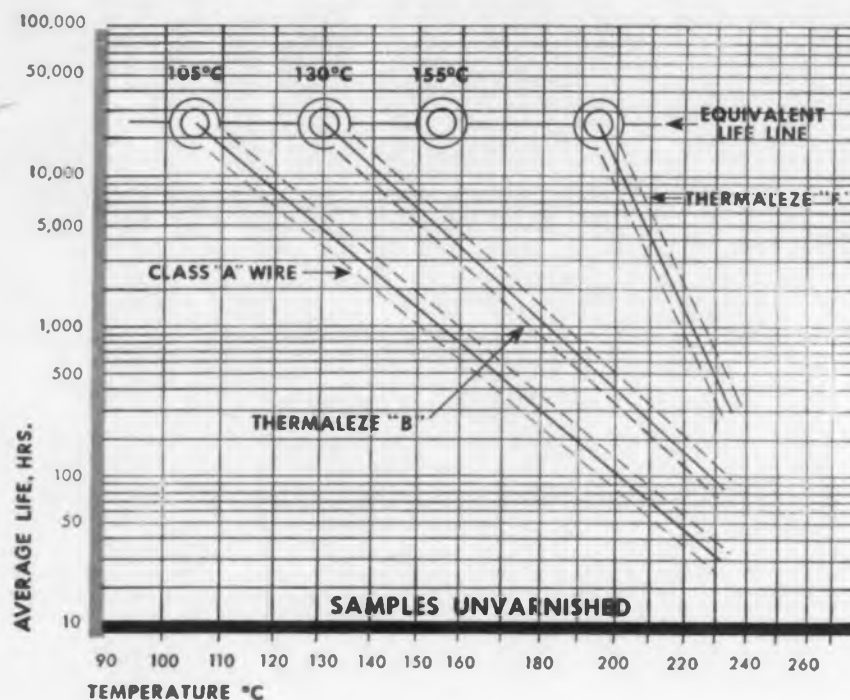


**PHELPS DODGE COPPER PRODUCTS**  
**CORPORATION**

**INCA MANUFACTURING DIVISION**  
FORT WAYNE, INDIANA

CIRCLE 70 ON READER-SERVICE CARD

AGED DIELECTRIC TWISTS  
AIEE Procedure #57



## Commutators

Have 50 channel capacity



These solid state commutators have a 50 channel capacity and a 24 kc sampling rate. Called Radiplex's, they provide asynchronous operation and high common-mode noise rejection. Two models are available: a high level unit with a full scale input of  $\pm 10$  v and a resolution of  $\pm 2$  mv; and a low level unit with a full scale input of  $\pm 10$  v and a resolution of  $\pm 10$   $\mu$ v. Both models have a self-contained power supply.

Radiation, Inc., Dept. ED, P.O. Box 37, Melbourne, Fla.

CIRCLE 71 ON READER-SERVICE CARD

## Power Transistors

Have 25 amp dc collector current



Power transistors 2N1162 through 2N1165 have a 25 amp dc collector current, 50 or 80 v collector to base voltage, and 35 or 60 v collector to emitter voltage. Maximum junction temperature is 90 C continuous and 100 C intermittent, and collector dissipation for mounting base temperature of 30 C is 50 w. The units are germanium pnp, alloy junction type with collector common to the case. Designed for high current switching and audio applications, they are hermetically sealed in a standard TO-3 package and meet MIL-T-19500A specifications.

Motorola Inc., Semiconductor Products Div., Dept. ED, 5005 E. McDowell Rd., Phoenix, Ariz.

CIRCLE 72 ON READER-SERVICE CARD

Don't forget to mail your renewal form to continue receiving **ELECTRONIC DESIGN**.





# MAXWELL MAGNETICS and MICROWAVE

Creative Imagination was for James Clerk Maxwell the catalyst that united a profound physical intuition and a formidable mathematical capacity in a brilliant formulation of electromagnetics—the basis of all today's practical electromagnetic applications.

At National Co. creative imagination is transmuting observed physical phenomena and mathematically formulated theory in such applications as long range microwave transmission—extending further our practical control of physical phenomena.

The implications of these new means of communications are manifold and the applications multitudinous.

National Co. is a community of minds and talents that enjoys the challenge and the prestige of success in such advanced fields as multipath transmission, noise reduction, correlation techniques for signal processing, Tropospheric scatter systems, Ionospheric scatter systems, molecular beam techniques, long range microwave transmission and missile check-out equipment using microwave and digital techniques.

National Co. has grown with the Tradition of New England electronics. Your needs and problems receive exceptional attention at National Co., because, here, *creativity is required, recognized and rewarded.*

Write or phone

*tuned to tomorrow* **National!** 

National Company, Inc., Malden, Mass.

MANUFACTURERS OF MATERIEL AND EQUIPMENT FOR U.S. DEFENSE

## NEW PRODUCTS

### Airborne Receiver Rack

For telemetry

Airborne receiver rack ATR-100 contains four of the company's type 1403 crystal controlled phase-lock telemetry airborne receivers; one type SDU-203 spectrum display unit; and one type CSD-170 crystal storage drawer. The type 1403 receivers operate in the 215 to 260 mc range and offer a choice of two second i-f amplifiers of different bandwidths, one of 500 kc at the 3 db points with an attenuation of 60 db 500 kc each side of center frequency and the other of 100 kc with better than 60 db attenuation 250 kc each side of center frequency. They have a noise figure of less than 8 db.

Nems-Clarke Co., Dept. ED, 919 Jesup-Blair Dr., Silver Spring, Md.

CIRCLE 73 ON READER-SERVICE CARD

### High Power Isolator

Provides 6 db isolation

Over its 350 to 400 mc frequency range, isolated model IUH2 provides over 6 db isolation. The unit has a maximum insertion loss of 1 db and can operate at average power levels above 10 kw. Peak power capacity is 10 mw. Without transitions, the isolator is 10 in. high, 27 in. wide, and 36 in. long.

Raytheon Mfg. Co., Special Microwave Device Group, Dept. ED, River Bldg. 2, Waltham 54, Mass.

CIRCLE 74 ON READER-SERVICE CARD

### K Band Magnetron

For missile use

Built for missile applications, type M4154 fixed frequency K band magnetron delivers a minimum peak power of 20 kw. It withstands severe shock and 30 g vibration at 20 to 2000 cps.

Sylvania Electric Products, Inc., Special Tube Operations, Dept. ED, Mountain View, Calif.

CIRCLE 75 ON READER-SERVICE CARD

◀ CIRCLE 76 ON READER-SERVICE CARD

## Transducers

### Converts frequency to voltage

Model SMC-15 Magacycler converts pulse rates of as low as 0 to 3 cps to linearly varying dc output. The SMC-5000 converts signals of 0 to 1250 cps up to 0 to 5000 cps to the desired linear dc output. The maximum frequency detected can be adjusted with a built-in attenuator through a more than 4 to 1 frequency detected can be adjusted with a built-in attenuator through a more than 4 to 1 frequency range. Full range linearity of better than 0.5% is standard while Red Line units are linear to as low as 0.1%. Standard temperature sensitivities are better than 100 ppm per degree C, with the Red Line units offering under 50 ppm from -60 to +100 C.

Pioneer Magnetics Inc., Dept. ED, 5858 Wilshire Blvd., Los Angeles 36, Calif.

CIRCLE 77 ON READER-SERVICE CARD

## Sonic Delay Line

### Lag type



For use with signals in the sonic frequency range, the F344 lag type delay line has an impedance of 1100 ohms, a bandwidth of 15 kc, and a total delay of 76  $\mu$ sec  $\pm$ 1%. Taps are provided at each 9.5  $\mu$ sec, and loading is prevented by precision isolation resistors. Insertion loss is 0.2 db at 15 kc and 3 db at 30 kc; phase linearity is 1%; and vswr is 0.5 db. The unit can be used individually or cascaded for longer delays.

Control Electronics Co., Inc., Dept. ED, 10 Stepar Place Huntington Station, N.Y.

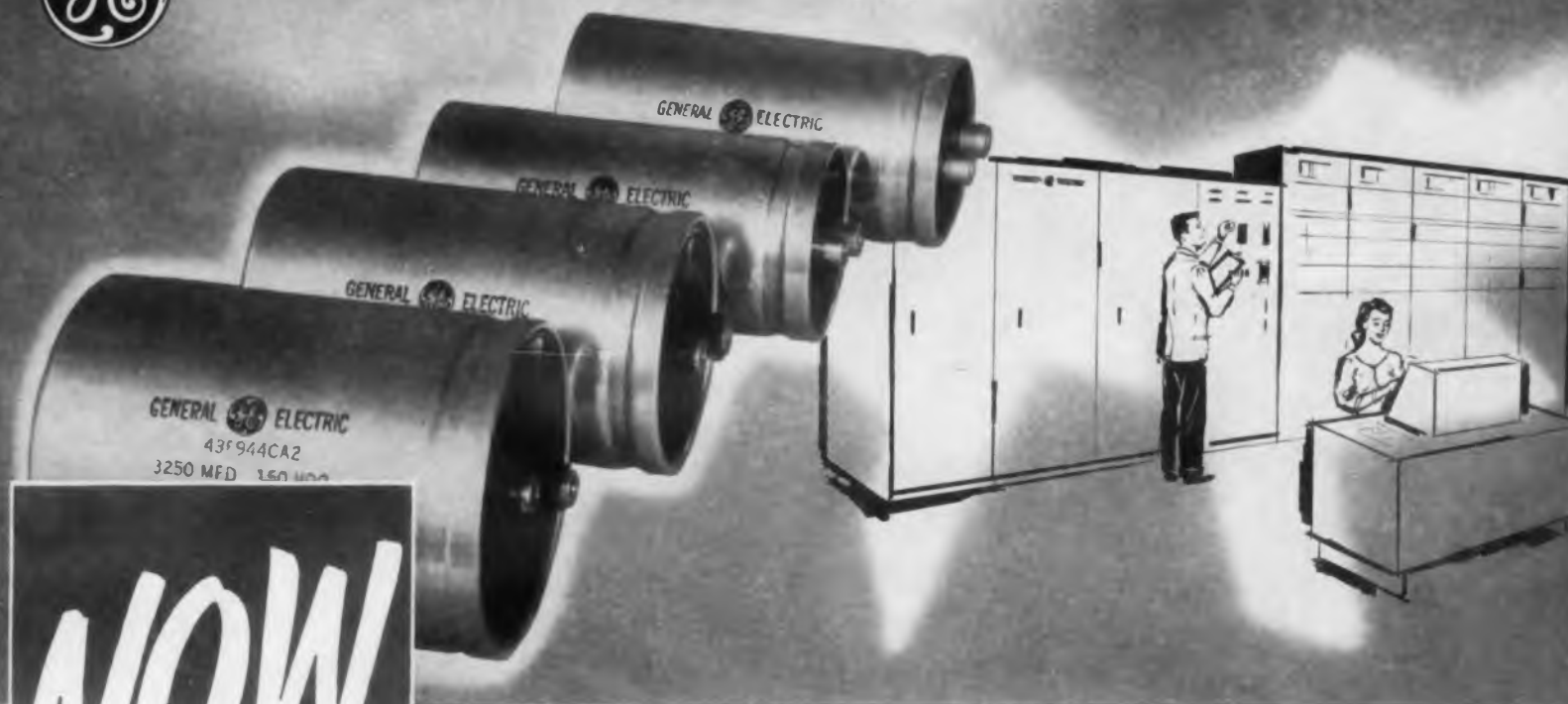
CIRCLE 78 ON READER-SERVICE CARD

CIRCLE 79 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1959



## COMPUTER-GRADE CAPACITORS . . .



**NOW**

General Electric offers . . .

**A new Alumalytic\* Capacitor case size with ratings to 150,000 microfarads**

### Choose from This Wide Range of G-E Ratings

Rated Volts	Surge Volts	NOMINAL CAPACITANCE IN MICROFARADS			
		Case Size 2" x 4 1/8"	Case Size 2 1/2" x 4 1/8"	Case Size 3" x 4 1/8"	Case Size 3" x 5 5/8"
3	5	45,000	70,000	100,000	150,000
5	7	25,000	45,000	65,000	120,000
10	15	20,000	32,000	50,000	75,000
15	20	15,000	25,000	36,000	54,000
25	35	8,700	13,500	21,500	37,000
25	40	7,000	11,000	17,000	25,000
35	45	6,000	9,200	14,200	21,500
50	75	4,000	7,000	10,000	15,000
75	100	2,750	5,000	7,000	10,000
100	135	1,950	3,500	4,500	7,000
150	185	1,250	2,400	3,250	5,000
200	250	900	1,450	2,250	3,500
250	300	700	1,250	2,000	2,500
300	350	575	1,050	1,600	2,100
350	400	450	750	1,200	1,600
400	475	350	625	1,000	1,400
450	525	300	550	850	1,300

NOTE: Operating temperatures -20 C to +65 C. For 85 C applications, another range of units is available with the same physical styles.

GENERAL ELECTRIC HAS EXTENDED ITS LINE of computer-grade Alumalytic capacitors to include unit ratings up to 150,000 microfarads. These higher ratings are available in a new case size—3" x 5 5/8".

**RELIABLE PERFORMANCE AND LONG LIFE** are built into General Electric's entire line of Alumalytic capacitors, using the highest purity materials. For example, 99.99% pure aluminum foil anodes insure an oxide-film dielectric with fewest points of high leakage current. This is essential for trouble-free operation and long shelf life.

**QUALITY IS MAINTAINED DURING MANUFACTURE** with stringent in-process controls. Filtered air and controlled humidity prevent variables due to weather changes. A strict inspection is the final check for uniform product quality.

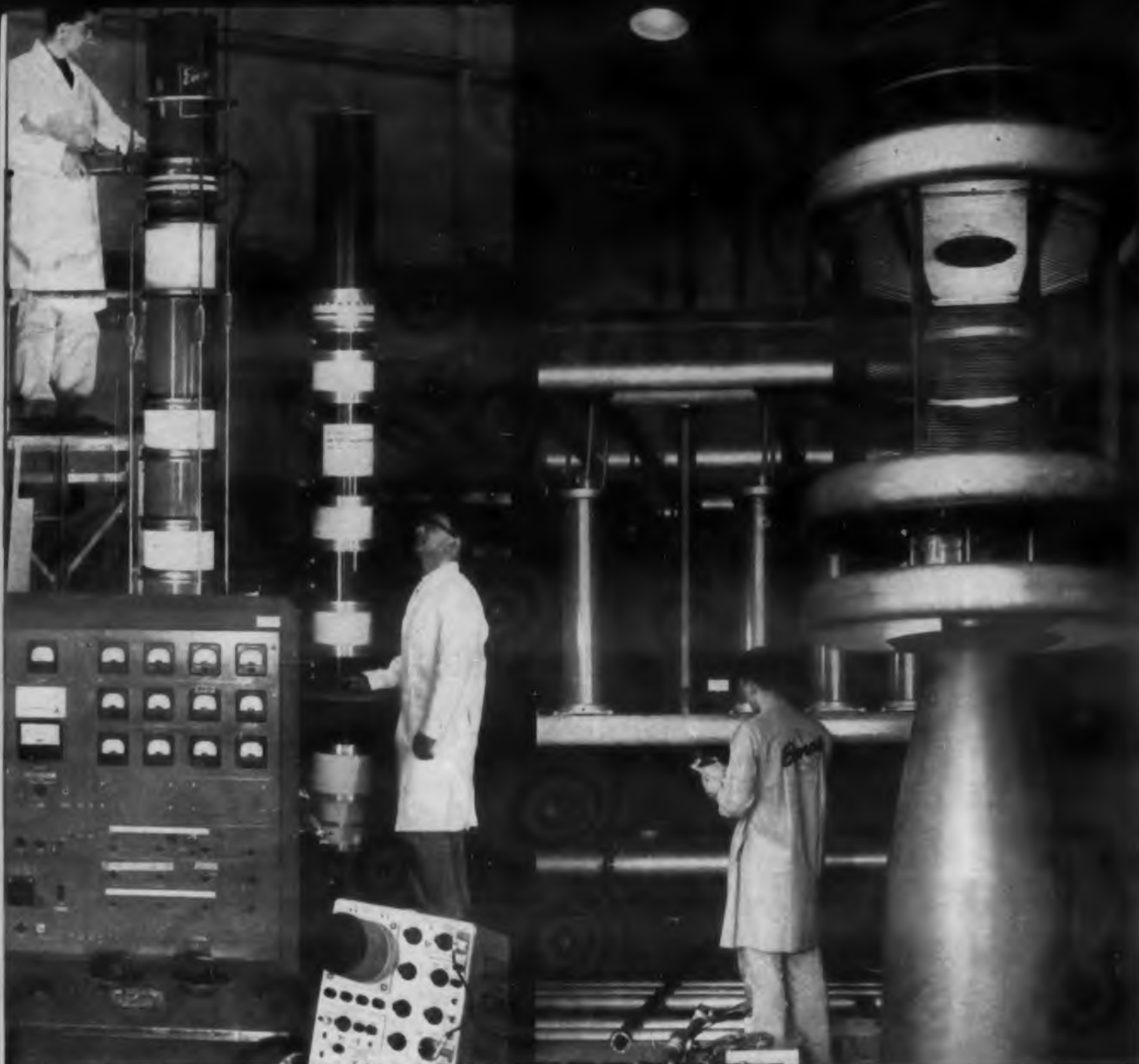
**FOR FURTHER INFORMATION OR QUOTATION**, contact your nearest General Electric Apparatus Sales Office, or write Section 449-9, General Electric Company, Schenectady 5, N. Y.

\*Registered Trademark of General Electric Company

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**





Portion of Eimac's extensive super-power klystron production and test area.

High-voltage d.c. supply used in manufacturing Eimac super-power klystrons.

## SUPER-POWER UHF KLYSTRONS FOR SPACE RADAR NOW IN FULL PRODUCTION AT EIMAC

Tracking fast-moving ballistic missiles and satellites at great distances requires exceptionally powerful radar equipment. Eimac super-power amplifier klystrons, capable of one and one-quarter megawatt peak power and 75 kw average power at ultra-high frequencies, have made these new "space radars" possible. Development of these klystrons, the world's largest electron tubes, has been completed at Eimac and full power tubes have been delivered. They are now being manufactured in production quantities. In addition to radar, Eimac super-power klystrons can be used in linear accelerator and

high-power tropo-scatter applications.

Production of these tubes is being carried on at the Eimac High-Voltage Laboratory in San Bruno, California, where development work was done. Complete facilities are available there for the fabrication, assembly, pumping and testing of these giant tubes. Two power supplies, each capable of producing 120,000 volts d.c. at two and four amperes are used in production and testing operations.

This success in developing and placing these tubes in full production in a relatively short time is indicative of Eimac's extensive experience in the

field of high-power UHF electron devices. Other Eimac amplifier klystron types are used widely in military and commercial tropo-scatter networks throughout the world.

For high power at ultra-high frequencies investigate the many advantages of Eimac external-cavity amplifier klystrons.

**EITEL-McCULLOUGH, INC.**



San Carlos • California

## NEW PRODUCTS

### Thermoelectric Material

For cooling small volumes

These thermoelectric bismuth telluride compositions cool or regulate the temperature of small volumes. Thirty grams of the material in a cooling junction with a temperature difference of 40 C can handle about 1/2 to 3/4 w heat load at its cold junction. With smaller temperature differences, this heat load can be considerably increased.

Merck & Co., Inc., Dept. ED,  
Lincoln Ave., Rahway, N.J.

CIRCLE 80 ON READER-SERVICE CARD

### Digital Voltmeter

Has automatic range switching

The model 520 digital voltmeter has automatic range and polarity switching throughout its 0 to  $\pm 1200$  v dc range. It also has a momentary, three-position lever switch which permits instant checking of both calibration and zero. This switch may be operated while the instrument is in use, thus providing an absolute check of any measurement. The unit can operate digital printers directly and has 0.1% full scale accuracy and 20 meg input impedance.

Franklin Electronics Inc., Dept. ED, Bridgeport, Pa.

CIRCLE 81 ON READER-SERVICE CARD

### VTVM

Has dc to 1500 mc frequency range

The model 1041B vtvm has a frequency range from dc to 1500 mc and a frequency response that is flat to within  $\pm 0.2$  db from 50 cps to 500 mc, or  $-0.5$  to  $+3$  db from 20 cps to 1500 mc. Its ranges are 25 mv to 300 v ac; 10 mv to 1 kv, dc; and 0.02 ohm to 500 meg. Center zero facilities are provided on all dc ranges.

Marconi Instruments, Dept. ED,  
111 Cedar Lane, Englewood, N.J.

CIRCLE 82 ON READER-SERVICE CARD  
CIRCLE 83 ON READER-SERVICE CARD

## Instrument Knobs

### Aluminum

With a special opening through which numbers or indications can be read, these aluminum instrument knobs unmistakably show their position. They are available in 12 colors.

Vemaline Products Co., Dept. ED, Hawthorne, N.J.

CIRCLE 84 ON READER-SERVICE CARD

## Q Meter

### Covers 1 kc to 300 mc

This Q meter covers 1 kc to 300 mc and measures Q from 5 to 1000. It provides accuracies of  $\pm 5\%$  at 100 mc,  $\pm 12\%$  at 200 mc, and  $\pm 20\%$  at 300 mc. Delta Q controls are provided to facilitate batch testing. A complete range of accessories, including test inductors and series and dielectric loss test jigs is available.

Marconi Instruments, Dept. ED, 111 Cedar Lane, Englewood, N.J.

CIRCLE 85 ON READER-SERVICE CARD

## Klystron

### Rated at 1 kw cw



Model VA-802, 1 kw cw, air-cooled, 4-cavity klystron can be continuously tuned from 1700 to 2400 mc and is focused with a permanent magnet. Designed specifically for forward scatter communication systems, it is suitable for both fixed station and transportable service. Power gain of each tube is from 40 to 50 db. Power output into flat line for a vswr of 1.1 or less is 1000 w, and rf drive power—for maximum efficiency tuning—is 0.1 w max. Typical efficiency is 40%.

Varian Associates, Dept. ED, 611 Hansen Way, Palo Alto, Calif.

CIRCLE 86 ON READER-SERVICE CARD

CIRCLE 87 ON READER-SERVICE CARD

## A NEW PRODUCT FROM TRANSITRON...

# IMPROVED SWITCHING SILICON DIODES

Transitron's advanced solid-state development program has now produced the industry's most versatile selection of computer switching diodes.

High forward conductance and 0.3 microsecond inverse recovery are combined with low 125°C leakage currents. The performance of logic circuits in the 10 ma region is improved with the low capacity (3  $\mu\text{f}$ ) 1N806-1N807 diodes. Higher current circuitry can be reliably operated using 1N808-1N809 diodes.

For less stringent temperature environments, Transitron also provides a selection of standard 100°C fast switching diodes.

Production quantities of all types are immediately available from stock. Small quantity requirements can be obtained from your authorized Transitron distributor.

### FAST SWITCHING SILICON DIODES, SUBMINIATURE GLASS PACKAGE

Type	Minimum Forward Current @ 1 V (ma)	Max. Rev. Current @ Specified Voltage ( $\mu\text{a}$ @ volts)		Minimum Saturation Voltage @ 100 $\mu\text{a}$ (25°C) (volts)	Reverse Recovery (256 JAN)			
		25°C	125°C		Max. Rec. Time $\mu\text{sec}$	Rec. Level $\mu\text{a}$	I ma	V volts
1N809	100	1.0 @ 200	50 @ 200	220	0.3	350	30	35
1N808	100	1.0 @ 100	50 @ 100	110	0.3	350	30	35
1N807	4*	.5 @ 175	50 @ 175	200	0.3	100	5	40
1N806	4*	.5 @ 100	50 @ 100	110	0.3	100	5	40
<hr/>								
		25°C	100°C	25°C				
1N663	100	5 @ 75	50 @ 75	100	0.5†	200	5	40
1N658	100	.05 @ 50	25 @ 50	120	0.3	500	5	40
1N659	6	5 @ 50	25 @ 50	55	0.3	88	30	35
1N660	6	5 @ 100	50 @ 100	110	0.3	88	30	35
1N661	6	10 @ 200	100 @ 200	220	0.3	88	30	35
1N643	10	1 @ 100	15 @ 100	200	0.3†	200	5	40
1N662	10	20 @ 50	100 @ 50	100	0.5†	400	5	40

\* Maximum 1 mc capacity = 3  $\mu\text{f}$  (-10 Volts)

† IBM Modified "Y" Circuit

Temperature Range -55°C to 150°C

For complete data, write for bulletins PB-51 and TE-135C

TRANSISTORS • RECTIFIERS • DIODES • REGULATORS • VOLTAGE REFERENCES



# Transitron



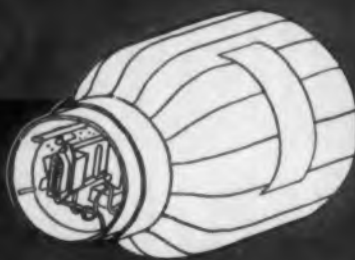
electronic corporation • wakefield, massachusetts



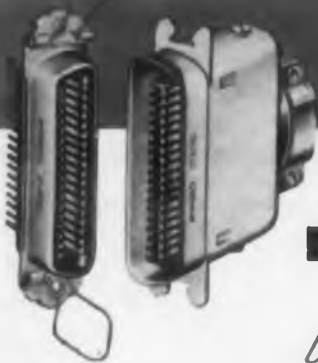
relays...



recorders...



satellites...



## rely on Amphenol Micro-RIBBON CONNECTORS

Since their introduction a short time ago, AMPHENOL Micro-Ribbon connectors have been used in an ever-increasing number of high-reliability applications: Radioactivity recorders, relays, telephone equipment, computer modules, satellites—in hundreds of miniaturized applications where there can be no compromise with reliability.

Micro-Ribbons are the first miniature rack & panel connectors to provide increased reliability over their standard-size counterparts. With an improved "ribbon" contact (no tiny pin contacts to bend and misalign), Micro-Ribbons mate smoothly and efficiently, have easy insertion and extraction. Both mating members are self-wiping, self-cleaning members with double contact action at all times.

Contacts	Rack & Panel Plugs	Mating Receptacles	Cable-to-Chassis Plugs	Mating Receptacles
14	57-10140	57-20140	57-30140	57-40140
24	57-10240	57-20240	57-30240	57-40240
36	57-10360	57-20360	57-30360	57-40360
50	57-10500	57-20500	57-30500	57-40500

Investigate the features and specifications of AMPHENOL Micro-Ribbon connectors—write for complete information.



connector division

AMPHENOL-BORG ELECTRONICS CORPORATION

chicago 50, illinois



"off-the-shelf  
delivery..."

To provide you with the advantage of off-the-shelf delivery, along with factory pricing and single-source expediting.

### AMPHENOL MICRO-RIBBONS

and other standard AMPHENOL components are carried in stock by Industrial Electronic Parts Distributors.

There is an Authorized AMPHENOL Distributor in your area who can have AMPHENOL components at your door today or tomorrow! Take advantage of this time and money saving service on your next requirement for moderate quantities of standard AMPHENOL Components.

Your local AMPHENOL salesman can supply you with the names of the Distributors in your area who stock the AMPHENOL products you require.

SERVICE TO INDUSTRY  
THROUGH AUTHORIZED  
ELECTRONIC PARTS DISTRIBUTORS



## NEW PRODUCTS

### Power Sources

Have adjustable output power

Designed to permit accurate calibration of bidirectional power monitors and termination wattmeters, model 215 power sources have output power that is adjustable from 20 to 100% of rated power. Tuning is continuous over the frequency ranges. Four models are available covering 25 to 50, 50 to 150, 150 to 470, and 470 to 1000 mc. The units are self-contained including power supply and are supplied in bench cabinets or for rack mounting.

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

CIRCLE 88 ON READER-SERVICE CARD

### VHF Transceivers

For local or remote control

Model 90C vhf transceiver and its remote control version, model 90CR, incorporate a 90 channel 118 to 127 mc transmitter and a tunable 108 to 128 mc receiver. They also contain a transistorized power supply and modulator. Shock mounted in a standard glove compartment opening, the units draw 2.2 amp at 28 v dc.

Dare, Inc., Dept. ED, Troy, Ohio.

CIRCLE 89 ON READER-SERVICE CARD

### X Band Magnetrons

For missile and airborne use

Magnetron 2J42B and 6027H are fixed frequency X band devices designed especially for missile and other airborne applications. Minimum peak power outputs are 14 kw and 18 kw respectively. The tubes withstand 5 g vibration at 10 to 500 cps with less than 3 mc frequency shift and less than  $\pm 0.5$  mc frequency modulation. They also withstand 50 g shock for 4 msec and may be operated up to 60,000 ft.

Sylvania Electric Products, Inc., Special Tube Operations, Dept. ED, Mountain View, Calif.

CIRCLE 90 ON READER-SERVICE CARD

CIRCLE 91 ON READER-SERVICE CARD

## FM-AM Generator

### Low noise

An fm-am signal generator for narrow band mobile work, model 995A/4 covers 1.5 to 220 mc. It drifts less than 0.002% per 10 min and has both stepped and continuous incremental frequency controls. An internal fm noise of less than 25 cps enables it to measure 70 to 80 db adjacent channel rejection at 25 kc channel spacing.

Marconi Instruments, Dept. ED, 111 Cedar Lane, Englewood, N.J.

CIRCLE 92 ON READER-SERVICE CARD

## Oscilloscope

### Monitors up to seven channels

Designed for continuous function monitoring of up to seven channels simultaneously in one rack unit, the model 218A oscilloscope provides a means for viewing and evaluating complex voltages. Mainly for use with tape recording and data handling systems, it is suited for measuring and analyzing mechanical quantities through a transducer. Such quantities include stress, strain, vibration, pressure displacement, and acceleration.

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

CIRCLE 93 ON READER-SERVICE CARD

## Microwave Ferrites

### Low loss

These microwave ferrites are low loss magnesium manganese compounds. Type M-022, for general applications at C band frequencies and above, can be used in Faraday rotation and reciprocal phase shifting devices. Type M-032, for use in the S band and below, has low saturation moment and narrow line width. It can be used in resonance isolators and performs well in coaxial phase shifters down to several hundred mc.

Motorola, Inc., Solid State Electronics Dept., Dept. ED, 3102 N. 56th St., Phoenix, Ariz.

CIRCLE 94 ON READER-SERVICE CARD

CIRCLE 95 ON READER-SERVICE CARD ➤

# THE BIG LOOK



2 1/2-inch size

**ACTUAL SIZE**—Although they look bigger, these a-c and d-c units are actually 2 1/2- and 3 1/2-inch sizes. Mounting is interchangeable with JAN, MIL and ASA (round) specifications. Widest range of scales and face-plate colors are available.



3 1/2-inch size

# General Electric small panel meters

BIG LOOK styling of General Electric's new small panel meters adds *functional beauty* to your products and equipment. Distinctive design creates the illusion of bigness, yet these new meters fit into the same panel space as old style meters. You get big border-to-border scale . . . *modern, clean-line design* . . . *your choice of seven attractive colors* . . . and widest selection of scales.

Up to 28% longer scales allow accurate readings. Tough neoprene gaskets provide *complete protection* of internal parts and movements from dirt, dust or water. Best of all, General Electric BIG LOOK meters are *competitively priced*. And you can plan on *fast delivery*, too, from a national network of authorized stocking distributors and G-E Apparatus Sales Offices.

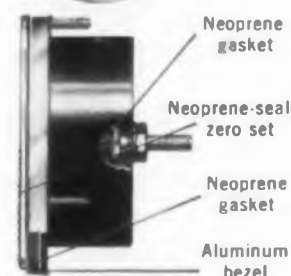
Let G.E.'s BIG LOOK in panel meters help you improve the appearance and reliability of your equipment at low cost. Get the full story. Just contact your G-E Apparatus Sales Engineer, or write for bulletin GEA-6678, Sect. 593-303, General Electric Co., Schenectady, N. Y.



**SELF-SHIELDED CORE-MAGNET**, used in d-c milliammeters below 5 MA and all microammeters, permits mounting of meters on magnetic or non-magnetic panels without special calibration.



**ALL A-C METERS** utilize moving-iron mechanisms—plus magnetic damping to settle the pointer quickly and accurately.



**COMPLETELY SEALED CASES** protect internal parts of instrument from harmful contaminants. Even zero-set is sealed with a neoprene O-ring.

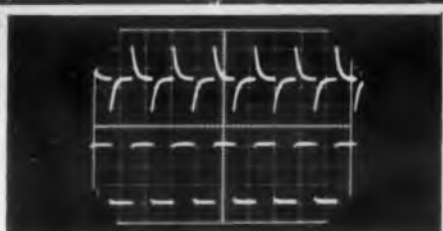
*Progress Is Our Most Important Product*

**GENERAL ELECTRIC**

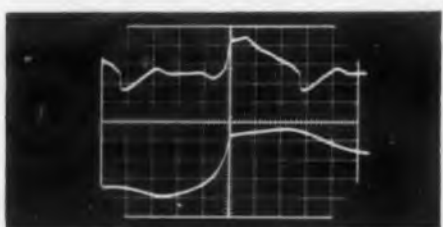




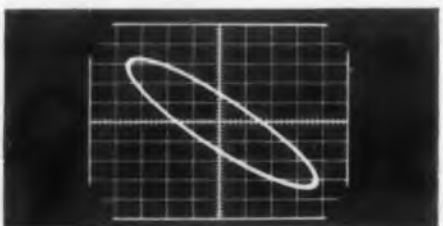
SHOWN IS M. SCHNEIDERMAN, PROJECT ENGINEER ON THE DUAL, USING HIS UNIT FOR ONE OF ITS MANY APPLICATIONS.



**DUAL-BEAM DISPLAY** — Outputs of the ultra-high-sensitivity deflection amplifiers of each channel are applied on identical time bases for clear and accurate comparison.



**EXPANDED TIME BASE DISPLAY** — With a signal from one channel applied on a calibrated time base, that same signal (or a different one) may be displayed on an expanded time base through the other channel. X5 expansion is available on either channel.



**ULTRA-HIGH-SENSITIVITY X-Y PLOTTING** — At the turn of a front panel control, outputs of the two deflection amplifiers may be applied to the X-Y axes of one channel, providing the most sensitive identical X-Y amplifier scope available. In this condition there is still an unused channel to display either of the above signals against time.

## AN ULTRA-HIGH SENSITIVITY DUAL-BEAM OSCILLOSCOPE OFFERING A GREAT VARIETY OF DISPLAYS

The Du Mont DUAL (Type 411) is a dual-beam oscilloscope of high sensitivity embodying an unusually varied selection of displays. It is a true dual-beam scope employing a multi-gun cathode-ray tube. Each vertical channel may be operated independently of the other, with complete amplitude calibration facilities on both.

### BRIEF SPECIFICATIONS

**SENSITIVITY** (both channels identical): Through amplifier, ac or dc—100 uvolts/major scale division (1 mv full scale).

**FREQUENCY RESPONSE:** dc to 100 kc

**SYNCHRONIZATION SOURCE:** External, power line or internal pickoff from either Y-amplifier; syncs on either polarity.

**SWEEP SPEEDS:** Calibrated sweeps, 19 fixed steps ranging from 1 sec/cm to 1 usec/cm in a 1-2-5 sequence. Uncalibrated sweep (through amplifier), continuously variable from 1 sec/cm to 2 usec/cm.

**SWEEP EXPANSION:** Up to five times full scale on either channel independently with no on-screen distortion.

**VERTICAL EXPANSION:** Up to three time full scale.

**VOLTS/DIVISION RANGES:** VOLTS PER DIVISION switch settings .001, .01, .1, 1 and 10 with MULTIPLIER switch settings x .1, x .5, x 1, x 2, and x 5.

**POWER SOURCE:** 115/230 volts  $\pm$  10%, single phase 50 — 400 cps. Transistorized heater regulation on all critical amplifier circuits.

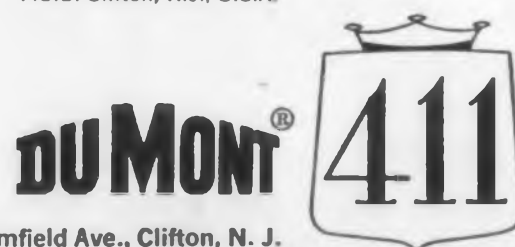
**CATHODE-RAY TUBE:** 5 ARP, operating at 2500 volts.

**MECHANICAL:** Size: Type 411, 17½" x 13½" x 23¼" overall. Type 411-R, 17½" x 19" (panel), 13½" (behind panel) x 21", 1¾" protrusion in front of panel. Weight approx. 70 pounds.

**HAND-CRAFTED WIRING THROUGHOUT**

**\$995<sup>00</sup>**

PRICE: Type 411 & 411-R  
F.O.B. Clifton, N.J., U.S.A.



**WRITE FOR COMPLETE  
INFORMATION**

INSTRUMENT DIVISION

Allen B. Du Mont Laboratories, Inc. • 760 Bloomfield Ave., Clifton, N. J.

## NEW PRODUCTS

### Tube Shield Liner and Shields

Dissipates up to 50% of heat



The Thermo-flex liner with the NW type shield will reduce the bare bulb temperature of tubes by more than 50% and when used with the TR type shield will reduce the temperature by approximately 35%. They are available in shields for all standard size miniature tubes as well as some of the larger noval type tubes such as the 6094. The shields and liners have been designed to meet the requirements of MIL-S-9372, MIL-S-19786 and SCL6307/2.

International Electronic Research Corp., Dept. ED, 145 W. Magnolia Blvd., Burbank, Calif.

CIRCLE 96 ON READER-SERVICE CARD

### Switching Transistors

High gain

Power transistors 2N1136, A, and B; 2N1137, A, and B; and 2N1138, A, and B are designed for use in power switching and control circuits. They are provided in current gain ranges of 50 to 100, 75 to 150, and 100 to 200 at a collector current of 3 amp dc. Featuring a flat beta curve, they have a 5 amp maximum current rating and can switch power up to 400 w. Collector to emitter breakdown voltage ratings are 40, 70, and 80.

Bendix Aviation Corp., Red Bank Div., Semiconductor Products, Dept. ED, 201 Westwood Ave., Long Branch, N.J.

CIRCLE 97 ON READER-SERVICE CARD  
CIRCLE 98 ON READER-SERVICE CARD

## Converters

Have 0.01% linearity

Model AC-1 manual ranging and AC-2 automatic ranging converters are designed for use with the company's digital voltmeters. They have a 30 cps to 20 kc range, 0.01% linearity, 0.02% stability, and 10 meg input impedance. Full-wave rectification provides an accuracy of  $\pm 0.1\%$  and 2 digits on four ranges.

Cubic Corp., Dept. ED, 5575 Kearny Villa Rd., San Diego 11, Calif.

CIRCLE 105 ON READER-SERVICE CARD

## Transfer Function Analyzer

Tests automatic control systems

Designed to test the frequency response of automatic control systems, this transfer function analyzer has a 0.5 cps to 10 kc range. It can deal with phase differences from 0 to 360 deg, amplitude differences to 70 db, and harmonic distortion to 100%. The equipment consists of the company's AD-880-A/1 two phase low frequency decade oscillator; AD-729-B/100 low frequency phasemeter; and AD-925-A tunable filter.

Muirhead Instruments, Inc., Dept. ED, 677 Fifth Ave., New York 22, N.Y.

CIRCLE 106 ON READER-SERVICE CARD

## Instrument Calibration Standard

Has digital readout

A digital reading instrument calibration standard, the model 1294 supplies dc voltages from 1 mv to 2 kv in 12 full scale ranges; dc current from 10  $\mu$ a to 30 amp in 12 full scale ranges; and ac voltages and currents over the same span with 14 full scale ranges for each function. Accuracy is  $\pm 0.1\%$  for dc and  $\pm 0.3\%$  for ac functions, and ac indication is true rms. Printed readout is available as an option.

