Ten-Year Oceanographic Program

page 40

NOVEMBER 20, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 47 PRICE SEVENTY-FIVE CENTS

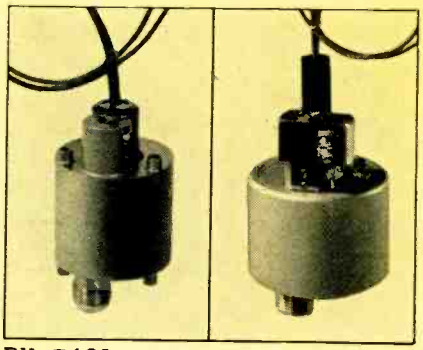
Missile Miss-Distance Indicator

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 1, No. 5

NEW RAYTHEON MICROWAVE TUBE DEVELOPMENTS

Miniature pulsed magnetrons for missile beacon applications are ruggedly constructed with integral magnets. The RK-7461 is tunable from 9,300 to 9,500 mc and has minimum peak power output of 60 watts. It is 1¼" in diameter and 2½" long, and weighs only 6 ounces.



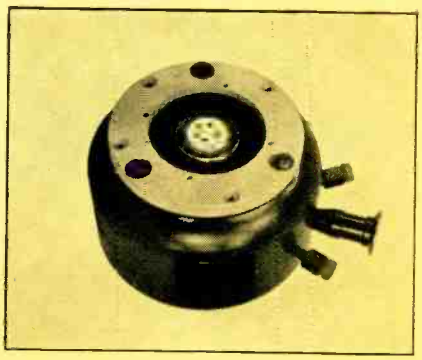
RK-7461 QK-735

The QK-735 is tunable from 5,400 to 5,900 mc with minimum peak power output of 400 watts. 1½" in diameter and 3¼" long, it weighs 8 ounces.

CIRCLE 182
Reader Service Card

* * *

Designed for electronic countermeasures and FM/CW operations, the QK-625 BWO provides a minimum CW power output of 180 watts and a nominal CW power output of 250 to 350 watts over the 2,500 to 3,000 mc band. The tube is voltage tunable over the entire range with tuning sensitivity of approximately 0.4 mc/volt. Liquid-cooled, the QK-625 BWO is equipped with an integral



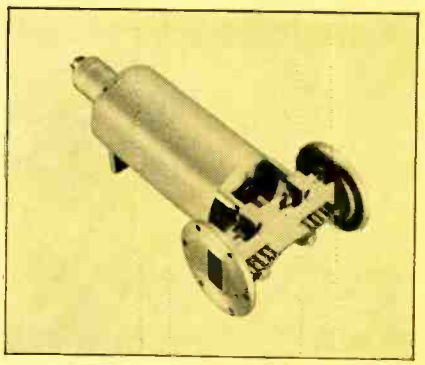
permanent magnet, and can be mounted in any position.

CIRCLE 180
Reader Service Card

* * *

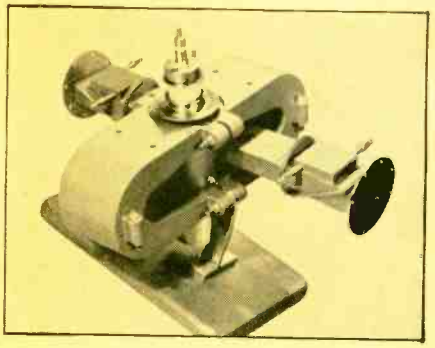
Small-signal gain of up to 35 db in microwave relay links is achieved by means of a new compact traveling wave tube amplifier -- the QK-542. This permanent-magnet focused CW tube has nominal saturated power output of 5 watts over 5,900 to 7,400 mc. An integral UG 344/U waveguide-type flange is supplied as standard. With an optional coaxial output coupler the QK-542 covers 4,000 to 8,000 mc.

CIRCLE 183
Reader Service Card



Ideal for linear accelerators and high-power radar systems. The QK-783 and QK-622 Amplitrons operate over the 2,700-2,900 mc and 2,900-3,100 mc bands, respectively, at a peak power of 3 megawatts and a typical efficiency of 75%. Because no heater is required, these tubes are capable of exceptionally long life. RF gain is 8 db under rated conditions, and as high as 12 db at lower peak power outputs. Phase pushing figure is less than 0.5 degrees for a 1% variation of anode current.

CIRCLE 181
Reader Service Card



* * *

Compiled as a Raytheon service to the field, new Consolidated Data Booklet contains comprehensive information about principal unclassified magnetrons, klystrons, backward wave oscillators and special purpose tubes manufactured by Raytheon. Characteristics presented include maximum ratings, typical operating values, band or frequency ranges and other essential data for microwave engineers and purchasing departments.

CIRCLE 184
Reader Service Card

A Leader in Creative Microwave Technology

RAYTHEON

electronics

NOVEMBER 20, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 47

JAMES GIRDWOOD, *Publisher*

W. W. MacDONALD, *Editor*

JOHN M. CARROLL, *Managing Editor*
Associate Editors: Frank Leary, Michael F. Tomaino, Howard K. Janis, Sylvester P. Carter, Roland J. Charest, William P. O'Brien, George Sideris, John F. Mason, William E. Bushor, Thomas Emma, Samuel Weber, Sy Vogel, Leslie Solomon, M. M. Perugini, George J. Flynn
Assistant Editors: Michael F. Wolff, Nilo Lindgren, Harold M. McKean
Regional Editors: Harold C. Hood (Pacific Coast, Los Angeles), Harold Harris (Midwestern, Chicago), Thomas Maguire (New England, Boston)
Market Research Editor: Edward DeJongh
Art Director: Harry Phillips
Production Editor: John C. Wright, Jr.
Editorial Assistants: Gloria J. Filippone, Arlene Schilp, Bernice Duffy, Patricia Landers, Carol Weaver, Marian L. Freed, Dolores A. Fornaro, Lorraine Rossi

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

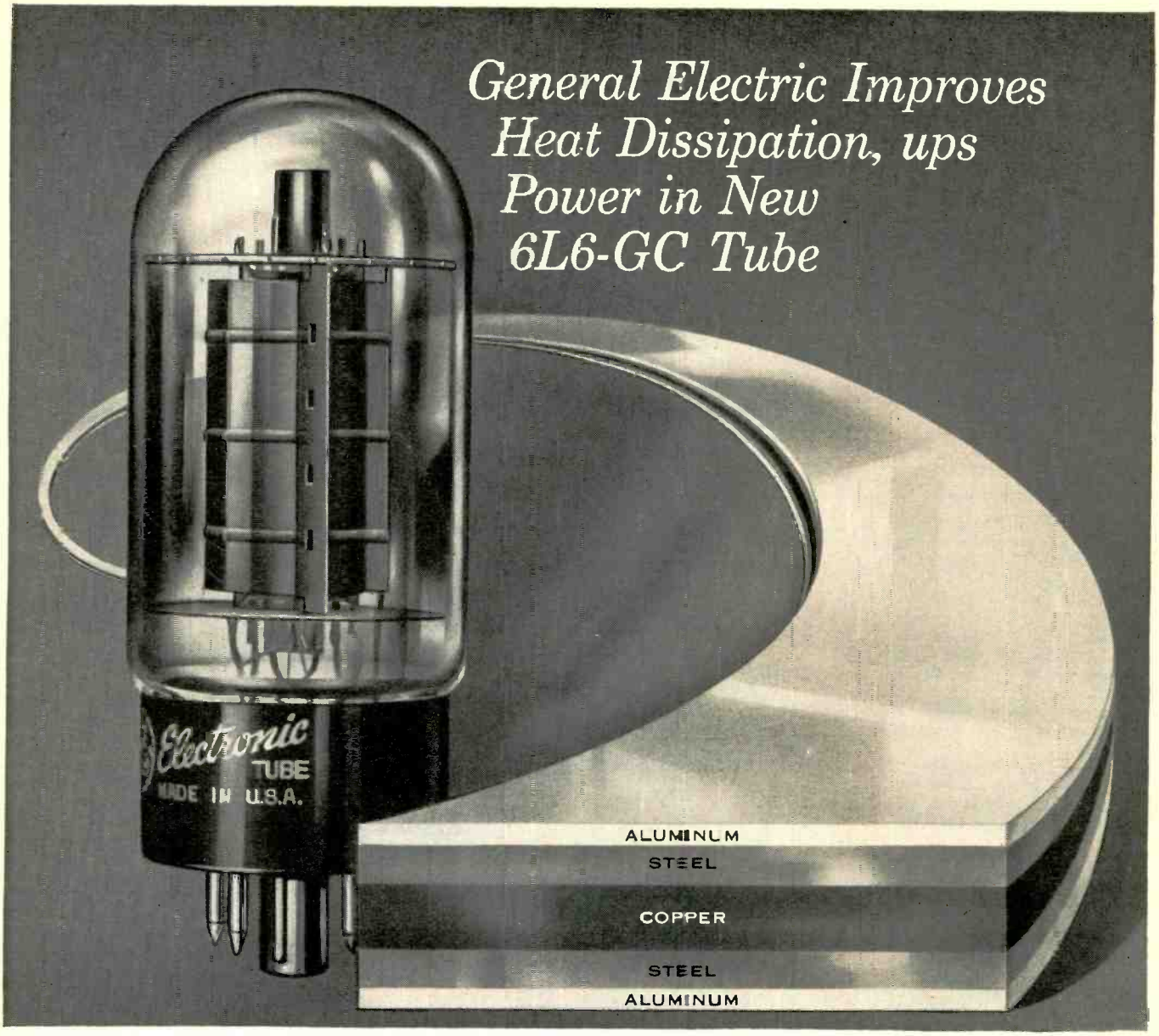
New York: Donald H. Miller, Henry M. Shaw, George F. Werner. *Boston:* Wm. S. Hodgkinson. *Philadelphia:* Warren H. Gardner, William J. Boyle. *Chicago:* Harvey W. Wernecke, Martin J. Gallay. *Cleveland:* P. T. Fegley, David M. Watson. *San Francisco:* T. H. Carmody, R. C. Alcorn. *Los Angeles:* Carl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

Issue at a Glance

Business

Engineering

Departments



WITH

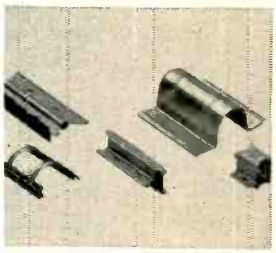
General Plate

COPPER-CORED ALIRON

Redesigned with improved heat dissipating anode material, General Electric Company's 6L6-GC audio power output tubes now offer important new advantages — maximum anode dissipation — or, rating increased 40 percent — cost one-third lower than comparable tubes — low distortion. And to obtain this improved value for their customers, General Electric Company used General Plate 5-layer copper-cored Aliron strip made available by Metals & Controls Division at the request of the Receiving Tube Department of the General Electric Company.

The copper, when combined with high emissivity aluminum-steel surfaces, results in a clad metal stock with improved heat conductivity . . . allows greater heat dissipation without danger of hot spots developing in tube anodes. The five layers are inseparably bonded together without intermediate brazing materials. Individual layer thicknesses are accurately controlled so that physical properties remain uniform.

Metals & Controls is constantly developing new clad metals which save weight, increase strength, conserve materials, improve performance and offer other advantages not found in single metals or alloys. Write for catalog GP-1 and get acquainted with General Plate Clad Metals.



OTHER GENERAL PLATE CLAD METALS USED IN TUBES

Copper-base Aliron — Aluminum on low-carbon steel on copper

Aliron® — Aluminum clad to both sides of low-carbon steel

Nifer® — Nickel clad to both sides of low-carbon steel

Alnifer® — Aluminum on low-carbon steel on nickel

METALS & CONTROLS

1311 FOREST STREET, ATTLEBORO, MASS., U. S. A.

A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

GENERAL PLATE PRODUCTS: Clad Metals • Electrical Contacts • Truflex® Thermostat Metal • Platinum Metals • Reactor Metals • Radio Tube & Transistor Metals

LAMBDA'S ALL-TRANSISTOR LINE

Delivered now • Guaranteed for five years

FOUR NEW POWER SUPPLIES

1-AMP and 2-AMP · CONVECTION COOLED

No internal blowers • No moving parts

0-32 VDC

0-1 AMP 0-2 AMP

Model LT 1095	$285
Model LT 1095M (metered)	$315
Model LT 2095	$365
Model LT 2095M (metered)	$395

- **Ambient 50° C at full rating.**
- **High efficiency radiator heat sinks.**
- Silicon rectifier.
- 50-400 cycles input.
- Special, high-purity foil, long-life electrolytics.
- **Compact. Only 3½" panel height.**
- **Short-circuit proof.**
- Protected by magnetic circuit breakers.
- Hermetically-sealed transformer. Designed to MIL-T27A.
- **All transistor. No tubes.**
- **Fast transient response.**
- Excess ambient thermal protection.
- Excellent regulation. Low output impedance. Low ripple.
- Remote sensing and DC vernier.

CONDENSED DATA

Voltage Bands . . . 0-8, 8-16, 16-24, 24-32 VDC

Line Regulation . . . Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 105-125 VAC.

Load Regulation . . . Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

AC Input . . . . . 105-125 VAC, 50-400 CPS

Electrical Overload Protection . . . Magnetic circuit breaker, front panel mounted. Unit cannot be injured by short circuit or overload.

Thermal Overload Protection . . . Thermostat, manual reset, rear of chassis. Thermal overload indicator light, front panel.

Size . . . . . 3½" H x 19" W x 14⅜" D.

Send for your copy.

New! **1959 CATALOG NOW AVAILABLE**

New 36-page edition contains information and specifications on Lambda's full line of transistor-regulated and tube-regulated power supplies.

LAMBDA ELECTRONICS CORP.

11-11 131 Street, College Point 56, N.Y.

CIRCLE 3 ON READER SERVICE CARD

electronics

November 20, 1959 Vol. 32, No. 47

Published weekly, including the ELECTRONICS BUYERS' GUIDE and REFERENCE Issue in mid-June as part of the subscription, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948) Founder.

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

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

Single copies in the United States, U. S. possessions & Canada 75¢; $1.50 for all other foreign countries. Buyers' Guide in the United States, U. S. possessions & Canada $3.00; all other foreign $10.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years; $12.00 for three years. Canada, $10.00 a year; $16.00 for two years; $20.00 for three years. All other countries, $20.00 a year; $30.00 for two years; $40.00 for three years. Second class postage paid at Albany, N. Y. Printed in U.S.A.

BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11; 68 Post Street, San Francisco 4; McGraw-Hill House, London E. C. 4; 85, Westendstrasse, Frankfurt/Main; National Press Bldg., Washington 4, D. C.; Six Penn Center Plaza, Philadelphia 3; 1111 Henry W. Oliver Bldg., Pittsburgh 22; 55 Public Square, Cleveland 13; 856 Penobscot Bldg., Detroit 26; 3615 Olive St., St. Louis 8; 350 Park Square Bldg., Boston 16; 1301 Rhodes-Haverty Bldg., Atlanta 3; 1125 West Sixth St., Los Angeles 17; 1740 Broadway, Denver 2; 901 Vaughn Bldg., Dallas 1. ELECTRONICS is indexed regularly in The Engineering Index.

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

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

Member ABP and ABC

SHOPTALK . . . editorial

ACADEMICALLY SPEAKING. Research projects now underway in colleges and universities frequently give the key to products and techniques of the future. To extend our coverage of this very important editorial area, ELECTRONICS recently sent some 180 letters to the deans or presidents of academic institutions telling of our interest in learning of their research work.

The responses were gratifying. In all, close to 125 schools replied with expressions of interest. A short time later reports began coming in on work in progress. For some of these details, turn to p 57.

THE NEW IN NEW ENGLAND. This week, on p 45, there's one example that drives home two points in our editorial aims: (1) Reporting the news while it's hot, not merely warm. (2) Giving on-the-spot coverage to regional activities. New England Editor Maguire has been living with NEREM for several weeks—the Northeast Electronics Research and Engineering Meeting. This is the area's big annual event. Last week, in his exclusive roundup headlined "New England in Ferment," Maguire brought you up to date on that part of our industry—the trends, the plans, the hopes. And he gave you a preview of NEREM. This week, he tells you what's happening . . . while it's happening.

BETWEEN THE RUSSIANS AND THE DEEP BLUE SEA. Oceanography has always had its share of interest and outstanding effort within the American scientific community, but the International Geophysical Year brought a revelation. As with outer space, the Soviets had quietly accelerated their efforts. Both the military implications of underwater research and the peaceful potentials of oceanographic science took on new importance. U.S. scientists had, in effect, been issued a challenge.

Now it appears this is the year for a decision if a long-range, orderly oceanographic effort is to be started and a belated, more expensive crash program is to be avoided. On p 40 Associate Editor Janis points out the crossroads at which U.S. oceanography stands.

Coming In Our November 27 Issue . . .

RADIATION DAMAGE. Effects of radiation on semiconductors are receiving great attention as researchers strive for solid-state devices that can function in space vehicles and around nuclear reactors. Assistant Editor Wolff attended the Second Conference on Nuclear Radiation Effects on Semiconductor Devices, Materials and Circuits in New York City this fall and heard a raft of papers on this subject. In his article next week, Wolff describes the effects of radiation on semiconductors and some techniques being used to increase radiation tolerance of semiconductor devices and circuits.

MORE ON TUNNEL DIODES. One of the intriguing features of the tunnel diode to circuit designers is its tolerance to radiation. Basic action of the tunnel diode has already been explained (ELECTRONICS, p 54, Nov. 6) and next week its characteristics and circuit applications are described.

I. A. Lesk, N. Holonyak, Jr. and U. S. Davidsohn of General Electric Co. in Syracuse, N. Y., show how tunnel diodes can be used in oscillators, sweep circuits, detectors, multivibrators and amplifiers. Values of typical tunnel diode parameters are given and the authors explain why the diode resists radiation.

SPRAGUE® RELIABILITY in these two dependable wirewound resistors

MINIATURE

Blue Jacket®

VITREOUS-ENAMEL POWER RESISTORS

Sprague's new improved construction gives even greater reliability and higher wattage ratings to famous Blue Jacket miniature axial lead resistors.

A look at the small *actual sizes* illustrated, emphasizes how ideal they are for use in miniature electronic equipment with either conventional wiring or printed wiring boards.

Get complete data on these dependable minified resistors, **write for Engineering Bulletin 7410.**

TAB-TYPE BLUE JACKETS: For industrial applications, a wide selection of wattage ratings from 5 to 218 watts are available in Sprague's famous Tab-Type Blue Jacket close-tolerance, power-type wirewound resistors. Ideal for use in radio transmitters, electronic and industrial equipment, etc. **For complete data, send for Engineering Bulletin 7400A.**

NEW SMALLER SIZE

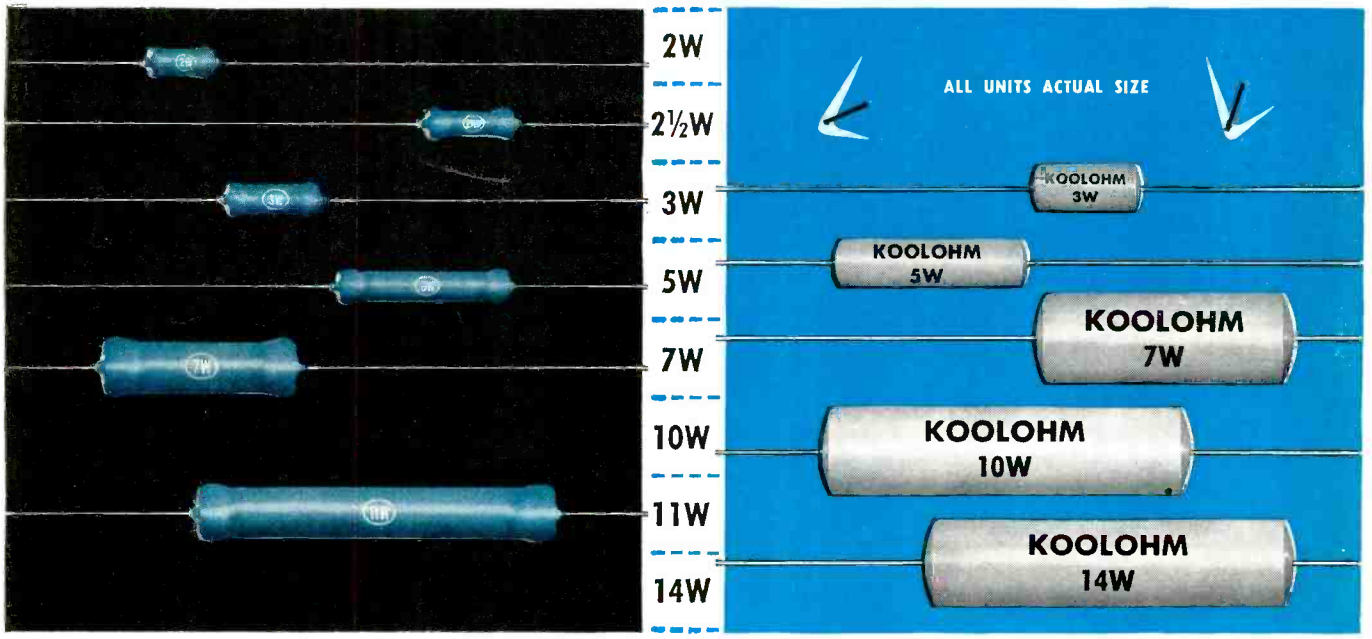
KOOLOHM®

INSULATED-SHELL POWER RESISTORS

New Koolohm construction features include welded leads and winding terminations—Ceron ceramic-insulated resistance wire, wound on special ceramic core—multi-layer non-inductive windings or high resistance value conventional windings—sealed, insulated, non-porous ceramic outer shells—*aged-on-load* to stabilize resistance value.

You can depend upon them to carry maximum rated load for any given physical size.

Send for Engineering Bulletin 7300 for complete technical data.



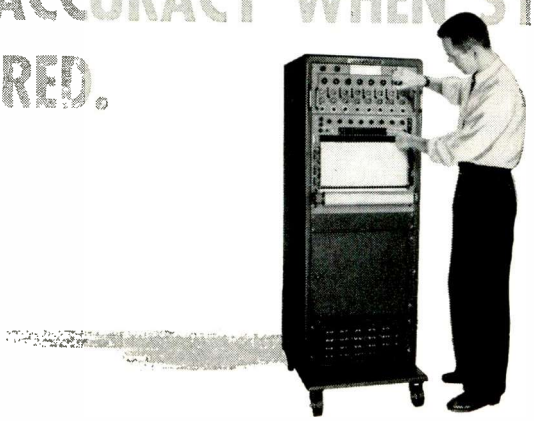
SPRAGUE ELECTRIC COMPANY

35 MARSHALL STREET • NORTH ADAMS, MASS.

SPRAGUE®
THE MARK OF RELIABILITY

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

THE PRACTICAL LOW COST ANSWER TO MULTI-CHANNEL OSCILLOGRAPHIC RECORDING PROBLEMS ··· SANBORN INTRODUCES THE FIRST OF THE 950 SERIES ··· THE 950-1500 SYSTEM ··· FOR FLOATING OR GROUNDED INPUTS FROM 10 μV TO 0.1 VOLT PER DIVISION ··· ALL-TRANSISTORIZED ELECTRONICS MOUNTED BEHIND A SINGLE 7" HIGH PANEL ··· FLUSH-FRONT RECORDER WITH 9 ELECTRICALLY-CONTROLLED CHART SPEEDS ··· IMPROVED, RUGGED GALVANOM-ETERS ··· CLEAR, INKLESS TRACES ··· RECTANGULAR COORDINATE RECORDINGS ··· ALL IN A SYSTEM DE-SIGNED SPECIFICALLY TO PROVIDE GREATER ECONOMY AND ACCURACY WHEN SYSTEM FLEXIBILITY IS NOT REQUIRED.



Additional features of the 950-1500 include: common power supply, built-in MOPA, front and rear inputs, easily serviced plug-in circuit cards, adaptability for use with other readout devices. When many channels are constantly in use for floating or grounded high gain inputs the simplified 950-1500 design assures dependable operation, yet at much lower "per channel" cost.

Complete details are available from Sanborn Sales-Engineering Representatives located in principal cities throughout the U.S., Canada and foreign countries.

SPECIFICATIONS

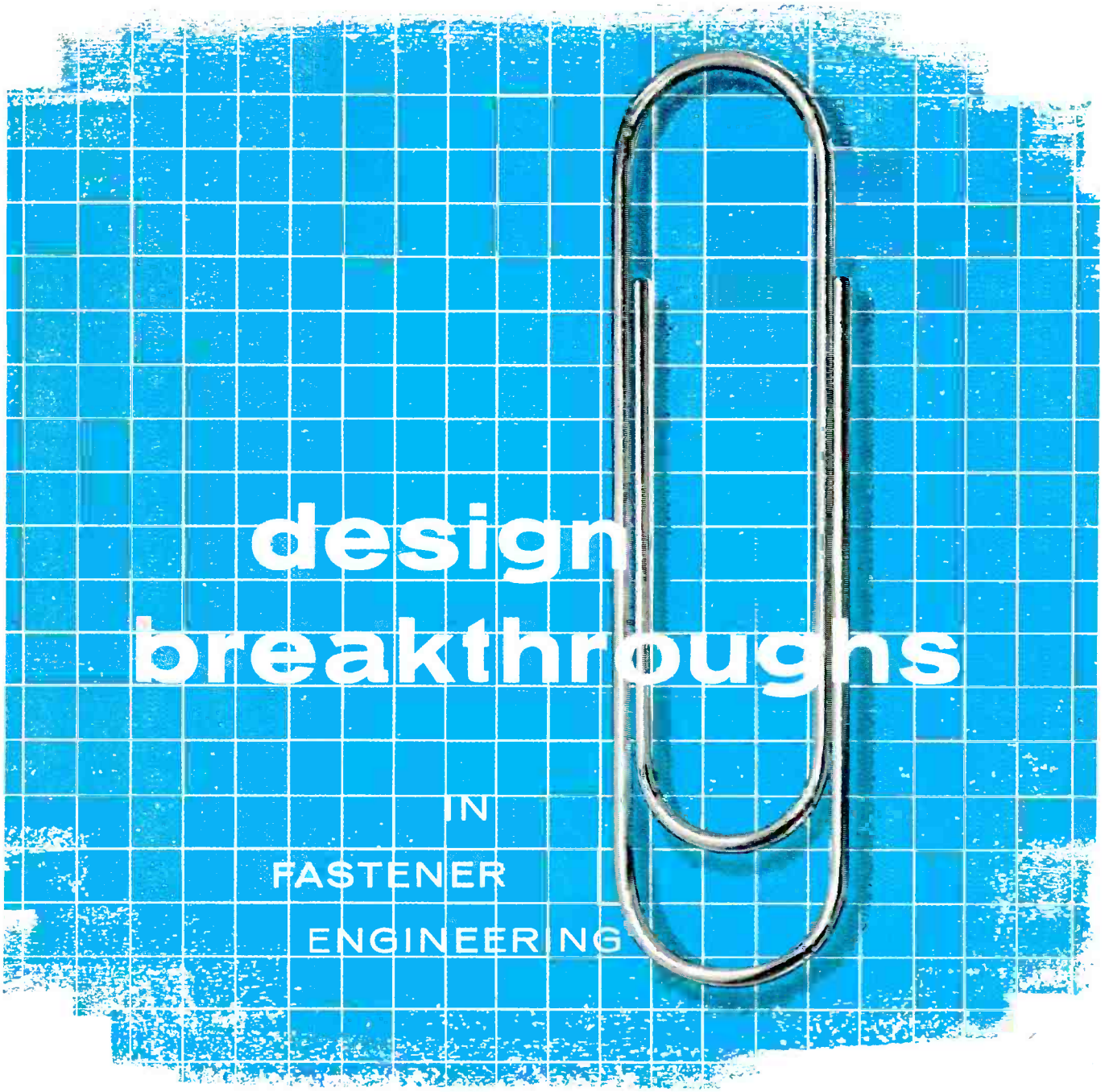
INPUT	100,000 ohms, all ranges, floating and guarded.
OUTPUT	400 ma. full scale, 15 ohms nominal load, ungrounded
LINEARITY	±0.4%
SENSITIVITY	10, 20, 50, 100, 200, 500, 1000 and 2000 uv per chart div
COMMON MODE REJECTION	100 db, min. dc
FREQUENCY RESPONSE	0-100 cps within 3 db at 10 div peak to peak. 0-50 cps within 3 db at 50 div peak to peak.
NOISE	¼ div peak to peak maximum.

(All data subject to change without notice)

NEREM '59 Comm. Armory, Boston, November 17, 18, 19.

SANBORN COMPANY

INDUSTRIAL DIVISION 175 Wyman Street, Waltham 54, Massachusetts



An important breakthrough in fastener design a good many years ago was the common paper clip. And, although DOT is not a manufacturer of paper clips, many a DOT industrial fastener has had an equally revolutionary effect on modern fastening technique. Hundreds of different DOT fasteners have created relatively minor revolutions in specific industries.

A DOT fastener may save a few man-minutes of labor. It may save material. Or it may improve product performance and hence saleability. But multiply each small improvement by the units in a true mass-production operation and the savings really pile up to impressive proportions.

Rather than spend your own design staff's time on fastening problems, it might pay you well to call in DOT. You'll have at your service a design and production organization with large-scale facilities for genuine mass-production of special-purpose fasteners and self-fastening devices of all kinds.

Supplementing the Carr Fastener Company are a number of other plants which form the United-Carr Fastener group. They are located in the principal production centers of the United States, Canada, England and Australia. Your nearest United-Carr field office (see below) is no further away than a telephone call from your desk.

MAKERS OF DOT FASTENERS

CARR FASTENER COMPANY

Division of UNITED-CARR Fastener Corp., Cambridge 42, Mass.

Offices In:

Atlanta, Boston, Chicago, Cleveland, Dallas, Detroit, Los Angeles, New York, Philadelphia, Syracuse

BROAD

with these convenient, precision

NEW AMPLIFIER!

Just clamp on probe and read current instantly!

hp 154A Voltage/Current Dual Channel Amplifier

SPECIFICATIONS

(When plugged into -hp- 150A/AR Oscilloscope)

CURRENT CHANNEL

Band Pass:	50 cps to 8 MC.
Sensitivity:	10 calibrated ranges, 1 to 1,000 ma/cm, 1, 2, 5, 10 sequence. Accuracy ± 5%. Vernier between steps (extends 1,000 ma/cm range to at least 2,500 ma/cm).
Max ac Current:	10 amperes rms 20 KC and above. Below 20 KC core saturation reduces current capability proportional to frequency.
Max dc Current:	Direct current to ½ amp has no appreciable effect.
Input Impedance:	Approx. 0.01 ohm shunted by 0.8 uh.

VOLTAGE CHANNEL

Band Pass:	dc coupled: dc to 10 MC, 0.035 μsec rise time. ac coupled: 2 cps to 10 MC, 0.035 μsec rise time.
Sensitivity:	9 calibrated ranges, 0.05 to 20 v/cm; 1, 2, 5, 10 sequence. Accuracy ± 5%. Vernier between steps.
Input Impedance:	1 megohm (nominal), 30 uuf shunt.

GENERAL

Vertical Presentation:	(1) Either voltage or current signal continuously or (2) voltage and current signals sampled at 100 KC or on alternate traces.
Vertical Position:	Each channel individually adjustable.
Price:	$430.00 (includes current probe).

The new hp 154A's exclusive "clamp-around" probe permits fast, direct measurement of current from 50 cps to 8 MC, 1 ma to 15 amperes (peak-to-peak) *without breaking into the circuit, loading, or voltage drop due to resistor insertion.* Here is a time-saving convenience feature of real significance in the investigation of transistors, logic circuits and other measurements where current information is of prime importance.

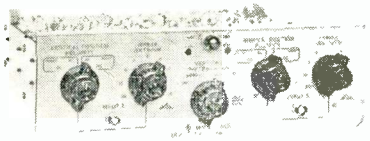
In addition, the 154A — actually two instruments in one—makes possible swift, simple and direct comparison between voltage and current waveforms. In this comparison service, one section of the 154A reads current while the other reads voltage in a manner identical with other hp voltage indicating instruments. Comparison is achieved by electronic channel switching—through alternate sweeps or 100 KC chopping. Either of the 154A's dual channels may also be used individually.

hp now offers better-than-ever service

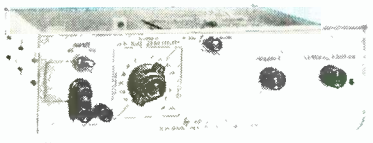
EN

the utility of your 150 A/AR oscilloscopes

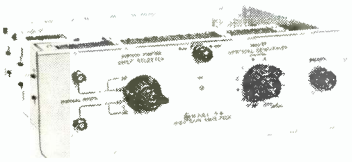
amplifiers and accessories



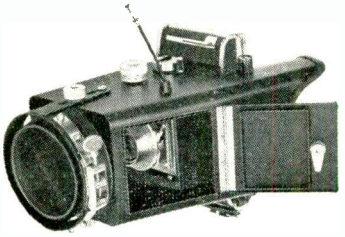
152B Dual Trace Differential Amplifier. New plug-in amplifier providing differential input and dual traces electronically switched between A and B channels at either 100 KC or on alternate sweeps. Sensitivity range 0.05 v/cm to 50 v/cm, input attenuator with 9 calibrated ranges in 1, 2, 5, 10 sequence and vernier. $250.00.



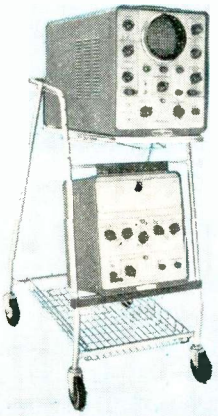
153A Very High Gain Amplifier. New plug-in permitting 150A to be used for many direct measurements from transducer without *preamplification*. Pass band dc to 500 KC, sensitivity 1 mv/cm to 125 v/cm, balanced input on all ranges. 15 calibrated ranges in 1, 2, 5, 10 sequence, 1 mv/cm to 50 v/cm; plus vernier. $125.00.



151B High Gain Amplifier. For 150A high gain unit with 5.0 mv/cm sensitivity, frequency response dc to 10 MC. 12 calibrated ranges on 1, 2, 5, 10 sequence, 5 mv/cm to 20 v/cm; accuracy ± 5%. Vernier adjustment. 1 megohm input impedance with 31 uuf shunt. Pass band rise time 0.035 μsec. Has 2 BNC terminals. $200.00.



196A Oscilloscope Camera. All new, most useful scope camera ever. Full-size, distortion free pictures; full picture area may be scaled. Simple multiple exposures; with one hand move lens through 11 detented positions. Pictures sharp, clear, compare to CRT resolution. Professional bellows prevents light leaks; easy tab pulling; set f-stop and shutter without removing camera from scope; mount on scope with one hand. Employs Polaroid® Land Camera back, new *flat* Wollensak 3" f/1.9 lens. Wt. 9 lbs. $425.00.



AC-115A Oscilloscope Testmobile. For 150 series oscilloscopes but fits others. 4" rubber tired wheels, heavy chrome tube construction, tilts 'scope to 30° in 7½° increments, folds for storage, shipping. $80.00 AC-116A Storage Unit fastens to AC-115A, holds 150A plug-ins or AC-117A Accessory Drawers. AC-116A, $22.50. AC-117A, $10.00.

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

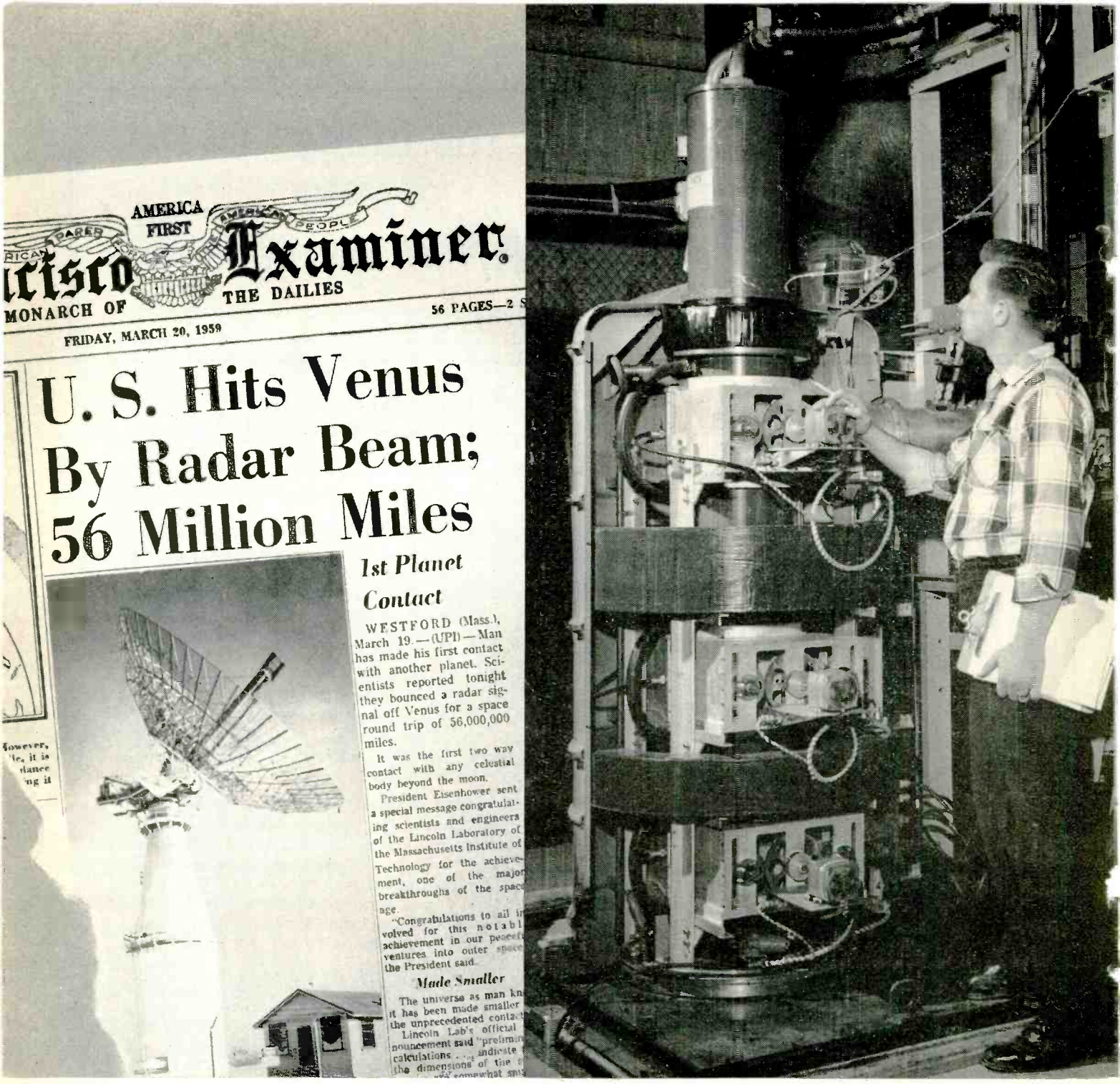
HEWLETT-PACKARD COMPANY

1002 Page Mill Road • Palo Alto, California, U.S.A.
Cable "HEWPACK" • DAvenport 5-4451
Hewlett-Packard S.A., Rue du Vieux Billard No. 1, Geneva, Switzerland
Cable "HEWPACKSA" • Tel. No. (022) 26.43.36

NOW! IN EUROPE!

In May, 1959, Hewlett-Packard S.A. was established in Geneva (a branch has since opened in Frankfurt am Main) offering technical sales and engineering help and information. Previously established relationships with representatives in other parts of Europe of course continue. In addition, there is a new - - warehouse in Basel stocking instruments and parts, and an - - factory near Stuttgart will soon be producing - - instruments for customers throughout Europe.

to our customers in Europe!



Eimac Klystron final amplifier at Millstone Hill Radar site.

EIMAC KLYSTRON POWERS VENUS CONTACT— 100 TIMES FARTHER THAN PREVIOUS RECORD!

On February 10 and 12, 1958, a high-power radar of M.I.T.'s Lincoln Laboratory transmitted and received radar signals between Earth and Venus. A round-trip of 56,000,000 miles! This historic event was man's first radio contact with another planet. It was by far the longest man-made radio transmission on record.

The final amplifier tube of this giant radar is a super-power Eimac Klystron, the same used in missile and satellite detection and tracking. Eimac's long experience and leadership in the development and manufacture of ceramic-metal power klystrons enabled the firm to design a super klystron capable of producing tremendous amounts of RF energy at the desired frequency.

In this application, as in tropo-scatter installations throughout the world, Eimac Klystrons have won a reputation for exceptional reliability and long life. Today Eimac manufactures power amplifier klystrons for ultra high and super high frequencies.

The transmitter for Lincoln Laboratory's giant radar was built by Continental Electronics Manufacturing Company. The radar was sponsored and is supported by the Air Research and Development Command of the United States Air Force.

EITEL-McCULLOUGH, INC.

Eimac

San Carlos • California

ELECTRONICS NEWSLETTER

TWO PARAMETRIC AMPLIFIERS under development at Bell Telephone Laboratories recently produced promising test results. In one a 40-percent bandwidth was achieved with a single lumped-element parametric amplifier, a type originally thought to be limited to relatively narrow-band use. Active element was a 10-13 micromicrofarad doubly diffused silicon diode. Device yielded 15-db gain at a center frequency of 500 mc. Another paramp designed at Bell Labs achieved an equivalent noise temperature of 20 K, comparable to a maser. Device used a gallium arsenide diode, operated at 6 kmc, and gave a bandwidth of 25 mc with a gain of 16 db. Diode was refrigerated to 90 K.

Midas early ICBM warning satellite will undergo R&D at a new Cape Canaveral facility. The satellite's infrared sensors will detect the extreme heat of missile firings. Midas is an Advanced Research Projects Agency program being executed by USAF's Ballistic Missile division, with Lockheed as prime contractor. Launchings will be made to prove vehicle design, electronic systems and subsystems, and to test ground equipment.

EUROPEAN AIR TRAFFIC CONTROL SYSTEM received British support at a recent meeting in Brussels of common market chiefs of civil aviation. A U. K. offer to join in study of legal, technical and other problems was regarded by common market spokesmen as "a new stage in European cooperation." The common market nations have discussed an agency to be called Eurocontrol, which would set up an electronic system to safeguard civil and military planes. The British desire to contribute to the project might stir new rivalry between British and American air traffic control schemes.

SYNCHRONOUS SINGLE SIDEBAND system for voice communications is coming into wide Air Force use following completion of word legibility tests. Suppressed carrier system—called Birdcall—was built by Collins Radio under Rome Air Development Center guidance. At USAF's Human Factors lab words read from ground and recorded aloft on magnetic tape were statistically evaluated for mean "legibility" and standard deviation. Results: higher mean legibility rate, lower deviation than obtained for a stock a-m system.

Minitrack stations will be operated for NASA in 1960 by Bendix Radio division of Bendix Aviation under a $2-million contract.

DOPPLER RADAR NAVIGATION SYSTEMS are being purchased in increasing numbers by the airlines for new jet aircraft. Trans-Canada Air Lines has ordered 11 Doppler systems from Collins Radio at a cost of $231,000. Installed in all six of TCA's ordered DC-8's, the system will relieve the navigator of some of his routine workload in connection with manual dead reckoning. New gear will be used with existing systems, and may reduce lateral separation between jets on North Atlantic routes. Delivery is slated for January, 1960. Airline has an option on purchase of 10 more systems as spares. Meanwhile, United Air Lines has placed an initial order for five Bendix DRA-12 Doppler radar navigation systems. Scheduled for almost immediate delivery, the systems will be installed on United's California-to-Hawaii DC-8 jet Mainliners which start service in January.

ELECTRONIC IRON LUNG weighing 56 pounds and able to run for 20 hours on built-in batteries has been used in 3,000 clinical cases in Britain. It was designed by two doctors and a medical technician at the Barnet group of hospitals near London. Patients are linked to the lung—dubbed the Barnet ventilator—by two plastic tubes. The machine is portable, can be used while patients are being moved, and may also be used in administering anesthetics. The lung will be manufactured next year on a large scale, said James Rochford, one of the inventors. He said it would sell for $1,075, less than half the cost of a conventional iron lung.

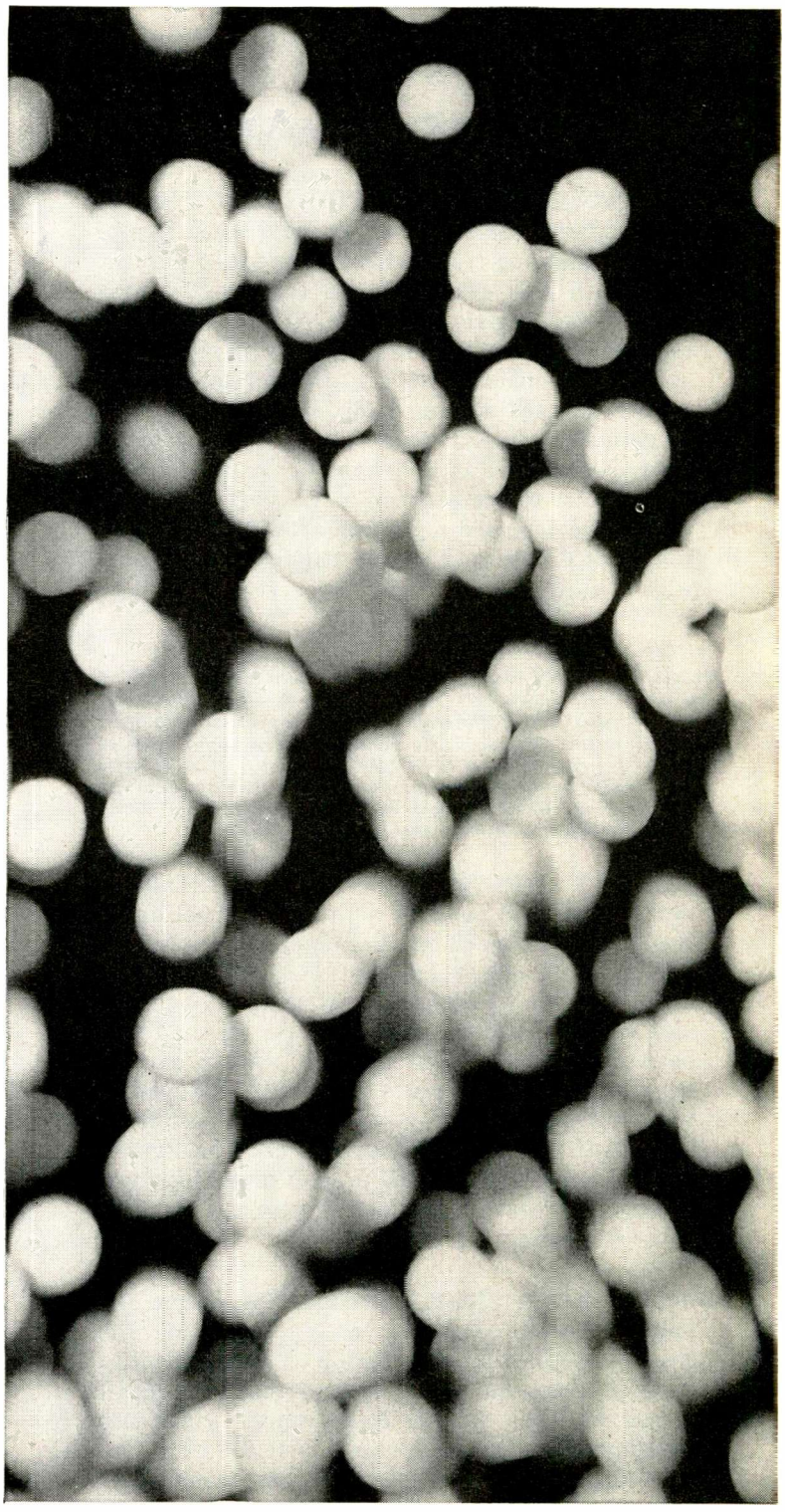
Transistorized single-sideband system for the Navy will be designed and developed by the Stromberg-Carlson division of General Dynamics under a $1.2-million BuShips contract.

AIRLINE RESERVATION SYSTEM using an advanced general-purpose computer is announced by American Airlines and IBM. Previous reservation systems used large-volume storage devices with relatively primitive control and indexing. The airline calls the system Sabre, expects that installation will be completed in 1962. AA and IBM have been working on development since 1953. The system, which the computermaker designates the IBM 9090, will use two IBM 7090's duplicated in a New York processing center, tied in with some 1,000 reservations desks and 10,400 miles of leased telephone lines.

SOLID-STATE AUTOMATIC PILOT is being developed by Bendix Aviation's Eclipse-Pioneer division which reportedly eliminates electronically-actuated mechanical devices. The company expects that new circuit developments will cut in half size, weight, power consumption and cost of tomorrow's flight control systems, with increased reliability too. Bendix believes such a system will tie in well with "the coming generation of airborne digital computing systems."

Take...

- forefront work essential to our National defense
- constant variety of interesting projects
- the academic atmosphere of a great University
- big Company orderliness plus small-group freedom
- inspirational elbow-rubbing with outstanding men
- a milieu free from dogma, time clocks, petty details
- "doing" as well as "thinking" projects
- stability, permanence, most fortunate living conditions
- leading institutions nearby for advanced degree work



Large-scale dynamical model of gas in operation

blend—and see why so many leading engineers and scientists come to and remain at

SYLVANIA MOUNTAIN VIEW OPERATIONS

on the San Francisco Peninsula

SYLVANIA MOUNTAIN VIEW OPERATIONS

occupy large, established facilities 45 minutes south of San Francisco in the Stanford-Berkeley scientific complex. They include

ELECTRONIC DEFENSE LABORATORIES — renowned quick-reaction electronic warfare capability, R&D and fabrication being performed by the Systems Engineering Laboratory, Equipment Engineering Laboratory, Advanced Analysis Department and Equipment Fabrication Facility.

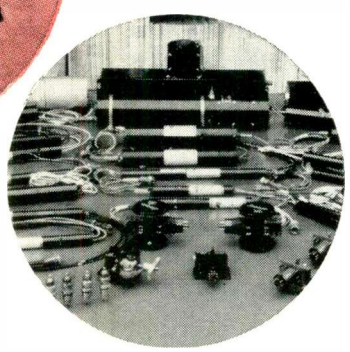
RECONNAISSANCE SYSTEMS LABORATORY — R&D on advanced ground and airborne reconnaissance systems involving antenna systems, receiving systems, data processing systems, related circuitry and hardware.

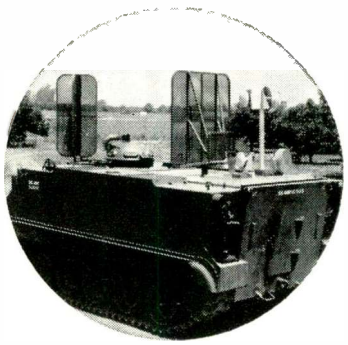
SPECIAL TUBE OPERATIONS — R&D and Product Engineering of microwave tubes and devices for missiles, radar, ECM, navigational devices. Includes the widely-known Microwave Physics Laboratory — research in plasma physics, ferromagnetic materials and gaseous electronics.

REWARDING ASSIGNMENTS NOW AT B.S., M.S., AND Ph.D. LEVELS IN

System Concept, Planning and Design . . . Receivers Transmitters . . . Digital Data Handling . . . Circuit Design Instrumentation . . . Product and Mechanical Engineering Electronic Packaging . . . Environmental Testing . . . System Integration and Evaluation . . . Theoretical and Experimental Physics . . . Microwave Tube Research, Development and Production . . . Solid State Physics . . . Sales Engineering . . . Engineering Writing

If your specialty appears above, your letter and resumé would be welcomed by Mr. Wayne Pearson at the address below. Why not write him tonight. Your answer will be prompt, complete and confidential.





SYLVANIA MOUNTAIN VIEW OPERATIONS

Box 188, Dept. B11, Mountain View, California

SYLVANIA

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

6129

WASHINGTON OUTLOOK

LATEST REALIGNMENT of this country's controversial space program—assigning the bulk of military projects to the Air Force and bolstering NASA's role in propulsion and in projects not tied to specific weapon systems—leaves one potential conflict area. The sore spot is communications satellites, a field which has both military and civilian utility.

Two agencies are active in the field of communications satellites. The Army now has responsibility for Project Notus to design and build a family of active satellites carrying aloft sending and receiving apparatus. The project was formerly under the supervision of the Pentagon's Advanced Research Projects Agency.

Project Notus has a $40-million budget this year, is likely to get even more in fiscal 1961. There are three phases to the project: Intercontinental point-to-point communication through a satellite delayed repeater technique; ground-to-air and ship-to-shore two-way communications through a satellite instantaneous repeater; and broadcast-type communications to ground and mobile units. Major contractors: Philco, GE, Bendix Aviation, ITT and Radiation, Inc.

NASA's communications satellites, in contrast, will be passive systems —inflatable spheres, without airborne equipment, which will serve as orbiting beam reflectors in space. A full-scale launching schedule is now getting under way.

- **Pentagon's ARPA will continue as a permanent agency** in charge of military-financed advanced scientific research. In essence it will serve as sort of a "Bureau of Standards" for all services.

  ARPA will continue as a source of business for the electronics industry, supporting work which is not distinctly the responsibility of any one service. A major area: advanced defenses against extra-atmospheric vehicles including space vehicles and ballistic missiles.

  ARPA's work against extraatmospheric vehicles is tabbed Project Defender and is geared toward exploration of fundamental phenomena, development of new systems concepts, and the application of new techniques—as contrasted with development or refinement of currently authorized systems such as the Army's Nike-Zeus.

  More than 50 programs now make up the project. Included are such programs as characteristics of the upper atmosphere radar development and GLIPAR (Guideline Identification Program for Antimissile Research). The latter is aimed to encourage what the Pentagon calls imaginative and bold approaches to antimissile defense.

- **A new rumpus is in the making** over the appointment of Charles L. Critchfield to head ARPA. He succeeds Roy Johnson, former GE vice president.