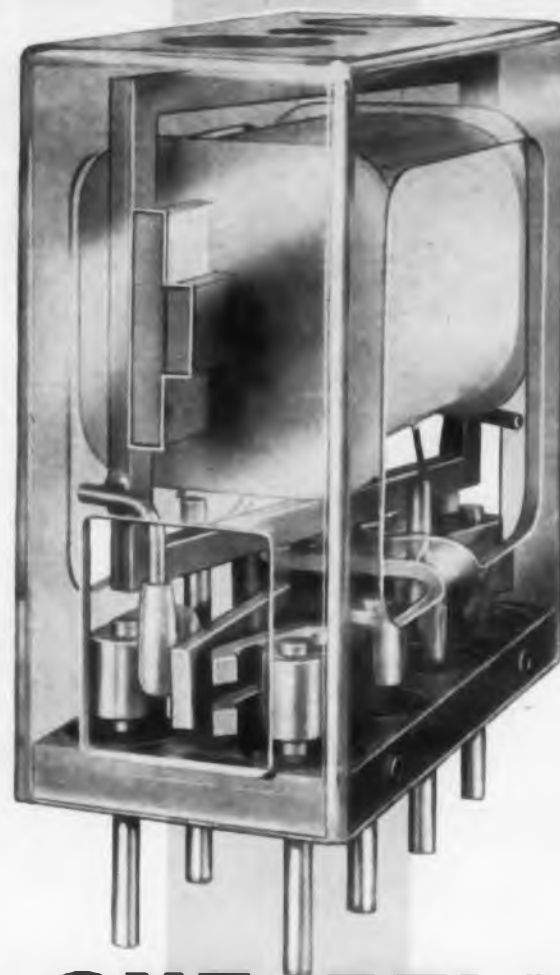
Radio Frequency Labs, Inc., Dept. ED, Boonton, N.J.

CIRCLE 107 ON READER-SERVICE CARD

CIRCLE 108 ON READER-SERVICE CARD

## 4 times actual size

Mock-up of CLARE Type F Relay enlarged to show operating mechanism. Note bifurcated contacts which enable this relay to handle a wide variety of contact loads.



## With this ONE RELAY

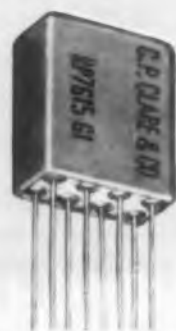
You can handle contact loads from 3 amperes down to 1 microampere, 1 millivolt

### SPECIFICATIONS

Ambient Temperature	-65° C to +125° C.
Shock	65 Gs for 11 milliseconds.
Vibration	5-75 cps at maximum excursion of 1/8 inch, 75-2000 cps at 20 Gs acceleration.
Dielectric Strength	Sea level—1000 volts rms between terminals and frame, and between adjacent circuits; 750 volts rms between contacts of a set. At 80,000 ft., 350 volts rms.
Insulation Resistance	1000 megohms minimum at 125° C.
Coils	Coils up to 10,000 ohms available for a wide range of voltage or current operation.
Nominal Operating Power	250 milliwatts.
Pickup Time	3.5 milliseconds nominal.
Dropout Time	1.5 milliseconds nominal.
Contact Arrangement	2 pdt (2 form C).
Contact Rating	3 amps resistive at 28 volts d-c or 115 volts a-c; also will handle loads of 1 microampere @ 1 millivolt reliably.
Contact Resistance	0.03 ohm maximum.
Contact Life	500,000 operations minimum at 2 amps; 100,000 operations minimum at 3 amps; 1,000,000 operations minimum at 1 amp.
Enclosure	Hermetically sealed, filled with dry nitrogen at 1 atmosphere pressure.
Mounting	All popular mounting arrangements available.
Terminals	Printed circuit; solder; plug-in (matching socket available). Variations of printed-circuit terminal length on 1/10-inch grid spacing available.
Weight	17 grams.
Military Specifications	MIL-R-25018, except as to contact bounce.



ACTUAL SIZE  
All popular mounting arrangements are available. Terminal arrangements nicely suited to 1/10 inch grid spacing.



• In one relay—the Type F—CLARE provides a precise component of unusual flexibility for long life operation under a wide variety of contact loads.

Tests have shown a performance of over 22,500,000 operations at 0.1 ampere, 115 volts a-c. Minimum contact life at 3 amperes is 100,000 operations. Contacts have carried 1 microampere, 1 millivolt for 700,000 operations with a failure resistance of 500 ohms, with no misses recorded.

This amazing low-level life is primarily a result of the use of gold plated contacts. These same contacts, however, will carry up to 3 amperes.

A special plug-in mounting arrangement that will stand extreme shock and vibration is now available.

The CLARE Type F Relay is hermetically sealed, operates perfectly in a wide range of temperatures, withstands heavy shock and vibration—is fast and more than moderately sensitive.

Send for Engineering Bulletin No. 124  
Write or call C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY.

# CLARE RELAYS

FIRST in the industrial field

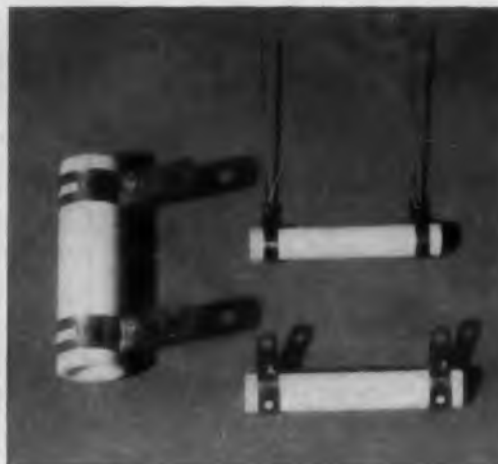




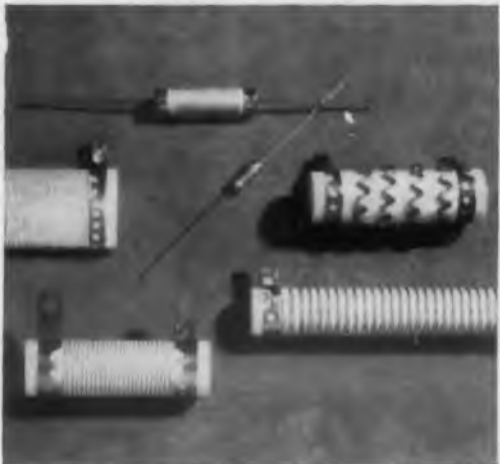
*tough tests for incoming material*



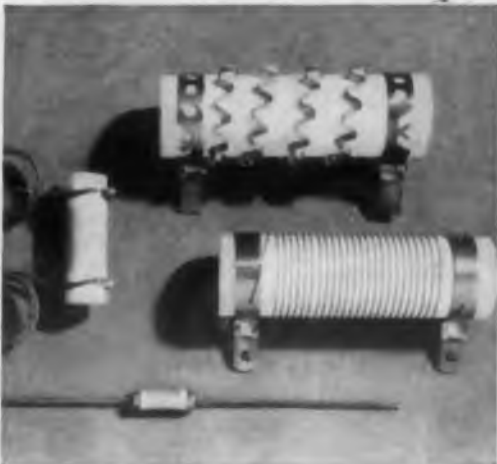
*specially selected ceramic core materials*



*rigid, low resistance terminals*



*finest alloy resistance wire*



*spot welded or silver brazed junctions*



**THIS IS A  
RESISTOR  
YOU CAN  
STAKE YOUR  
REPUTATION ON**



*our own VITROHM enamel, first coat . . . and final coat*

### **Built-in VITROHM reliability, from core to final vitreous enamel, lets you solder these resistors in and forget 'em**

They come in a tremendous variety of sizes, shapes and ratings, but all Ward Leonard VITROHM resistors have one thing in common: They're built for maximum reliability.

Take just one point—ceramic cores, for example: Made by Ward Leonard to exacting specs, the cores feature low-porosity, high-dielectric-strength ceramic for maximum moisture exclusion and good electrical insulation. What's more, the thermal coefficient of linear expansion of ceramic is specially selected to make the core compatible with resistance wire, enamel and terminals . . . to prevent cracking, crazing, peeling, or layer separation.

And there's the same meticulous care with all the other elements that go to make up a finished VITROHM resistor: terminals, spot welded or brazed junctions, resistance wire, and last but not least, W/L VITROHM enamel, formulated and manufactured in our own modern enamel smelting plant . . . provides complete electrical and mechanical protection.

To insure reliability in your product . . . specify VITROHM's. Write for data packed catalog #15, and list of stocking Electronic Distributors: Ward Leonard Electric Co., 77 South Street, Mount Vernon, N.Y. (In Canada: Ward Leonard of Canada Ltd., Toronto.)

CIRCLE 56 ON READER-SERVICE CARD

**WARD  
LEONARD  
ELECTRIC COMPANY**  
MOUNT VERNON, NEW YORK

**LIVE BETTER...Electrically**

**Result-Engineered Controls Since 1892**



## **NEW PRODUCTS**

### **Taper Pin Connectors**

**Dual row**



Type UPCC-FDTP printed card connectors have two rows of taper pin terminals linked mechanically and electronically for use with AMP 53 taper pins. Available with 7, 11, 15, 19, 23, or 32 contacts, they may also be obtained in custom configurations.

U. S. Components, Inc., Dept. ED, 454 E. 148th St., New York 55, N.Y.

CIRCLE 57 ON READER-SERVICE CARD

### **Telemetry Equipment**

**Modular**



Transistorized airborne or ground based telemetry equipment for data acquisition. K-series modules can be supplied as systems or as individual units. The current line consists of: electronic commutators for time-division multiplexing of high level data signals; mechanical commutators for time-division multiplexing of high and low level signals; low level amplifiers for raising millivolt commutated inputs to the 0 to 5 v level; pulse width keyers for coding commutator outputs; and low voltage system power supplies. The units operate from -55 to +100 C and withstand 30 g, 5 to 2000 cps vibration and 200 g, 11 msec shocks.

Applied Science Corporation of Princeton, Dept. ED, P.O. Box 44, Princeton, N.J.

CIRCLE 58 ON READER-SERVICE CARD

**Don't miss an issue of *ELECTRONIC DESIGN*; return your renewal card today.**

**ELECTRONIC DESIGN • April 29, 1959**

## Static Inverters

Have high stability



Model 12-115-60AC static inverters have non-saturating time-constant design which permits frequency stability over as much as  $\pm 60\%$  of the input dc voltage. Efficiency up to 95% is obtained by elimination of zener diodes and other voltage regulation devices. Standard units have square-wave output, both sinusoidal output is available. The completely transistorized units are protected against overload and short circuit, and operating temperature range is  $-40$  to  $+70$  C. Input voltage: 12 v dc. Output voltage: 115 v ac, rms. And output power is 175 va continuous, 250 va intermittent.

Static Inverters Corp., Dept. ED, 2501 East 68th St., Long Beach, Calif.

CIRCLE 113 ON READER-SERVICE CARD

## Precision Potentiometer

Noise free

A 4 w, multisection, wirewound potentiometer, model 158 provides noise free operation from  $-55$  to  $+105$  C. It is available in resistances up to 150 K and has an independent linearity of  $\pm 0.25\%$ , resistance tolerance of  $\pm 5\%$ , and resolution of 0.05%. Insulation resistance is 100,000 meg and life expectancy is 5 million revolutions. Special models are available with 0.2% independent linearity,  $\pm 1\%$  resistance tolerance, 0.025% resolution, 500,000 meg insulation resistance, and a  $-65$  to  $+150$  C temperature range.

New England Instrument Co., Dept. ED, 320 Main St., Woonsocket, R.I.

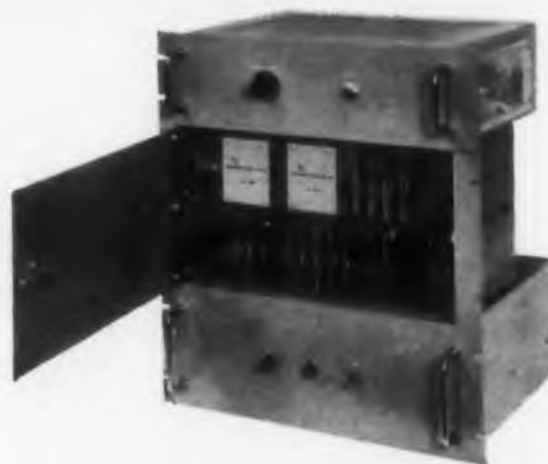
CIRCLE 114 ON READER-SERVICE CARD

CIRCLE 115 ON READER-SERVICE CARD ➤

quality control series no. 2  
UNDER WATER TEST

THIS  
TELEMETER  
MAGNETICS  
MEMORY CORE  
WAS TOWED FROM HERE  
TO CATALINA BY  
OCEAN LINER  
(and it definitely got wet!)

SILLY TEST  
but we hope it attracts your  
attention to the thorough  
three-stage inspection and testing  
given every TMI product—  
from ferrite cores to core arrays  
to buffers and memory systems



TMI Type 1092-BQ8A  
Core Storage Buffer

## DATA SYSTEMS COMPATIBILITY—with the New TMI Core Storage Buffer

This fully transistorized unit stores up to 1092 eight-bit characters at 100-kc rate. The buffer is compactly designed for relay rack mounting and is complete with integral power supply. Ideally suited to synchronizing data systems operating at different speeds.

Features include: interlaced load and unload • capacity expansion • convenient clear control • internal checking circuits • ease of installation • economy • unit is priced 22% below previously available buffers of similar characteristics.

In addition to the Type 1092-BQ8A, TMI produces a full line of core storage buffers for an almost infinite variety of applications. Units are available in capacities from 80 to 2184 characters. Components, assemblies, and completed buffers each undergo rigorous tests. Request copy of specification #191 containing complete data.

## IMPORTANT JOB OPPORTUNITIES

Expansion to handle our increasing business activity plus research and development in new areas have created openings for qualified computer engineers. Investigate the wonderful opportunities offered by TMI in Southern California

## TELEMETER MAGNETICS Inc.

Manufacturers of Ferrite Cores • Core Arrays • Buffers • Memories

2245 pontius avenue, los angeles 64, california • 306 "h" st., n.w. washington 13, d.c.



This is  
BJ ELECTRONICS

# Business

The 8th definition of **business**, according to Webster, reads as extracted, "... to increase business by advertising." This advertisement has the sole purpose of offering the capabilities of BJ Electronics, Borg-Warner Corporation, to military suppliers for the manufacture of precision electronics. From your print specifications, this establishment will fulfill orders quickly and economically, utilizing 10 years of know-how and over 90,000 sq. ft. of new, completely equipped facilities. Consider your need, then ... consider this a direct solicitation of your sub-contract electronic business.

Write for facilities brochure. BJ Electronics, Borg-Warner Corporation, 3300 Newport Boulevard, Santa Ana, California. National Direct Dial Number 714 KI 5-5581, TWX 5291.



## NEW PRODUCTS

### Pulse-Waveform Generator

Frequencies of 0.01 to 2000 cps



Long calibrated pulses, sine, triangular and square waves can be generated with this unit. Signals are generated over a frequency range of 0.01 to 2000 cps. Pulse lengths are calibrated from 100  $\mu$ sec to 10 sec, with an accuracy of  $\pm 3\%$ . Constant duty cycle operation may be selected with calibrated pulse duty of 10 to 90% over the full frequency span. Maximum pulse amplitude is 50 v at 40 ma. Dial accuracy is  $\pm 2\%$ , frequency stability  $\pm 1\%$ , and output stability within 2%.

Kennedy Co., Dept. ED, 2487 E. Washington St., Pasadena, Calif.

CIRCLE 127 ON READER-SERVICE CARD

### Beam Switching Tube Tester

Checks all ten positions

Designed for the company's type 6700 and BD-301 beam switching tubes, the model 600 tester permits quick checking of all ten tube positions both statically and dynamically. It has an internal power supply, a spade voltage meter, a variable spade voltage control, a target current meter, and a built-in pin straightener. Other features include visual indication of beam position, manual or automatic cycling, and provision for monitoring cathode current externally and for monitoring and adjusting grid bias level.

Burroughs Corp., Dept. ED, P.O. Box 1226, Plainfield, N.J.

CIRCLE 128 ON READER-SERVICE CARD

CIRCLE 129 ON READER-SERVICE CARD

## Signal Generator

Output of 4 to 410 mc

Model SG-54A standard signal generator has an output of from 4 to 410 mc. Incidental fm is less than 300 cps at 50% modulation of any rf or modulation frequency. vswr is less than 1.1 and frequency drift less than 0.001% over a 10 min period after warm-up. Output level is continuously variable from 0.1 to 100,000 mv. The carrier may be internally or externally sine wave modulated or externally pulse modulated. In pulse modulation, the rise time is better than 1  $\mu$ sec from 6 mc to 120 mc and better than 0.5  $\mu$ sec from 120 to 410 mc. Frequency calibration is within 0.5% and resettability better than 0.05%. Modulated spectrum distortion is less than 3% at 50% modulation.

Trad Electronics Corp., Dept. ED,  
101 First Ave., Asbury Park, N.J.

CIRCLE 130 ON READER-SERVICE CARD

## TWT Amplifier

Provides 30 db gain

This twt amplifier provides a 30 db power gain from 12 to 16 kmc. It uses a permanent magnet twt weighing less than 5 lb and needs no electromagnet for focusing. Power supply regulation is 0.1%, ripple is 10 mv, and total weight is 55 lb.

Menlo Park Engineering Co.,  
Dept. ED, 711 Hamilton Ave.,  
Menlo Park, Calif.

CIRCLE 131 ON READER-SERVICE CARD

## Potentiometers

650 ohm to 100 K range

Series T single-turn potentiometers are 7/8 in. in diameter and have standard resistances ranging from 650 ohms to 100 K. Power rating is 1.2 w at 40 C, derating to zero at 125 C. The units have standard linearity tolerances of  $\pm 0.5$  and  $\pm 0.2\%$  and meet MIL-R-19 and NAS 710 specifications.

Beckman Instruments, Inc., Heli-  
pot Div., Dept. ED, 2500 Fullerton  
Bl., Fullerton, Calif.

CIRCLE 132 ON READER-SERVICE CARD  
CIRCLE 133 ON READER-SERVICE CARD

# Lambda Power Supplies have been the first choice of engineers in every independent poll



*The only power supplies guaranteed for 5 years*

This unprecedented five-year guarantee is the strongest proof of consistent trouble-free power supply performance ever offered. It is bolstered even further by a series of independent surveys which prove that Lambda equipment is preferred by more than 50% of the engineers who specify power supplies.

## CHECK LIST: LAMBDA REGULATED DC POWER SUPPLIES

Model	Style	Voltage Range (VDC)	Current Range (MA DC)	Regulation Impedance Ripple (Table I)	5.3 VAC Output (Amps)	Meters	Output Voltage Control	Output Terminals	Size Weight (Table II)	Price (U.S. and Canada) F.O.B. Factory College Pt., N. Y.
<b>TRANSISTORIZED</b>										
LT-1095	Rack	0-32	0-1000	A	—	None	Rear	Rear	S-1	285.00
LT-1095M	Rack	0-32	0-1000	A	—	2 1/2" rect	Rear	Rear	S-1	315.00
LT-2095	Rack	0-32	0-2000	B	—	None	Rear	Rear	S-1	365.00
LT-2095M	Rack	0-32	0-2000	B	—	2 1/2" rect	Rear	Rear	S-1	395.00
<b>TUBE REGULATED</b>										
C-280	Rack	0-200	0-200	C	10A	None	Rear	Rear	S-2	184.50
C-280M	Rack	0-200	0-200	C	10A	3 1/2" rect	Rear	Rear	S-2	214.50
C-281	Rack	125-325	0-200	C	10A	None	Rear	Rear	S-2	159.50
C-281M	Rack	125-325	0-200	C	10A	3 1/2" rect	Rear	Rear	S-2	189.50
C-282	Rack	325-525	0-200	C	10A	None	Rear	Rear	S-2	169.50
C-282M	Rack	325-525	0-200	C	10A	3 1/2" rect	Rear	Rear	S-2	199.50
C-480	Rack	0-200	0-400	D	15A	None	Rear	Rear	S-2	259.50
C-480M	Rack	0-200	0-400	D	15A	3 1/2" rect	Rear	Rear	S-2	289.50
C-481	Rack	125-325	0-400	D	15A	None	Rear	Rear	S-2	244.50
C-481M	Rack	125-325	0-400	D	15A	3 1/2" rect	Rear	Rear	S-2	274.50
C-482	Rack	325-525	0-400	D	15A	None	Rear	Rear	S-2	259.50
C-482M	Rack	325-525	0-400	D	15A	3 1/2" rect	Rear	Rear	S-2	289.50
C-880	Rack	0-200	0-800	E	20A	None	Rear	Rear	S-3	340.00
C-880M	Rack	0-200	0-800	E	20A	3 1/2" rect	Rear	Rear	S-3	370.00
C-881	Rack	125-325	0-800	E	20A	None	Rear	Rear	S-3	315.00
C-881M	Rack	125-325	0-800	E	20A	3 1/2" rect	Rear	Rear	S-3	345.00
C-882	Rack	325-525	0-800	E	20A	None	Rear	Rear	S-3	360.00
C-882M	Rack	325-525	0-800	E	20A	3 1/2" rect	Rear	Rear	S-3	390.00
C-1580	Rack	0-200	0-1500	F	30A	None	Rear	Rear	S-4	550.00
C-1580M	Rack	0-200	0-1500	F	30A	3 1/2" rect	Rear	Rear	S-4	580.00
C-1581	Rack	125-325	0-1500	F	30A	None	Rear	Rear	S-4	575.00
C-1581M	Rack	125-325	0-1500	F	30A	3 1/2" rect	Rear	Rear	S-4	605.00
C-1582	Rack	325-525	0-1500	F	30A	None	Rear	Rear	S-4	650.00
C-1582M	Rack	325-525	0-1500	F	30A	3 1/2" rect	Rear	Rear	S-4	680.00
28	Rack	200-325	0-100	G	3A	None	Rear	Rear	S-5	59.50
28M	Rack	200-325	0-100	G	3A	3 1/2" rect	Rear	Rear	S-5	89.50
29	Rack	100-200	0-100	H	3A	None	Rear	Rear	S-5	69.50
29M	Rack	100-200	0-100	H	3A	3 1/2" rect	Rear	Rear	S-5	99.50
32	Rack	200-325	0-300	J	2 @ 5A	None	Rear	Rear	S-6	139.50
32M	Rack	200-325	0-300	J	2 @ 5A	3 1/2" rect	Rear	Rear	S-6	169.50
33	Rack	100-200	0-300	J	2 @ 5A	None	Rear	Rear	S-6	154.50
33M	Rack	100-200	0-300	J	2 @ 5A	3 1/2" rect	Rear	Rear	S-6	184.50
50R	Rack	0-500 0-50 0-200	0-500 Bias High Imped.	K L M	2 @ 5A	4 1/2" rect	Front	Fr & rear	S-7	420.00
<b>REGULATED POWER SUPPLIES—PORTABLE AND BENCH</b>										
25	Bench	200-325	0-100	G	3A	None	Front	Front	S-8	69.50
26	Bench	100-200	0-100	H	3A	None	Front	Front	S-8	79.50
50	Bench					See Model 50R above			S-9	440.00
71	Portable	0-500 0-50 0-200	0-200 Bias High Imped.	N P Q	2 @ 5A	3 1/2" rect	Front	Front	S-10	310.00

**TABLE I**  
DC OUTPUT VOLTAGE REGULATION,  
IMPEDANCE, RIPPLE

REGULATION		Internal Impedance (ohms)		Ripple, rms (millivolts or %)	
Line (105-125 VAC)	Load (min to max)	Less than	Less than	Less than	Less than
A 0.15% or 20MV	0.15% or 20MV	0.50		1 mv	
B 0.15% or 20MV	0.15% or 20MV	0.025		1 mv	
C 0.15% or 0.3V	0.25% or 0.5V	6		3 mv	
D 0.15% or 0.3V	0.25% or 0.5V	3		3 mv	
E 0.15% or 0.3V	0.25% or 0.5V	1.5		3 mv	
F 0.15% or 0.3V	0.25% or 0.5V	0.75		3 mv	
G 1%	1%	10		10 mv	
H 1%	1%	10		5 mv	
J 1%	1%	4		10 mv	
K 0.15% or 0.1V	0.5% or 0.3V	2		8 mv	
L 0.1%	unregulated	3,300		2 mv	
M 0.1%	unregulated	17,500		5 mv	
N 0.15% or 0.3V	0.15% or 0.3V	4		5 mv	
P 0.1%	unregulated	5,500		2 mv	
Q 0.1%	unregulated	25,000		5 mv	

**TABLE II**  
SIZES AND WEIGHTS

Size	H x W x D (inches)	WEIGHT	
		Net (lbs)	Shipping (lbs)
S-1	3 1/2 x 19 x 14 1/2	35	85
S-2	5 1/4 x 19 x 14 1/2	53	80
S-3	7 x 19 x 14 1/2	84	100
S-4	8 3/4 x 19 x 14 1/2	120	140
S-5	5 1/4 x 19 x 8	19	23
S-6	10 1/2 x 19 x 9 1/4	42	52
S-7	10 1/2 x 19 x 14 1/2	89	140
S-8	8 x 14 x 6	19	23
S-9	12 1/2 x 22 x 15	110	150
S-10	13 x 8 3/4 x 14 1/2	49	85

## GENERAL SPECIFICATIONS

(when fully loaded) at an input of 115 VAC. This value allows for voltage drop in connecting leads. Dual outputs may be connected in series or parallel.

**DUTY CYCLE** Continuous duty at full load.

**METERS** Where meters are indicated, a separate voltmeter and milliammeter are provided.

**OVERLOAD PROTECTION** Ample protection is provided against external overload and internal failure conditions by means of fuses.

Circuit breakers of the magnetic, "trip-free" type are employed in Models 50, 50R, 71 and LT series as protection against external overloads. And in the LT series, the transistor complement is independently protected by special transistor circuitry.

**STYLE** Rack Models are designed for mounting on standard 19" relay racks.

Bench Models are provided with compact, specially-designed, ventilated cabinets equipped with carrying handles. The power supply units may be removed from their cabinets for mounting in standard relay racks (except Models 25, 26 and 71).

**RATINGS AND COMPONENTS** All components used are of the highest quality and are operated well within manufacturers' ratings. Hermetically-sealed, oil-filled capacitors are used exclusively, except in LT series, where special high purity foil, long-life electrolytics are used. "C" and "LT" series power supplies use hermetically-sealed magnetic components exclusively. Ample safety factors are provided in the design to insure the long life, and the dependable, trouble-free operation so desirable in industrial and laboratory applications.

All specifications and prices subject to change without notice.



**LAMBDA ELECTRONICS CORP.**

11-11 131 STREET • COLLEGE POINT 56, NEW YORK

INDEPENDENCE 1-8500 CABLE ADDRESS: LAMBDATRON, NEW YORK

Keep this  
check list handy



## NEW PRODUCTS

### Miniature RF Filters

Have 0 to 1250 mc cutoff frequencies



These lumped constant, low pass rf filters have cutoff frequencies from 0 to 1250 mc and provide sharp attenuation in the stop-band region. At a frequency of 1.2 times cutoff, attenuation is 20 db or higher; and at 1.5 times cutoff, it is at least 60 db. Units down to 100 mc cutoff are 3-1/2 in. long, including end connectors. Suited for the generation of signals for testing the frequency response of rf circuits, or in vswr measurements, the filters may also be used in transmitter or telemeter systems for missiles and aircraft. They are finished in nickel plated brass with BNC male and female end connectors. Input power is normally 10 w, maximum; impedance, 50 ohms.

Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.

CIRCLE 121 ON READER-SERVICE CARD

### Voltage Regulator

Has 115 v rated output

With a 150 w load and a constant frequency of 60 cps, the LVR-150 voltage regulator maintains an output voltage within  $\pm 0.5\%$  of the rated 115 v through input variations between 95 and 130 v. With a 200 w load and 105 to 130 v input variation, the output is regulated to within  $\pm 2\%$ . The unit can also regulate output voltage to within  $\pm 5\%$  with rated load, 95 to 130 v input variation, and 50 to 63 cps frequency variation. The main assembly is housed in a 5 x 6 x 6 in. case with a four terminal input-output plug, and the diode bridge and associated components are mounted under a cover plate on the side of the main unit.

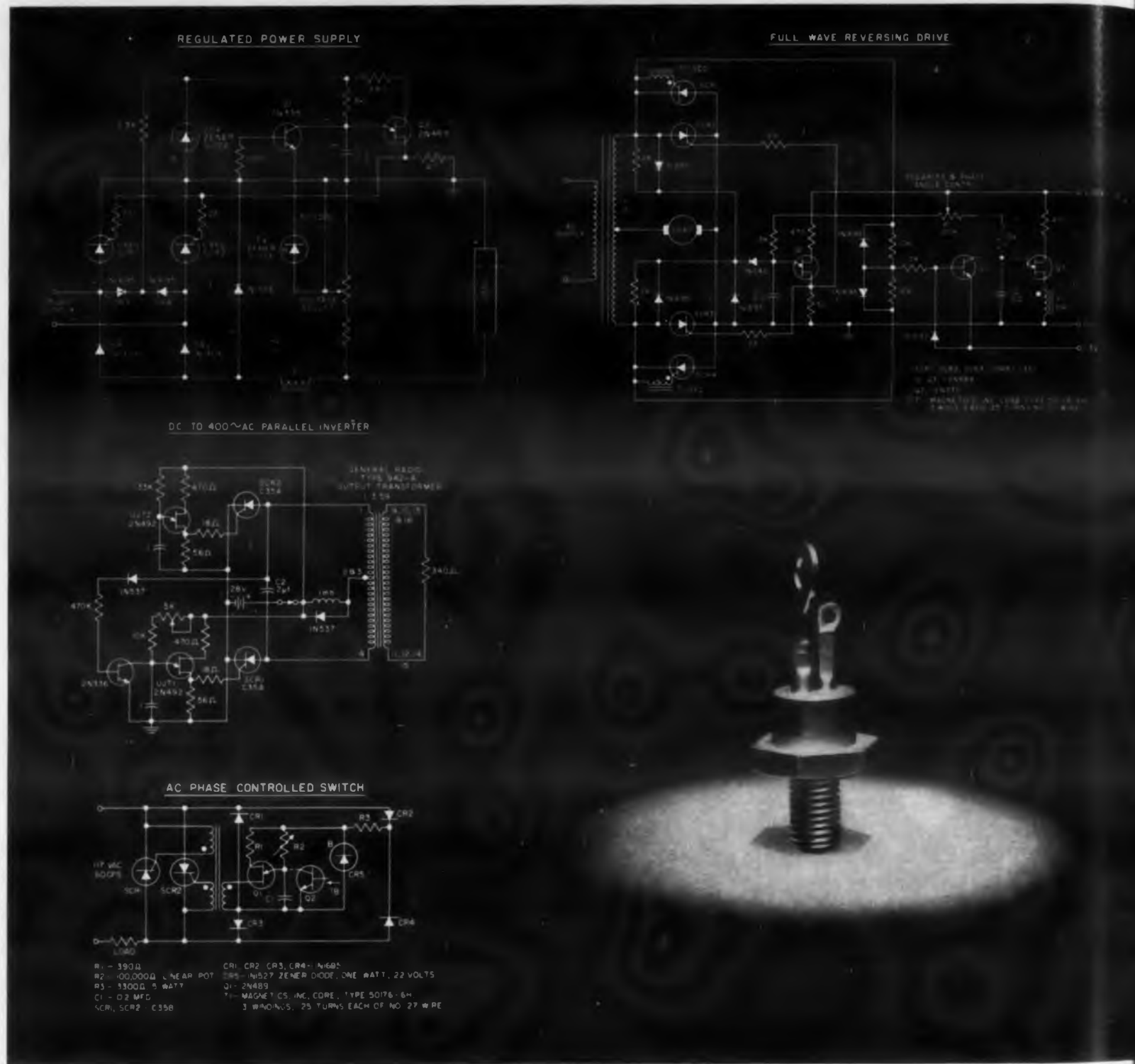
J. B. Rea Co., Inc., Electronics Div., Dept ED, 2202 Broadway, Santa Monica, Calif.

CIRCLE 122 ON READER-SERVICE CARD

Don't forget to mail your renewal form to continue receiving **ELECTRONIC DESIGN**.

## General Electric Semiconductor News

### New prices, new circuits for



**FOUR BASIC CIRCUITS.** Above are four basic designs for the Controlled Rectifier using the unijunction transistor as the firing means. The unijunction is a precision trigger, putting out short, high current pulses. The frequency of these pulses will not vary with the supply voltage or temperature, yet can be variably controlled with a silicon triode from a low level feedback signal. Unijunction firing circuits are easily synchronized with 60 cycle line frequency. In short, the unijunction provides the simplest and least expensive means for precision firing of the Silicon Controlled Rectifier.

General Electric's new silicon medium-current rectifiers, Types 1N2154 thru 1N2160, are ideal as companion devices to the controlled rectifier for reverse-voltage protection and, also, for applications in full-wave circuitry.

#### SAMPLE LIST OF POWER HANDLING AND OTHER JOBS THAT CAN NOW BE DONE BETTER BY THE G-E CONTROLLED RECTIFIER

- Converters, DC to DC, DC to AC
- Phase controlled DC power supplies, regulated & unregulated
- Frequency converter, current control

- Power switch for automatic temperature control
- electronic flash
- Reversible motor control
- AC variable speed induction motor

- Dynamic braking
- Light dimmers
- Thyatron replacement for relay drivers
- Pulse width conversion

- High speed printer for digital computer
- Welding control
- Ignitron firing
- Circuit breaker replacement

# revolutionary G-E Controlled Rectifier

"Controlled rectifiers may revolutionize the electrical industry." This statement was made a year ago by a respected news publication. Since then samples have been studied by hundreds of firms. Many new circuits have been developed which promise important improvements in functions, reliability, simplicity, accuracy and lower cost. In just one year prices have been reduced 75 percent (see chart below). And now, the G-E Silicon Controlled Rectifier is a standard, production-line item, warranted in writing and available at sharply reduced prices.

This is the time for design engineers to exploit the inherent advantages of the Silicon Controlled Rectifier in their circuit designs. Many applications are proved...the firing circuits have been refined...the product line is stabilized...and it makes sound economic sense. Call or write your G-E Semiconductor Sales Representative for complete details. The Controlled Rectifier is also available from many local G-E Distributors.

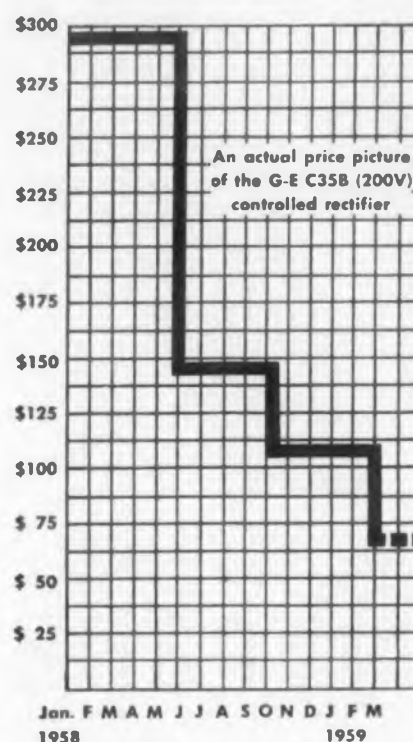
**HOW THE G-E CONTROLLED RECTIFIER WORKS.** The Silicon Controlled Rectifier is a three junction semiconductor device for use in power control and power switching applications requiring blocking voltages up to 400 volts and load currents up to 16 amperes. Series or parallel circuits may be used for higher power applications.

The G-E Controlled Rectifier's reverse characteristic is similar to a normal silicon rectifier in that it represents essentially an open circuit with negative anode to cathode voltage. The forward characteristic is such that it will block positive anode to cathode voltage below a critical break-over voltage if no signal is applied to the gate terminal. However, by exceeding the forward break-over voltage or applying an appropriate gate signal the device will rapidly switch to a conducting state and present the characteristically low forward voltage drop of a single junction silicon rectifier.

**DETAILED NOTES** are available on the application of the G-E Silicon Controlled Rectifier, plus reprints of articles that have appeared in technical journals. Write to Section S25359, Semiconductor Products Dept., General Electric Company, Electronics Park, Syracuse, New York.

**STEADY PRICE DROP.** Since its introduction one year ago, the price of the typical G-E Controlled Rectifier has dropped more than 75 percent. This results from improved manufacturing techniques and volume production. The G-E Controlled Rectifier is now a production-line item, warranted in writing for one year and subjected to the same quality control tests imposed on all General Electric transistors and rectifiers.

The G-E Controlled Rectifier is also available at even less cost (ZJ39L series) for use at 100°C and below, with currents up to 10 amperes.



NOTES on the APPLICATION of the SILICON CONTROLLED RECTIFIER

## MAXIMUM ALLOWABLE RATINGS (Resistive or Inductive Load)

	C35U	C35F	C35A	C35G	C35B	C35H	C35C	C35D
Continuous Peak Inverse Voltage (PIV)	25	50	100	150	200	250	300	400 volts
Transient Peak Inverse Voltage (Non-Recurrent < 5 millsec.)	35	75	150	225	300	350	400	500 volts
RMS Voltage (V <sub>RMS</sub> ), Sinusoidal	17.5	35	70	105	140	175	210	280 volts
Average Forward Current (I <sub>F</sub> )	Up to 16 amperes							
Peak One Cycle Surge Current (I <sub>surge</sub> )	150 amperes							
Peak Gate Power	5 watts							
Average Gate Power	0.5 watts							
Peak Gate Current (I <sub>G</sub> )	2 amperes							
Peak Gate Voltage (V <sub>G</sub> ) (forward)	10 volts							
Storage Temperature	-65°C to +150°C							
Operating Temperature	-65°C to +125°C							

CHARACTERISTICS (At Maximum Ratings)	C35U	C35F	C35A	C35G	C35B	C35H	C35C	C35D
Minimum Forward Breakover Voltage (V <sub>BO</sub> )	25	50	100	150	200	250	300	400 volts
Maximum Reverse (I <sub>R</sub> ) or Forward (I <sub>S</sub> ) Leakage Current (Full Cycle Average)	6.5	6.5	6.5	6.5	6.0	5.5	5.0	4.0 ma
Maximum Forward Voltage (V <sub>F</sub> AVG)	0.86 volts (Full Cycle Average)							
Maximum Gate Current To Fire (I <sub>GF</sub> )	25 ma							
Maximum Gate Voltage To Fire (V <sub>GF</sub> )	3 volts							
Typical Gate Current To Fire (I <sub>GF</sub> )	10 ma at +1.5 volts (Gate to Cathode Voltage)							

ZJ39L Series—lower cost series with ratings similar to above, but for use up to 100°C maximum, with forward current ratings up to 10 amperes.  
ZJ50 Series—a high-current series now in development, and available on a prototype-sample basis.

**GENERAL ELECTRIC**

CIRCLE 123 ON READER-SERVICE CARD

## Temperature Monitoring System

Multipoint



This continuous temperature monitoring system consists of monitor modules, each of which receives inputs from 10 thermistor probes, and an alarm indicator module. Up to 10 modules, 100 points, can be handled by one alarm indicator module, and all points are monitored simultaneously. No scanning devices are used. Designed to detect and furnish warning when the temperature at any protected point reaches a preselected high or low limit, the system can provide protection for processing equipment and all types of industrial installations. It monitors temperatures from -25 to +600 F.

Fenwal Inc., Dept. ED, Ashland, Mass.

CIRCLE 124 ON READER-SERVICE CARD

## Large Waveguide Window

For multimegawatt applications

This large waveguide window is designed for multimegawatt applications with the company's WR-2100 waveguide. It provides good radio frequency continuity and a standing wave ratio of 1.03 over a 10% band.

I-T-E Circuit Breaker Co., Dept. ED, 1900 Hamilton St., Philadelphia 30, Pa.

CIRCLE 125 ON READER-SERVICE CARD

## Variable Speed Drive

Has 10 turn vernier dial

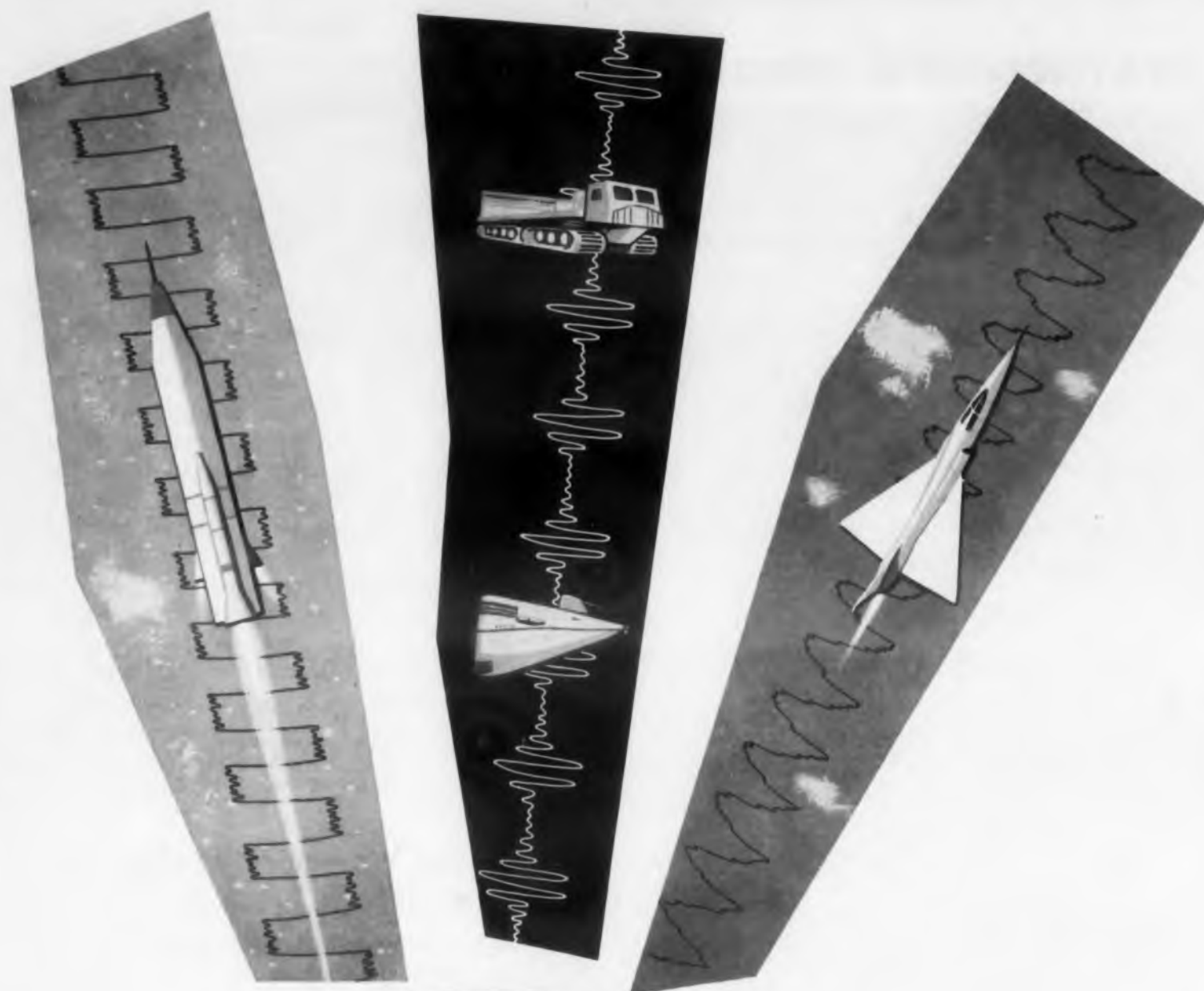
For exact adjustment to any speed setting or for duplication of previous speed settings, this 2 in. square Servotran variable speed drive can be furnished with an accurately calibrated vernier 10 turn dial. The unit can provide output shaft speeds infinitely variable from 0 to 1200 rpm, forward and reverse. It is available with motors in the 1/100 to 1/40 hp range. Other models for applications requiring between 1/1000 and 1/10 hp are also available.

Humphrey, Inc., Humphrey Products Div., Dept. ED, 3794 Rosecrans St., San Diego 10, Calif.

CIRCLE 126 ON READER-SERVICE CARD



FOR OPTIMUM PROTECTION FROM VIBRATION/SHOCK/NOISE



utilize **LORD** capabilities

Greater reliability—your problem? LORD can help you do something about it. Protective mounting systems, designed, tested and produced at LORD, insure high reliability for sensitive equipment.

LORD is a diversified, capable technical organization, supported by modern facilities and prepared to complete challenging assignments in controlling vibration, shock and noise.

Your project can benefit from experience gained in working on Atlas, Talos, Jupiter, B-58, F-105, F11F, Convair 880, ground support, vehicular, shipboard, submarine and other advanced classified projects.

LORD is ready to work as an integral member of your team.

LORD MANUFACTURING COMPANY • ERIE, PA.

#### FIELD ENGINEERING OFFICES

ATLANTA, GEORGIA - Cedar 7-9247	DETROIT, MICH. - Diamond 1-4340
BOSTON, MASS. - Hancock 6-9135	KANSAS CITY, MO. - Westport 1-0138
CHICAGO, ILL. - Michigan 2-6010	LOS ANGELES, CAL. - Hollywood 4-7593
DALLAS, TEXAS - Riverside 1-3392	NEW YORK, N. Y. - Circle 7-3326
DAYTON, OHIO - Baldwin 4-0351	PHILADELPHIA, PA. - Pennypacker 5-3559
SAN FRANCISCO, CAL. - EXbrook 7-6280	

"In Canada - Railway & Power Engineering Corporation Limited"

CIRCLE 116 ON READER-SERVICE CARD

## NEW PRODUCTS

### Precision Potentiometer

Operates at 230 C



The series 42 wire-wound precision potentiometer is designed to operate at temperatures up to 230 C, with a wattage rating of 0.25. Resistance change after 255 hr at 230 C is less than 0.1%. Insulation resistance is 10,000 meg min. Resistance tolerance is  $\pm 5\%$  from 1 to 100,000 ohms. Independent linearity is  $\pm 0.5\%$  and noise is less than 5  $\mu$ v. It has screw terminals for simple and positive connections and comes with bushing type mounting, although servo type can be furnished.

Clarostat Mfg. Co., Inc., Dept. ED, Dover, N. H.

CIRCLE 117 ON READER-SERVICE CARD

### Decoder Modules

For binary coded decimal information



Decoder modules type BCD-8421 and BCD-4221 are designed to take the respective binary coded parallel information directly to the input of a beam switching tube and display the equivalent decimal information on a Nixie in-line indicator tube. The beam switching and Nixie tube combination has an access time of 1  $\mu$ sec and an inherent memory. The modules are plug-in, printed circuit type and have display repetition rates in excess of 1 kc.

Burroughs Corp., Electronic Tube Div., Dept. ED, Box 1226, Plainfield, N.J.

CIRCLE 118 ON READER-SERVICE CARD

Have you sent us your subscription renewal form?

Circle 119 for Allied  
Circle 120 for Texas

ELECTRONIC DESIGN • April 29, 1959

# ALLIED

...for **all** your  
**ELECTRONIC**  
**SUPPLY**  
**NEEDS**

**SAME-DAY  
SHIPMENT**

...next-day delivery  
(by air where required)

# on TEXAS INSTRUMENTS SEMICONDUCTORS

# O.E.M.

## PRICES ON

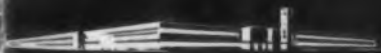
## Silicon Transistors: 1-999

## Germanium Transistors: 1-99

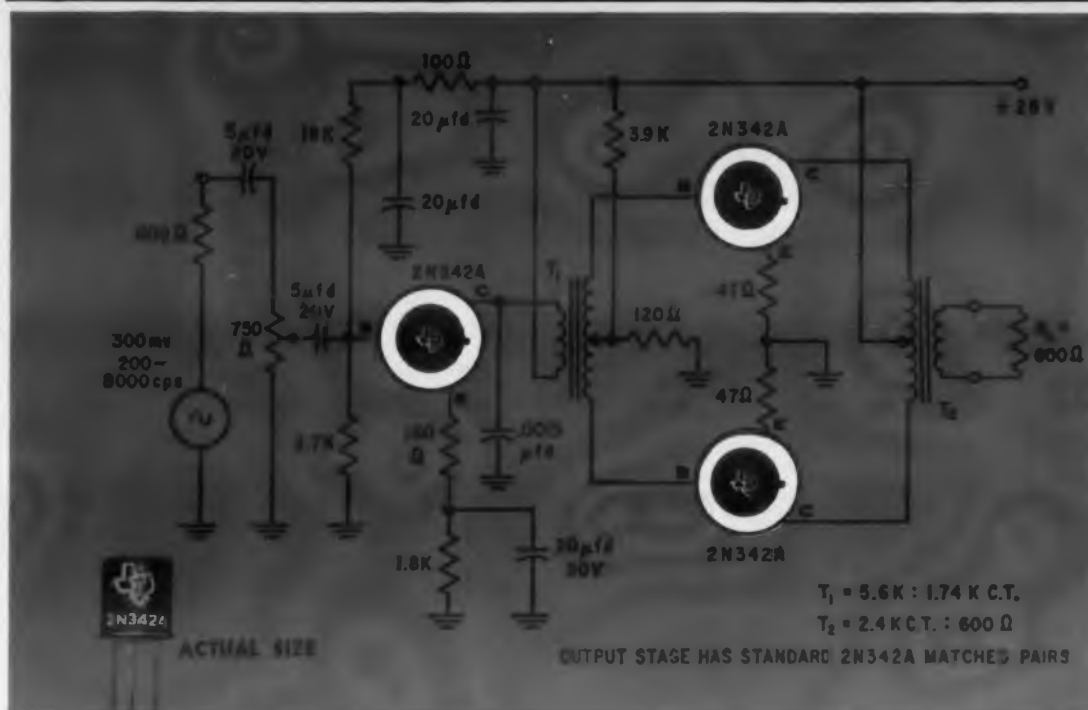
## Silicon Diodes and Rectifiers: 1-999

# ALLIED RADIO CORP.

100 N. WESTERN AVE.  
CHICAGO 80, ILLINOIS  
HAYmarket 1-6800  
TWX: CG - 2898



# TRANSISTORIZED INTERCOM EXCEEDS MIL-E-5272B SPECS



**150-mw output from -55°C to 100°C at less than 10% harmonic distortion over frequency range**

Frequency response @ 25°C  
stable within  $\pm 2$  db of 1000  
cps 100 mw reference level  
from 200 to 8000 cps

**Frequency response @ -55°C  
and 100°C within  $\pm 3$  db of  
25°C frequency response**

**Less than 3-db gain variation  
@ -55°C and 100°C compared  
to 25°C measurement**

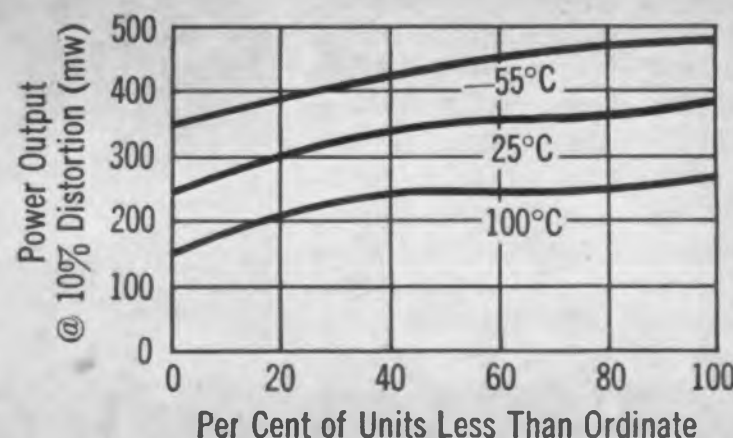
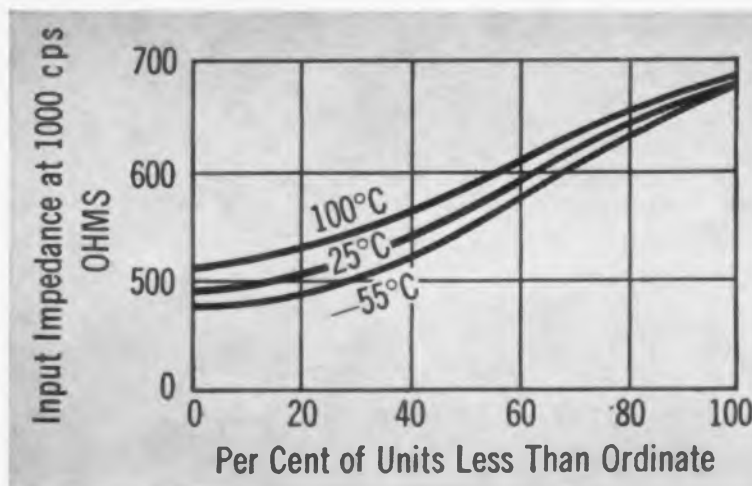
## LOUD AND CLEAR AT 100°C!

**...with TI 2N342A silicon transistors from stock**

You can satisfy the 71°C equipment requirements of MIL-E-5272B at 100°C with the intercom amplifier circuit shown above — using TI 2N342A silicon transistors with . . . guaranteed 3-to-1 linear beta characteristics . . . 85-v collector-to-emitter breakdown, giving a wide safety range with 28-v aircraft supplies . . . plus dissipation capability of 1 watt at 25°C and 200 mw at 125°C.

The newest addition to the *use-proved* TI 2N339 series introduced in 1957, this medium-power unit carries the full-year TI guarantee and is immediately available *off-the-shelf* from all TI distributors in 1-249 quantities. For production quantities, contact your nearest TI sales office.

### TYPICAL INTERCOM AMPLIFIER PERFORMANCE CHARACTERISTICS USING 2N342A TRANSISTORS



**from THE WORLD'S LARGEST SEMICONDUCTOR PLANT**



TEXAS INSTRUMENTS  
INCORPORATED

SEMICONDUCTOR-COMPONENTS DIVISION

POST OFFICE BOX 312 • 13800 N. CENTRAL EXPRESSWAY  
DALLAS, TEXAS



## NEW PRODUCTS

### Transistorized Power Inverter

Dc to sine wave ac



Model 591-J transistorized power inverter is designed to insure maximum performance from ac gyros and motors. No excess heat is created because the output waveshape, being sinusoidal, avoids the heat-producing harmonics. Unit is fully encapsulated and hermetically sealed. Nominal input voltage: either 24, 26 or 28 v dc. Output voltage: 26 and 115 v ac standard. Output frequency of 400 cps is standard, with 1200, 1500 and 2000 cps available. Output power: 40 va; operating temperatures:  $-55$  to  $+71$  C.

Arnold Magnetics Corp., Dept. ED, 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE 134 ON READER-SERVICE CARD

### Receiving System

For low-level beacon signals

A complete receiving system, the Microlock model 90208-2 receives low-level beacon signals from missile or satellite borne transmitters, permitting accurate measurements of position and velocity as well as recording of telemetered information. Sensitive to signals down to  $-150$  dbm, the system is designed for use with an interferometer antenna system and operates on a phase-locked-loop principle. Angular position can be determined to an accuracy of 1 mil. The system is mounted in a standard relay rack and is furnished with power supplies and alignment and monitoring equipment.

Resdel Engineering Corp., Dept. ED, 330 S. Fair Oaks Ave., Pasadena, Calif.

CIRCLE 135 ON READER-SERVICE CARD

**ENGINEERS - SCIENTISTS - PHYSICISTS**

# Let's SWAP Resumes!

The vigorous growth of our new electronic department, staffed with over 500 highly skilled specialists, has created many openings at an executive level on such vital programs as:

- Design, development and manufacture of an advanced high speed automatic checkout system for F-101B aircraft utilizing latest digital techniques, logical design techniques, transistorization, and high speed tape programming.
- Systems engineering.
- Systems analysis on advanced aircraft and space vehicles.

Take this opportunity to further your professional career, in a creative climate, complemented by a comfortable suburban home environment, and the most opportune educational facilities at two renowned local universities.

... and now may we have the opportunity of reviewing your resume.

Please write in confidence to:

Mr. Raymond F. Kaletta, Engineering Employment Supervisor  
P.O. Box 516, St. Louis 66, Missouri



# MCDONNELL Aircraft

Lambert-Saint Louis MUNICIPAL AIRPORT • BOX 516, ST. LOUIS, MO.

## PERSONAL:

NAME - McDonnell Aircraft  
ADDRESS - Beautiful suburban St. Louis, Missouri  
AGE - 20 years  
HEALTH - Excellent, growing with vigor and stability.  
PHYSICAL APPEARANCE - 3,930,076 gross square feet of floor area dedicated to the mastery of air and space. A beautiful campus-like environment featuring the most advanced facilities for creative achievement.  
SIZE - A total staff of 25,000; 4,000 of whom comprise our Engineering Divisions.

## MILITARY SERVICE:

A prime contractor of U.S. Defense Department.

## BUSINESS ACHIEVEMENTS:

PAST -  
FD-1 Phantom - First all-jet airplane to take off and land on aircraft carrier.  
F2H Banshee - Famous Korean War fighter jet.  
Little Henry and XV1 Convertiplane - First ramjet helicopter. XV1 Convertiplane made first successful conversion from helicopter to airplane flight.

PRESENT  
Talos - the airframe and power plant of this missile designed and developed at McDonnell.  
F-101 Voodoo - Holder of three transcontinental speed records, the F-101B Interceptor now in quantity production.  
F3H Demon - Missile carrying all weather Navy fighter now in production and fleet service.  
F4H - Production award winner for Mach 2+ all weather Navy fighter.  
Quail - Prime contractor for air-launched Air Force decoy missile.  
Utility Jet - Company is vigorously engaged in the Air Force UCX competition for a multi-purpose, 4-jet trainer-transport. McDonnell entry will be capable of going anywhere in the world at cruising speeds over 550 m.p.h.  
Electronics - Development and quantity production of an electronic automatic checkout system for 101B aircraft. This system will completely check out the many electrical and electronic systems and sub-systems within minutes.  
Space Exploration - McDonnell just awarded contract by N.A.S.A. to develop and build FIRST MANNED SATELLITE CAPSULE.

## FUTURE OBJECTIVES -

McDonnell will continue to diversify and intensify its efforts in all areas of engineering research, development and production, related to air and space vehicles for our Armed Forces.

## Hybrid Tees

For large waveguides



This hybrid Tee, which can be used as either test equipment or as a functional part of a system, is made in both plain and folded types. Waveguide sizes range from WR770 through WR2300, covering a uhf frequency range of 320 to 1450 mc. Among applications are: power dividers; balanced mixers; sideband modulators; power discriminators and phase detectors.

I-T-E Circuit Breaker Co., Dept. ED, 1900 Hamilton St., Philadelphia 30, Pa.

CIRCLE 136 ON READER-SERVICE CARD

## Insulation Testers

### Portable

Portable Hipot testers S2, DC, S5 DC, and S10 DC cover 0 to 2, 0 to 5, and 0 to 10 kv dc, respectively. They incorporate a 4 in. meter for direct indication of leakage current; a direct reading, 4 in. kilovoltmeter connected directly across the output; and a dead front safety grounded control panel. They are protected against overloads and surges and provide a continuously adjustable output voltage from zero to maximum. The units can be used to measure leakage current, for breakdown testing, or as high voltage power supplies where a few milliamperes of current is adequate. They measure 8 x 14 x 8 in. and weigh 20 lb.

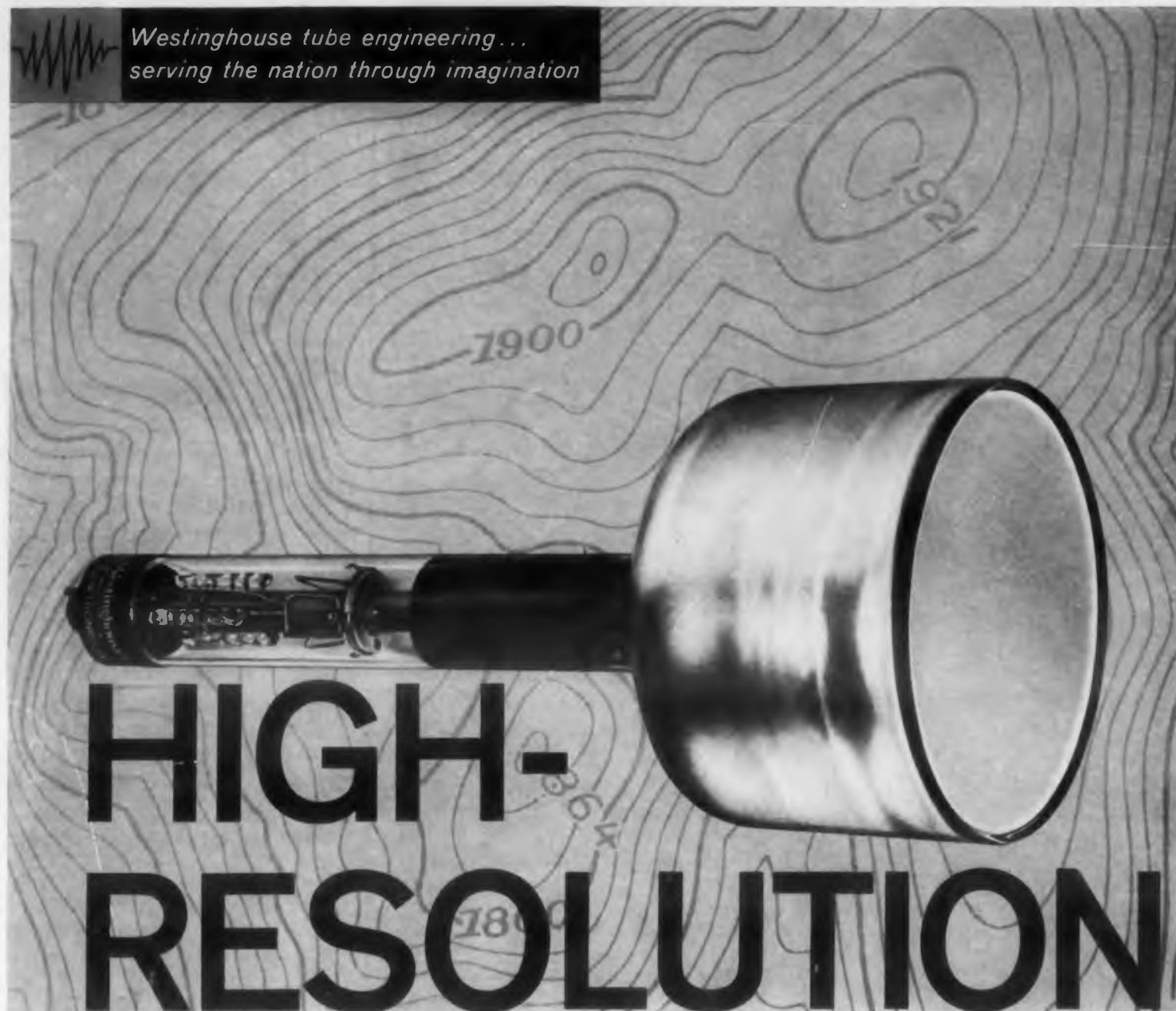
Peschel Electronics, Inc., Dept. ED, RFD 1, Patterson, N.Y.

CIRCLE 137 ON READER-SERVICE CARD

◀ CIRCLE 870 ON READER-SERVICE CARD



Westinghouse tube engineering...  
serving the nation through imagination



## radar display tube

*New cathode-ray tube features electrostatic-focus and offers proven performance in high-resolution radar.*

The Westinghouse 5CEP11 is a high-resolution, electrostatic-focus, magnetic-deflection cathode-ray tube primarily designed for presentation of radar displays. It's particularly useful in conjunction with photographic recording systems, such as radar reconnaissance for mapping. The face-plate is optically flat, and employs gray glass for superior contrast. The 5CEP11 will produce a line width not to

exceed 0.0015" at 10 KV anode potential. Line width is measured in production at half amplitude of the light energy distribution of a single line—this is a precise measurement not subject to operator error.

The 5CEP16 is designed for flying spot scanners and also has 0.0015" line width. Sample or production quantities of either 5CEP11 or 5CEP16 are available.

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

**Westinghouse**  
Electronic Tube Division, Elmira, N. Y.

CIRCLE 138 ON READER-SERVICE CARD

## NEW PRODUCTS

**POCKET ADDING MACHINE AND SLIDE RULE.**—This 13-scale log-log slide rule has a 5 in. scale length and a six digit adding machine on its reverse side. A P scale makes it possible to find any sine and cosine of an angle without determining the angle.

Harrison Home Products Corp., Dept. ED, 565 Fifth Ave., New York 17, N.Y.

CIRCLE 139 ON READER-SERVICE CARD

**LIGHTHOUSE TRIODE.**—General purpose model GL-6771 is a high mu, metal ceramic unit for use in grounded grid service as a radio frequency amplifier, oscillator, or frequency multiplier. As a cw oscillator, it can be used at frequencies to 4000 mc.

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

CIRCLE 140 ON READER-SERVICE CARD

**MINIATURE INSTRUMENT NUTS.**—Miniature turned nuts in a range of types, shapes, and sizes for use in precision instruments and miniaturized equipment. Supplied to customer specifications with standard or special threads in diameters down to 1/8 in. hexagon. Lengths and diameters are held to  $+0.000$  and  $-0.005$  in.

Fischer Special Mfg. Co., Dept. ED, 422 Morgan Ave., Cincinnati 6, Ohio.

CIRCLE 141 ON READER-SERVICE CARD

**TUBE SOCKET SAVERS.**—These rugged units are designed for 7, 8, and 9 pin miniature sockets in electron tube testers.

Forway Industries, Inc., Dept. ED, 122 Green Ave., Woodbury, N.J.

CIRCLE 144 ON READER-SERVICE CARD

**SOLID STATE POWER SUPPLIES.**—Miniature Transpac short-circuit and transient proof power packs cover 5 to 60 v dc in fixed and adjustable voltage types. Available in ratings to 200 ma, they operate from an input source of 105 to 125 v ac, 60 or 400 cps.

Electronic Research Associates, Inc., Dept. ED, 67 Factory Place, Cedar Grove, N.J.

CIRCLE 145 ON READER-SERVICE CARD

**CHASSIS LATCH.**—The 35L is designed for engaging, disengaging, and carrying equipment filled drawers from electronic racks. It has a pushbutton release mechanism on the locking device which permits quick release of multiple pin connectors commonly used with plug-in chassis. Adequate mechanical advantage is provided to engage connector plugs with forces of 400 lb.

Camloc Fastener Corp., Dept. ED, 61 Spring Valley Rd., Paramus, N.J.

CIRCLE 146 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1959

**GEAR SET VERNIER.**—Automatically provides vernier calibration settings to an accuracy tolerance within 1/1000 in. regardless of human errors in reading and lining up a vernier to the hairline marker and inaccuracies in the manufacture of the vernier dial.

Jos. Gelb Co., Dept. ED, 52 Arlington St., Newark 2, N.J.

CIRCLE 147 ON READER-SERVICE CARD

**ULTRASONIC CLEANING TANK.**—Series TH Sonogen ultrasonic cleaning tank-transducers have an integral heater, dual thermostatic control, and twin-wall construction. Available in eight standard sizes with 1 to 32 gal tank capacity and transducer input from 65 to 1000 rf w.

Branson Ultrasonic Corp., Dept. ED, 40 Brown House Rd., Stamford, Conn.

CIRCLE 148 ON READER-SERVICE CARD

**ELECTRICAL RESISTANCE PROBE.**—Highly sensitive to environmental changes, this probe measures corrosion and hard-to-detect liquid and gaseous contaminants. It can detect the slightest change in humidity, ozone concentration, or water content in a nonaqueous liquid. In missile systems, it can detect corrosive conditions which may harm delicate electromechanical components long before any actual corrosion occurs.

Crest Instrument Co., Div. of Magna Products, Inc., Dept. ED, 11808 S. Bloomfield Ave., Santa Fe Springs, Calif.

CIRCLE 149 ON READER-SERVICE CARD

**HIGH CURRENT TERMINAL BLOCKS.**—Types T and U, respectively rated 125 and 250 amp at 750 v, have tubular type terminals for connecting wire leads without lugs. Type T accommodates AWG 6 to 1/0 wire and has 1 to 6 terminals per block. Type U has socket head screws in its terminals and accommodates AWG 4 to 250 MCM wire. Types L, O, and S, designed for the connection of leads with lugs, are rated at 750 v for 100, 125, and 225 amp, respectively, and handle up to 1, 1/0, and 4/0 AWG.

Curtis Development and Mfg. Co., Dept. ED, 3250 N. 33rd St., Milwaukee 16, Wis.

CIRCLE 150 ON READER-SERVICE CARD

**PRESSURE SENSITIVE TAPE.**—Thermal curing type TGV Teflon impregnated fiberglass tape has a temperature range of -100 to +500 F and adheres to any dry, clean surface. For both mechanical and electrical applications, it is available in 18 yd rolls and 1/2, 3/4, 1-1/2, and 2 in. widths.

The Connecticut Hard Rubber Co., Dept. ED, 407 East St., New Haven 9, Conn.

CIRCLE 151 ON READER-SERVICE CARD

Don't forget to mail your renewal form to continue receiving **ELECTRONIC DESIGN.**

ELECTRONIC DESIGN • April 29, 1959



## TYPE 581

The new Tektronix Type 581 is a general-purpose oscilloscope with excellent transient response and high-speed sweeps. Risetime is 3.5  $\mu$ sec and sweep time is calibrated to 0.01  $\mu$ sec/cm. Passband is dc to approximately 100 mc.

The vertical deflection system is designed for plug-in preamplifiers. A low-capacitance probe is an integral part of the Type 80 Plug-In Preamplifier, which provides a calibrated deflection factor of 0.1 v/cm. Sufficient signal delay is included in the main vertical amplifier to permit displaying the leading edge of the waveform under observation.

The wide sweep range of the Type 581 includes calibrated sweeps fast enough to take advantage of its rise-time capabilities. Calibrated sweeps from 0.05  $\mu$ sec/cm to 2 sec/cm are available in 24 steps, and a 5-x magnifier increases the calibrated range to 0.01  $\mu$ sec/cm. Sweep time is continuously adjustable from 0.01  $\mu$ sec/cm to 5 sec/cm.

Versatile triggering includes amplitude-level control, and preset stability for operating convenience. Lockout-reset circuitry provides for one-shot sweep operation.

A new Tektronix cathode-ray tube with distributed-type vertical-deflection plates is used in the Type 581. 10-kv accelerating potential assures a bright trace, even at low sweep-repetition rates. An amplitude calibrator is also incorporated in the Type 581, with square-wave output from 0.2 mv to 100 v in 18 steps.

## TYPE 585

The Tektronix Type 585 has, in addition to the identical general specifications of the Type 581, a second time base generator. This time-base generator, designated TIME BASE B, acts as a delay generator, providing a wide range of calibrated sweep delay. Two modes of sweep delay are available—triggered (delayed sweep is started after the

delay period by the signal under observation), and conventional (delayed sweep is started at the end of the delay period by the delayed trigger). Calibrated sweep delay is continuously variable over the range of 1  $\mu$ sec to 10 sec. Color-correlated controls eliminate confusion, making this new high-performance oscilloscope easy to operate.

## PRICES

TYPE 581, without plug-in units ..... \$1375  
TYPE 585, without plug-in units ..... \$1675  
TYPE 80 Plug-In Preamplifier, with Probe \$ 150

(Other plug-in preamplifiers are currently in development.)

Prices f.o.b. factory.

## Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon  
Phone CYpress 2-2611 • TWX-PD 311 • Cable: TEKTRONIX

**TEKTRONIX FIELD OFFICES:** Albertson, L. I., N.Y. • Albuquerque • Atlanta, Ga. • Bronxville, N.Y. • Buffalo • Cleveland • Dallas • Dayton • Elmwood Park, Ill. • Endwell, N.Y. • Houston • Lathrup Village, Wash. • East Los Angeles • West Los Angeles • Minneapolis • Mission, Kansas • Newtonville, Mass. • Orlando, Fla. • Palo Alto, Calif. • Philadelphia • Phoenix • San Diego • St. Petersburg, Fla. • Syracuse • Towson, Md. • Union, N.J. • Washington, D.C. • Willowdale, Ont.

**TEKTRONIX ENGINEERING REPRESENTATIVES:** Hawthorne Electronics, Portland, Oregon • Seattle, Wash. • Hytronic Measurements, Denver, Colo. • Salt Lake City, Utah

Tektronix is represented in 20 overseas countries by qualified engineering organizations.

CIRCLE 152 ON READER-SERVICE CARD



Where only the **best**  
is good enough . . .



MODEL UHR-240

## Krohn-Hite power supplies are used

In basic electronic instruments for lab or test work, *less* than the best may be a dangerously bad bargain. Unexpected limitations — of reliability, range, precision — can throw out weeks of work on today's jobs, and can make tomorrow's tougher jobs untouchable.

The *best* instrument of its type is probably a bit more expensive, but it's worth buying . . . because you can believe in it today, and will rely on it tomorrow. An example is the Krohn-Hite Model UHR-240 ultra-high-regulation power supply. Here are some facts about it.

**MAIN DC OUTPUT:** zero to 500 volts, continuously adjustable, at zero to 500 milliamperes.

**REGULATION:** less than 0.001% plus 0.002 volt from no load to full load.

**LINE STABILIZATION:** less than 0.003% plus 0.003 volt, for 10% change.

**OUTPUT IMPEDANCE:** DC — less than  $(0.005 + 0.00002 \times \text{output volts})$  ohm; AC — less than 0.05 ohm plus 0.1 microhenry.

**RIPPLE:** less than 0.1 millivolt rms.

**DC BIAS OUTPUT:** zero to minus 150 volts, continuously adjustable, at zero to 5 ma; regulation less than 1%.

**DC HEATER OUTPUTS:** 5 to 12.6 volts, adjustable, at zero to 2.5 amperes.

**AC HEATER OUTPUTS:** two, each 6.3 volts at 10 amperes.

There's a lot more you should know about the UHR-240 . . . and about the other Krohn-Hite power supplies, oscillators, tunable electronic filters and amplifiers. In all of them, you'll find the same far-ahead engineering, design and construction. Because K-H instruments are good enough even for tomorrow's most critical work, they are increasingly chosen today where true reliability and precision are needed.



Write for your free copy of the new Krohn-Hite Catalog.

**Krohn-Hite CORPORATION**

580 Massachusetts Avenue, Cambridge 39, Mass.

CIRCLE 153 ON READER-SERVICE CARD

## NEW LITERATURE

### RF Chokes

154

A new rf choke coil technical data sheet contains a detailed description of the electrical parameters for the complete line of chokes which are available in a 100,000 to 1 inductance range, said by the manufacturer to be the widest range available in a small size, high-reliability line. The entire standard line of Essex chokes is described by the data sheet which lists parameters for 123 different units with inductance values from 0.1 h to 10 mh. The units shown include the logarithmic series as well as the preferred series. The data sheet announces that all Essex encapsulated choke coils are nonflammable, and it explains the company's ability to produce, on special order, choke coils with inductance values rather than the 123 standard preferred and logarithmic series listed. Essex Electronics, Berkeley Heights, N.J.

### Converter-Inverters

155

A 4-page, 2-color data file describes company's Transidyne line of converter-inverters. The data file shows pictures of the various case styles and lists features and specifications of the four basic series. For your free copy of Data File 701, write Spectrol Electronics Corp., 1704 South Del Mar Avenue, San Gabriel, Calif.

### Communication Accessories

156

Twenty-four page catalog covers toroidal coils, laminated transformers, filters, magnetic amplifiers and dc to dc converters. Basic catalog 858 includes graphs, pictures, dimensions of units, electrical characteristics and a price list. Communication Accessories Co., Lee's Summit, Mo.

### PTFE Tubing

157

A new, three-color, four-page brochure contains prices, tolerances, sizes and application information on PTFE (polytetrafluoroethylene) tubing. A gate-fold chart lists electrical, mechanical, chemical and thermal properties of the high temperature tubing, opposite a full page of purchasing information such as price, color packaging and terms. Cross-reference charts are provided for "Super-Thin", "Thin-Wall" and "ASTM Wall" PTFE tubings by AWG size and footage. Another chart lists dimensional tolerances for all PTFE tubings by AWG size. Irvington Div., Minnesota Mining and Manufacturing Co., 900 Bush Avenue, St. Paul 6, Minn.

Have you sent us your subscription renewal form?

## DORSETT Telemetry Systems & Components



Custom —  
designed to  
meet your  
space & weight  
requirements

- Complete Systems • FM Transmitters
- VC Oscillators • RF Power Amplifiers
- Transistorized VCO's

Save size, weight, power, time and money . . . with a Dorsett complete telemetry package. Includes power supplies, regulators, calibrators, amplifiers, the required number of VCO's, mixer and FM transmitter. Dorsett also designs and manufactures individual telemetry components . . . like the new transistorized VCO's which are revolutionizing power, space, and weight concepts. Dorsett engineers will work closely with you on your special needs. Dorsett equipment has passed the most rigid inspections of prime contractors and military agencies. You can be sure of prompt delivery of reliable equipment. Dorsett has designed many different types of telemetry packages and can provide you with the smallest, lightest, lowest power equipment available. For example, one of Dorsett's many models provides 9 oscillators, mixer, and power supply in as little space as  $2\frac{1}{4} \times 3\frac{1}{4} \times 5\frac{1}{2}$ ". For complete information on your specific needs call, write, or wire, Dorsett, today.

**DORSETT Laboratories, Inc.**  
Box 862  
Norman, Okla.

TEL. JE 4-3750

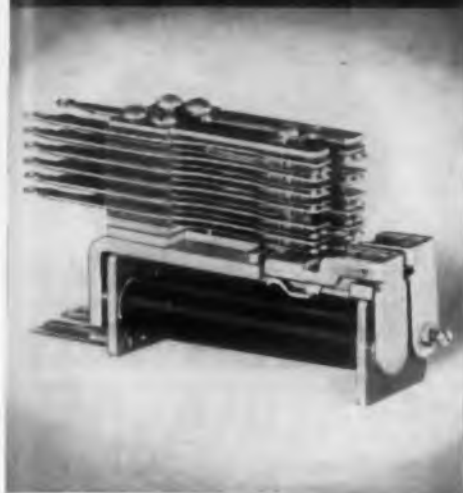
CIRCLE 158 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1959

# Stromberg-Carlson

"TELEPHONE QUALITY"

## Relays



... available immediately for any part of your operation that depends on electromechanical switching.

Proven by many years of meeting the exacting requirements of the telephone industry, these twin-contact relays of unsurpassed reliability are available in many types. The following are representative:

**Type A:** general-purpose relay with up to 20 Form "A" spring combinations. This relay is excellent for switching operations.

**Type B:** a gang-type relay with up to 60 Form "A" spring combinations.

**Type BB** relay accommodates up to 100 Form "A" springs.

**Type C** (illustrated): two relays on the same frame. A "must" where space is at a premium.

**Type E:** has the characteristics of Type A relay, plus universal mounting arrangement. Interchangeable with many other makes.