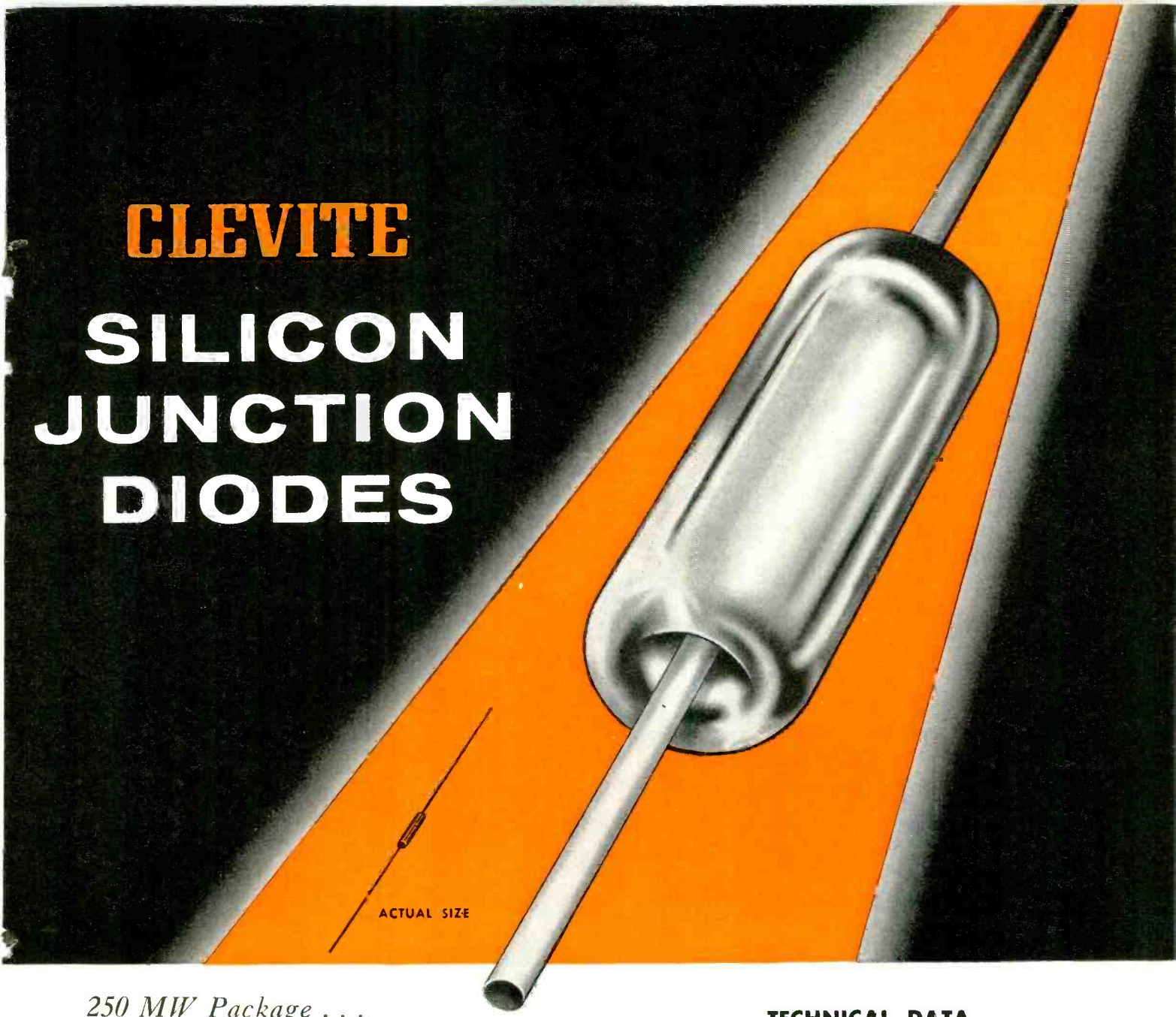
  Critchfield is director of scientific research for Convair. He will remain on Convair's payroll while heading ARPA. This is authorized under a 1951 law allowing the Pentagon to hire up to ten persons "of outstanding experience and ability" without compensation by the government. The objective has been to permit such men to continue earning private salaries in excess of civil service pay.

  Critchfield's new Pentagon slot is probably the highest ever to be filled under the scheme. The House government operations subcommittee is now studying whether a conflict of interests is involved. When the initial furor dies down, the Pentagon will probably be able to explain that there is no other way to get topnotch men to fill certain key Defense Dept. jobs and that the officials are not involved in contract-making or other functions directly involving their old companies.

CIRCLE 15 ON READER SERVICE CARD→

CLEVITE

SILICON JUNCTION DIODES



250 MW Package . . .
Fast Switching and JAN Types
Featuring . . .

- **MECHANICAL RELIABILITY** — Rugged, hermetically sealed, subminiature packages. Designed to meet both military and commercial requirements.
- **ELECTRICAL SUPERIORITY** — Excellent high temperature operation . . . thermally stable . . . high forward conductance . . . efficient rectification.
- **JAN TYPES** — IN457, IN458 and IN459 conform to JAN Specifications.

For details, write for Bulletin B217A-1 B217A-2

TECHNICAL DATA

Type	Max. DC Inver. Oper. Voltage	Forward Current @ Specified Voltage	Max. Inverse Current @ 25°C	Max. Inverse Current @ 150°C	Test Volts
IN457	60 V	20 ma @ 1.0 V	0.025 μa	5.0 μa	60 V
IN458	125 V	7 ma @ 1.0 V	0.025 μa	5.0 μa	125 V
IN459	175 V	3 ma @ 1.0 V	0.025 μa	5.0 μa	175 V
1N662	90 V	10 ma @ 1.0 V	20 μa	100 μa (@ 100° C)	50 V
1N663	90 V	100 ma @ 1.0 V	5.0 μa	50 μa (@ 100° C)	75 V
1N778	100 V	10 ma @ 1.0 V	0.5 μa	30 μa (@ 125° C)	100 V
1N779	175 V	10 ma @ 1.0 V	0.5 μa	30 μa (@ 125° C)	175 V

OTHER CLEVITE DIVISIONS:

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

Silicon Junction Diodes Germanium Diodes Power Transistors Solder Lug Power Transistors

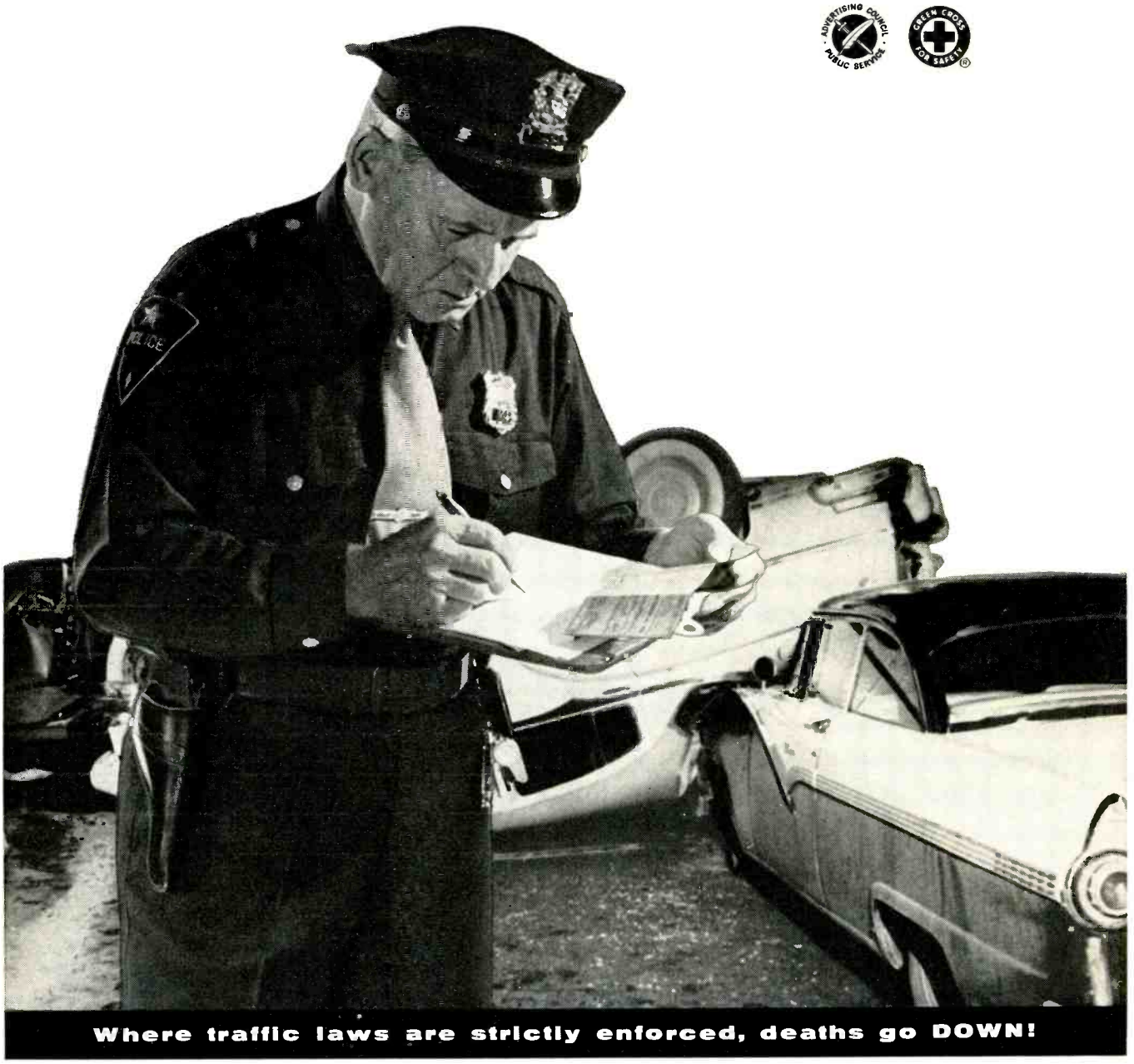
CLEVITE
TRANSISTOR PRODUCTS
241 CRESCENT ST., WALTHAM 54, MASS.
TWinbrook 4-9330

A DIVISION OF CLEVITE CORPORATION

Last year, traffic accidents killed 37,000, injured 1,400,000

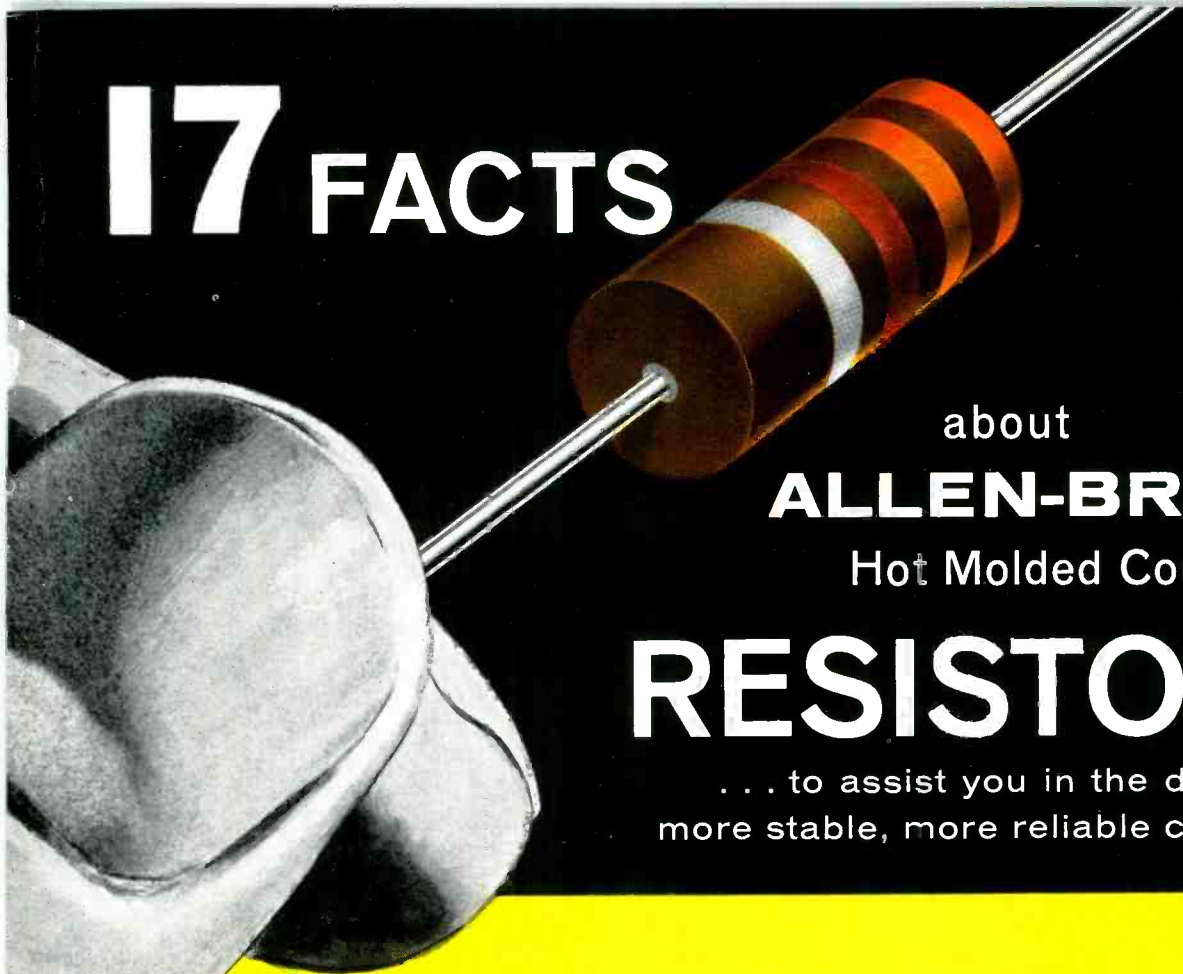
. . . and they wasted Five Billion Dollars!

Traffic accidents' human toll is so tragic we sometimes overlook their staggering economic waste. Five Billion Dollars in lost wages, medical expenses, insurance costs and property damage! Your business—every business—shares in this loss. So you have a double interest in helping reduce traffic accidents. And you *can* help! Drive safely and obey the law yourself . . . certainly. But go further. Use your influence to promote safe driving and urge strict law enforcement. To make your efforts more effective, join with others working actively to reduce traffic hazards in your community. *Support your local Safety Council!*



Published in an effort to save lives, in cooperation with the National Safety Council and The Advertising Council.

17 FACTS



about

ALLEN-BRADLEY

Hot Molded Composition

RESISTORS

. . . to assist you in the design of more stable, more reliable circuits

Circuit reliability is determined by the quality of the components and the understanding with which they are applied. A-B hot molded resistors are universally recognized for their quality and reliability. Here are 17 facts that will assist you with your design and development work.

1. Resistance changes due to humidity are temporary, but Allen-Bradley resistors can be returned to their original value by proper conditioning or "loading."

2. Resistance changes due to increase in moisture content are always positive.

3. Resistance change due to humidity varies with the resistance value and is less in the lower values.

4. Resistance change which has occurred due to humidity may be returned to the original value by conditioning the resistor at 100°C for 48 hours.

5. Resistors operating at 1/10 rated wattage load are hardly—if at all—affected by humidity.

6. Hermetically sealed resistors do not change because of humidity.

7. Resistance change due to "load life" is permanent and ultimately negative.

8. Resistance change due to "load life" can be minimized—on the order of 1% to 2% in many thousands of hours of service by derating the resistor approximately 50%.

9. This same result can be attained by limiting the maximum operating surface temperature of the resistor under load to 100°C.

10. Resistance change due to soldering is positive; but if the resistor is dry, it will return to its original value in a matter of hours.

11. The temperature characteristic of the Allen-Bradley resistor is positive above and below room temperatures between +10°C and +80°C ambient.

12. The temperature characteristic of the Allen-Bradley resistor is negligible from +10°C to +80°C ambient.

13. The voltage characteristic of the Allen-Bradley resistor is negative. It is less at elevated temperatures than at room ambient (+10°C to +80°C).

14. The voltage characteristic is less in low-value resistors than in high-value units—it is linear.

15. The voltage characteristic and the temperature characteristic tend to cancel one another in an Allen-Bradley resistor under average operating conditions where both voltage and temperature are present.

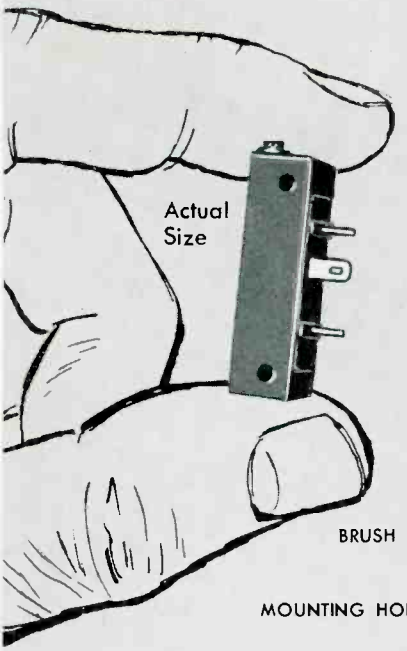
16. The "heat sink" to which a resistor is connected affects its rating. Resistors operated in parallel should be derated unless an adequate "heat sink" is provided.

17. The quality and reliability of Allen-Bradley resistors are exactly the same regardless of the "tolerances" for which the resistor is listed.

5-59-E

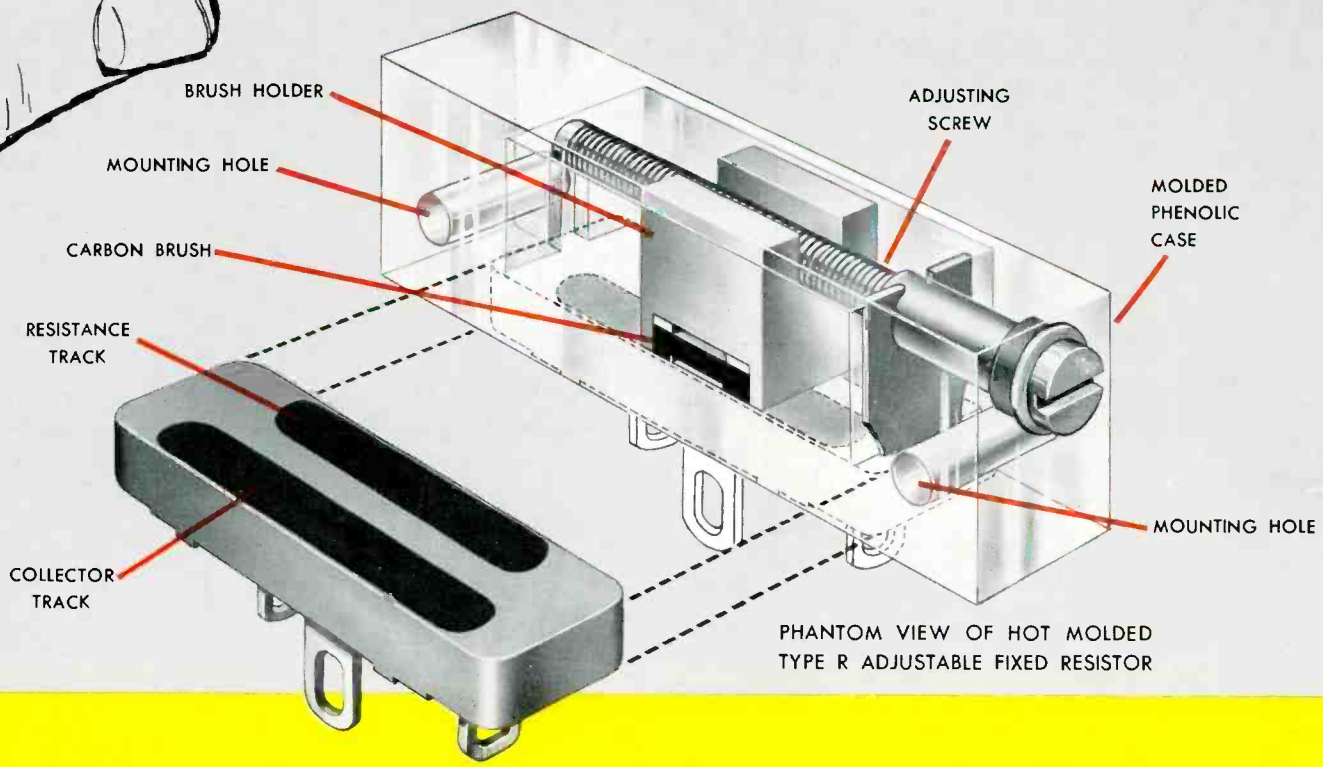
ALLEN-BRADLEY | *Quality* Electronic Components

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.



NEW ALLEN-BRADLEY

Adjustable Fixed Resistor



PHANTOM VIEW OF HOT MOLDED TYPE R ADJUSTABLE FIXED RESISTOR

Exclusive hot molded dual track resistance element and carbon brush give unmatched reliability and long life

SPECIFICATIONS

Power Rating: ¼ watt at 70°C ambient
Voltage Rating: 350 volts maximum
Temperature Range: −55°C to 120°C
Resistance Range: total resistance values from 100 ohms to 2.5 megohms ±10% or ±20%
Adjustment: approximately 25 turns
Dimensions: approximately 1¼" x 21/64" x ¼"
Terminals: lug and pin type terminals on 0.1" grid system and are gold plated for ease of soldering.

Here's a new, compact, adjustable fixed resistor—the Type R—with Allen-Bradley's exclusive hot molded resistance element. It's the same type resistance element used in the popular Type J and Type G units . . . which have proved unequaled for reliability and long life. Operation is exceptionally smooth—no abrupt resistance changes occur with adjustment. The molded case of the Type R adjustable fixed resistor is watertight and dust-tight. The mounting for the moving element is self-locking to assure stable setting—and the entire unit can be "potted" after adjusting. The adjustment screw has a "free wheeling" clutch to prevent damage.

Send for complete information on this latest addition to the Allen-Bradley line of *quality* potentiometers.

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

A-B QUALITY

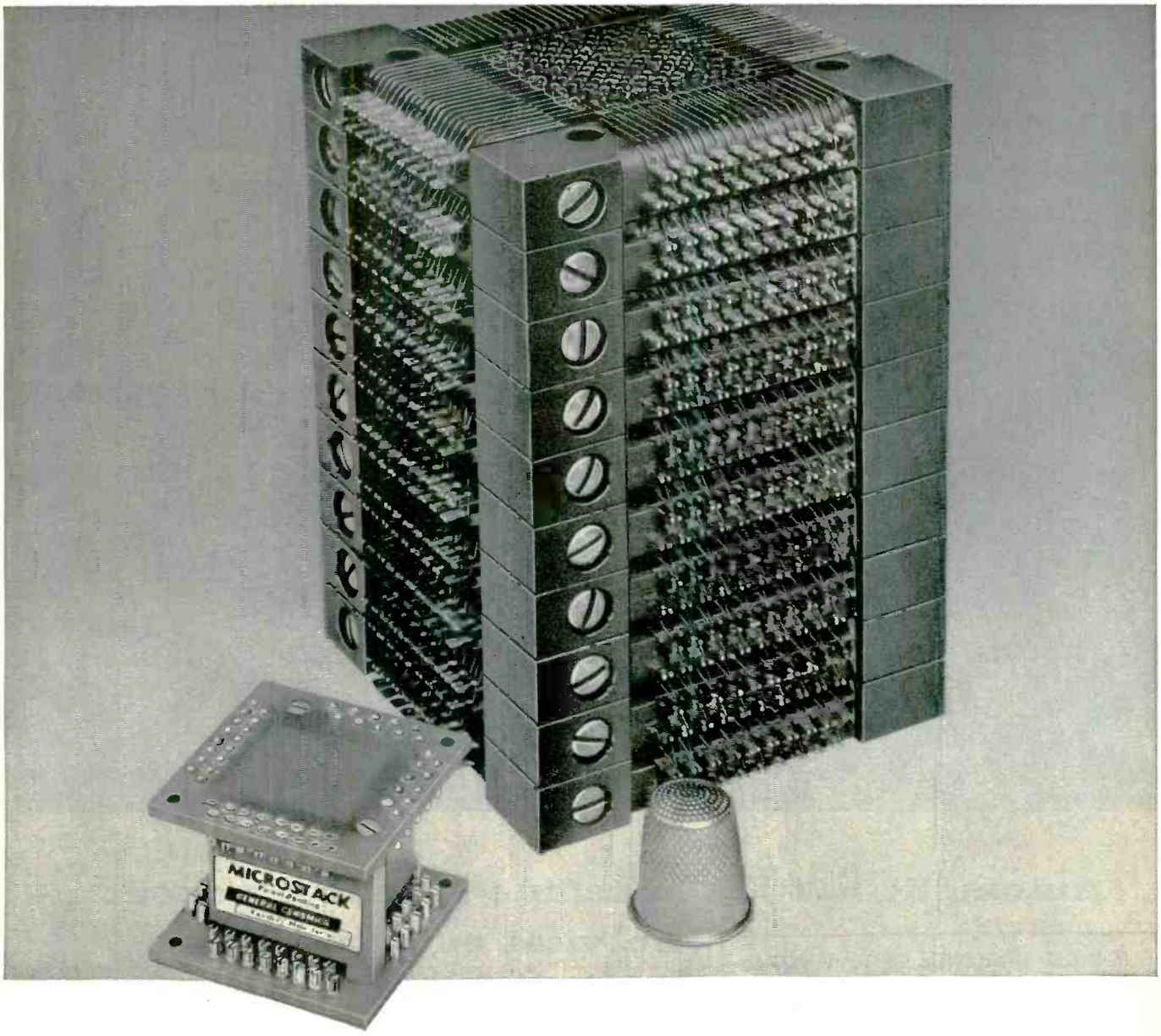
ALLEN-BRADLEY

QUALITY

ELECTRONIC COMPONENTS

5559-E

Designing in miniature?
Here's how to save space—



...90% of it!

New G-C MICROSTACK* for coincident current memory systems has a physical volume just 10% that of conventional stack. MICROSTACK shown with 2560 cores measures only 1.125″ x 1.4″ x 1.4″, a reduction in size from 3½″ x 3½″ x 5″.

This miniature stack consists of an array of 16 x 16 x 10. Solder connections are greatly reduced (from 1192 to 104), thereby substantially increasing reliability.

Noise level in the new MICROSTACK is as low as that of conventional types. The new MICROSTACK is available with all standard memory cores. Standard packages are available with coincident current wiring in 10 x 10 x 8, 16 x 16 x 8 and 32 x 32 x 8 arrays.

For further information, please write on company letterhead—address inquiries to Dept. E.

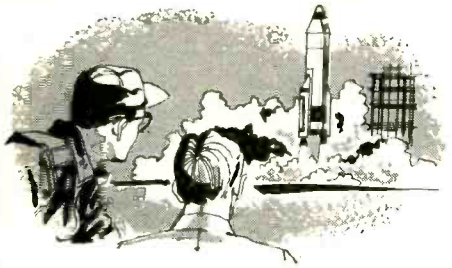
* Trademark

GENERAL CERAMICS
ORIGINATOR OF THE SQUARE LOOP FERRITE

General Ceramics Corporation
KEASBEY, NEW JERSEY, U.S.A.

Automatic Wire-Wrap® machine speeds production on vital military project

FOR THE CHALLENGE OF TOMORROW



Ever looking ahead to the challenge of tomorrow, Gardner-Denver men constantly seek new and better ways to cope with the growing complexity of industry and the resultant tough problems that lie ahead. At Gardner-Denver there's no substitute for men—our 100-year philosophy of growth.

To produce electronic equipment containing literally *thousands* of connections packed into a small space—that was the problem facing engineers recently on an important new military project. The solution came in the form of this unique "Wire-Wrap" machine—designed and built by Gardner-Denver.

Operated either manually or automatically by punched cards or tapes, the machine can place 10,000 wires on a 20″ x 20″ modular terminal board. It wraps all terminals for lastingly secure, solderless connections—in a 10″ x 10″ wrap area—and puts as many as three connections on each terminal, completing the entire wrapping cycle for one wire in approximately six seconds.

This is just one more example of special machines designed and built for *reliability*—by Gardner-Denver. If you have a special problem in multiple operations of connecting wires, drilling holes, or fastening screws and nuts, it'll pay you to talk to a Gardner-Denver special machines engineer. Ask for bulletins.

GARDNER-DENVER Since 1859 — 100 1959 YEARS

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

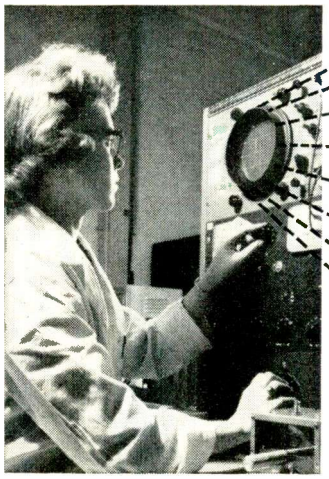
GARDNER-DENVER

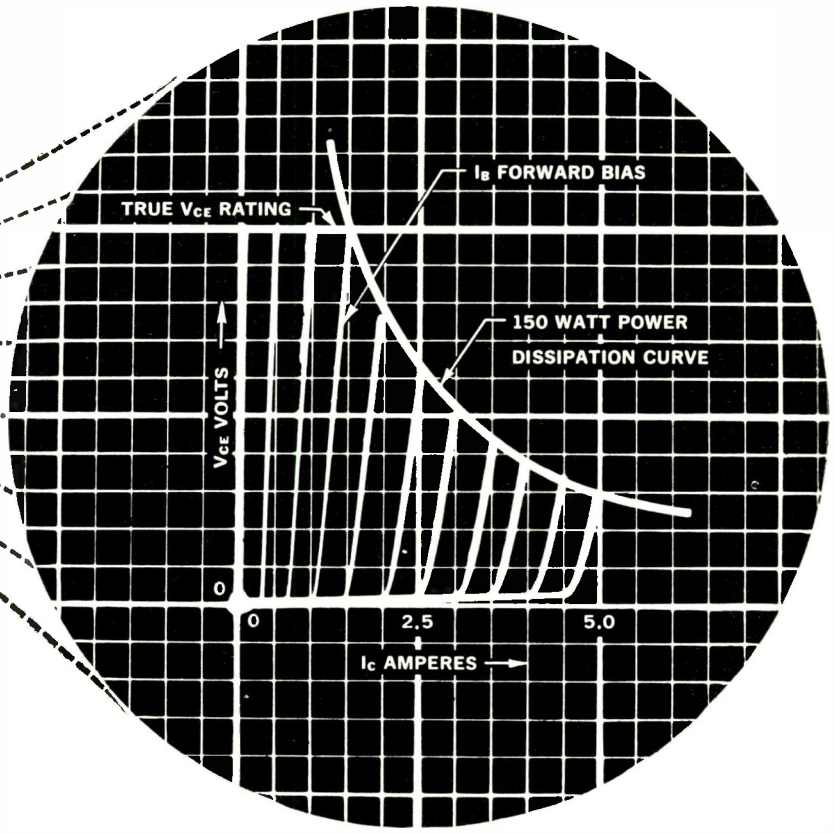
Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

WESTINGHOUSE SILICON POWER TRANSISTORS

2N1015
2N1016





TRUE VOLTAGE RATINGS

Guaranteed by 100% power testing

This Power-voltage Test consists of testing the transistor in common emitter configuration under all bias conditions in the area defined by the *TRUE* voltage rating of the transistor (V_{CE}); the constant power dissipation curve for the transistor (150 watts); and its rated current (2 amps for 2N1015 and 5 amps for 2N1016).

The voltage at which alpha equals one, and other voltage ratings commonly given for transistors such as V_{CES}, V_{CER}, V_{CEX} and V_{CBO}, are *above* the voltage rating given to these transistors.

Each Westinghouse silicon power transistor has been completely tested throughout its rated voltage-power-current region before shipping. Thousands of transistors performing under all types of operating conditions have proved the validity of this method of *TRUE* voltage rating.

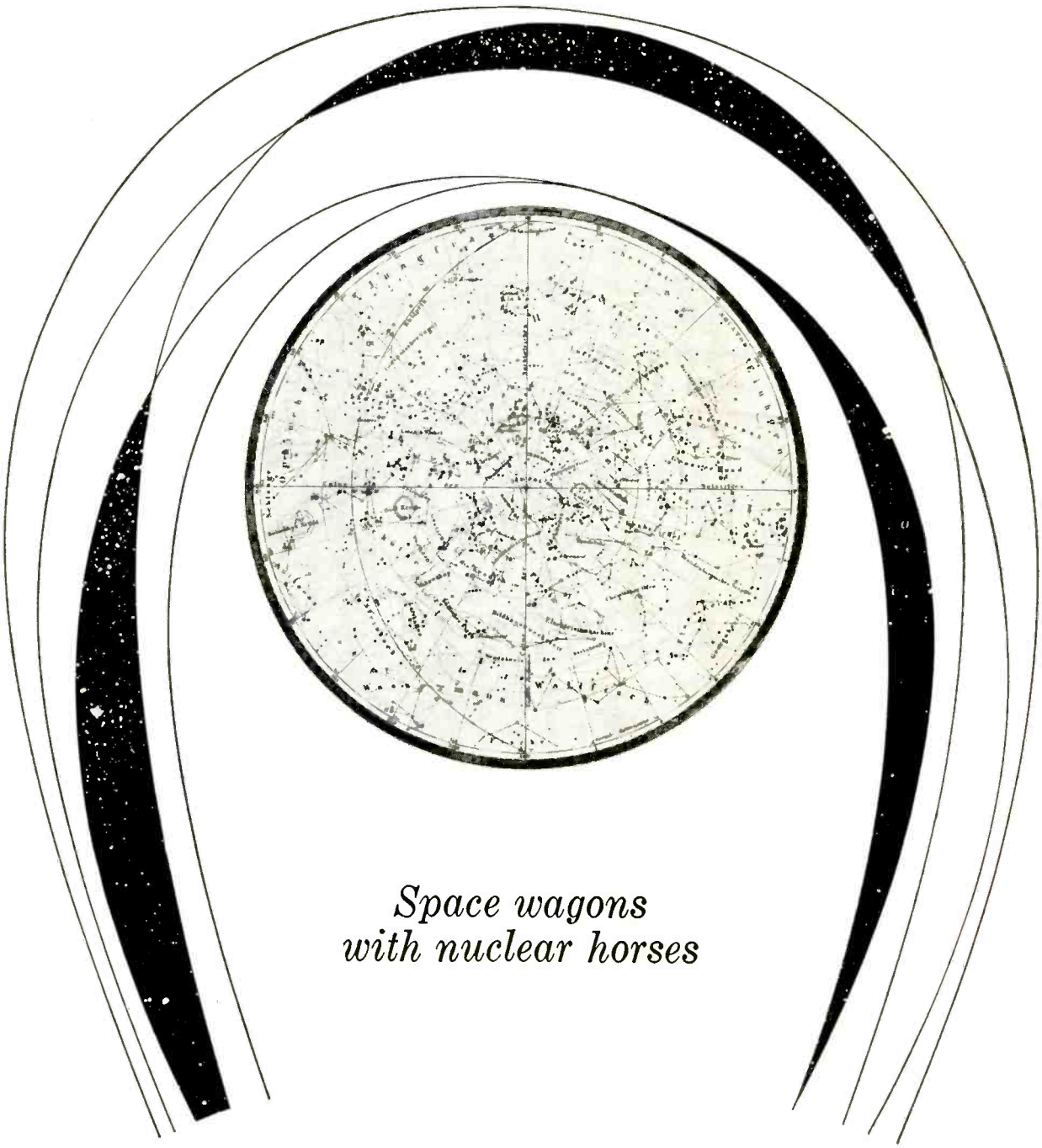
TRUE voltage ratings from 30 to 200 volts give you complete freedom in designing your equipment—you can operate Westinghouse silicon power transistors at the manufacturer's ratings without risking transistor failure. This *TRUE* voltage rating of Westinghouse silicon power transistors coupled with their still unequaled low saturation resistance and low thermal drop makes them an ideal first choice for military, industrial and commercial applications.

Type	V_{CE}*	B (min)	R_S (max)	I_C A (max)	T_J max. operating	Thermal drop to case (max)
2N1015 2N1015A 2N1015B 2N1015C 2N1015D	30 60 100 150 200	10 @I_C=2 amp	.75 ohms @I_C=2 amp I_B=300 ma	7.5	150°C	.7°C/W
2N1016 2N1016A 2N1016B 2N1016C 2N1016D	30 60 100 150 200	10 @I_C=5 amp	.50 ohms @I_C=5 amp I_B=750 ma	7.5	150°C	.7°C/W

*TRUE voltage rating (The transistors can be operated continuously at the V_{CE} listed for each rating.)

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

Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Pa.



Space wagons with nuclear horses

Space exploration will really come of age when manned rockets can leave earth, accomplish their missions and return without disposing of parts of themselves en route. This breakthrough depends on the rapid development of both nuclear rocket engines and space vehicles capable of using them. Douglas is putting forth a major research effort in the area of manned nuclear space ships. Every environmental, propulsion, guidance and structural problem is being thoroughly explored. Results are so promising that even if the nuclear engine breakthrough comes within the next five years, Douglas will be ready to produce the vehicles to utilize this tremendous new source of space power! Douglas is seeking qualified scientists and engineers for this and other vital programs. Some of our immediate needs are listed in the column on the facing page.

Elmer Wheaton, Engineering Vice President, Missiles and Space Systems, goes over new space objectives that will be made possible by nuclear propulsion with Arthur E. Raymond, Senior Engineering Vice President of DOUGLAS

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT

Merger Plans Under Study

MERGER PROPOSAL involving **Consolidated Electrodynamics Corp.**, Pasadena, Calif., and **Bell & Howell**, Chicago, is being studied by directors and shareholders of both companies. If the merger is approved, there will be a distribution of three additional B&H shares for each four held. Following this distribution, CEC shareholders will receive shares of B&H on a one-for-one exchange. Bell and Howell income last year was $59 million. CEC's was $32 million. CEC, which manufactures aviation and missile test gear, instrumentation and control systems and magnetic tape gear, employs about 3,000 people.

• **Daystrom Inc.**, Murray Hill, N. J., reports earnings for the six months and second quarter ended Sept. 30 at more than double those of the corresponding periods last year. Net income for the six-month period rose to $802,000 or 88 cents a share from $396,000 or 41 cents a share in 1958. Sales rose to $41,350,000 from $35,800,000 a year ago. Company officials expect to exceed earlier forecasts of about $85 million in sales for this fiscal year.

• **Telecomputing Corp.**, Los Angeles, announces purchase of **Monrovia Aviation Corp.**, Monrovia, Calif., a wholly-owned subsidiary of **Carrier Corporation.** Purchase price is understood to be in excess of $2 million. Annual sales of MAC, which manufactures aircraft subassemblies and ground support equipment, top the $5-million mark. The company has a backlog in excess of $4 million, employs about 450 persons in a plant occupying 156,000 sq ft of floor space.

• **Allen B. DuMont Labs**, Clifton, N. J., reports profits of $148,426 on sales of $5,482,681 for the sixteen weeks ended Oct. 11. For the first 40 weeks of 1959, on sales of $14,726,117, income of $30,754 was realized. This income will not be taxable because of DuMont's tax loss carry forward. Company officials point out the earnings mentioned do not reflect profit from the recent sale of its East Paterson, N. J., plant.

• **Clevite Corp.**, Cleveland, discloses net earnings of $2.51 a share for the first nine months of this year. Sales and other revenues brought in a total of $62,448,000. Both figures are new highs, according to company executives. In the same period of 1958, earnings were $1.08 a share and sales and revenues were $46,922,000.

• **Magnavox**, Ft. Wayne, Ind., also reveals new highs in income with a report that sales for the fiscal quarter ended Sept. 30 advanced 48 percent. This year's figure is $25,661,000, compared with $17,372,000 for the third fiscal quarter of 1958. Net income after taxes rose 72.3 percent over the $722,000 reported last year. This year's earnings for the quarter were $1.06 per share, compared with $0.61 for last year.

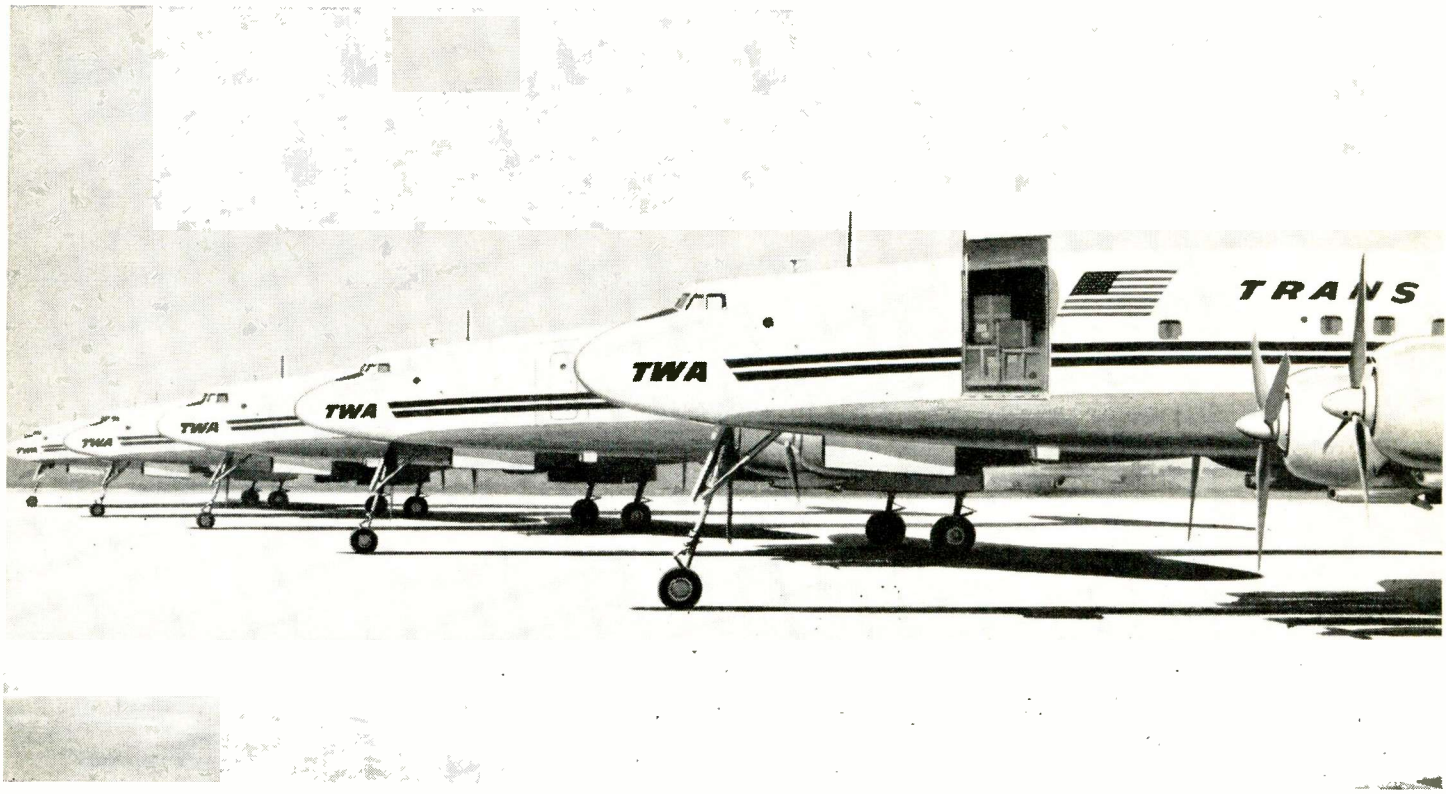
25 MOST ACTIVE STOCKS

WEEK ENDING NOVEMBER 6

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Lear	2,165	23¼	19½	20½
Elec & Mus Ind	1,696	9½	8½	9½
Muntz Tv	985	3⅞	2⅝	3½
Int'l Tel & Tel	745	38¼	37⅛	37⅜
Reeves Sndcrft	719	10⅝	8⅝	9¼
Zenith Radio	663	118½	107¾	111¼
RCA	628	65½	64	64½
Gen Dynamics	604	45½	43	44⅞
Sperry Rand	594	24⅛	22¾	23¼
Gen Precis Equip	528	50	47¼	50
Avco Corp	519	14⅛	13¼	13⅝
Gen Electric	500	82½	80¼	81¾
El-Tronics	469	1½	1⅛	1½
Burroughs	460	34⅜	32⅝	33¾
Gen Tel & Elec	453	76	71⅝	76
Varian Assoc	436	43¼	40¼	40⅞
Admiral Corp	435	22⅜	21	21½
Univ Control	394	17½	16¼	16¾
Dynamics Corp Amer	351	10¾	9⅝	10
Clarostat Mfg	347	11	9¾	10½
Raytheon	326	52¾	48⅞	50
Philco Corp	324	26¼	24⅝	24¾
Westinghouse	271	99⅜	97⅜	97⅜
Ampex Corp	270	111¼	104	107½
Gen Transistor	244	38½	36	37⅛

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

TWA'S EXPANDED ADDS MORE FLIGHTS...

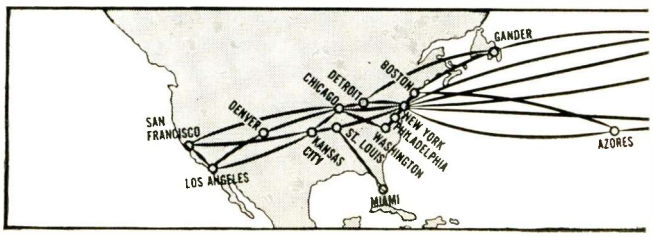


Larger, faster Super Sky Merchant Fleet provides more

• **Across The U.S.A.,** TWA's expanded Super Sky Merchant Fleet adds more flights . . . offers more service with great, all-cargo Super-H Constellations, to provide the most widely scheduled air freight service. Daily service to New York, Philadelphia, Pittsburgh, Columbus, St. Louis, Kansas City, Chicago, Los Angeles and San Francisco.

• **Overseas to Europe,** TWA's new Super Sky Merchants now offer four transatlantic flights each week to provide service to Shannon, London, Frankfurt, Paris, Zurich, Geneva, Milan, Rome.

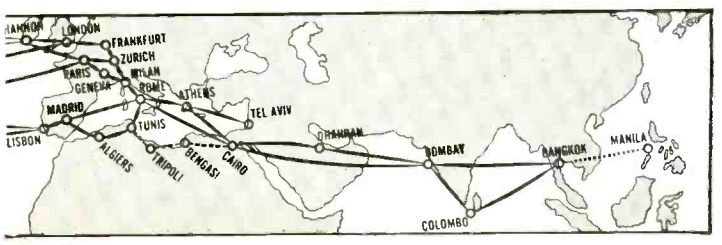
Whenever—whatever you ship, specify TWA. Call your Freight Forwarder or your nearest TWA Air Freight office today.



SKY MERCHANT FLEET OFFERS MORE SERVICE!

widely scheduled air freight service than ever before

- **Huge Cargo Doors** permit handling of extra-length items, and make it possible to load bulky machinery and equipment without disassembling.
- **Pressurized** and temperature-controlled cabins mean almost anything goes by TWA—from live animals and perishables to delicate electronic equipment.
- **Spacious Compartments** and reinforced flooring do away with almost all restrictions on the weight and size of your shipments.



SHIP THE FASTEST WAY

SHIP TWA

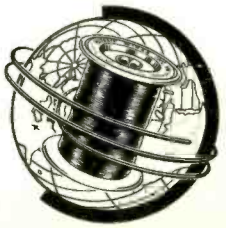
USA · EUROPE · AFRICA · ASIA

NIKE HERCULES

With deadly accuracy the U.S. Army's new Nike Hercules ground-to-air guided missile streaks out to meet an approaching enemy air force. Its nuclear warhead can wipe out an entire formation.

Western Electric selected Teflon* insulated wire for use in building the alert guidance and control systems of this faster, higher climbing Nike.

As leading specialists in high temperature insulated wires and cables, the men and women at Hitemp are proud of this choice, and the role Teflon wiring plays in giving America a strong new perimeter of defense.



HITEMP WIRES, INC.

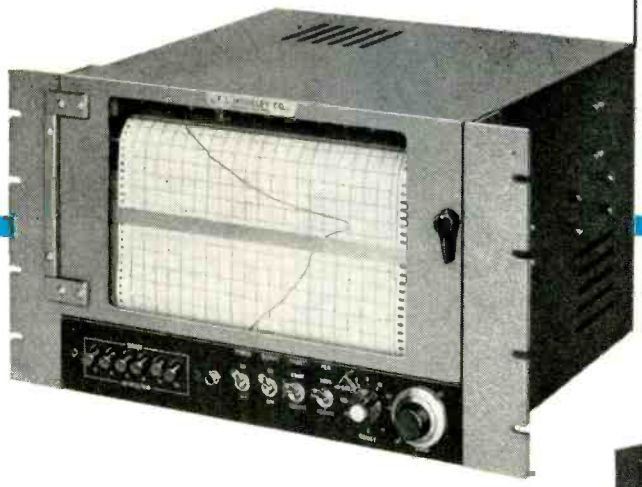
1200 SHAMES DRIVE, WESTBURY, NEW YORK

*Du Pont's trade name for Tetrafluoroethylene

AUTOGRAF • AUTOGRAF • AUTOGRAF

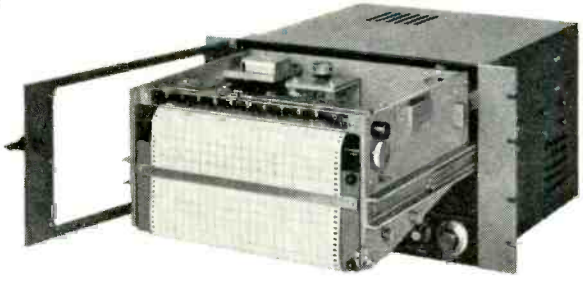
Ever see a NEW STRIP-CHART RECORDER that offered you all this:

- 6 push-button variable chart speeds
- Transistor speed switching; no gears
- 0.05% full scale sensitivity
- 0.2% resolution and accuracy
- Local or remote chart or pen control
- Continuous span voltage, 5 mv to 100 v

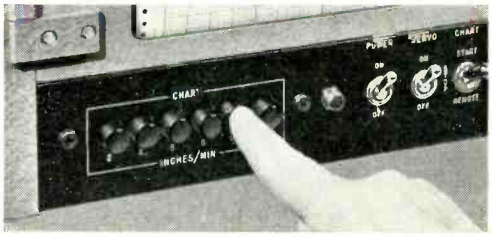


The all-new Moseley Model 80A Strip-Chart Recorder is a precision instrument providing greater versatility and convenience than any commercial strip-chart recorder previously available.

Model 80A gives you instant selection — through transistor switching — of 6 chart speeds. All other function controls are grouped in a newly convenient array on one front panel. The input range of 5 mv to 100 v is covered in 10 steps, or by vernier for completely continuous span voltage control. Input resistance is 200,000 ohms/v through 10 v, 2 megohms on higher ranges. Full range zero set, pen speeds to 0.25 sec full scale, chopper amplifier, standard 120′ rolls. For 19″ relay rack. $1,750.00.



Glass door protects chart; ball-bearing carriage rolls out for easy chart or circuit access



Six chart speeds, 2, 4, 6, 8, 15 and 60 in/min selected instantly by front panel push buttons.

NEW! TYPE F-2 LONG-STRIP CURVE FOLLOWER

New-concept curve follower tracks, converts ordinary recorded trace to electrical energy; requires no metallic inks or re-drawing. Employs unique photoelectric-oscillating mirror principle; permits digital output for tapes, cards, etc.

SEE YOUR MOSELEY REPRESENTATIVE OR WRITE DIRECT FOR DETAILS

Pioneer and leader in X-Y and Strip-Chart Recorders

AUTOGRAF recorders

F.L. MOSELEY COMPANY
Dept. A11, 409 N. Fair Oaks Ave., Pasadena, California
MUrray 1-0208 TWX PASA CAL 7687
Field representatives in all principal areas
6076

On the Market . . .

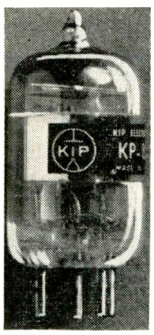
COINCIDENCE THYRATRON

double or triple control

The KP-80 is the first ion deflection thyratron. It is a triple control coincidence tube which greatly simplifies control circuitry. The tubes have three control electrodes for *double-* or *triple-*coincidence circuit functions.

The tubes are used in computers, automation control apparatus, conveyor selector systems, coding and programming devices, counters, etc.

In addition to the customary shield, there are two symmetrical control electrodes which have equal sensitivity. In double-control circuits, a signal on only one grid (up to and exceeding plus 40 volts) will not fire the tube, but small (4.5 volt) simultaneous signals on both grids cause conduction. In triple control circuits, three simultaneous signals are required for conduction and signals (up to 20 volts) applied to any one or two grids will not fire the tube. More than a dozen circuit components are eliminated by the KP-80 in double control circuits, and triple coincidence circuits eliminating more than two dozen precision components are also possible. The KP-80 has a 6.3 volt, 150 mA heater cathode, with an anode operating voltage of 150 v.



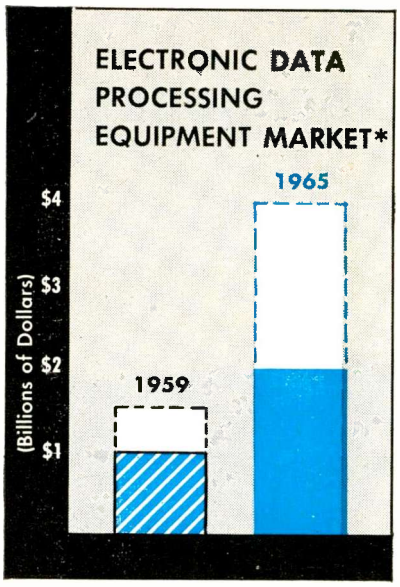
Actual Size

A subminiature tube, the KP-150 is also available for double coincidence and indicating circuits.

For further details on these and other Special Purpose Electron tubes contact KIP ELECTRONICS CORPORATION, DEPT. 922, BOX 562, STAMFORD, CONNECTICUT.

MARKET RESEARCH

Data Processing Sales Rise Seen



*Includes general and special-purpose computers and auxiliary equipment sold to industrial, commercial, military and other government agencies. White areas in bar chart columns cover range of estimates

OUTLOOK for electronic data processing equipment business is bright, sales estimates cited by two edp manufacturers indicate.

Market for edp equipment amounts to more than $1 billion today, says Robert E. Lewis, president of Sylvania Electric Products, subsidiary of General Telephone & Electronics. "Moreover, by 1965 the market should at least double to $2 billion and keep rising," Lewis adds.

IBM marketing executive William G. Stevenson, at a recent Pacific Coast Investment Forum, cited a survey which claims the edp market will grow from an estimated $1.5 billion in 1959 to $4 billion in 1965. By 1970 the market will grow to $7 billion, according to the survey.

Sylvania's Lewis, in support of his claim that edp is on the threshold of a period of major expansion, pointed to the establishment of the computer as an essential tool in such defense projects as missile and satellite research.

He also said there is a growing realization within industry that automatic data processing can extend vital business procedures systems to a degree of skill, speed and effectiveness that has never been even remotely achieved to date.

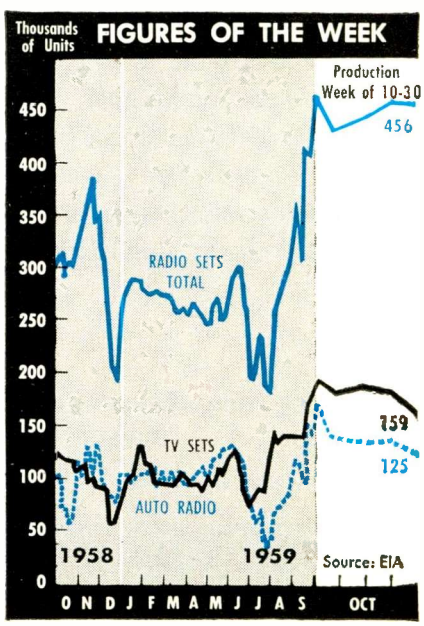
IBM's Stevenson said improved systems knowledge can expand the computer industry's sales volume 10 to 20 times that of today's level. "The rate of growth in computer use will depend much less on the speed of technological advance in computer design," Stevenson said, "than on our ability to apply computers efficiently and imaginatively."