Complete details and specifications on all Stromberg-Carlson relays are contained in our *new relay catalog*. Contents include: spring combinations, table of equivalents, contact data, variations and special features, plus complete mounting and cover information.

The catalog is available on request.

**STROMBERG-CARLSON**

A DIVISION OF GENERAL DYNAMICS CORPORATION

Telecommunication Industrial Sales  
116 Carlson Rd. • Rochester 3, N.Y.



CIRCLE 159 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1959

## Cathode Ray Tubes

160

A new booklet lists the characteristics of television picture tubes and cathode ray tubes for specialized commercial, industrial and military applications. The 42-page booklet constitutes a complete reference to all popular tube types of American manufacturers, and characteristics and mechanical dimensions of most EIA-registered tubes. Tubes listed in the new Sylvania booklet are grouped under two general headings depending on whether they employ magnetic or electrostatic focus. Within these groups the tubes are listed numerically-alphabetically. Essential data such as maximum ratings, heater voltages, typical operations information, and bulb dimensions can be readily determined where individual data sheets are not available. Special sections on phosphor characteristics and proper tube handling highlight the presentation. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N.Y.

## Potentiometer and Bridge Instruments 161

A new 64-page edition of Bulletin P1245-A, covers complete specifications of company's potentiometer and bridge instruments in indicating, recording, and controlling models. Information concerning rack mounting instruments, high-speed and multipoint instruments, and miniature instruments is included, in addition to descriptions of standard round-chart and strip-chart instruments. One section of the bulletin is devoted to sensing elements and attachments for use with Dynamaster instruments. Resistance bulbs, magnetos, photocells, conductivity cells, frequency converters, computing, totalizing, and digital read-out attachments are among those listed. A section describing the incorporation of Dynamaster instruments into other manufacturers' equipment is also included. Request Bulletin P-1245-A from The Bristol Co., Waterbury 20, Conn.

## Transformer Catalog

162

"Pulse-Transformers", a 24-page catalog, is designed to assist engineers in the application of transformers to their specific needs. Complete with many tables, charts, and schematics this manual covers a brief history of low-level pulse transformers, their measurements, specifications, applications, interchangeability, dielectric ratings, manufacturing, and other data. Also included is information on some 2000 standard design transformers (available from stock), as well as case types and specifications data to aid the engineer who requires transformers of custom design and manufacture. "Pulse Transformers" is available on request by writing PCA Electronics Inc., 16799 Schoenborn St., Sepulveda, Calif.



## — and now for the heat test!

So you *did* build your own pot! Now — will it function at 150°C? It *might*, if you made sure to use some real cool winding wire (say, with no more than 20 parts per million temperature coefficient)! A specially-designed heat-resistant element card would also be handy to keep things cool! But you don't *have* to build 'em-yourself and then go through all this barbecue-broil testing, to be assured of pots with good high-temperature characteristics!

Why take "pot luck", when Ace has all these special high-temperature design features — neatly packaged in the Acepot X-500! Our exclusive design dissipates internal heat to the mounts, allowing greater dissipation at high temperature. So put away your chef's hat — and rely on Ace's four years of testing. For high temperature performance — the X-500's your answer. See your ACErep!



The X-500 Acepot. From -55°, up to 150°C, with special heat-resistant elements. Excellent resolution, ±0.3% linearity. 1/2" size, 1/4-ounce. Prompt delivery.

**ACE**

ELECTRONICS ASSOCIATES, INC.

99 Dover Street, Somerville 44, Mass.

SOMerset 6-5130 TMX SMVL 181 West. Union WUX

Acepot® Acetrim® Aceset® Aceohm® \*Reg. Appl. for  
CIRCLE 163 ON READER-SERVICE CARD



# Editorial Critique



*Electronic Design* is getting a thorough going over . . . The scene above is typical of the editorial conference held after each issue goes to press. These special meetings, called by Edward E. Grazda, Editor, help to improve editorial standards by constructive self-criticism. Editors exchange points of view, make suggestions, comment on clarity and conciseness; discuss technical points. These discussions are aimed, as always, toward making your magazine more interesting, useful, and informative. Your own reactions, ideas, and comments are often mentioned here — all helping to keep the magazine more closely tuned to the main current of reader needs and interests.

## NEW LITERATURE

### Semiconductor Preforms

165

Bulletin A-68, a 4-page illustrated technical bulletin describing high purity semiconductor preforms used in making alloy junctions in germanium and silicon devices, include information on analyses of alloys, specifications and tolerances of discs, spheres, and washer preforms, along with previously unpublished phase diagrams of semiconductor alloys. Bulletin A-68 shows typical analyses of semiconductor elements such as lead, antimony, indium, gold, gallium, cadmium, indicating the importance of minimal impurities. In addition to metallurgical information, Bulletin A-68, lists specifications and tolerances on high purity preforms produced from these alloys. Bulletin A-68 also shows company's unique facilities for the production of high purity preforms. Accurate melts, analyses their own alloys, rolls and forms these alloys, and by maintaining their own tool and die facilities can rapidly tool up to produce either small or very large production runs. Inspection facilities depicted in the bulletin show a system of close control on size and weight of preforms by mechanical, optical, and electronic methods. Accurate Specialties, Inc., 37-11 57 St., Woodside 77, N.Y.

### Alternators

166

A new, four-page illustrated folder, detailing its dramatic new line of alternators, features silicon rectifiers in lieu of standard selenium rectifiers. According to the literature, the new type alternators provide infinite operating life and vastly reduced maintenance. The folder graphically illustrates how the new silicon rectifier because of its considerably smaller size, has been successfully combined with the basic alternator, thus providing an alternator system with only two components instead of the previous three (the alternator, the rectifier, and the regulator). More than 30 illustrations highlight design and application features. The literature also contains detailed specifications and operating information. Copies may be obtained from the Leece-Neville Co., 1374 East 51st St., Cleveland 3, Ohio.

### Test Equipment

167

A new data folder, providing specifications and prices for transistorized digital test equipment describes 10 of the firm's standard building blocks which can be used in a wide variety of test setups, through use of patch cords. Digital Equipment Corp., Maynard, Mass.

Don't miss an issue of **ELECTRONIC DESIGN**; return your renewal card.

## SOMETHING NEW IN SLOTTED SECTIONS



Actually, this is a new kind of Standing Wave Detector, which completely makes obsolete the 8-foot monsters, for impedance and VSWR measurements from 100 to 1000 mc/s.

The PRD Type 219 is only 8 inches long and weighs a "pocketable" four and one-half pounds.

As if these facts were not startling enough, the 219 also features:

- Direct reading of VSWR
- Direct reading of angle of reflection coefficient
- Direct reading of reactive component sign
- Matched load for self-calibration supplied
- Adaptability to most coaxial lines, including the LT and new TNC series
- Low cost
- Rugged construction

Listed below are a few of the important specifications.

Frequency Range:	100 to 1000 mc/s
Residual VSWR:	Less than 1.03
Minimum Input Signal:	Approx. 1V at 100 mc/s; 0.1V at 1000 mc/s for measuring a matched load
Characteristic Impedance:	50 ohms
Detector:	Crystal included
RF Input Connector:	BNC jack
RF Output Connector:	Type N jack supplied. Connector types available include types C, BNC, LT, TNC, 7/8" coax.
Audio Output Connector:	BNC jack
Dimensions:	8" L x 5" W x 5 3/4" H
Weight:	4 1/2 pounds

f.o.b. Brooklyn, New York

Note to owners of the new PRD Catalog, E-8: Don't bother reading this ad. All these details and more can be found on page B-13. If you are unfortunate enough not to own a copy of this designers' workbook, send your request on your company letterhead please.

If all you want are specifications on the 219, fill out the inquiry card in this magazine.



**POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC.**

Factory & General Office:  
202 Tillary St., Brooklyn 1, N.Y.  
ULster 2-6800

Western Sales Office:  
2639 So. La Cienega Blvd., Los Angeles 34, Calif.  
TEXas 0-1940

CIRCLE 168 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • April 29, 1959



## SATELLITE-PROVED RELIABILITY...

in the 215 mc to 245 mc telemetering band

**THE MODEL REL-09 HF** is a ruggedized miniature R-F power amplifier. With a solid history of reliability in current missile systems, the unit proved its indifference to the adversities of space environment by functioning perfectly while in orbit as part of the Vanguard satellite. The 5-inch, 1-pound amplifier delivers an 11-watt output to a 52-ohm load with a 1.4-watt input drive. For full specs, write for Data File ED-724-1



size: 4.95" L x 3.58" W x 1.09" H



**RHEEM MANUFACTURING COMPANY**  
DEFENSE AND TECHNICAL PRODUCTS DIVISION  
11711 WOODRIDGE AVENUE, IRVINE, CALIFORNIA

CIRCLE 169 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • April 29, 1959

## Guide to Silicones

170

Latest additions to the Dow Corning Silicone line include three brochures which detail the growing use of different silicone products in their respective fields of application. "1959 Guide to Dow Corning Silicones" is a 16-page illustrated brochure discussing new materials to improve products and reduce costs. Nature, properties, and applications of adhesives through water repellents are described. The four-page leaflet, "Nothing Sticks to Paper with Syl-Off Silicone Coatings" discusses the advantages of this product. "Silicones in Missile Design" is an illustrated folder describing rigid materials, rubbery materials, fluid materials, and dielectric materials for electrical and electronic systems in missile and support equipment. Dow Corning Corp., Midland, Mich.

## Pushbutton Switches

171

This two-page data sheet covers a new series of "One-Shot" Switches. The unit consists of a pushbutton switch assembly with an electronic circuit which produces a single, microsecond length pulse with each operation. Data sheet includes photo, dimension drawing, specifications, circuit schematic, pulse curve oscillographs and application information. Micro Switch, Division of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

## Electronic Components

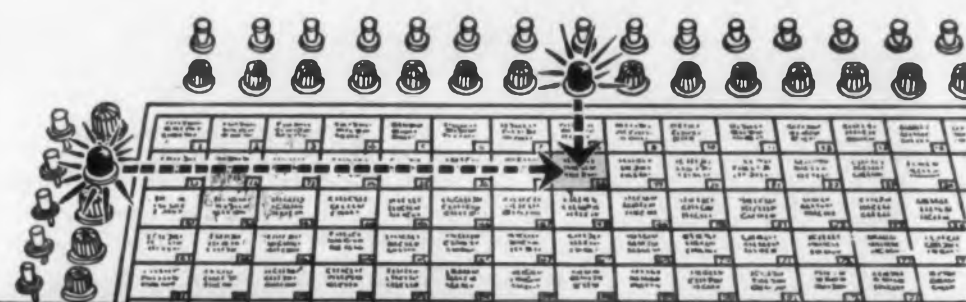
172

Catalog 558, a 12-page two-color brochure, lists Hitachi electronic receiving tubes and transistors. Also included are several types of capacitors, resistors and audio equipment. Electronic Utilities Co., Division of the Sampson Co., 2244 S. Western Ave., Chicago 8, Ill.

## Batteries

173

"A Reusable Primary—The Yardney PB Silvercel® Battery," is a technical bulletin describing this recently developed battery which combines the recyclability of the secondary battery, the fast activation of the primary and the high power output of the silver-zinc system. The illustrated brochure explains the PM Silvercel battery's outstanding characteristics—highest specific power, highest specific energy and longest activated stand life yet achieved by a primary, reusability and fast activation. It compares the battery's energy and power with other battery systems, and discusses its applications, electrical characteristics (energy, power discharge rates), construction, charging, fast activation, wet stand, recycling, soaking time and other technical data. Yardney Electric Corp., 40-50 Leonard St., New York, N.Y.



## DIT-MCO

## MATRIX CHART

## ERROR LOCATION

## SYSTEM

**SAVES UP TO 90%**

**CORRECTION TIME!**



## Pinpoints All Circuit Flaws Instantly...Plots and Simplifies Test Procedure...Provides a Permanent Record!

DIT-MCO's revolutionary Matrix Chart is the only error location device which puts all circuit information . . . errors, circuit numbers, type of flaws, etc. . . directly in front of the operator of this Automatic Electrical Circuit Analyzer. It plots the entire test sequence and pinpoints every circuit flaw . . . instantly! Horizontal and vertical indicator lights cross reference to indicate the exact error location, circuit number and type of flaw. As errors are detected, they are recorded on the proper matrix square and the test continues.

Once the test sequence has been completed, all corrections are made direct from the Matrix Chart. This group correction feature saves up to 90% of error correction and/or interpretation time by eliminating time-consuming searches through complex manuals and wiring diagrams. After corrections have been noted on the Matrix Chart, it provides a complete record of test circuits, test specifications, instructions, results and modifications. This concise, understandable record improves interdepartmental communications and provides co-ordination through all stages of planning, production and maintenance. Non-technical personnel easily master operation of the Analyzer and use of the Matrix Chart System. The final Matrix Chart can follow the product for future overhaul and maintenance use.

DIT-MCO, Inc. employs an experienced staff of sales engineers in the field. Contact your field sales engineer or write for important facts about DIT-MCO Automatic Electrical Circuit Analyzers.



**PLUGBOARD PROGRAMMING SPEEDS TESTING!**

## DIT-MCO, INC.

ELECTRONICS DIVISION • BOX 04-20  
911 BROADWAY • KANSAS CITY, MO.

Jump-wired plugboard programming permits use of simple, straightforward adapter cables. Circuit modifications never present headaches because all changes are easily made by re-jumpering the readily accessible plugboards.

## Partial List of DIT-MCO Users

Aircraft Radio Corp. • AiResearch Manufacturing Co. • American Bosch Arma Corp. • American Machine & Foundry Co. • American Motors • Amphenol Electronics Corp. • Autonetics, A Division of North American Aviation, Inc. • Bell Aircraft Corp. • Bendix Aviation Corp. • Boeing Airplane Co. • Cessna Aircraft Co. • Chance Vought Aircraft, Inc. • Chrysler Corp. • Convair • Douglas Aircraft Co., Inc. • Dukane Corp. • Electronic Products Corp. • Fairchild Aircraft Division • Farnsworth Electronics Co. • Frankford Arsenal • General Electric Co. • General Mills, Inc., Mechanical Division • General Precision Laboratory, Inc. • Goodyear Aircraft Corp. • Grumman Aircraft Engineering Corp. • Hazeltine Electronics Division, Hazeltine Corp. • Hughes Aircraft • International Business Machines Corp. • Jefferson Electronics Products Corp. • Lockheed Aircraft Corp., Missile Systems Division • Martin, Baltimore • Minneapolis-Honeywell, Aeronautical Division • Motorola, Inc. • Northrup Aircraft, Inc. • Pacific Mercury Television Mfg. Corp. • Radio Corp. of America • Radioplane Co. • Raytheon Manufacturing Co. • Servomechanisms, Inc. • Sikorsky Aircraft • Sperry Gyroscope Co. • Summers Gyroscope Co. • Sun Electric Co. • The Swartwout Co., Autronic Division • Temco Aircraft Corp. • Thompson Products • Topp Industries Inc. • Trans World Airlines • U. S. Naval Air Station Overhaul and Repair Depots • U. S. Naval Ordnance Laboratory, White Oak • Vertol Aircraft Corp. • Western Electric Co. • Westinghouse Electric Corp.

CIRCLE 174 ON READER-SERVICE CARD



## KELLOGG PUSH-BUTTON HANDSET

**SUPERIOR TRANSMISSION...  
HIGH SIGNAL-TO-NOISE RATIO**

Manually operated, normally open push-button control... receiver and transmitter in one lightweight instrument... ideal for 2-way radio, dictating machines, etc. Uses ring armature... 5db increase in output over extended frequency range. Unique, completely gold-plated carbon chamber with superior carbon granules... best transmission in its class.

Write for complete specifications and details.



Kellogg Switchboard and Supply Company, 6650 South Cicero Avenue, Chicago 38, Illinois. Communications Division of International Telephone and Telegraph Corporation

CIRCLE 175 ON READER-SERVICE CARD

## Shatterproof, Clear Plastic Containers

for packaging individual components!

- For individual packaging or kits • Wide range of sizes • 1/5 the weight of glass • Lower shipping costs • Can be printed or decorated • Low cost • Reusable • Also Available in Color.

Write for complete prices and literature

**LERMER PLASTICS, INC.**

572 South Avenue, Garwood, N. J.

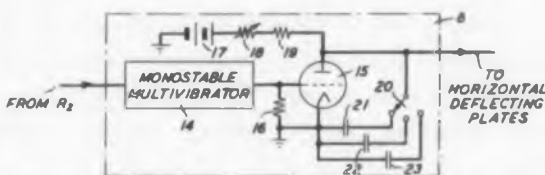
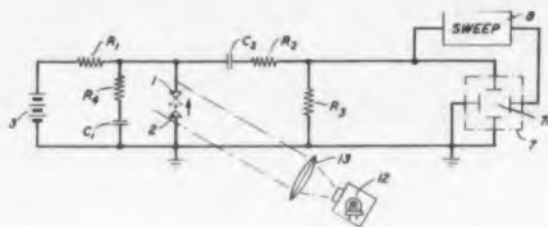
PIONEERS AND SPECIALISTS IN PLASTIC CONTAINERS SINCE 1919  
CIRCLE 176 ON READER-SERVICE CARD

# PATENTS

## Velocity Measurement of Relay Contacts

Patent No. 2,864,054. Willard S. Boyle and James L. Smith. (Assigned to Bell Telephone Labs., Inc.)

Rate of closure of contacts is measured by displaying, on a calibrated oscilloscope, the time interval from arc discharge across the contacts to the time of actual contact. For fixed voltage and pressure, the spacing for arc discharge is obtained from Paschen's law; actual contact



is the instant a storage capacitor discharges.

Initially, capacitor  $C_1$  charges fully and ultraviolet lamp 12 illuminates the contact spacing with photoelectrons to insure reproducibility of the spacing for the arc. As contacts 1 and 2 move together, capacitor  $C_1$  discharges at the time the arc initiates and the crt sweep 3 is triggered. Capacitor  $C_1$  recharges as the contacts move closer and the second discharge of the capacitor, when the contacts touch, precisely marks the time of closure  $T$  on the oscilloscope display.

## System for Selectivity Energizing One of Three Circuits Responsive to Variation of Two Conditions

Shih C. Chao. (Assigned to International Business Machines Corp.)

Individual signals gate selected circuits while the signals simultaneously exclusively gate another circuit.

Battery 25 sets the pnp transistors beyond cut off. Closing switch 12 permits only transistor 1 to conduct and closing



**NEW**

**STANDARD RELAY**

**HAS DRY CIRCUIT TO 10 AMP VERSATILITY**

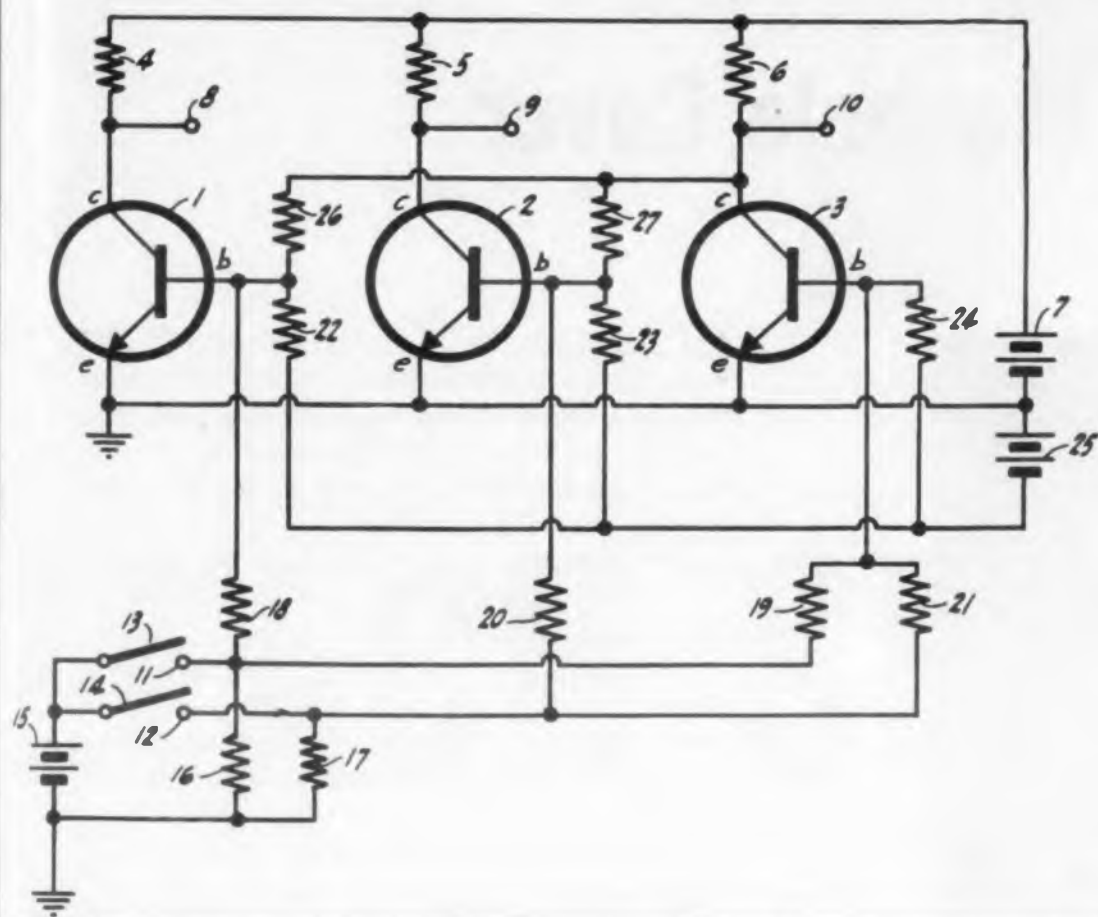
Completely new Babcock BR-7 miniature DPDT relay, ruggedly designed for diversified MIL-SPEC airborne and missile applications, will permit contact loads from dry circuit conditions to 10 amperes. Single size for all uses with 0.2" grid spaced header supplied for interchangeability. Specifically engineered for greater reliability, extended life and extreme sensitivity. Minimum life at 10 amps—300,000 operations at 25°C and 100,000 operations at 125°C. Meets or exceeds applicable specifications for life, temperature, vibration (30 g min. to 2,000 cps), and shock. 480 mw pull-in for 10 amp contacts, 80 mw for 2 amp contacts, lower for SPDT and special adjustments. Can size: 1.26 x 1.07 x 0.56 in. Complete header arrangements, mounting methods and special mountings available. For Technical Bulletin, write BABCOCK RELAYS, INC., 1640 Monrovia Ave., Costa Mesa, Calif.

CIRCLE 177 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1959

switch 14 causes only transistor 2 to conduct; for both instances, resistors 19 and 21 divide the input signals to hold the third transistor cut off. However, when

switches 12 and 14 close together, these voltage divider resistors are shorted, transistor 3 conducts and the output voltage is fed back to cut off transistors 1 and 2.



## A capacitor "FORM-FACTOR" that permits TIGHT CIRCUITRY DESIGN

Electron Products' metallized paper capacitors feature small size, and equally as important... the "form-factor." Series M-150 and W-150 are available FROM STOCK in round, rectangular and wafer configurations to suit your requirements for miniaturized packaging. These series have self-healing characteristics for utmost in reliability. Also available in hermetically sealed rectangular or round tubes for extreme environmental conditions.

### SPECIFICATIONS:

Operating temperatures:  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  or higher on special order.

Voltages Available: 100, 200, 300, 400 and 600 volts.

Values: from .001 mfd to any value specified. Standard values available from stock

Send for literature

**Electron Products** CO.  *Capacitors and Interference Filters*  
DIV. OF PRECO, INC.

430 N. HALSTEAD STREET • PASADENA, CALIFORNIA • RYAN 1-0666, ELGIN 5-7101

CIRCLE 178 ON READER-SERVICE CARD



*New  
and  
Hot!*

## REC's NEW DEICED TEMPERATURE PROBE

This extraordinary new Model 102D gives accurate total temperature measurement while deicing heater operates

The unique ability of this probe to permit precise total temperature measurements *while* deicing heat is continuously applied opens up numerous possibilities. Model 102D will deice within one minute when subjected to icing conditions defined in Section 3.5, paragraph g of MIL-P-25632A (USAF). Model 102D is designed for use at flight speeds up to Mach 2 and higher.

Tell us about your project. We welcome your inquiry for complete information on Model 102D, or any of REC's many other precision units.

**NEW CATALOG. No. 115811.** Illustrated compilation of data on over 50 different REC probes ranging from  $-260^{\circ}\text{C}$ . to  $1500^{\circ}\text{C}$ ., plus REC pressure transducers and pitot-static tubes.



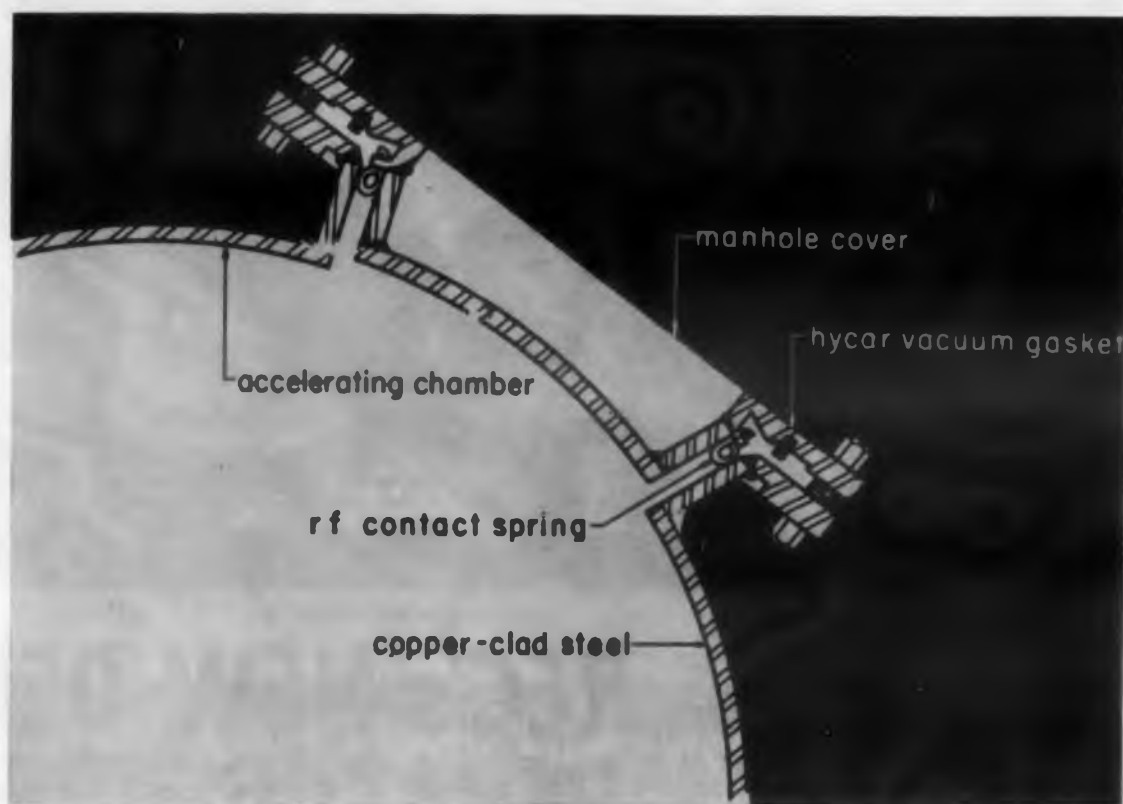
**ROSEMOUNT  
ENGINEERING  
COMPANY**

4914 West 78th Street • Minneapolis 24, Minn.

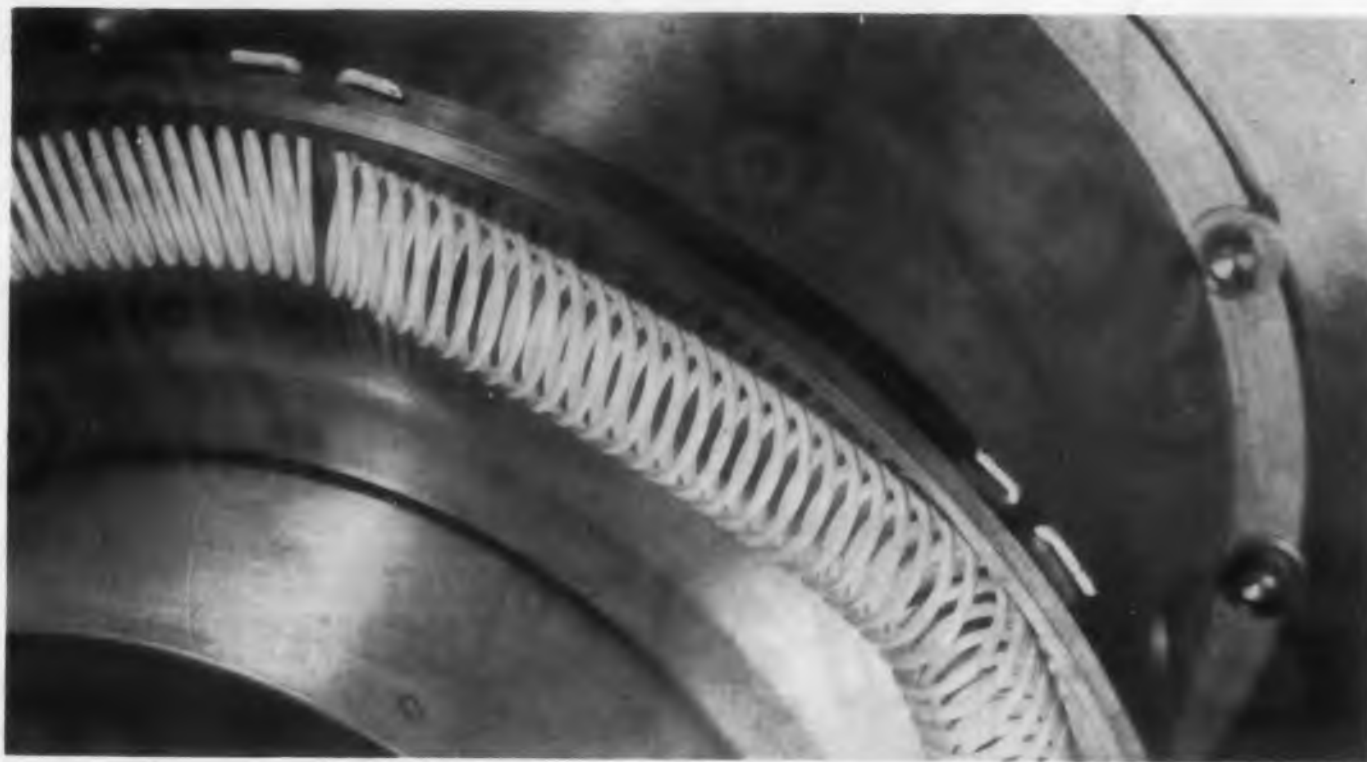
CIRCLE 179 ON READER-SERVICE CARD



# Radio Frequency Manhole Cover



**Fig. 1.** Cross section of an accelerating chamber of the HILAC, showing a manhole cover and rf-contact spring.



**Fig. 2.** Radio frequency contact for a transmission-line joint of the HILAC.

**I**N THE heavy-ion linear accelerator (HILAC) the accelerating chambers are made of copper-clad steel. The rf and vacuum cavities are integral; opening one cavity simultaneously opens the other. Therefore, all covers must have both a vacuum gasket and an rf contact.

To facilitate entry it is desirable to use only one set of clamping bolts for making both the rf contact and the vacuum seal.

An arrangement which has proved successful for the manhole covers of the HILAC is shown in Fig. 1. The unique element of this is the rf contact spring. This spring is designed so that the contact force rises to a maximum with a deflection of only 1/16 in., even though the spring diameter is 1 in.

The contact force remains almost constant with further deflection. Because of this, the spring can accommodate large surface roughness and still give a successful rf contact that can be reused indefinitely.

The HILAC has been operating for nearly two years at rated power (70 mc, 42 amp rms on a 3 per cent duty cycle) and there have been no spring replacements due to burnout. One spring section had to be replaced because of mechanical damage, but the circumstances only proved the ruggedness of the design.

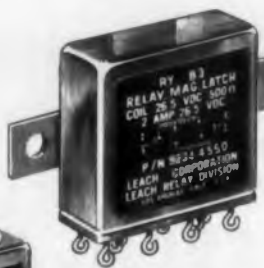
One of the manhole covers was accidentally dropped when it was about a foot above the hole. The rf contact spring piloted the 400 pound cover into the hole and absorbed enough shock so that nothing was damaged except one 6 in. spring section. It took only a minute to clip off the ends of the damaged spring, insert the ends of a new one, and bend them over.

Although this design has been used only in the HILAC, it is apparent that it could be applied to other situations. For instance, in a variable-volume resonator where it is necessary to have an rf contact between a sliding piston and a cylinder wall, this spring might prove ideal.

The work on the manhole cover was done under auspices of U.S. Atomic Energy Commission.

*Luther R. Lucas, Lawrence Radiation Laboratory, University of California, Berkeley, Calif.*

TYPE 9234-4550 2PDT, 2AMP, MAGNETIC LATCH RELAY



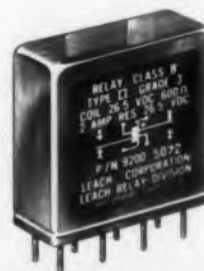
(BRACKET MOUNTING, SOLDER HOOK TERMINALS, HERMETICALLY SEALED)

TYPE 9200-5091 2PDT, 2AMP, RELAY



(STUD MOUNTING, SOLDER HOOK TERMINALS, HERMETICALLY SEALED)

TYPE 9200-5072 2PDT, 2AMP, RELAY



(PLUG-IN OR PRINTED CIRCUIT MOUNTING, HERMETICALLY SEALED)

# LEACH SUBMINIATURE CRYSTAL CAN RELAYS

(SHOWN ABOVE...ACTUAL SIZE)

**torture-tested  
to perfection  
for big  
relay performance**

These sensitive Leach subminiature relays deliver big relay performance... in a crystal can size that makes them ideal for use in missile control circuits in airborne or ground equipment and in computer and printed circuits.

Torture-tested to perfection in the Leach Production Reliability Center, these subminiatures are designed to meet the critical extremes of vibration, shock and other stringent environmental requirements in military and commercial applications.

They meet the specifications of both MIL-R-25018 and MIL-R-5757C—as well as MIL-R-6106C, including

the minimum current test requirements. Uniform contact pressure and overtravel are guaranteed for the life of these balanced-armature relays. They are available in a wide range of socket, stud and bracket mountings to meet specific customer requirements.

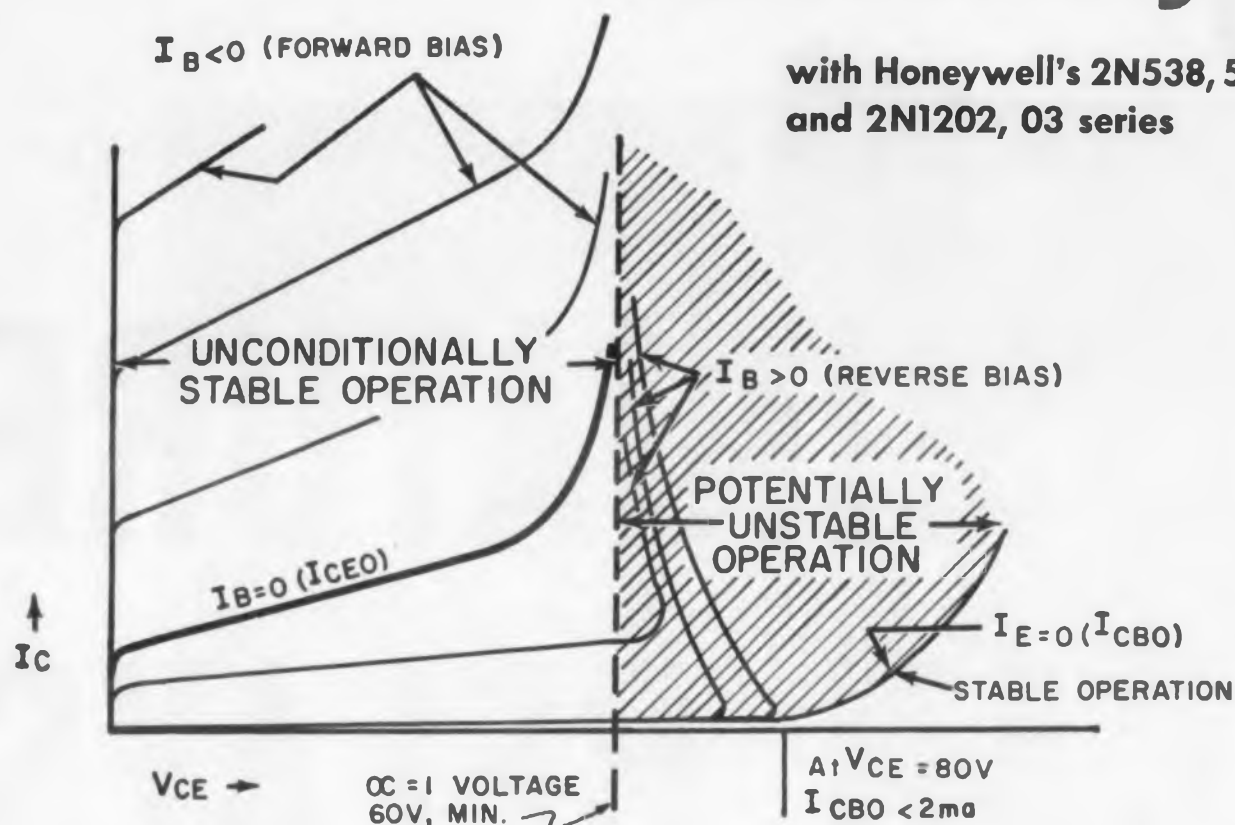
*Write today for Leach Crystal Can Relay Brochure containing specifications, typical ratings and other information on these subminiatures! Or contact your nearest Leach sales representative to discuss your specific subminiature relay requirements.*

**RELIABILITY** → **LOOK TO LEACH**  
RELAY DIVISION...LEACH CORPORATION  
5915 AVALON BOULEVARD, LOS ANGELES 3

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



# New Honeywell formula for power transistor reliability



with Honeywell's 2N538, 539, 540  
and 2N1202, 03 series

**N**OW THESE Honeywell Power Transistors guarantee minimum  $\alpha=1$  voltage to insure stable operation under all bias conditions up to 60 volts. This rating permits operation of both class A and class B transformer-coupled output power amplifiers from a 28VDC source. Proper back bias extends safe operating voltage up to the collector diode design limit of 80 volts.

Contributing to the superior reliability of Honeywell Power Transistors are built-in stability through improved design and processing methods *plus* significant dynamic testing.

Honeywell's 2N538, 539 and 540, and 2N1202 (characterized at  $\frac{1}{2}$  amp) and 2N1203 (120 volt collector diode) Power Transistor Series are rugged, hermetically sealed germanium PNP transistors suited to servo amplifier, power conversion, voltage regulation and switching applications.

These new improved Honeywell Power Transistors give you two other bonuses—new lower prices, plus 1 year warranty. For complete data on these transistors, or for a copy of Honeywell's new Technical Booklet "Fundamental Voltage Limitations of a Transistor," contact one of the following offices:

- UNION, NEW JERSEY.....(MUrdoch 8-9000)
- BOSTON, MASSACHUSETTS.....(ALgonquin 4-8730)
- CHICAGO, ILLINOIS.....(IRving 8-9266)
- LOS ANGELES, CALIFORNIA.....(RAYmond 3-6611 or  
PArkview 8-7311)
- ATLANTA, GEORGIA.....(TRinity 4-9776)

Or write Minneapolis-Honeywell, Dept. ED-4-82,  
Minneapolis 8, Minnesota.

## Honeywell



First in Control

CIRCLE 182 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

### Optical Gaging Cuts Costs Improves Efficiency

In microwave tube assembly, accurate physical measurements are essential. Bomac Laboratories, Inc., an important company in the microwave tube field, has found great economies through the use of a Kodak Contour Projector.

This instrument, shown in the photo, is used for rapid, accurate inspection of incoming material, in-process part measurements, and statistical quality evaluation.

During incoming inspection, multiple hole alignment on flat surfaces, angles of blind holes (via surface illumination), and decreasing angle slopes are but a few of the ways Bomac uses optical gaging. In many cases, components cannot readily be inspected by other means.

Furthermore, it is possible to check several dimensions of a part simultaneously with contour projection. Some of the general types of measurements include: thread forms, angles, hole locations, and the relationship between two or more parts of subassemblies.

One of the beauties of this method is that there is no wear to a light beam, no matter how often it is used. Hence, wear allowances need not be considered.



Contour projection allows for precise measurement of intricate parts.

Don't miss an issue of **ELECTRONIC DESIGN**; return your renewal card.

ELECTRONIC DESIGN • April 29, 1959

## Shaft Turns, Syncs Scope

We needed to generate a synchronizing signal from a rotating shaft to trigger a scope. The shaft was on a "Servo Breadboard." A trigger was needed to relate mechanical and electrical rotation.

A mechanical brush contact was tried. This worked, but the contacts tended to float, at higher rpm's, giving an erratic trigger.

A simple method of generating the desired pulse is shown in Fig. 1. A 1N469 phototransistor is used in a simple amplifier circuit. The light source is a prefocused GE224 "Penlite" bulb. Both transistor and light are mounted by their leads in the positions shown. Fig. 2 shows the amplifier circuit.

The output trigger is approximately one to two v (depending on how critically the light source is adjusted). The rise and fall time is constant, at approximately 90  $\mu$ sec, over a motor speed of 500 to 4000 rpm.

Philip L. Writer, Engineer, Computers & Controls Div., Litton Industries, Beverly Hills, Calif.

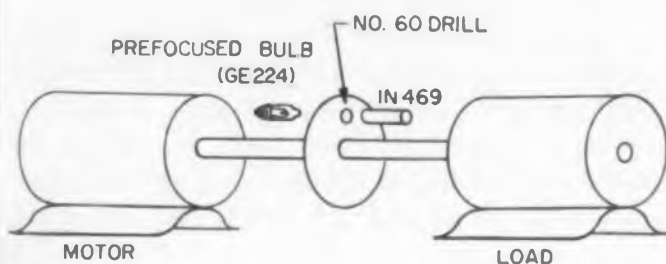


Fig. 1. The disk, mounted on the rotating shaft, provides a sync signal everytime the small hole allows light to strike the phototransistor.

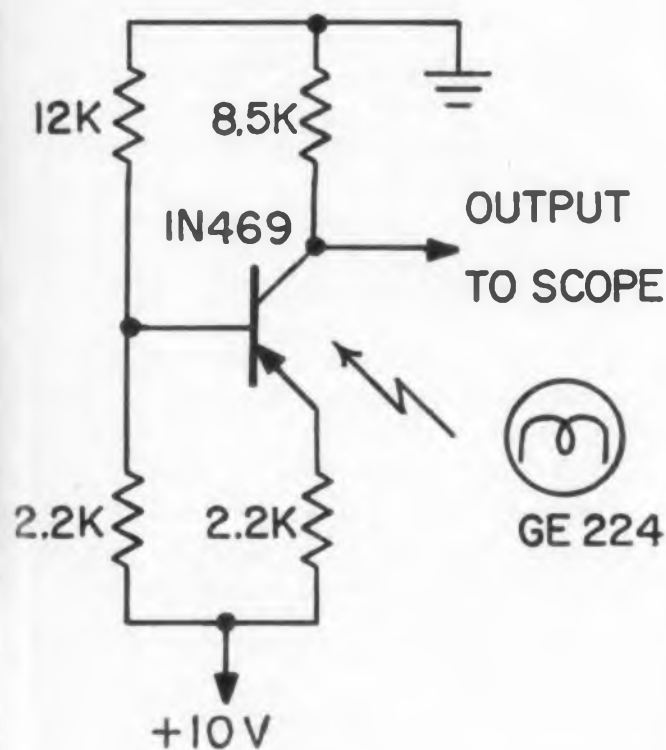


Fig. 2. Phototransistor circuit to provide scope sync.

# FAIRCHILD SILICON MESA TRANSISTORS IN BOTH POLARITIES

Four models of great importance to the computer-circuit designer



Greatly enlarged photo of Fairchild 2N696 before capping

Important — because for high-speed switching, Fairchild's 2N696, 2N697, 2N1131 and 2N1132 are the most advanced transistors available. They are solid-state diffusion devices, a type that is certain to dominate computer-circuit applications in the future because of its superior combination of speed, power and reliability. Fairchild Semiconductor Corporation was first to offer solid-state diffused NPN silicon transistors of such high performance — and again first in offering PNP silicon transistors closely matching these NPN transistors in both high frequency and DC characteristics. All are in quantity production and available from stock.

### Speed and power in combination

80 milli-micro-second rise time is typical. Two-watts dissipation at 25°C. and 10 ohms maximum saturation resistance provide high-current capability even at elevated junction temperatures.

### Utmost reliability

Storage at 300° C. in excess of 1000 hours caused no serious changes in these transistors, assuring a large safety factor at operating temperatures. Mesa construction as shown in enlarged photograph provides extraordinary ruggedness by eliminating suspension of any significant masses. Units have survived 22,000g, 4-millisecond duration shock test without damage.

### NPN and PNP closely matched

The circuit designer need no longer be limited by unavailability of PNP transistors. Fairchild has them. And they are closely matched to the NPN transistors in DC characteristics, affording opportunities for circuit designs based on complementary symmetry.

ABSOLUTE MAXIMUM RATINGS (25° C.)						
$V_{CE}$	Collector to emitter voltage					30v
$V_{CB}$	Collector to base voltage					40v
$V_{EB}$	Emitter to base voltage					5v
Total dissipation at case temperature 25° C.						2 watts
at case temperature 100° C.						1 watt
ELECTRICAL CHARACTERISTICS (25° C.)						
SYMBOL	CHARACTERISTIC	MIN.	TYPICAL	MAX.	TEST CONDITIONS	
$h_{FE}$	D. C. pulse current gain	2N1131 15 2N1132 30		45 90	$I_C = 150mA$	$V_C = 10V$
$V_{BE SAT.}$	Base saturation voltage		1.0V	1.5V	$I_C = 150mA$	$I_B = 15mA$
$V_{CE SAT.}$	Collector saturation voltage		0.9V	1.5V	$I_C = 150mA$	$I_B = 15mA$
$h_{FE}$	Small signal current gain at $f = 20mc$		2.5		$I_C = 50mA$	$V_C = 10V$
$C_{ob}$	Collector capacitance		35 $\mu f$	45 $\mu f$	$I_B = 0mA$	$V_C = 10V$
$I_{CBO}$	Collector cutoff current		.01 $\mu A$	1.0 $\mu A$	$V_C = 30V$	$T = 25° C.$
			5.0 $\mu A$	100 $\mu A$	$V_C = 30V$	$T = 150° C.$

ABSOLUTE MAXIMUM RATINGS (25° C.)						
$V_{CE}$	Collector to emitter voltage					40v
$V_{CB}$	Collector to base voltage					60v
$V_{EB}$	Emitter to base voltage					5v
Total dissipation at case temperature 25° C.						2 watts
at case temperature 100° C.						1 watt
ELECTRICAL CHARACTERISTICS (25° C.)						
SYMBOL	CHARACTERISTIC	MIN.	TYPICAL	MAX.	TEST CONDITIONS	
$h_{FE}$	D. C. pulse current gain	2N696 20 2N697 40		60 120	$I_C = 150mA$	$V_C = 10V$
$V_{BE SAT.}$	Base saturation voltage		1.0V	1.3V	$I_C = 150mA$	$I_B = 15mA$
$V_{CE SAT.}$	Collector saturation voltage		0.5V	1.5V	$I_C = 150mA$	$I_B = 15mA$
$h_{FE}$	Small signal current gain at $f = 20mc$		5		$I_C = 50mA$	$V_C = 10V$
$C_{ob}$	Collector capacitance		20 $\mu f$	35 $\mu f$	$I_B = 0mA$	$V_C = 10V$
$I_{CBO}$	Collector cutoff current		.01 $\mu A$	1.0 $\mu A$	$V_C = 30V$	$T = 25° C.$
			5.0 $\mu A$	100 $\mu A$	$V_C = 30V$	$T = 150° C.$

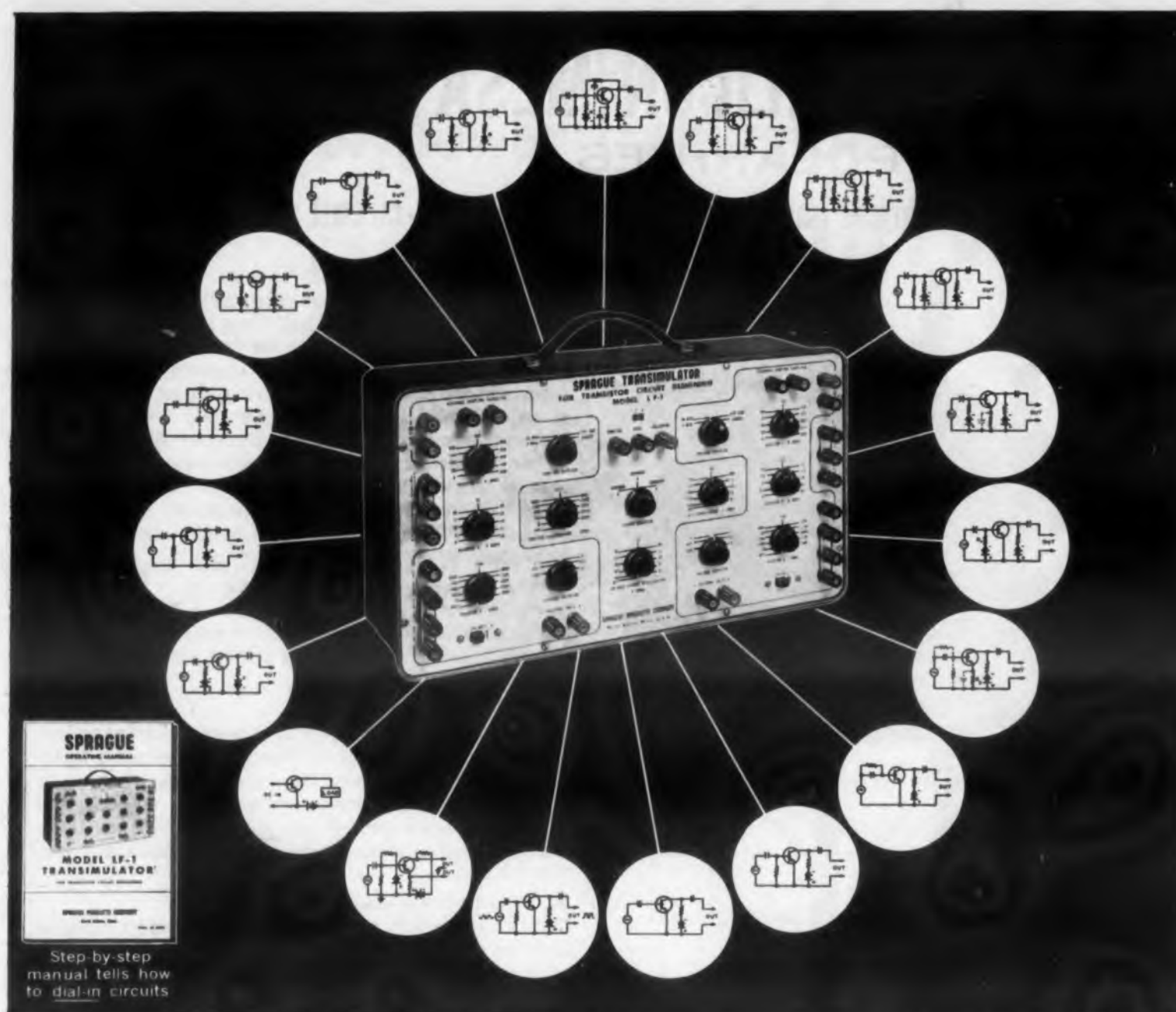
For specification sheets, write Dept. B-4-29

844 CHARLESTON ROAD • PALO ALTO, CALIFORNIA • DA 6-6695



CIRCLE 183 ON READER-SERVICE CARD





## DIAL-IN TRANSISTOR CIRCUITS with handy, time-saving Transimulator\*

*Transistor circuits in minutes!* No breadboarding, no soldering. Set a few dials on the Sprague LF-1 Transimulator and you're ready to make speedy and accurate evaluations of the operating parameters involved in your circuit design. It's like giving wings to your circuit ideas.

The Transimulator duplicates any amplifier stage, a-c or direct-coupled, short of high power audio output . . . whether the transistors are PNP, NPN, or surface barrier. And it does lots more. The operating manual details a wide variety of circuit variations. In

step-by-step fashion the manual tells you how to set up at least 19 separate circuits. It treats direct-coupled circuits as well as transformer-coupled circuits, multiple stage operation, and measurement of transistor parameters.

The Transimulator takes the fiddlin' and fussin' out of transistor circuit designing. You go right from diagrams to circuits with no wasted motion. The Transimulator pays for itself many times over because it helps you work faster . . . work better.

**only  
\$79.50**

**SPRAGUE®**  
THE MARK OF RELIABILITY

\*Trademark

### SEE THE TRANSIMULATOR IN ACTION!

...at your nearest authorized Sprague distributor.  
Sprague Products Co., 347 Marshall St., North Adams, Mass.

CIRCLE 184 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

### Ten Minute Interval Timer

A need recently arose for an interval timer which would allow another piece of equipment to be activated from 5 sec to 1 minute, then turn this equipment off and accurately wait anywhere from 3 minutes to 10 minutes. Both intervals were to be adjustable.

Since such long intervals demand very large capacitors, especially in transistorized equipment, the new and small GE Tantalytic capacitors were used.

The circuit, shown in Fig. 1, works as follows. Assume that at  $t = 0$ , 30 v is applied to the circuit. Immediately the zener diode assumes a reference voltage, but at the same time  $C$ , which is 2300  $\mu$ f, is thrown across the zener diode terminals through  $R1$ , the charge resistance. This heavy load causes the diode to go out of regulation. Therefore,  $C$  starts to charge essentially from zero. Eventually, the zener diode regains regulation and the capacitors start to charge asymptotically to the zener's terminal voltage with a time constant as determined by  $R1$  and  $C$ .

As  $C$  charges, the voltage across  $C$  is used to supply bias current to the base thru  $R4$  and  $R6$ . Thus, as the base current increases, so does the collector current until the "pull in" current has been reached in the relay. At this point, (1) the controlled circuit is disconnected (pin 1 of relay),

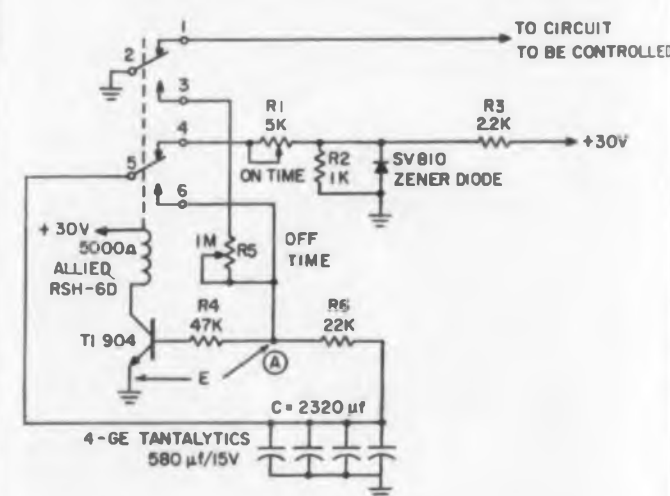


Fig. 1. Long interval timer takes advantage of large capacity available in small size tantalum capacitors.

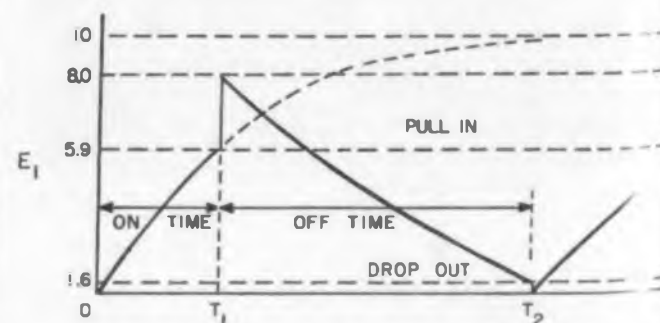


Fig. 2. Voltage at point A as a function of time.

(2) a resistor  $R5$  is connected to ground, (3) resistor  $R6$  is shorted out. Event 3 has particular significance, for it causes the full charged voltage of the capacitors to be used as base bias.

Fig. 2 is a plot of the voltage appearing at point A. At  $t1$ ,  $E1$  rises 2 v higher, and this adds greatly to the time interval. The capacitor then starts to discharge exponentially until at  $t2$ , insufficient bias current flows to maintain the relay energized. The process then repeats itself.

With the values shown, the on time can be varied between 3 sec to over a minute, and the off time can be varied from less than a minute to 5 minutes. With  $R5$  removed, a time of almost 10 minutes has been obtained.

Gerald Wilner, Development Engineer, ITT Laboratories, Nutley 10, N. J.

### TV Antenna for Radio

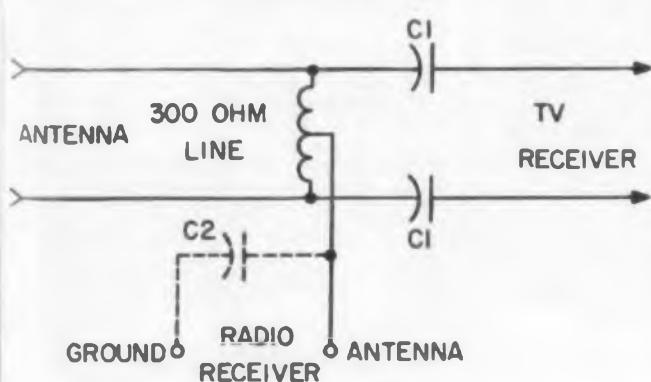
Because of its location, an outdoor TV antenna constitutes a good radio antenna, too. And its connection to the radio receiver can tremendously improve reception. However, it is bothersome to connect and disconnect the ribbon every time one wants to switch from TV to radio.

A permanent installation is easily made and well worth the trouble. The accompanying diagram shows all that is needed is a coil and two capacitors. They can be inserted anywhere in the line, generally right at the connection to the TV receiver. However, if the ribbon passes near the radio receiver, it can simply be cut at the nearest point.

A small terminal strip is used to support the coil and capacitors. The coil is but a choke to block the high TV frequencies. It can be made by winding 40 turns of hookup wire on a 1/4 in. diameter form, and is not critical. A center tap is provided.

The capacitors  $C1$  block the low radio frequencies. They can have a value of 20 to 50  $\mu\text{f}$ . To obtain a good match at the radio input, it may be necessary to connect a capacitor  $C2$  between antenna and ground terminals. Its value should be around 100  $\mu\text{f}$ .

Dr. A. V. J. Martin, Carnegie Institute of Technology, Pittsburgh 13, Pa.



TV Antenna for radio.



# MICROMODULES

*a bright, new opportunity for scientists and engineers*

RCA Somerville is headquarters for the major research, design and development of the miniature cube-shaped encapsulated units that function individually as complete circuits and sub-systems—MICROMODULES!

Initiated by the U.S. Army Signal Corps, with RCA as the prime contractor, the Micromodule Program has received almost instantaneous recognition as a truly major electronics advance. There can be no doubt of Micromodules dramatic commercial and military future with the realization that a *ten-times size reduction over the best existing equipment is both possible and practical!*

RCA's Micromodules Program offers opportunities in:

SUBMINIATURE CIRCUIT DESIGN  
and APPLICATIONS

MICRO-ELEMENTS RESEARCH AND DEVELOPMENT

Resistors • Capacitors • Inductors • Transistors  
Inquiries are invited for key openings at RCA's new, ultra-modern Semiconductor and Materials headquarters in suburban Somerville, New Jersey (just 35 miles from New York City), from individuals with degrees in . . .

ELECTRICAL ENGINEERING • PHYSICS • CHEMISTRY  
PHYSICAL CHEMISTRY • CHEMICAL ENGINEERING  
CERAMICS

Phone or Write: Mr. J. B. Daly, RAndolph 5-4500



**RADIO CORPORATION OF AMERICA**

Semiconductor and Materials Division

Somerville, New Jersey

CIRCLE 873 ON READER-SERVICE CARD





## REAL RELIABILITY

NEW ceramic feed-through capacitors

NEW for missiles, computers and military

- -55°C to + 125°C Operating temperature range
- Outstanding moisture, vibration, and thermal shock resistance
- Exceeds requirements of MIL-C-20B and MIL-C-11015A

Maida Development Company, with over 10 years experience in manufacturing quality ceramic capacitors, now presents the type 287 feed-through capacitor for those applications requiring the highest reliability over a wide range of environmental conditions and operating temperatures. It is outstanding in high IR at 125°C, Thermal and mechanical shock resistance, capacitance, drift, and general sturdy construction. Capacities up to 1200  $\mu\text{f}$  at 350 WVDC available. Write or phone for specification bulletin.

**MAIDA** Development Co., Inc.  
214 Academy St., Hampton, Va.  
Phone Park 3-0785

CIRCLE 186 ON READER-SERVICE CARD

Send for Your FREE Copy of This

## NEW DESIGN MANUAL NO. 401G

(Illustrated in color)

20 pages



- ✓ 120 STANDARD TYPES AND SIZES
- ✓ FREE VELLUM SERVICE
- ✓ THREE WEEK DELIVERY 1ST ARTICLE
- ✓ STANDARD INSTRUMENT PANELS
- ✓ ALL ALUMINUM CONSTRUCTION
- ✓ SUBMERGENCE-PROOF TO MIL-STD-108C
- ✓ CONSTRUCTED TO MIL-T-945A
- ✓ COMPLETE DESIGN INFORMATION

TA MFG. CORP. INSTRUMENT CASE DIVISION

4607 Alger St., Los Angeles 39, Calif. • Tel. CHapman 5-3748  
TWX Glendale, California 7025 • WUX Los Angeles, California

CIRCLE 187 ON READER-SERVICE CARD



## STANDARDS AND SPECS

Sherman H. Hubelbank

### Magnetic Materials

MIL-P-55034, STABILITY OF POWDERED MAGNETIC MATERIALS (MOLDED) FOR CORES (FOR USE IN ELECTRICAL AND ELECTRONIC PARTS), 19 SEPTEMBER 1958

Covered in this spec is the evaluation of the uniformity and the stability under environmental conditions of molded, powdered magnetic materials for use as cores in such electrical and electronic parts as coils, transformers, etc. The cores covered by this spec are intended for use in applications where uniformity and stability of electrical and magnetic characteristics under adverse environmental conditions is a prime requisite. Specific performance of cores is not covered in this spec.

### Composition Resistors

MIL-R-94B, VARIABLE COMPOSITION RESISTORS, AMENDMENT 1, 24 NOVEMBER 1958

A requirement was added to Acceleration and Shock that movement in the arm incurred during these tests shall not result in a resistance change greater than 10 per cent. Test procedures have been modified. The requirements of Method 205 of MIL-STD-202 have been added for shock testing.

### Flanges, Waveguides, Fittings

MIL-F-3922, FLANGES, WAVEGUIDES, AND ASSOCIATED FITTINGS, SUPPLEMENT 1A, 15 NOVEMBER 1958

Improved versions of the old flanges, incorporating a modified gasket groove, have been added. The new flanges and gaskets are completely interchangeable with the old versions.

### Aircraft Microphones

RTCA 258-58/DO-91, MINIMUM PERFORMANCE STANDARDS FOR AIRCRAFT MICROPHONES, NOVEMBER 1958

Covered in this standard are the minimum performance standards for the sound pressure-electrical current transducer, the connector cord, and other components which form a part of the microphone such as switches, connector plugs, and amplifiers. Inasmuch as the measured values of radio performance characteristics may be a function of the method of measurement, standard test

## Here's How You Can DIRECTLY Compare Impedances

Magnitude on One Meter — Phase Angle on Another Meter



### IMPEDANCE RANGES:

Resistance: 2 Ohms to 20 Megohms  
Capacitance: 40  $\mu\text{f}$  to 500  $\mu\text{f}$   
Inductance: 20  $\mu\text{h}$  to 10,000  $\mu\text{h}$

### METER RANGES:

Impedance-Magnitude Differences: 0.3%, 1% and 10%  
Phase-Angle Differences: 0.003, 0.01, 0.03 and 0.1 radians

### INTERNAL TEST FREQUENCIES:

100, 1000, 10,000 and 100,000 cycles

TYPE 1605-A Impedance Comparator: \$790

Write for Complete Information

## GENERAL RADIO COMPANY

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U.S.A.

Broad Avenue at Linden, Ridgefield, N. J. NEW YORK AREA 1000 N. Seward St. LOS ANGELES 38  
8055 13th St. Silver Spring, Md. WASHINGTON, D. C. 1150 York Road, Abington, Pa. PHILADELPHIA  
1182 Los Altos Ave., Los Altos, Calif. SAN FRANCISCO 6605 W. North Ave., Oak Park, Ill. CHICAGO

In CANADA: 99 Floral Parkway, TORONTO 15

CIRCLE 188 ON READER-SERVICE CARD

Be sure to see GRC  
at the Design  
Engineering Show  
Booth 1524

- ☐ Reduce costs
- ☐ Simplify assembly
- ☐ Improve appearance with

# GRC

DIE CAST ZINC ALLOY  
& MOLDED NYLON

## FASTENERS

now . . .  
NYLON NUTS  
added to GRC's  
extensive line of  
NYLON SCREWS



Brand New! Nylon hex nuts in ten sizes: #2 thru 5/16" . . . complementing GRC's Nylon Screw line. Nuts are single chamfered, washer-faced, double counter-sunk. All available from stock . . . samples sent immediately.

GRIES REPRODUCER CORP.

World's Foremost Producer of Small Die Castings  
40 Second St., New Rochelle, N.Y. • New Rochelle 3-8600

- High in quality
- Uniformly accurate
- Low in cost
- Wide range of stock styles, types, sizes and threads

Produced in one high speed automatic operation, GRC's exclusive methods assure uniformity, smooth, rustproof & corrosion resistant surfaces and the lowest possible cost. New kinds of fasteners never before available . . . modifications in stock fasteners for specialized use . . . infinite variety in styles, types and sizes, have been made possible by GRC's special automatic die casting and molding machines.

Write, wire, phone RIGHT NOW for prices, your copy of GRC's NEW DETAILED CATALOG

**GRIES**

DIE CAST  
ZINC ALLOY

Wing Nuts

Cap Nuts

Thumb Nuts

Thumb & Wing Screws

MOLDED  
NYLON

Screws

Hex Nuts

Washers

Screw Insulators

CIRCLE 189 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • April 29, 1959

# NEW

general  
purpose  
**power  
relay**



**TYPE "U"**

New... low-cost... ruggedly built for long life and trouble-free operation. Single coil construction employs box-type magnetic field. Complete AC-DC electrical and physical characteristics are outlined in Bulletin "U." Write for your copy today.

## COMAR

ELECTRIC COMPANY  
3349 ADDISON ST., CHICAGO 18, ILL.

RELAYS • SOLENOIDS • COILS • SWITCHES • HERMETIC SEALING

CIRCLE 190 ON READER-SERVICE CARD



## WALDOM PANEL METERS

- Accurate to within 2% of full scale.
- All sizes, types, scales.
- Clear plastic and black bakelite.

Write... We'll refer you to a WALDOM stock-carrying distributor in your area.

Manufactured by IDEAL PRECISION METER CO., INC.  
Sold to Electronic Parts Distributors exclusively through

**WALDOM ELECTRONICS INC.**

4623 WEST 53RD STREET, CHICAGO 32, ILLINOIS

CIRCLE 191 ON READER-SERVICE CARD

conditions and methods of test are recommended. Copies of this standard are available from the Radio Technical Commission for Aeronautics, Room 1072, Building T-5, 16th & Constitution Avenue, N.W., Washington 25, D.C. for \$0.25 per copy.

### Aircraft Headsets and Speakers

RTCA 257-58/DO-90, MINIMUM PERFORMANCE STANDARDS FOR AIRCRAFT HEADSETS AND SPEAKERS, NOVEMBER 1958

Equipment covered by this standard includes the electrical current-sound pressure transducer, the connector cord, and other components which form a part of the headset or speaker assembly such as headbands, ear plugs, enclosures, connectors, amplifiers, and attenuators. Also included are standard test conditions and standard methods of test. Copies of this standard are available from the Radio Technical Commission for Aeronautics for \$0.25 each.

### Airborne Receiving Equipment

RTCA 222-58/DO, MINIMUM PERFORMANCE STANDARDS FOR AIRBORNE ILS GLIDE SLOPE RECEIVING EQUIPMENT, OCTOBER 1958

Minimum performance standards under both standard test conditions and environmental test conditions are established by this standard. Also included are standard test conditions and methods of test. Copies of this standard are available from the Radio Technical Commission for Aeronautics, Room 1072, Building T-5, 16th & Constitution Avenue, N.W., Washington 25, D.C. for \$0.30 per copy.

### Screws

ASME B18.6.4, SLOTTED AND RECESSED HEAD TAPPING SCREWS AND METTALIC DRIVE SCREWS, 1958

Covers thread-forming screws, thread-cutting screws, and metallic-drive screws. Details given include boundry diameters, body dimensions, thread classifications, thread length, point design, chamfers, and fillets. General specs cover quality, finish, tolerances, limits, and other pertinent information. Also included is a conversion chart to identify ASA, manufacturers' and Federal Service's designations and tapping screw nomenclature. Copies of this publication are available from the Society of Mechanical Engineers, 29 West 39th Street, New York 18, N.Y., for \$4.00 per copy.

**Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.**

## UNIQUE DESIGN ROTARY SWITCH— 5-SECOND WAFFER REPLACEMENT

No Unsoldering or Disassembling... No Wire Removing...  
Simply Lift out Any Wafer & Replace Instantly...  
Highly Reliable—Presently Supplied for Military Applications



Reduces to seconds maintenance which otherwise could take a full day or more, saving valuable time. Error-proof replacement. Lift out, instantly replace any wafer. New design obsoletes old switches.

Switches are available in sizes approx. 2" x 2", 3" x 3" and 4" x 4" with lengths to accommodate up to 36 wafers. Virtually unlimited choice of switch circuit configurations. All connections are to a single bank of receptacles and are conveniently accessible from one side of the aluminum housing. Contacts are silver, gold or rhodium plated on a copper base. Wafers can be made to include printed circuitry and components in addition to their normal switching function.

Switches may be manually, motor or solenoid operated for use in any rotary selector switch application. Manufactured under license from Tabet Mfg. Co. and covered by U. S. Patent No. 2,841,660. Other U. S. and foreign patents pending. Write for details today.



**CHICAGO DYNAMIC INDUSTRIES, INC.**  
**PRECISION PRODUCTS DIVISION**  
1725 DIVERSEY BLVD., CHICAGO 14, ILLINOIS

27-9761

CIRCLE 192 ON READER-SERVICE CARD



**FREE!**  
From ALPHA METALS

This handy ALPHA soldering guide contains valuable technical data. Included are:

- Prevention of silver scavenging
  - Effects of rare metals in soldering
  - Effective soldering of joints requiring high creep strength
- Get your copy... Act now!

In Chicago, Ill.  
**ALPHA-LOY CORP.**  
2250 S. LUMBER ST.

Other ALPHA products:  
Solder Preforms.  
Wide Range of Fluxes.  
High Purity Metals.

**ALPHA METALS, INC.**, 58C Water St., Jersey City 4, N.J.  
Send me free your New Tips on Soldering.

Name \_\_\_\_\_ Title \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 193 ON READER-SERVICE CARD



*Explore new areas  
at IBM in*

# SOLID STATE

Solid state studies are now yielding important discoveries at IBM. Ranging from basic research to product development, solid state projects include a study of the behavior of molecules adhering to a surface in an ordered array. Another project involves the correlation of transistor parameters with circuit transient performance. In magnetics, engineers and scientists are developing a ferrite core which will function normally at 500°C., and a one-million bit memory drum weighing only five pounds. Advanced work such as this requires creative engineers and scientists with inquiring minds and an enthusiasm for investigating the unknown.

At IBM you will enjoy unusual professional freedom and the support of a wealth of systems know-how. Comprehensive education programs are available, as well as the assistance of specialists of many disciplines. Working independently or as a member of a small team, your individual contributions are quickly recognized and rewarded. This is a unique opportunity for a career with a company that has an outstanding growth record.

#### CAREERS AVAILABLE IN THESE AND RELATED AREAS . . .

Circuit design  
Component engineering  
Computer design  
Cryogenics  
Inertial guidance

Logic  
Magnetism  
Mathematics  
Metallurgy  
Microwaves

Nuclear physics  
Optics  
Phosphors  
Physical chemistry  
Physics

Radar circuits  
Reliability  
Semiconductors  
Systems engineering  
Transistors

Qualifications: B.S., M.S., or Ph.D. in Electrical or Mechanical Engineering, Physics, Mathematics, or Physical Chemistry — and proven ability to assume a high degree of technical responsibility in your sphere of interest.

## ASSIGNMENTS NOW OPEN INCLUDE . . .

**MAGNETICS ENGINEER** to design and analyze magnetic core circuitry for use in advanced digital computers. Must understand application of these circuits to logical connectives and systems, and be familiar with basic fundamentals of nonlinear magnetics. Qualifications: B.S., M.S., or Ph.D. in E.E. or Engineering Physics plus 2 to 5 years' experience with magnetic circuits and a strong interest in logical circuit application of magnetics.

**CIRCUIT ENGINEER** to develop advanced circuit designs based on transistor-diode logic for digital systems; to review new circuits for application in digital control systems and define basic techniques for improving performance characteristics; to participate in advanced analytical studies associated with the application of transistor circuitry to pulse and digital systems. Qualifications: B.S., M.S., or Ph.D. in Electrical Engineering. Minimum of two years' experience with pulse circuitry, transistor circuit design or digital techniques. A knowledge of magnetic devices or solid state physics is highly desirable.

**CHEMIST AND PHYSICAL CHEMIST** to initiate fundamental studies of the phenomena of surface boundary layers relating to absorption friction, wear, and surface energy states. Qualifications: B.S., M.S., or Ph.D. degree in Chemistry, Chemical Engineering, or Physical Chemistry and suitable experience.

**SOLID STATE ENGINEER** to carry out applied research studies on precision linear circuitry employing solid state devices. Qualifications: B.S., M.S., or Ph.D. degree plus experience in feedback amplifier and servo design.

**METALLURGICAL OR PHYSICAL ENGINEER** to handle research and advanced development relating to electrical connections, vacuum melted metals, and thin film techniques. Qualifications: B.S. in Physics or Metallurgy plus extensive knowledge of materials and means of joining metals. Thoroughly experienced with metallograph, photomicrography, and experimental techniques.

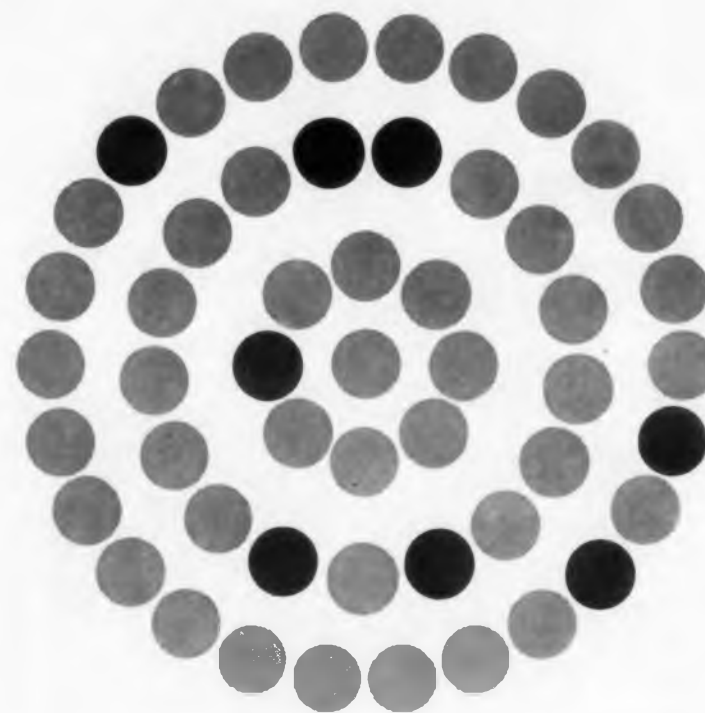
**PHYSICIST** to supervise efforts in integrated circuit development and fabrication using variety of thin film components. Qualifications: Advanced degree in Physics and well-qualified experimental experience.

**TRANSISTOR ENGINEER** to direct projects dealing with device and process development of transistors and advanced types of multi-element semiconductor devices. Qualifications: M.S., or Ph.D. in Physics or E.E. with 2 years' experience in semiconductor field.

For details, write, outlining background and interests, to:

Mr. R. E. Rodgers, Dept. 555-D-5  
IBM Corporation  
590 Madison Avenue  
New York 22, N. Y.

**IBM**  
INTERNATIONAL BUSINESS MACHINES CORPORATION



**At MOTOROLA in PHOENIX...**  
**There's an uncommon opportunity to**  
**BE RECOGNIZED in engineering circles**

It's the nature of us humans to be stimulated... to do better work... when others in the same profession know about our accomplishments. At Motorola in Phoenix, the *project approach* assures the engineer that his sparks will not be smothered by anonymity. Every Motorola engineer is provided responsibility commensurate with his ability; his contributions as a member of a project team form the basis for his career advancement. Motorola, heavily engaged in diversified electronics research and production, encourages each engineer to carry his idea through to practical reality. If you are attracted by a creative atmosphere such as this — and by the sunny atmosphere of the nation's most enjoyable climate — write to Mr. Kel Rowan, Department B-5.



**MOTOROLA**

**Western Military Electronics Center** 8201 E. McDowell Rd. Phoenix, Arizona

## OPPORTUNITIES



Electronic Engineers, Mechanical Engineers, Physicists—SYSTEM ANALYSIS, DESIGN AND TEST—Radar • Missile Guidance • Navigation • Combat Surveillance • Communications • Field Engineering • Data Processing and Display—CIRCUIT DESIGN, DEVELOPMENT AND PACKAGING—Microwave • Pulse and Video • Antenna • Transistor • R-F and I-F • Servos • Digital and Analog TECHNICAL WRITERS AND ILLUSTRATORS, QUALITY CONTROL ENGINEERS, RELIABILITY ENGINEERS

Motorola also offers opportunities at Riverside, California and Chicago, Illinois

CIRCLE 871 ON READER-SERVICE CARD



## HIGH TEMPERATURE CAPACITORS BY BENDIX

### DESIGN FEATURES

Temperature Range . . .  $-55^{\circ}$  to  $+315^{\circ}\text{C}$ . Capacitance . . . 0.05 to 4.0 uf at 600 VDC. Voltage Range . . . 600 V to 3000 V per section. No Voltage Derating, Low Capacitance and Power Factor Variation, Environmental Resistant, Hermetically Sealed, Rugged Construction, Nonstrategic Materials, Minimum Size and Weight, High Altitude Operation.