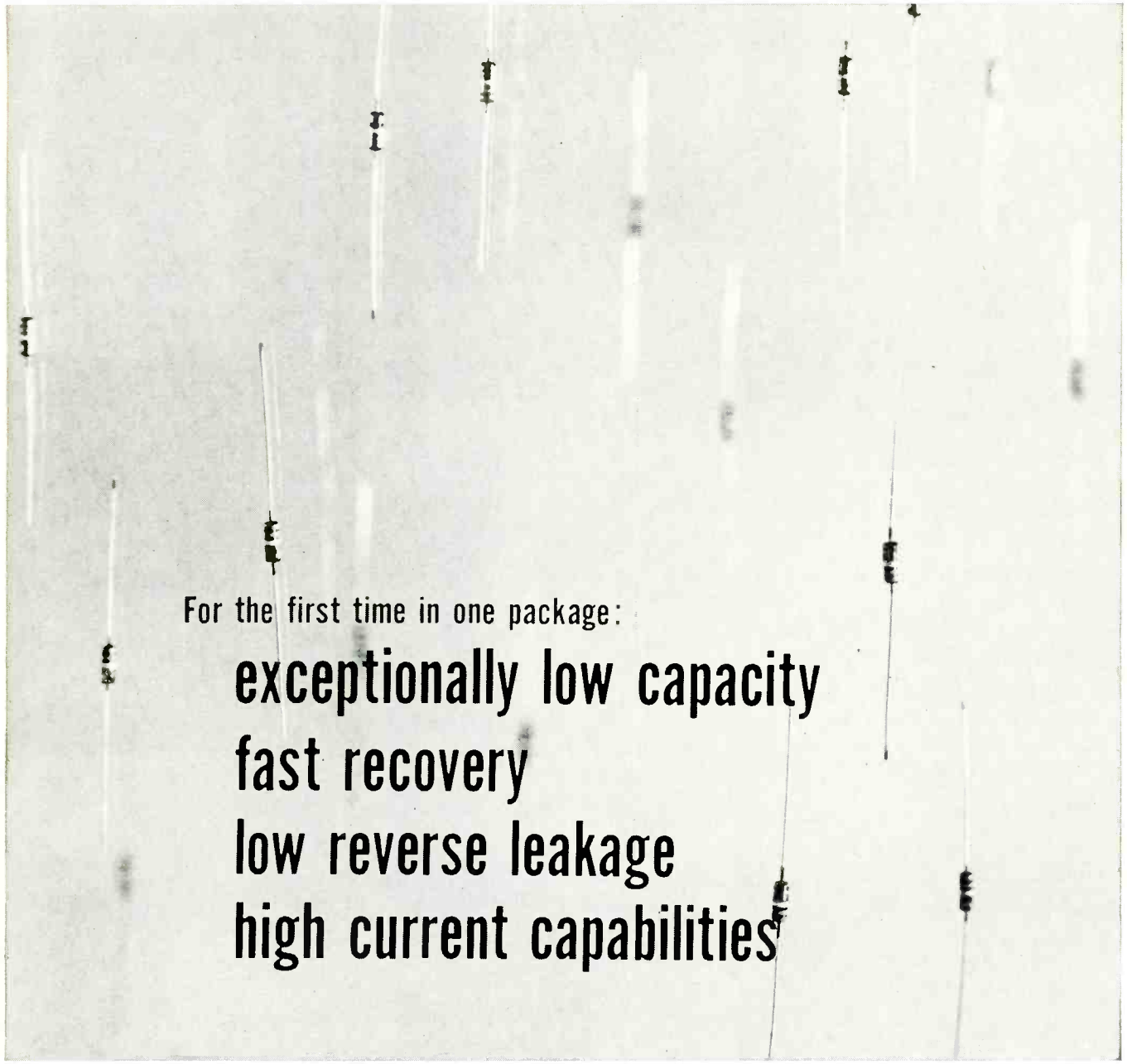
Lists Developments

Development of check handling equipment through cooperation of the banking industry and computer manufacturers, work with airlines on reservation control systems, and development of electronic data processing systems for national brokerage houses, are outstanding examples of recent systems development work which were cited by Stevenson.

ELECTRONICS estimates this year's edp market will amount to about $1.25 billion. Some manufacturers say the $4-billion level will be hit in 1970 rather than 1965.

In any case, no manufacturer feels the market will stand pat. Opinions vary only on the pleasant side: how big will the expansion be?





For the first time in one package:

exceptionally low capacity
fast recovery
low reverse leakage
high current capabilities

100 mA Min. @ 1V Forward Current...0.3 μsec recovery...4 μμf at −2V... that's what you get with the new Hughes computer diodes. With these characteristics, *these diodes will cover practically every major computer switching requirement.*

You can always count on them for top performance. Hermetically sealed in glass envelopes, these Hughes computer diodes have been engineered for extreme reliability under adverse environmental conditions.

For additional information concerning these unique Hughes diodes call or write the Hughes sales office nearest you. They are located at:

Boston, *4 Federal Street; Woburn, Mass.; WOburn 2-4824*
Newark, *80 Mulberry Street; Newark 2, N. J.; MArket 3-3520*
San Francisco, *535 Middlefield Road; Palo Alto, Calif.; DA 6-7780*
Syracuse, *224 Harrison Street; Syracuse 2, N. Y.; GRanite 1-0163*
Chicago, *6120 West North Ave.; Chicago 39, Ill.; NAtional 2-0283*
Philadelphia, *1 Bala Avenue; Bala-Cynwyd, Penn.; MOhawk 4-8365*
Los Angeles, *690 N. Sepulveda; El Segundo, Calif.; OR 8-6125*

Or write, Hughes Products, Marketing Department,
SEMICONDUCTOR DIVISION, NEWPORT BEACH, CALIFORNIA.

TYPICAL SPECIFICATIONS:

Type	Min. E_S (@ 100μA)	Min. Forward Current @ 25°C (@ +1.0V)	Max. Reverse Current (μA) @ 25° C	@ 100° C	Reverse Recovery* Reverse Resistance (R) (ohms)	Maximum Recovery Time (μsec)
1N840	50	150	0.1 @ 40V	15 @ 40V	400 K	0.3
1N837A	100	150	0.1 @ 80V	15 @ 80V	400 K	0.3
1N841	150	150	0.1 @ 120V	15 @ 120V	400 K	0.3
1N843	250	150	0.1 @ 200V	15 @ 200V	400 K	0.3
1N844	100	200	0.1 @ 80V	15 @ 80V	400 K	0.5
1N845	200	200	0.1 @ 160V	15 @ 160V	400 K	0.5

*Measured in JAN test circuit and switched from 30mA forward current to −35V.

TYPICAL CAPACITANCE: C_{-10} = 2.2μμf $C_{-1.5}$ = 4.4μμf C_{-0} = 9.0μμf
Operating Temp. Range: −65°C to +150°C Storage Temp. Range: −65°C to +200°C

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

SEMICONDUCTOR DEVICES · STORAGE AND MICROWAVE TUBES · CRYSTAL FILTERS · OSCILLOSCOPES · RELAYS · SWITCHES · INDUSTRIAL CONTROL SYSTEMS

HUGHES FAMILY OF DIRECT-VIEW STORAGE TUBES

World's most complete line of storage tubes!

TONOTRON® TUBE: displays full range of grey scale images for daylight viewing. Ideal for weather radar, PPI presentations, "B" scan projections and other complex radar systems.

MEMOTRON® TUBE: displays successive transients until intentionally erased. Permits direct comparison and analysis of wave forms without photography.

TYPOTRON® TUBE: displays any combination of 63 symbols or characters at speeds to 25,000 per second. Retains presentation until intentionally erased.

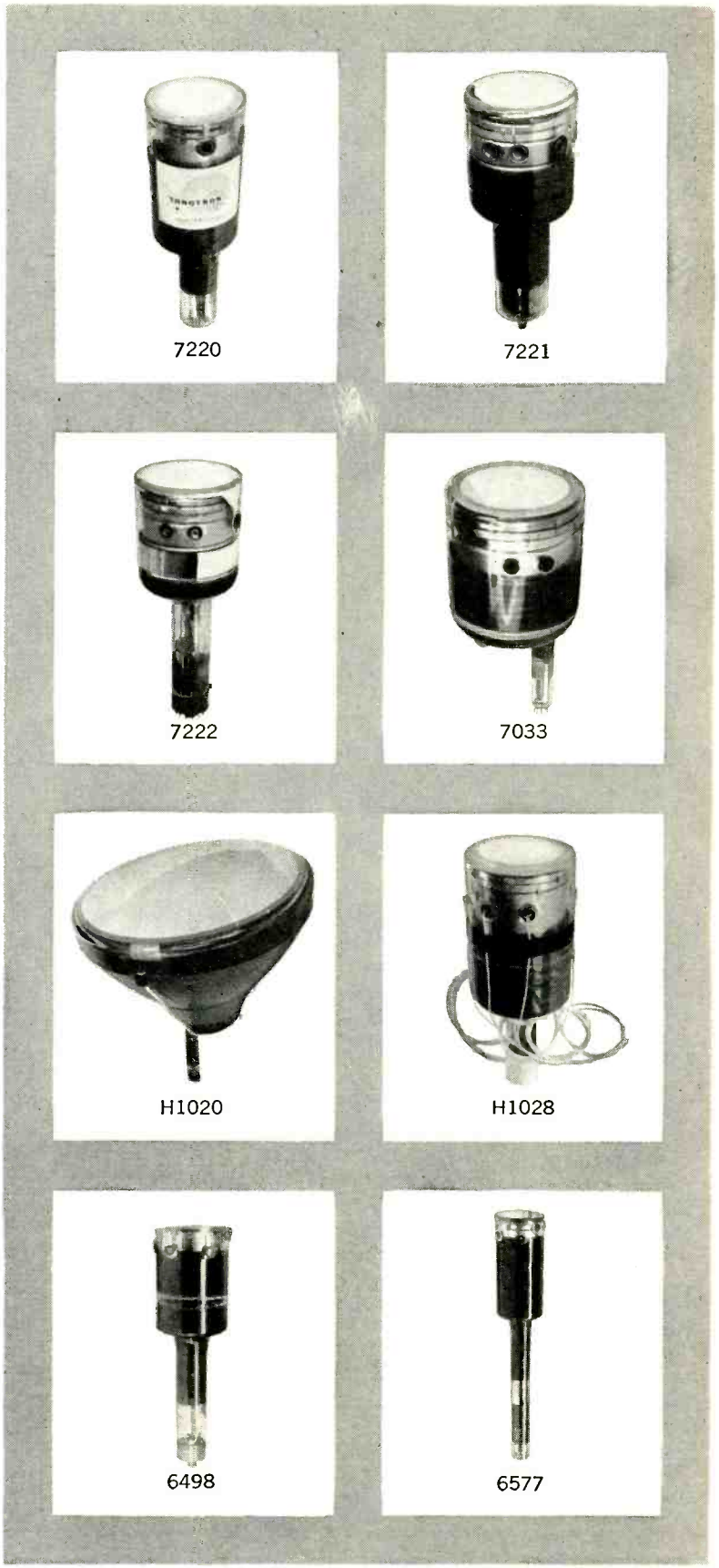
STORAGE TUBE CHARACTERISTICS

7220 TONOTRON TUBE Screen diameter: 3″ Standard phosphor: P1 Deflection: Electrostatic	7221 TONOTRON TUBE Screen diameter: 5″ Standard phosphor: P20 Deflection: Electrostatic
7222 TONOTRON TUBE Screen diameter: 5″ Standard phosphor: P20 Deflection: Electrostatic	7033 TONOTRON TUBE Screen Diameter: 5″ Standard phosphor: P20 Deflection: Electromagnetic
H1020 TONOTRON TUBE Screen Diameter: 21″ Standard phosphor: P20 Deflection: Electromagnetic	H1028 TONOTRON TUBE Screen diameter: 4″ Standard phosphor: P1 Deflection: Electrostatic
6498 MEMOTRON TUBE Screen Diameter: 5″ Standard phosphor: P1 Deflection: Electrostatic	6577 TYPOTRON TUBE Screen diameter: 5″ Standard phosphor: P1 Deflection: Electrostatic

9 additional TONOTRON tubes and 4 additional TYPOTRON tubes available.

For full and complete information on how Hughes storage tubes may fill your particular needs and applications, write or wire: HUGHES PRODUCTS, Electron Tube Division, P.O. Box 90427, International Airport Station, Los Angeles 45, California.

For export information, write: HUGHES INTERNATIONAL, Culver City, California.



ELECTRON TUBE DIVISION

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

SEMICONDUCTOR DEVICES • STORAGE TUBES AND DEVICES • MICROWAVE TUBES • VACUUM TUBES AND COMPONENTS • CRYSTAL FILTERS • MEMO-SCOPE® OSCILLOSCOPES • INDUSTRIAL CONTROL SYSTEMS

VTP's FAMILY OF SPECIALIZED CRTs

World's finest special-purpose tubes in production quantities!

Do you need tube characteristics which will enable you to tighten your "specs"? Or, have you a particular tube application demanding high operating performance with extreme reliability under difficult environmental conditions? If so, Vacuum Tube Products can supply you with specialized CRTs in production quantities to fill your most exacting requirements.

VTP's broad experience, unmatched "know how" and excellent facilities guarantee you custom-designed tubes in the quantity needed ...tailored to your environmental specifications:

- Shielded or unshielded,
- with or without special mountings,
- potted or unpotted,
- with the exact phosphor you require.

TUBE CHARACTERISTICS

VTP 3ABP Screen diameter: 2.68″ Deflection: Electrostatic Overall length: 10.75″	VTP 5XP-11 Screen diameter: 5¼″ Deflection: Electrostatic Overall length: 17⅝″
VTP 5ACP4 Screen diameter: 4.25″ Deflection: Electromagnetic Overall length: 11⅛″	VTP 12GP Screen diameter: 12″ Deflection: Electrostatic Overall length: 22″
VTP P1XP-11 Screen diameter: 1.0″+ Deflection: Electrostatic Overall length: 7.5″	VTP 16AFP-19 Screen diameter: 14.738″ Deflection: Electromagnetic Overall length: 19.146″
VTP 5BC Screen diameter: 4.95″ Deflection: Electromagnetic Overall length: 7 7/16″	VTP 928006-2E Screen diameter: 4.5″ Deflection: Electrostatic Overall length: 18.38″

For detailed specifications and data sheets on VTP's specialized CRTs as well as specific application information, write: VACUUM TUBE PRODUCTS, P.O. Box 90427, International Airport Station, Los Angeles 45, California.

For export information, write: HUGHES INTERNATIONAL, Culver City, California.

VTVO

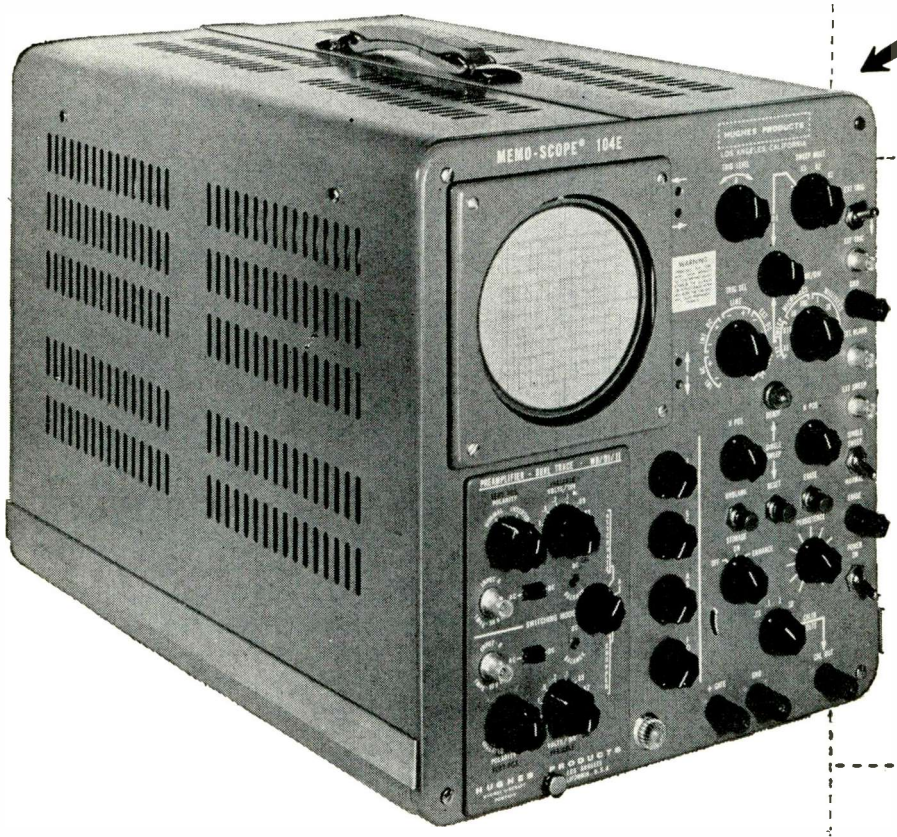
VACUUM TUBE PRODUCTS

a division of HUGHES AIRCRAFT COMPANY

new improved "Memo-Scope®" oscilloscope

Still using "old-fashioned" methods for measuring non-recurring transients? If so, now is the time to investigate the easy way to solve your most difficult transient measurement problems with the latest model Hughes "Memo-Scope" oscilloscope.

Why? Because *new* features, *new* advanced circuitry, *new* panel layout and *new* mechanical design now assure maximum accuracy in all your transient measurements—*plus* higher performance, greater dependability and easier operation!



The Hughes "Memo-Scope" oscilloscope (Model 104E) stores nonrepetitive events for an indefinite period—hours, or days—keeping them available for thorough study until intentionally erased.

new improved features

- Simplified panel layout, redesigned trigger circuit...assure easier operation,
- Advanced mechanical design gives:
  - Better cooling for longer component life,
  - Far greater accessibility for maintenance,
  - Increased ruggedness; resistance to vibration,
- Built-in single-sweep circuit ("1-shot" trigger) at no extra cost,
- Available for either 110 v. or 220 v. operation.

applications

- Data reduction equipment trouble-shooting
- Physical testing: shock, stress, strain
- Ultrasonic flaw detection
- Semiconductor testing
- Ballistics and explosives research ...and many others.

INDUSTRIAL SYSTEMS DIVISION

HUGHES PRODUCTS

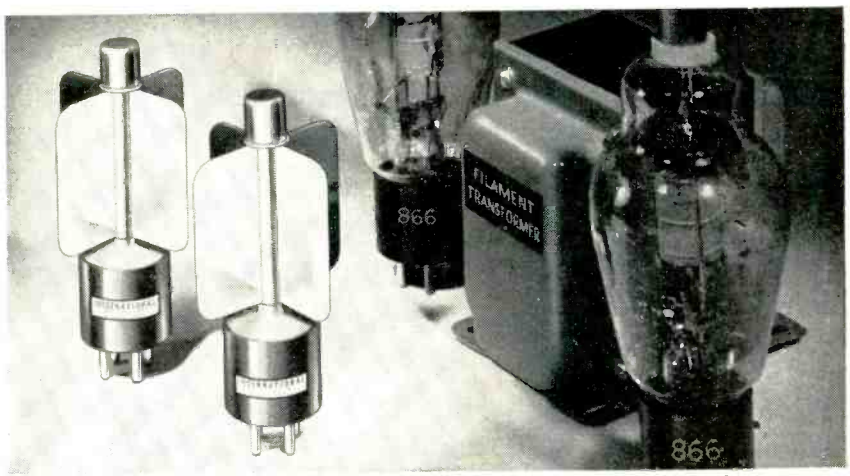
For complete information on the new improved Hughes "Memo-Scope" oscilloscope (Model 104E), detailed data sheets and application analysis of your transient measurement problems, write or wire: HUGHES PRODUCTS Industrial Systems Division, International Airport Station, Los Angeles 45, California

INTERNATIONAL RECTIFIER CORPORATION

A WORLD OF DIFFERENCE THROUGH RESEARCH

RECTIFIER NEWS

Silicon Plug-In Equivalent of the Type 866 Mercury Vapor Tube Can Improve the Design of Communications Equipment 9 Ways!



Fulfilling the need for a compact, reliable unit to replace cumbersome, short-lived Type 866 mercury vapor rectifier tubes, a silicon plug-in equivalent is now available to design engineers. It offers real miniaturization and the reliability needed in a variety of communication and power supply applications.

In a compact package ⅓ of the size of equivalent 866 tube circuitry, the new ST-7 silicon unit provides virtually unlimited life, operating temperatures from −65°C to +75°C, requires no warm-up time and generates a minimum of heat.

The ST-7 is a multiple junction cartridge, hermetically sealed for high reliability and is equipped with radial cooling fins to provide optimum power dissipation. Rated at 6,400 PIV, these units will supply dc output currents of 250 ma at 75°C ambient temperatures. The entire housing and cooling fins act as a highly efficient heat exchanger, and is equipped with a tube base for direct insertion into existing tube sockets if desired.

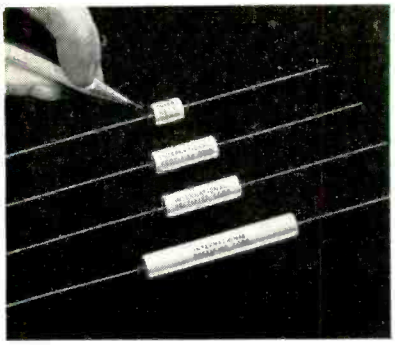
For complete data, and information on how it can improve equipment design 9 ways, ask for Bulletin SR-209 . . .

CIRCLE READER SERVICE CARD NO. 402

High Voltage Rectifiers for High Altitudes – up to 90,000 feet without Corona!

This new series of high altitude silicon cartridge type rectifier covers the PIV range from 600 to 10,000 volts, are ceramic-encased to prevent surface creepage and to minimize flashover problems encountered in high altitude operations. Units tested to 90,000 feet simulated altitude operated at 1600 volts with no evidence of corona.

Designated JEDEC types 1N2373 through 1N2381, this hermetically sealed cartridge series provides dc output currents from 75 to 250 ma (at



25°C). They have an operating temperature range from −55°C to +150° C, and feature wide application to radar power supplied, high voltage bias supplies and airborne/missile instrumentation . . . wherever miniaturization, top reliability, high temperature operation and high altitude performance are required.

To receive Bulletin SR-227 . . .

CIRCLE READERS SERVICE CARD NO. 401

Compact High Voltage "Packaged Rectifiers" Provide up to 100,000 Volts... up to 1 Amp!

If rectifiers in this voltage range fit into your project plans, write to our Electronics Products Department where ratings, configurations and package designs can be tailored to your most exacting requirements.

Silicon High Voltage Rectifiers feature Ultra-Stable Characteristics at High Temperatures . . .

CIRCLE READER SERVICE CARD NO. 403

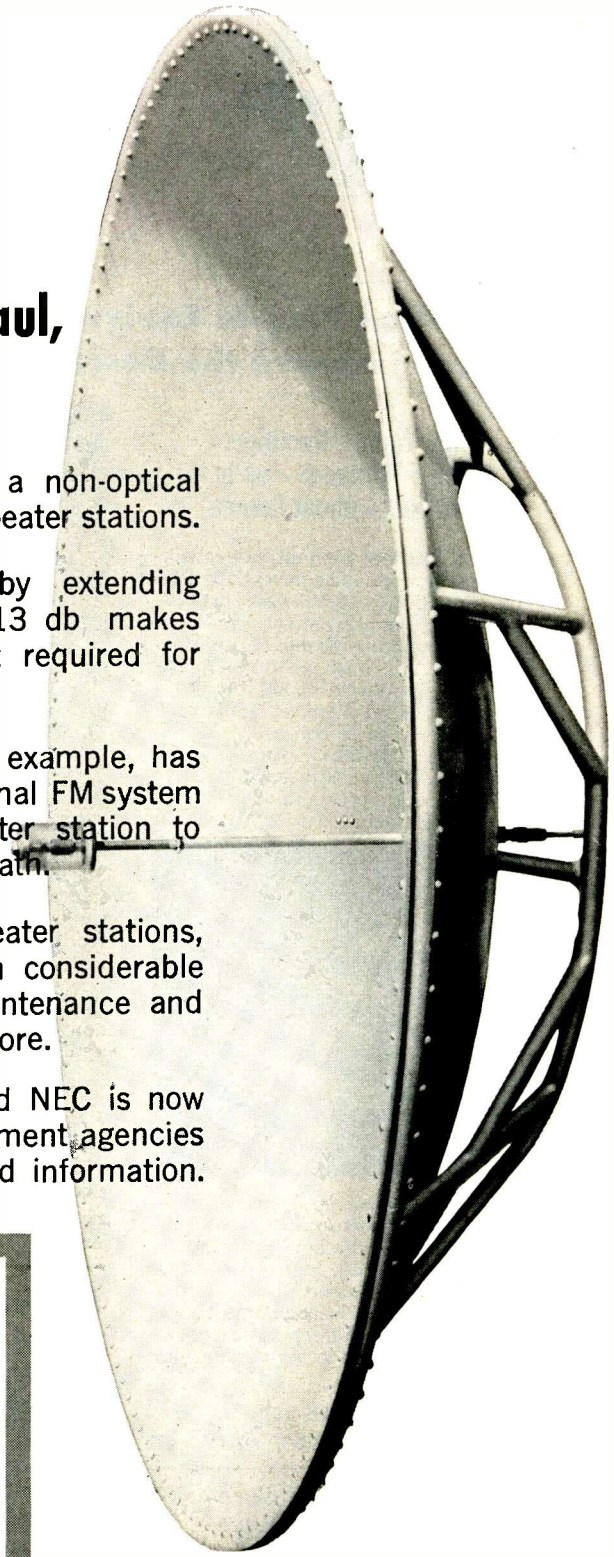
Types 1N1130 and 1N1131 1500 PIV, 300 ma rated silicon rectifiers for missile and airborne equipment exhibit stability of characteristics at high temperatures never before attained. Units are stud mounted for optimum heat dissipation, may be operated up to 150°C. Their high inverse voltage (1500 volt minimum) and ability to withstand shock and vibration especially suits them for missile and airborne equipment. Choice of polarity eliminates the need for high voltage insulation between stud and chassis. Ask for Technical Bulletin SR-226.

FOR SAME DAY SERVICE ON PRODUCT INFORMATION DESCRIBED ABOVE, SEND REQUEST ON YOUR COMPANY'S LETTERHEAD

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281 • CABLE RECTUSA
BRANCH OFFICES: NEW YORK CITY AREA OFFICE: 132 E. 70th St., TRafalgar 9-3330 • NEW YORK STATE AREA OFFICE: 2366 James St., Syracuse, N.Y., HOward 3-1441 • CHICAGO AREA OFFICE: 205 W. Wacker Dr., FRanklin 2-3888 • NEW ENGLAND AREA OFFICE: 17 Dunster St., Cambridge, Mass., UNiversity 4-6520 • PENNSYLVANIA AREA OFFICE: Suburban Square Bldg., Ardmore, Pa., Midway 9-1428 • MICHIGAN AREA OFFICE: 1799 Coolidge H'way, Berkley, Mich., Lincoln 9-1144 • IN CANADA: International Rectifier of Canada, Ltd., 1581 Bank St., Ottawa, Ontario, Regent 3-6880

New from Japan . . .

Important advance in short-haul, multi-channel communications



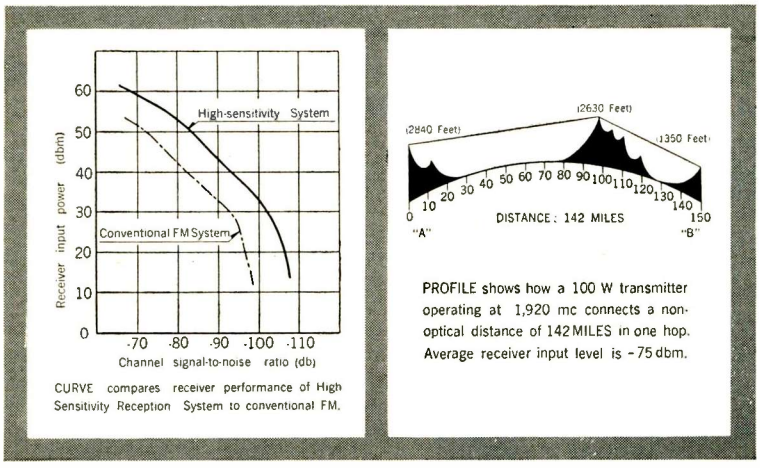
Microwave 60-channel voice transmission over a non-optical path up to 300 MILES is now possible without repeater stations.

NEC's High Sensitivity Reception System, by extending threshold level and improving S/N ratio 10 to 13 db makes this hop with only 1/20 of the power output required for conventional systems.

A 100 W transmitter in the 1,800-mc band, for example, has a scatter path of 100—150 MILES. A conventional FM system requires 2 KW output and at least one repeater station to connect the same distance over a non-optical path.

By eliminating high-power amplifiers and repeater stations, the High Sensitivity Reception System results in considerable reduction in initial investment. Savings in maintenance and power consumption are estimated at 40% or more.

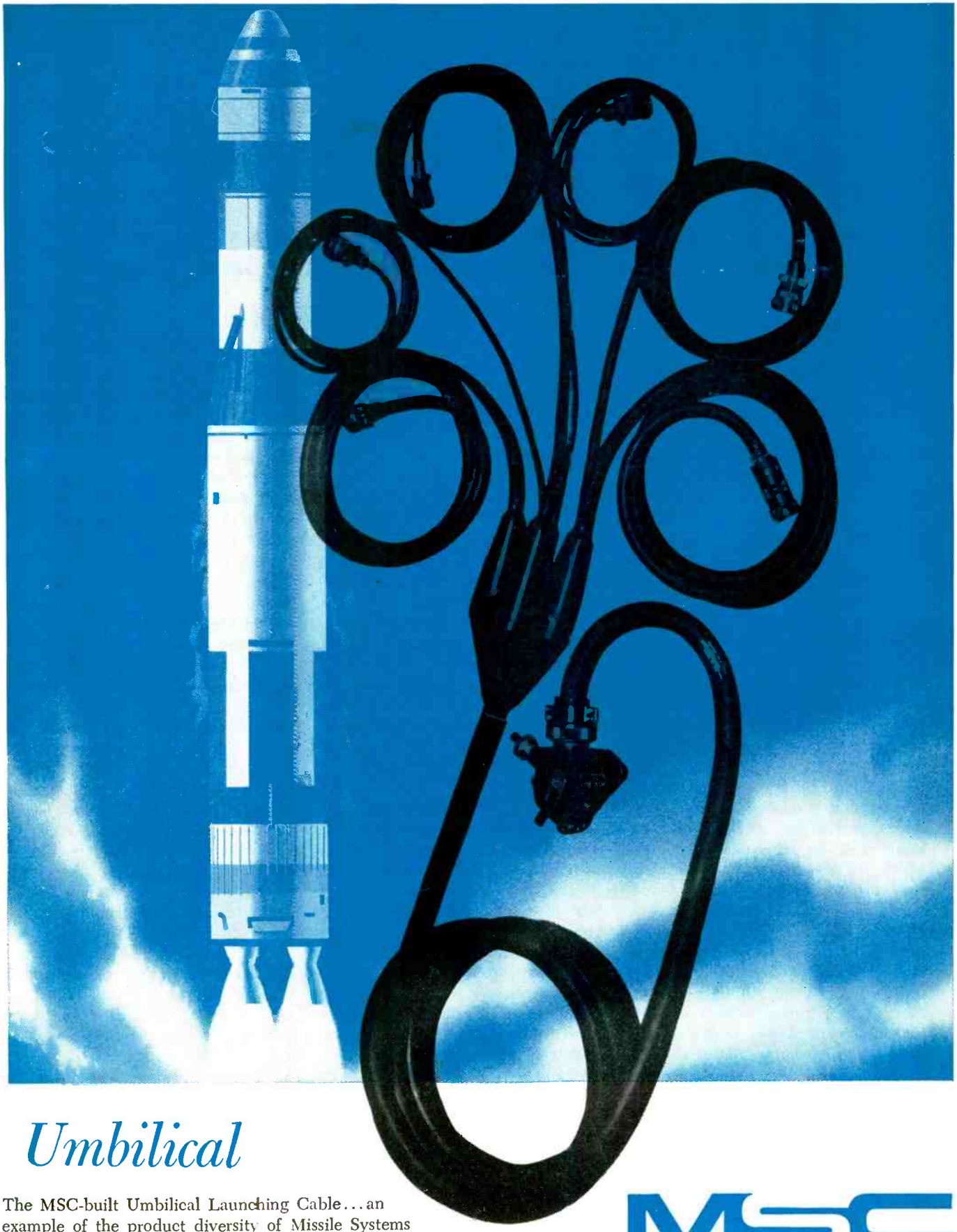
Extensive propagation tests have been made, and NEC is now prepared to supply commercial users and government agencies anywhere in the world. Please write for detailed information.



CURVE compares receiver performance of High Sensitivity Reception System to conventional FM.

PROFILE shows how a 100 W transmitter operating at 1,920 mc connects a non-optical distance of 142 MILES in one hop. Average receiver input level is -75 dbm.

NEC *Nippon Electric Company Ltd.*
Tokyo, Japan
Electronics / Communications Systems



Umbilical

The MSC-built Umbilical Launching Cable... an example of the product diversity of Missile Systems Corporation. Like all products that bear the MSC label, this system has proven its reliability. Just as it is a life-line to the success of a mission, so also are MSC's contributions material to the future accomplishments of *all* facets of the electronic industry. MSC's variety of products form one continual life-line... feeding an industry which is already changing the life patterns of generations to come.

MSC

MISSILE SYSTEMS CORP.
11949 VOSE ST., NORTH HOLLYWOOD, CALIF.

Engineering and Manufacturing Corporation of Texas / subsidiary
Dallas, Texas

What's Different About the New Computers

It is a case of "microevolution"—that is, the new circuits and novel approaches embodied in second-generation computers resulted from a long period of small advances

ADVENT of the second generation of computers ("Computers: New Jobs, Abilities," ELECTRONICS, p 52, Oct. 16) was heralded by a host of microevolutionary developments. As one computerman commented to ELECTRONICS last week, "You don't vault suddenly into a new order of accomplishment; it comes gradually."

Evolution in Components

Production of lower priced, reliable transistors was a boon to circuit and system designers. This, along with other solid-state developments—such as refinements in core storage, research in core-diode and diode-capacitor logic — permitted sophistication to be crammed into less space.

Transistorization reduced environmental problems by cutting down generation of heat, and in some cases by increasing the stability of circuits in unfavorable ambients. Avco Research & Development, for example, produced solid-state computer "building blocks" capable of operating in the range from −58 to 185 F.

Development of thin magnetic films and cryogenic devices will ultimately mean as much as, or more than, the transistor breakthrough. Thin films promise to be one of the few devices that will perform efficiently at millimicrosecond switching speeds.

Circuit Improvements

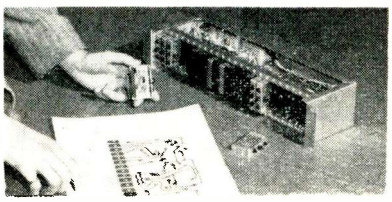
New circuit techniques have helped. The development of asynchronous adders and accumulators upped processing speeds by eliminating resynchronizing periods. Refinement of parallel adding and transfer techniques materially reduced processing time, was itself made possible by the reduction in size effected through transistorization.

Making tape units capable of handling records of varying lengths cut out another source of wasted time: the spacing digits formerly used to pad out a block to its fixed length.

Buffer storage to work with input and output gear was an early step in separating computing functions from input-output processing. Buffers are nowadays made an integral part of the main memory, eliminating buffer-to-memory transfer time. This, coupled with the gradual separation of computing and control functions, releases computing equipment for its main work.

Error detection and location systems were of key importance in improving the business world's acceptance of digital computers. Now, with techniques such as Datamatic's Orthotronic Control, computermakers are taking the first steps into the vastly more complicated field of automatic error correction. Orthotronic corrects most random errors and some systematic errors introduced by the computing machinery. Equivalent abilities are built into the Larc.

Systems offered on the commercial market in the last year or so all contain technological advances which characterize the second computer generation. Computermakers have concentrated much engineering manpower on microevolutionary developments: Mod III of IBM's 705 system, for example, was 30 percent faster than earlier 705's due to many small internal modifications.



Solid-state components and new package techniques—as in these Avco R&D packages—help both production engineering and logical design

IBM learned some years ago that users of the extremely fast 704 system (designed for scientific use) were fudge-coding commercial problems and making better time than on the business-oriented 705. The firm combined concepts of the two into the IBM709, then transistorized that system to make the IBM-7090, gaining even more speed and pointing the way toward eliminating the distinction between scientific and commercial systems.

The Univac Solid-State 80 or 90 (so called for its alternative ability to work with 80- or 90-column punched cards) is similar to the computer delivered by Remington Rand to USAF's Cambridge Research Center in 1955. It was modified for commercial sale in Europe a couple of years later, then redesigned electronically for U. S. production. It contains 20 tubes and about 1,500 magnetic-amplifier cards.

National Cash Register has developed many methods of capturing data on paper tape, cards or magnetic tape from conventional types of office machinery. The firm is also deep in the development of its NCR-304, which will first be installed in 1961 at giant New York department store R. H. Macy's. The NCR304 will be transistorized throughout, will use FR300 digital tape units from Ampex. These in turn will operate from a wide variety of first-

Univac Solid-State computer contains many modifications, is similar to USAF Cambridge Research Computer

stage input devices, either directly or through paper-tape transfer media. The 304 will have a built-in command structure for many much-used commercial programs.

Philco, Olivetti and General Electric are other computermakers who will use Ampex's FR300 digital units. GE will include the tape devices in its GE-100 bank system.

Advanced Systems

Datamatic division of Minneapolis-Honeywell, in producing the Honeywell 800, feels confident that it is tapping a 30,000-company market. The medium-large 800 is completely transistorized, controls its processing traffic by an independent unit, and contains a multiprogram control facility that permits it to divide itself into eight parts to handle up to eight independent programs at a time.

RCA's transistorized 501 system can control up to 63 tape stations, uses variable-length tape records, and has an expandable memory. The system was originally offered with a medium-scale computing unit, model 503. Two other central units are now added to the line, the smaller 502 and larger 504.

Philco's S1000 and S2000 Transac systems made use of the Philco-developed surface-barrier transistor to achieve high computing speed. The S2000 also uses an asynchronous parallel adder-accumulator, has a 900-line-a-minute printer among its output auxiliaries. Drums and tape are used for bulk storage, and the core storage comes in 4,096-word packages expandable to 65,536 words.

European Developments

British EMI has two general-purpose systems, the Emidec 1100 and 2400. The 1100 uses core-transistor logic and both drum and core memory. The 2400 is transistorized throughout and designed for the commercial market. It has a 1-mc clock, 0.2-microsecond switching speeds, and a 36-bit asynchronous parallel adder-accumulator. Diode-capacitor circuits provide high-speed temporary internal storage, with main memory of 4,096 aphanumeric words augmented by both 1-inch tape for bulk data and 4-inch tape for general file.

Compagnie des Machines Bull is now producing the Gamma 60, a fully transistorized, self-programmed system with the capability of handling several programs independently and simultaneously. The French system uses tape and drum units for bulk storage and cores for high-speed internal memory. Instructions for the 60 are written in symbolic mnemonic form, translated internally into machine code.

Peripheral Gear

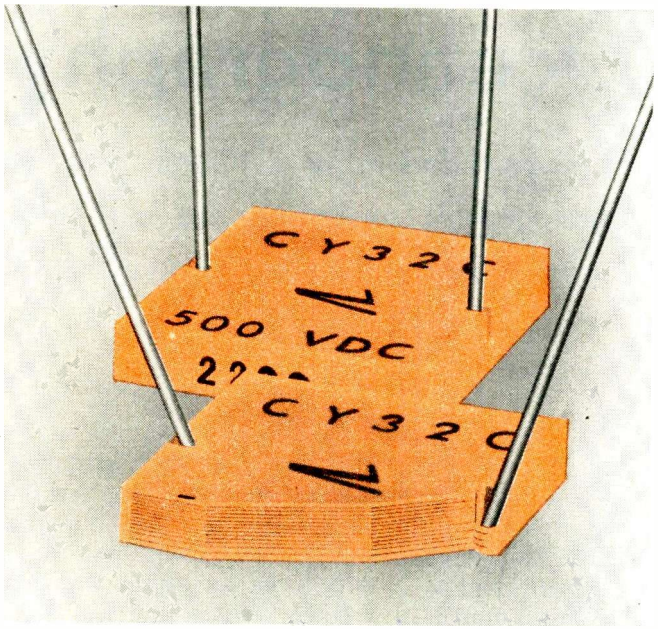
Language translators such as those produced by Electronic Engineering Co. and Telemeter Magnetics Inc. are beginning to alleviate the communications block among computers of different manufacture. EECo developed its model ZA100 to translate between Sage computers and IBM709, and from IBM709 tape to paper tape for wire transmission or into punched cards. The company also built a translater for David Taylor Model Basin to go between that Navy lab's Univac and its IBM704.

Some computer users have jumped into the game themselves. The Livermore (Calif.) atomic laboratories found themselves with a Univac and a few IBM704's, a Univac tape-fed high-speed printer and no IBM counterpart. Technicians modified the Univac unit to read IBM tapes and saved the lab a few-score thousand dollars.

At the Navy Proving Ground in Dahlgren, Va., computermen came up with a universal data transcriber. Navy's UDT can take data from cards, paper tape, magnetic tape or "almost any source of digital data that does not exceed 500,000 bits per second." Its output can be cards, paper tape, magnetic tape, low- or high-speed printers, point plotters or other digital gear.

Computermakers are beginning to build these translating capabilities into their machines. Larc will read anybody's magnetic or paper tape or punched cards. Builders like Datamatic and RCA routinely generalize their first-stage input devices to accommodate various standard record forms, and are developing buffer units to let their tape machines read magnetic tapes of other brands.

...in any environment, silicones protect



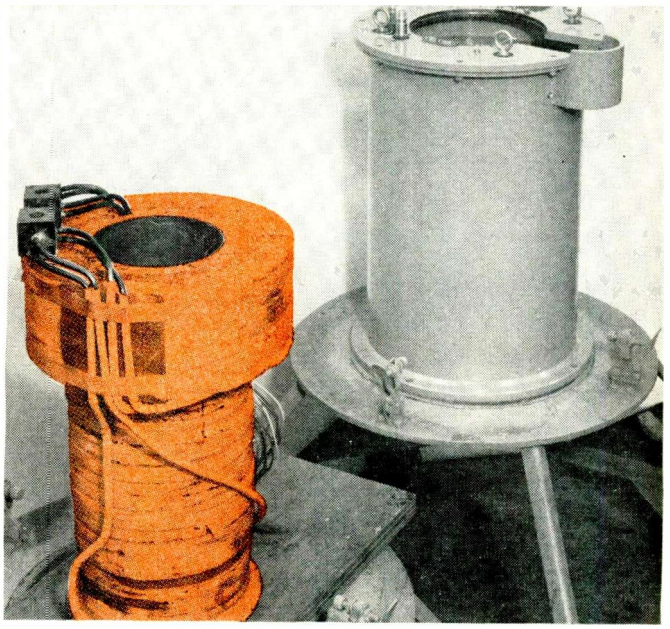
Fluid Short-Stop Deflects Moisture

Employed in many airborne guidance, tracking, computing, and telemetering units, "Vitramon" Capacitors are porcelain-bodied to resist adverse conditions such as heat and humidity. But Vitramon engineers realized that only a small amount of condensation on the porcelain could cause leakage paths and lead-to-lead shorts. They solved the problem by dipping each capacitor in Dow Corning silicone fluid. The micro-thin coating is moisture-repellent . . . durable. The silicone surface "beads" water, preventing condensed moisture from forming a conductive film.

CIRCLE 37 ON READER SERVICE CARD

This Resin Is As Good As Its Bond

The Osborne Electronic Corporation makes, among other things, specialty transformers for airborne electronic systems. Look hard and you'll see an Osborne unit in the Jupiter Ground Support Equipment control box on the facing page. At the center of each Osborne transformer is a coil bobbin which must have maximum mechanical and electrical strength in minimum thickness to allow maximum copper content in the core window area. Normal tolerance is ±.015. In addition, they must withstand temperatures from —65 C to over 200 C, be free of voids or pinholes. Osborne engineers have found the most economical way of producing top quality silicone-glass laminate coil bobbins of special sizes and shapes for their custom transformers is by winding glass tape on a mandrel, then saturating it with Dow Corning solventless resin applied by paint brush. Dow Corning resin cures with heat; no pressure needed. It provides the high physical strength to resist heavy wire winding pressure.

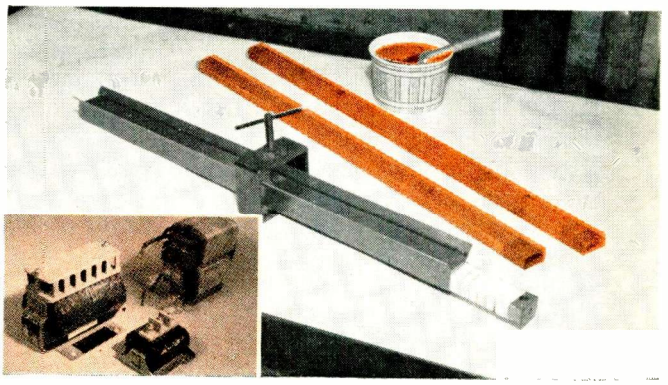


Silastic® Insulates Beyond The Call

This giant Klystron focusing coil, a product of Varian Associates, is destined for a vital role in space-age electronics. Designed for 5000 hours minimum life, it operates at 1650 watts input and is cooled by liquid heat-exchange. *Inlet* coolant temperature is 125° C!

Where does Silastic, the Dow Corning silicone rubber, fit in? It's over, under, and around every layer of the coil. A paste form of Silastic is coated on each successive winding and over the copper cooling coils as well. Dielectric strength, resiliency, and resistance to heat and moisture are essential. The coil must withstand water immersion tests, vibration tests, a shock test of 10 G's for 15 cycles of 11 micro-seconds each, and environmental testing which includes severe thermal cycling.

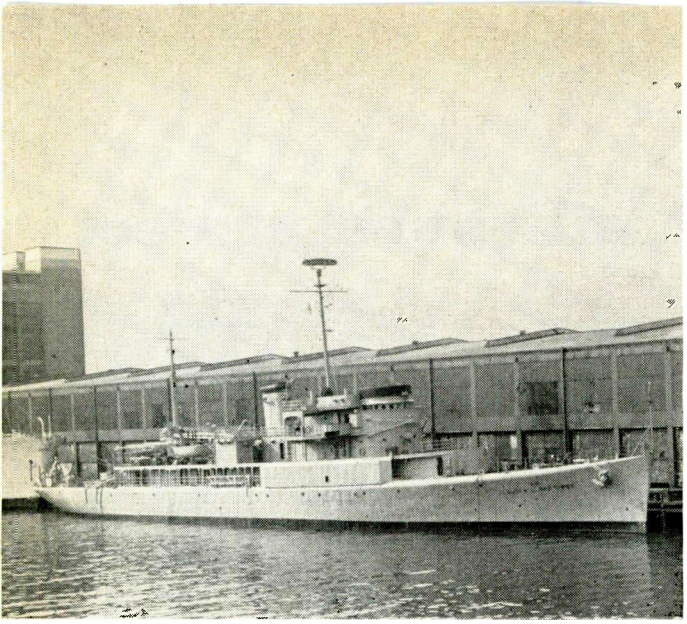
CIRCLE 39 ON READER SERVICE CARD



CIRCLE 40 ON READER SERVICE CARD

CORPORATION MIDLAND, MICHIGAN

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



USNS Josiah Willard Gibbs, Navy oceanographic vessel, during recent New York visit

Renaissance in Oceanography

If recommendations for a 10-year program of oceanographic expansion are accepted by Congress, electronics will play a key role

AMERICAN OCEANOGRAPHY, for years little more than a modest scholarly pursuit, is now coming to life. It's being jarred by fast-moving Soviet civilian efforts that first became apparent during the International Geophysical Year and by the growing Soviet submarine fleet.

Funds for ships, electronic equipment, research and survey work could run into hundreds of millions of dollars over 10 years if Congress becomes as concerned with parity with the Soviets in oceanography as it is in space research.

A 10-year program is shaping up based on recommendations made by the Committee on Oceanography of the National Academy of Sciences-National Research Council. At least two bills are under consideration by a Senate subcommittee. A House subcommittee has held hearings and is reportedly drawing up a bill.

Scientists Hopeful

Richard Vetter, executive secretary of the Committee on Oceanography, told ELECTRONICS that scientists are hopeful Congress will give the green light to expansion of oceanographic efforts this year to avoid a "crash program" later.

"Five years ago we hardly ever heard of the Russians doing oceanographic work," Vetter said. "They didn't attend international meetings of the International Union of Geodesy and Geophysics." In the last few years, though, Soviet scientists have attended international meetings in force.

Even more than upper atmosphere research, Vetter points out, oceanography is a field that owes its present potential to electronics. He compares the incentive to progress in marine science from high-speed computers, telemetry and advanced measuring and recording devices to the internal combustion engine's effect on agriculture.

However, American progress in applying electronics to the study of the oceans has not kept pace with the flowering of electronics here.

On the other hand, the USSR Academy of Sciences, with the status of a ministry (ELECTRONICS, p 24, Dec. 10, '57) and in a direct chain of command under Premier Khrushchev, for some time has been accelerating its oceanographic efforts simultaneously with its electronics and space programs (ELECTRONICS, p 18, Sept. 18). During IGY, claim the Soviets, more than 20 of their oceanographic expeditions covered over 270,000 miles performing double the amount of work done by U. S. oceanographers.

'Has No Equal'

New Soviet research ship *A. I. Voyeykov*, built on order for the Main Administration of the Hydrometeorological Service under the Council of Ministers, sailed on its first voyage this fall. According to the Russians, it "has no equal in the world as to equipment and construction."

Statistics on the *Voyeykov*: displacement, 3,600 tons; length, about 277 ft; main engine power, 2,000 hp. The ship is capable of voyages up to 3½ months long and up to 15,000 nautical miles without making port. It has 38 laboratories and model shops containing new Soviet-designed equipment and six hydrological electric winches. A sister ship, to be named the *Yu. M. Shokolskiy*, is being built.

Two of the best ships available this year to American oceanographers have been 1,800 ton Navy salvage and rescue ships converted for oceanographic use only last year and operated by the Military Sea Transportation Services for the Woods Hole Oceanographic Institution and the Scripps Institution of Oceanography.

New Equipment

So urgent has oceanographic research become that a number of ships at Woods Hole are now being completely refitted with new and remodeled electronic equipment. New gear includes:

Latest echo sounders operating at different frequencies and different depths, including one at the ocean bottom for identifying marine life and objects.

Geothermal gradient device for studying the dynamics of the earth below the crust by measuring the heat conductivity of the bottom.

New sonar depth meter submerged with instruments and pointed upward for determining instrument depth.

Sound velocity meter that consists of pressure, temperature and salinity sensing devices tied to a digital computer, necessary because the speed of sound through water varies with the chemistry of the water.

Despite stepped-up activity, a really great American oceanographic effort has yet to be made. "Have plans, need money" is the way one scientist puts it. Right now the biggest need is probably for ships, not old Navy castoffs, but new specially designed research vessels that can hold a large variety of oceanographic equipment and an adequate complement of scientists.

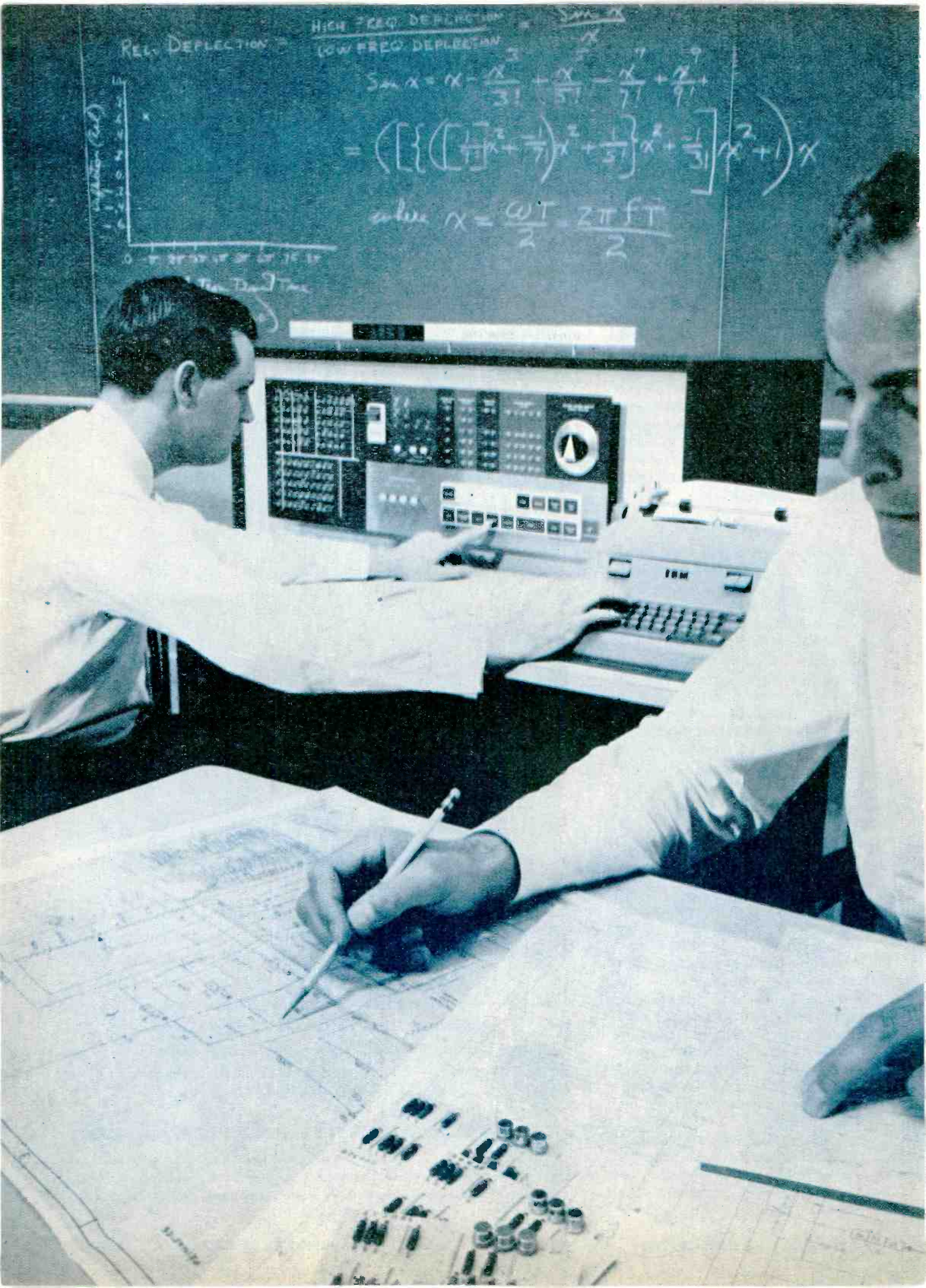
Even with sufficient funds to buy new ships, the government and private oceanographic institutions are faced with a basic problem. It is one of naval architecture. As Richard Vetter states the problem, "Nobody seems to know how to build small ships that are seaworthy and adequate for oceanography." Some scientists would like to see the Maritime Administration beefed up with funds and authority to attack this problem effectively.

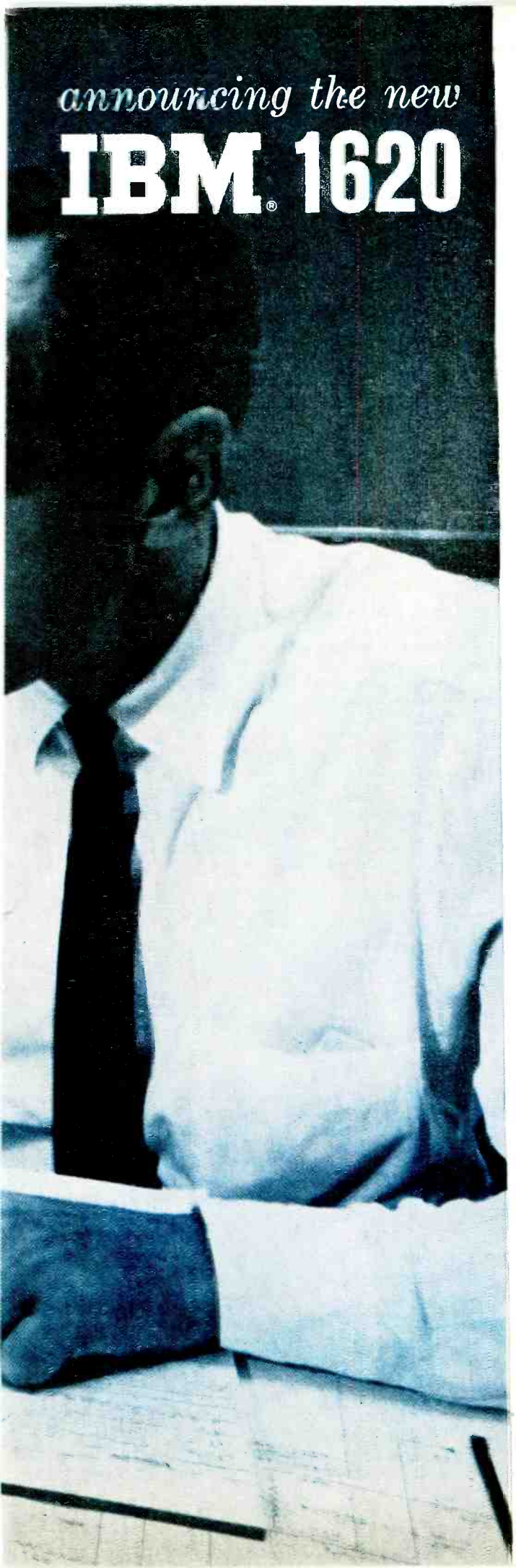
Now Have Funds

Meanwhile it is understood that the Navy and the National Science Foundation now have funds available for building new research ships and are making plans.

Support is building up in the Senate for a new role for the U. S. Coast & Geodetic Survey which, like the Maritime Administration, is under the Commerce Department. If the present limitation of staying within coastal waters was removed, this agency could be enlisted to perform deep sea survey work—a natural extension of its present activity. Oceanographic planners would also like to see the Bureau of Commercial Fisheries of the Interior Department have a role in future research.

The Navy's oceanic research and survey arm is the Hydrographic Office, which is also the biggest repository of oceanographic data in the country. Civilian scientists, anxious to push ahead with research and participation in the International Geophysical Cooperation programs, say military jurisdiction over information hamstrings their efforts. They feel that a civilian data center, freely disseminating scientific data collected through civilian efforts, would do much more to advance American oceanography. It is believed that plans for a data center are being discussed.


REL. DEFLECTION =
HIGH FREQ. DEFLECTION
LOW FREQ. DEFLECTION
$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \frac{x^9}{9!}$
$= \left(\left[\left\{\left(\frac{1}{7}\right)x^2 + \frac{1}{5}\right\}x^2 + \frac{1}{3}\right]x^2 + 1\right)x$
$\text{also } x = \frac{\omega T}{2} = \frac{2\pi f T}{2}$



announcing the new

IBM® 1620

first solid state engineering computer in the low-price field

Here is a new and powerful stored program, desk-size computer designed to bring more computing ability to engineering problems at low cost.

Transistorized throughout, the IBM 1620 is the only solid state, core-storage computer in its price class.

Easy to learn—easy to operate—easy to communicate with —this powerful computer relieves engineers from routine calculations—frees them for creative tasks.

Data is fed into the 20,000-digit magnetic core memory of the 1620 via punched paper tape. Alpha-numeric output is printed at the console typewriter in desired format, under stored program control.

This new computer with its two-address instruction format and variable field length, gives you up to 50% more storage capacity than a fixed word-length system.

All notations of input and output are in the decimal system. An unlimited decimal field and internal self-checking assure accuracy. A powerful two-address instruction format adds to the 1620's timesaving capabilities.

Programming is simplified through the use of IBM Fortran —a mathematical programming system which compiles machine instructions from algebraic and English language notation. A library of programs for standard engineering computations will also be part of the 1620 package.

Call your IBM representative—ask him to show you all the unique features of the IBM 1620. Like all IBM data processing equipment, this system may be purchased or leased.

BALANCED DATA PROCESSING

IBM®

Balanced Data Processing combines systems and services inseparably to produce performance in the best tradition of more than 45 years of IBM experience. It means more production per data processing dollar for you.

new

MICRO-MINIATURE CERAMIC CAPACITORS
OFFER A PACKAGE DENSITY
OF 432,000 PARTS PER CUBIC FOOT

excellent for complete assembly encapsulation

actual size

The reliability built into the "VK" Capacitor is a hard, tested fact — backed by the name and reputation of the company that made the "VITRAMON" monolithic porcelain capacitor a synonym for capacitor reliability.

A minutely controlled process, continuous life and environmental testing, plus 100% tests for Dissipation Factor, Insulation Resistance and Capacitance guarantee that each "VK" Capacitor in your circuit will perform as predicted. Pre-production lot-by-lot qualification tests on all materials used, craftsmanship of the highest order and ten years of experience dedicated exclusively to the manufacture of high-reliability capacitors assure that these tiny units will function predictably under the most punishing conditions to which a component of this type is subject.

Vitramon® INCORPORATED

P.O. BOX 544 • BRIDGEPORT 1 CONNECTICUT

VK*

micro-miniature CAPACITORS

47-10,000 mmf
200 vdc without derating
-55° C to 150° C operation

Square precision molded cases in only two sizes and a single standard 0.2" lead spacing for all values simplify circuit design, guarantee uniformity, facilitate handling, give greater mechanical stability.

The DAPON** resin used in "VK" Capacitor cases assures environmental reliability through every stress to which such components are susceptible.

ENVIRONMENTAL CHARACTERISTICS

Moisture Resistance: Operational in 95% relative humidity at 200 vdc. When tested in accordance with MIL-STD-202A, Method 106, with rated voltage applied, Insulation Resistance is greater than 10,000 megohms at 95% relative humidity. Dissipation Factor is less than 2.5%, and capacity change less than 10% at 25°C and 50% relative humidity.

Temperature and Immersion: When tested in accordance with MIL-STD-202A (with maximum temperature extended to 150°C), Method 102A (test condition C) and Method 104A (test condition B), Insulation Resistance is greater than 10,000 megohms, Dissipation Factor is less than 2.5% and capacity change is less than 10%.

Temperature Shock: "VK" Capacitors show no evidence of electrical damage when subjected to 10 cycles of alternate immersion in silicone oil at 160°C and water at 0°C (±10°C) for a minimum duration of ½ minute each bath.

Vibration: No evidence of physical damage has been found when tested per MIL-STD-202, Method 204 (test condition B) when ⅜ in. lead mounted and vibrated for four hours in each of three mutually perpendicular planes (10 cps to 2,000 cps) at 15 G's.
Shock: When ⅜ in. lead mounted and subjected to 3 shocks of one millisecond duration in each of 3 mutually perpendicular planes at 100 G's per Method 202A of MIL-STD-202, "VK" Capacitors show no evidence of physical damage.

Altitude: When tested in accordance with MIL-STD-202, Method 105A (test condition D) requiring a minimum of 100,000 feet, "VK" Capacitors suffer no electrical breakdown at 150% of rated voltage.

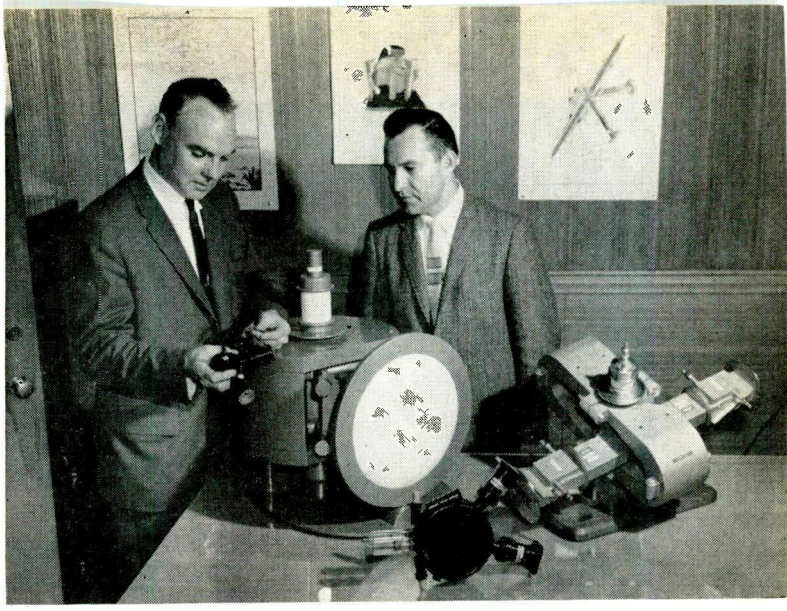
Life: Following 1,000 hours at 150°C and 200% of rated voltage, measurements at 1 kc and 25°C show a Dissipation Factor less than 2.5% and an Insulation Resistance greater than 10,000 megohms.

Conforms to requirements of MIL-C-11015B

*Trade Mark
**Trade Mark of Food Machinery and Chemical Corp.

This week at NEREM . . .

New Advances In Microwave



Early Amplitron tube, left, shown beside wooden mockup of new microwave tube 20 to 50 times more powerful

BOSTON—Advances in microwave tube technology make it possible and economically practical to generate hundreds of kilowatts of power at frequencies of 3,000 mc and above in one envelope, it was reported here this week.

At the Northeast Electronics Research and Engineering Meeting (NEREM), William C. Brown of Raytheon described broadband 3,000-mc amplifiers which operate at 20-kw output and efficiencies of 75 to 80 percent. He said new techniques will increase the power levels of these tubes by a factor of at least 10. A colleague, Harold Hart, outlined applications of superpower microwaves to space problems.

More than 8,000 visited NEREM, and an extensive technical program spotlighted advanced design and R&D concepts, management problems, a tutorial session on plasmas, and the impact of Soviet, Japanese and NATO-nation developments on U. S. electronics.

Speaker From France

Among speakers at the international session were Roger Aubert, president of the electronics section of the French Society of Electricians; and K. C. Black, science advisor to SHAPE.

An MIT trio explored thermoelectric temperature control of electronic components, following two talks on thermionic engines (ELECTRONICS, p 69, Nov. 13). As an illustration of steady-state thermoelectric cooling, the trio described use of a Peltier cooler to extend a transistor's dissipation limit, citing advantages of this method over a thermal short circuit.

An experimental 9-pin miniature r-f pentode with a gain-bandwidth figure of merit of only 120 was reported by George R. Henderson of CBS Electronics. Applications using this secondary emission device include a multivibrator with less than 10 millimicrosecond rise time, also a single-pulse generator with a rise time of less than 4 millimicroseconds at one-ampere current levels.

Propose System

An emission current regulating system was proposed by Jerald F. Annese and Dwight F. Batteau. The system maintains a given emission from a temperature-limited directly heated cathode against variations in line voltage, changes in contact resistance and anode supply, and variations in specific emission, while still providing 50 kv of insulation from ground for the emitter.

Emission current controls the pulse rate of a neon tube oscillator. Optical coupling of the light from the neon tube to a photoelectric cell provides high voltage insulation and signal readout. The resulting electrical pulses are amplified and integrated to produce an error signal. The error signal is applied in the proper polarity and magnitude to control a regulated power supply which thereupon provides direct current heating power for the cathode.

Describe Circuits, Concepts

New chopper-type circuits using a single controlled rectifier as a power switch were described by John D. Harnden Jr. of General Electric.

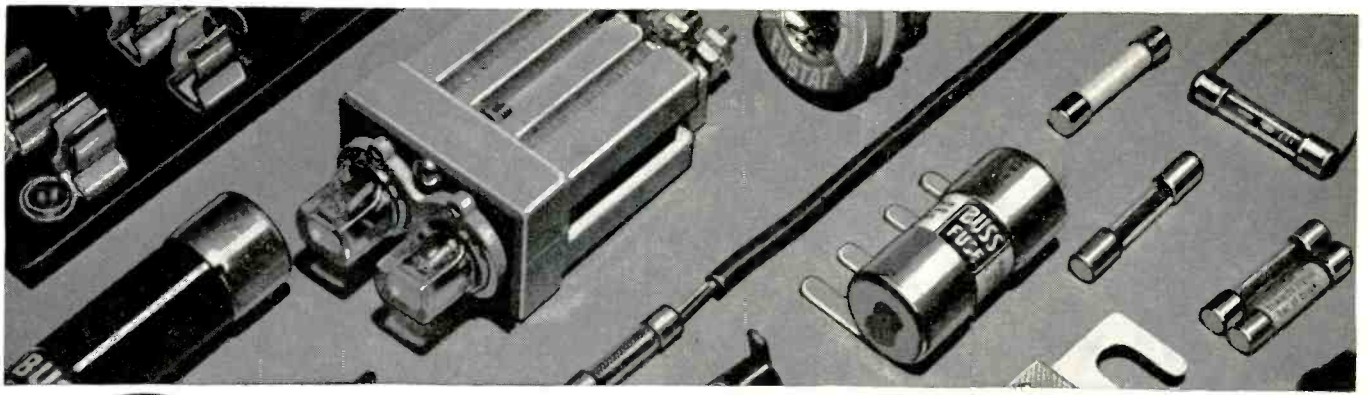
He cited applications in areas such as d-c amplifier, regulated power supply, d-c motor control and ultrasonic generator.

Reports Method

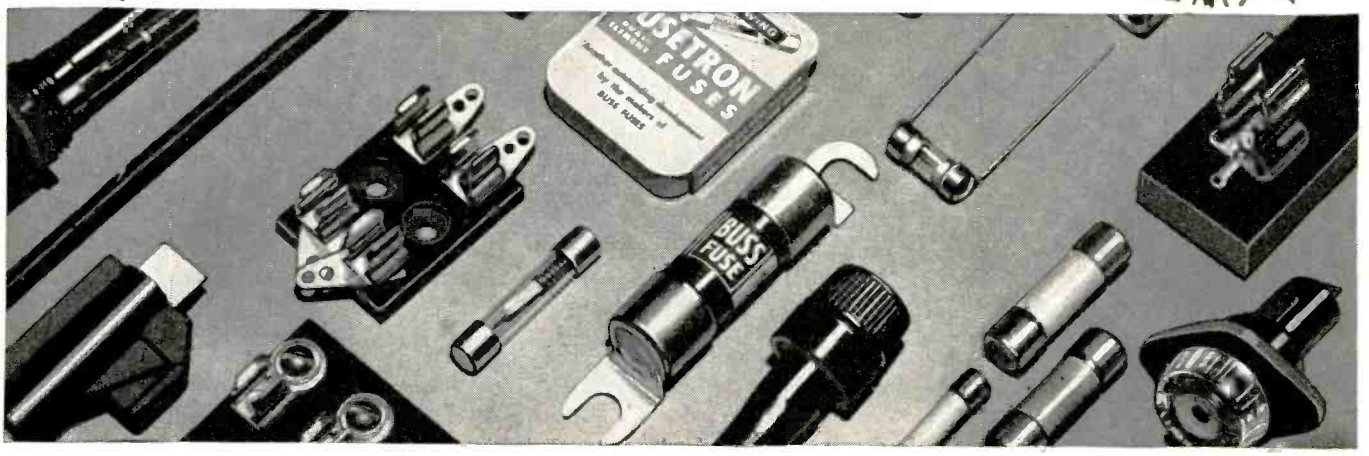
Arthur DiVenuti of Transitron reported a method for selecting the commutating capacitance which would be sufficient to turn off the controlled rectifier for a given turn-off time as a function of load current, applied voltage (magnitude and slope) and temperature.

Also described were: operation of a transistorized silica delay line memory which has operated at 20 mc, with 50 mc operation projected; use of fiber optic bundles linked with closed-circuit tv for monitoring of the oral cavity in dental classes and clinics; an input-output control system designed into the new Sage solid-state computer, which allows simultaneous control of many input/output devices and releases the central processing system from control functions; and a new concept of a traveling wave transformer consisting of 2 to 4 coupled helical transmission lines with properly designed mutual coupling.

Frequency bandwidth ratios of 10^3 to 10^5 may be achieved, said H. Gunther Rudenberg of Transitron. Transformers have been designed with 50-kc to 500-mc range, and extension of the traveling wave concept to the higher microwave frequencies was reported as being feasible.



Specify BUSS Fuses!



Because there's a BUSS or FUSETRON fuse to fit Your Every Electrical Protection Need.

With the world's largest fuse research laboratory plus 44 years of experience in solving electrical protection problems — it isn't surprising that BUSS has the most complete line of fuses in the industry.

The BUSS and FUSETRON fuse lines includes:

Single-element fuses for circuits where quick-blowing is needed, such as for instrument protection.

Single-element fuses for normal circuit protection.

Dual-element, slow-blowing fuses for circuits where harmless current surges occur.

Indicating fuses where signal must be given when fuses open, or to activate an alarm.

BUSS and FUSETRON fuses range in size from 1/500 amperes up — and there's a companion line of fuse clips, blocks and holders. Whatever your fuse requirements, the chances are more than good there's a BUSS or FUSETRON fuse to satisfy them.

If you have a special protection problem . . . extensive BUSS laboratory facilities and a large engineering staff are at your disposal to help you save money and engineering time.

For more information on BUSS and FUSETRON Small Dimension fuses and fuseholders, write today for BUSS bulletin SFB.

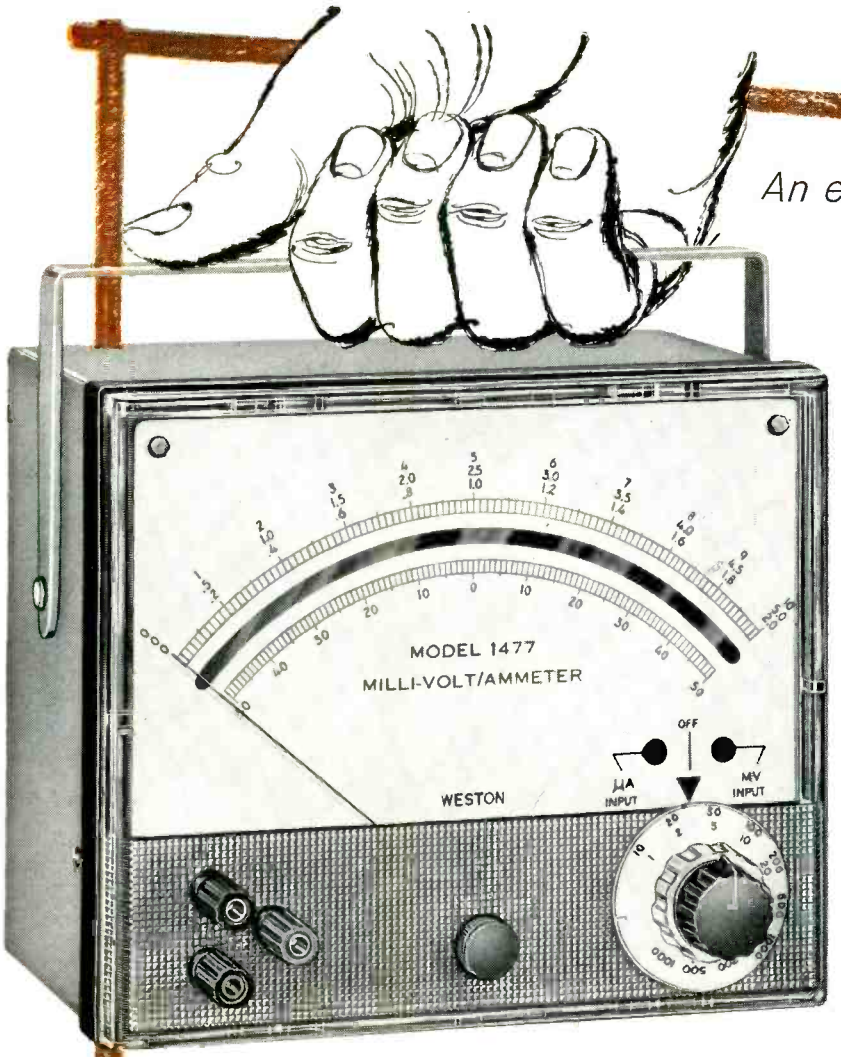
BUSSMANN MFG. DIVISION,
McGraw-Edison Co.
University at Jefferson, St. Louis 7, Mo.

1159

BUSS fuses are made to protect - not to blow, needlessly.

BUSS makes a complete line of fuses for home, farm, commercial, electronic, electrical, automotive and industrial use.

FUSETRON BUSS — TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION — McGRAW EDISON



An exceptional new tool for lab or industry!

WESTON *Zero Load* ELECTRONIC MILLI-VOLT/ AMMETER

Check these outstanding features and exclusives:

- Measurement, amplification and transduction of a wide span of D-C current and voltage ranges — 10 to 1000 microamps and 1 to 1000 millivolts full scale — in a single 5½-pound unit.
- Unique INDUCTRONIC® servo-amplifier provides extreme high gain and full feedback — for accuracy and stability unaffected by variations in line voltage or frequency, condition of tubes, or other variables.
- Model 1477 is a true D-C meter with zero-drift comparable to a permanent magnet moving coil instrument. No mechanical switches or choppers are used.
- Essentially zero power-drain from the source being measured.
- Power-gain is sufficient to drive indicating meter plus any external load up to 5,000 ohms. Power output is available at terminals in rear of unit.
- Knife-edge pointer and 7.2-inch mirror scale provide unmatched readability.
- Gain stability and output linearity are both within 0.1% at ranges above 1 millivolt or 200 microamps.
- Resolution capability is within 2 microvolts or .02 microamps.
- Power requirements: 115 volts A-C, 50 to 1600 cycles, 35 watts.
- Less expensive than competing instruments offering lower stability.

For full information, contact your local Weston representative . . . or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

A DAYSTROM UNIT

WESTON *Instruments*

WORLD LEADER IN MEASUREMENT AND CONTROL

Finding Tomorrow's

Long Island company's unique program helps schoolboys decide if engineering is for them

Supervisor stands by—ready to instruct and help—as students wire and solder electronic components for a digital computer

By **W. A. GREGORY,** Amityville, N. Y.

A UNIQUE industry-school program —designed to interest students in engineering careers—is underway on Long Island, N. Y.

This five-year project is the Summer Work Experience Program, a joint endeavor of local high schools and Airborne Instruments Laboratory, a division of Cutler-Hammer, Inc. Each summer 20 high school students with engineering potential work at AIL as technical aides.

The basic objective is to place students in close association with experienced science and engineering personnel in the framework of daily, on-the-job work experience.

All students are treated as adults and encouraged to accept mature responsibilities.

Each student works for eight weeks. When he starts he is cleared for security and issued his employee's badge.

Then he reports to the engineer who has been assigned as his work supervisor. He meets other engineers and technicians in the section he will work in, and is briefed on the particular project with which they are engaged.

For the next two or three weeks he will be a member of this team, eight hours a day, forty hours a week, with definite duties.

He sees and participates in the thinking and planning of the group. He studies and reads up on the problems. He sees first-hand how the engineers reach conclusions and solutions. He also learns that all engineering is not glamorous, that behind each technical advance are hours upon hours of routine checking, rechecking and changing.

For two hours each Friday afternoon he attends a seminar with all other technical aides. There, through reports and directed discussion, he learns from the others a little of what they are doing. Thus he sees his work in reference to the larger whole.

Sometimes an expert lectures on a special subject or demonstrates and explains the workings of a com-

Engineers

plex machine like the Cytoanalyzer. Occasionally the group visits a nearby installation where company-made equipment can be seen in action.

At the end of each two or three weeks, he is rotated to a different department.

Submit Reports

Each two weeks he turns in to the project coordinator a detailed work report showing exactly how his time has been spent and his reactions to the work. Likewise, each two weeks, his work supervisor turns in a detailed report on the student's aptitudes and attitudes and his personal observations as to the boy's potential.

After eight weeks, the student has a pretty good idea whether or not engineering is for him—and whether he is cut out for engineering.

If the answer in both cases is yes, he returns to high school or enters college with a far greater degree of certainty about his career than would be possible otherwise.

One keystone of the program is helping potential engineers tailor their educational plans.

While the Long Island experiment still has two more years to run—many of the original 1957 group are now juniors in college—it is certain to be judged a success.

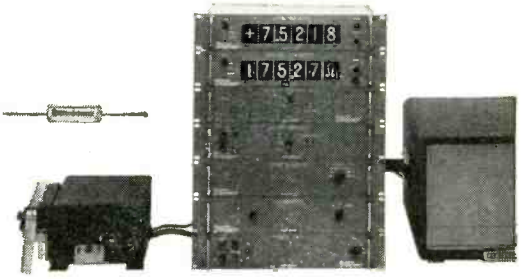
Reactions of the company, schools, engineers and technicians, parents and the students themselves leave no room for doubt on that score.

Vice-president John Dyer, chief of Airborne's Research and Engineering Division, and Howard Gresens, director of personnel, who originated the experiment, are convinced that it will play a significant role in setting a pattern of expanded industry-school cooperation to discover science and engineering talent early and channel it into these fields.

Gresens points out that of the first two summers' 40 students, 37 are still in college and 30 of these are preparing for careers in science and engineering. And of these, 19 are preparing for some branch of engineering.

Low cost, versatile DIGITAL SYSTEMS

for automatic testing of transistors resistors diodes and capacitors



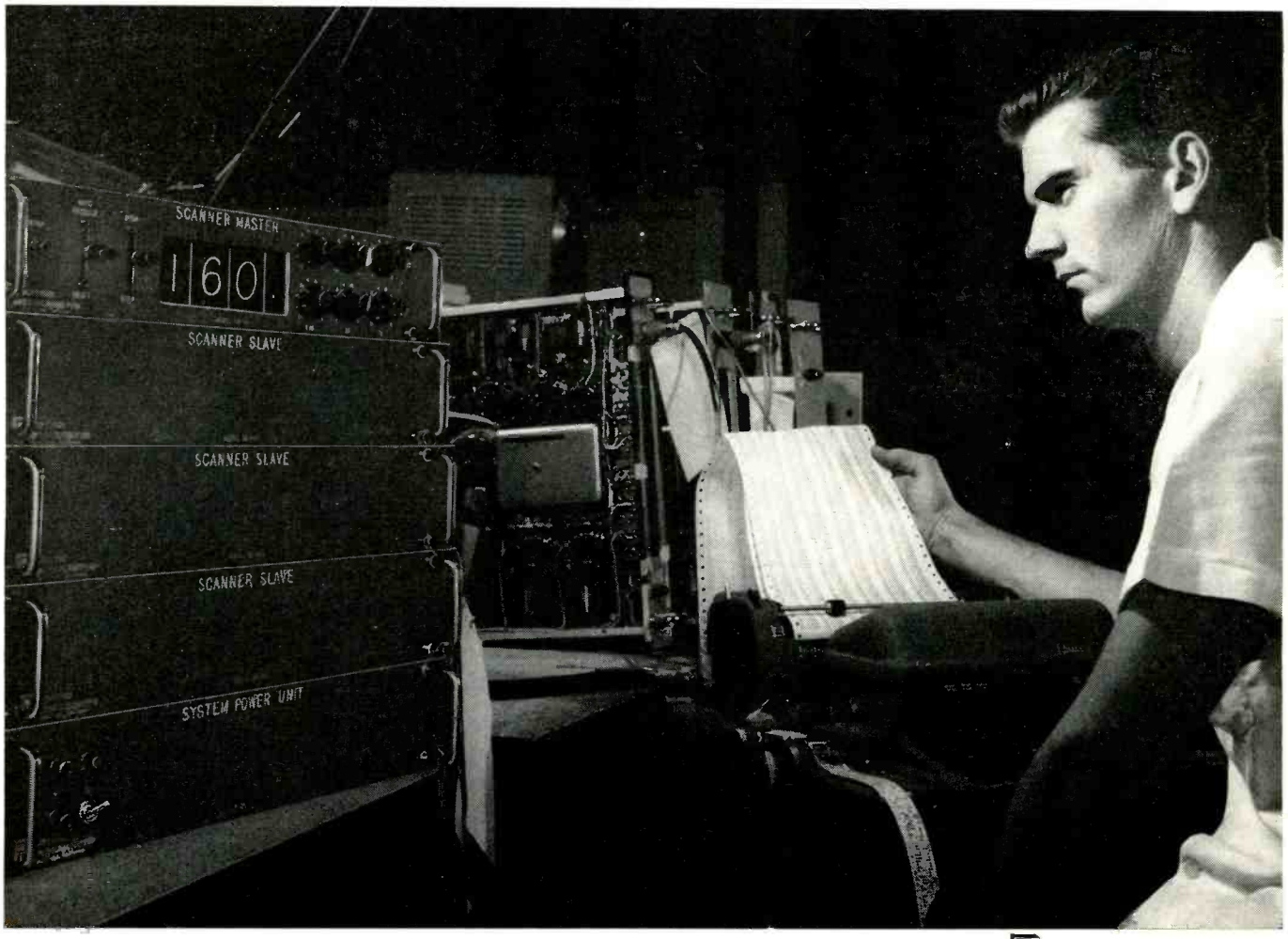
Typical E-I system for evaluating components—includes 100 channel input signal scanner. Can digitize DC voltage, resistance, AC voltage and DC/DC voltage ratio analogs. Digital equivalents are recorded on strip printer for "quick look" data and on punch paper tape for additional data reduction by digital computer.

Small E-I automatic digital systems provide many advantages. First, they cost less. This is primarily the result of large-quantity manufacture of modules which make up the E-I system. Cost is almost a linear function of performance capabilities desired in the system.

Second, they are exceptionally versatile. The E-I system can be expanded simply by adding appropriate modules. Typical systems presently in use measure resistance, capacitance, DC and AC voltages, DC/DC ratios, AC/DC ratios, AC/AC ratios and combinations of these. Measurements to four or five digits can be visually displayed and printed out at rates up to five readings per second. Operation can be semi- or totally automatic with go/no go comparison of values and programmed readout at periodic intervals. Scanners can be provided for scanning thousands of single and multi-wire input channels. In brief, the E-I system has an extensive scope of operating capability.

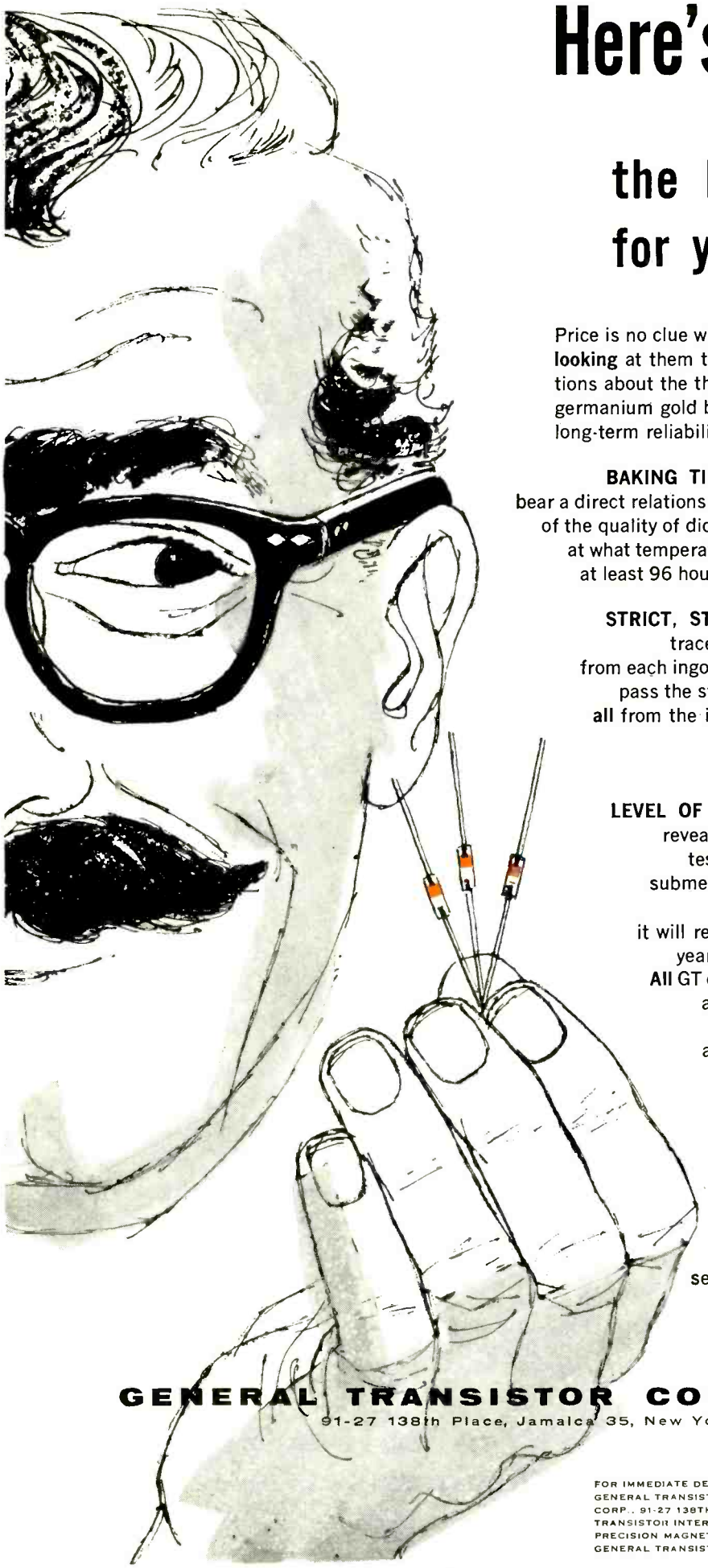
Third, E-I systems provide unmatched reliability. Where practicable, circuits are totally transistorized. The use of etched, plug-in circuit boards, and modular internal construction make maintenance checks and in-plant repairs easy.

Lower cost, maximum versatility and greater reliability—if you want these advantages in your component test system, contact your nearest E-I representative. He can give you complete information or answer any specific questions you may have.



Electro Instruments, Inc.

3540 AERO COURT
SAN DIEGO 11, CALIF.



Here's how to pick the best DIODES for your money

Price is no clue when diodes sell for about the same, and just **looking** at them tells nothing. But if you ask the right questions about the three key factors in the production of **quality** germanium gold bonded diodes, you have your clues to more long-term reliability for your money. Here they are:

BAKING TIME AND TEMPERATURE
bear a direct relationship to long-term stability. You get a measure of the quality of diodes by asking: "How long do you bake, and at what temperature?" (**All** GT diodes are baked at 140°C for at least 96 hours—the highest and longest in the industry!)

STRICT, STATISTICAL, HISTORY LOGGING
traces the progress of every single wafer made from each ingot of germanium. At GT, if a few wafers fail to pass the stringent GT quality tests along the way, then **all** from the ingot are suspect and can be identified and pulled out. There are no "stowaways" in a shipment of GT quality diodes.

LEVEL OF TESTING STANDARDS
reveals the level of quality. Ask about "everyday" test standards. (In the GT Seal Test, diodes are submerged in a penetrant-dye solution for 24 hours under 75 psi. This test is so sensitive that it will reveal a leak so small it would take over 300 years for 1 cc of gas to diffuse through the case.) **All** GT quality tests—100% electrical, 100% shock and vibration, and 100% temperature cycling—are at the highest industry level... and as a final mark of quality, the color bands on GT Germanium Gold Bonded Diodes are baked on to stay.

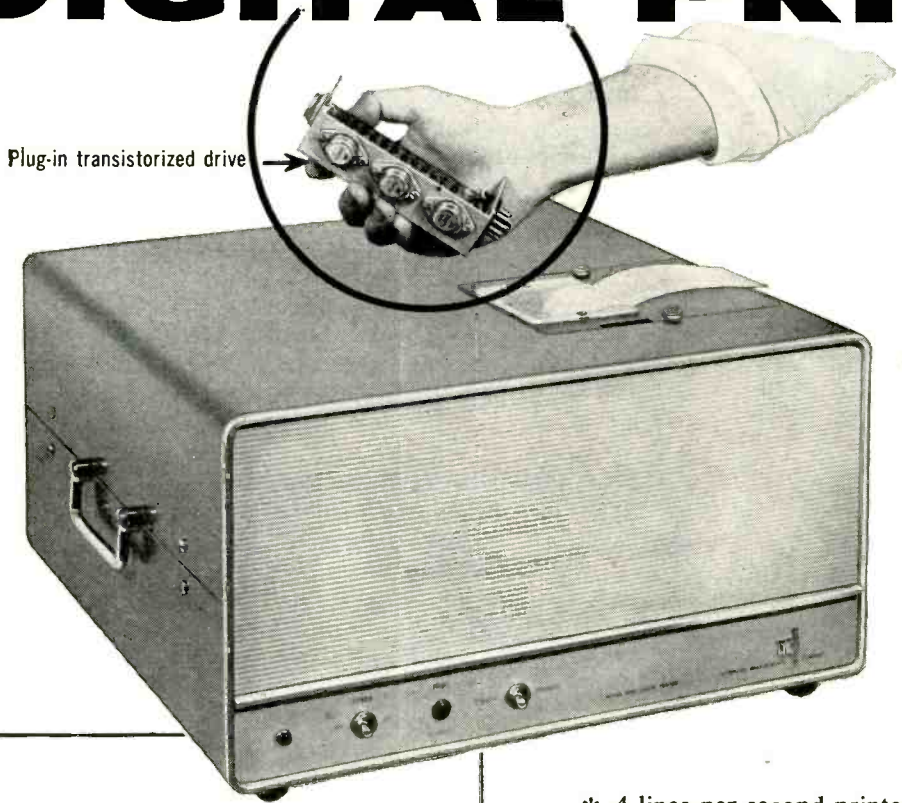
GT is equipped to supply diodes tested to individual customer requirements, such as JAN Qualification Inspection Tests and many others.
To get the full measure of quality in Germanium Gold Bonded Diodes, see your GT representative; or write directly to the company with know-how **NOW.**

GENERAL TRANSISTOR CORPORATION
91-27 138th Place, Jamaica 35, New York

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. PRECISION MAGNETIC RECORDING HEADS AVAILABLE FROM GENERAL TRANSISTOR WESTERN CORP., 6110 VENICE BLVD., LOS ANGELES, CALIF.

only CMC makes a

solid state DIGITAL PRINTER



Announcing the 400 CT-

The most versatile digital printer ever made

SPECIFICATIONS

Printout capacity	6 digits standard.
Accuracy	determined by basic counting instrument.
Display time	0.2 seconds minimum, maximum controlled by the counter.
Weight	60 lbs.
Power requirements	115 volts ±10%, 50-60 cps 25 watts
Dimensions	17" W x 8½" H x 16½" D. (Rack mounting available as option D.)
Warranty	One year on electronics; 1.5 million lines @ 4 lines per second on matrix; 10 million lines @ 4 lines per second on printer assembly, or 1 year, whichever occurs first.
Price	$1350.00. Add $10.00 for rack mount.

* 4 lines per second printout * Takes 1-2-2-4 or 1-2-4-8 four line code * No stepping switches * Operates from only 6 volt input * Parallel entry * Special options available including 10 line and analog output * 6 digit printout, up to 12 digits on special order * Rugged unitized construction * Completely compatible with CMC's new solid state frequency-period counters, and other types of transistorized counting equipment.

For a demonstration of this remarkable new printer and complete technical information, call your nearby CMC engineering representative or write to us direct. Please address Dept. 1811.

CMC

Computer-Measurements Company *A Division of Pacific Industries, Inc.*

12970 Bradley Avenue • Sylmar, California

Phone: EMpire 7-2161

Engineer-Scientist Coming

U. S. scientific education is now undergoing sweeping changes in philosophy and content

CAMBRIDGE, MASS.—The engineering-scientist — an arranger, composer and innovator—will begin to emerge from schools of engineering in the next five years as the product of sweeping changes in the philosophy and content of scientific education in the U. S.

The engineers of the future will be a breed apart from craftsmen, technicians, custodians of known technology, says Dean Gordon S. Brown of the MIT School of Engineering.

They will be so well-grounded in science that they themselves can be the instigators of change and can shape modern scientific knowledge into useful new configurations of matter, elements, devices, systems.

Engineer's Needs

No one can predict what machines or devices the electrical engineer will be working with in the future, Dean Brown points out. But whatever they are, they will involve charged carriers, electrical and magnetic fields, and the interaction of these phenomena with materials; whatever the device or system, the engineer will be processing energy or information.

He will need intensive training in physics, field theory, structural chemistry and other disciplines—the whole pervaded by the hard-headed purposefulness of engineering.

"Doing engineering is practicing the art of the organized forcing of technological change," says Dean Brown, chief architect of MIT's revolution in engineering education. The pilot program—resulting from a study begun in the pre-Sputnik days of 1956—is being expanded and the pace stepped up by a $9,275,000 grant from the Ford Foundation, nearly half of the foundation's $19,050,000 to 10 universities and institutes.

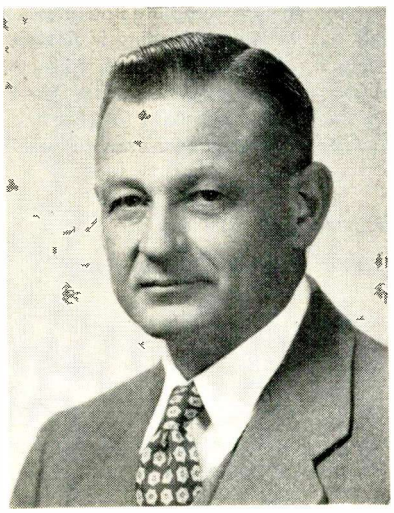
MIT's efforts will be directed to educating teachers as well as students. The whole educational process is changing, from elementary school up, says Dean Brown. The new students will demand of the college faculty a more rigorous, more intellectually penetrating course of studies. The prospective engineer-scientist will be lost to society if he is not put in an environment which can tax his ability.

Greater Flexibility

The MIT program will be geared to those who will go on for doctor's degrees. It is expected, however, that B.S. recipients will have greater flexibility and get more mileage out of their degrees than previously.

Core curricula for training of the engineer-scientist will cut across traditional departments and prepare the student for frontier fields, such as materials, propulsion, energy processing, information processing.

The Ford Foundation money will be used by MIT to endow seven professorships in newly emerging fields; evolve syntheses of courses to couple the basic sciences with the new fields; develop labs and lab apparatus to illustrate fundamental concepts and to develop skill at experimental learning; set up internships, research fellowships, loan programs, visiting professorships and various educational conferences.

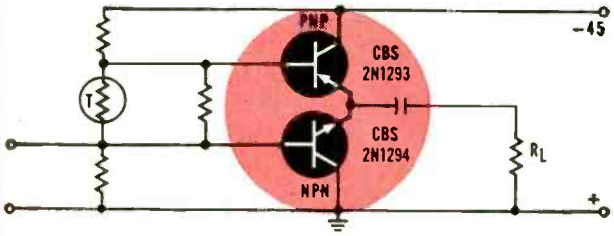


Dean Gordon S. Brown of MIT's School of Engineering is working to prepare students for tomorrow's "frontier fields"

First of a series of
complementary power transistor lines

NEW CIRCUIT ECONOMIES THROUGH COMPLEMENTARY POWER TRANSISTOR PAIRS

Complementary pairs of CBS NPN and PNP power transistors eliminate input and output transformers in push-pull circuits. Resulting advantages are many: Economy. Miniaturization. Improved frequency response. Ease of applying negative feedback. Etc.



COMPLEMENTARY CLASS B AMPLIFIER

NOTE THE IDENTICAL DATA FOR THESE NPN-PNP PAIRS

NPN Type	Max. W. Diss.*	Max. V_{CBO} ‡	Max. V_{CES}‡	Min. h_{FE} (I_C=0.5A)	Max. Thermal Res.°C/W	PNP Type
2N326	7	35	35†	30	8	**2N1291**
2N1292	20	35	30#	30	3	**2N1291**
2N1294	20	60	45#	30	3	**2N1293**
2N1296	20	80	60#	30	3	**2N1295**
2N1298	20	100	80#	30	3	**2N1297**

All types have: Max. collector current, 3 amps; storage temperature, −65 to +85°C. *25°C base mounting temperature. ‡Polarity: NPN positive, PNP negative. †I_{CES} = 1 ma max. #I_{CES} = 10 ma.

A SURVEY of customer applications resulted in this planned line of five CBS NPN-PNP pairs that make possible new design economies in complementary circuitry. Mounted in the popular TO-3 diamond package, they feature high voltages . . . up to 100 volts, and proven reliability (they exceed the MIL-T-19500A specification). They offer the first complete line of complementary power transistors . . . with more coming in flexible ranges of ratings and packages . . . for audio, control, voltage-regulation, servo and computer applications. Check the basic simplicity of the circuit and the abbreviated data for this first versatile and comprehensive CBS line. Write for complete technical Bulletin E-332A.

More reliable products
through Advanced Engineering

CBS semiconductors®

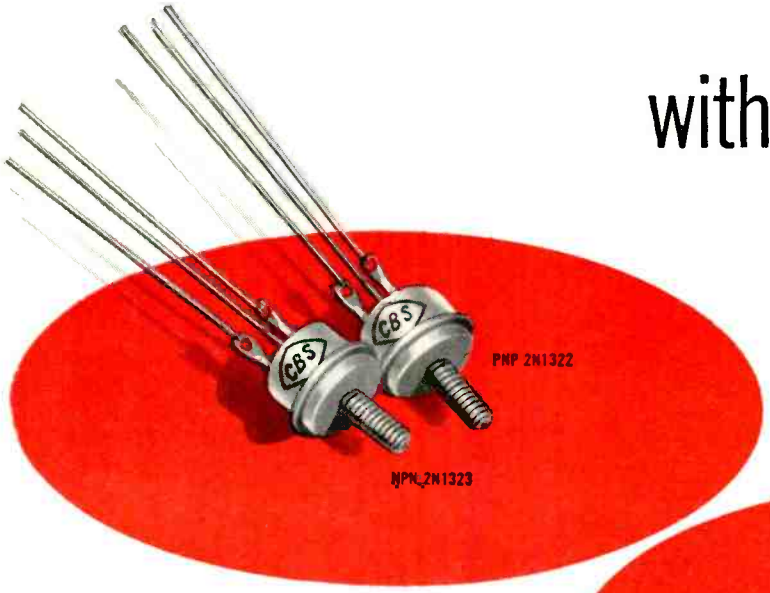
CBS ELECTRONICS, Semiconductor Operations
A Division of Columbia Broadcasting System, Inc.

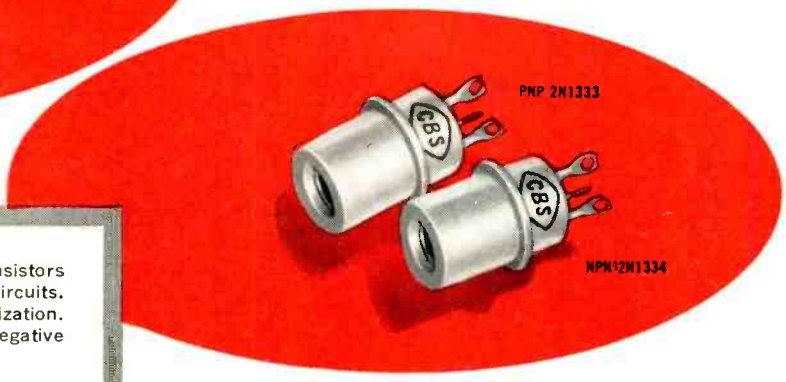
Sales Offices: **Lowell, Massachusetts,** 900 Chelmsford St., GLenview 4-0446 • **Newark, N. J.,** 32 Green St., MArket 3-5832 • **Melrose Park, Ill.,** 1990 No. Mannheim Rd., ESTebrook 9-2100 • **Los Angeles, Calif.,** 2120 S. Garfield Ave., RAymond 3-9081

Second *of a series of complementary power transistor lines*

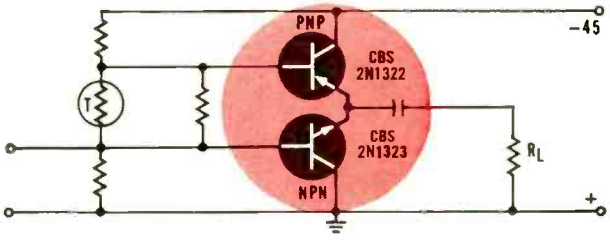
NOW... COMPLEMENTARY CIRCUIT ECONOMIES

with INDUSTRIAL NPN-PNP POWER TRANSISTOR PAIRS





Complementary pairs of CBS NPN and PNP power transistors eliminate input and output transformers in push-pull circuits. Resulting advantages are many: Economy. Miniaturization. Improved frequency response. Ease of applying negative feedback. Etc.



Typical Industrial Complementary Push-Pull Amplifier

INDUSTRIAL NPN-PNP POWER TRANSISTOR PAIRS

NPN Type	Package	Max. W. Diss.*	Max. V_{CBO}‡	Max. V_{CES}‡	Min. h_{FE} (I_C=0.5A)	Max. Thermal Res. °C/W	PNP Type
2N1321 2N1329	Male Female	20	35	30#	30	3	2N1320 2N1328
2N1323 2N1330	Male Female	20	60	45#	30	3	2N1322 2N1078
2N1325 2N1332	Male Female	20	80	60#	30	3	2N1324 2N1331
2N1327 2N1334	Male Female	20	100	80#	30	3	2N1326 2N1333

All types have: Max. collector current, 3 amps; storage temperature, —65 to +85°C.
*25°C base mounting temperature. ‡Polarity: NPN positive, PNP negative.
#I_{CES} = 10 ma.

Enthusiastic acceptance of the diamond-package line of CBS NPN-PNP power transistors has disclosed a demand for additional pairs in industrial packages. These new industrial types make possible the same design economies of complementary circuitry. Mounted in TO-10 and TO-13 male and female packages, they are supplied with solder lugs or flying leads. And they feature high voltages (up to 100 volts) and proven quality (they exceed the MIL-T-19500A specification). The new units add another complete industrial line to the growing lines of CBS complementary power transistors for audio, control, voltage-regulation, servo and computer applications. Check circuit and abbreviated data. Write for complete data sheets: Industrial types, Bulletin E-360; diamond types, E-355. Order now from your local Manufacturers Warehousing Distributor. Watch for a higher power line soon.

More reliable products through Advanced Engineering

CBS semiconductors®

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

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

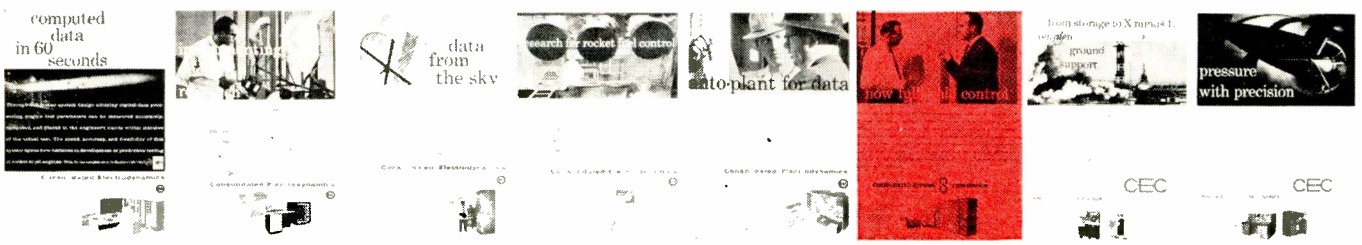
new symbol for systems

In five years of operation, Consolidated Systems has climbed from less than one-quarter million to over ten million dollars per year in custom-engineered systems for dynamic and static testing, chemical analysis, industrial control, and high-speed analog and digital data processing. This unprecedented growth in specialized systems (including missile ground support and cryogenics) is proof of quality—of performance—and of customer satisfaction. Over 500 systems have been designed, manufactured, installed, and kept in service. These are *operating* systems producing data where time is critical and performance is paramount. Read about them in Bulletin 1458-X3.

CONSOLIDATED SYSTEMS CORPORATION

1500 So. Shamrock Ave., Monrovia, California

A SUBSIDIARY OF CONSOLIDATED ELECTRODYNAMICS



Schools Report New Studies

INCREASING their already significant role in electronics, the nation's universities are ending this year with announcements of many new technical developments and activities.

Some of these will have fairly immediate practical value, others will make their contribution by using basic research to pave the way for future expansions. Here are some examples:

• **University of Florida**—Researchers here report progress in studies of collisions of gaseous ions. The objectives of their work are threefold: the investigation of forces between ions and gas atoms and molecules by elastic scattering measurements; the investigation of in-elastic processes (such as electron exchange and electron detachment) which occur in collisions of ions with neutral particles; and the formation of ions by electron bombardment of gas molecules.

This research is being applied to gaseous electrical discharges, negative ion stability, upper atmosphere physics and ion-molecule reactions in gases. University authorities reveal that a new high-sensitivity high-resolution mass spectrometer for studies of negative ion formation is being constructed on the campus.

Also underway at UF are (1) experiments aimed at simulating aerodynamic heating and other types of surface heating of aircraft structures, and (2) applications of induction heating to the study of materials and structures at high temperatures. One 20-kw and two 200-kw r-f generators are being used on the project.

Ion interactions in electron beams are also being studied. This project is concerned with the nature and cause of instabilities which occur in electron beams in microwave tubes due to the presence of positive gas ions.

University scientists have constructed experimental tubes to check theories regarding the effect of boundaries in the frequency of certain modes of oscillating and to determine the effects of oscillations on beam shapes.

• **Polytechnic Institute of Brooklyn**—Dr. Arthur A. Oliner, research professor of electrical engineering, is winding up a trip to Japan where he lectured on development on microwave electronics before Japan's Institute of Electrical Engineers and the Tokyo section of IRE. His visit included tours of Japanese electronics laboratories.