The E-315 capacitor offers proven stability of operation over the temperature range of  $-55^{\circ}$  to  $+315^{\circ}$  Centigrade\* with no voltage derating and low capacitance variation. Of rugged hermetically sealed construction and nonstrategic materials, this capacitor is built for high altitude and severe environmental operation.

This nonpolarized capacitor is available in a variety of sizes in a capacity range of from 0.05 to 4.0 microfarads at 600 VDC. It is also available in higher voltage ratings. Performance data and operating characteristics are given in Technical Bulletin SL-61 which is supplied upon request.

\*Confirmed by qualification test of 1000 hours at 100% rated voltage over ambient temperature range of  $-55^{\circ}$  to  $+315^{\circ}\text{C}$ .

Now Available  
in Production Quantity

# E-315



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

Scintilla Division

Sidney, New York

CIRCLE 194 ON READER-SERVICE CARD



MODEL 208G



MODEL 198S



MODEL 214G

## HAVE A SPECIAL PROBLEM? TALK WITH TABER ENGINEERS.

### Taber TRANSISTOR AMPLIFIERS

MODEL 208G Transistor Hydraulic Valve Drive. Ambient Temperature  $-50^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ , power output 150 mw, input signal 5V rms, input impedance 3000 ohms, output 10V DC, load impedance 2000 ohms CT., power supply  $+12\text{V}$  @ 20 ma,  $-12\text{V}$  @ 20 ma, switching input 6.3V rms @ 10 ma, 40 G's @ 60 cps.

MODEL 198S for High Temperatures, 90 db open loop gain plug-in amplifier, 3 db to 60 db closed loop gain,  $-60^{\circ}\text{C}$  to  $+125^{\circ}\text{C} \pm 1\%$  gain stability ( $\pm 5\%$  @  $+150^{\circ}\text{C}$ ) 1 meg input impedance, output 5.0V rms across 50 K ohms, 40 G's at 60 cps,  $\frac{7}{8}'' \times \frac{7}{8}'' \times 2\frac{1}{2}''$ , weight 1.8 ozs.

MODEL 214G, A.C. Error Amplifier for Printed Circuit Resolvers, up to 120 db closed loop gain, open loop gain over  $10^3$ , noise under 0.1 microvolts at 2 ohms, 5V rms output, for carriers 50 cps to 20 KC,  $1\frac{1}{2}'' \times 3\frac{1}{2}'' \times 7''$ , weight 15 ozs.



... Write for Literature and Prices ...

**TABER INSTRUMENT CORPORATION**

Section 161 107 Goundry St. North Tonawanda, N. Y.  
Telephone: LUDlow 8900 TWX - TON 277

CIRCLE 195 ON READER-SERVICE CARD

## RUSSIAN TRANSLATIONS

# Nonlinear and Parametric Phenomena in Radio Engineering

Part 17

A. A. Kharkevich

(Translated by J. George Adashko)

Chapter 2

## Generation of Oscillations

### 28. Microwave Oscillators

The oscillator circuits already described are not suitable for the generation of microwave frequencies. This is due first to the fact that at microwave frequencies the parasitic parameters of the circuit and of the tube begin to play an important role.\*

By changing the method of wiring and the construction of the parts, and in particular by using special tubes that differ greatly from ordinary tubes, it is possible to generate frequencies up to 500 mc with customary circuits. Secondly, at microwave frequencies it becomes necessary to allow for the transit time of the electron in the space between the tube electrodes, since the time becomes comparable with the oscillation period.

This results, in the case of the conventional generator, in insurmountable difficulties of basic character. But, on the other hand, the same cir-

\*Parasitic parameters are those not taken into account in the first-approximation basic circuit, namely, lead capacitance, capacitance between individual circuit elements, capacitances to ground, inductance of leads, etc.

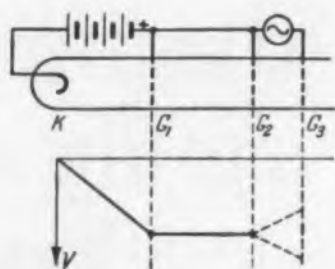


Fig. 98. The cathode end of a klystron tube and its voltage diagram.

cumstance can be used to construct many types of oscillators, in which the finite transit time of the electrons serves as the very basis for the oscillation mechanism.

In modern microwave practice, use is made of essentially three types of oscillators: (1) the klystron oscillator, (2) the magnetron oscillator, and (3) the backward-wave oscillator.

We shall not deal with the theory of these oscillators. However, to gain an idea of certain principles underlying the use of the finite electron velocity for the generation of microwaves, we present a brief qualitative description of the phenomena that take place in a klystron.

Klystron operation is based on velocity modulation of an electron beam with subsequent automatic conversion of the velocity modulation into density modulation of the electron beam. The term modulation is used here simply in that sense, that a certain parameter is varied by means of an applied signal.

Let us examine Fig. 98, which shows, for the time being, only a portion of the klystron. In addition to the cathode K, there are three other electrodes in the form of grids. Grid  $G_1$  serves as the accelerating electrode, and is positive relative to the cathode. An alternating voltage is applied between grids  $G_2$  and  $G_3$ . The corresponding potential diagram is shown in the lower half of Fig. 98.

The electrons emitted by the cathode are accelerated in the region  $K-G_1$  and travel through region  $G_1-G_2$  at a uniform speed, at which they enter the space  $G_2-G_3$ . This region is under the influence of an alternating field, which either decelerates or accelerates the electrons. The electron beam that leaves the region  $G_2-G_3$  is thus velocity modulated, i.e., the electrons move at different velocities. As a result, the faster electrons overtake the slower ones in the space to the right of  $G_3$ , and electron bunches, i.e., regions with increased electron density, are produced.

It is easy to see that the bunches are periodic along the klystron axis and form a traveling density wave. The length of this wave, i.e., the distance between neighboring bunches, is

$$\lambda = v/f$$

where  $v$  is the average velocity prior to modulation.

# Now

## An all-around pressure-tight seal for hinged-cover transit cases with

# LINK-LOCK and HINGE-LOCK



No. 3 LINK-LOCK



No. 3 HINGE-LOCK

Two HINGE-LOCK and two LINK-LOCK Fasteners provide all-around sealing pressure on this container manufactured for the U.S. Navy by the Bonded Structures Division, Swedlow Plastics Company.

The new Simmons HINGE-LOCK, used in combination with LINK-LOCK, provides an even, pressure-tight seal on equipment containers and transit cases with hinged covers. A half-turn applies pressure to both types of fasteners. When pressure is released HINGE-LOCK becomes a free-operating hinge, and LINK-LOCK disengages to permit opening.

Originally developed by Simmons Fastener Corp. for the Engineering Department of Swedlow Plastics Company, Bonded Structures Division, HINGE-LOCK is similar in principle and appearance to LINK-LOCK. Both are available in light and medium duty sizes as matched hardware. LINK-LOCK is also available in a higher-capacity, heavy-duty size.

**SEND TODAY** for complete data, including dimensions, capacities. Engineering service is available... Outline your requirements. Samples on request.

Visit us at Booth 325, 1959 DESIGN ENGINEERING SHOW, Philadelphia, May 25-28

See our 8 page catalog in Sweet's Product Design File

# SIMMONS

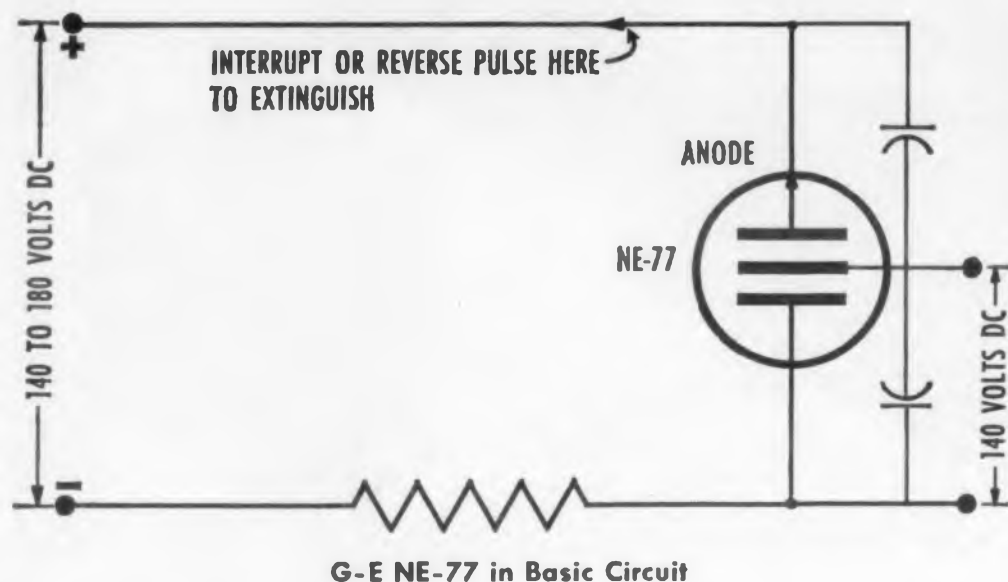
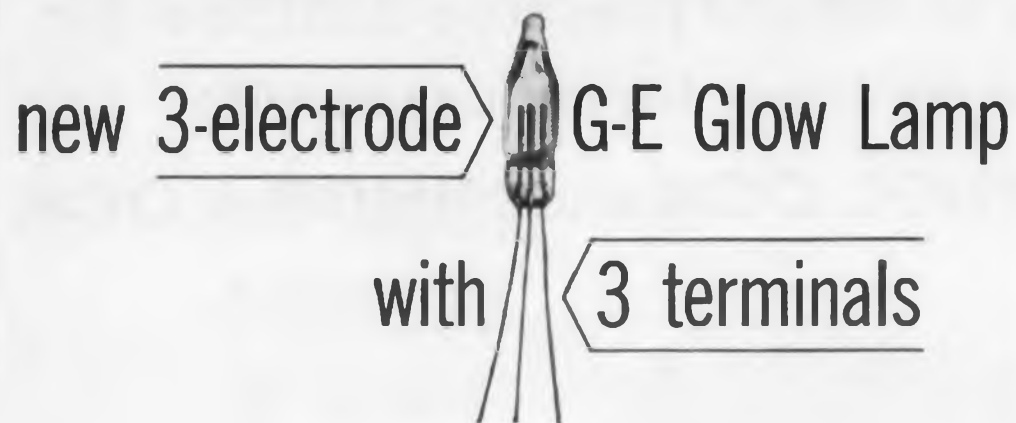
## FASTENER CORPORATION 1763 North Broadway, Albany 1, New York

QUICK-LOCK • SPRING-LOCK • LINK-LOCK • HINGE-LOCK • ROTO-LOCK • DUAL-LOCK

CIRCLE 196 ON READER-SERVICE CARD



# For triggering and switching . . .



The new G-E Glow Lamp NE-77 contains three electrodes instead of two, with connections being made by means of three wire terminals. It requires no heater current and has the same shape and bulb dimensions as the familiar NE-2.

To start the lamp with 140 to 180 volts d.c. across the outer electrodes, a pulse of 140 volts must be applied to the center electrode trigger. Without using the trigger, more than 200 volts would have to be applied across the power circuit before the lamp would accidentally break down. As little as 80 microamperes in the trigger circuit will operate the lamp.

Once started, the new NE-77 will continue to conduct until the circuit is interrupted or a reverse pulse is introduced in the power circuit. For further information, write for the free engineering data sheet #3-8161. General Electric Co., Miniature Lamp Dept., Nela Park, Cleveland 12, O.

*Progress Is Our Most Important Product*  
**GENERAL  ELECTRIC**

## RUSSIAN TRANSLATIONS

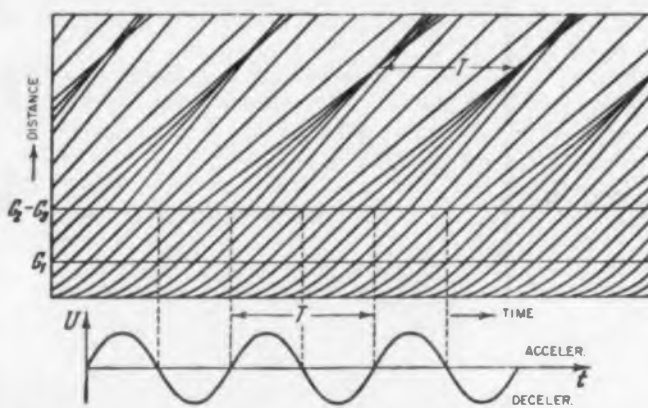


Fig. 99. This drawing shows how bunching takes place in the klystron.

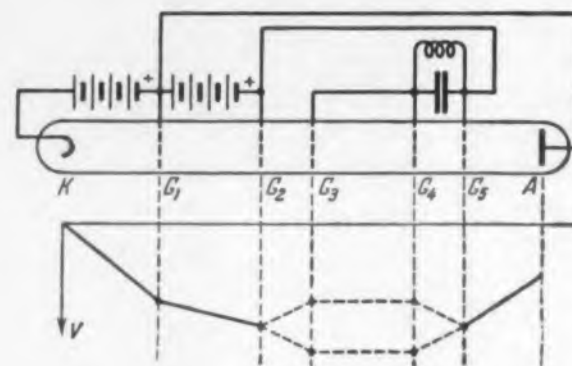


Fig. 100. The klystron oscillator.

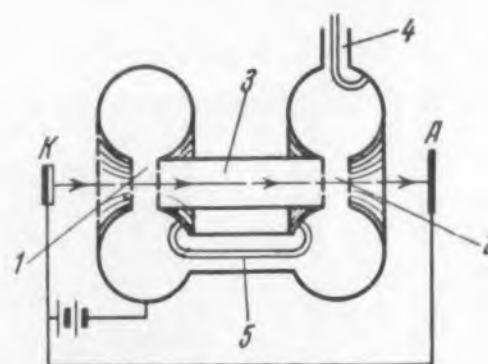


Fig. 101. A klystron with two resonant cavities. 1 and 2 represent toroidal cavity resonators. The bunching space (3) is in the form of a tube as is the feedback loop (5). The ac pickoff is at 4.

tion and  $f$  is the modulation frequency. This process is called bunching, and the combination of grids  $G_2$  and  $G_3$  is called the buncher. The space in which the bunches are formed is called the bunching space or the drift space.

The bunching process is explained by Fig. 99, the lower half of which shows the time variation of the alternating buncher voltage. The upper portion of the diagram shows, in distance-time coordinates, the motion of the electrons. For simplicity it is assumed that the electrons leave the cathode at equal time intervals.

Upon acquiring equal velocities after passing

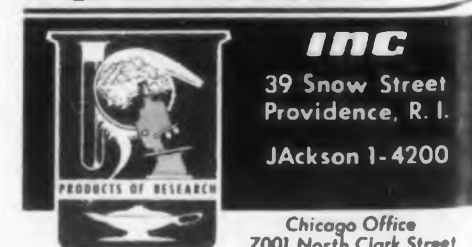
# the most significant development..in gold plating..in over 100 years



an entirely new gold complex . . . produces mirror bright, hard electroplates in rack or barrel plating . . . it produces a bright, hard 24 Karat (99.8%) gold plate . . . the ONLY 24 Karat bright gold . . . OROSENE 999 24K gold electroplates are twice as hard and equally as ductile as ordinary 24K plates . . . contains NO silver, sulphur compounds or antimony . . . has exceptional tarnish and sulphide resistance . . . barrel solutions have the best throwing power and leveling of ANY gold for barrel plating . . . has only ONE addition agent . . . self-regulating and simple to control . . . solves many problems where ordinary bright, hard or 24K golds have failed.

Write, wire, phone or TWX for further details.

## Technic \*Patent Pending



39 Snow Street  
Providence, R. I.  
JACKSON 1-4200

Chicago Office  
7001 North Clark Street  
CIRCLE 197 ON READER-SERVICE CARD



## It's Easy to Write for ELECTRONIC DESIGN

As a design engineer it's very likely that many of the problems you have encountered and solved can be of real help to others. Why not tell *Electronic Design's* 28,400 readers about it? This effort can be of real, direct, immediate service to the industry. If you think you have an idea for an article, send us an outline or abstract—we'll look it over and return with suggestions for the completed piece.

### FREE

This booklet describes how easy it is to write for *ELECTRONIC DESIGN*. Complete details are included concerning types of articles needed, treatment, payment, etc. For your copy simply circle the reader service number shown below.



CIRCLE 241 ON READER-SERVICE CARD

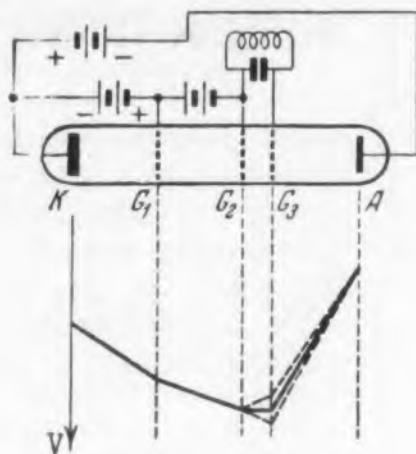


Fig. 102. The reflex klystron and its voltage diagram.

through the accelerating field, the electrons enter the buncher  $G_2$ - $G_3$ , where the electron velocity is either increased or decreased, depending on the sign of the buncher voltage (see sinusoidal curve in the lower portion of the diagram). The motion of the electrons leaving the buncher is represented by straight lines with different slopes. The steeper lines correspond to the faster electrons.

It is seen from the diagram that thanks to the different slopes, the straight lines that represent the motion of the electrons form converging beams. This is a graphic explanation of the formation of electron bunches.

The variable-density electron beam formed in the bunching space can be used to induce a current in an external circuit. For this purpose, use is made of two additional grids  $G_4$  and  $G_5$ , to which we connect a tank circuit tuned to the proper frequency. If the voltage is now picked off the tank circuit and fed back to the buncher, we obtain the klystron oscillator of Fig. 100.

The spent electrons fall on the collector A and flow through it to the cathode. The combination of grids  $G_4$  and  $G_5$  is called the catcher. To excite the system, a suitable adjustment of the phase of the feedback is necessary. For a specified construction and fixed distance between the buncher and the catcher, the phase of the feedback can be regulated by varying the accelerating voltages on  $G_1$  and  $G_2$ .

The construction of a klystron with two resonators is shown in Fig. 101, where 1 and 2 denote toroidal cavity resonators (shown in cross section). The buncher and the catcher are formed by pairs of perforated disks, which serve as capacitive inserts in the resonators. The bunching space is made in the form of a tube 3. Still another tube contains the feedback loop 5. Loop 4 serves to pick off the alternating voltage.

The reflex klystron is the most widely used. It differs from the system just considered in that the buncher and the catcher are combined. After passing through a pair of grids, which comprise the buncher, the electron beam is retarded by a nega-

# NEW



All-Electronic Model 410 . . . \$490

## Digital Voltmeter

0.1% comparative accuracy

0 to 1000 V dc in 3 ranges

Franklin's new Model 410 Digital Voltmeter is designed with the manufacturer in mind. Completely electronic, the Model 410 eliminates reading errors . . . provides a degree of accuracy that can't be matched by conventional instruments.

Use it in the lab, on the production line or in the field . . . you'll find the 410 tough, reliable under all conditions. And remember . . . only Franklin instruments carry a one year *unconditional* guarantee. Write for data sheet 2002.

### BRIEF SPECIFICATIONS

RANGES	0 to 10, 100, and 1000 V* dc positive or negative.
ACCURACY	ABSOLUTE: $\pm 0.3\%$ full scale, 0 to 10 V range, $\pm 0.5\%$ full scale, all other ranges. COMPARATIVE: $\pm 0.1\%$ full scale, all ranges.
INPUT IMPEDANCE	20 megohms, all ranges.
LONG TERM STABILITY	$\pm 1.5\%$ full scale, over an 8-hour period with a room temperature range of 25° F.
DIMENSIONS	10 3/4" W x 11" H x 15 1/2" D.
WEIGHT	26 lbs.
POWER REQUIREMENTS	107 to 123 V ac, 60 cps, 200 watts (approx.).

\* Instrument will read over-scale up to approximately 10%. Readings of 1000 and over are presented as three digits with the first digit understood.

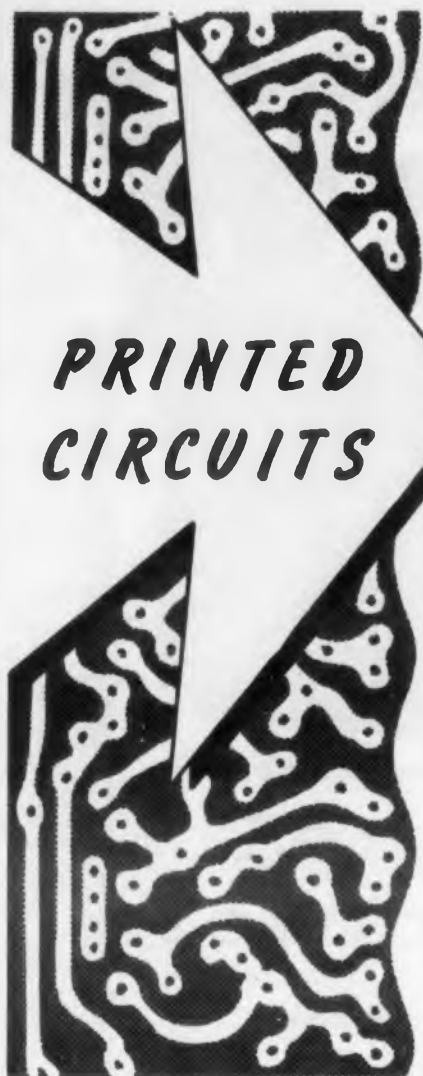


FRANKLIN  
electronics, inc.

BRIDGEPORT • PENNA.

CIRCLE 198 ON READER-SERVICE CARD





## PRINTED CIRCUITS

### DESIGN • PRODUCTION • ASSEMBLY

#### Completely Integrated Service

Printed Circuits for Military and Industrial  
Electronic Equipment

"Packaging" of circuits, from schematic  
diagram into Printed Circuit or Modular form.

Production in small or medium quantities —  
prototypes to a few thousand boards.

Secondary operations: Plating — Fabrication  
— Assembly — Dip Soldering — Encapsulation.

Rigid Inspection and Quality  
Control insure the production of High  
Reliability Printed Circuits to Exacting  
Specifications.

**Ansley** *PLUS*  
**Module**

Adds a third dimension to printed circuitry. It  
may answer your design problem. Ask us for  
details.

PRINTED **ANSLEY** CIRCUITS

PRINTED CIRCUIT  
DESIGN and PRODUCTION

ARTHUR ANSLEY MFG. CO.  
NEW HOPE, PA. PHONE, AXTEL 7-2711

Write for our booklet... "Some Suggestions  
on Printed Circuit Layout and Design."

CIRCLE 199 ON READER-SERVICE CARD

## New CANNON XLR plugs for audio and electronic uses



### GREATER VALUE AT NO INCREASE IN PRICE

Improved features illustrated above give you more for  
your money than any similar plug on the market.

These deluxe audio plugs, in handsome satin nickel  
finish, give protection against disagreeable interference  
and mechanical noises. Positive latch holds firmly, yet  
allows for quick disconnect. Improved strain relief  
bushings and cable clamps accommodate full range of  
microphone cables. Series includes wide variety of shell  
types, with three and four contacts. Mates with Cannon  
former XL series.

Like all the plugs in the complete Cannon line the  
XLR series is manufactured of finest quality materials  
for reliable, long-lasting service. See the distributor  
nearest you or write for Bulletin XLR-3.

CIRCLE 200 ON READER-SERVICE CARD

**CANNON  
PLUGS**

27,000 kinds to choose from! Call on  
Cannon for all your plug needs. If  
we don't have what you want, we'll  
make it for you. We're ready to  
help you at any stage—from basic  
design to volume production—with  
the largest facilities in the world  
for plug research, development  
and manufacturing. Write us  
today about your problem. Please  
refer to Dept. 438

**CANNON ELECTRIC COMPANY**  
3208 Humboldt St., L.A. 31, California

Where Reliability for Your Product  
Is Our Constant Goal

346

## RUSSIAN TRANSLATIONS

tive field and turns back, passing again through  
the same pair of grids which now serve as the  
catcher. The diagram of the reflex klystron and a  
corresponding potential diagram are shown in  
Fig. 102.

The bunching process in the reflex klystron is  
explained in Fig. 103. This diagram differs from  
Fig. 99 in that the lines representing the motion  
of the electrons that leave the buncher are not  
straight but parabolic (corresponding to the mo-  
tion in an accelerating field of opposite direction).  
The electrons return to  $G_2-G_3$ . Bunches are formed  
as a result of the difference between the initial  
velocities.

It is obviously necessary to tune the system in  
such a way that the bunches are formed in the  
 $G_2-G_3$  zone. It should be noted that there is no  
separate feedback loop in the reflex klystron, and  
the feedback is effected through the electron  
beam. The reflex klystron can be tuned not only  
by varying the accelerating positive potentials on  
 $G_1$  and  $G_2$ , but also by varying the negative po-  
tential on the reflecting electrode A.

### 29. Relaxation Self Oscillations

So far we have considered generators of oscil-  
lations that are nearly sinusoidal. Such self oscil-  
lations are called nearly-harmonic. However, in  
electronics we employ also self oscillations with  
waveforms that differ greatly from sinusoidal.

Such self oscillations, which sometimes feature  
abrupt jump-like changes in current or voltage,  
or jump-like changes in the rate of variation of  
these quantities (graphically represented by oscil-  
lograms in the form of broken lines) are called re-  
laxation self oscillations.

The essential difference between the waveforms  
of nearly-harmonic and relaxation self oscillations  
is due to the difference in the arrangement and  
operation of the generators of these types of oscil-  
lations.

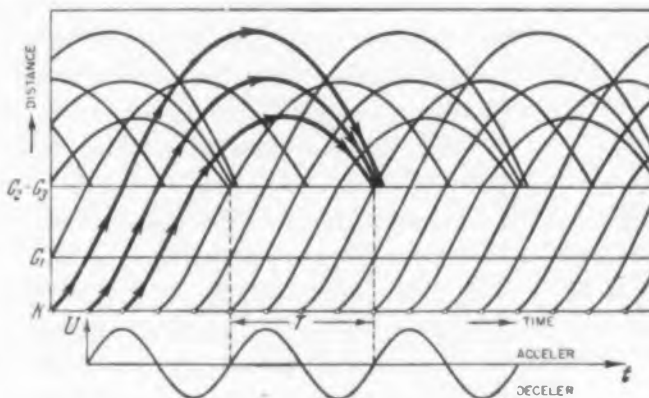


Fig. 103. The bunching process in the reflex klystron.



Air-Marine's new S frame motor  
offers outstanding reliability even  
at extremes of temperatures and  
altitude. Two models are available:  
the Hi-Slip which increases speed  
with altitude lower densities, and  
a CONSTANT SPEED, 11,000 rpm  
or 20,000 rpm.

Both models are available in 2 or  
4 pole units up to 1/150 h.p.  
These rugged design, epoxy-potted,  
400 cps induction motors are  
obtainable for 115 V. 1 $\phi$  or 208 V.  
3 $\phi$  operation.



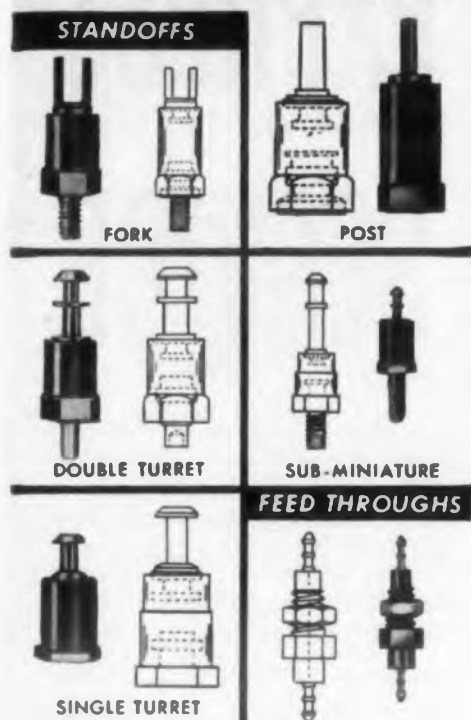
**air · marine  
motors, inc.**  
AMITYVILLE, NEW YORK  
LOS ANGELES, CALIF.

For further information about our  
complete line write for catalog.

CIRCLE 201 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1959

## GET THE EXACT TERMINAL YOU NEED AT NEW LOW PRICES!



### FROM THE LARGEST STANDARD and CUSTOM LINE AVAILABLE...

Over 100 varieties are furnished as standard. This includes a full range of types, sizes, body materials and plating combinations. Specials can be supplied to any specification. The Whitso line is complete to the fullest extent of every industrial, military and commercial requirement.

Standoff terminals include fork, single and double turret, post, standard, miniature and sub-miniature body types—male, female or rivet mountings—molded or metal base. Feed through terminals are furnished standard or to specification.

Whitso terminals are molded from melamine thermosetting materials to provide optimum electrical properties.

**Body Materials:** Standard as follows—melamine, electrical grade (Mil-P-14, Type MME); melamine impact grade (Mil-P-14, Type MMI); and phenolic, electrical grade (Mil-P-14, Type MFE).

**Plating Combinations:** Twelve terminal and mounting combinations, depending on electrical conditions, furnished as standard.

**Specials:** Body materials and plating combinations, also dimensions, can be supplied to any custom specifications.

### PROMPT DELIVERY IN ECONOMICAL QUANTITY RUNS

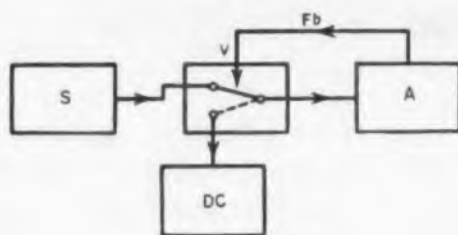
Get facts on the most complete, most dependable source for terminals and custom molded parts. Request catalog.



9326 Byron Street, Schiller Park, Illinois  
(Chicago Suburb)

CIRCLE 202 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1959



**Fig. 104.** The mechanism of a relaxation oscillator. S is the energy source, A an accumulating (storage) element, V a valve,  $F_b$  a feedback connection, and  $D_c$  a discharge circuit.

The generator for nearly-harmonic oscillations usually contains an LC tank circuit (or an equivalent LC circuit), i.e., an oscillating system containing (at least) two reactance elements capable of energy storage. From the energy point of view, oscillations occur in the tank circuit, because the energy stored in the tank circuit is alternately concentrated entirely either in the magnetic field of the coil or in the electric field of the capacitor. This energy transfer takes place periodically.

If there are no losses, the oscillation is strictly sinusoidal. In the presence of losses the amplitude diminishes with time exponentially because the stored energy diminishes continuously. On the other hand, if the energy losses are replenished from a source, as they are in every oscillator, the oscillations are undamped, and their waveform differs from sinusoidal only in as much as this is dictated by the nonlinearity that limits the amplitude.

The mechanism of a relaxation oscillator is different. It is characterized by the fact that there is a single (in the simplest case) energy storage element. The periodic process in a relaxation oscillator consists of having the energy storing element accumulate an increasing supply of energy, until a certain definite upper level is reached. Then a certain valve discharges the accumulating element through a discharge circuit, until the energy reserve reaches a definite lower level. Now the valve operates again and makes the accumulating element resume charging.

This is explained in the block diagram of Fig. 104, in which S is the energy source, A the accumulating element, V the valve,  $F_b$  the feedback connection, and  $D_c$  the discharge circuit. It follows from this general description that the relaxation oscillator is characterized by the presence of a valve that can assume two fixed positions, one of which corresponds to charging the accumulating element, and the other to discharging.

The valve is controlled by feedback from the accumulating element. The feedback serves to operate the valve when two fixed energy levels are reached, an upper one and a lower one. It follows



**MODEL AVS 321**  
Precision AC Power Supply  
1 volt to 1000 volts AC  
35 cycles to 10 KC  
Digital set voltage to  $\pm 0.1\%$

**MODEL AVS 320**  
Fixed voltage regulator. Four fixed voltages between 1 volt and 300 volts at all frequencies 35 cycles to 20 KC. Will make any power amplifier. A precision voltage supply.



## PRECISION A.C. VOLTAGE INSTRUMENTATION



**MODEL 30 Power Amplifier**  
30 Watts 0.1% Distortion  
Output 1 to 300 volts AC  
35 cycles to 20 KC

**MODEL AVA 500 Power Amplifier**  
500 Watts 2% Distortion  
Output 115 - 230 volts  
300 cycles to 2 KC



**MODEL AO .1 Audio Oscillator**  
20 cycles to 20 KC  
1 volt RMS Output with short term stability of 0.05%  
frequency stability  $\pm 1\%$   
Distortion 0.1%  
The ideal oscillator for A.C. voltage measurements

Complete details and specifications on HOLT Precision AC Voltage Instrumentation are yours upon request . . . Write Today.

*Holt* **INSTRUMENT  
LABORATORIES**  
O C O N T O • W I S C O N S I N



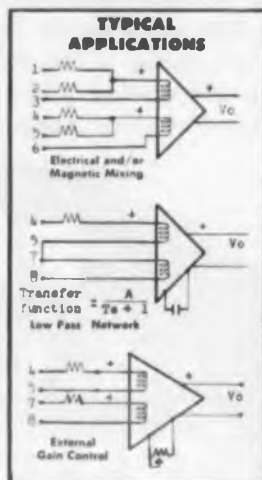
CIRCLE 203 ON READER-SERVICE CARD



"O" SERIES  
CARRIED IN STOCK FOR  
IMMEDIATE DELIVERY

## TOROTEL MAGNETIC AMPLIFIER

The 02-type magnetic amplifier is a lightweight D.C. amplifier operating from a 115V, 400-cps source. The linear, gain stability and null characteristics of the amplifier make it very adaptable to use in Analog Computer and instrumentation.



**TOROTEL, INC.**  
5512 EAST 110th STREET KANSAS CITY, MO.

CIRCLE 204 ON READER-SERVICE CARD

## RUSSIAN TRANSLATIONS

that the swing of the relaxation oscillations does not depend on the energy balance, but is determined only by the difference between the two levels at which the valve operates.

All these general properties of relaxation oscillators can be readily understood by examining the simplest case, that of a relaxation oscillator with a gas discharge tube. The oscillator is shown in Fig. 105.

The energy source is the battery  $E$  which charges, through resistor  $R$ , and capacitor  $C$  which serves as the accumulating element. The valve employed is the gas discharge tube  $T$ , which also serves as the circuit into which the accumulating element discharges. The oscillator operates as follows.

When the battery is connected, the capacitor starts charging. When its voltage reaches a value  $U_2$ , the "firing voltage" of Tube  $T$ , the gas in the tube ionizes and the tube resistance, which up to then was quite large, is sharply reduced to a small value  $r$ . The capacitor starts discharging rapidly into this resistance. When the voltage drops to a Value  $U_1$ , at which the ionization ceases, the resistance of the tube again rises sharply, and the capacitor-charging process is repeated.

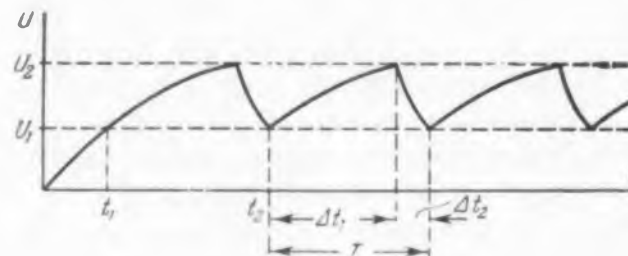
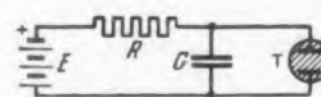
The course of the phenomenon is shown by the oscillogram in Fig. 106, which shows time variation of the capacitor voltage. The swing of the oscillations depends only on the voltage difference  $U_2 - U_1$ . As to the frequency, it depends on the time constants of the charge and discharge circuits, and also on the supply voltage.

Let us evaluate the oscillation period. It consists of two sections  $\Delta t_1$  and  $\Delta t_2$ , of which the first determines the charge time and the second the discharge time. For the charge process we have

$$U = E \left( 1 - e^{-\frac{t}{\tau_1}} \right)$$

where  $\tau_1 = RC$  is the time constant of the charge circuit. We can write the following two equations

**Fig. 105.** The simplest relaxation oscillator uses a gas tube.



**Fig. 106.** Voltage variations on the capacitor in the relaxation oscillator of Fig. 105.

# EXPRESS SERVICE

When critical design time is running out and you need to eliminate that 8 to 12 week wait for delivery of single turn, special prototype, linear or non-linear potentiometers, pick up your phone, dial our number and tell us what you need. Chances are, we can design and deliver a 2" size functional unit within **THREE DAYS** after your call.

This "Express Service" for prototypes is a tremendous time-saver, not only for you, the engineer...but for other departments of your firm. Spec writing, prints, requisitioning are all eliminated along with the costly delays in vital research and breadboard work. In fact, you'll find that in the design of "specials" and delivery of prototypes, we're just about the fastest in the field.

Next time you need a prototype precision pot, instead of picking up your pencil, pick up your phone and give us a call.

**MICRO-LECTRIC DIVISION  
OF MICRO MACHINE WORKS**



19 DEBEVOISE AVENUE  
ROOSEVELT, L. I., N.Y.  
FR 8-3222

CIRCLE 206 ON READER-SERVICE CARD

FROM JUST ONE HEAD... TO A COMPLETE

STEREO • MONAURAL • ERASE



LINE IN JUST 2 YEARS

## DYNAMIC GROWTH IN MAGNETIC TAPE RECORDING HEAD PRODUCTION

A dependable source serving the industry with precision quality magnetic heads created individually to your exact specifications and quantity requirements. Let our design engineers and production people solve your tape recording head problems... write, wire or call for details.

**MICHIGAN MAGNETICS, INC.**

Vermontville, Michigan

ENTERTAINMENT • SPECIAL APPLICATION

CIRCLE 205 ON READER-SERVICE CARD

## TRANSISTOR TRANSIENT PROTECTOR



ALTO Model N210 Transistor Transient Protectors safeguard 28 volt circuits by automatically reducing high voltage spikes and surges to a safe level. Protectors include an LC filter for extremely fast spikes, a power transistor circuit for slower transients. Response time is 50  $\mu$ sec, load current 25 amps maximum, clipping level 35 volts (other values to order) and maximum input spike and line voltage 80 v total. Nominal range 24 to 32 v dc; power required 0.5 watts. 2 1/2" x 2 1/2" x 3 1/2". Prompt delivery, \$295 to \$365 each.

## SUBMINIATURE TIME DELAY RELAYS



ALTO N17 Time Delay Relays use all-silicon semi-conductors for utmost reliability. Delay is established by RC time-constant circuitry permitting an overall accuracy of  $\pm 3\%$  and better over limited temperature range. Delay 0.05 sec to 60 sec, preset at factory. Ambient temperatures ranges  $-55^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ , input 24 to 32 v dc, current drain 50 ma at 28 v, shock 50 G's for 11  $\mu$ sec. \$187 to \$210 each, quantity discounts.