• **University of California**—Electronics Research Laboratory officials report disclosure by Prof. J. R. Singer of an electronic method of measuring blood flow. The process works on the basis of the absorption of radio energy by protons, in this case, those of hydrogen atoms contained in the blood stream.

The part of the body to be studied is placed between the poles of a large electromagnet. This causes the protons, normally oriented at random, to align themselves in the same direction. A burst of radio energy is next sent through the tissue (less than 0.01 watt). Part of this energy is absorbed by the protons, knocking them out of alignment. A small receiver is used to measure the difference between the radiated energy and the residual energy of the radio burst. Through a short-duration continuous time check, researchers can determine the number of new protons entering the test area and from this calculate the rate of flow.

• **Marquette University**—Research on a 58,000-mc reflex klystron amplifier is being done here by Dr. Thomas Koryu Ishii in the university's new millimeter wave laboratory. Ishii is attempting to make a positive gain detector of millimeter waves using the regenerative action of the electron beam of the QK295 reflex klystron.

The new lab here, opened in July, is being operated on a research basis, under the direction of Prof. James D. Horgan.

Tuition Supplements—
One Good Way To Help Our Colleges And Universities

The business community has made an impressive start in going to the desperately needed financial aid of our colleges and universities. Business contributions to higher education have increased from only $40 million in 1950 to $136 million in 1958.

This rise in financial aid to higher education should be a great source of satisfaction to the business community. But it goes only part way toward meeting the growing needs of colleges and universities for financial help. Over the next ten years business aid to our privately supported colleges and universities alone must increase to at least $500 million a year merely to provide decent faculty salaries and meet the increased operating costs of taking care of enrollments that will almost double.

One pervasive reason why many business firms have not joined the ranks of the companies contributing to higher education seems to be that, in the interest of prestige and public relations, they are making their provision of aid contingent upon finding some particularly novel way of providing it. So long as this point of view persists, business aid will lag, for there are simply not enough ways of providing financial aid that are both notably novel and sensible.*

How The Plan Works

There are, however, some well-tested ways of providing aid which improve rather than fade in appeal with more using. One such way is the making of supplemental tuition payments to colleges and universities at which a company's employees take courses.

Many companies have scholarship or tuition-refund programs which cover all or part of the costs to their *employees* of taking college courses. But, in most colleges and universities, tuition charges fall far short of covering the full cost of the education given. By making an unrestricted "cost-of-education" grant a part of their employee scholarship or tuition-refund plans, these companies could make a material contribution toward covering the *college's* full costs as well.

The tuition supplement can be a fixed amount or a percentage of the tuition charged. Some plans provide for supplements as high as 100% of tuition, though there is usually an upper limit to the total supplemental payment given for each employee enrolled in the institution.

The plan seems to have originated with the Ford Motor Company Fund. When we at McGraw-Hill first learned of it, it appealed to us as having so many advantages, and so few disadvantages, that we adopted it as one part of our own program of financial aid.

---

*The efforts of the McGraw-Hill Publishing Company to find a suitable method of aiding higher education prompted the writing of a "more or less Socratic dialog" entitled *A Business Wrestling with the Problem of Aid to Colleges and Universities*. Copies of this pamphlet, which underlines the difficulty of finding both a novel and satisfactory method of providing aid, are available on request.

HOW THE HEADS OF SOME OF THE INSTITUTIONS TO WHICH McGRAW-HILL HAS MADE GRANTS FEEL ABOUT THE TUITION SUPPLEMENT PLAN

"We are pleased not only because this addition to the never adequate supply of non-earmarked funds is a most welcome one, but also because it attests to the fact that the employees of our neighboring business firms are benefiting from the courses we offer at times convenient for them. We hope this mutually beneficial plan may continue and grow with the years."

Grayson Kirk, President
Columbia University

"I shall take this occasion to express deep sentiments of appreciation, in my own name and in the name of the members of the Board of Trustees, for the very effective manner in which your corporation is aiding higher education by the payments made under your tuition supplement plan. Certainly your action is indicative of the fact that you realize industry and higher education must join forces to preserve the basic American system of free enterprise."

Very Reverend John A. Flynn, C.M.
President, St. John's University

"The growing recognition by business and industry of the financial needs and important services rendered to the community by the colleges and universities is most encouraging, and Temple University is deeply appreciative of the fine support extended through McGraw-Hill's program of supplementary grants."

Robert L. Johnson, President
Temple University

The Plan's Advantages

The main advantages of the tuition supplement plan are:

- **It is simple and easily administered.** Payments can be made when scholarships or tuition refunds are granted, or at another time convenient to the company.
- **It relieves the company of the difficult and sometimes disagreeable task of choosing one college rather than another.** The individual employee makes the choice.
- **It directly serves the interest of the company by encouraging and aiding the institutions where its employees take courses.** In a sense, the company makes contributions in direct proportion to the value it receives in education for its employees.
- **It directly serves the interest of the colleges and universities receiving the grants by getting money to them in the form most appreciated**—unrestricted funds to be used at the discretion of their administrators.

Largely because tuition supplements are unrestricted as to use, this plan enjoys the unqualified approval and gratitude of the schools receiving such aid. This is not true of some of the other plans for granting aid to colleges and universities.

Tuition supplements, of course, can't be regarded as large efforts relative to the need of higher education and the responsibilities of business. But they are a very practical and useful first step, involving almost no problems. If you are not familiar with the idea of supplemental grants, why not discuss it with some of your friends in the field of higher education?

The Price Of Novelty

Our experience with tuition supplements indicates that this is an excellent plan, and we are glad to recommend it to other companies looking for an effective method of providing financial aid to higher education.

At any rate, we hope that business firms will not postpone granting financial aid until they find some novel way of doing it. If they do, it will be another case of too little and too late.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw
PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

MEETINGS AHEAD

Nov. 23-24: Solid Facts About Solid State, Symposium, ISA, IRE, Ben Franklin Hotel, Philadelphia.

Dec. 1-2: Circuit Theory, Mid-West Symposium, PGCT of IRE, Brooks Memorial Union, Marquette Univ., Milwaukee.

Dec. 1-3: Eastern Joint Computer Conf., AIME, ACM, PGEC of IRE, Hotel Statler, Boston.

Dec. 3-4: Vehicular Communications, Annual Meeting, PGVC of IRE, Colonial Inn & Desert Ranch, St. Petersburg, Fla.

Dec. 8-10: Electrical Insulation, Applications, Nat. Conf., AIEE, NEMA, Shoreham Hotel, Cleveland.

Jan. 11-13: Reliability & Quality Control, National Symposium, ASQC, IRE, EIA, AIEE, Statler Hotel, Washington, D. C.

Jan. 31-Feb. 5: Comparison of Control Computers, Winter General Meeting, AIEE, New York City.

Feb. 3-5: Military Electronics, Winter Convention, Biltmore Hotel, Los Angeles.

Feb. 10-12: Solid State Circuits Conf., AIEE, IRE, Univ. of Penn., Philadelphia.

Feb. 11-13: Electronic Representatives Assoc., Annual Convention, Drake Hotel, Chicago.

Feb. 20-29: Component Parts and Electronic Tubes, International Exhibition, Porte de Versailles, Place Balard, Paris.

Mar. 21-24: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

Apr. 3-8: Nuclear Congress, EJC, PGNS of IRE, New York Coliseum, New York City.

Apr. 18-19: Automatic Techniques, Annual Conf., ASME, IRE, AIEE, Cleveland-Sheraton Hotel, Cleveland.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 114.

NEW

HIGH-VOLTAGE SILICON MESA TRANSISTORS

FAIRCHILD'S 2N699 OFFERS ANOTHER UNIQUE COMBINATION

120 VOLTS collector to base voltage, permits greater voltage swings in amplifier and oscillator circuits and more protection in inductive switching circuits. Maximum base-emitter turn-on voltage is only 1.3 volts for I_C=150 mA and I_B=15 mA.

120 MEGACYCLES typical gain-bandwidth product means excellent broad-band video performance. In addition the units will provide typically 18 db neutralized gain at 30 mc and 30% efficiency in a 70 mc oscillator circuit.

300° C SURVIVAL has been assured. Every transistor produced at Fairchild has been preaged a minimum of 60 hours at 300° C before test. This provides extra reliability at their recommended maximum operating junction temperature of 175° C.

2 WATTS dissipation at 25° C—the combination of power with high frequency that is available only in double diffused silicon transistors.

In Fairchild's recent succession of new transistor announcements, each has offered some exceptional combination of characteristics previously unattainable. The 2N699 combines high collector voltage rating with high-frequency performance, medium power capabilities and low saturation resistance. Its applications range from low-current high-frequency I-F circuits to high-current, low-frequency relay drivers. Other products nearing production at Fairchild promise even greater advances in the state of the art.

2N699—ELECTRICAL CHARACTERISTICS (25° C)

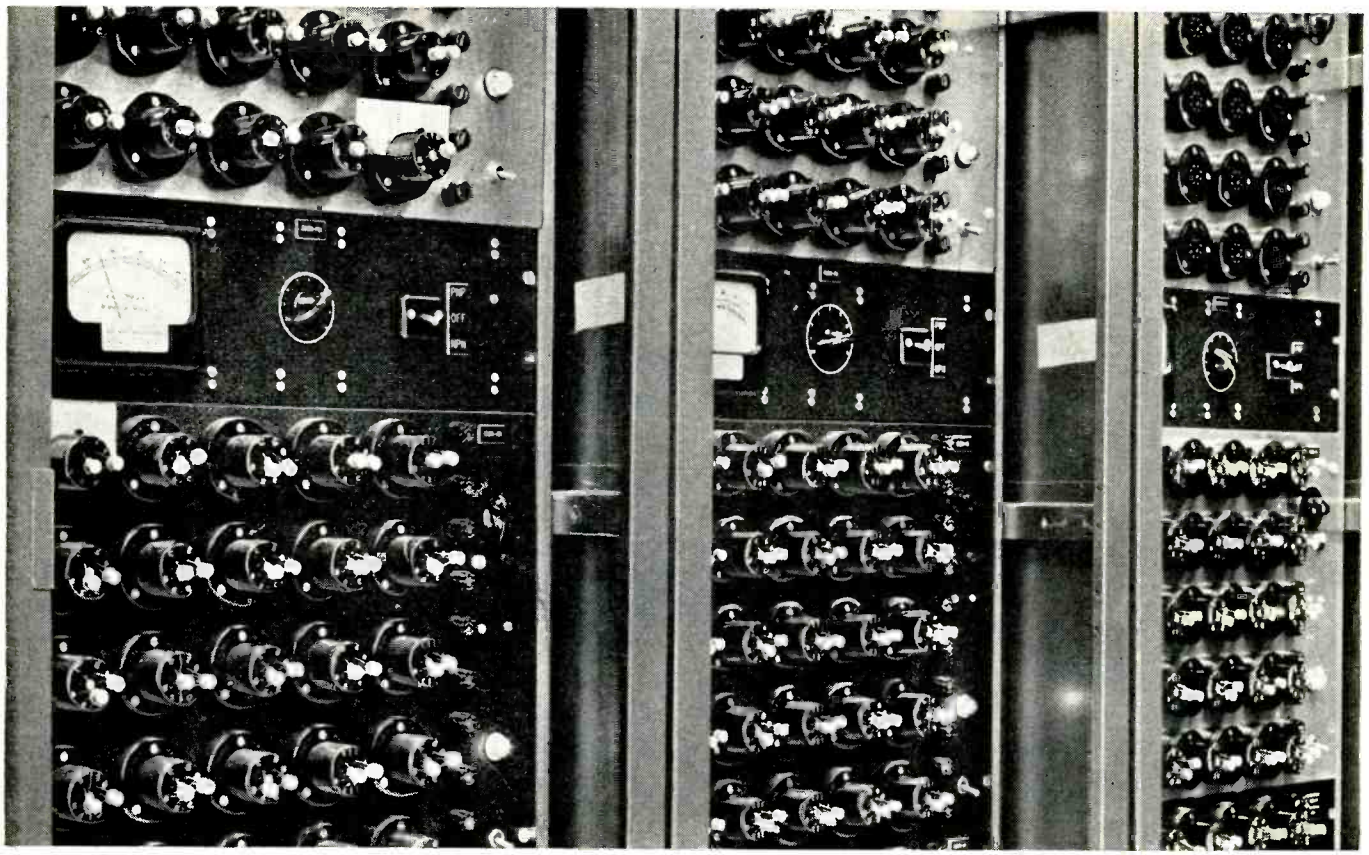
Symbol	Characteristic	Min.	Typ.	Max.	Test Conditions	
h_{FE}	D.C. pulse current gain	40		120	I_C = 150ma	V_C = 10v
$V_{BE(sat)}$	Base saturation voltage		1.0	1.3	I_C = 150ma	I_B = 15ma
$V_{CE(sat)}$	Collector saturation voltage			5v	I_C = 150ma	I_B = 15ma
h_{fe}	Small signal current gain at f = 20 mc	2.5	5.0		I_C = 50ma	V_C = 10v
C_{ob}	Collector capacitance		14$\mu\mu$f	20$\mu\mu$f	I_E = 10ma	V_C = 10v
I_{CBO}	Collector cutoff current			2μa	V_C = 60v	T = 25°C
				200μa	V_C = 60v	T = 150°C

A new plant of nearly ten-times increased capacity opened in June 1959 to fill demand created by new products introduced in less than a 12-month period.

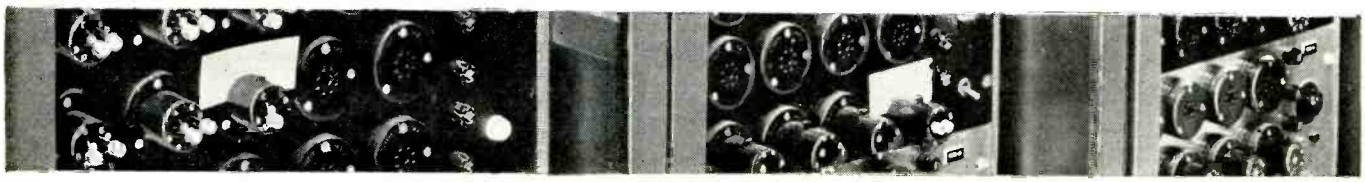
For full information, write Dept. A-11-20.

FAIRCHILD SEMICONDUCTOR CORPORATION

545 WHISMAN ROAD • MOUNTAIN VIEW, CALIF. • YOrkshire 8-8161
Regional sales offices in Los Angeles and Philadelphia



At this moment, 30,000 transistors are on test at General Electric



Among the more than 30,000 transistors you will find right now on General Electric's cycled life-test racks are Series 2N43 PNP germanium devices dating back to 1952.

Each of these 2N43's has clocked at least 40,000 hours of operating life. This represents five years of "power-on" operation without failure. And the "old" 43's still live on!

Since 1952, General Electric Company has produced and thoroughly tested well over 20-million transistors. A quarter-million of these devices have been subjected to from 1000 to 10,000 hours of maximum-rated-power.

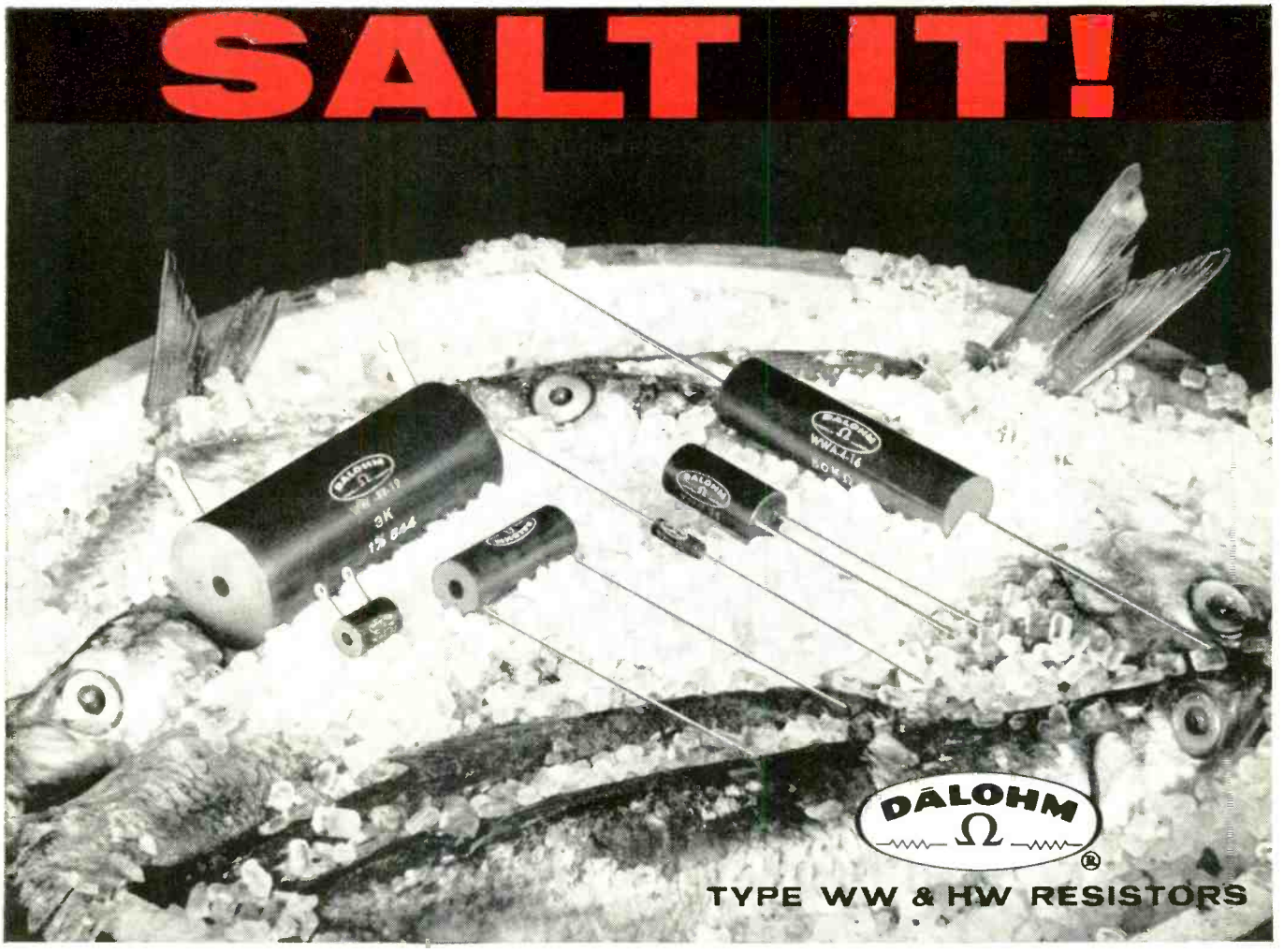
Life testing is but one of many exacting product quality-assurance criteria *all* General Electric semiconductor products must meet. For example, on an average, 16 separate quality-level tests . . . electrical, mechanical, environmental, as well as life . . . are given every General Electric transistor.

Through its system of stringent quality control, General Electric strives to continuously raise the stability/long-life reliability goals for semiconductor products—to the ultimate benefit of the user, the industry and the country at large.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Semiconductor Products Department, Electronics Park, Syracuse, New York



INHERENT STABILITY
Assured in a DALOHM WW or HW Resistor

Salt — a preservative in some instances and a gnawing destroyer in others — has no effect at all on the inherent stability that is standard in Dalohm resistors.

Stored on the shelf for months . . . or placed under continuous load . . . operating in severe environmental, shock, vibration and humidity conditions . . . Dalohm precision resistors retain their stability because it has been "firmly infixed" by Dalohm design and methods of manufacture.

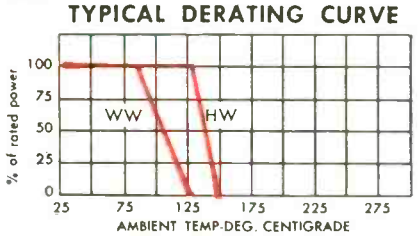
For all applications demanding resistors that meet or surpass MIL specifications, you can depend on Dalohm.

WIRE WOUND • BOBBIN TYPE • ENCAPSULATED
DALOHM TYPE WW & HW RESISTORS

High resistance value, wire wound resistors designed for non-inductive requirements demanding the closest tolerances. Encapsulated in carefully compounded material, selected for matching coefficient of expansion to that of wire.

Configurations: WWA—axial leads; WWP—parallel leads; WWR—radial leads; WWL—lug style terminals; WW-RB—military style with lug terminals; HW—high temperature applications.

TYPICAL DERATING CURVE



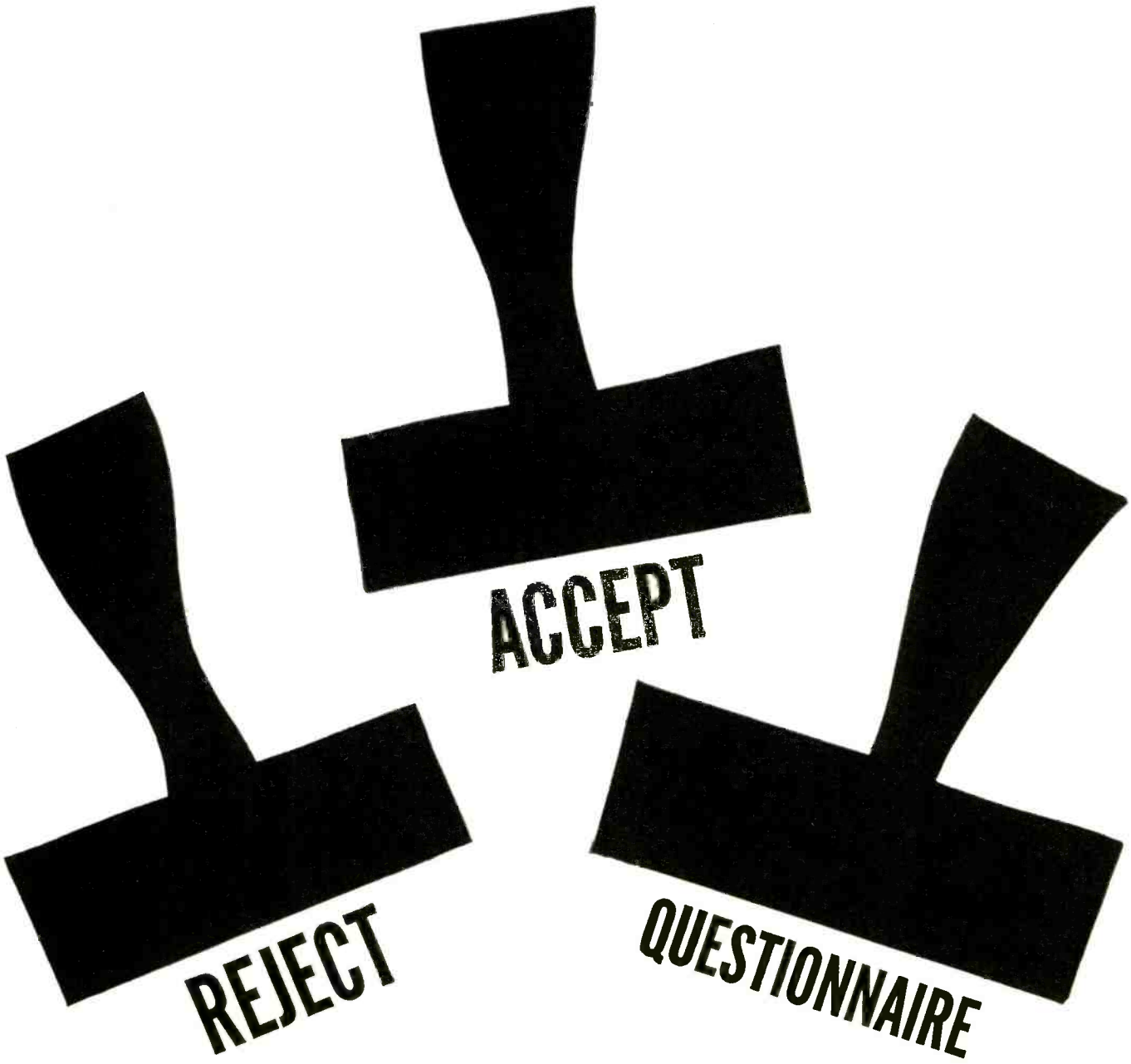
- **Rated at** 0.1 watt to 2 watts, with a wide selection of sizes
- **Resistance range** from 0.6 ohm to 6 megohms, depending on type
- **Tolerance** ± 0.05%, ± 0.1%, ± 0.25%, ± 0.5%, ± 1%, ± 3%
- **Temperature coefficient** 20 P.P.M. per degree C.
- **Operating temperature range** from —55° C. to + 125° C. for WW Type and —55° C. to + 145° C. for HW Type
- **Smallest in size,** ranging from 1/8" x 3/8" to 7/8" x 2 1/8"
- Surpass MIL-R-93B, characteristics A and C and MIL-R-9444 (USAF).

Write for Bulletin R-26, with handy cross-reference file card.

SPECIAL PROBLEMS?

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

from **DALOHM**
Better things in smaller packages
DALE PRODUCTS, INC.
1300 28th Ave., Columbus, Nebr.



THREE TOOLS FOR QUALITY CIRCULATION

Members of a select group, the readers of **electronics**

As fast as subscription orders are received they are examined individually—by Hugh J. Quinn, Circulation Manager, who stamps each card:

ACCEPTED — to indicate a subscriber is actually engaged in research-design/production/management as a maker or user of electronics equipment.

QUESTIONNAIRE — to delay acceptance until information concerning the subscriber—his function, his company, his title are definitely known.

REJECTED — whenever the order indicates that the individual is NOT within the editorial field of the publication.

electronics is a member of a select group too—The Audit Bureau of Circulation publications—comprised of those magazines and newspapers whose publishers believe that a reader's interest in a publication is best demonstrated when he pays to receive it—those publishers willing to submit to exhaustive periodic audits in order to prove that their circulation is among those individuals they are pledged to serve, and among screened *selected* individuals ONLY.

The Electronics Man "buys" what he reads in...

A McGRAW-HILL PUBLICATION / 330 WEST 42nd STREET, NEW YORK 36, N. Y.

STACKPOLE

Coldite 70+®

fixed composition **RESISTORS**

1/2-, 1- and 2-watt sizes

The resistors that are setting today's higher performance standards! Unmatched for load life and moisture resistance—and, with performance that exceeds MIL-R-11 requirements. And now, for the first time, you can get such resistors in a *complete* line of RC-42 (2-watt); RC-32 (1-watt) and RC-20 (1/2-watt) types from stock from leading distributors!

FROM STOCK . . . from these selected STACKPOLE distributors:

BALTIMORE, MD.
Kann-Ellert Electronics, Inc.

BATTLE CREEK, MICH.
Electronic Supply Corp.

BIRMINGHAM, ALA.
MG Electrical Supply Co.

BOSTON, MASS.
Sager Electrical Supply

BROOKLYN, N. Y.
Electronic Equipment Corp.

CLEVELAND, OHIO
Pioneer Electronic Supply Co.

DALLAS, TEXAS
Wholesale Electronics Supply Co.

DAYTON, OHIO
Srepco, Inc.

DENVER, COLO.
Denver Electronics Supply Co.

GLENDALE, CALIF.
R. V. Weatherford Company

INDIANAPOLIS, INDIANA
Radio Distg. Co.

KANSAS CITY, MO.
Burstein-Applebee Co.

MELBOURNE, FLORIDA
Electronic Supply

MIAMI, FLORIDA
Electronic Supply

NEW YORK, N. Y.
Harvey Radio Co.

PHILADELPHIA, PA.
Almo Radio Co.

SAN DIEGO, CALIF.
Radio Parts Co.

SCRANTON, PA.
Fred P. Pursell

SEATTLE, WASH.
C & G Radio Supply Co.

ST. LOUIS, MO.
Interstate Supply Co.

SYRACUSE, N. Y.
Morris Electronics of Syracuse

TACOMA, WASH.
C & G Radio Supply Co.

WASHINGTON, D. C.
Electronic Wholesalers, Inc.

WATERBURY, CONN.
Bond Radio Supply Co. Inc.

WEST PALM BEACH, FLA.
Goddard Distributors, Inc.

WICHITA, KANSAS
Interstate Electronic Sup. Corp.

WILBRAHAM, MASS.
Industrial Components Corp.

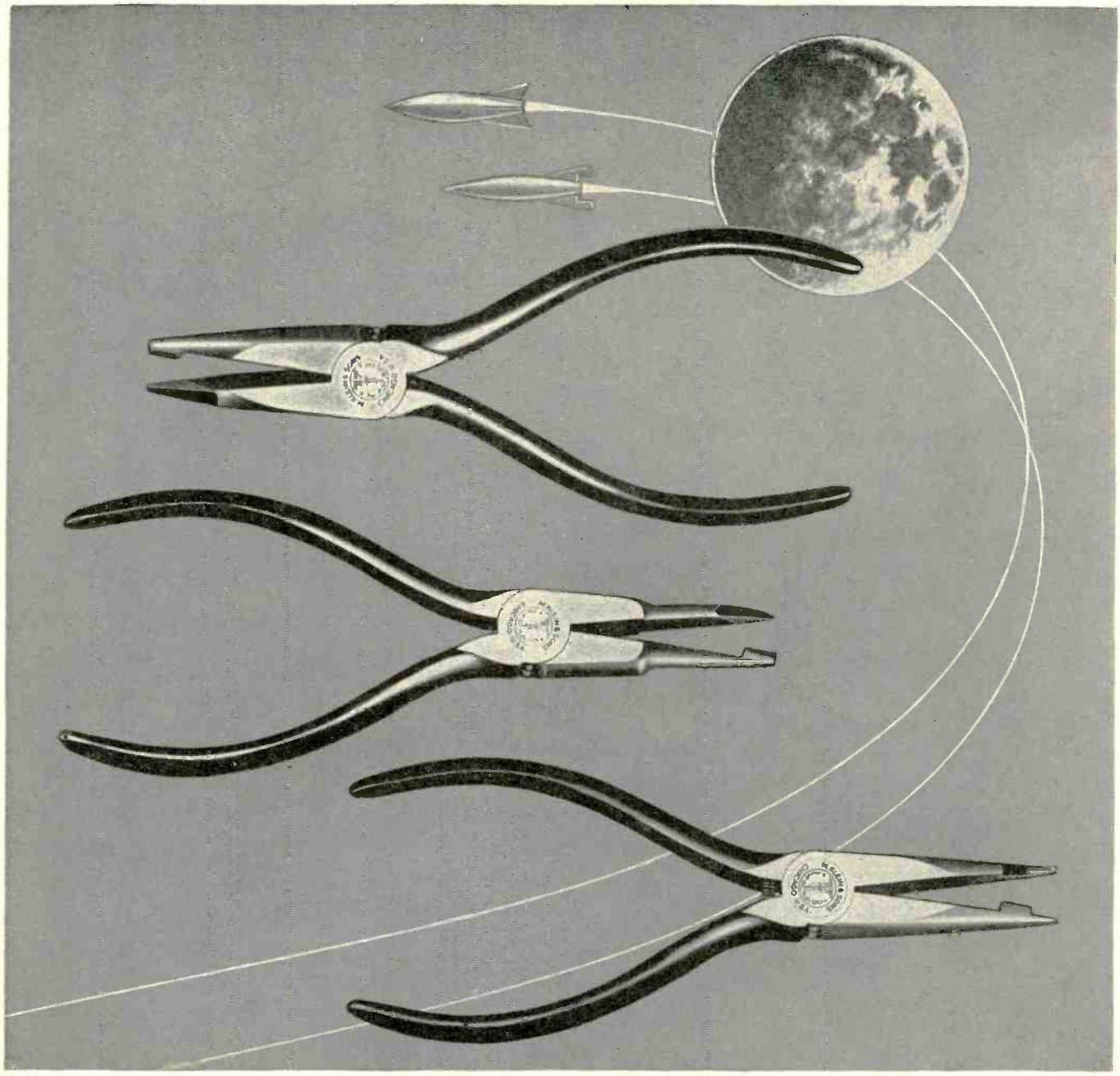
WINSTON-SALEM, N. C.
Dalton-Hege Radio Supply

. . . and G-C/STACKPOLE, TOO!

Attractively packaged by G-C Electronics for service replacement uses, Coldite 70+ Resistors are also available through over 800 G-C distributors.

THREE KLEIN PLIERS

to make electrical wiring easier



Here are three newly engineered Klein Pliers which will solve difficult problems in the wiring of electronic assemblies. Catalog 101-A illustrates and describes these and twenty other new pliers in the Klein line. If you wire electronic assemblies, write for a copy.

ALL-PURPOSE ELECTRONIC PLIER
Patent pending

Shear blade cuts flush and holds clipped end of wire

Requires no sharpening; will cut hard or soft wire. Smooth, continuous action prevents shock which may damage resistors. For bare wire up to 18 gauge.

No. 260-6—length 6⅜"

No. 260-6C—with coil spring that holds jaws open

NEEDLE-NOSE PLIER Patent pending

Similar to No. 260-6 but nose has been slimmed down to permit use in confined areas.

No. 261-6—length 6⅜"

No. 261-6C—with coil spring to hold jaws open

LONG-NOSE PLIER—KNIFE AT TIP Pat. No. 2,848,724

Jaws behind blade hold clipped wire end firmly

A shear-cutting plier that will cut hard or soft wire. Blade is at the tip of the plier. Supplied with coil spring to keep jaws apart.

No. 208-6PC—length 6⅝"

Mathias Established 1857 **KLEIN** & Sons Chicago, Ill., U.S.A.

7200 McCORMICK ROAD • CHICAGO 45, ILLINOIS

Write for Catalog 101-A, which shows the complete line of Klein Pliers, including 20 pliers recently developed.

have you checked this

Remote Actuator for jobs

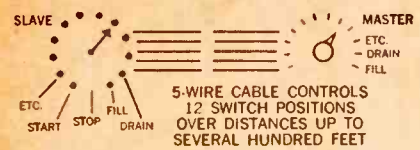
under Shock and Vibration?

...OAK ROTARY SOLENOIDS

(Mfd. under license from G. H. LELAND, INC.)

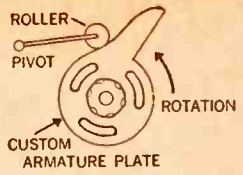
MODEL 5E
SHOWN ACTUAL SIZE

CUSTOM-BUILT FOR—



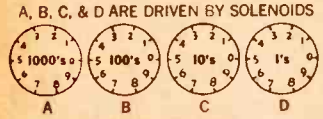
5-WIRE CABLE CONTROLS 12 SWITCH POSITIONS OVER DISTANCES UP TO SEVERAL HUNDRED FEET

MASTER-SLAVE DEVICES
(Incremental Positioning)



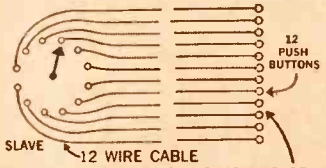
CAM LIFTS

A, B, C, & D ARE DRIVEN BY SOLENOIDS



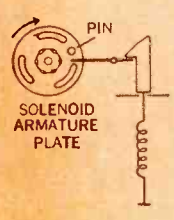
4 DECADE COUNTER
ADDED SWITCHING ALLOWS PRESETTING A FUNCTION TO OCCUR AT ANY COUNT SUCH AS SHUT OFF WATER AT 397 COUNT, ETC.

PRESETTABLE COUNTING DEVICES

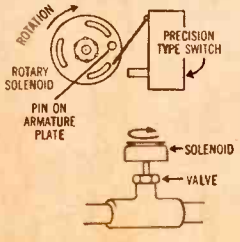


INSTANTANEOUS POSITIONING OF SLAVE BY PUSHING A BUTTON

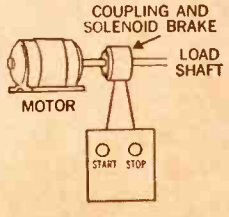
AUTOMATIC SWITCHING



TRIPPING DEVICES

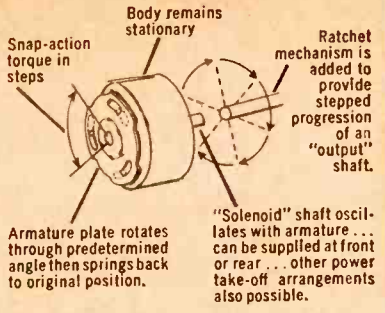


ACTUATORS



CLUTCHES and BRAKES
(When Modified for Straight Pull)

OPERATES IN ANY POSITION



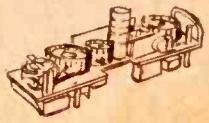
EXTREMELY ADAPTABLE

HERMETICALLY SEALED

ROTATES IN BOTH DIRECTIONS

WITH SEALED DUST CAP

BUILT INTO COMPLETE SUBCHASSIS



stepping torques from 6.4 to 64 inch-ounces

If you've been searching for an actuator that meets such specs as MIL-S-4040A, and is remarkably small for the amount of work it can do, investigate Oak Rotary Solenoids. They operate on DC and are designed for intermittent service. Standard models give steps of 25°, 35°, 45°, 67.5°, or 95° in either a left or right-hand direction. Self-stepping or externally pulsed units are also built. Oak Rotary Solenoids find wide use in both commercial and military equipment. Why not evaluate their unusual capabilities for your next project. We will be glad to help you engineer the job. Just send us a short description and sketch.

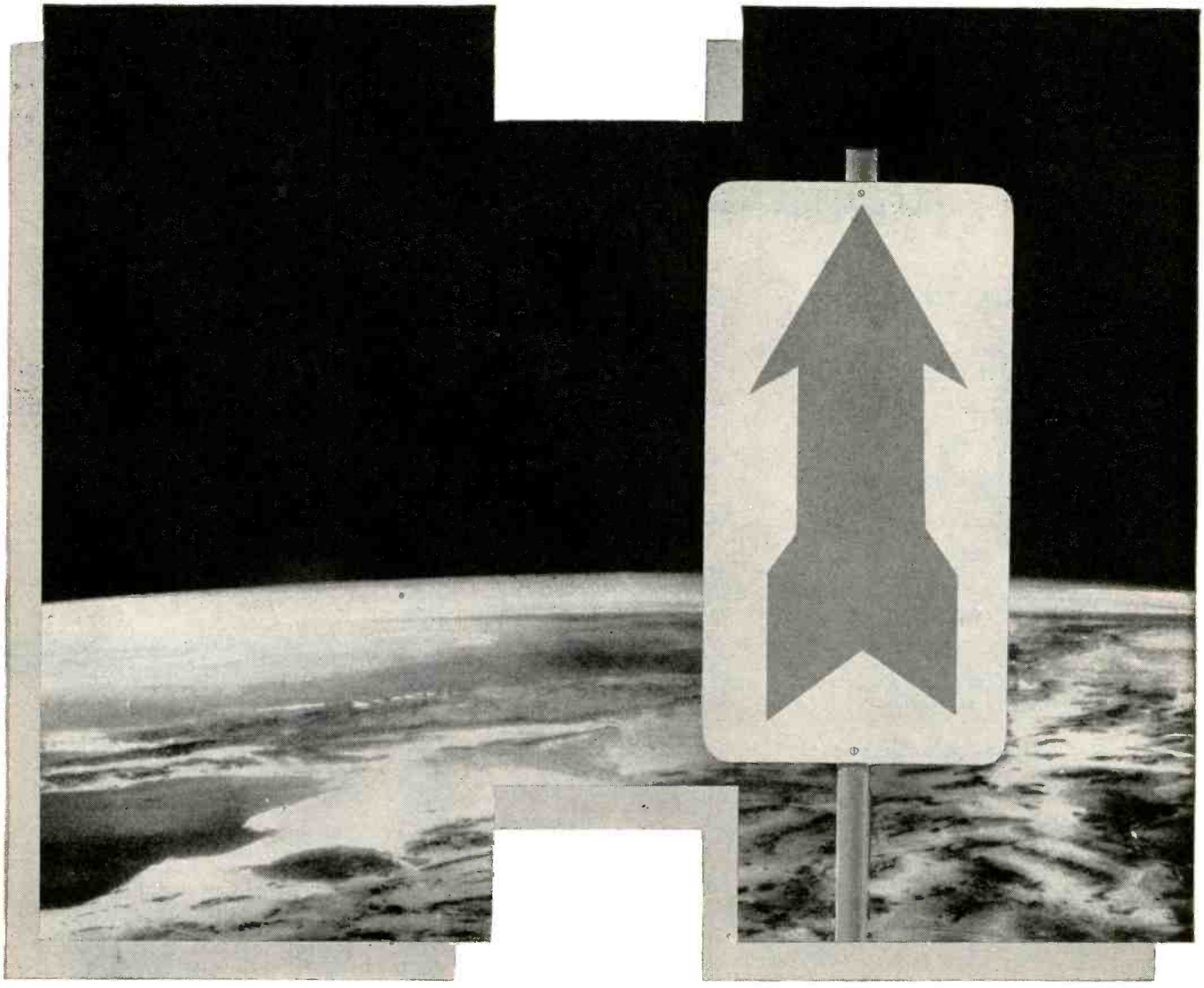
OAK MFG. CO.

1260 Clybourn Ave., Dept. G Chicago 10, Illinois
Phone: MOhawk 4-2222

SWITCHES • ROTARY SOLENOIDS • CHOPPERS
VIBRATORS • TUNERS
SUBASSEMBLIES

CIRCLE 67 ON READER SERVICE CARD 67

Sign of the



Southern California and Arizona from 143 miles up, *photographed from a Navy Viking 12 rocket, fired from White Sands, N.M. Dark patch at lower left is the Gulf of California.*

times

Going up... and out into space... this is one of the assignments of engineers in the laboratories at Hughes.

To meet the demands of the Space Age, a wide variety of new projects is being initiated. Here are just a few examples:

Space Ferry Systems—To provide the initial apparatus for space station assembly.

Communications Satellites—Unique packages for space satellite applications.

ALIRBM—Air launched intermediate range ballistic missiles.

Global Surveillance Satellite Systems—To keep the world under surveillance.

Satellite Interception Systems—To destroy hostile satellites.

Meteor Communications—Scattering electromagnetic energy off meteors to establish long-range communications.

Futuristic Instrumentation Displays—Instrumentation displays for satellites and hypersonic vehicles.

Other Hughes activities are also participating in advanced Research and Development. Engineers at Hughes in Fullerton are developing new types of radar antennas which scan by electronic rather than mechanical means. Hughes Engineers in El Segundo develop test equipment which is as advanced as the equipment being tested. At Hughes Products, the commercial activity of Hughes, new ways have been found to *cast* silicon into desired configurations... and storage tubes with 21" diameters have been developed.

Today Hughes offers Engineers and Physicists the chance to work on stimulating projects in a wide variety of fields. Never have the opportunities been more promising!

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

Nuclear Electronics	Communications
Infrared	Circuit Design & Evaluation
Digital Computers	Solid State Physics
Systems Design & Analysis	Electroluminescence
Thin Films	Storage Tubes
Field Engineering	Quartz Crystal Filters

Write in confidence to Dr. R. A. Martin
Hughes General Offices, Bldg. 6-D11, Culver City, Calif.

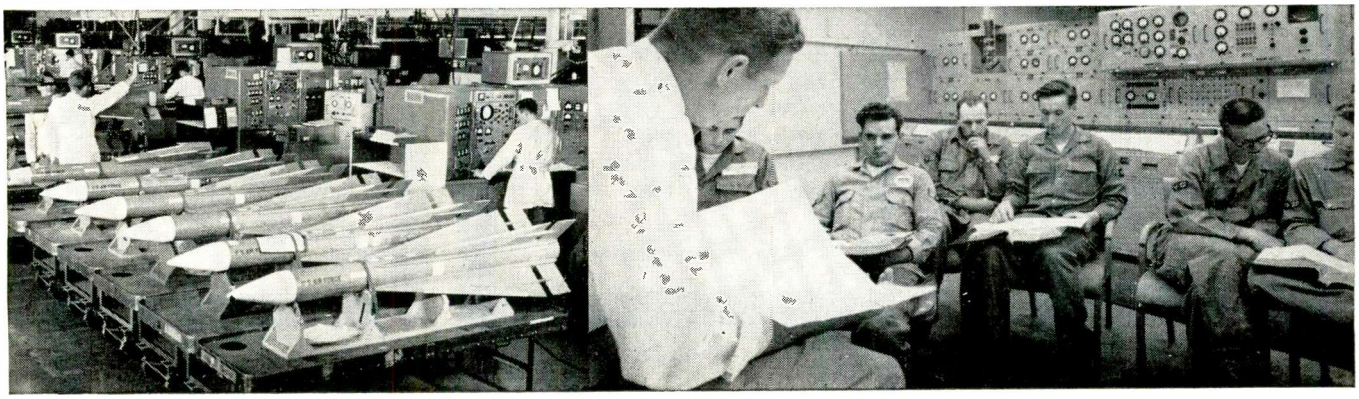
The West's leader in advanced ELECTRONICS

HUGHES

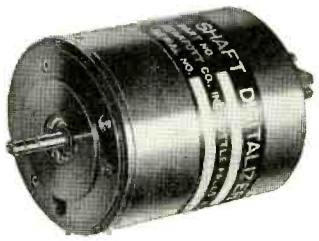
HUGHES AIRCRAFT COMPANY
Culver City, El Segundo,
Fullerton and Los Angeles, California
Tucson, Arizona

Advanced Falcon guided missiles *are manufactured by the Hughes facility in Tucson... the largest electronics facility in all of Arizona!*

Maintaining liaison *with Air Force Personnel and airframe manufacturers, Hughes Field Engineers give instruction in the over-all systems operation of advanced Hughes equipment.*



BASIC BUILDING BLOCKS FROM KEARFOTT



Analog-to-Digital Converters

Kearfott's rugged shaft position-to-digital converters are resistant to high shock and vibration and high and low temperature environments. Ideally suited for missile applications, these converters are available for many uses, including latitude, longitude, azimuth or conventional angular shaft displacement conversion and decimal count conversion. Exclusive drum design provides large conversion capacity in smallest size. Combination counter converter assemblies for both visual and electrical readout also available.

TYPICAL CHARACTERISTICS

Kearfott Unit No.	P1241-11A
Code	Cyclic Binary
Range	0-32,768 (2^{15})
Bits per Revolution	16
Revolutions for Total Range	2,048
Volts D.C.	10.5
Current (ma.)	20
Inertia (gm. $cm.^2$)	20
Unit Diameter (in.)	1⅛
Unit Length (in.)	3
Life	10^6 Revolutions or 10^3 hours
Static Torque (in.-oz.)	2 (break) 1 (running)
Weight (oz.)	5
Maximum Speed (RPM)	600

Write for new ADAC brochure.

BASIC BUILDING BLOCKS FROM KEARFOTT

20 Second Synchro

This synchro, just one of a broad line offered by Kearfott, provides the extreme accuracy required in today's data transmission systems. Kearfott synchro resolvers enable system designers to achieve unusual accuracy without the need for 2-speed servos and elaborate electronics. By proper impedance matches, up to 64 resolver control transformers can also operate from one resolver transmitter.

TYPICAL CHARACTERISTICS — SIZE 25

	Transmitter	Control Transformer
Type Resolver		
Part Number	Z5161-001	Z5151-003
Excit. Volts (Max.)	115	90
Frequency (cps)	400	400
Primary Imped.	400/80°	8500/80°
Secondary Imped.	260/80°	14000/80°
Transform. Ratio	.7826	1.278
Max. Error fr. E.Z.	20 seconds	20 seconds
Primary	Rotor	Stator

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT

Integrating Tachometers

Kearfott integrating tachometers, special types of rate generators, are almost invariably provided integrally coupled to a motor. They feature tachometer generators of high output-to-null ratio and are temperature stabilized or compensated for highest accuracy integration and rate computation. Linearity of these compact, lightweight tachometers ranges as low as .01% and is usually better than ± .1%.

TYPICAL CHARACTERISTICS

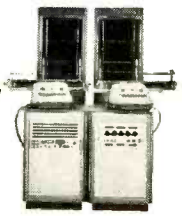
	Size 11 (R860)
Excitation Voltage (400 cps)	115
Volts at 0 rpm (RMS)	.020
Volts at 1000 rpm (RMS)	2.75
Phase shift at 3600 rpm	0°
Linearity at 0-3600 rpm	.07
Operating Temperature Range	−54° +125°

Write for complete data.

Miniature Floated Gyro

Electrohydraulic Servo Valve

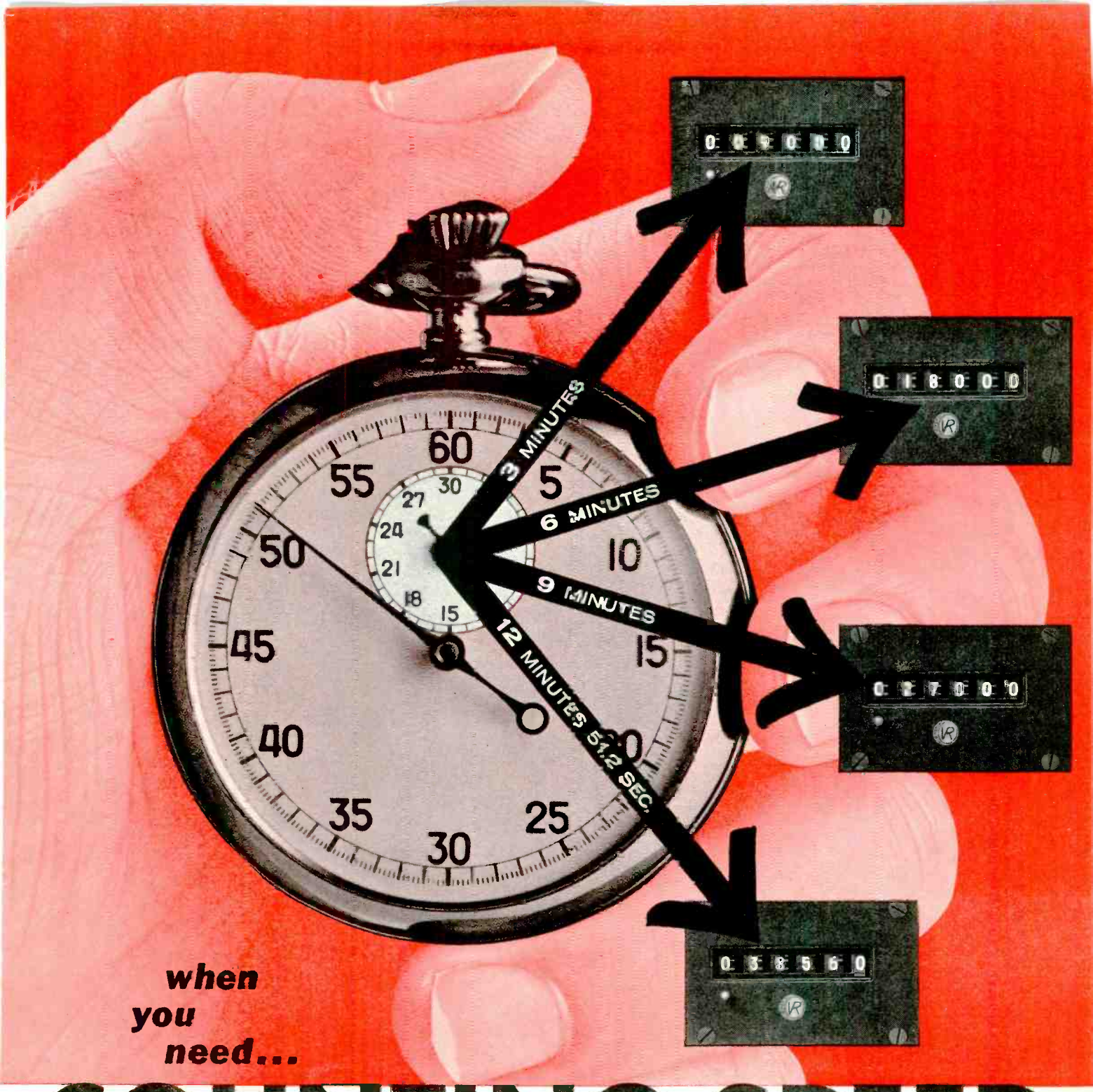
Scanalog 200-Scan Alarm Logging System



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. Vinedo Avenue, Pasadena, Calif.



when you need...

COUNTING SPEED

Specify VEEDER-ROOT No. 1591 Quick Reset, High Speed Magnetic Counter

The No. 1591 resets to zero with the flick of o finger with manual reset, or in one second with electrical reset.

The No. 1591 is designed for accurate, dependable remote indication of machine operation, or for counting articles at high speed. Speed is 3000 counts per minute, 4 or 6 figures, manual or electrical reset, and made for panel mounting. Maximum panel area required is: 1.7″ x 2.1″ for four figures and 1.7″ x 2.8″ for six figures. The 1591 is *available from stock.*

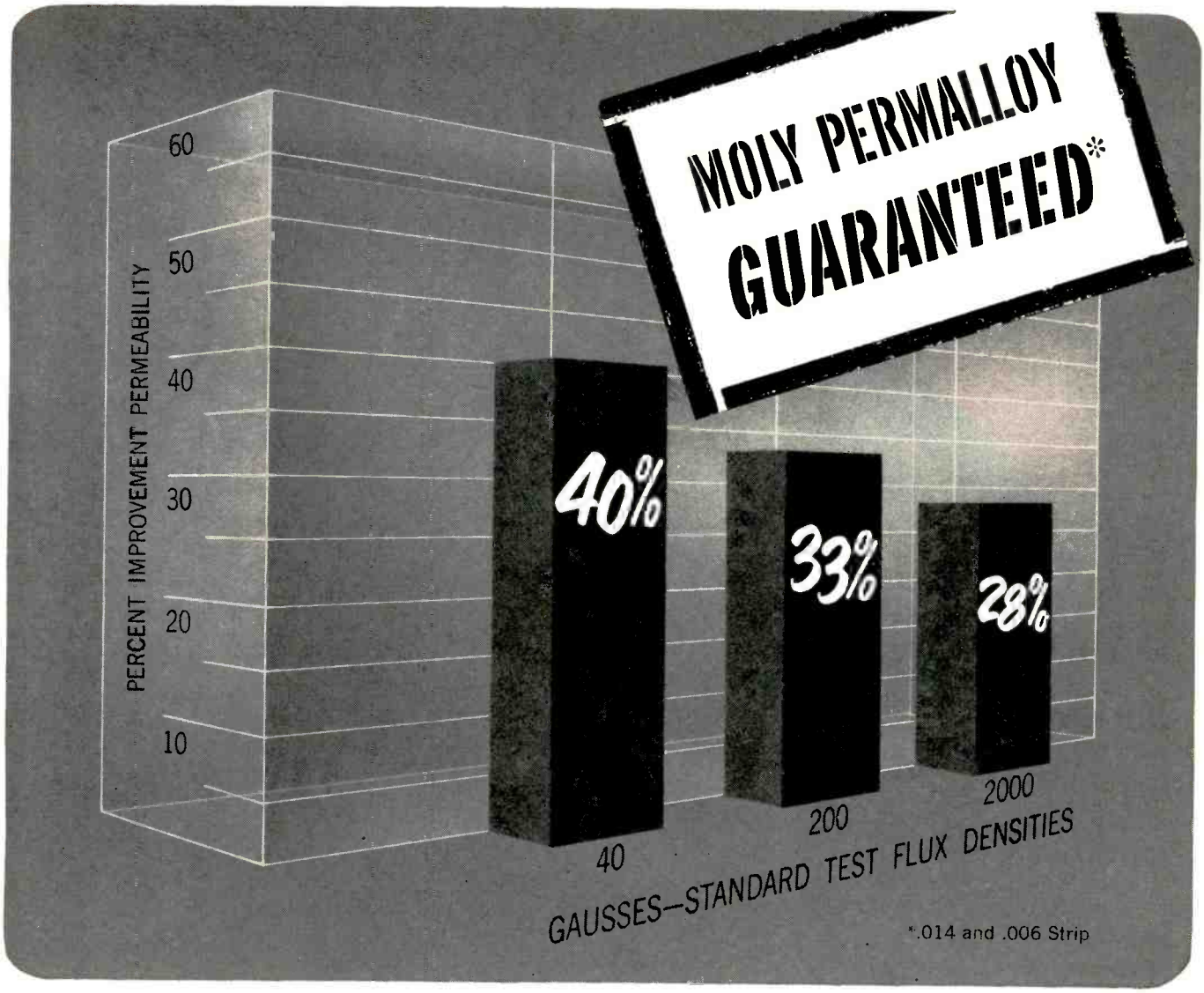
Send for Veeder-Root Technical Information. Complete catalog data will be sent to you at once and application assistance is available from a Veeder-Root Counting Engineer if desired. Write or call today.

Veeder-Root Inc.
HARTFORD 2, CONNECTICUT
"The Name that Counts"

Hartford, Conn. • Greenville, S. C.
Altoona, Pa. • Chicago • New York
Los Angeles • San Francisco • Seattle
St. Louis • Montreal. *Offices and Agents in other principal cities*

CIRCLE 71 ON READER SERVICE CARD

Experience**—the added alloy in **A-L Stainless, Electrical and Tool Steels



GUARANTEED PERMEABILITY OF MOLY PERMALLOY...

at values higher than old average specifications

Molybdenum Permalloy nickel-iron strip is now available from Allegheny Ludlum with *guaranteed* permeability values. And the new guarantees are much higher than the old typical values. This exceptionally high quality means absolute uniformity for the user—new consistency and predictability for magnetic core performance.

Improved permeability of A-L Moly Permalloy is the result of Allegheny's program of production research on nickel-bearing electrical alloys. A similar improvement has been made in AL-4750 strip steel. Research is continuing on silicon steels including A-L's famous Silectron (grain oriented silicon steel), plus other magnetic alloys.

Another plus in dealing with Allegheny Ludlum is the operation of complete lamination fabrication and heat treatment facilities. A-L's years of experience in producing quality laminations result in practical know-how in solving problems common to core materials.

This working knowledge is available to all. Give us a call for prompt technical assistance on *any* problem involving electrical steels, laminations, or magnetic materials. Write for more information on A-L Moly Permalloy. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. E-23.***

WSW 7273

ALLEGHENY LUDLUM

STEELMAKERS TO THE ELECTRICAL INDUSTRY

Export distribution, Electrical Materials: AIRCO INTERNATIONAL INC., NYC 17

Export distribution, Laminations: AD. AURIEMA, NYC 4

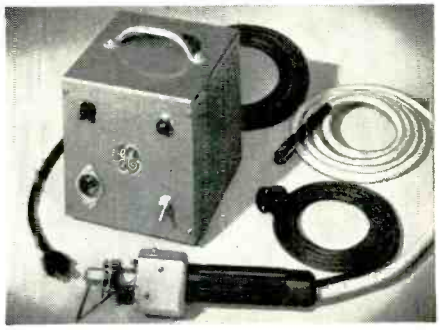
General Electric device now provides reliable salvage of printed wiring assemblies

Now you can repair complex, heat-sensitive, miniaturized printed wiring assemblies effectively and reliably.

A new dual-purpose Induction De-Solder and Solder Device from General Electric has been developed specifically to meet military and commercial electronic industry requirements. It offers you a means of *salvaging expensive components, removing defective components completely, and remaking or repairing solder joints in printed wiring assemblies*—without the difficulties normally associated with this work. All old solder is removed, leaving clean, tinned eyelets and leads.

The device can be controlled either automatically or manually; results in up to 20 percent man-hour savings, and is particularly effective for removal of multiple terminal components.

WRITE FOR BULLETIN GEA-6994 or contact your nearby G-E Apparatus Sales Office for more information. Section 723-40, General Electric Company, Schenectady 5, N. Y.



A NEW G-E RESISTANCE SOLDERING TOOL provides void-free solder joints for reliable, high-quality connections required by aircraft and missile applications. The new tool eliminates tip arcing or flashing, preventing pitting; is hand-operated, requiring no pedals; and features a zirconium-tungsten electrode that does not require frequent redressing, maintenance or replacement. Write for Bulletin GEA-6588.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Here's an electronics man who's hard to place.

You know him as the man you've got to reach to sell the electronics industry. His company identification badge (symbolized at right) is the most familiar means of telling at a glance (by its code letters—"R", "D", "P", "M") that you may find him in **R**esearch, **D**esign, **P**roduction, or **M**anagement.

What's the title of this electronics man?

But, whatever his department, whatever his title, the function of this engineering-trained man is likely to involve buying and specifying electronic equipment. One sure way to pinpoint him: he reads **electronics**, the only magazine that reaches these 52,000 key buyers and specifiers every week.

PHOTO OF PARAMETRIC AMPLIFIERS PRODUCED BY HUGHES AIRCRAFT COMPANY

THE ELECTRONICS MAN
"BUYS" WHAT HE READS IN...

electronics

... and the Electronics Buyers' Guide and Reference Issue

A McGRAW-HILL PUBLICATION

330 West 42nd Street, New York 36, New York

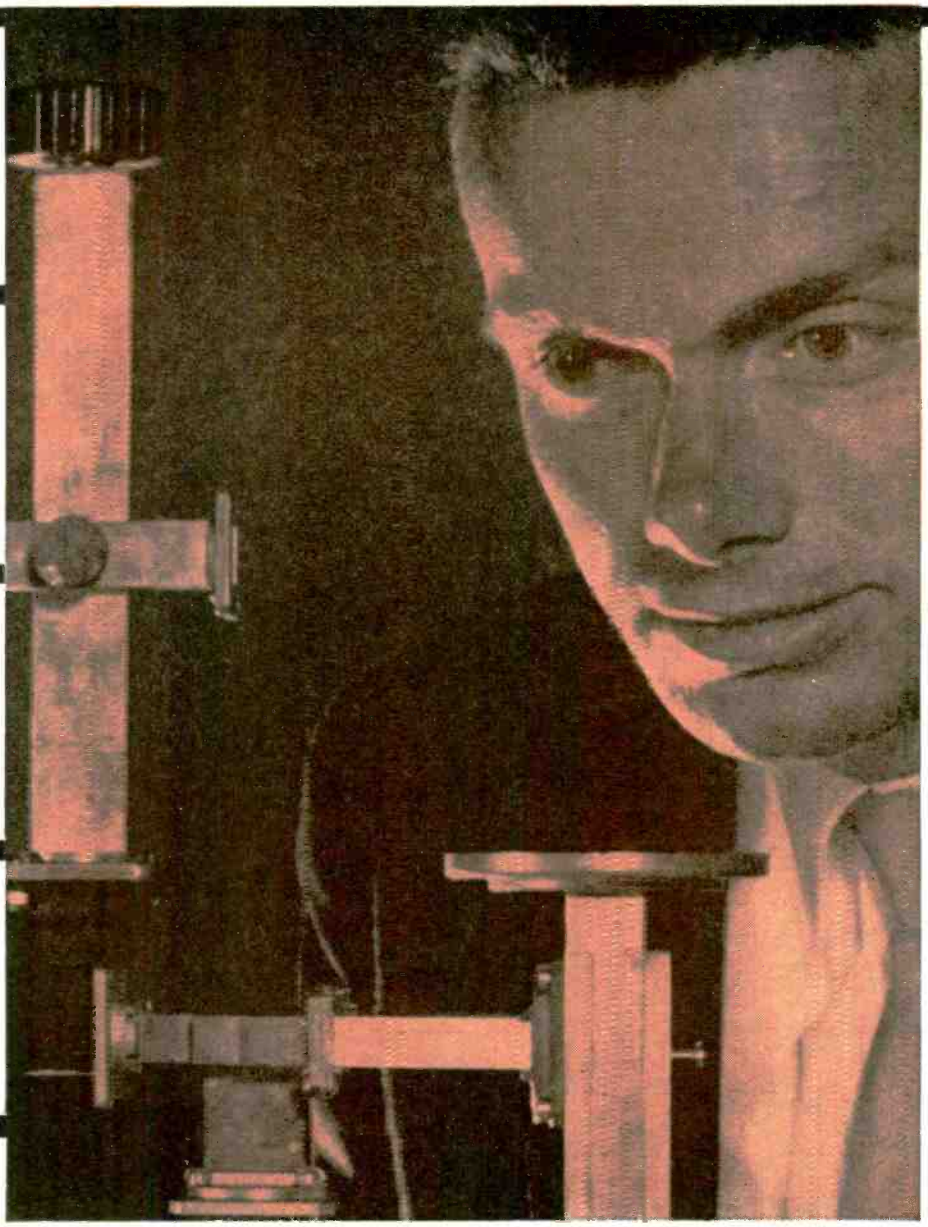
IDENTIFICATION

R

D

P

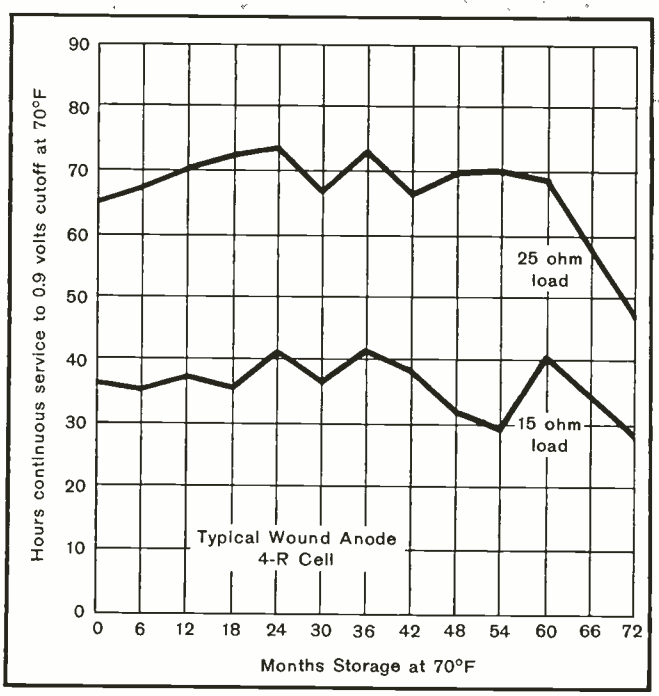
M

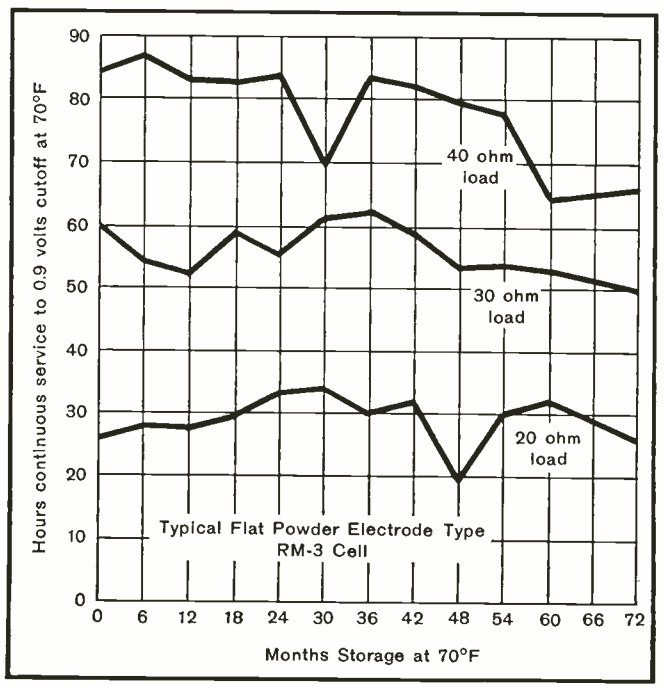


6XK-5XKW

S Q

Still "FRESH" After 6 Years Storage — Mallory Mercury Batteries





An extensive series of storage tests, now well past the six-year mark, proves that Mallory Mercury Batteries can take extremely long storage far past the point where ordinary batteries become useless.

Some typical test curves are shown here. Note that even at the end of six years, Mallory Mercury Batteries remain close to their "newly-made" capacity.

This extraordinary stability is one of the unique characteristics of the mercury battery system, pioneered and constantly refined by Mallory. During periods of storage, the system does not deteriorate. And during discharge, output voltage stays practically constant out to the limit of battery life. This is an ideal discharge for providing fade-free performance in transistor circuits.

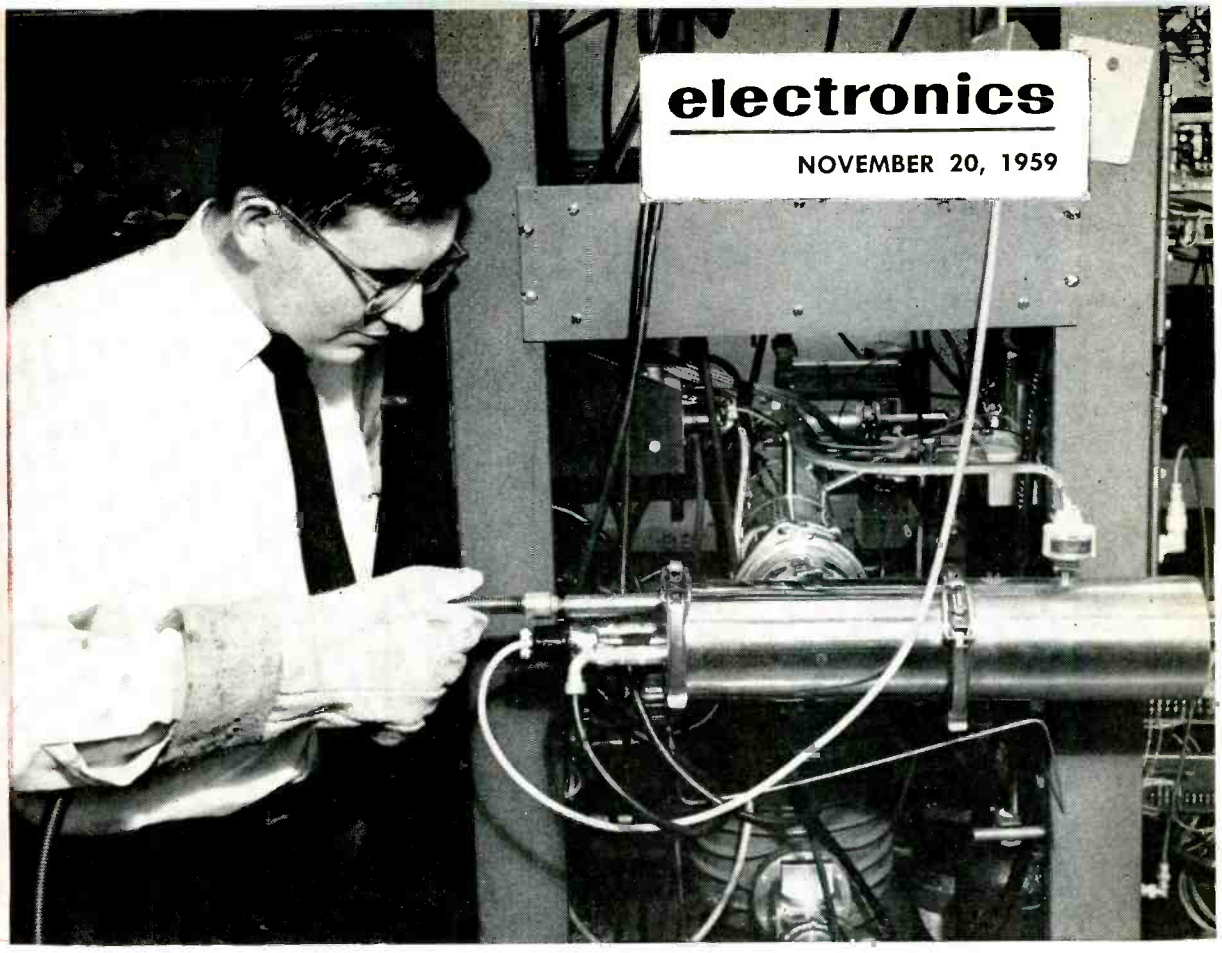
The long service and storage life you get from Mallory Mercury Batteries mean unmatched convenience and dependability to users of your battery powered products. Their high energy content in compact size makes possible new feats of miniaturization. And their precise, stable output offers opportunities for use in instrument circuits, calibration and voltage reference applications.

A consultation with one of our engineers will help you apply our standard models in your product, or will start us on development of special battery packs for your requirements.

Mallory Battery Co., Cleveland, Ohio
a division of

P.R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO. Inc., INDIANAPOLIS 6, INDIANA

electronics
NOVEMBER 20, 1959



Ammonia maser (being filled with liquid nitrogen) operates in microwave range, uses waveguide as both transmission line and input gate

Microwave Computer Circuits

By FRANK LEARY, Associate Editor

Techniques for millimicrosecond computer logic and switching circuitry use waveguide or stripline, fast diodes, twt's, parametric oscillators

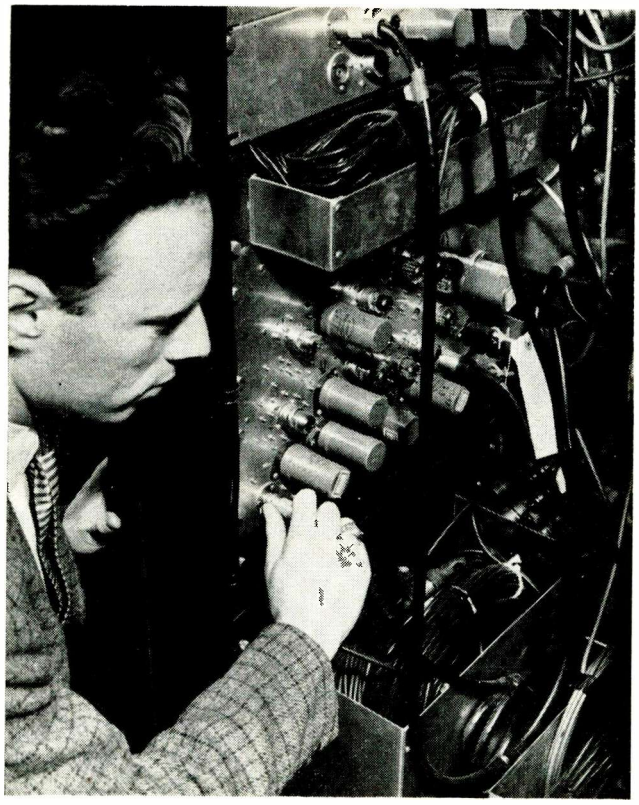
THE COMPUTER TECHNOLOGY seems to be pushed by economic pressures into a perennial pursuit of higher speeds. In recent years, the principal increases in speed have been brought about by use of circuits and components operating in parallel, developments of components with fast reaction-times, and sophistications in logic, systems design, and programing.

Further advances will come from microevolutionary developments in semiconductors and in programing, but major breakthroughs will be needed before the computer technology can take any more giant steps.

Two avenues of research hold the greatest promise for the computer technology in the next five to ten years. One is the development of cryogenic circuits, which present the attractive possibility of both increased speed and sharply diminished size. The other, and more immediately reachable, is the use of microwave components. (See ELECTRONICS p 39, May 1, 1959.)

PASSBAND PHILOSOPHY—Most conventional information-handling systems are baseband systems, in which the signals occupy a frequency band starting at or near zero and extending to some upper limit. This upper limit is, in practical systems, determined by the gain-bandwidth product of available amplifying devices, and can seldom go above 50 mc. For computer circuits operating at millimicrosecond rates, bandwidths in the hundreds of megacycles would be required.

A practical alternative is the carrier or passband system, in which information is represented, not by the presence or absence of r-f or d-c, but by either of two phases or two frequencies of r-f energy. The familiar frequency-shift key system used in com-



Coaxial cable served as distributed-parameter delay in this experimental 50-mc adder, an early IBM approach to microwave-range computers

munications is an example of passband application. Bandwidths for passband-type amplifiers seldom need to be greater than 10 mc.

WAVEGUIDE "NOT" CIRCUIT—Waveguides and transmission line are more than signal carriers for logic systems in the microwave range. The interference of fields inherent in these components is put to good use in performing logical functions such as gating.

A microwave T can function as a simple NOT circuit. A c-w carrier of some fixed phase is fed into one arm; information is represented by signals of opposite phase in the other arm. If no signal is present in the information arm, the carrier passes through the T; signals present in both arms interfere destructively in the T. This simple circuit possesses the disadvantage that the carrier is reflected into the input arm; a hybrid ring corrects this problem.

The hybrid ring in Fig. 1 is $3\lambda/2$ in circumference, with active arms $\lambda/4$ apart. When no signal appears on the information line, half the c-w carrier is absorbed in the termination at (2), and the other half appears at the output. Destructive interference cancels the carrier out of the information line, since the information line is $\lambda/2$ from the carrier line in one direction and λ in the other.

If a signal appears in the input line, it and the carrier arrive out of phase at (4), interfering destructively for no output, and all the signal is absorbed in the termination.

In tests of this circuit using stripline, actual values of c-w at the output were reduced 23 db when the information signal was present.

"AND" CIRCUIT—A stripline AND circuit requires the use of a nonlinear element for sharp discrimination between conduction and cutoff. The element, a microwave point-contact diode, controls the output gating action of the circuit and is called an expander.

The expander diode is placed at the end of $\lambda/4$ of stripline to form a quarter-wave stub shunting the transmission line. The diode is biased not to conduct under no-signal conditions. If the r-f power level in the transmission line is insufficient to cause conduction in the diode, the diode presents an open circuit $\lambda/4$ away from the line, thus shorting the line and preventing transmission. If r-f causes conduction, the shunt impedance in the line rises and the r-f is passed to the output. The AND circuit is shown in Fig. 2.

The two inputs to the hybrid ring in Fig. 2 are $\lambda/2$ apart, with the shunted output line between them $\lambda/4$ away. If a single input is present, half the power is absorbed in the termination and the other half appears at the expander. If two signals of the same phase and amplitude appear, they interfere destructively at the termination but reinforce at the expander. Thus four times as much power is incident on the expander when two signals are present in the ring as when only one appears. The four-to-one relationship simplifies selection of a bias value for the expander diode.

If the termination is removed from the fourth arm of the ring in Fig. 2, the circuit will make a primitive half-adder, with the sum output appearing at arm (4), and the carry in arm (2). Two coincident inputs will interfere destructively at (4) to produce a carry at the expander; any single input will lack power

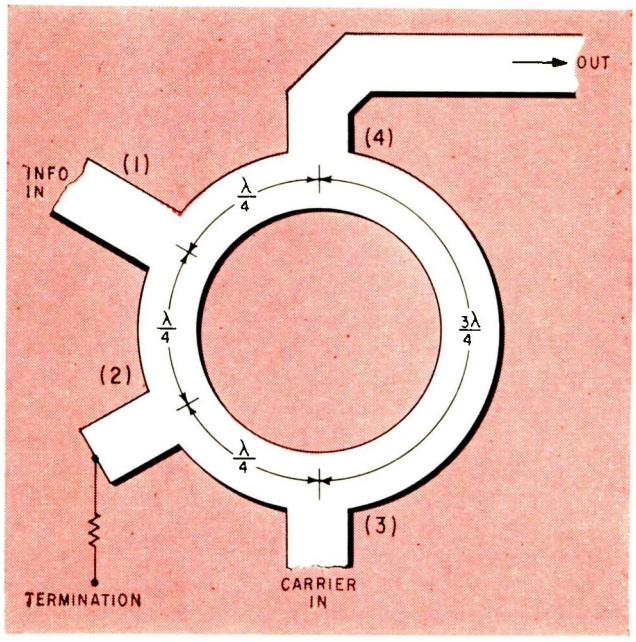


FIG. 1—Hybrid ring NOT circuit. Signals interfere destructively at (4); ring geometry also makes carrier cancel itself at (1) when information signal is not present, thus keeping the carrier out of the information line

Microwave Computers: Advantages and Problems

The idea of using microwave circuitry in computers is not new. Kilomegacycle clocks, information rates in the hundreds of megacycles, and millimicrosecond switching are attractive ideas, and early probings are beginning to pay off now. Phase-locked subharmonic oscillators—parametrons, for example—go back five or six years, and logic using T-junctions and waveguide is as old as the missile technology.

Thin ferromagnetic film also holds great promise for microwave applications. "It it one of the few components," says University of Pennsylvania researcher Herbert Callen, "which may be expected to perform successfully at one-millimicrosecond switching speeds."

But microwave's attractions are counterbalanced by problems. One is size: a computer may have 10,000 or more connections, and making them with waveguide would result in a plumber's nightmare. Efficient stripline, thin films and small components materially reduce this problem, but cannot eliminate it.

Another problem is cost. Traveling-wave tubes and plumbing fixtures are costly in themselves, also cost more to assemble and maintain than more conventional parts.

For both problems, one answer is simplicity. The simpler designs, using the most sophisticated design techniques, will be the ones that break the back of the microwave computer problem

to fire the expander but will pass as a sum to (4).

The phase of the sum output, however, will depend on which input caused it, since one is $\lambda/4$ from the termination and the other is $3\lambda/4$. To correct this situation requires either greater complexity of circuitry or the addition of a demodulator-modulator circuit in the sum output to allow a c-w of fixed phase to pass when a sum is produced.

PHASE-DETERMINED HALF-ADDER—Figure 3 shows a hybrid-ring complex that serves as a half-adder and corrects the phase ambiguities in the Fig. 2 circuit.

Signal inputs *A* and *B* are divided equally between two hybrids I and II. They are combined in I, passing through an adjustable attenuator to hybrid III.

Hybrid II functions as an AND circuit, passing a carry output when both inputs are present. The carry output is split so that half of its power arrives at hybrid III in phase with the combined signal from hybrid I. The attenuator is adjusted to equalize the amplitudes of both inputs to III whenever both *A* and *B* signals are present at I and II. Hybrid III serves as a NOT circuit, so that no sum is produced if *A* and *B* are both present, but either *A* or *B* will produce a sum from hybrid III.

In such hybrid-ring circuits, signal amplification can be provided by twt's and regeneration by means of diode regenerators. Subharmonic oscillators can be used both to amplify and regenerate; these circuits can also perform logical operations such as gating.

DIODE-WAVEGUIDE CIRCUIT—In baseband systems, logic will frequently require modulating and demodulating the information signal to make best use of the frequency-response characteristics of various

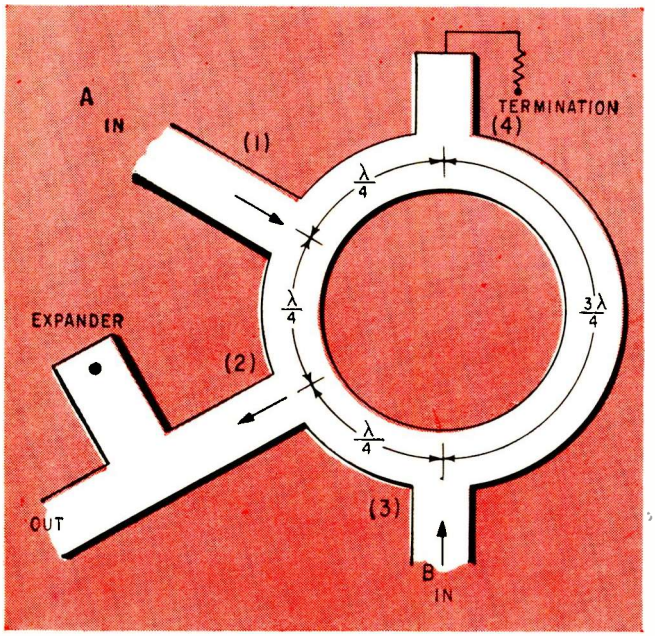


FIG. 2—Logical AND circuit using hybrid ring. Expander (diode in quarter-wave stub) gates output when both input signals are are present. Removal of stub termination at (4) changes circuit to primitive half-adder

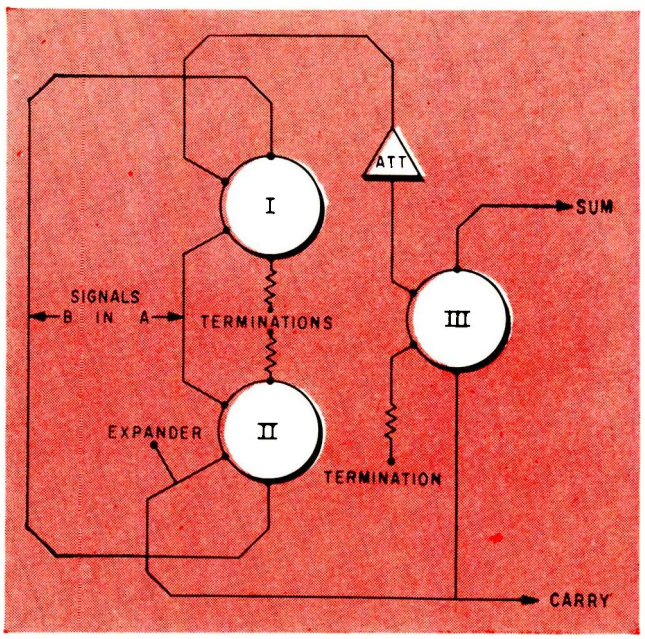


FIG. 3—Phase-determined half-adder using hybrid ring. Ring I combines signals; ring II serves as logical AND circuit to produce carry; ring III is logical NOT circuit to suppress sum when carry is present

components. A basic circuit consisting of a diode modulator controlled by the signal from a diode detector can be used to perform AND, OR, and EXCLUSIVE OR functions on pulsed microwave signals. The functional diagram of the circuit is shown in Fig. 4.

The modulator is actually a bridge circuit using waveguide hybrid. If the admittances of the modulator diodes M_a and M_b are equal, the bridge is balanced.

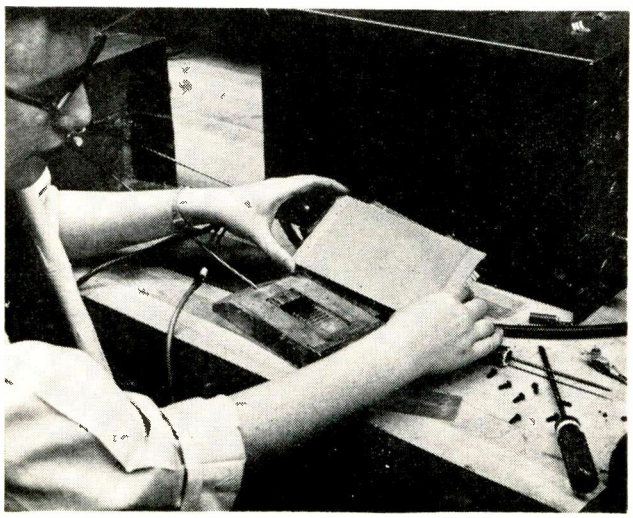
When the modulator is balanced, r-f power from C will pass into the output when either A or B but not both are present. If C is always supplied, then the output becomes the EXCLUSIVE OR function of either A or B. If B is never supplied, the output is the AND function of A and C. If B and C are always supplied, the output signifies NOT A.

If the modulator-diode admittances are not equal, the modulator is unbalanced, and the output is the OR function of A or B.

SUBHARMONIC OSCILLATORS—A year or so before his death in 1957, John von Neumann patented the idea of a phase-locked subharmonic oscillator, a resonant circuit in which a nonlinear element made possible two or more modes of oscillation. These parametric subharmonic oscillators operate by energy transfer from a pump frequency to the oscillator frequency through the nonlinear storage element. In the microwave range, this element is the nonlinear capacitance of a semiconductor diode, suggested by von Neumann because it was small and usable at extremely high frequencies.

The same idea is employed in the parametron, a phase-locked oscillator employed as the basic circuit in computers made by Nippon Telephone & Telegraph. The parametron was developed by E. Goto of NT&T and M. Takahashi at the University of Tokyo, and uses a nonlinear inductance rather than capacitance.

Parametron speeds are limited by the hysteresis losses incurred in the inductance at high switching



Thin ferromagnetic films—a couple of molecules thick—are future logic elements for microwave computers. IBM researcher here prepares to test field penetration

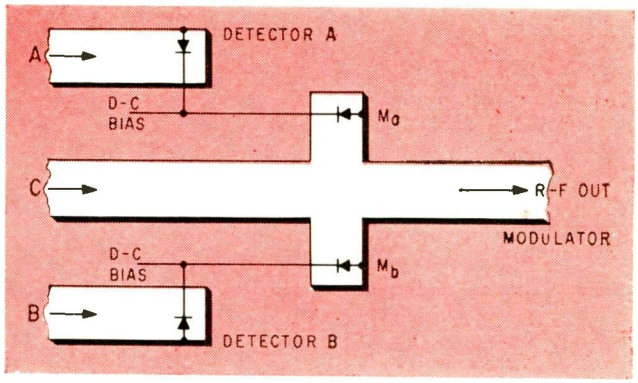


FIG. 4—Diode-waveguide circuit capable of serving as logical AND or OR circuit. Modulator operates as a bridge, reacting to detector outputs. Diode bias is from constant-current source

and information rates, and is basically a vhf-range device. Kilomegacycle rates are entirely feasible with phase-locked oscillators using nonlinear capacitances.

PLO THEORY—The phase-locked oscillator (PLO) circuit requires a nonlinear reactive element whose reactance can be made to vary at some frequency f' which is an even multiple of the characteristic or oscillating frequency f of the tank circuit of which it is a part. The frequency f' is usually set at $2f$, and is referred to as the pump or pumping frequency.

When the correct relationship exists (1:2 is the most efficient), an effective negative resistance appears in the tank circuit at its characteristic frequency f. The nonlinear element will oscillate parametrically at its frequency f', with the result that it will pump the tank much as a child pumps on a swing, at twice the frequency of the swing oscillations.

Tank oscillations can be steered to start on the upswing or downswing when the tank is pumped, thus providing zero or 180-deg phase relationships at the information frequency. This in turn provides the binary discrimination needed for computer operation.

A lumped-parameter PLO is shown in Fig. 5; the stripline configurations for a microwave version of the same circuit are shown in Fig. 6. The nonlinear capacitance of the 1N93 diodes in Fig. 5 is the oscillating parameter. The diodes are back-biased, and two of them are used in order to balance the circuit and isolate the pump from the output line.

In the microwave version in Fig. 6, the filter is used to isolate the pump from the information frequency. A microwave point-contact diode provides the variable capacitance.

OPERATION—As pump power is applied to the tank of a PLO, there are at first no oscillations and no output appears.

Beyond some point, the tank begins to respond to the pump and begins to oscillate at its frequency f.

The tank can begin in either zero or 180-deg phase —either on the upswing or downswing—depending on noise in the tank. A lock signal may be provided to steer it into one or the other phase.

As pump power increases further, the tank output increases until it reaches a saturation level. This

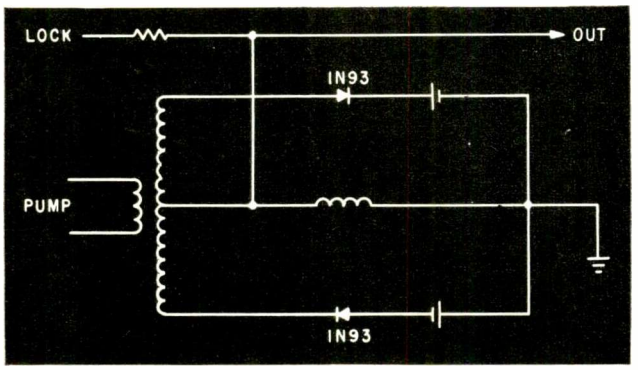


FIG. 5—Phase-locked subharmonic oscillator using lumped parameters. Oscillating parameter is nonlinear capacitance of the two 1N93 diodes

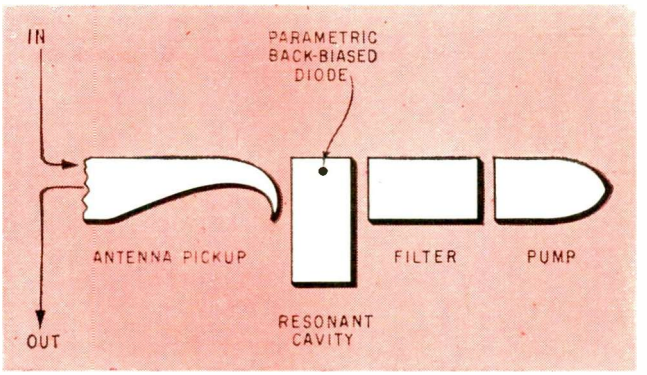


FIG. 6—Microwave version of phase-locked oscillator. Microwave point-contact diode provides oscillating parameter. Filter isolates pump frequency from incoming or outgoing signals

maximum output point is established by the diodes, which begin to conduct excessively and load the tank circuit.

As the pump goes beyond the saturation level, output decreases, finally going to zero and cutting off tank oscillation.

As pump power is reduced from the overdriving level, the path of tank output is retraced, excepting that oscillations continue beyond the pumping level at which they began.

PLO TECHNIQUES IN COMPUTERS—The PLO can be forced into one or another mode by a locking signal of desired phase injected into the tank. The lock must be applied for a long enough period, and at strong enough level, to quench the oscillations of the opposite phase and then restart the tank in the new phase.

To initiate a desired phase when the PLO is not oscillating requires only a small amount of forcing or locking signal. The tank can rise to full output from no output in about 8 cycles working as high as $f = 4$ kmc.

Even this delay can be shortened by keeping a low-level locking signal always on, then pulsing the pump. Tank output will follow the phase of the first pulsed cycle of pump energy and will rise to full output in less than two cycles.

In the region between a pump-power level insufficient to cause the tank to respond and the level at which the tank will definitely respond, there is a zone of ambiguity. In this zone, the PLO can operate as a tristable device, with two phases of operation and a jammed-off condition possible. This zone of ambiguity can be used for certain sophisticated techniques requiring tristability.

By force-switching, PLO's can be made to serve as memory devices. However, reading selected bits from a PLO store cannot yet be accomplished with reasonable surety of not altering the memory; and, of course, the memory is volatile. The circuits are capable of detecting information or discriminating among bits of information, can be used to amplify information signals and can store data—all at millimicrosecond rates. The phase-locked oscillator has the added advantage of being relatively insensitive to reasonable variations in both components and power supply.

TWT'S—Traveling-wave tubes amplify over a broader portion of the frequency spectrum than other types of tubes, and thus are suited for use in microwave circuits of either baseband or passband type. But the delay in a twt is at least a significant fraction of a bit interval in millimicrosecond pulse circuits, and may be several times as long. This fact makes it necessary to rethink the logic of any circuit requiring twt amplifiers.

Trigger pairs, for example, can no longer be regarded as monostable or bistable reflex circuits, but must be approached as recirculation loops. In one sense, a flip-flop does operate as a recirculation loop in which a pulse of one polarity recirculates either for a predetermined length of time, or until replaced by a pulse of opposite polarity.

A circuit can be designed around a single twt to perform this same function and operate in place of a conventional flip-flop. Such a circuit takes two or three cycles to build up the output signal to usable levels. This delay is comparable to the stabilizing time for an ordinary flip-flop.

Full-adder circuits present a special problem because the carry digit must recirculate from output to input in exactly one bit-interval. With twt's introducing a greater delay, it becomes necessary to consider multiplexing the adder lines. A single twt might be time-shared four ways, among either four different augend-addend combinations or for four parts of the same combination, so that its inherent delay would be no less than the necessary bit-to-bit waiting time.

ACKNOWLEDGEMENT—Much of the information contained in this article was presented at a symposium on microwave techniques for computing systems sponsored by the information systems branch of Office of Naval Research. Work summarized here was reported at the symposium by representatives of RCA, Bell Telephone Laboratories, GE, IBM, Sperry Rand and the University of Illinois. ELECTRONICS is grateful for the cooperation of H. E. Tompkins, editor of *IRE Transactions on Electronic Computers*, which will publish the full proceedings.

Design Trends in Mobile

Very-high-frequency range can be dramatically increased by the higher effective elevation of repeater station antennas. Selective coding for individual stations increases versatility

By L. G. SANDS, Consultant, Ridgewood, N. J.

IN THE DECADE since the FCC licensed the first mobile repeater station, use of repeaters has become widespread. The increasing demand for extended range has resulted in the development of new repeater station equipment.

Recent announcements of new equipment from commercial manufacturers include: a cross-band repeater by DuMont which receives signals on one band and transmits on another; a compact cross-frequency repeater by Kaar for use in the 450-470 mc band only; and a single-frequency repeater by Motorola which picks up a signal, records the audio intelligence and retransmits it on the same frequency after a short delay.

An interesting development in control of repeater stations is selective or coded dialing. With selective dialing equipment, mobile operators can call one another without alerting units not concerned. At the same time they can control a number of different functions at the repeater station itself.

In the 450-470 mc band, mobile-to-mobile range is ordinarily restricted to 3 or 4 miles, but this range can be increased to 20 miles with a repeater station using a 60-foot high antenna support. Mountain-top repeater installations can extend range to as much as 200 miles.

Basic Repeater Station

The basic repeater station is nothing more than a receiver and transmitter.

Received intelligence picked up from mobile units is retransmitted so that it can be heard by mobile units which would otherwise be out of range.

The repeater receiver is turned on at all times, but the transmitter is turned off until an incoming signal overcomes the receiver squelch. Squelch circuit operation has been described by this same author previously. (ELECTRONICS, April 10, 1959.) Transmitter tube filaments are kept turned on so that the repeater will be ready to operate without delay.

Matching Circuit

In a conventional repeater, the audio output from the secondary of the receiver output transformer is fed to the audio input of the transmitter. In a design developed by General Electric, however, the audio signal is picked up at the receiver discriminator and fed to the low

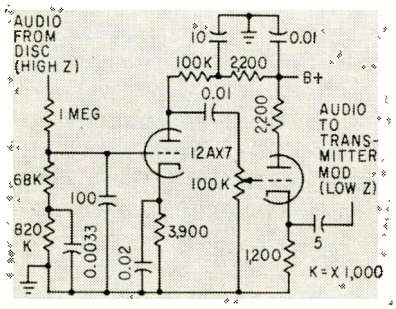


FIG. 1—Electronic impedance matching circuit between receiver and transmitter

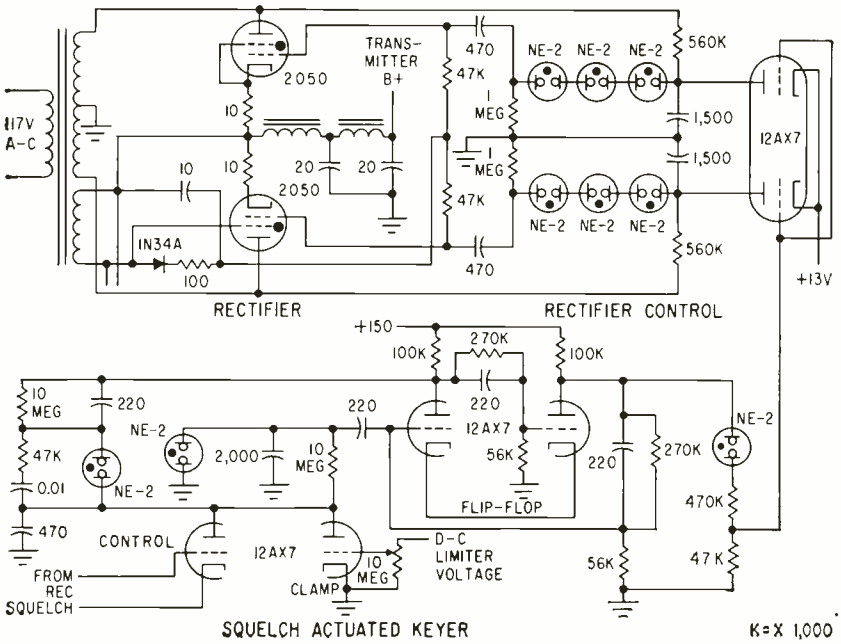
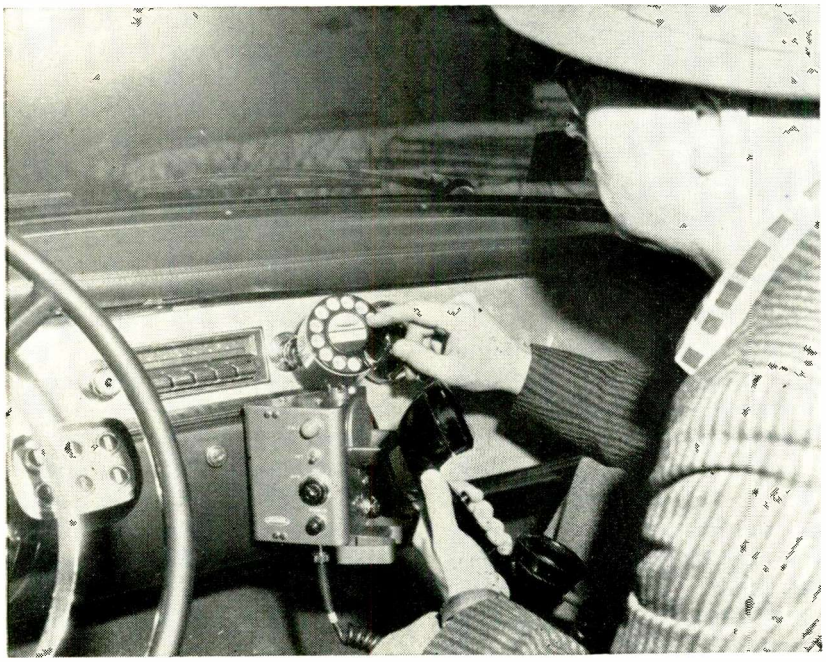
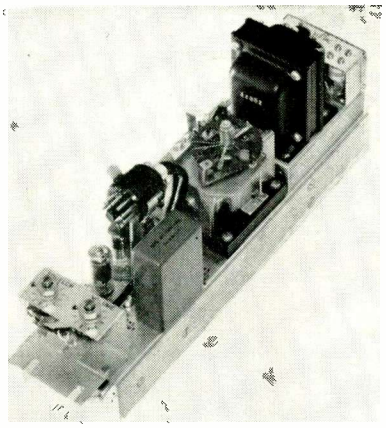


FIG. 2—Fail-safe repeater control scheme. Transmitter plate supply is activated by increase in receiver squelch voltage (absence of noise). In absence of signal or in event of receiver malfunction transmitter will not operate

Radio Repeaters





Dial pulse decoder shows escapement wheel selector. Some selector types can be set to any of 20,000,000 different code combinations

Operator of mobile radio dials to unlock repeater station. Privacy is assured, for the unlocking code can be changed at any time

impedance input of the transmitter through an electronic impedance matching circuit as shown in Fig. 1. The signal from the discriminator is fed to the grid of an audio amplifier stage through an R-C network whose high impedance does not disturb the discriminator circuit. Output of this audio stage feeds a cathode follower whose output feeds the low impedance audio input of the transmitter.

Transmitter Power

Power consumption by the repeater transmitter may be reduced by turning off transmitter tube filaments and providing means for turning them on and keeping them on long enough to permit communications. When a signal is intercepted, the transmitter tube filaments are turned on and, after a time delay, plate voltage is applied. The filaments are held turned on by another time delay arrangement for several minutes after the repeater has been used. This setup will be satisfactory where repeater use is infrequent.

Usually, the transmitter plate voltage is keyed by a carrier-operated relay. This carrier-operated relay system consists of an electronic control circuit which is actuated by the receiver squelch voltage and which controls an electromechanical relay whose contacts key the transmitter.

To avoid repeater malfunctions owing to relay troubles, the Kaar TR502 repeater uses thyratrons to key the transmitter. The thyratrons serve as the rectifiers in the transmitter power supply. Normally they do not conduct, but when an incoming signal opens the receiver squelch the thyratrons conduct and provide d-c to the transmitter.

Figure 2 shows the circuit that is

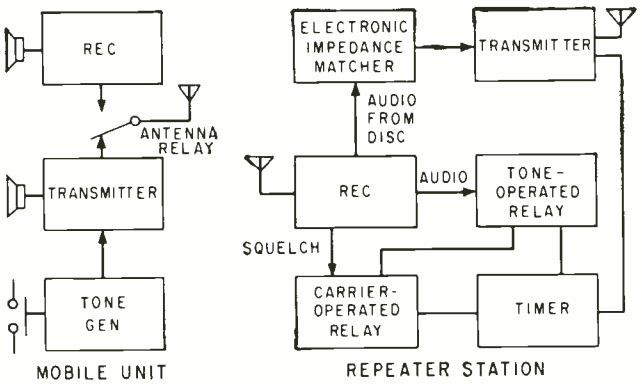


FIG. 3—With tone-gated lock out, mobile unit uses repeater station by transmitting a tone burst which actuates the tone-operated relay allowing carrier control of repeater transmitter

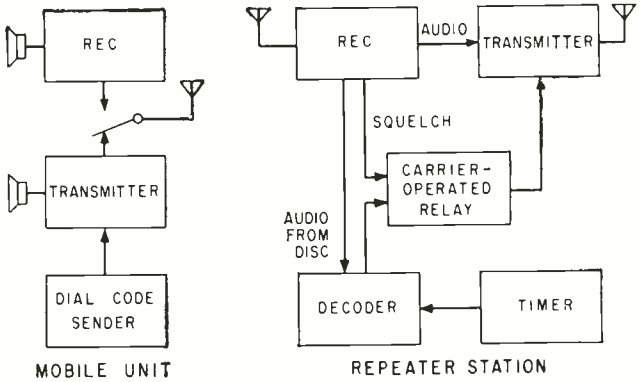


FIG. 4—With dial lock out, mobile operator dials to gain access to repeater. Decoder cuts in the carrier-operated relay so that the presence of carrier will turn on transmitter

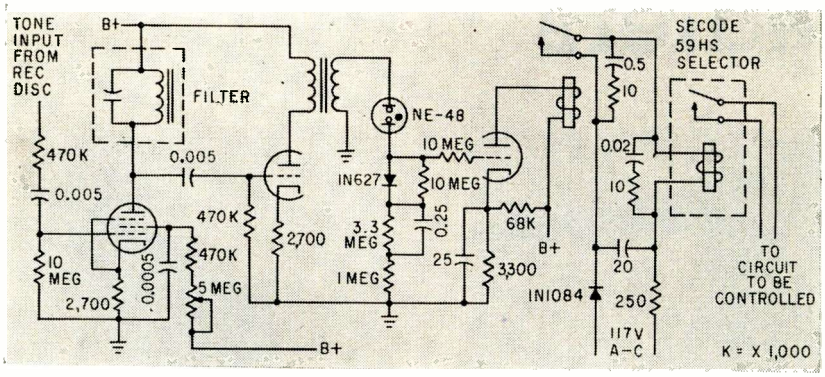


FIG. 5—Decoder circuit used in repeater station with dial lock out

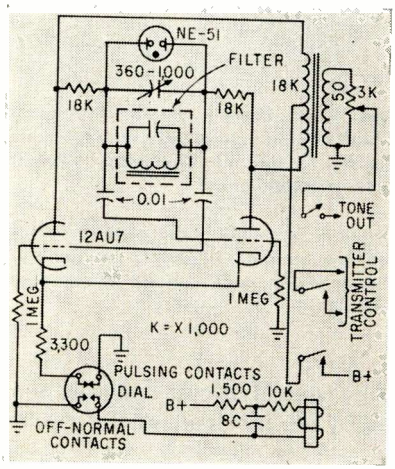


FIG. 6—Dial code sender circuit used in mobile units to unlock repeater station

used. The squelch tube voltages are extended to the electronic control unit. When these voltages indicate a received-signal condition, a free-running relaxation oscillator is energized and triggers a flip-flop. Under standby conditions, the flip-flop keeps the thyratrons in a nonconducting state. When the relaxation oscillator is running, the flip-flop reverses and applies pulses to the thyratrons causing them to conduct. This design prevents the transmitter from being activated in the event of receiver failure.

Coded Repeaters

The trend in FCC thinking apparently is to require that repeater stations respond to a coded signal rather than to the carrier alone. Therefore, manufacturers are designing systems relying on such techniques as tone-gated squelch, frequency-selective keying and dial-coded tones.

In General Electric's tone-gated system, shown in Fig. 3, each mobile unit is equipped with a single-tone or two-tone audio oscillator which transmits a coded tone burst. This coded tone actuates a tone receiver at the repeater station allowing the carrier-operated relay to actuate the transmitter. A time delay holds the transmitter on for five seconds after receipt of the matching tone. Thus, two units can intercommunicate without the transmitter dropping out when either mobile unit stops transmitting.

A three-minute timer is also provided which allows the carrier-operated relay to actuate the transmitter by carriers which are not accompanied by the tone. After the three-minute period has elapsed without carrier, a tone is required to again activate the repeater transmitter.

Dial Code Sender

Another positive way to lock out a repeater is to equip it with a decoder which allows the transmitter to be turned on only after receipt of a train of tone pulses of a specific combination. Figure 4 shows such a system.

The Secode RPD-634 decoder, shown in Fig. 5, responds to tone pulses produced by a telephone dial. Each mobile unit is equipped with a dial code sender, whose circuit is shown in Fig. 6. To actuate the repeater station, a mobile unit operator dials a number which may be a single digit such as 4 or a longer number such as 3-5-3. The decoder closes its contacts only when it intercepts the right code. Then, voice transmission follows in the normal manner.

It is not necessary to dial the repeater number for each transmission. The repeater is unlocked initially by dialing and responds to the carrier for an exchange of communications. A timer puts the lockout into effect a few minutes after no carrier has been sensed, necessitating the redialing of the number to unlock the repeater.

When the dial of the code sender is pulled, the tone generator and the mobile transmitter are turned on. When the dial is released, its pulsing contacts break the tone circuit causing the transmission of break pulses (absence of tone) which conform in number to the dialed digit.