**ALTO**  
SCIENTIFIC COMPANY

855 Commercial Street  
Palo Alto, California  
DAvenport 1-3434

5569

CIRCLE 207 ON READER-SERVICE CARD

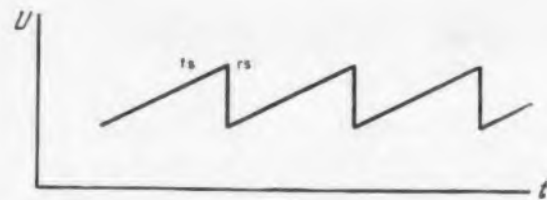


Fig. 107. A sawtooth voltage derived from a relaxation oscillator if the charge time is very large, and the discharge time very small. The letters on the figure represent the forward sweep and the return sweep.

$$U_1 = E \left(1 - e^{-\frac{t_1}{\tau_1}}\right), U_2 = E \left(1 - e^{-\frac{t_2}{\tau_1}}\right)$$

(see Fig. 106) from which we find

$$t_1 = \tau_1 \ln \frac{E}{E - U_1}, t_2 = \tau_1 \ln \frac{E}{E - U_2}$$

and hence also the charging time

$$\Delta t_1 = t_2 - t_1 = RC \ln \frac{E - U_1}{E - U_2}$$

This expression shows that the greater the value of  $E$  at given values of  $U_1$  and  $U_2$ , the smaller the difference between unity and the quantity under the logarithm, and the smaller the charging time. The charging process is given by the formula

$$U = U_2 e^{-\frac{1}{\tau_2}(t-t_2)}$$

where  $\tau_2 = rC$  is the time constant of the discharge circuit. When  $t = t_3$  a voltage value  $U = U_1$  is reached. We obtain

$$U_1 = U_2 e^{-\frac{1}{\tau_2}(t-t_2)} = U_2 e^{-\frac{\Delta t_2}{\tau_2}}$$

hence

$$\Delta t_2 = rC \ln \frac{U_2}{U_1}$$

We now obtain the oscillation period by adding  $\Delta t_1$  and  $\Delta t_2$ .

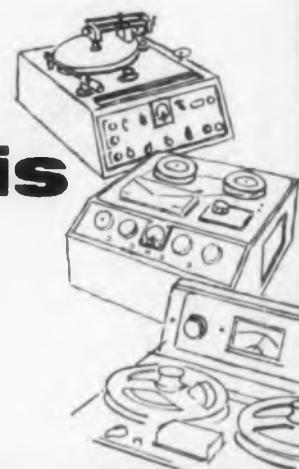
$$T = \Delta t_1 + \Delta t_2 = C \left( R \ln \frac{E - U_1}{E - U_2} + r \ln \frac{U_2}{U_1} \right)$$

We see that the oscillation period depends on the time constants of the discharge and charge circuits, i.e., on the values of  $RC$  and  $rC$ , on the ratio of the firing and extinction voltages  $U_2$  and  $U_1$ , and on the supply voltage  $E$ .

If  $E$  and  $R$  are taken sufficiently large and  $r$  and  $C$  sufficiently small, the waveform approaches that shown in Fig. 107. A voltage of such form is called a sawtooth voltage and is extensively used in radio engineering as a sweep voltage in cathode-ray oscilloscopes, in television, radar, etc.

The sweep voltage usually must meet rather stringent requirements as to linearity on the forward sweep ( $f_s$  on Fig. 107) and minimum dura-

# NOW rapid analysis of recorder frequency response 20 cps- 200 kc



### SG-1R features include

1. Separately adjustable swept signal pulse outputs.  
1 volt rms signal with 75 db attenuation.  
4 volt peak pulse reducible to zero.
2. Two log sweeps: 40 cps-20 kc and 400 cps-200 kc.  
Adjustable linear sweeps: Any linear segment within 20 cps to 200 kc range may be selected.
3. SG-1R log amplifier provides 40 db calibration in addition to linear amplitude calibration.
4. SG-1R may be used as normal SG-1 sweep generator for tests of filters, amplifiers, etc. Sawtooth output drives oscilloscope H axis in such applications.

## PANORAMIC SWEEP GENERATOR MODEL SG-1R

Plots recorder's relative amplitude response vs. frequency on oscilloscope screen. Trace repeats each second.

An optional version of the versatile Model SG-1, this new Panoramic Sweep Generator combines the swept signal with a synchronizing pulse. Sweep frequency test records are made using SG-1R. Calibrated CRT screen furnished.

- Ideal for tape, wire, and disk recorders.
- Much faster than point-by-point methods.
- One cps repetition rate permits easy synchronization with many oscilloscopes, e.g. H-P #150A, DuMont #304 and #401. We will supply oscilloscope if desired.
- Internal frequency markers speed set-up and insure accuracy.
- Precise enough for lab use.
- Simple enough for production test.



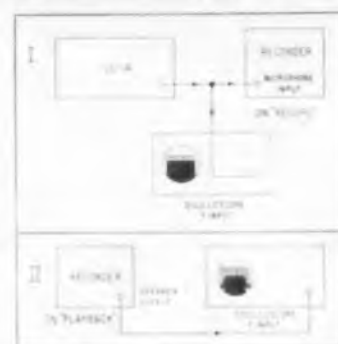
WRITE TODAY FOR COMPLETE SPECIFICATIONS AND PRICES  
Ask for the current issue of "The Panoramic Analyzer."

524 South Fulton Ave.  
Phone: OWens 9-4600

• Mount Vernon, N.Y.  
Cables: Panoramic, Mt. Vernon, N.Y.

CIRCLE 208 ON READER-SERVICE CARD

**PANORAMIC**  
RADIO PRODUCTS, INC.



Block diagram shows recorder test set-up with oscilloscope and SG-1R.



## ENGINEERS

STANFORD RESEARCH INSTITUTE offers unique and professionally challenging employment in the Electromagnetics Laboratory. Activities include microwave theory and techniques, theory and design of antennas, investigation of related phenomena and devices.

Attractive salaries for experienced professional personnel with degrees in Electrical Engineering or Physics to participate in research involving:

### MICROWAVE

Microwave Filters and Strip-Line Components

Microwave Antennas

Ferrite Devices

Parametric Amplifiers

### ANTENNA

Basic Antenna Theory

Antennas for Aircraft, Missiles, and Space Vehicles

Electronically Scanned Antennas

Microwave Antennas

For Information Contact:

Professional Employment Manager

**STANFORD RESEARCH INSTITUTE**

MENLO PARK • CALIFORNIA

CIRCLE 872 ON READER-SERVICE CARD

**KESTER**  
Formula Number  
**1571**  
Printed Circuit  
**SOLDERING FLUX**  
Write for Sample and Engineering Details  
**KESTER SOLDER COMPANY**  
4266 Wrightwood Avenue • Chicago 39, Illinois  
Newark 5, New Jersey • Brantford, Canada

CIRCLE 210 ON READER-SERVICE CARD

## RUSSIAN TRANSLATIONS

tion of return sweep ( $r_s$ ). The simplest circuit of Fig. 105 which we have analyzed does not satisfy these two requirements. The linearity of the forward sweep can be improved considerably by replacing the resistor  $R$  with a current limiter, such as a saturated diode. However, to generate a sawtooth sweep voltage it is preferable to use special, more highly developed relaxation oscillators.

### 30. Relaxation Oscillators

One of the earliest relaxation oscillators circuits is the symmetrical multivibrator,\* which has retained its value to this day. The diagram of a symmetrical multivibrator is shown in Fig. 108. Both halves of the circuit can be considered as two separate generators, interconnected in such a way that one of the generators serves as the valve that controls the operation of the other.

To describe the operation of the circuit, we shall start with such a state, in which the currents and the plate circuits of the two tubes are exactly equal. This is an equilibrium state, which, however, is unstable. In fact, let the current of the first tube increase somewhat.

In this case the tube voltage becomes smaller than the initial value, and the capacitor  $C_1$  starts discharging. The discharge current, flowing through resistor  $R_{g2}$ , produces a negative voltage on the grid of the second tube. Consequently the voltage on the plate will increase and the plate current will diminish.

Owing to the increased plate voltage, capacitor  $C_2$  will start charging. The charging current, flowing through resistor  $R_{g1}$ , will produce a positive voltage on the grid of the first tube, and consequently a further increase in current of the first tube.

This analysis shows that the initial state we considered, in which the currents and the voltages of

\*This is an oscillator capable of generating many frequencies (in the sense of having a rich spectrum). The multivibrator was used in its time to calibrate wave meters, with the harmonic frequencies serving as reference points.

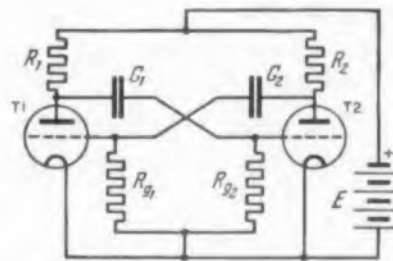


Fig. 108. The symmetrical multivibrator.



**a good way  
to measure  
0.00003 ohm**

The Keithley 502 Milliohm meter offers speed, ease, and accuracy in the measurement of low resistances. Typical uses are corrosion tests, checking resistivity of metals, semi-conductors, printed circuits, switch and relay contacts.

Battery operation, a ruggedized meter, and protective cover make the 502 ideal for field tests of squibs, carbon bridges and other explosive devices. Features include:

- 13 overlapping ranges from 0.001 ohm to 1000 ohms full scale.
- accuracy within 3% of full scale; a four-terminal measuring system eliminates errors due to clip and lead resistance.
- 2 microwatts maximum dissipation across sample.
- no calibration or zero adjustments.
- instantaneous indication of resistance without zero drift or errors due to thermal EMF's.
- lightweight and portable. Furnished with protective cover and set of four test leads.

Details about the Model 502 Milliohm meter are available in Keithley Engineering Notes, Vol. 6 No. 3. Write for your copy today.

**KEITHLEY  
INSTRUMENTS, INC.**

12415 Euclid Ave., Cleveland 6, Ohio

CIRCLE 211 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • April 29, 1959

# NATIONAL NCI Chokes

**R-45** series, a new family of ferrite bead chokes for use as filament chokes, parasitic suppressors, and series elements of low-pass filters for frequencies from 5 to 200 mc. Insulated with an impregnated fiberglass sleeving, these chokes will handle 2 amperes of filament current with voltage drop of less than 0.02 volts, temperatures to the Curie point of 125°C.

**R-40** series ferrite-core chokes...extremely high Q for small size. They are primarily for use in networks and filters at frequencies from 50 kc to 1500 kc, and as resonant elements in IF and RF circuits. Fungus-proof varnish impregnation per MIL-V-137A.

## R-25

series MIL-inductance chokes for high frequency circuits, as filament chokes and peaking coils, inductance per MIL-C15305A, coil forms per MIL-P-14, and impregnation per MIL-V-173A.

## R-33, R-50 and R-60

series RF coils are wound on molded phenolic forms per MIL-P-14 and coated with a tough, fungus-resistant varnish. R-50-10 choke is wound on a powdered-iron coil form instead of phenolic.

National features a full line of stock choke items, and will wind chokes to your specification on any standard form. Send us your requirements. Write for components catalog.

**National** Since 1914  
Company, Inc. Malden 48, Mass.

CIRCLE 212 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • April 29, 1959

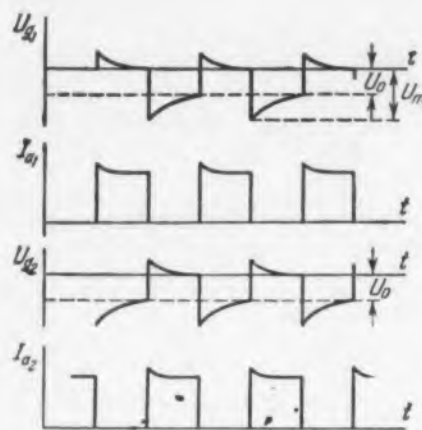


Fig. 109. Grid voltages and plate currents in the symmetrical multivibrator of Fig. 108.

both halves of the circuit are equal, is really unstable.

The increase in the current of the first tube and the increase in the negative voltage on the grid of the second tube are both very rapid. As a result, the first tube becomes saturated, and the second becomes blocked by the large negative voltage. Now capacitor  $C_1$  continues to discharge through  $T_1$  and  $R_{g2}$ ; the discharge current, and with it the negative grid voltage of  $T_2$  decreases until  $T_2$  starts conducting.

During the instant that the voltage across it drops, capacitor  $C_2$  starts discharging, and the currents and voltages change abruptly, as described above, but with the roles of two halves of the circuit interchanged.

The time variations of the plate currents and grid voltages of both halves of the circuit are shown in Fig. 109. Owing to the symmetry of the circuit, the durations of the plate current pulses are the same in both halves. Thus, the waveform of the plate current in each tube is nearly rectangular. Incidentally, by changing the parameters, it is possible to obtain also a nearly triangular form. The form of the oscillation depends on the charge and discharge time constants.

It is seen from the circuit of Fig. 108 that the time constant for charging is

$$\tau_t = C \left( R_g + \frac{R_i R}{R_i + R} \right)$$

and the time constant for discharging

$$\tau_d = C \left( R + \frac{R_g r_g}{R_g + r_g} \right)$$

where  $C$  is the capacitance,  $R$  the resistance in the plate circuit,  $R_i$  the tube resistance (from the cathode to the anode),  $R_g$  the resistance in the grid circuit, and  $r_g$  is the tube resistance (cathode-grid).

Usually  $\tau_t \gg \tau_d$ . In this case the waveform of the oscillations is never rectangular. Knowing the time constant, it is possible to find the oscillation period. During one half of the period, the grid volt-

**NAECON**

11th Annual National Aeronautical  
Electronic Conference—Dayton, May 4-6



## ingenuity

Many electronic packaging engineers are optimistic about heretofore insoluble problems of extreme miniaturization in exacting environments. Opportunity to apply such sophistication of attitude now exists throughout the strata of Litton Industries.

Areas of production:

INERTIAL GUIDANCE AND CONTROL  
RADAR AND COUNTERMEASURES  
TACTICAL DATA PROCESSING SYSTEMS  
COMPUTER AND CONTROL SYSTEMS  
SPACE RESEARCH

Those attending NAECON May 4-6 will find it no problem at all to arrange for an interview. Telephone number of our Dayton office is Baldwin 3-4156.

If unable to attend, address inquiries  
to the Research and Engineering Staff.



**LITTON INDUSTRIES**  
ELECTRONIC EQUIPMENTS DIVISION  
BEVERLY HILLS, CALIFORNIA



## Two Stage—Large Capacity—High Vacuum WELCH DUO-SEAL® VACUUM PUMP with VENTED-EXHAUST

Patent Pending



- Reduces pumpdown time
- Vented Exhaust Permits Pumping of Most Condensable Vapors
- Eliminates Use of Traps or Oil Separators
- Reduces Oil Changes Required

### GUARANTEED VACUUM

Vent closed, 0.1 micron. When the vent is open, only slightly higher ultimate pressures result—usually in the range of 1 micron.

### FREE AIR CAPACITY

140 liters/minute  
(5 cubic feet)

PAT. NO. 2,337,849

1402B. DUO-SEAL VACUUM PUMP,  
Motor Driven. For 115 Volts, 60  
Cycles, A.C. Each, \$310.00

1402C. DUO-SEAL VACUUM PUMP,  
Motor Driven. For 230 Volts, 60  
Cycles, A.C. Each \$310.00

1402D. DUO-SEAL VACUUM PUMP,  
Motor Driven. For 115 Volts, D.C.  
Each, \$416.50

For attached Belt Guard, add \$17.50  
to above price.

1402. DUO-SEAL VACUUM PUMP,  
Unmounted. With pulley, but without  
motor, belt, or base. Each, \$240.00

## W. M. WELCH SCIENTIFIC COMPANY

DIVISION OF W. M. WELCH MANUFACTURING COMPANY

ESTABLISHED 1880

1515 Sedgwick Street, Dept. ED, Chicago 10, Illinois, U. S. A.

CIRCLE 215 ON READER-SERVICE CARD



McLean

IMPROVED

## RING FANS

Workhorses  
For Cooling

It's easy to mount these rugged aluminum propeller fans on the top, bottom, side or back of your cabinet. They give quick, quiet, vibrationless cooling and have no welds, joints, rivets or seams to break or loosen. You get up to 395 CFM, highly-reliable motors, push or pull air flows and a variety of sizes. McLean also makes a complete line of packaged cooling equipment for every electronic need.

**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

CIRCLE 216 ON READER-SERVICE CARD

## RUSSIAN TRANSLATIONS

age diminishes from the maximum value  $U_m$  to the cutoff value  $U_o$ . Thus

$$U_o = U_m e^{-\frac{1}{2} \frac{I}{\tau \epsilon}}$$

hence

$$T = 2 \tau \epsilon \ln \frac{U_m}{U_o}$$

The cutoff voltage is a parameter of the tube. As to  $U_m$ , at the start of the discharge, i.e., directly after the current jump, it has a value.

$$U_m = E \frac{1}{1 + \frac{R_i}{R} + \frac{R_i}{R_u}}$$

The period thus depends on the tube parameters, on the circuit parameters, and on the supply voltage.

Another example of a relaxation oscillator is the blocking oscillator used principally to obtain various brief pulses (of duration down to fractions of a microsecond). The blocking oscillator circuit is shown in Fig. 110. It consists of a triode and a transformer, which couples the plate and grid circuits. The tank circuits are formed by the winding inductances and their distributed capacitances, whose equivalents are shown dotted in the diagram.

The circuit of Fig. 110 can be considered as a degenerate ordinary oscillator with tuned grid and plate circuits. It is characterized by the fact that the processes that take place in the circuits are aperiodic in character and occur in intermittent sharp jumps. These jumps, called "blocking" in foreign literature are the reason for the name of this oscillator.

We shall examine the operation of this circuit from the instant when the capacitor  $C_o$  is charged and the grid is negative relative to the cathode, so that the tube is cutoff. Capacitor  $C_o$  is discharged through resistance  $R_g$ . The time constant of the discharge is  $R_g C_o$ . When the voltage reaches a value  $U_o$ , the tube starts conducting and plate current flows.

Owing to the strong positive feedback, a positive voltage will appear on the grid, causing a further rapid rise in the plate current. This process, which is very fast, causes the anode voltage to drop almost to zero (which is the "blocking"). When the resultant grid voltage (which equals the

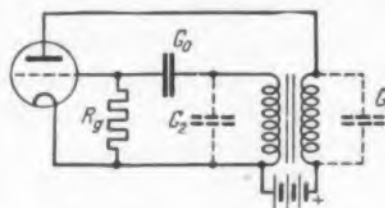


Fig. 110. A basic blocking oscillator.

## LACING TAPE PROBLEMS? GUDEBROD CHARTS THE ANSWER

	GUDE-GLASS	TEMP-LACE H	STUR-D-LACE H	GUDE-LACE H	GUDE-LACE
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 217 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1957

# FAST



## ... accurate D-C resistance measurements with L&N's 4735 Guarded Wheatstone Bridge

Perform laboratory experiments, make routine resistance measurements or calibrate resistors faster—more accurately—with L&N's 4735 Guarded Wheatstone Bridge.

This advanced instrument has many new features including: high accuracy with a wide operating range . . . guarding of detector circuit to prevent resistance errors due to humidity effects . . . minimizing of thermals by special construction features . . . elimination of tedious plug and block ratio settings due to use of a single rotary switch.

**List No. 4735 Guarded Wheatstone Bridge**, normally available for delivery from stock.

**Range**—0.01 ohm to 1,111 megohms.

**Limit of Error**— $\pm(0.05\% + 0.001 \text{ ohm})$  up to 100 megohms;  $\pm 0.5\%$  above.

**Rheostat Switches**—Five decades of enclosed switches in steps of 10 x (1000 + 100 + 10 + 0.1).

**Multiplier Dial**—Eleven-position enclosed switch. Multipliers:  $10^{-5}$  to  $10^5$ .

**Current Rating** (of rheostat arm used as resistance box, determined by highest decade in use)—For 0.1 $\Omega$ , 1.1 amp; for 1.0 $\Omega$ , 0.35 amp; for 10 $\Omega$ , 0.11 amp; for 100 $\Omega$ , 0.035 amp; for 1000 $\Omega$ , 0.011 amp.

**Galvanometer Sensitivity Keys**—Three tap keys provide sensitivities of approximately 1, 1/100 and 1/1000. A battery reverse key is provided.

**Case**—Metal, gray enamel finish; 19" x 9" x 7" for bench use. Wt. is 13 lbs.

**Price**—\$450.00 f.o.b. Phila. or North Wales, Pa. (subject to change without notice). Order List No. 4735 from L&N, 4908 Stenton Ave., Phila. 44, Pa.

**LEEDS** **NORTHROP**  
Instruments Automatic Controls • Furnaces

CIRCLE 218 ON READER-SERVICE CARD

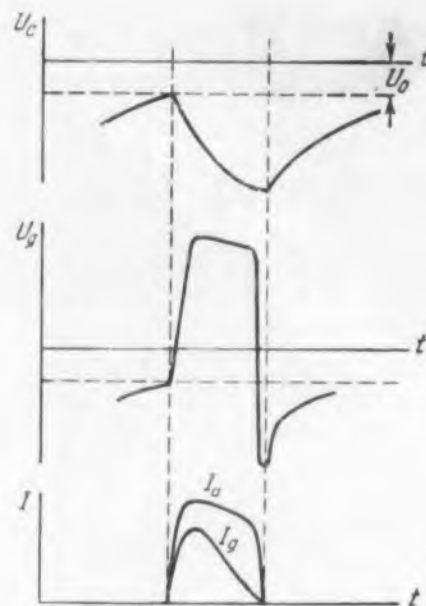


Fig. 111. Voltage and current variations in the blocking oscillator circuit.

sum of the negative voltage across  $C_o$  and the positive voltage induced by the feedback) drops to zero, grid current appears and the capacitor starts charging rapidly through the grid-cathode space, with a time constant  $C_o r_g$ .

At this stage of the process the grid voltage is positive and a voltage appears on the plate. The tube has a small transconductance at this instant and changes in the grid voltage do not affect the plate current noticeably.

But later on, after the grid voltage reaches a maximum and starts diminishing, the transconductance increases. Finally, conditions favorable for the next jump are reached. The reduction in the grid voltage causes a reduction in the plate current, which causes a further reduction in the grid voltage, and the tube is cut off at very high speed. The cycle then repeats. Fig. 111 shows the time variation of the capacitor voltage  $U_c$ , of the grid voltage  $U_g$  and of the grid and plate currents  $I_g$  and  $I_p$ .

The self excitation condition of the blocking generator can be written in the following form (provided  $C_1$  and  $C_2$  are very small compared with  $C_o$ ):

$$k S_a - \frac{1}{n R_i} - \frac{n}{R_g} - n S_g + \frac{1}{r_g} > 0$$

where  $S_a$  and  $S_g$  are, respectively, the transconductances of the plate and grid circuits,  $R_i$  and  $r_g$  are the internal cathode-plate and cathode-grid resistances,  $n$  is a transformation ratio and  $k$  the coupling coefficient (close to unity in our case). The minimum duration of the pulses depends on the leakage inductance of the transformer and on the parasitic capacitance  $C_1$ . The pulse repetition rate is determined essentially by the time constant for charging capacitor  $C_o$ , and is  $T \approx R_o C_o$ .

(This concludes Chapter 2. Chapter 3 starts in the next issue.)

## TRANSISTORIZED CRYSTAL OSCILLATORS

"flat-as-a-pancake"

only one of  
numerous oscillator  
innovations from

**Delta f**

fraction-of-an-inch height fits perfectly into printed circuits . . . a custom design for aircraft and computing equipments.

PACKAGE  
DESIGNS  
TO YOUR  
NEEDS



Standard or  
"customized" oscillators;  
crystal or tuning fork units . . .

**FROM 60 CYCLES TO 100 MC**

Apply unique Delta-f facilities to your requirements: completeness of frequency range; both standard oscillators and "customized" designs; exclusive "plug-in" or "integral built-in" mountings to your specifications. Write today for complete specifications on the all-inclusive Delta-f line.

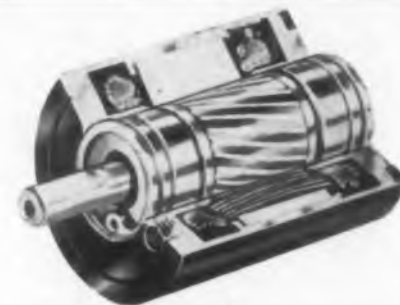
**DELTA-f INC.** / 113 E. STATE ST. / GENEVA 5600 / GENEVA, ILL.



CIRCLE 219 ON READER-SERVICE CARD



Specialized  
Randac Epoxy  
Resin Used in  
"S" Frame Motor  
(MIL-E-5272)



Courtesy: Air Marine Motors Inc.  
Amityville, N.Y. & Los Angeles, Calif.

## RANDAC SYSTEM K-02

Component manufacturers now encapsulate rotating equipment with ease, for improved performance under humid conditions; more rugged construction, less damage during manufacture and operation; reduced overall cost.

K-02, proved the best epoxy resin system, is now available for rotating equipment such as synchronous, resolvers, blower, fan, and other types of A.C. and D.C. motors.

System K-02 features:

- High temperature stability (up to 200°C.)
- Low coefficient of thermal expansion
- Room temperature handling • Long pot life

Mitchell-Rand engineers are available for technical assistance, consultation on epoxy materials and application problems.

**MITCHELL-RAND**

Specialists in  
Electrical  
Insulating Materials

MANUFACTURING CORP.

51 Murray St., New York 7 • Phone: COrtlandt 7-9264

CIRCLE 220 ON READER-SERVICE CARD

GUIDANCE
90°
X
X
X
20°
X
7
X

t-re  
ny  
ne  
..  
e-  
ed  
s.  
er  
ls.  
nd  
th  
ni-  
he  
ec-  
ta  
fi-  
od

D  
NC,  
N.Y.  
7, Pa.

CARD  
1957



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 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., 46 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

46 STEWART AVE., BROOKLYN 37, N. Y. • HYacinth 7-7600  
CIRCLE 221 ON READER-SERVICE CARD

## GERMAN ABSTRACTS

E. Brenner

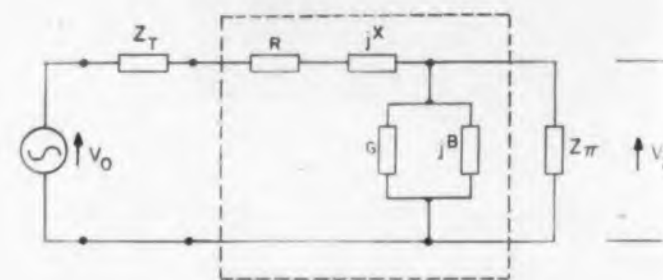
### Attenuation in the Passband of Filters

**F**ILTERS which are designed on a pure-reactance basis have attenuation in the passband due to the losses in the reactive components, generally the coils. When high  $Q$  elements are used and attenuation constant  $\alpha_d$  can be related to the phase function  $\beta(\omega)$  through the equation

$$\alpha_d = \frac{\omega}{2Q} \frac{d\beta}{d\omega}$$

Eq. (1) is a good approximation only when all the elements in the filter have a  $Q$  which is nearly the average value used in that equation. The use of equal  $Q$  elements does not result in

the best design because the quality which is required of each element is not the same at all frequencies, i.e. it depends on the frequency band in which the element is effective. Moreover, Eq. (1) applies only to filters in which coils and capacitors are used. When other components, such as quartz crystals, are employed, it does not apply.



**Fig. 1.** Image terminated half section. The image transfer function,  $\ln(V_0/2V_2)$  is calculated using for  $Z_T$  and  $Z_\pi$  the image impedances of the lossless ( $R=G=0$ ) two port.

### Time Delays in P-N Junctions

**W**HEN p-n junction diodes are used in the sinusoidal steady state with large amplitude currents, two time delay effects are observed. When the diode is forced from the conduction into the nonconduction region, the current collapses  $\alpha/\omega$   $\mu$ sec after it has passed through zero. The approximate waveform is shown in Fig. 1. This time delay is due to a capacitive effect which occurs because of a storage of charge in the path regions of the junction. In the conducting direction, it is observed that the peak current amplitude, for constant impressed voltage, decreases with increasing frequency.

Denoting the life time of the charge carriers by  $\tau$ , the charge in the diode can be calculated assuming that for sufficiently large amplitudes the current waveform during conduction is sinusoidal, as shown in Fig. 1, when the voltage across the diode is sinusoidal.

The differential equation of the charging process can be written as

$$\frac{dQ}{dt} = I_m \sin \omega t - Q/\tau$$

and, subject to the initial condition  $Q(0) = 0$  has the solution:

$$Q(t) = \frac{I_m \tau}{\omega \tau + 1} \left( e^{-t/\tau} + \frac{\sin \omega \tau}{\omega \tau} - \cos \omega \tau \right)$$

Hence the charge at  $\omega t = \pi/2$ , denoted by  $Q_d$  and the charge at  $\omega t = \pi$ , denoted by  $Q_o$  can be calculated as a function of frequency. The result is shown in Fig. 2. The curve for  $Q_d$  is confirmed by the experimental observation that the admittance in the conducting direction decreases with increasing frequency. Moreover, it follows that the corresponding time constant ( $L/r$ ) can be approximated by  $\tau$ .

The charge  $Q_o$  controls the time delay for transition to the zero current state. Solving Eq. (1) on a new time scale, subject to the initial condition  $Q(0) = Q_o$  and replacing  $Q$  with  $-Q$ , one can solve for  $\alpha$ . The result is

$$\exp [ - (\pi + \alpha)/\omega \tau ] = \frac{\sin \alpha}{\omega \tau} - \cos \alpha$$

Experiments indicate that the value of  $\alpha$ , as given by Eq. (3), is too large, probably because the diode is not fully discharged when the current flow ceases.

The total charge  $Q_c$  which is collected is given by

$$Q_c = I_m \tau \frac{1 - \cos \alpha}{\omega \tau}$$

and its frequency dependence is also shown in Fig. 2. The difference  $Q_o - Q_c$  is the charge lost by recombination during the "reverse" time.

It can be shown that for the image terminated half section, shown in the Fig. 1, the image transfer function for high  $Q$  elements results in the attenuation constant  $\alpha_d$  where

$$\alpha_d = \frac{1}{2} (R/Z_T + G/Z_\pi)$$

where  $Z_T$  and  $Z_\pi$  are the image impedances of the half section if the losses are ignored. In terms of the  $Q$ 's of the coils, it can be shown that Eq. (2) has the form

$$\alpha_d = \frac{k_1}{Q_1} + \frac{k_2}{Q_2} + \frac{k_3}{Q_3} \dots \quad (3)$$

where  $k_1, k_2 \dots$  are frequency dependent "weighting factors" which are determined by the element values.

The original paper includes an elaborate example dealing with a quartz crystal filter as well as a discussion of the numerical evaluation of the weighting factors from the frequency dependence of image and driving point impedances.

*Abstracted from an article by J. Boehse, Frequenz, Vol. 12, No. 12, December 1959, pp 380-383.*

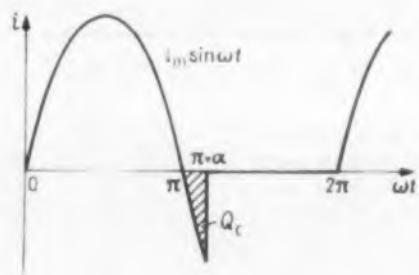


Fig. 1. Approximate current waveform for the p-n junction diode.

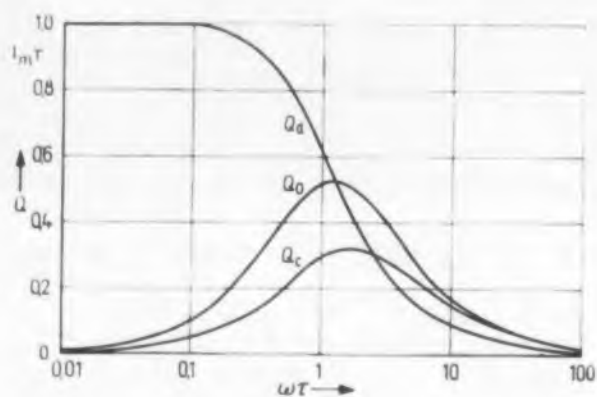


Fig. 2. Stored charge at the time  $\omega t = \pi/2$ ,  $Q_d = Q(\pi/2\omega)$ , at the instant  $\omega t = \pi$ ,  $Q_0 = (\pi/\omega)$ , and net charge  $Q_c$  as a function of (normalized) frequency.

*Abstracted from an article by W. Heinlein, Archiv der Elektrischen Uebertragung, Vol. 12, No. 11, November 1959 pp 510-514.*

fabricated enclosures and chassis



military transit/instrument combination cases



stock deep drawn aluminum boxes and covers



attractive instrument housings



modular re-usable shipping containers

## Let Zero Solve Your Packaging Problem . . .

Zero has just one business . . . designing and producing packages for commercial and military use. Zero's "One-Source" concept is unique . . . provides you with everything you need in packaging, from basic design and engineering through all processes of finishing and testing. Every operation performed under one roof with one responsibility . . . at the lowest possible cost. Contact your Zero Representative on your next packaging job, or send your specifications direct to the factory.

CATALOG AND FACILITIES REPORT ON REQUEST.



**ZERO MANUFACTURING CO.**

1121 Chestnut Street, Burbank, California  
Telephone Victoria 9-5521 • TWX 9862

Zero sales representatives are located in 26 cities to serve you.

CIRCLE 222 ON READER-SERVICE CARD



**marion**  
advancement  
in instrument  
design



**SEALED  
RUGGEDIZED  
PANEL METERS**

The "Original"  
MIL-M-10304-A  
Instrument

HERMETICALLY SEALED... GLASS-TO-METAL

MIL 2 1/2" (MR26) and MIL 3 1/2" (MR36) sizes. Also 1 1/2" Ruggedized and 4 1/2" Sealed Models. ua, mo, amp, mv, volt, KV, AC rectifier types for voltage, decibel and VU measurement. Standard ranges. Bulletin on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Company, Manchester, N. H., U. S. A.

Copyright © 1958, Marion

**marion**  
\*WHERE ELECTRONICS MEETS THE EYE\*  
**meters**



CIRCLE 223 ON READER-SERVICE CARD

# New 1959 DIGITAL INSTRUMENTATION CATALOG

CMC

*Ready now...*

**12 PAGES — Featuring**

- ★ New transistorized frequency meter
- ★ New digital voltmeter
- ★ New fast digital printer and
- ★ The complete CMC line

Write for your **FREE** copy today.  
Address Dept 194A

**Computer Measurements  
Company** • A Division of Pacific Instrument, Inc.

5528 Vineland Ave., North Hollywood, Calif.

CIRCLE 224 ON READER-SERVICE CARD

# MEETINGS

May

- 3-7 Symposium on Electrode Processes, Philadelphia, Pa.
- 4-6 11th National Aeronautical Electronics Conference (IRE), Dayton, Ohio
- 4-8 85th Society of Motion Picture and Television Engineers Convention, Fontainebleau Hotel, Miami Beach, Fla.
- 5-7 URSI Spring Meeting (PGI, PGIT, PGGT), Washington D.C.
- 5-7 7th National Conference on Electro-Magnetic Relays, Stillwater, Okla.
- 6-8 1959 Electronics Components Conference (IRE, AIEE, EIA, WCEMA), Philadelphia, Pa.\*
- 6-8 7th Regional Technical Conference and Trade Show (IRE), Albuquerque, N. Mex.
- 11-12 Symposium on Industrial Uses of Radioisotopes, Atlanta, Ga.\*
- 11-13 National Power Instrumentation Symposium, Kansas City, Kan.
- 11-13 National Symposium (PGMT, IRE), Boston, Mass.
- 11-13 2nd Annual Joint Conference on Automatic Techniques, Chicago, Ill.\*
- 11-13 Radio Technical Commission for Marine Services Assembly Meeting, Mt. Royal Hotel, Montreal, Canada
- 12-14 Annual Frequency Control Symposium, Signal Research and Development Laboratory, Fort Monmouth, Berkeley-Carteret Hotel, Asbury Park, N.J.
- 18-20 5th Annual National Symposium on Instrumental Methods of Analysis, Houston, Tex.
- 18-20 Electronics Parts Distributors Show, Chicago, Ill.\*
- 18-20 Fifth National Symposium on Instrumental Methods of Analysis, Instrument Society of America, Hotel Shamrock Hilton, Houston, Tex.
- 19-21 AIEE Middle Eastern District Meeting, Baltimore, Md.
- 20-22 National Spring Meeting, Society for Stress Analysis, Sheraton Park Hotel, Washington D.C.
- 25-27 National Telemetry Conference (IAS, ISA, AIEE, ARS), Denver, Colo.\*
- 25-29 International Convention on Transistors and Associated Semi-Conductor Devices, London, England\*

**1959 Electronic Components Conference, May 6-8**

Benjamin Franklin Hotel, Philadelphia, Pa. Sponsors: IRE, EIA, AIEE, WCEMA. Theme: New Concept for Space Age. Contact *John E. Hickey, Jr., The Chilton Co., 56th & Chestnut Sts. Philadelphia 39, Pa.*

**Symposium on Industrial Uses of Radioisotopes, May 11-12**

Georgia Tech Campus, Atlanta, Ga. Sponsors: Georgia Tech., Office of Isotopes Dev. (AEC), and Lockheed Aircraft Corp. This symposium is designed to serve an eleven-state area and will show industrialists the many ways in which they can use isotopes to save time. For further information contact: *Richard Wiegand, Director, Short Courses & Conferences, Georgia Institute of Technology, Atlanta, Ga.*

**Second Annual Conference on Automatic Techniques, May 11-13**

Pike Congress Hotel, Chicago, Ill. Sponsored jointly by ASME, AIEE, and IRE. The meeting

# new MINIATURE SWITCHING COMMUTATORS



Now, from Airflyte Electronics, comes lightweight, miniature switching commutators featuring low noise, low torque, long life and angular accuracy of 10 minutes of arc. Available either motor driven or hand detented, they meet MIL Specs. 5400 and 5272.

Ideal for programing, data processing, selecting, telemetering, high-speed sampling, analog-digital conversion, sync. drives, multi-pole and multi-throw switches and sinusoidal switches.

**Airflyte**

Write for Catalog #AE-16.

**ELECTRONICS COMPANY**

535 Avenue A. Bayonne, New Jersey

CIRCLE 225 ON READER-SERVICE CARD

# Harvey-Wells presents



**SPEED  
ACCURACY  
RELIABILITY**

**5 mc Data Bloc • Data-Pac**

... Data Bloc units are basic building blocks which can be reused any number of times ... compact design permits rapid assembly of shift registers, counters, pulse generators for digital logic and data handling systems ... later production runs made easy by compatible Data-Pac units ...

NMR instrumentation, electromagnets and power supplies, error signal comparator ... digital components.



**HARVEY-WELLS ELECTRONICS, INC.**  
Research and Development Division

5168 WASHINGTON ST., W. ROXBURY 32, MASS.

CIRCLE 226 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1959

Here's  
data  
on the

*New*

## DIAL HEAD AGASTAT® time/delay/relays

These relays have recently been re-designed—improved in performance and appearance. So you'll want up-to-date specs.

This free folder gives complete details on all models. In it you'll find operating specs, timing ranges, contact capacities, dimensions, diagrams of contact and terminal arrangements, and data on mounting and installation accessories.

For your copy, write: Dept. A34-424



AGA

ELASTIC STOP NUT CORPORATION OF AMERICA

Elizabeth, New Jersey

CIRCLE 227 ON READER-SERVICE CARD

## NEW Metron MINIATURE COMPONENTS FOR ADJUSTABLE SPEED... IN SMALL SPACE



2/3  
ACTUAL  
SIZE

For use

in countless precision  
devices where  
continuously adjustable  
speed is required...  
If small space and  
adjustable speed is your  
problem, investigate  
Metron Miniature  
Adjustable Ratio  
Speed Drives TODAY!

Extremely small

Up to 0.025 HP and 10,000 RPM

Choice of 5 speed controls

All aluminum housing

Complete, ready-to-go

Compact, adaptable

Quick delivery

Write for Bulletin 96 for details...

INSTRUMENT COMPANY

Metron

460 Lincoln St., Denver 3, Colo.

NEW YORK • CHICAGO • DETROIT •  
LOS ANGELES • CLEVELAND •

CIRCLE 228 ON READER-SERVICE CARD

will avoid the complex engineering problems usually associated with automation. It will cover instead, progress now being made in automatic controls and ways in which they may be applied to any industry. For further information contact: F. D. Snyder, c/o Westinghouse Electric Corp., 40 Wall St., New York 5, N.Y.

### Electronic Parts Distributors Show, May 18-20

Conrad Hilton Hotel, Chicago, Ill. An expanded educational program for distributors designed to bring further benefits to the industry will be a special highlight of the show.

### National Telemetry Conference, May 25-27

Brown Palace and Cosmopolitan Hotel, Denver, Colo. Sponsored annually by the American Rocket Society, IAS, AIEE, and ISA. Theme: Investigation of Space. Twelve Sessions are tentatively scheduled for the meeting including such subjects as: Special Telemetry Techniques for Satellites and Space Vehicles; Sub-miniaturization; Telemetry of Bio-Medical Information from Man in Space; Transistorization and Data Processing. For information contact Ralph Schmidt, AVCO Mfg. Co., 201 Lowell St., Wilmington, Mass.

### International Convention on Transistors and Associated Semi-Conductor Devices, May 25-29

To be held in London, this convention has been organized by the radio and telecommunication section of Britain's Institution of Electrical Engineers to mark the tenth anniversary of the transistor. It will be the most comprehensive ever held on transistors and will cover design, manufacture, basic theory, characteristics, measurements, applications, and equivalent circuits. To provide the widest possible interest, the International Transistor Exhibition will be held at the same time. For details contact Industrial & Trade Fairs Ltd., Drury House, Russell Street, London, W. C. 2, England.

### Paper Deadlines

May 10: Deadline for receipt, in triplicate, of a 100-200 word abstract and a 500-word summary of papers for the 1959 National Symposium on Telemetry to be held in San Francisco, September 28-30. July 10 is deadline for receipt of full-length papers on specially provided master sheets. Submit papers as early as possible on significant work in telemetry and related fields, such as space vehicle communication systems, satellite instrumentation, data processing equipment, new developments in telemetry equipment, and flight test electronics. Further inquiry should be directed to: George L. Larse, Program Chairman, Lockheed Aircraft Corporation, Missile Systems Division, Sunnyvale, Calif.

## TRANSFORMERS for APPLICATIONS UP TO 350°C

Engineering "know how" and manufacturing facilities are available at Acme Electric to produce prototypes or production runs of transformers that must function with operating temperatures up to 350°C.



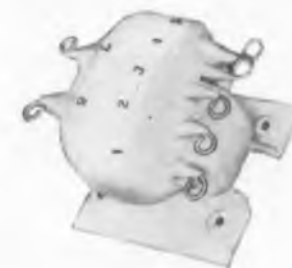
T-36127  
Weight: 14 ounces. VA: 47.8  
50°C rise, 125°C ambient  
12 KV test @ 30,000 feet



T-34671  
Weight: 4 1/4 lbs. VA: 705  
165°C rise, 125°C ambient  
12 KV test @ 30,000 feet



T-34894  
Weight: 260 grams VA: 26.4  
30°C rise, 125°C ambient  
6.2 KV test @ 30,000 feet



T-36196  
Weight: 235 grams. VA: 32  
31°C rise, 125°C ambient  
5.2 KV test @ 30,000 feet

### ACME ELECTRIC CORPORATION

904 WATER STREET CUBA, NEW YORK  
West Coast Plant: 12822 YUKON AVE., HAWTHORNE, CALIF.  
PO 3254

Acme **ACME** Electric  
TRANSFORMERS

CIRCLE 229 ON READER-SERVICE CARD

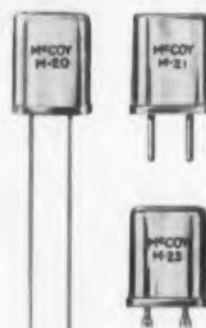
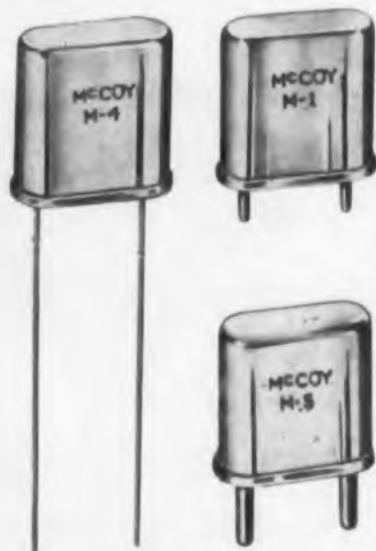


# McCoy...

**A SYNONYM FOR  
QUALITY,  
STABILITY AND  
DEPENDABILITY IN  
CRYSTALS**

Regardless of size,  
weight, or shape,  
a McCoy crystal will  
deliver the  
utmost in stability  
under extreme  
conditions of  
shock and  
vibration.

Frequency range  
of M-1, M-4 and M-5;  
200 kc. to 200 mc:  
M-20, M-21 and M-23;  
3.0 mc. to 200 mc.



All Crystals Shown Actual Size



**Free... illustrated catalog**

Send for Your Copy Today

# McCoy

**ELECTRONICS CO.**  
MT. HOLLY SPRINGS, PA.  
Dept. ED 4  
Phone HUter 6-3411

CIRCLE 230 ON READER-SERVICE CARD

## REPORT BRIEFS

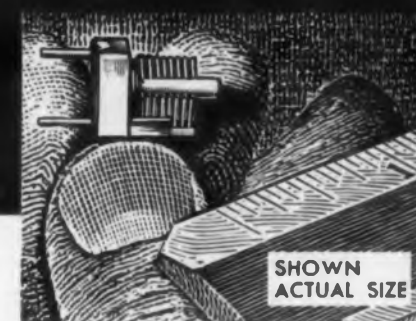
### Noise Sources in Radio Receivers

Considered in this study were problems of standard noise sources in a radio receiver, calibration of secondary standards, and their use in measuring receiver noise factors—problems which are associated with the use of the receiver in radio astronomy where noise is the intelligence measured. A review of figure of merit concepts and receiver measuring practices using gas-discharge noise sources led to formulae which are said to reduce computations to simple additions of excess noise temperature and attenuations. Hot-body noise sources were used as standards in development and calibration of gas-discharge noise sources. Studies of calibrations and source design problems disclosed sources of errors, useful design features, and special techniques valuable for receiver measurements and calibrations. *Fundamentals in Noise Source Calibrations At Microwave Frequencies*, J. E. Sees, Naval Research Laboratory, Jan. 1958, 24 pp, \$0.75. PB 131367 from OTS, U. S. Department of Commerce, Washington 25, D.C.

### Electronic Materials Rated

Electronic transformer materials which appear best suited for use at 500 C and under intense nuclear radiation, the severe environmental combination in which future military electronic equipment may be expected to operate, are identified in a report of recent research for the Air Force. The broad evaluation of transformer basic materials showed mica paper, glass-served silver wire, and grain-oriented silicon steel to have best properties after aging for 1000 hours. The materials were also shown to perform together as transformers. For mechanical moisture protection of transformers, an encapsulating technique using a thin ceramic coating in conjunction with a stainless steel mesh was found feasible. Tests under combined high temperature and radiation tentatively indicated that effects on both materials and transformers were primarily caused by temperature. An exception appeared to be in the dielectric breakdown strength of air. Evaluation results were expected to form a basis for a tentative design practice for construction of transformers and inductors tolerant to the severe environment. Two volumes of the research appear in a single report. *Ultra High Temperature Miniaturized Power Transformers and Inductor Materials*, Volumes 1 & 2, H. B. Harms, J. C. Fraser, General Electric Company for Wright Air Development Center, U. S. Air Force, May 1958, 476 pp, \$6.00. Order PB 151141 from OTS, U. S. Department of Commerce, Washington 25, D.C.

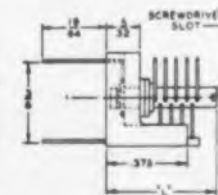
**New  
sub-miniature  
capacitor meets  
MIL-C-92 (Proposed)**



**High torque-to-mass ratio—  
excellent mechanical stability!**

Designed for high torque-to-mass ratio and excellent mechanical stability, the tiny "T" capacitor shown above has a "Q" greater than 3000 at 1 mc. and a very low temperature coefficient. Rotor and stator plates permanently soldered . . . rotor contact spring is beryllium copper . . . plates are .0003" silver-plated brass . . . ceramic is Grade L-4 or better steatite, DC-200 treated. Terminals provided for printed circuit board applications. Requires only two small machine screws for chassis or panel mounting. Available for use on government contracts in production quantities with approval of the U. S. Army Signal Corps only.

For specifications  
and further infor-  
mation on the "T"  
capacitor describ-  
ed above, write for  
Data Sheet 758.



ACTUAL SIZE

**OTHER CAPACITORS**—In addition to the sub-miniature "T" capacitor described above, E. F. Johnson also manufactures a complete line of other air variable capacitors. Types include: ceramic soldered Type "L's", Type "M" miniatures, Type "K" to JAN-C-92, and many other types. For complete specifications on all Johnson electronic components, write for your copy of our newest components catalog, described below.



**New Catalog**

Write today for our newest components catalog, listing complete specifications and prices!  
• Capacitors • Knobs and Dials  
• Sockets • Inductors • Pilot Lights • Connectors • Insulators



**E. F. JOHNSON CO.**

2320 Second Ave. S.W. • Waseca, Minn.

CIRCLE 231 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1959

# STATIC SWITCH

...up to 150 amps  
in 3 micro-seconds  
"with no bounce!"



SILICON semi-conductor devices suitable to circuits up to 400 V that will handle current surges up to 150 amps in continuous 16 amp currents.

- no moving parts
- virtually indestructible
  - ✓ will stand extremely high shock and vibration
  - ✓ surpasses most missile requirements
- operates up to 125C°
- isolated signal and load current
- extremely low signal energy and rapid switching time of 3 micro-seconds with no holding-power required
- weighs only 3½ oz.

## IMMEDIATE DELIVERY "OFF THE SHELF"

other solid state devices, DC-DC converters, DC-AC sine wave inverters, frequency sensors, voltage sensors, time delays and programmers, etc.

for complete information, write:



division of THE VICTOREEN INSTRUMENT COMPANY.  
3025 W. Mission Rd., Alhambra, Calif.

CIRCLE 232 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1959

## Target Data Processing Systems

This report studies the human capabilities in tasks assigned to operators of target data processing systems using manual detection and tracking. Two aspects of detection and tracking task design are discussed. First, the type and number of tasks which can profitably be assigned to an operator are reviewed. The second discussion offers some suggestions for facilitating performance of the basic tasks of detection, tracking, and monitoring. The information is said to be particularly applicable to semiautomatic systems in which electronic data storage is provided. *Some Problems in The Design of Human-Operated Target Data Processing Systems*, T. J. Coonan, Naval Research Laboratory, Sept. 1958, 7 pp, \$0.50. Order PB 151113 from OTS, U. S. Department of Commerce, Washington 25, D.C.

## Visual Coding Dimension

An investigation was conducted to determine whether the flash rate of a flashing light was a suitable coding dimension for the presentation of information. Results showed that no more than five discriminable steps of flash rate could be used for encoding information. The report states that the investigation showed that flash rate was not a good information code for cathode ray tube displays, but it might be a very useful code for exterior lighting displays on aircraft or on the ground. *Flash Rate As A Visual Coding Dimension For Information*, J. Cohen, A. J. Dinnerstein, Antioch College for Wright Air Development Center, U. S. Air Force, May 1958, 13 pp, \$0.50. Order PB 151185 from OTS, U. S. Department of Commerce, Washington 25, D.C.

## Aircrew Fatigue Problems

Outlined in this report is a plan for an experimental program designed to determine the effects of confinement stresses of a five-man crew. These men would be isolated in a flight station for 120 hours. The experimental crew compartment is described and illustrated. Performance tasks, programming and recording instruments, together with the laboratory techniques planned for use in the experiment, are explained. *Aircrew Fatigue Problems During Extended Endurance Flight: Phase 1-Planning*, O. S. Adams, Lockheed Aircraft Corporation for Wright Air Development Center, U. S. Air Force, May 1958, 86 pp, \$2.25. Order PB 151189 from OTS, U. S. Department of Commerce, Washington 25, D.C.

Don't miss an issue of *ELECTRONIC DESIGN*; return your renewal card today.

LEFT: STUD 7/16-11/16

CENTER: AXIAL LEAD TOP HAT

RIGHT: STUD INSULATED

COLUMBUS ELECTRONICS CORPORATION  
DOUBLE DIFFUSED SILICON RECTIFIERS  
COLUMBUS ELECTRONICS CORPORATION  
DOUBLE DIFFUSED SILICON RECTIFIERS  
COLUMBUS ELECTRONICS CORPORATION  
DOUBLE DIFFUSED SILICON RECTIFIERS  
COLUMBUS ELECTRONICS CORPORATION  
DOUBLE DIFFUSED SILICON RECTIFIERS  
COLUMBUS ELECTRONICS CORPORATION  
DOUBLE DIFFUSED SILICON RECTIFIERS  
COLUMBUS ELECTRONICS CORPORATION  
DOUBLE DIFFUSED SILICON RECTIFIERS  
COLUMBUS ELECTRONICS CORPORATION  
DOUBLE DIFFUSED SILICON RECTIFIERS  
COLUMBUS ELECTRONICS CORPORATION  
DOUBLE DIFFUSED SILICON RECTIFIERS



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

## NEW

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

HIGH VOLTAGE up to 2000 PIV	LOW FORWARD DROP 1.5 Volts, DC
EXTREMELY LOW LEAKAGE 1 $\mu$ A	FORWARD CURRENT up to 20 Amps.

## NEW

INSULATED STUD silicon rectifiers offering these quality features...

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

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

WRITE FOR FULL DETAILS

COLUMBUS ELECTRONICS CORP.

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

CIRCLE 233 ON READER-SERVICE CARD





### THROUGH THE EYE OF HALLAMORE CLOSED CIRCUIT TELEVISION

...each testing complex at the massive  
MARTIN-DENVER "Titan" facility

is visually monitored, from as close as 10" from direct missile blast as well as from perimeter checkpoints. Environmentally protected, transistorized Hallamore cameras (Model CC420), remotely controlled from more than 2000 feet, provide a continuously clear picture through every phase of firing. Over 32 Hallamore designed, manufactured, and installed CCTV systems support the Hallamore designed and installed electronic system (over 900 racks) that provides telemetry for the entire Martin-Denver testing complex. Hallamore capability and creativity can be the answer to your systems requirement. Write Hallamore Electronics Company, 8352 Brookhurst, Anaheim, California. TWX: AH 9079...a division of The Siegler Corporation



ENGINEERS... FOR IDEAL WORKING CONDITIONS WITH A DYNAMIC, CREATIVE ORGANIZATION. ADDRESS RESUME TO BRIEF ENGINEER

# HALLAMORE

CIRCLE 234 ON READER-SERVICE CARD

## REPORT BRIEFS

### Sensory Capacity as Data Source

A general survey of what is known about man's ability to make use of his sensory capacities for gathering information is presented. Some comparisons between different sense modalities are made and the problem of sensory interactions is discussed. Use of some of the subordinate sensory channels is also examined. *Man's Senses As Informational Channels*, G. H. Mowbray, J. W. Gebbard, Applied Physics Laboratory, Johns Hopkins University, for U.S. Armed Forces, May 1958, 71 pp, \$2.00. Order PB 151160 from OTS, U. S. Department of Commerce, Washington 25 D.C.

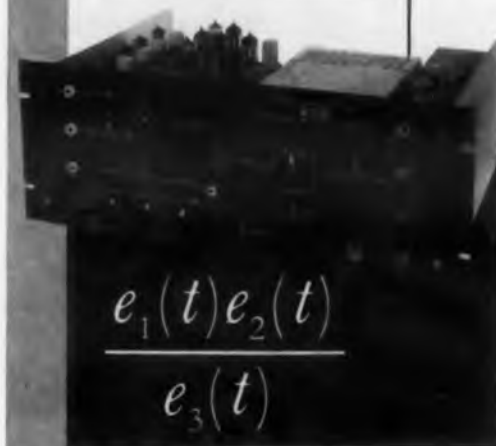
### Vanguard Satellite Receiver

An earth satellite command receiver was developed for use in Vanguard and other United States satellites. This receiver turns on the satellite instrumentation upon command from a ground-based Minitrack station. It is a vhf double-superheterodyne type utilizing a small portion of the 108-Mc Minitrack transmitter power as the first local oscillator. The basic design of the various components provides for economical use of satellite battery power and at the same time a reasonable degree of security against accidental interrogation from unauthorized sources. *Project Vanguard Report No. 35: Minitrack Report No. 6—The Vanguard Satellite Command Receiver*, D. S. Hepler, U. S. Naval Research Laboratory, Sept. 1958, 11 pp, \$0.50. Order PB 151112 from OTS, U. S. Department of Commerce, Washington 25, D. C.

### Radio Stars for Vanguard Tracking

The Mark II Minitrack System, whose function is primarily the tracking of artificial satellites, was also designed for the tracking of radio stars. A means of external calibration of the system by tracking these radio-noise sources is described and illustrated. Results obtained by this method are presented and compared with results obtained by the complex but more precise method used in calibrating Prime Minitrack stations. It is reported that the tracking of radio stars does in fact provide an adequate system calibration if sufficient data are taken. The system is described briefly and an operational analysis is made. *Project Vanguard Report No. 33: Minitrack Report No. 7—Calibrating the Mark II Minitrack System with Radio Stars as Signal Sources*, V. R. Simas and G. C. Kromiller, Jr., U. S. Naval Research Laboratory, Oct. 1958, 28 pp, \$0.75. Order PB 151163 from OTS, U. S. Department of Commerce, Washington 25, D. C.

## The plus is precision!



## NEW analog multiplier- divider by Philbrick

This is Philbrick's K5-M — which provides improved long term stability. Accuracy, including drift, is better than 0.10v in all 4 quadrants.

#### FEATURES:

- Accepts 3 variable inputs  $e_1, e_2, e_3$  and yields  $e_1 e_2 / e_3$
- 3-digit decade provides adjustable scaling voltage
- Useful response even beyond 10 kcps.
- Needs no auxiliary equipment to obtain products, ratios, squares, square roots, etc.
- Requirements: 115vac filament power; 110ma at  $\pm 300$ vdc
- Mounts on standard 7" rack panel

Here's a new and higher degree of precision, speed, and flexibility at your fingertips for analog computation, correlation, precision modulation, control, many other applications.

For full information, write:

GEORGE A.

**PHILBRICK**  
RESEARCHES, INC.

285 Columbus Ave., Boston 16, Mass.  
Commonwealth 6-5375

THE ANALOG WAY IS THE MODEL WAY

CIRCLE 235 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1959

## NEW IDEAS . . . NEW PRODUCTS FOR BETTER TESTING

### CONSTANT CURRENT SOURCES



**Model 5900**  
**Constant Current Source**  
... provides up to 100 ma. D.C. of well regulated current for semi-conductor development, testing of current-sensitive devices, meter calibration and many other applications in one compact, economical unit.

Variations covering extended ranges, better regulation, stability, and other special features available. Price . . . \$325.00 F.O.B. Phila., Pa.

### LOW INPUT DROP MICRO-AMMETER



**Model 5902**  
**Low Drop Current Meter**  
... permits measurements of .1 micro-ampere full-scale with less than 10 microvolts drop across the input. Response time of 5 milliseconds, 1/2% basic accuracy and 9 full scale ranges to 1 MA. Satisfies

the needs of fast, accurate measurement of small currents at extremely low source potentials. Price . . . \$475.00 F.O.B. Phila., Pa.

### DIODE TEST EQUIPMENT



MRC has made significant contributions in the area of automatic testing of semi-conductor devices such as transistors, diodes and thermistors. Combining electronic and mechanical skills, equipment has been designed for

completely automatic testing of widely varying parameters. Correspondence is invited regarding specific areas of interest.

**Specialists** in the solution of difficult measurement problems, MRC offers engineering assistance in answering your test requirements. Write, wire or phone for details to Measurements Research Company, Castor & Kensington Aves., Phila. 24, Penna. JE 5-0911.



**MEASUREMENTS  
RESEARCH CO.**

Div. Prudential Industries Inc.

CIRCLE 236 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 29, 1959

### Vibration Manual

The Vibration Manual for Engineers, a Navy publication containing formulas useful to design engineers in minimizing mechanical vibration difficulties, was prepared by the Structural Mechanics Division of the Navy's David Taylor Model Basin. It updates an earlier manual having the same title (1944). The revised edition has the main purpose of expediting calculations required by the practicing engineer. Most formulas conform with a notation based on the inch-pound-second systems of units. They are presented in case form and are illustrated and explained. A *Vibration Manual for Engineers (Second Edition)*, R. T. McGoldrick, Structural Mechanics Division, David Taylor Model Basin, U. S. Navy, Dec. 1957, 32 pp, \$1.00. PB 131785 from OTS, U. S. Department of Commerce, Washington 25, D.C.

### Audio Filter

Design of an active, low frequency, bandpass filter is described. The synthesis technique made use of RC elements with transistor negative impedance converters to obtain complex poles. Very steep skirt selectivity and 20 db of transmission gain were achieved, but the variation of filter properties with temperature limits this particular filter to use in an environment such as might be encountered normally in a laboratory. It is felt that this limitation is not fundamental and could be substantially alleviated by the use of different transistor types. *Audio Filter*, P. Z. Grayum, Philco Corp., 5 Dec. 56, 29 pp, microfilm \$2.70, photocopy \$4.80. Order PB 135512 from Library of Congress, Washington 25, D.C.

### Theory of Systems

The first three of the five sections present complete developments of theories followed in current engineering practice. Section one discusses the tasks that can and cannot be performed by digital control systems and digital computing systems. Sections two and three contain developments of theories of discrete and of continuous mechanisms. The final two sections are specialized. One discusses weighting functions for continuous mechanisms from the point of view of functional analysis. In the last section, an important class of mechanisms known as finite automata is analyzed using algebraic techniques. *Fundamental Concepts In The Theory of Systems*, University of Chicago for Wright Air Development Center, U. S. Air Force, Nov. 1957, 137 pp, \$2.75, Order PB 151242 from Office of Technical Services, U. S. Department of Commerce, Washington 25, D.C.

Have you sent us your subscription renewal form?



## Get rack-mounting VERSATILITY with Chassis-Trak Slides

Ease of installation . . . space-saving design . . . smooth, trouble-free operation—these are sound reasons for specifying Chassis-Trak Slides. Still another reason is *versatility*.

Suppose you want to transfer a piece of equipment from one cabinet or rack to another. Nothing to it with Chassis-Trak. Simply press a push button spring and the entire chassis comes out. Then slip it into another rack equipped with Chassis-Trak Slides and the changeover is complete. Because Chassis-Trak parts are interchangeable (even on different models and sizes), equipment fitted with slides in one work area can be mounted without modi-

fication in Chassis-Trak-equipped cabinets *anywhere*.

Chassis-Trak Slides come in nine stock lengths and support loads up to 275 lbs. More than 200 standard models meet every installation need. Approved for military use.

Chassis-Trak "Detent" slide, shown in one of seven different tilting positions.



**chassis  
Trak  
inc.**

For further information contact:

525 South Webster, Indianapolis 19, Indiana

CIRCLE 237 ON READER-SERVICE CARD



## Sir Francis Drake Cracks a Case

One foggy day in 1588, a single ship of the Spanish Armada managed to sneak behind Drake's entire British fleet lying in the English Channel off Plymouth Hoe, and drop a 10 pounder smack in the middle of a bowling match between Sir Francis and his friend Walter Raleigh.

The new radar was caught completely by surprise. Had the IFF (Identification: Francis or Foe?) system failed? Was the operator tuned to the wrong Channel? Was there something wrong with the tubes? Drake was determined to find out. He was inside the shack in a trice, whatever that is. "Avast!" he roared at the radarman, "I must inspect those tubes!"

Drake picked up a magnetron and looked at it. "Aha!" he ex-

claimed. "Just as my razor-keen mind suspected!" With that, he seized the hapless operator by the throat and shook him like a tumblerful of sidecars. "I arrest you for stealing Bomac tubes\* and substituting these inferior substitutes, WILLIAM SHAKESPEARE!"

"I confess, how'd you guess?" said Shakespeare, ever the poet.

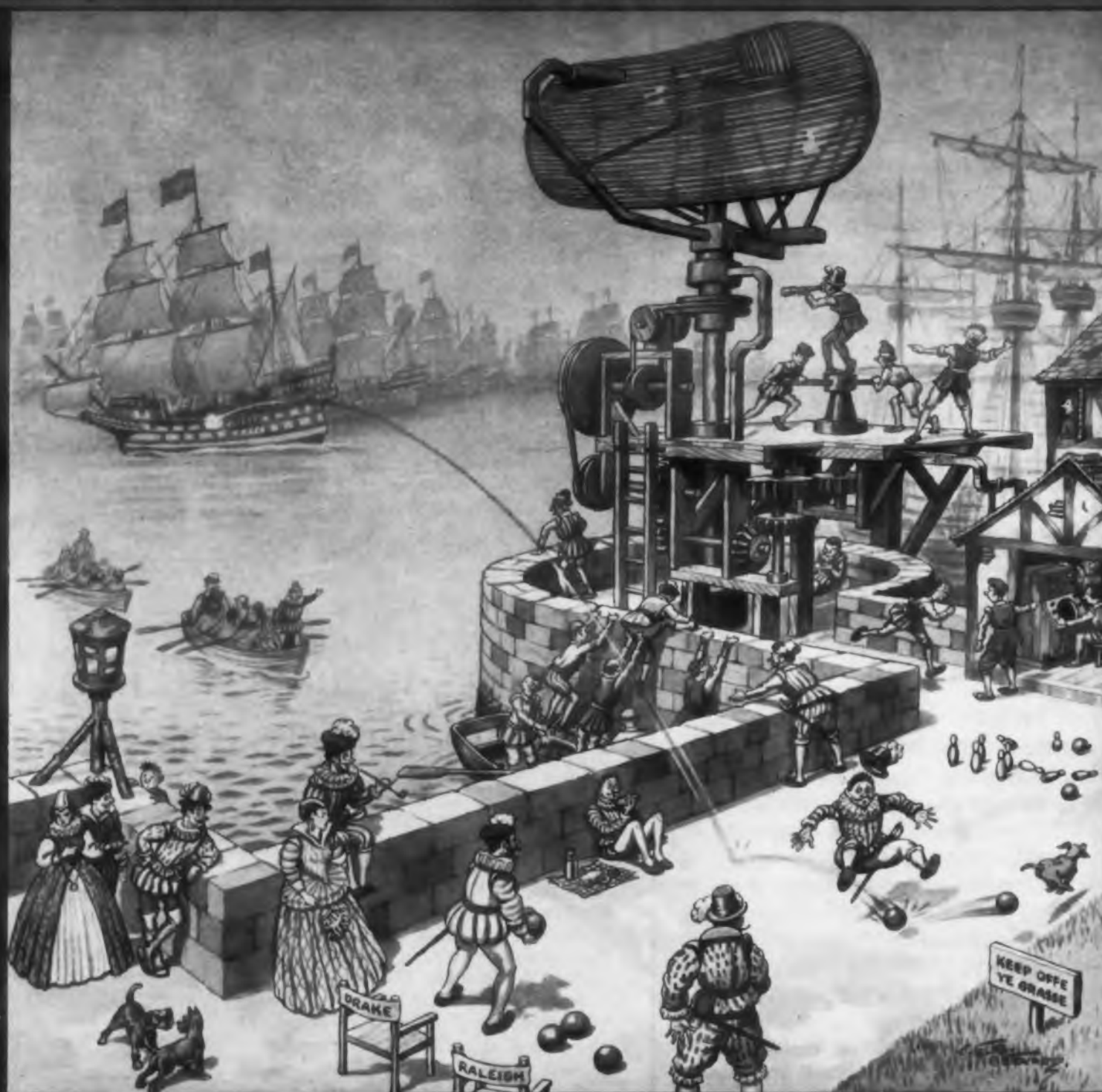
"Elementary for a razor-keen mind like mine," answered Drake.

"Only you could have conceived the cunning scheme of replacing Bomac tubes with factory seconds labeled 'Bethmac' as a publicity stunt for your new play — Macbeth!"

"Yours is a razor-keen mind indeed!" marveled Shakespeare as they led him away. "I haven't even written Macbeth yet!"

"Plenty of time where you're going," said Drake — and went off to bowl over the Armada.

No 13 of a series... BOMAC LOOKS AT RADAR THROUGH THE AGES



\* Bomac makes the finest microwave tubes and components either side of the English Channel

# Bomac

Leaders in the design, development and manufacture of TR, ATR, Pre-TR tubes; shutters; reference cavities; crystal protectors; silicon diodes; magnetrons; klystrons; duplexers; pressurizing windows; noise source tubes; high frequency triode oscillators; surge protectors.

Offices in major cities—Chicago • Kansas City • Los Angeles • Dallas • Dayton • Washington • Seattle • San Francisco • Canada: R-O-R Associates Limited, 1470 Don Mills Road, Don Mills, Ontario • Export: Maurice I. Parisier, 741-745 Washington St., N. Y. C. 14, N. Y.

## ADVERTISERS' INDEX

April 29, 1959

Advertiser	Page
AGA Div. of Elastic Stop Nut Corp.	115
AMP, Inc.	21
Ace Electronics Associates	85
Acme Electric Corp.	115
Aerovox Corp.	10
Air Marine Motors, Inc.	104
Airflyte Electronics	114
Allied Radio Corp.	79
Alpha Metals, Inc.	97
Alto Scientific Co.	107
Amphenol Borg Electronics Corp.	68
Ansley, Arthur Mfg. Co.	104
Atlas E-E Corp.	22
BJ Electronics Borg-Warner Corp.	74
Babcock Relay, Inc.	88
Bendix Aviation Corp., Pacific Div.	40
Bendix Aviation Corp., Red Bank Div.	24
Bendix Aviation Corp., Scintilla Div.	100
Berkeley, Div. of Beckman Instruments, Inc.	8
Bomac Laboratories, Inc.	120
Brew, Richard D. & Co., Inc.	11
Burndy Corporation	16
Burnell & Co., Inc.	5
CBS-Hytron	35
Cannon Electric Co.	104
Centralab, Div. of Globe-Union, Inc.	23
Chassis-Trak Corp.	119
Chicago Dynamics Industries, Inc.	97
Clare, C. P. & Company	71
Clevite Transistor Products	28
Columbus Electronics Co.	117
Comar Electric Company	97
Computer-Measurements Corp.	114
Crosley Div. AVCO Mfg. Corp.	60
Daven Co., The	61
Delta-f, Inc.	111
Dialight Corp.	112
DIT-MCO, Inc.	87
Dorsett Laboratories	84
Dow Chemical Company, The	43
DuMont, Allen B. Labs., Inc.—Ind. Tube Div.	70
ESC Corporation	57
Eitel-McCullough, Inc. (Eimac)	66
Electrical Industries	29
Electro Engineering Works, Inc.	31
Electro Instruments	Cover III
Electro-Measurements, Inc.	17
Electron Products, Inc. (Preco, Inc.)	89
Epoxy Products Inc.	51
Fairchild Semiconductor Corp.	93
Franklin Electronics, Inc.	103
G-V Controls, Inc.	1
General Electric Co., Apparatus Div.	69
General Electric Co., Lamp Division	102
General Electric Co., Capacitors	65
General Electric Co., Semiconductor Products Dept.	76, 77
General Instrument Corp.	13
General Radio Co.	96
General Transistor Corp.	20
Gries Reproducer Corp.	96
Gudebrod Brothers Silk Co., Inc.	110
Hallamore Electronics Company	118
Harvey-Wells Electronics, Inc.	114
Hewlett-Packard Company	41
Hi-Temp Wires, Inc.	56
Holt Instrument Laboratories	105
Hughes Aircraft Co.	39
International Business Machines Corp.	98, 99
International Resistance Co.	14
Iron Fireman Mfg. Co., Electronic Div.	45
Jerrold Electronics Corp.	48
Johnson Mfg. Corp.	116
Jordan Electronics	117

◀ CIRCLE 238 ON READER-SERVICE CARD

Advertiser	Page
Kearfott Co., Inc., Little Falls Div.	46
Keithley Instrument Co.	108
Kellogg Switchboard & Supply Co.	88
Kester Solder Co.	108
Kouff & Esser	47
Krohn-Hite Corp.	84

Page	Advertiser	Page
115	Lambda Electronics Corp.	75
21	Leach Corp.	91
85	Leeds & Northrup Co.	111
115	Lerner Plastics	88
10	Litton Industries, Inc., Electronic Equip-	109
104	ment Div.	
114	Lockheed Aircraft Corp., Missile Systems	59
79	Div.	
97	Lord Mfg. Co.	78
107		
168		
104		
22		

74	McCoy Electronics Co.	116
88	McDonnell Aircraft Corp.	80, 81
40	McLean Engineering Laboratories	110
	Mada Development Co.	96
	Marion Electrical Instruments	114
	Measurements Research	119
	Metron Instrument Co.	115
	Michigan Magnetics, Inc.	106
	Micro-Electric, Div. of Micro Machine Works	106
	Minneapolis-Honeywell Co.	37, 92
	Mitchell-Rand Mfg.	111
	Motorola, Inc., Western Military Electronics	
	Center	99

National Co., Inc.	64, 109
--------------------	---------

Oak Mfg. Co.	27
--------------	----

35	Pacific Semiconductors, Inc.	60, 61
104	Panoramic Radio Products, Inc.	107
23	Phelps Dodge Copper Products, Co.	62, 63
119	Philco Corp., Lansdale Tube Div.	7
97	Phillbrick, George A., Researches, Inc.	118
71	Photocircuits Corp.	30
28	Polytechnic Research & Development Co.	86
117	Potter & Brumfield	72
97	Potter Instrument Co.	6
114		
60		

61	Radio Corp. of America, Electron Tube	
111	Div.	IV
112	Radio Corp. of America, Employment Div.	95
87	Raytheon Mfg. Co., Microwave & Power	
84	Tube Div.	55
43	Raytheon Mfg. Co., Semiconductor Div.	2
	Raytheon Mfg. Co., Special Microwave De-	
	vices	4
	Rheem Mfg. Co.	87
	Rosemount Engineering Co.	89
57		
66		
29		
31		
ver 111		
17		
89		
51		

57	Segal, Edward	15
66	Shell Chemical Corp.	Cover II
29	Simmons Fastener Corp.	101
31	Solid State Electronics	52
ver 111	Southco, Div. of South Chester Corp.	49
17	Sprague Electric Co.	9
89	Sprague Products Co.	94
51	Stanford Research	108
	Stromberg-Carlson Co., Div. of General	
	Dynamics	85

1	T. A. Manufacturing Corp.	96
69	Taher Instrument Corp.	100
102	Technic, Inc.	102
65	Technical Information Corp.	53
76, 77	Technology Instrument Corp.	25
13	Tektronix, Inc.	83
96	Telemeter Magnetics, Inc.	73
20	Texas Instruments, Inc.	79
96	Trotel, Inc.	106
110	Transitron Electronic Corp.	67

118	Varian Associates	12
114		
41		
56		
105		
39		

97	Widdom Electronics, Inc.	97
58	Ward Leonard Electric Co.	58
110	Welch, W. M., Mfg. Co.	110
82	Westinghouse Electric Corp., Industrial	
34	Tube Div.	
105	Whitlock Signals, Inc.	
	Whitso, Inc.	105

113	W. O. Mfg. Co.	113
-----	----------------	-----

CIRCLE 239 ON READER-SERVICE CARD ➤

# NEW! Electro Instruments totally-transistorized, modular



## NEW ENGINEERING IMPROVEMENTS THROUGHOUT

- Faster slewing speeds—  
Pen: 30"/sec.;  
Carriage: 30"/sec.
- Greater accuracies—  
Static: 0.1%;  
Dynamic: 0.2%.
- 0.05% internal calibration.
- High precision internal Zener diode reference.
- New improved vacuum hold-down system.
- Vernier control between ranges.
- Input function modules in rack mountable case can be removed from plotter for remote operation.
- Calibrated scales on both axes.
- Front panel gain control
- Vacuum release on front panel.
- Visible ink supply.

One basic plotter with input modules available for general purpose, computer, low level differential, time base, curve following and other specialized functions.

	Model 410 Computer Module	Model 420 General Purpose Module	Model 430 Low Level Differential Module	Model 450 Curve Follower Module	Model 460 Time Base Module
Input Ranges	Single Ended 0.1, 1.0, 10v/in, calibrated vernier	Single-Ended 16 steps, 1m v/in to 100 v/in, plus vernier	Differential 16 steps, 1m v/in to 100 v/in, plus vernier	Single-Ended	Single-Ended 0.1, 0.2, 0.3, 0.6, 1.0, 2.0 in/sec
Accuracy: Static	± 0.1% F/s	± 0.1% F/s	± 0.15% F/s	± 0.25% F/s	(time) ± 1.0% F/s
Dynamic	± 0.2% F/s	± 0.2% F/s	± 0.2% F/s	± 0.1% F/s	(sweep) ± 0.5% F/s
Linearity					
Input Resistance	2 megs, all ranges	1 meg to 3 megs Depending on range	1 meg to 3 megs Depending on range		
Zero Adjust	Full scale X and Y plus 9" offset	Full scale X and Y plus 9" offset	Full scale X and Y plus 9" offset		
Reference	Internal Zener diode and external ± 100v computer	Internal Zener diode	Internal Zener diode		Internal Zener diode
Calibration	Internal 0.1, 1.0, 10v Accurate to ± 0.05%				
Common Mode Rejection			DC, 120 db AC, 100 db at 60 cps 50 v dc or peak ac		
Max. Common Mode Voltage					
Principle of Operation				80 cps magnetic induction	Electronic integration
Zero Drift				None	

Dimensions All Modules: 8 1/2" W x 3 1/2" H x 7 3/4" D

### Model 400 Plotter

3540 Aero Court  
San Diego 11, California



Recording Size: 10" x 15"  
Slewing Speed: X, 40"/sec; Y, 30"/sec  
Inputs: X and Y inputs, and computer reference  
Power: 115 ± 10 v, 60 cps  
Dimensions: 19" W x 19 1/2" H x 11 3/4" D  
Ambient Temperature Range: 0-55°C  
Controls: Power off, standby, operate, pen; vacuum release; curve follower, amplifier; local, remote.

# Electro Instruments, Inc.





# ARE YOU DESIGNING A "CALLBACK"?

Or, are you wisely designing "around" a dependable easy-to-obtain-in-the-field Preferred Tube Type?

Some day, the tv or radio set you designed is going to need service. Some day, a service dealer is going to have to replace a tube type you specified. Can the service dealer replace with a *stock* tube? That is one of the big tests of an original design.

There are more than a thousand tube types you can design "around". But, the majority of today's tv and radio circuits employ less than a hundred of those types. For good reason, too. Over the years those *preferred* types have proven to be tops...in quality...in versatility...in reliability and replaceability.

If the tubes you specified for your design are Preferred Tube Types, you can bet that field replacement will not be a problem. If not—it may mean a "callback" and a customer who begins to doubt his choice of sets. Help keep them sold with Preferred Tube Types.

Your RCA Field Representative has the complete story of how you benefit by using Preferred Tube Types. Call him at the RCA Field Office nearest you.



#### RCA FIELD OFFICES

EAST: 744 Broad 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.*

April 29, 1959