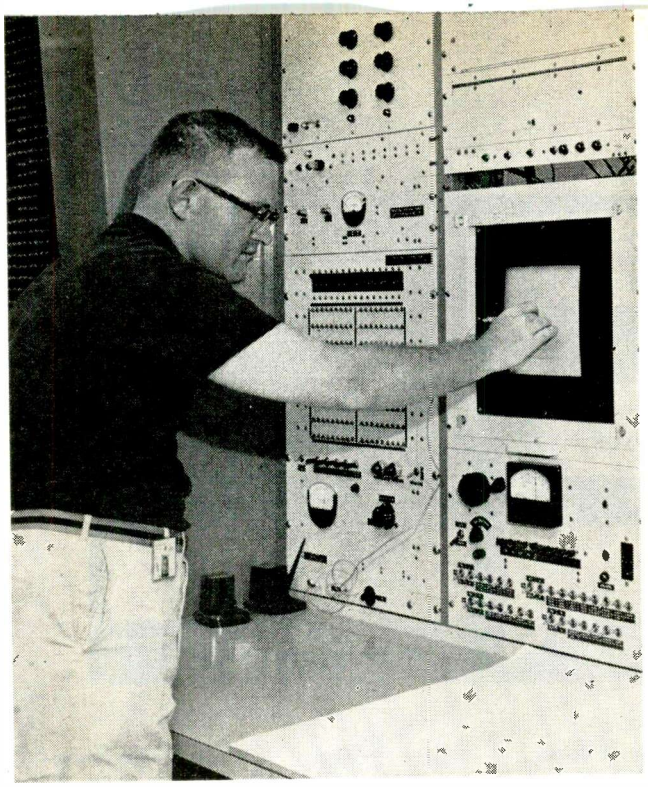
The decoder first amplifies the tone and then, with each break in the tone, keys a relay whose contacts actuate a Secode 49HS or 59HS electromechanical selector. A neon bulb in the decoder unit prevents noise pulses from keying the selector.

With each break in tone, the selector advances one step. The selector is set to respond to a specific code by placement of code pins in a notched code wheel. The 49HS selector can be set to respond to any of 300,000 different code combinations; the 59HS can be set to any of 20,000,000 different combinations.

When an improper code is intercepted, the selector steps and then drops back to standby. However, when a matching code is intercepted, a pair of contacts mate and close the necessary circuits to permit carrier to activate the transmitter. Since the contacts close only momentarily, mechanical or electrical latching is required. A timer is used to disable the latched control circuits.

Functions Controlled

Selectors are available with up to five contacts, each responsive to a different dialed code. Up to five functions can be controlled at the repeater station, such as: turning on transmitter tube filaments for quick response to dialed commands for repeater activation; turning off transmitter filaments; transferring circuits to standby equipment; unlocking electric door latch on repeater station equipment shelter to permit entry of authorized personnel; and permitting activation of repeater by carrier.



Operator reads crt display with pen-type sensor

Light-Pen Links Computer to Operator

Photoelectric sensing device reads computer-controlled cathode-ray tube display to allow operator to direct progress of a program or control auxiliary equipment attached to the computer

By **BENJAMIN M. GURLEY*** and **CHARLES E. WOODWARD**, MIT Lincoln Laboratory, Lexington, Mass.

CATHODE-RAY-TUBE DISPLAYS are frequently employed as a high-speed output monitor for a digital computer. When a display is used in conjunction with a photoelectric sensing device such as the light pen of the Lincoln Laboratory TX-2 computer, the pen becomes an instrument of two-way communication between operator and machine.

As used with TX-2, the light-pen system consists of a computer-controlled crt display, a photodiode in a pen-shaped holder for observing the display, a high-gain amplifier for the output of the photodiode, and quantizing circuits to bring the signal into digital form. A simplified block diagram of the system is shown in Fig. 1.

The computer program specifies X and Y coordinates of the spot to be displayed, along with the duration of the intensification. If, when the spot is displayed, the operator is pointing the light pen at the spot the flash is sensed by the photodiode. After amplification the signal from the flash fires a Schmitt trigger, which in turn produces a pulse to set a previously cleared flip-flop to a ONE. If the operator does not point the pen at the spot the flip-flop remains cleared. The computer can then sense the state of the flip-flop: A ONE indicates that the operator is interested in the spot just displayed, a ZERO that he is not interested. The computer program can make a decision based on the state of the flip-flop.

The light pen, shown in the photographs, was designed to be rugged, lightweight and easy to handle. Circuits are transistorized for reliability and compatibility with existing computer circuits.

Operation

The operator holds the pen within a quarter inch of the crt implosion shield and aims it at the point of interest. There is only one control, sensitivity, which is a potentiometer located in the high-gain ampli-

*Now with Digital Equipment Corp., Maynard, Mass.

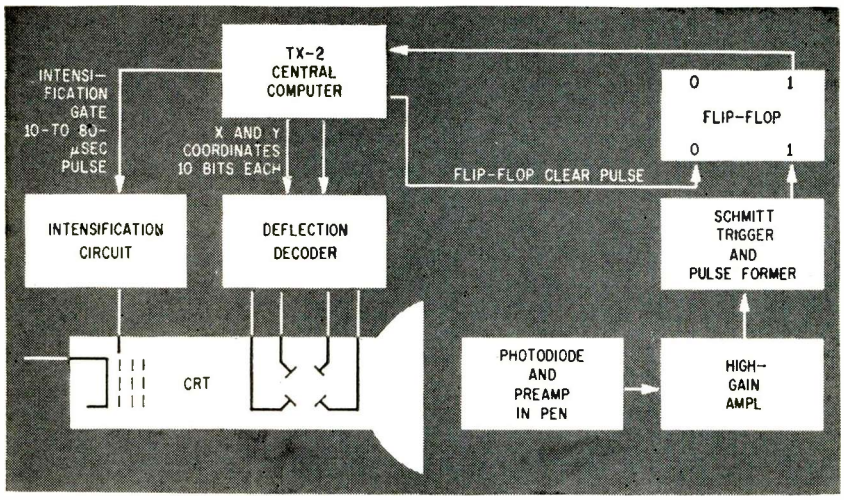


FIG. 1—Simplified block diagram of light-pen system

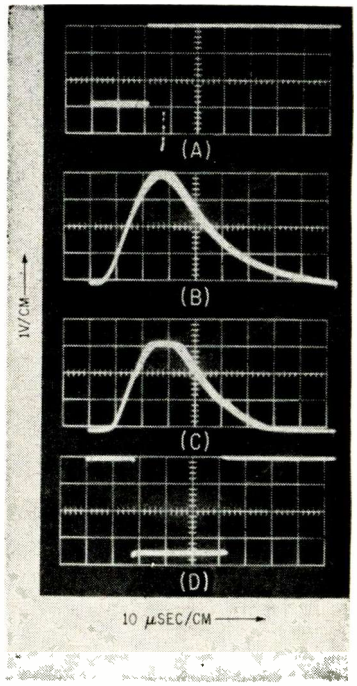


FIG. 2—Typical light-pen system waveforms: (A) intensification gate pulse; (B) unloaded main amplifier output; (C) amplifier output into Schmitt trigger; (D) trigger output

fier. If the operator desires, he can select a preset sensitivity by switching in a back-of-panel trimmer, also located in the high-gain amplifier.

Typical waveforms associated with the light pen are shown in Fig. 2. The intensification gate, Fig. 2A, is a 20-μsec pulse. Output of the P7 phosphor of the crt, as observed at the amplifier output, is shown in Fig. 2B. It is a rising exponential, increasing throughout the intensification period and, in fact, rising briefly after beam current is cut off. The amplifier output driving the Schmitt trigger and pulse former is shown in Figure 2C, signal being clipped by trigger input circuits. The trigger fires at approximately −2 volts, which is two-thirds the swing between clamps (Fig. 2D.).

Pen Configuration

The light pen assembly consists of a lens, a photodiode and a preamplifier mounted in an aluminum shell the size of a fountain pen. As shown in the exploded view, the device is easily disassembled for maintenance.

The lens increases the effective light-gathering area of the photodiode. It is a plastic light pipe, large in diameter at the front of the pen and necked down to match the diode aperture at the other end.

A photodiode for this application must have high sensitivity. Ideally it would have its peak spectral response in the blue region to respond to the flash from the crt, yet provide some rejection of white room light. Unfortunately, the only diodes now available are germanium and silicon types, which have peak responses in the infrared region. Early models of the pen used an extremely fast germanium diode.[1] The speed of this diode proved unnecessary for the long (10- to 80-μsec) flashes used, so a commercial germanium diode of moderate speed was utilized in later models.

A preamplifier is incorporated to raise the signal level before it is fed over the coaxial lead to the main amplifier. The preamplifier is an emitter follower with special decoupling in its collector circuit so power and signal can be supplied simultaneously over a single coaxial cable (Figs. 3, 4). Collector current is kept low, 40 μa dc, to reduce transistor noise.

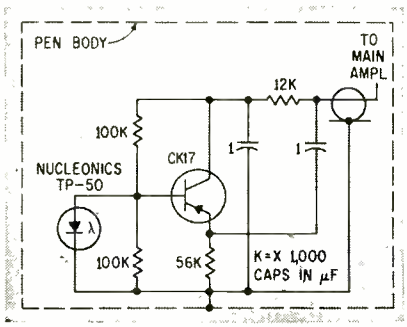


FIG. 3—Preamplifier built into pen-shaped holder

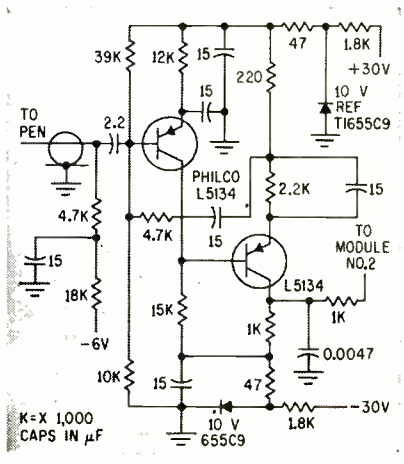


FIG. 4—First module of 4-stage main amplifier

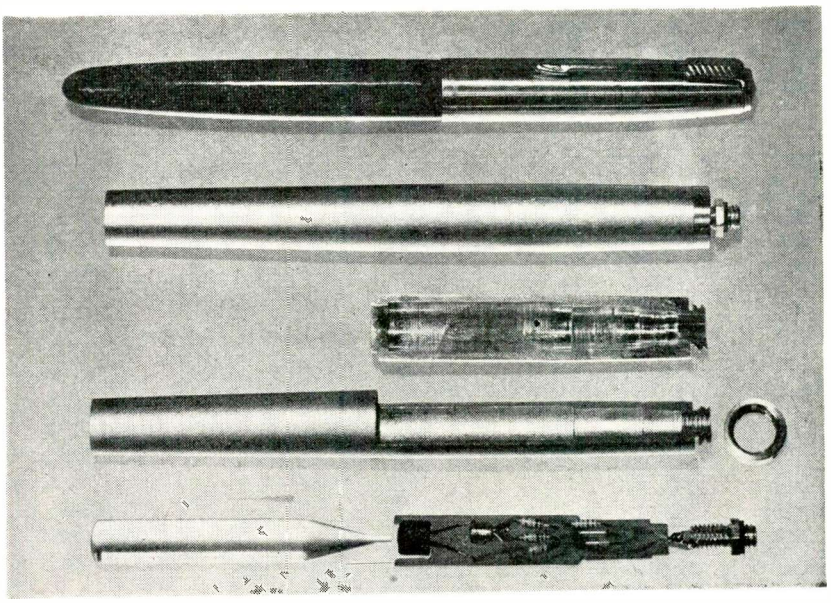
Main Amplifier

The main high-gain amplifier, input stage shown in Fig. 4, consists of four 2-transistor wide-band-amplifier modules. Each incorporates inverse feedback to hold current gain to a highly stable value of 21. Individual amplifier modules have pass bands of 5 cps to 5 mc at the −3 db points. Each module incorporates a breakdown-diode power-supply filter to make it possible to

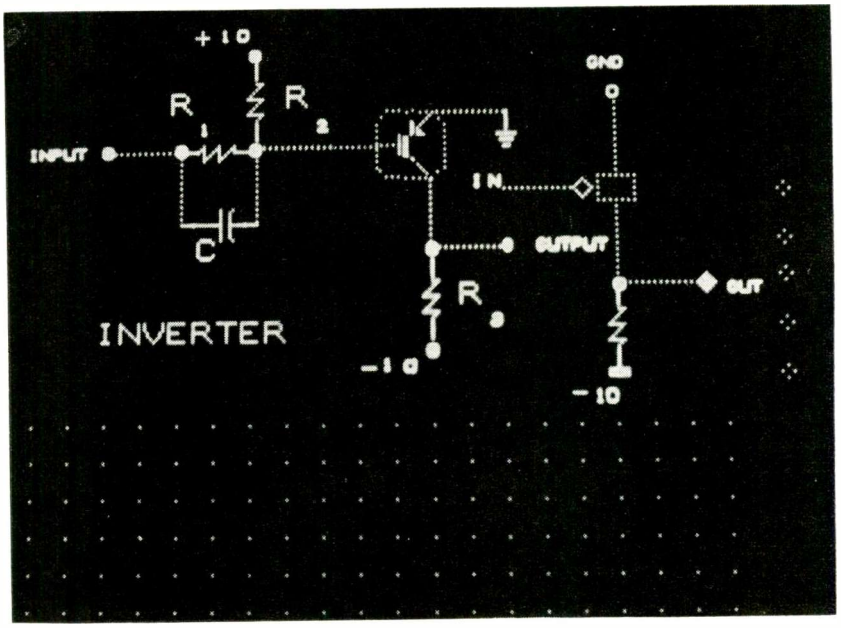
run the high-gain amplifier from associated computer power supplies, which often are inadequately filtered for such low-level circuits.

Pass bands of the amplifier modules, originally designed with possible use in other video-amplifier applications in mind, are much wider than needed for the light-pen signal. The interstage coupling networks of the amplifier were designed to raise the lower cutoff frequency to 500 cps to provide some rejection of 120 cps room light picked up by the photodiode. A low-pass filter was added to lower the upper cutoff frequency to 80 kc to avoid sensitivity to stray electrical pickup.

The amplifier circuits, including the preamplifier, have a current gain of several million. Output of the last amplifier stage drives a Schmitt trigger requiring a 1-ma 2-v signal.



Disassembled pen with light-pipe lens and preamplifier mounting board removed is shown at bottom. Above is assembled light pen, at top fountain pen for size comparison



Sample cathode-ray-tube pattern drawn using control link

Applications

The light pen has many uses. For example, it can be used to write information into the computer. The computer program can display a matrix of dots on the crt. By pointing the pen at these dots the operator can write a pattern—perhaps a word or a circuit diagram—into the computer memory, where it can be used by the program. During the writing process the program can signal the operator that it has received the message to store any given dot by either erasing that dot from the displayed matrix or by intensifying it.

In another application the displayed dots can be used as so many pushbuttons to control a program in progress. Since the program may have control over auxiliary equipment this is tantamount to controlling the equipment itself from the display console.

Simulates Typewriter

In one case the auxiliary equipment controlled was the display itself. A program was written by John T. Gilmore, Jr., of Lincoln Laboratory to simulate a typewriter using only the crt display and light pen.

The program displayed a rectangular array of dots in the lower half of the crt screen. These were the typewriter keys. Pointing the light pen at any key caused the program to write the corresponding letter—actually a small array of dots arranged in the form of the letter—in a line near the top of the display. Successive letters were printed across the line, and a carriage-return key made it possible to print several lines. It was also possible for the operator to draw special symbols (by a dot matrix called for by one key) and to move them about the face of the crt. In this way patterns, such as circuit diagrams, could be drawn. An example of such a pattern is shown in the photographs.

The work reported in this article was performed by Lincoln Laboratory, Lexington, Massachusetts, operated by the Massachusetts Institute of Technology with joint support of the U. S. Army, Navy and Air Force.

REFERENCES

(1) D. E. Sawyer and R. H. Rediker, Narrow Base Germanium Photodiodes, *Proc IRE*, 46, p 1122, June 1958.

How Rings Aid Design

Retaining rings which satisfy many different fastening requirements are tabulated. Formulas aid in calculating design loads.

By HOWARD ROBERTS,
Manager of Engineering Services, Truarc Retaining Rings Division, Waldes Kohinoor, Inc., Long Island City, N. Y.

COMPONENT DESIGN may be simplified through the proper use of retaining rings. The number, size and weight, complexity of components in an assembly may be reduced. Thus rings are ideally suited to electronic applications where miniaturization and lower manufacturing costs are design objectives.

FASTENING REQUIREMENTS—Retaining rings satisfy a wide range of fastening requirements in electronic assemblies. Because stamped retaining rings are essentially hard tempered springs, their shearing strength and their thrust and impact capacity, is high. Most rings are seated in deep grooves which increase the fasteners' static and dynamic load capacities.

Self-locking rings, which do not require grooves, are useful for assemblies in which the ring will not be subjected to any sizable thrust, but rather must serve as a positioning or locking device. For some applications, rings are available in sizes to accommodate shafts as small as 0.040 in. in diam.

The rings are easy to assemble and disassemble with simple hand tools and often can be installed with mechanized equipment which eliminates threading, tapping, drilling and other costly and time-consuming machining operations. Accurate location of ring grooves, which usually can be cut simultaneously with other production processes, assures precise seating of components in the assembly, and minimizes binding or end-play.

Some of the most widely used standard rings are shown in Table I. Except for certain self-locking types, all rings are reusable following disassembly.

RING APPLICATIONS—Table II lists the materials from which most retaining rings are manufactured, together with their shear strength and temperature limits. In selecting rings for individual applications, a number of factors should be considered. Size, loading conditions, clearance and method of assembly and disassembly are most important when selection is made.

Formulas for calculating safe design loads are

Table I . . .

Type	Size Range (in.)	Thrust Load[a] (lbs)	Materials[b]	Characteristics, Application
AXIAL ASSEMBLY TYPES				Tapered section assures constant circularity, groove pressure. Withstand heavy thrust loads, high rpm's. Used widely to retain bearings and cover plates in synchro motors, servo mechanisms; position windings on resistors Bowed and beveled types take up end-play. Used to pretension tuning shafts preload bearings; retain tube sockets, lock nulling slugs in synchro housings
Basic Internal	1/4 to 10	350 to 220,200	CS BC PB SS AL	
Basic External	1/8 to 10	110 to 220,200		
Inverted Internal	3/4 to 4	1,650 to 34,200	CS BC PB SS AL	Inverted lugs and increased section height provide better clearance, higher shoulder uniformly concentric with housing or shaft. Used to retain cover plates, shielded bearings, ball and roller bearings, other parts large corner radii or chamfers
Inverted External	1/2 to 4	1,100 to 34,300		
RADIAL ASSEMBLY TYPES				Narrow, tapered section provides low shoulder uniformly concentric with shaft Used in potentiometers, recording instruments, other assemblies where clearance is critical
Crescent External	1/8 to 2	85 to 7,300	CS BC PB SS AL	
E-Ring External	0.040 to 1-3/8	13 to 4,100	CS BC PB SS AL	Functions as large shoulder on small diameter shafts. Retains hinge pins, springs, linkages, tuner shafts, position precision gears in small gear drives. Bowed ring available for end-play take-up
Reinforced[2] E-Ring External	3/32 to 7/16	50 to 600	CS BC PB SS AL	Provides greater gripping power, higher rpm limits than conventional E-rings Resists heavy vibration and shock loads, relative rotation

. . . Design, Characteristics and Applications of Retaining Rings

Type	Size Range (in)	Thrust Load[a] (lbs)	Materials[b]	Characteristics, Application
 Locking Prong External	3/32 to 7/16	80 to 700	CS BC SS	Prongs prevent ring from being forced out of groove. Bowed construction provides spring tension for end-play take-up. Retains tuner shafts, other control devices in radios, TV sets, tape recorders, other instruments
 Inter-Locking External	15/32 to 3-3/8	2,000 to 43,500	CS BC PB SS AL	Two-part ring designed to withstand high rpm's. Provides shoulder uniformly concentric with shaft. Used for retaining bearings in high-speed motors, applications in which parts rotate at varying speeds relative to ring
SELF-LOCKING RINGS				
 Circular External	3/32 to 1	27 to 220	CS BC SS	Push-on type fastener. Prongs lock ring on shaft against movement in one direction. Retains small sockets, hinge pins, linkages, other components which normally do not have to be removed for field servicing or maintenance
 Circular Internal	5/16 to 2	45 to 150	CS BC SS	Used in bores and housings. Secure against movement in one direction. Holds caps in capacitors, similar applications where ring must function as positioning and locking device
 Grip Ring External	5/64 to 3/4	10 to 90	CS BC PB SS	For ungrooved shafts, tubes, bosses, die-cast and plastic studs. Locks against movement from either direction. Adjustable after assembly and re-usable. Replaces set-screw collars, cotter pins. Ideal for components which must be removed for servicing, maintenance

Type	Size Range (in.)	Thurst Load[a] (lbs)	Materials[b]	Characteristics, Application
 Triangular External	1/16 to 7/16	25 to 270	CS BC	Dished body. Prongs lock against shaft under spring pressure. Accommodates moderate tolerances, heavy thrust loads. Holds laminates in position in transformers, also retains medallions and ornaments to chassis
 Triangular Nut External	Thread Series 6-32 to 1/4-28		CS BC	Dished body flattens under torque. Eliminates need for lock washers. Secure against moderate impact, vibration. Used on control devices to hold screw settings
SPECIAL TYPES FOR ELECTRICAL USE				
 Terminal External	31/32	3,200[c]	BC	Inner tab locks ring on shaft. Large tab serves as wire shoulder, contact or terminal
 Coil Shoulder External	5/16 to 1/2	Ring usually used on plastic or fiber tubes. Thrust capacity not a factor	BC	External ring used as coil shoulders. Elongated lugs serve as terminals; inner tab locks ring on tubular shaft
 Detent Spring Internal	1-1/16	5,000	CS	Internal ring without lugs. Acts as precision detent spring. Notches facilitate assembly, disassembly

a—P_T (See Table III on following page) Value for carbon spring steel rings, installed on shaft or in housing made of hardened steel, with properly mating parts
b—See Table II on following page
c—Value for beryllium copper ring

Rings are available in sizes to accommodate shafts as small as 0.040 in. in diam. for some applications. The basic internal and external rings are ideal for applications in which the fasteners will be subjected to heavy thrust loads or high rotational speeds. If it is necessary for the ring to take up end-play caused by accumulated tolerances or wear in the retaining parts, bowed or beveled rings should be considered. Bowed rings provide resilient end-play take-up. Beveled rings, which are installed in grooves with a corresponding bevel of the load-bearing wall, act as a wedge to provide rigid take-up. Available finishes are given in Table II.

Table II
Materials and Finishes Used in Rings

Basic Material[a]	Shear Strength (psi)	Temp. Limits (deg F)	Remarks
Carbon Spring Steel (CS)	120,000 to 150,000[b]	−100 to 650[b]	800–900 F, use 2/3 P_r[d] 1,200 F, 3/10 P_r
Beryllium Copper (BC)	82,000 to 110,000[c]	−100 to 650	800–900 F, use 2/3 P_r
Phosphor Bronze (PB)	48,000 to 60,000	−42 to 212	Not recommended for use above 212 F
Stainless Steel (SS)	120,000 to 150,000[b]	−100 to 900	At 1,000–1,100 F use 2/3 P_r
Aluminum (AL)	38,000	−100 to 650	.....

a Available in variety of protective or decorative finishes
b Varies according to ring size
c Varies according to ring style
d Allowable thrust load of ring (See Table III)

Table III
Formulas for Calculating Safe Design Loads

Definition of Terms	Type of Stress	Formula
a —acceleration of parts (in/sec²)		
d —groove depth (in)	Static thrust load on ring	$P_r = \frac{St\pi s_s}{F}$
E —modulus of elasticity of groove	Static thrust load on groove	$P_g = \frac{Sd\pi s_y}{F}$
f —frequency (cps)		
F —safety factor[a]		
h —largest section of ring (in)	Impact loading on ring	$I_r = \frac{P_r t}{2}$
I_g —allowable impact load on groove (lbs)		
I_r —allowable impact load on ring (in lbs)	Impact loading on groove	$I_g = \frac{P_g d}{2}$
P_g —allowable static thrust load on groove (lbs)	Vibration loading on ring	$wa \leqq 540 P_r$
P_r —allowable static thrust load on ring (lbs)	Vibration loading on groove	$wa \leqq 400 P_g$
P_{rr}—allowable rotating thrust load on ring exerted by adjacent part (lbs)	Harmonic oscillation for ring or groove	$a \simeq 40\rho f^2$
S —shaft or housing diameter (in)		
s —working stress of ring under maximum expansion or contraction (psi)	Allowable thrust load onring when retained part rotates relative to ring	$P_{rr} \leqq \frac{sth^2}{\mu 18S}$
s_s —ultimate shear strength of ring material (psi)		
s_y —tensile yield strength of groove material (psi)	Elastic deformation (temporary displacement of retained part under load)	$\delta = \frac{T}{Ed}$
t —ring thickness (in)		
T —acting load (lbs)		
w —weight of retained parts (lbs)		
δ —deflection (in)		
μ —coefficient of friction (dry parts 0.15–0.20)		
ρ —amplitude (in)		

a Varies with ring design and material. Value is 4 for basic steel internal and external rings.

given in Table III. For maximum thrust capacity under both static and dynamic loading conditions, the abutting face of the retained part should have a square corner. The retained part should permit reasonably concentric uniform loading against the ring.

Rings for inverted lugs provide a shoulder which is uniformly concentric with shaft or housing. Inverted rings are useful for retaining parts with large corner radii, such as those found on bearings, or chamfers.

Of the radially assembled types, crescent rings are best for clearance. E-rings and reinforced E-rings provide a large shoulder on small diameter shafts. The bowed locking-prong ring is useful for taking up end-play and for providing spring tension on retained parts. The two-part interlocking ring is intended for assemblies in which the ring will be subjected to high rpm's or when the retained parts rotate at varying speeds relative to the ring. The circular push-on types are ideal for plastic studs and fiber tubes.

STANDARDS—Stamped retaining rings are covered by a number of Government and industry standards. These include Department of Defense Military Standards MS 16624 through MS 16634 and MIL-R-21248; and National Aircraft Standards NAS 669-670, which supercede NAS 50-51. The rings also have been assigned various Federal Stock Number Classifications. Figures 1 and 2 below illustrate the use of retaining rings on actual assemblies. Rings replace screws and shim washers, eliminate tapping of studs, reduce size and overall height of units.

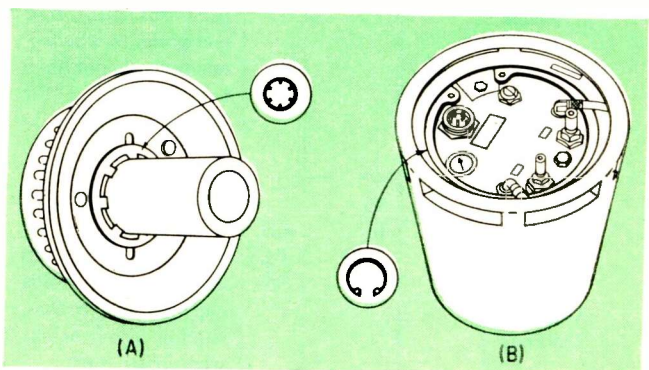


FIG. 1—Knob assembly (A) uses circular self-locking ring to position and lock dial skirt on plastic knob shaft. Push-on type ring is installed without groove, accommodates tolerances of plastic parts to eliminate end play. Portable industrial X-ray unit (B) uses beveled external ring to lock end plate of transformer tube housing

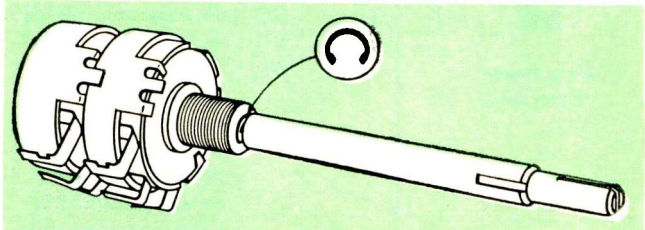
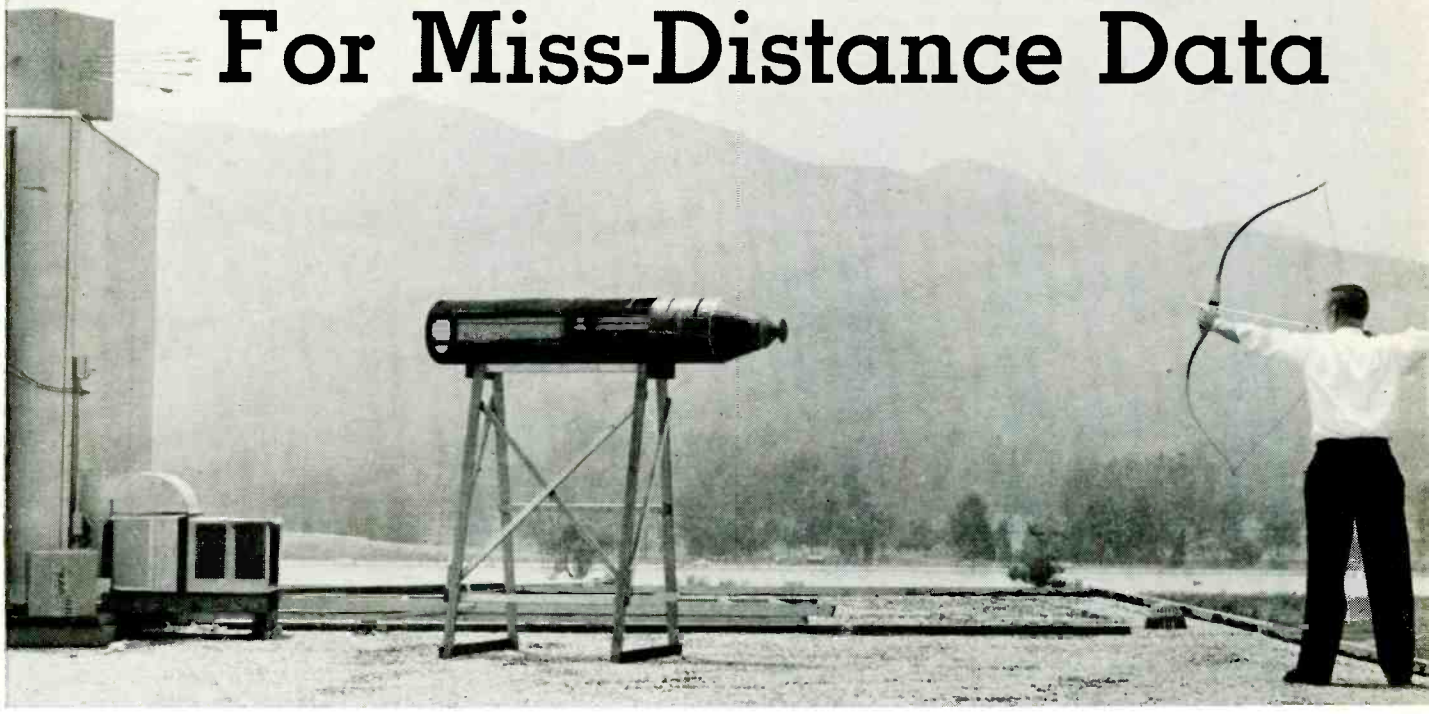


FIG. 2—Radially-assembled crescent ring locks threaded ferrule on potentiometer shaft. Low shoulder, uniformly concentric with shaft, provides clearance necessary for assembly of panel locknut. Ring may be removed easily and reused

Low-Cost Active Radar For Miss-Distance Data



Old-fashioned ballistic missile (arrow) is used to check a new miss-distance indicator. The mdi can detect objects at closing speeds up to Mach 10 and at altitudes to 100,000 feet

By servoing the sweep frequency of an f-m radar, the miss-distance of a missile can be found quickly and accurately

By **WILLIAM H. DOTY,** Director of Engineering, Electronic Specialty Company, Los Angeles, California

FINAL EVALUATION of a missile weapon system must be made from live tests. This is particularly true for tests of the guidance system. The missile must be fired against operational targets to make sure it approaches them close enough to be effective. For a positive kill, the missile must enter a predetermined zone around the target. The extent of the kill zone is determined from the energy and type of warhead.

If the guidance system can bring the missile into the lethal zone a successful mission is accomplished. Because many of the targets are expensive, and must simulate as closely as possible the intended operational targets, they cannot economically be regarded as expendable. Live warheads are accordingly not used in the test missiles.

A successful close approach to the target is just as effective as a direct hit. Evaluation of the weapon system is therefore made without hitting the target, provided it can be determined how close the missile approaches. This is the function of the miss-distance indicator (mdi).

Miss-Distance

There are several methods of determining if the missile comes within lethal range of a target during a test. Most of these fall into three distinct groups: optical, radar with missile participation, and radar without missile participation. All of these methods can be ground-based or airborne. In addition, miss-distance can be found with radio methods by using a ring-around system between target and missile. All these methods have advantages and disadvantages and all have been applied to the specialized testing of different classes of vehicles.

One way of finding the miss-distance is to track both missile and drone. Then, by a long process of data reduction, compute the trajectories in x, y, and z, thus solving the equations for the closest approach of the trajectories in space and time. This is a laborious process and suffers from the serious disadvantage that at long ranges errors arise from poor angular resolution of the radar and its shaft digitizers. Errors result because sine-cosine information needed to convert from polar to cartesian range coordinates is usually obtained by low resolution potentiometer pickoffs. If digital pickoffs are used the computer load is very great when real time data is required. Hence this system suffers from the disadvantage of complex and expensive ground equipment and the

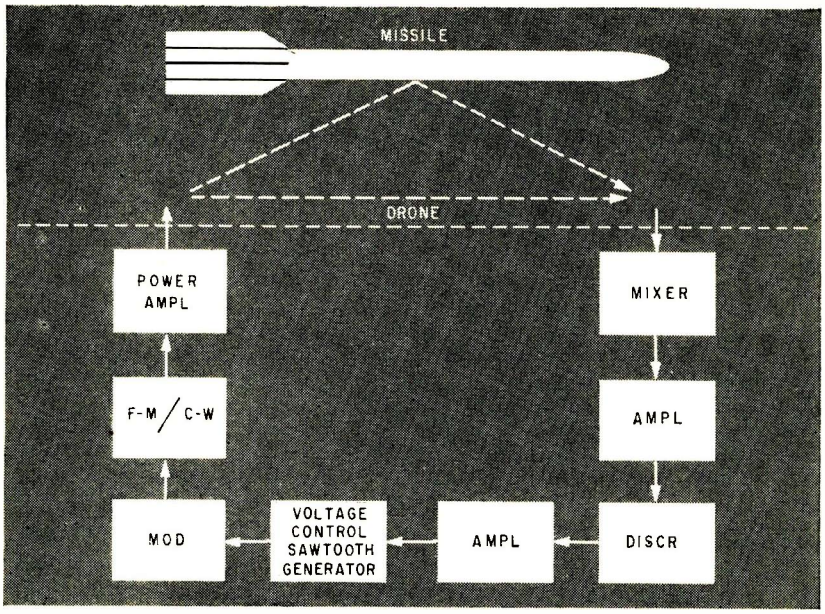


FIG. 1—Sawtooth generator is controlled by error signal developed in the discriminator. Transmitter sweep rate becomes a measure of distance between target and missile

continued expense of data processing.

Optical range systems may be inherently more accurate than radar systems when tracking both missile and target drone at medium ranges but they are dependent on good weather conditions. They also require a laborious and time-consuming film reading process to determine azimuth, elevation and boresight error. The data must then be processed in a trajectory computer.

Airborne Systems

Airborne optical systems with photo instrumentation on the target craft also suffer from data reduction delays. The film must be processed and read on specialized readers before the data can be interpreted. This system has, however, the great advantage that it can easily show explosion point by the flashing of a light on the missile. Also, the system is inexpensive in hardware. A typical optical system, for example, may require about $200 worth of equipment in the drone and about $20 in the missile. The main cost of this type of mdi goes into ground equipment and the continued labor of data processing. For an extensive test program, data processing costs can be high.

Feedback time for test results is an important factor in missile system development. Everything possible is done to reduce this time. Accordingly, any system which produces data immediately is highly desirable.

Several airborne electronic systems approach this ideal. One type of system relies on the Doppler effect. A c-w signal is radiated from the drone, reflected from the missile and received back at the drone where the receiver looks at the Doppler shift. Frequency shift caused by the relative motions of target and missile becomes zero at the instant the missile stops approaching the drone and starts to pull away from it.

To interpret the Doppler data it is necessary to match curves previously calculated for speed and miss distance. This is a time consuming process which does not lend itself readily to rapid data processing. Consequently the main disadvantage of the Doppler system is the volume of data reduction required. A Doppler system is also expensive, especially if it uses a transponder in the missile. Equipment for the drone is in the region of $10,000 and there is the continued cost of data processing.

Any mdi which requires equipment within the missile is at a disadvantage. The missile-borne equipment is expensive and can only be used once. While drone equipment can be used for several tests, missile equipment is usually destroyed. Furthermore, it is not always convenient to put equipment in the missile because of space and weight limitations. This is especially true for small air-to-air missiles and projectiles.

New Indicator

A new mdi system has recently been developed and is shown in the photographs. The new unit requires no equipment in the missile, requires no ground equipment, needs negligible data processing and avoids the use of a telemetry link. Cost is about $2,000 for installation in a drone.

The system was designed to combine the best features of pulse and Doppler radars without suffering their usual disadvantages. It is an active radar system completely contained within the target vehicle.

Since all the electronics are contained within the target vehicle, no transponders or other equipment is required on the missile. Further, no modifications of the missile are needed.

Figure 1 is a block diagram of the system. It is essentially a conventional f-m/c-w radar except for one feature. The receiver output is fed

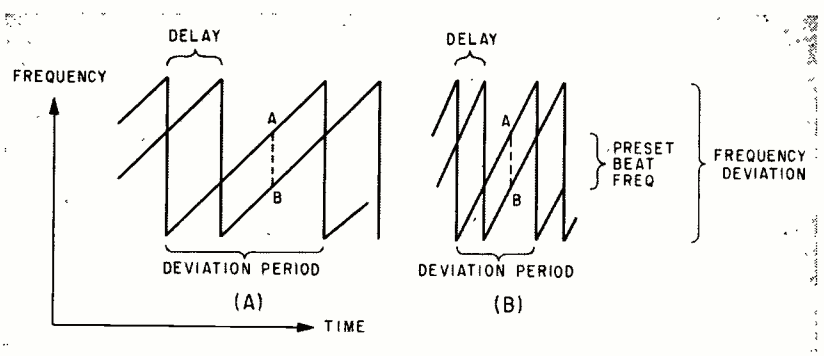


FIG. 2—Transmitter sweep rate is shown for a missile at two distances. For *A*, the missile is farther away than at *B*

into a sawtooth generator for the continuous adjustment of the transmitter sweep frequency. The sweep period is directly related to miss-distance and, without any drift or calibration errors which occur in a telemetering system, miss-distance can be read out directly at a ground station.

Drone Receiver

The drone receiver gets a small signal directly from the transmitter and a reflected signal from the missile. But the transmitter frequency is being varied by the sawtooth generator. Since the signal reflected from the missile is delayed in time, it is therefore at a different frequency than the direct signal. The difference frequency is a function of the sweep rate and the distance of the missile from the transmitter. It can be seen that if the difference frequency is held constant by varying the sweep rate, then the sweep rate is a measure of the distance between missile and target.

The two signals appearing at the receiver input are shown in Fig. 2. The preset difference or beat frequency is illustrated by the length of line *A-B* and the total sweep band is illustrated by the height of the sawtooth wave. As the missile approaches the target the delay period between transmitted and reflected signals becomes smaller and the sweep frequency must be increased correspondingly to hold the preset beat frequency constant. This is illustrated by the increased slope of the second waveform in Fig. 2.

Difference Frequency

The constant difference frequency is selected with attention to the range required of the mdi. For a range of 1,000 feet, for example, a frequency of 8 kc can be chosen. The received signals are passed to a discriminator which is set for 8 kc. If the beat note produced by the reflected signal and the direct signal is 8 kc, there is no output from the discriminator. However, if the beat note differs from 8 kc, the output from the discriminator is proportional to this difference.

The discriminator output is applied through an amplifier to the sawtooth generator to change the slope of the sawtooth by varying the sweep at a constant frequency deviation. The slope is changed so as to bring the beat note back to 8 kc. When the sweep frequency is greatest, the deviation period is least, and the missile makes its closest approach to the target. The actual value of the sweep frequency at this time therefore represents the miss-distance.

A ground station can receive the signal from the drone and rapidly determine when the closest approach took place and how far the missile was from the target. Ground reception requires an L-band f-m receiver tuned to the mdi transmitter. Its output can be displayed on an oscilloscope or can be passed to a tape recorder for integration with range time and other data. The system uses a 100-watt transmitter for about 100 miles line of sight range with respect to the ground station.

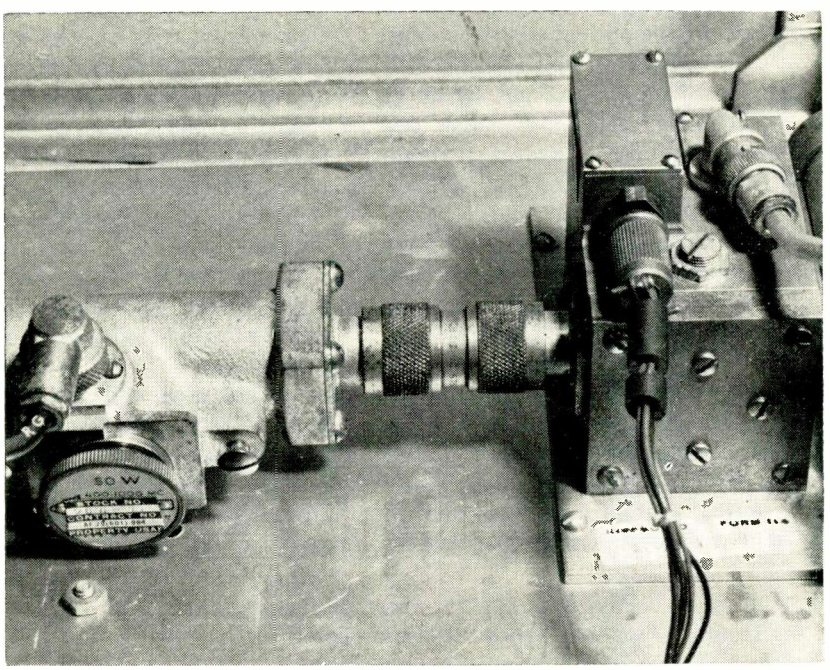
To overcome the effects of Doppler frequency shifts, a triangular wave shape is used instead of the simple sawtooth shown in Fig. 2. This causes the Doppler to add and subtract on alternate half cycles.

The transmitter, shown in the photograph, operates between 800 and 1,000 mc. It will be adapted to the 2,200- to 2,300-mc band for future use. A typical frequency deviation used is 5 mc, at a sweep rate of 6.3 kc. The receiver is a superhet whose local oscillator signal is the transmitter leakage. The received r-f signal is amplified and passed to the discriminator.

The system weighs 16 pounds and occupies 600 cubic inches. It can be used at closing speeds between zero and Mach 10 and at altitudes up to 100,000 feet. Its scoring range is normally 1,000 feet.

Continued demand for reduced lead time in the development of weapon systems calls for an absolute minimum of elapsed time between a missile test and the availability of test reports to the pilots and ground firing crews.

With transmitters of different power, the same basic system can be used at ranges up to 1,000 feet on a radar target area of two square feet. Actual miss-distance is immediately available at the monitor station, which uses a simple receiver tuned to the mdi transmitter. The monitor station can be ground based or airborne, depending on the requirements of the test. Thus a telemetering link is not needed for the transmission of data.



The f-m/c-w radar transmitter operates from 800 to 1,000 mc. The actual transmitter is at the right side of photo

New Figure of Merit

Range determination in infrared systems is aided by using the quantity Q. Knowing the value of Q for the given conditions permits using a nomograph to solve for the unknown parameter. Tables of Q values are available

By CHARLES S. WILLIAMS and JEROME J. REDMANN, Texas Instruments Inc., Dallas, Texas

COMPUTING THE MAXIMUM effective range the required area of the optical entrance pupil or the signal-to-noise ratio available at the cell output of an ir (infrared) detecting system, can be simplified by use of a nomograph. Before a nomograph can be constructed, a useful range equation must be developed. This equation will be derived and then simplified by an approximation and a graphical integration.

Figure 1 illustrates the geometry that determines the amount of radiation received by the optical system. The energy radiated per second from the source to the optical system is proportional to the area of the source, α, and to the solid angle subtended by the optical entrance pupil from an element of area on the source. The solid angle is the area of the entrance pupil, A, divided by the square of the distance, R. This is true if the optical system is a large distance from the source compared to the diameter of the entrance pupil.

If we consider an element of area on the source, the power radiated from the element into a hemisphere is given by Planck's radiation law, and $J(\lambda, T)$ expresses this radiation in watts per square centimeter per 0.1 micron zone of the spectrum. Dividing $J(\lambda, T)$ by π gives the radiation in a unit solid angle.

Table I—Part of Typical Q-Value Table

CELL No. 7 NEP = 2.2×10^{-10} AREA = 3.5 mm²

Path	Target Temp K	100% Optical Trans	Two Element Silicon Optics	One Element Sapphire Optics	3μ LWP Filter	Silicon and 3μ Filter	Sapphire and 3μ Filter
3.4 Mile Path With 13.7 mm Water	300	1 61 9	1 40 9	1 31 9	1 61 9	1 40 9	1 30 9
	301	1 65 9	1 43 9	1 34 9	1 64 9	1 43 9	1 33 9
	350	7 72 9	6 51 9	6 34 9	7 64 9	6 47 9	6 27 9
	450	6 56 10	5 23 10	5 47 10	6 34 10	5 14 10	5 28 10
	500	1 41 11	1 10 11	1 18 11	1 35 11	1 07 11	1 13 11
	550	2 72 11	2 07 11	2 29 11	2 55 11	2 00 11	2 15 11
	650	7 71 11	5 61 11	6 54 11	6 90 11	5 28 11	5 84 11
	750	1 70 12	1 19 12	1 45 12	1 44 12	1 08 12	1 22 12

Example: Read 1 61 9 as 1.61×10^9 Ft^{-2}

Neglecting the effects of transmission through the atmosphere and the optical system, the power at each wavelength, $P(\lambda)$, received by the optical system is

$$P(\lambda) = \frac{\alpha A}{R^2} \frac{J(\lambda,T)}{\pi} \text{ in watts.} \quad (1)$$

Notice that in going to the detector cell from the source, the radiant energy must pass through the atmosphere and be attenuated at each wavelength. This energy must also pass through an optical system, and be further attenuated by the optical elements before reaching the detector cell. Transmission by the atmosphere, as a fraction of the energy that would be transmitted through the same path length of empty space, is $\tau(\lambda)$. The fraction of radiant energy that passes through the optical system is expressed as $E(\lambda)$. Considering transmission of atmosphere and optical elements, the power reaching the cell, as a function of wavelength is

$$P(\lambda) = \frac{\alpha A}{\pi} \frac{\tau(\lambda) E(\lambda) J(\lambda,T)}{R^2} \quad (2)$$

The cell does not respond equally well to energy at different wavelengths so that $P(\lambda)$ should be weighted at each wavelength. The weighting function is $S(\lambda)$, the relative spectral response of the cell. The weighting function is defined so that a watt of monochromatic energy at the wavelength λ is $S(\lambda)$ times as effective in producing a signal

For Finding Infrared Range

as a watt of energy at the wavelength at which the spectral response is normalized. The ratio of Jones' S plotted as a function of λ may be used as the spectral response. Then the effective power weighted with respect to power at λ_m, received at the wavelength λ is $P_w(\lambda)$.

$$P_w(\lambda) = \frac{\alpha A}{\pi} \frac{\tau(\lambda)E(\lambda)S(\lambda)J(\lambda,T)}{R^2} \quad (3)$$

Optical Efficiency

The optical efficiency η is used to account for any obscuration and loss of stray rays and represents the fraction of the energy intercepted by the optical system which reaches the cell when $E(\lambda)$ is one. The equation for the weighted power becomes

$$P_w(\lambda) = \frac{\alpha A \eta}{\pi} \frac{\tau(\lambda)E(\lambda)S(\lambda)J(\lambda,T)}{R^2} \quad (4)$$

Total weighted power received by the cell is obtained by integrating with respect to wavelength.

$$P_w = \int_0^\infty P_w(\lambda)\partial\lambda = \frac{\alpha A \eta}{\pi} \times \int_0^\infty \frac{\tau(\lambda)E(\lambda)S(\lambda)J(\lambda,T)\partial\lambda}{R^2} \quad (5)$$

Next, an expression for the minimum power at λ_m, which when incident upon the cell will cause the detecting system to recognize it as signal in the presence of noise, will be set up. This recognition occurs at some minimum signal-to-noise ratio, C. Let B be that power, called noise equivalent power, which, when received by a cell, produces a signal equal to the noise.

If the limiting noise for the system is cell noise, the minimum power is the NEP (Noise Equivalent Power) of the cell. The NEP's for many cells have been measured under standard testing conditions, and the NEP must be modified when the cell is used under different conditions. This is not easy because the relationships between NEP and chopping frequency and area may not be known precisely.

If the limiting noise is some other noise, such as amplifier or radiation noise, it must be expressed in terms of an amount of power incident upon the cell that would produce a signal equal to the noise.

The term NEP_m is used to represent the noise equivalent power as measured using monochromatic radiation to distinguish from

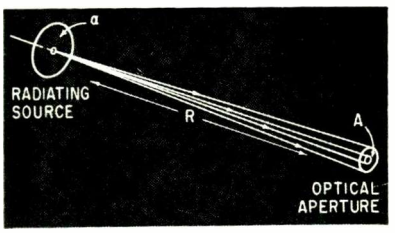


FIG. 1—Power radiated from source is a function of wavelength and temperature

NEP as used for the noise equivalent power when using 500 K black body radiation.

Measurement of NEP_m is made at λ_m. The product of B and C is the desired expression for the minimum detectable signal. Equating the minimum detectable signal to the weighted power as received by the cell, we have

$$CB = \frac{\alpha A \eta}{\pi} \times \int_0^\infty \frac{\tau(\lambda)E(\lambda)S(\lambda)J(\lambda,T)\partial\lambda}{R^2} \quad (6)$$

The usefulness of Eq. 6 is limited by the difficulty in evaluating the integral. A simplified equation would be very useful for general application to infrared detecting systems. Unfortunately, the reduction to a simple, useful form requires some procedures which may not be entirely satisfying mathematically. The procedure discussed in the following paragraphs is one method of simplification, and the result is generally useful so long as the user understands the approximations involved and exercises due precautions regarding its limitations.

Simplification

For a given atmosphere, $\tau(\lambda)$ is a function of the distance through which the infrared energy must be transmitted because it is related to the number of triatomic molecules between the target and the detector. The atmospheric molecules that absorb infrared are: H_2O, HDO, N_2O, O_3, and CO_2 of both isotopes of carbon, C^{13} and C^{12}.

In addition to being a function of R, $\tau(\lambda)$ is a function of the atmospheric pressure and the partial pressure of each gas to which absorption is due. It is approximately correct that $\tau(\lambda)$ depends upon the total number of absorbing molecules of each kind in the transmission path and does not depend upon the distribution of the molecules along the path.

The attenuation due to water vapor is so great that it is also approximately correct that the transmission may be expressed as a function of the amount of precipitable water vapor in the path rather than the distance between source and the detector. By considering $\tau(\lambda)$ a function of the amount of precipitable water, we may remove R from under the integral sign.

In using this approximation, a precaution must be observed regarding admissable values of R. A value of R used in the equation or a value of R determined by the equation, must be compatible with the atmospheric transmis-

sion $\tau(\lambda)$ that is used. As an example, using measured values of $\tau(\lambda)$ for a path containing 1.1 mm of water, a range of 5 miles is unacceptable, unless there is some reason to believe that the path along this 5 miles contains roughly the equivalent of 1.1 mm of precipitable water. This might be true for a 5-mile path in the upper atmosphere which contains a relatively small quantity of water vapor.

The integral is evaluated by a graphical integration.

$$\int_0^\infty \tau(\lambda)E(\lambda)S(\lambda)J(\lambda)\partial\lambda = \sum_{i=1}^{66} \tau(y_i)E(y_i)S(y_i)J(y_i) \quad (7)$$

At $i = 1, y_i = y_i = 1.1$ microns
$y = y_{(i-1)} + 0.2$ microns
$\tau(y_i)$, $E(y_i)$, $S(y_i)$, and $J(y_i)$ are the average values of the variables in the 0.2 micron region about the wavelength y_i. A quantity Q is defined as:

$$Q = \frac{18.59 \times 10^2}{\pi} \sum_{i=1}^{66} \frac{\tau(y_i)E(y_i)S(y_i)J(y_i)}{NEP_m} \quad (8)$$

Substitution of Q into the range equation gives

$$CR^2 = \alpha A \eta Q \quad (9)$$

The constant in Eq. 8 is chosen so that R and A in Eq. 9 may be in ft and sq ft, respectively.

Quantity Q

The quantity Q is a function of the radiant emittance of the target, the atmospheric transmission of radiation from the target, the transmission properties of the optical system including filters and the spectral response and NEP of the cell. Typical spectral response curves are shown in Fig. 2. Tabulations of Q values for various cells and optics are available. Table I shows part of a typical tabulation. Complete tables for 19 cells have been published in The Proceedings of IRIS, a classified journal, and can be obtained from Texas Instruments Inc., Dallas, Texas.

By defining the Q-value increment, ΔQ, as the Q of the target minus the Q of the background and β as the signal-to-noise ratio of the detector output, Eq. 9 can be expressed as:

$$\beta R^2 = A\alpha\,\Delta Q \quad \text{when } \eta = 1. \quad (10)$$

The nomograph of Fig. 3 expresses graphically the relationship indicated in Eq. 10. Use of this nomograph allows solving for any one of the five variables when the other four are known.

For low temperature targets, ΔQ may be negative. In this case the instrument detects the target as a cold object, if the target is nearer the detector than the radiating background.

Unique problems arise when the cold body is viewed through aircraft exhaust gases (as in tail-warning infrared). These problems and their solutions are not discussed in this article.

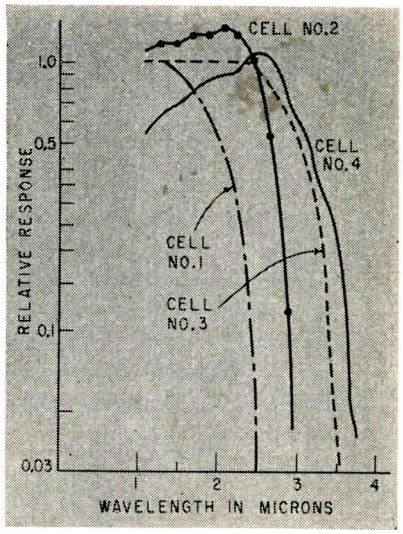


FIG. 2—Typical spectral response curves

In calculating Q-values, targets were assumed to radiate as black bodies. If the target radiates as a grey body, Q-value should be multiplied by emissivity ϵ of the target. If the target exhibits a significant departure from blackbody spectral radiance, the engineer should estimate the effects of the departure and multiply Q-value by a compensating fraction. Where η is not unity, ΔQ must be multiplied by π.

To read the Q-value from tables estimate the distance R, or make a trial computation to find an approximate R. Estimate the atmospheric condition with respect to humidity and estimate R large for a dry atmosphere or where the entire atmospheric path is more than 10,000 ft in altitude. Estimate R smaller for damp, humid conditions.

For example, (See Table I), if 5 miles is a very rough guess for a sea-level transmission path, use the 3.4 miles path. With the target at 650 K and using a two-element silicon lens, the Q-value for cell No. 7 is 5.61×10^{11}.

The user of a cell having a response curve the same as cell No. 7 but having a different NEP (identified as NEP′) would find the Q-value for his cell, Q', by

Table II Nomograph Instructions

Connect With Straightedge	Note Where Straightedge Crosses
To Find R:	
1. A and α	$A\alpha$ line
2. $A\alpha$ and ΔQ	$A\alpha\Delta Q$ line
3. $A\alpha\Delta Q$ and β	R scale. Answer
To Find A:	
1. R and β	$A\alpha\Delta Q$ line
2. $A\alpha\Delta Q$ and ΔQ	$A\alpha$ line
3. $A\alpha$ and α	A scale Answer.
To Find α	
1. R and β	$A\alpha\Delta Q$ line
2. $A\alpha\Delta Q$ and ΔQ	$A\alpha$ line
3. $A\alpha$ and A	α scale. Answer
To Find β:	
1. A and α	$A\alpha$ line
2. $A\alpha$ and ΔQ	$A\alpha\Delta Q$ line
3. $A\alpha\Delta Q$ and R	β scale. Answer
To Find ΔQ:	
1. A and α	$A\alpha$ line
2. R and β	$A\alpha\Delta Q$ line
3. $A\alpha$ and $A\alpha\Delta Q$	ΔQ scale. Answer

Definitions and Units

α = IR source or target area in sq ft.
R = Range (Distance from source to detector) in ft.
ΔQ = Q-value increment (see text) in ft.$^{-2}$
β = Signal-to-noise ratio of detector output.
A = Area of entrance pupil detecting system in sq ft.

A NEW ALL MOLDED OCTAL SOCKET by CINCH

NO. 29329

NO. 29329

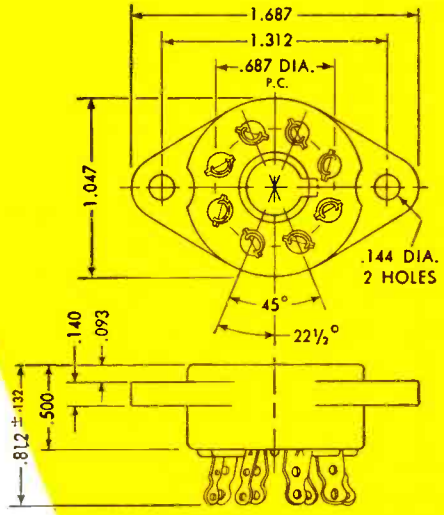
This new all molded Octal socket offers a complete one piece construction. The saddle and body are a single casting.

The standard socket is molded of general purpose Bakelite. Contacts are of brass, cadmium plated. Mica insulation with brass or phosphor bronze contacts can be made available.

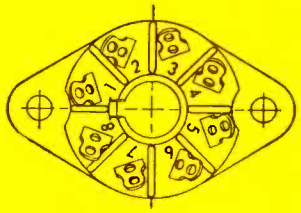
Two contact layouts can be supplied as shown below:

CINCH MANUFACTURING COMPANY
1026 South Homan Ave., Chicago 24, Illinois
Division of United-Carr Fastener Corporation, Boston, Mass.

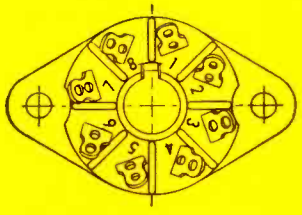
Centrally located plants at Chicago, Illinois, Shelbyville, Indiana, La Puente, California and St. Louis, Missouri.



TYPE 1



TYPE 1



TYPE 2

multiplying the known Q-value by the ratio of the NEP's:

$$Q' = \frac{2.2 \times 10^{-10} \times 5.61 \times 10^{11}}{\text{NEP}'}$$

Typical Solution

Problem: Solve for range R when the entrance pupil area A is 0.25 ft², the target size is 2 ft², the target Q-value is 6.55×10^{10}, the background Q-value is 1.55×10^{10}, and the required β is 10. Refer to Fig. 3.

Step 1: Locate 0.25 on A and 2 on a. Place a straightedge connecting these points, and note where the straightedge crosses $A\,a$, (point 1).

Step. 2: Locate the value of ΔQ, **5.0 x 10^{10}** on ΔQ and place a straightedge connecting this point and point 1 on Aa line. Note where the straightedge crosses $Aa\,\Delta Q$ (point 2).

Step 3: Locate 10 on β, and place a straightedge connecting this point and point 2 on $Aa\,\Delta Q$. The range is read at the point where the straightedge crosses R, namely 5×10^4 ft (point 3).

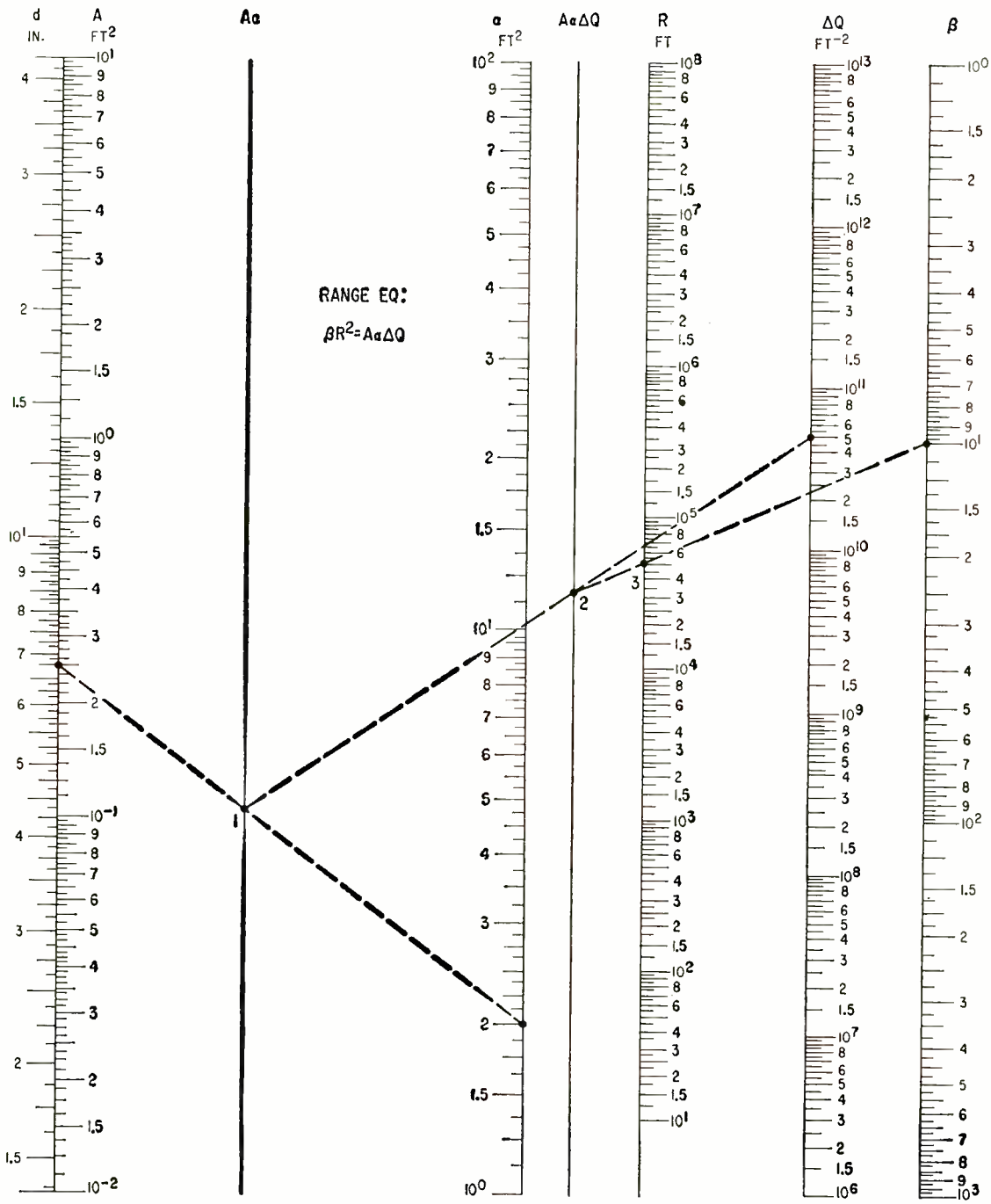
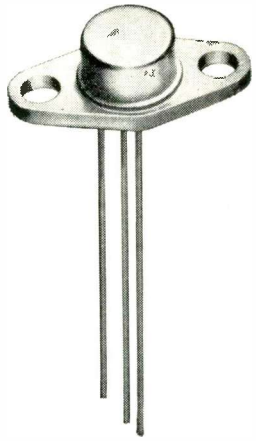


FIG. 3—Using this nomograph and Table II makes it possible to solve for unknowns in range equation. Column labeled *d* gives diameter in inches of lens having area *A*

DELCO RADIO ANNOUNCES REDUCED PRICES ON POWER TRANSISTORS



Effective November 1, Delco Radio's line of high quality, high reliability power transistors is now being offered at prices reduced as much as 34% in production quantities.

Lower prices are possible at this time as a result of new manufacturing techniques, design improvements, and increased production.

Delco Radio's power transistors have established enviable records for performance and reliability in virtually limitless applications. The new prices reflect Delco Radio's policy of offering products of the highest quality and performance at the lowest possible price.

These reduced prices will now permit many additional applications where transistor cost has been a limiting factor. Contact your Delco Radio representative for details and for applications assistance.

DELCO RADIO

DIVISION OF GENERAL MOTORS
KOKOMO, INDIANA

BRANCH OFFICES

Newark, New Jersey
1180 Raymond Boulevard
Tel: Mitchell 2-6165

Chicago, Illinois
5750 West 51st Street
Tel: Portsmouth 7-3500

Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

Recognition System Reads Ten Words

HANDWRITING reader has been invented at Bell Telephone Laboratories. It has a ten-word vocabulary —*zero* through *nine*, spelled out. The device demonstrates methods that might be applied in machines designed to read a wider variety of material.

Reading machines could be valuable in business or industry where information must be translated into machine language by punched cards, tape, or by pressing adding machine or typewriter keys.

To use the reader, the writer moves a metal stylus over a special surface just as if he were writing with a pen. When he touches an *identify* button with the stylus, a light appears beside the numeral corresponding to the word he has just written.

The device reads cursive script—connected handwritten material—despite variations in individual style. It reads by entire words rather than letter-by-letter. It picks out features of the overall shape of the word, such as word length, dotting of the letter *i*, and number and position of vertically extended letters like *h* and *g*.

FIG. 1—Ten-word reader was 97 percent accurate in test of 1,000 words written by 20 persons

The user must write within limits on the special surface. He must not print words nor lift the stylus between letters. He must dot the letter *i*. Despite these requirements, the machine was 97 percent accurate in a test of 1,000 words written by 20 persons.

Fifteen horizontal metal strips alternately sandwiched between strips of insulation form the surface. The wired stylus makes contact with the metal bars, two of which are made of brass. The brass conductors enclose the middle third of the writing space, in which small letters such as *e* or *n* are written. Vertically extended letters like *t* and *g* are carried beyond the brass conductors.

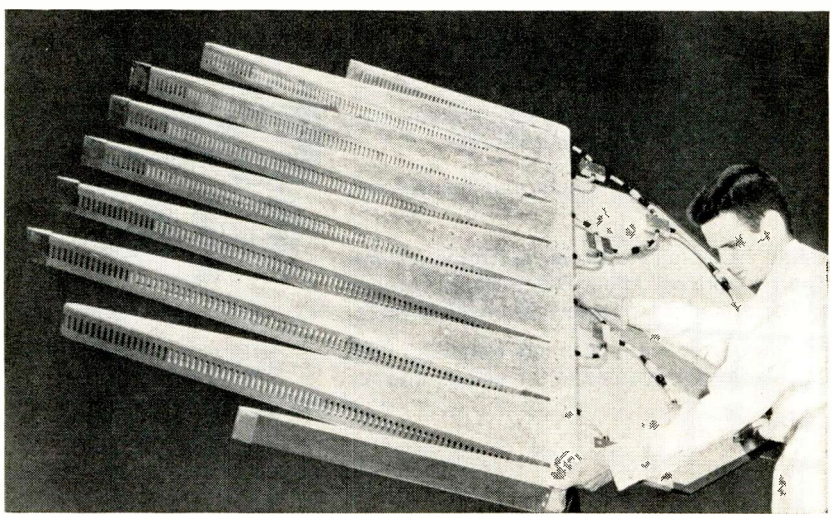
The middle bar is connected to a counter that provides horizontal location of features. If a feature comes before the stylus has crossed the middle bar six times, the feature is considered to be in the left portion of the word; if later, it is in the center or right portion.

A logic circuit examines each word for six features. They are lower vertical extension within left portion, lower extension in middle or right portion, upper extension in left portion, presence of more than one upper left extension, more than nine crossings of middle bar and a dotted *i*. The dotted *i* is detected when the stylus is lifted from the center portion to the upper portion at the end of a word.

As examples, *zero* is identified by a lower left extension, *four* upper and lower left extensions and *seven* more than nine crossings.

Theoretically, four separate tests are sufficient to identify ten words. Because of the great variation in writing styles, a practical recognition system should include some redundancy. This system therefore has two extra tests.

Low Silhouette Antenna

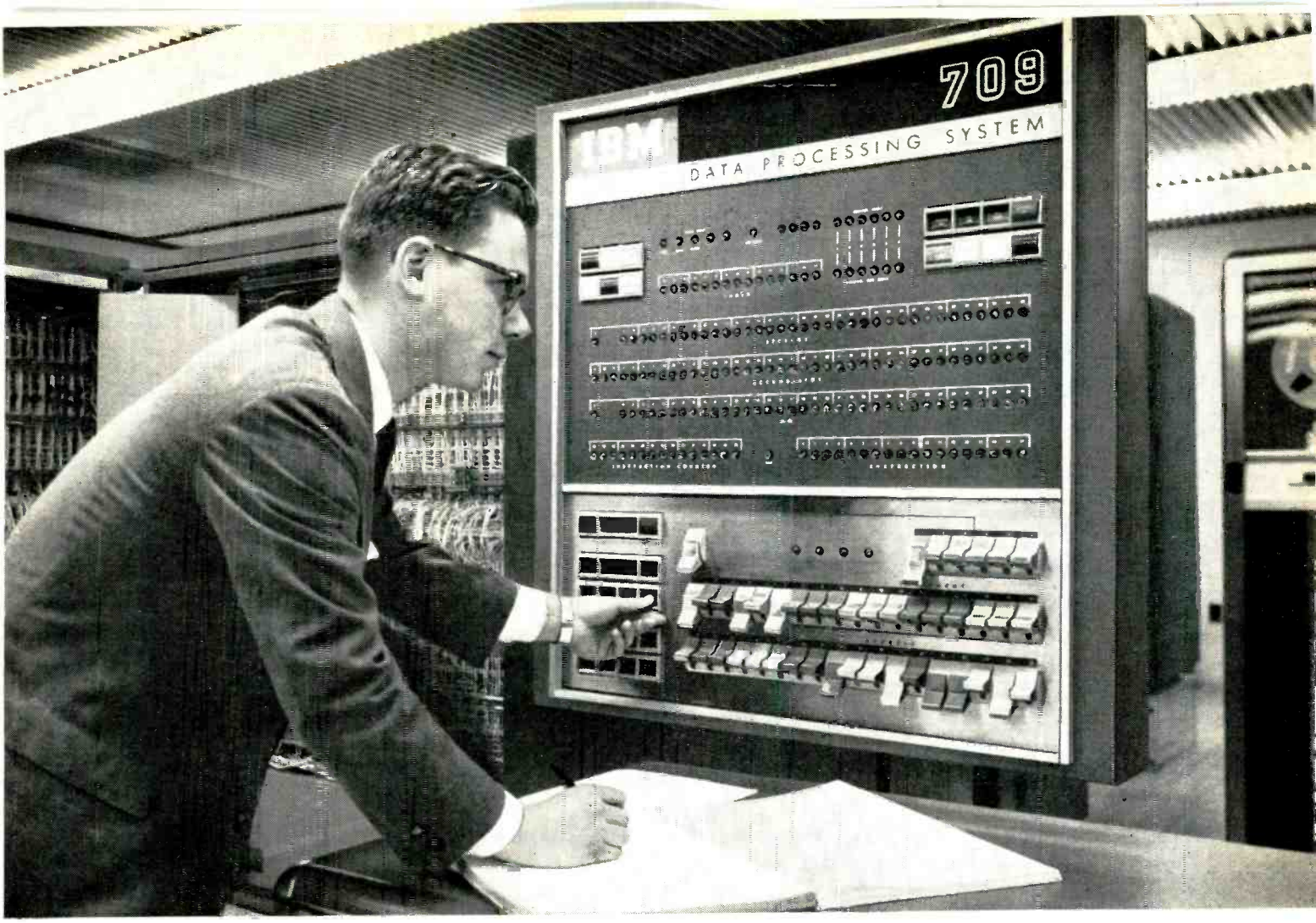


Retarded wave surface antenna with high gain and low silhouette was developed by Chance Vought Electronics Division for use in airborne early warning radar as well as ground based and shipboard radars. One-sixth scale model of 35-ft retarded surface wave antenna is shown

Air Traffic Control System Developed

DEVELOPMENT of an air traffic control has been announced by Lockheed. It would automatically and continuously tell ground controllers the location, identity and altitude of all aircraft over the country.

The Lockheed Tracking and Control System (LOCTRACS) is said to be less costly and more versatile and to give more thorough coverage than previously developed systems. The Federal Aviation Agency is



Programmer makes operational check from "driver's seat" of IBM 709 Data Processing System — the most up-to-date system utilizing electron tubes.

Tung-Sol 5687 contributes to the prime reliability of the IBM 709 Data Processing System!

The IBM 709 Data Processing system counts on unfaltering dependability from over 500 Tung-Sol 5687 Twin Triodes — approximately 340 5687's are found in the Arithmetic and Logic unit; the remainder in the Magnetic Drum Storage unit.

Because the Tung-Sol 5687 offers excellent power handling ability, the IBM 709 employs it largely in power follower circuits to supply high current requirements . . . in driving lines with high capacity loading. Frequent 200 millimicrosecond pulses make the latter a key job in the 709. Other special-circuit uses of the 5687 include: master oscillator, pulse shaping inverters, magnetic drum write head drivers, relay drivers and single-shot multivibrators.

5687 performance points up the reliability you'll find characterizes Tung-Sol tubes and semiconductors. It gives designers in-use testimony that lets them specify Tung-Sol for critical sockets with complete assurance of full-life trustworthiness. For full technical information on the Tung-Sol 5687, or other Tung-Sol tubes or semiconductors, contact: Tung-Sol Electric Inc., Newark 4, New Jersey. TWX: NK 193

ts TUNG-SOL®

CIRCLE 101 ON READER SERVICE CARD

currently evaluating the system concept.

System Operation

The country would be divided into square sectors 70 to 100 miles on a side. Each sector would be provided with four fixed receiving antennas and a microwave link or cables for transmitting data to a centrally located point.

Lightweight transmitters installed in all aircraft would transmit encoded information identifying the aircraft and its altitude. Bandwidth would be about 2 mc. All transmitters would operate on the same frequency.

Ground acquisition equipment would be used in conjunction with air traffic control computer equipment. It would pinpoint each aircraft in the stipulated geographical sector 600 times per minute.

Pulses transmitted by the aircraft in all directions would be received by the four ground-based receivers in each sector. The received pulses would be relayed by microwave relay link or cables to a surveillance center. The four pulse trains would be passed through fixed delay lines to compensate inequalities in transmission distance.

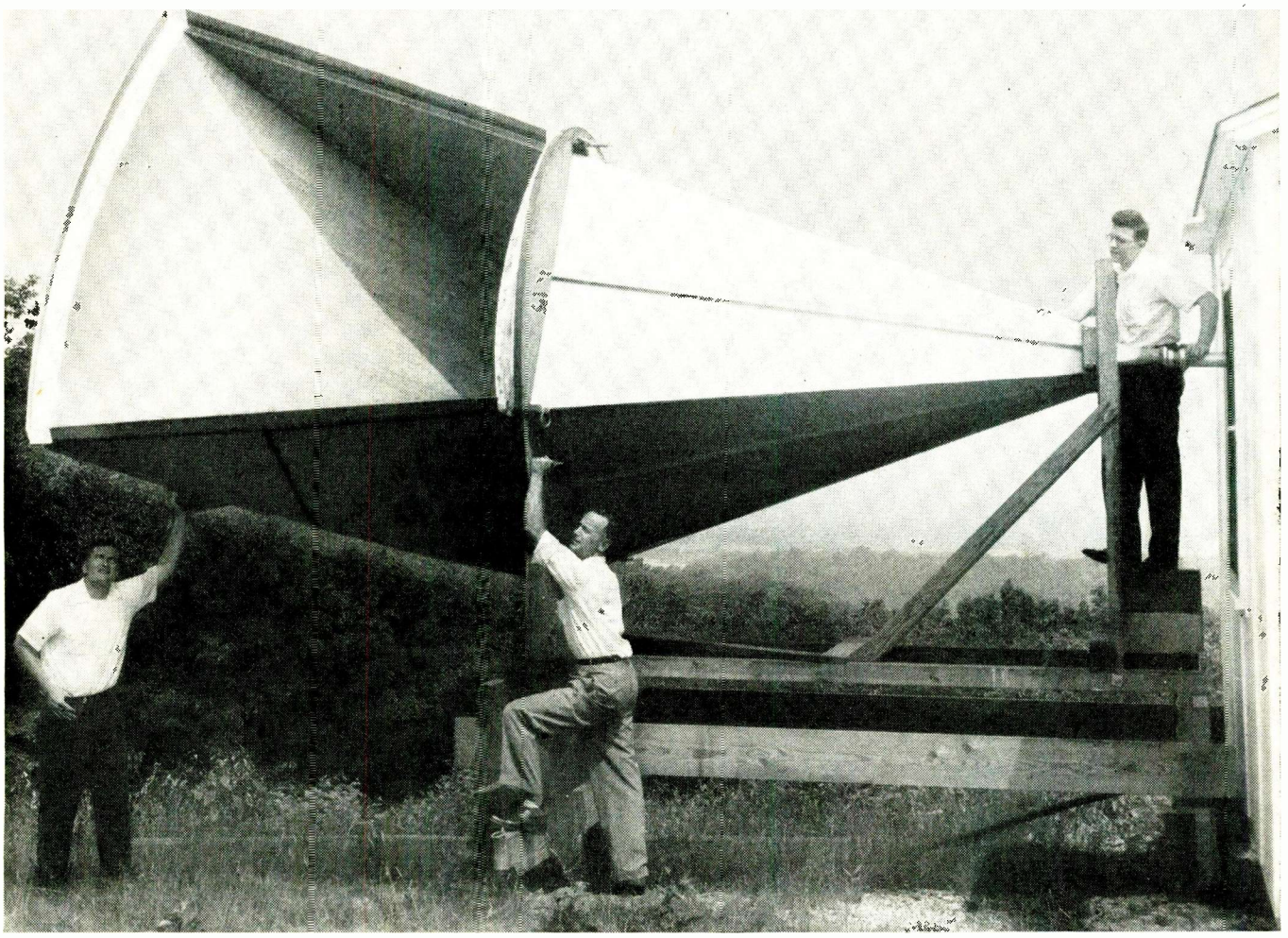
The geographic sectors are subdivided into square surveillance elements from one-sixth to one mile on a side. Coincidence detectors determine over which element an aircraft is located. This is accomplished by entering each of the four pulse trains into one of four digital delay lines. Each delay line is provided with taps placed at one-microsecond intervals. A given combination of taps is used to bring the four pulses into time coincidence.

The pulses arrive simultaneously on all four inputs to a coincidence detector that represents a particular surveillance element. A corresponding display light is activated and a data pulse is supplied to the data readout.

Equipment Requirements

An effective nationwide system could be achieved with 630 large sectors and an additional 70 smaller ones (25 to 30 miles per side) located at terminals of air routes for detection of aircraft in more congested locations.

It is estimated that 33 digital



At Bell Laboratories, Holmdel, N. J., a horn reflector antenna is beamed skyward by scientists Edward Ohm, David Hogg and Robert DeGrasse. The maser amplifier, which employs a ruby cooled in liquid helium, is inside building at right. Over-all "noise" temperature of antenna, amplifier and sky is only 18°K at 5600 megacycles.

ANOTHER STEP TOWARD SPACE COMMUNICATIONS

The above antenna is part of a new ultra-sensitive radio receiving system under development at Bell Telephone Laboratories. It has extraordinary directivity. Beamed skyward, it ignores radio "noise" from the earth, yet picks up extremely weak signals from outer space.

The signals are amplified by the latest Bell Laboratories "maser" amplifier. The maser principle was first demonstrated, using gas, by Prof. C. H. Townes and his collaborators at Columbia University. Bell Laboratories scientists applied it to the solid state guided by a theoretical proposal of Prof. N. Bloembergen of Harvard University. Their latest traveling wave maser amplifier employs a ruby mounted in a waveguide. The ruby is excited to store energy. As signals pass through, they absorb this energy and are thus amplified. The device uniquely combines the characteristics needed for practical space communication: extremely low inherent noise and the ability to amplify a broad frequency band.

At present the receiving system is being used to pick up and measure minute radio noise generated by the atmosphere. It also foreshadows important advances in long distance communications. For example, it could extend the range of space-probe telemetering systems, could help make possible the transatlantic transmission of telephone and TV signals by bouncing them off balloon satellites—and has numerous applications in radio astronomy and radar.

This pioneer development in radio reception is one more example of the role Bell Laboratories plays in the pursuit of better communications technology.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

computers would be used in a nationwide system. Thirty-six sectors with associated equipment would be tied into each computer.

Flexibility Is Design Aim of New Accelerator

PRELIMINARY engineering design studies on a multiparticle variable-energy cyclotron have been completed by scientists at Oak Ridge National Laboratory.

Technicians of Catalytic Engineer Constructors, prime contractor, have moved into a second research and development phase where final design work will be completed. Catalytic has used results of ealier studies performed in 1957 by the ORNL staff on a 48-inch cyclotron concept, since then abandoned in favor of the more advanced machine.

Versatility

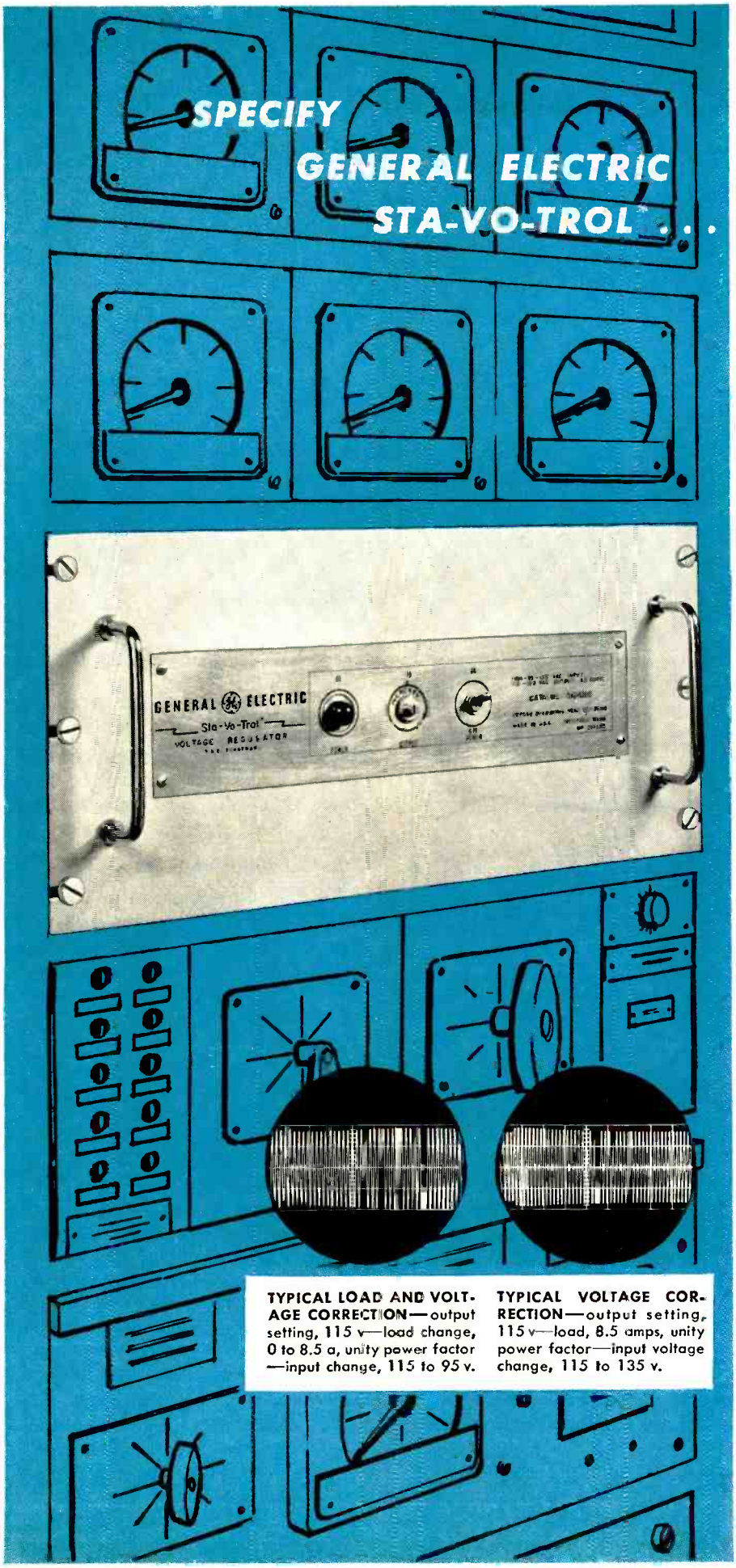
The new design incorporates an azimuthally varying magnetic field and variable-frequency resonant and oscillator system in place of conventional fixed-frequency system of the original 48-inch design.

Key feature of the machine will be its versatility. Based on analog studies it will surpass existing ones in strength of beam and in accelerating a variety of particles over a wide range of energies.

According to an AEC headquarters physicist the cyclotron will be able to handle particles of hydrogen, helium, lithium and of elements as heavy in the periodic table as oxygen. Energy ranges of the machine are: proton, 75 mev; deuteron, 40 mev; and heavy ions, 1 to 100 mev.

Existing cyclotrons can attain greater energy ranges but they contrast to the multiparticle cyclotron in being frozen to one function, such as accelerating a given particle to a given energy.

The Oak Ridge cyclotron would furnish assistance to a score of present studies going on in the fields of nuclear reactions, radioisotope production, fast neutron behavior, nuclear chemistry and radiation damage from a health physics point of view.



TYPICAL LOAD AND VOLTAGE CORRECTION—output setting, 115 v—load change, 0 to 8.5 a, unity power factor—input change, 115 to 95 v.

TYPICAL VOLTAGE CORRECTION—output setting, 115 v—load, 8.5 amps, unity power factor—input voltage change, 115 to 135 v.

New Static Voltage Control

For reliable automatic voltage control of critical loads

New General Electric Sta-Vo-Trol regulator gives you maintenance-free, automatic, *static* voltage control using unique rate feedback and industry-proven zener diode sensing.

Static components eliminate tubes, brushes, and other moving parts.

Sta-Vo-Trol regulators assure you reliable, constant voltage—regardless of line or load fluctuation—giving optimum performance of critical military and commercial electronic equipment.

Sta-Vo-Trol REGULATOR SPECIFICATIONS:

- Rating: 1 Kva output, 0 to 8.5 amperes, single phase, 60 cycles ±5%
- Input range: 95 to 135 volts
- Output range: 115 volts normal, 110 to 120 adjustable
- Accuracy: ±0.25% bandwidth†
- Response time: 6 to 12 cycles‡
- Load power factor range: 0.5 lagging to unity
- Wave-form distortion: 3%

† ±0.25% bandwidth for any line and load changes at constant power factor; ±0.5% bandwidth for changing load power factor.

‡ 6 to 12 cycles for 63% correction after ordinary line and/or load changes; up to 30 cycles for complete correction.

NET PRICE—$475

(type SLR-1000)

World-wide General Electric application and service facilities are available to you. For more information about the benefits of specifying G-E Sta-Vo-Trol voltage regulators for your application, write to Section 425-25, General Electric Co., Schenectady, N. Y.

* Trademark of General Electric Company for static voltage regulators.

Progress Is Our Most Important Product

GENERAL ELECTRIC

High-Frequency Microwave Generator

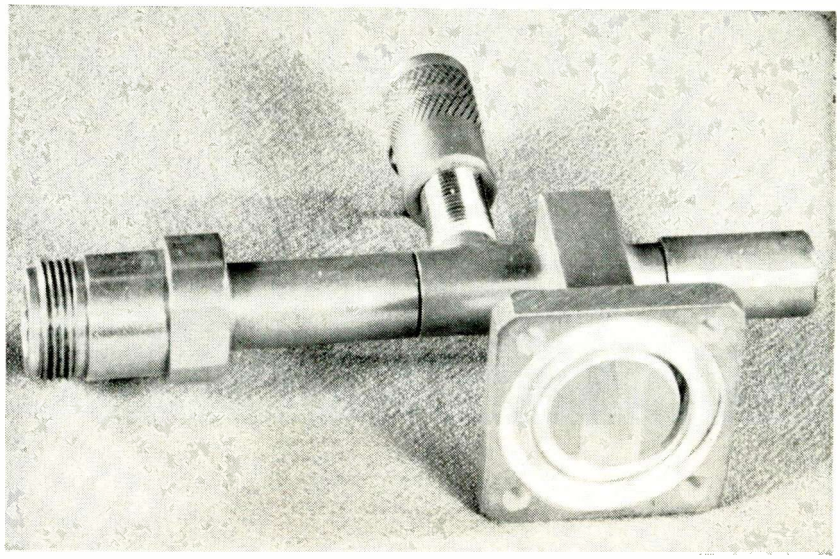
By K. A. STEELE, Radio & Electrical Engineering Division, National Research Council, Ottawa, Canada

LOW POWER klystrons, suitable for microwave test sets, are at present considerably more expensive for frequencies above X-band than for X-band and lower frequencies. Also, at high microwave frequencies, transmission from source to load becomes an increasingly more difficult problem if low attenuation and stability are important. Rigid waveguide is often inconvenient for field-test setups for checking equipment performance.

Overcoming Drawbacks

This frequency multiplier mount was designed to overcome these drawbacks and provide a Ku-band test signal when available sources are too expensive or when no primary source exists at the desired frequency. This crystal harmonic generator for the 7 kmc to 14 kmc band can obtain a milliwatt of second harmonic peak pulse power with a type 2K26 klystron source and a 1N78 crystal diode as the nonlinear element in the multiplier.

A short length of flexible coaxial line may be used to transmit 7 kmc energy to a harmonic generator connected directly to the equipment under test. A six foot length of RG-55/U cable, for example, has about 3 db attenuation at 7 kmc/s and is stable to within about $\pm\frac{1}{4}$ db when flexed.



Crystal harmonic generator designed for second harmonic output over 12,500 kc to 14,500 mc

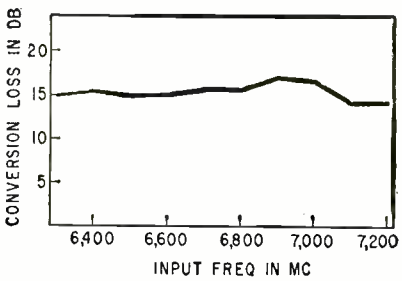


FIG. 2—Second harmonic conversion loss using a 1N78 diode in the mount. Fundamental peak power is equal to 19 ± 3db above one milliwatt

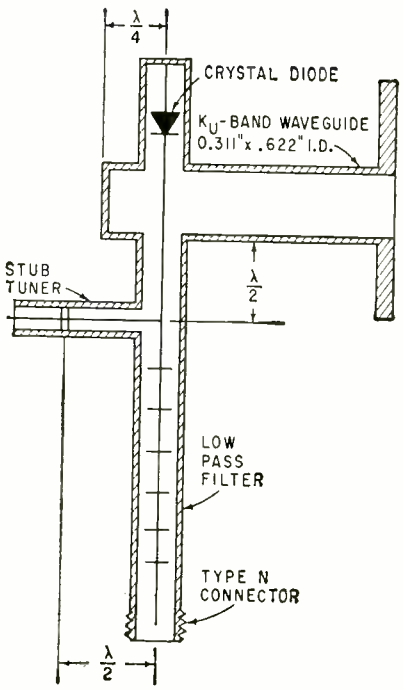


FIG. 1—Multiplier mount dimensions in Ku-band wavelengths

The mount shown in the photo is designed for second harmonic output over the frequency range from 12,500 kc to 14,500 mc. Type 2K26 and 5726 klystrons have been used as the source of fundamental power. An adjustable shorted stub is connected to the input transmission line for tuning the mount. A low pass filter is also incorporated in the input to the mount to reduce the amount of harmonic power transmitted into the input line. The presence of the filter results in an increase in harmonic output of the order of 10 db. The cut-off frequency of the filter is 7,300 mc.

Adjustable Stub

A schematic representation of the multiplier mount showing the important electrical dimensions is shown on Fig. 1. When the shorted stub line is a half wavelength long for the Ku-band frequency, it will be a quarter wavelength long at the fundamental frequency. The stub then has little effect on the input frequency transmitted to the mount through the low pass filter, but provides a short circuit to the second harmonic at the waveguide end of the input coaxial line.

The non-linear element of the harmonic generator is a mixer type crystal diode. Type 1N26 and 1N78 diodes have been used. Measurements on a limited number of diodes indicated approximately the same performance for both types. Peak pulse input power of 20 db above 1 milliwatt (1 microsec pulse at 1,000 prf) has been used with no evidence of diode deterioration. The multiplier mount has never been used with *cw* input.

The results of conversion loss

utmost in performance

TYPE 33M

MOLDED mylar* CAPACITOR

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

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

Temperature Range: "The Type 33M is designed to operate over the temperature range of —55°C. to +85°C. Satisfactory performance at 125°C. can be obtained by derating the voltage to 50% of the 85°C. value."

Dissipation Factor: The dissipation factor of the Type 33M capacitor does not exceed 1% at normal equipment operating temperature over the complete audio frequency range.

Tolerances: Available in capacitance tolerance values of ±5%, ±10%, ±20%.

Life Test: These units will withstand a life test of 250 hours at 125% of rated voltage at 85°C. Life tests at 125°C. should be made at 125% of the derated voltage.

Dielectric Absorption: Dielectric absorption of Type 33M capacitors is less than half that of oil impregnated paper capacitors.

Moisture Resistance: Type 33M capacitors will successfully withstand the moisture resistance tests specified in Spec. MIL-C-91A.

Insulation Resistance: The insulation resistance of these capacitors will exceed 5,000 meg/mfd. over the normal operating temperature range.

• Write for engineering bulletin TSC-206A

*DuPont's trademark for polyester film.

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

SC-59-6

measurements using a 1N78 diode in the mount are shown on Fig. 2. The maximum pulse power available from a 2K26 klystron was used in these measurements[1]. This varied from 16 to 22 db above a milliwatt over the frequency range. The measurement accuracy is estimated to be within ±2 db. Fundamental and second harmonic power was measured by the heterodyne method[2]. Additional tuning devices at the coaxial input or in the waveguide output of the mount may increase the second harmonic output by about 2 or 3 db.

The third harmonic is at least 10 db down relative to the second when the stub line is tuned for maximum second harmonic output.

The author wishes to thank Mr. A. Staniforth and Mr. J. H. Craven for their advice regarding the design of the mount.

REFERENCES

(1) A. K. Scrivens, Pulse Modulated Beam Current Improves Operation of Mixer Series Klystrons, *Canadian Electronics Engineering*, Oct. 1958, NRC 4888.
(2) L. K. Anderson, Measurement of Low Power Microwave Pulses by Comparative Methods, NRC ERA-308.

Extending Range of Thyratron Tube

DETAILED INFORMATION about an improved gas-filled triode with a hot cathode, is reported in a Czechoslovak export journal[1]. Called a Tesla Hydrogen Tacitron, this new tube is said to extend the applicability of the thryatron at higher frequencies and pulse repetition rates, and eliminate high noise caused by arc discharge, which in some cases prevents application of the classic thyratron.

According to the report, a tacitron, filled with a rare gas or with mercury vapor, widens the applicability of the thyratron because its grid potential controls not only the moment of arc ignition, but also its extinguishing. The discharge can be interrupted with a negative bias of the grid without altering the anode circuit, and the time required for breaking the current flow is considerably shorter than the deionization time of the thyratron.

The grid attains instantaneously its controlling property and keeps the tacitron closed regardless of the

deionization time of the applied gas filling. In all other respects, according to the report, the tacitron retains all the properties of a thyratron.

Current Break

It is claimed that the current of a tacitron, depending upon its applied bias and the sources resistance, can be broken within 0.1 microsecs, and this time does not exceed 15 microsecs even under unfavorable conditions. Experiments have shown that it is possible to break the current of a glowing tacitron by the application of a negative pulse of 1 microsecs length to its grid. In pulse operation it is possible to achieve repetition rates above 500 kc.

Application possibilities cover heavy-duty equipment and its use is suggested as an oscillator, especially as a d-c to a-c inverter.

REFERENCE

(1) A. Hix and P. Hix, Tesla Hydrogen Tacitrons, *Kovo Export*, Vol 5, 1959, Rude Pravo, Praha, Czechoslovakia.

Quick-Connect Circuit Board

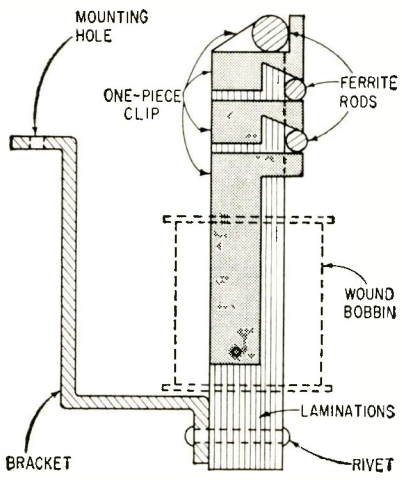
New electronic circuit board, developed by Plastic Associates of Laguna Beach, California, permits trainee to assemble circuit exactly as he finds it in schematic. Since there are no soldered connections, the circuit may be rapidly assembled and disassembled and the components used again, without damage. Connections are made by inserting wire leads into one of the 108 conductive cells shown at bottom. Gold-plated eyelets contain black elastic cores that stretch when pulled upwards, permitting wires to be inserted or removed

Racks Permit Batch Assembly

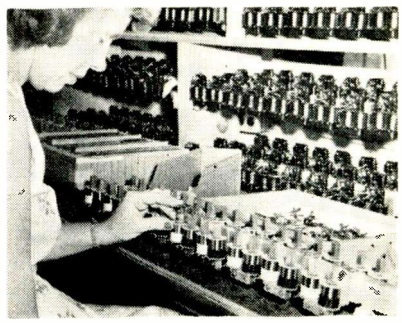
RACKS SIMPLIFY the production of Increductor controllable inductor type of high frequency saturable reactor made at CGS Laboratories, Inc., Wilton, Conn. The racking method protects partially-finished units from handling damage and also provides a means of assembling, encapsulating and storing the inductors in batches of 18 units.

Each rack is a piece of wood ¾ x 1½ x 31 inches. Headless nails are spaced along the top edge. The mounting brackets of the inductors are hung from the nails by means of the mounting holes in the brackets. Nine are hung on each side.

First step in assembly is stacking the U-laminations and riveting them to the brackets, providing a solid base. The subassembly is hung on the brackets. The wound bobbins are slipped over the laminations and pushed down to the bracket.



The clips shown in Fig. 1 (looking from inside the laminations) are slipped over the inside edges of the lamination stack. The clips are made of copper spring alloy and hug the stack ends on two sides.



Assembling Increductors. Completed units are in storage racks

FIG. 1—One-piece metal clip aligns and holds ferrite rods

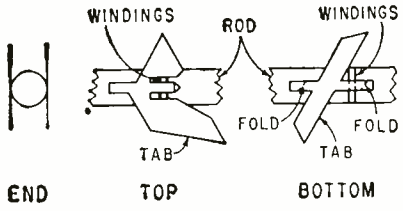


FIG. 2—Rubber bands and cement keep tabs of top rod in place until dipping

The wound ferrite rods are slipped into the prongs of the clips. No other fastening is used.

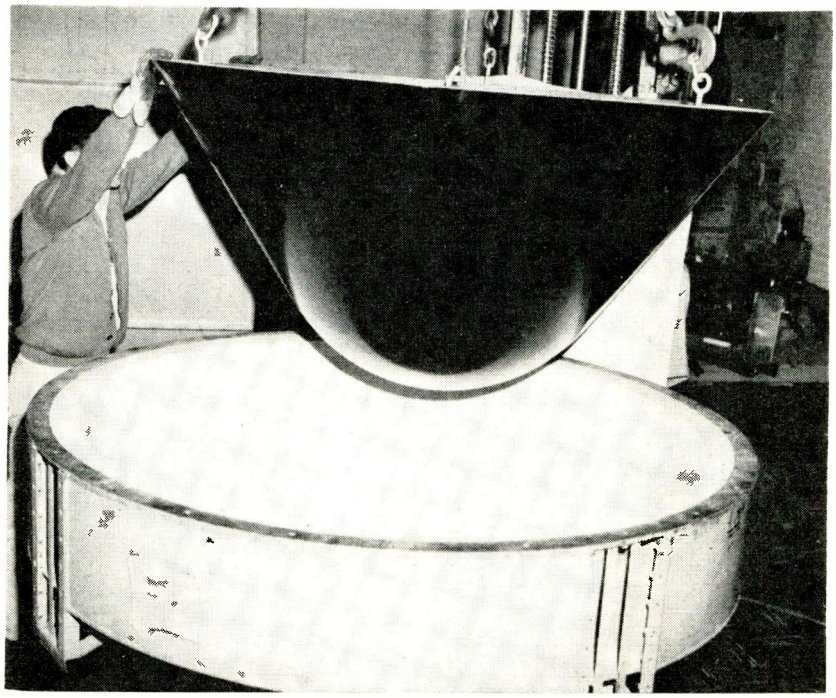
The rods are prepared by winding on each the required number of magnet wire turns and cementing the wire in place. To apply cement, the wound rods are laid parallel in waxed, corrugated paper spacers on wood and aluminum frame fixtures. This permits many rods to be cemented with a few brush strokes. The frame also serves as a tote tray.

The top rod has 2 specially-shaped tabs as part of the high frequency coil. The tabs are stamped from sheet copper and fixed to the rod. The bottom tab's ears are folded over the wire winding and held in place by rubber bands. The top tab is held in place by the rubber bands and cement (Fig. 2).

The leads of the windings have been stripped of insulation, tinned and coated with silicone grease to permit cleaning off the encapsulant.

Completed assemblies are dipped 9 at a time in a tank, as long as

Foam Cushions Missile Nose Cone



Nose cones of Thor ballistic missiles are being shipped and handled in containers lined with form-fitting polyurethane foam. The containers, built by General Electric Co., Missile and Space Vehicle Dept., Philadelphia, Pa., simplify packaging while protecting the cone's highly-polished surface from scratching and marring. Polyurethane is foamed in the steel contained shell by the Dayton Rubber Co., Dayton, Ohio. The case is cleaned by sandblasting and the mold positioned. Chemicals which react to form the foam are placed in the cavity between shell and mold and expanded. The new foam used is reported to have excellent temperature stability, does not absorb moisture and forms a thick, smooth skin. Twelve cubic feet, weighing 96 pounds, are used in each case

For Capacitors with GREATER RELIABILITY . . .

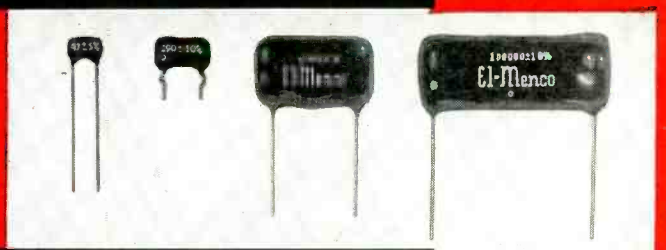
Choose El-Menco

The Capacitors You Find Wherever There's Electronics!

EL-MENCO DUR-MICA CAPACITORS

Only 1 Failure Per 43,000,000 Unit-Hours!

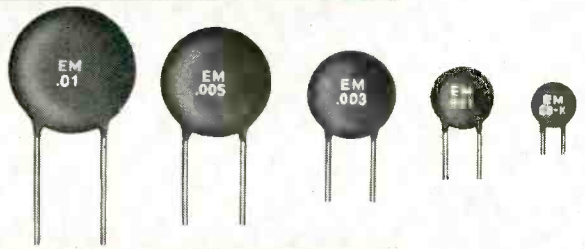
- It has been computed that "debugged" DM30, 10,000 MMF units, when subjected to 257,000 hours of life at 85°C with 100% of the rated DC voltage applied, will yield only 1 FAILURE PER 43,000,000 UNIT-HOURS!
- DM15, DM16, DM19, DM20 . . . perfect for miniaturization and for new designs using printed wiring circuits. Also available in DM30, DM42 and DM43.
- New "hairpin" parallel leads insure easy application.
- Exceed all electrical requirements of military specification MIL-C-5A.



EL-MENCO CERAMIC DISC CAPACITORS

Toughest Ever!

- Available in 500 working volts DC and 1,000 working volts DC ratings.
- Low-loss phenolic coating that is wax impregnated.
- Flat design assures reduced self-inductance . . . particularly adaptable to very high frequency applications.
- Insulation resistance far exceeds the 10,000 megohms minimum requirement.
- Exceed all electrical requirements of E.I.A. specifications RS-198.

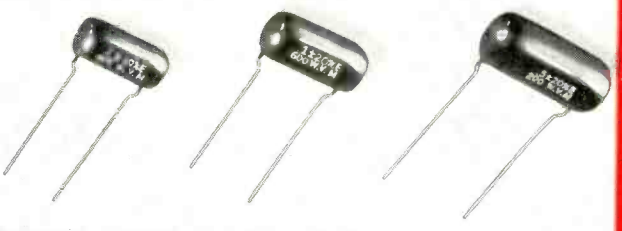


EL-MENCO *MYLAR-PAPER DIPPED CAPACITORS

Only 1 Failure in 7,168,000 Unit-Hours!

- Life tests at 100°C with rated voltage applied have yielding only 1 FAILURE PER 716,800 UNIT-HOURS for 1 MFD. Since the number of unit-hours of these capacitors is inversely proportional to the capacitance, 0.1 MFD Mylar-Paper Dipped capacitors will yield only 1 FAILURE PER 7,168,000 UNIT-HOURS!
- Working volts DC: 200, 400, 600, 1000 and 1600.
- Durez phenolic resin impregnated.
- Tolerances: ± 10% and ±20% (closer tolerances available).
- Dielectric strength: 2 or 2½ times rated voltage, depending upon working voltage.
- Exceed all electrical requirements of E.I.A. specification RS-164 and military specifications MIL-C-91A and MIL-C-25A.

*Registered Trademark of DuPont Co.

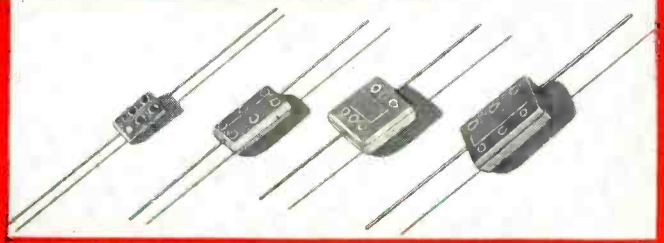


EL-MENCO MOLDED MICA CAPACITORS

Superior Performance!

- Unmatched for excellent stability, dielectric strength, high insulation resistance, extremely high "Q" and correspondingly low power factor.
- Units can be subjected to a short "debugging" life test at elevated voltage and temperature for removal of early life failures and for improved reliability.

Write for Free Samples and Booklets on Any of The Above Capacitors



El-Menco Capacitors

EL-MENCO OFFERS A COMPLETE LINE OF CAPACITORS . . . STANDS READY TO SERVE ALL YOUR CAPACITOR NEEDS.

THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors

WILLIMANTIC CONNECTICUT

• molded mica • dipped mica • mica trimmer • dipped paper
• tubular paper • ceramic • silvered mica films • ceramic discs

Arco Electronics, Inc., 64 White St., New York 13, N. Y.
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

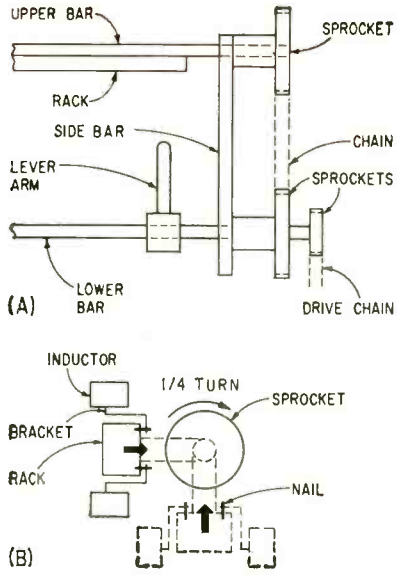


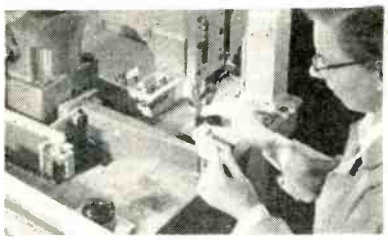
FIG. 3—Rack dips 9 assemblies into encapsulant with 1 motion

the racks, of thermoplastic resin. The racks are hung on the upper bar of the mechanism shown in Fig. 3A. The heads of the nails in the racks are slipped into slots in the bar.

As the lever arm is raised, tilting the lower bar, side bars and upper bar and rack toward the tank, the rack tilts a quarter-turn clockwise (Fig. 3B). The 9 inductors which are now hanging down are dipped. The rack is lifted from the bath, a shift lever is pushed, causing the chain drive to rotate the rack so that the other 9 inductors are in dipping position.

Assembled units prior to dipping

Dipping assemblies into tank sized to accept 9 units



Rivets are used to stack laminations and fasten them to bracket

Racks are also used for storage. The ends of the racks are hung from horizontal wood strips nailed to the sides of the storage spaces.

Rotating Fixture Improves Brazing

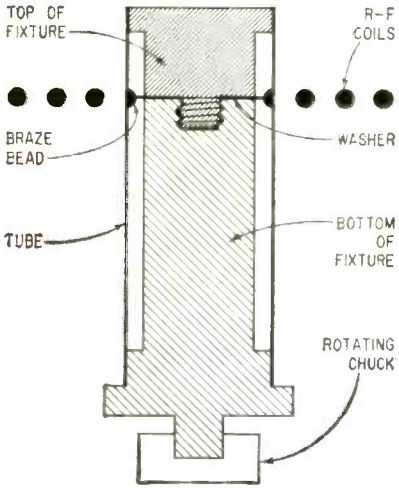


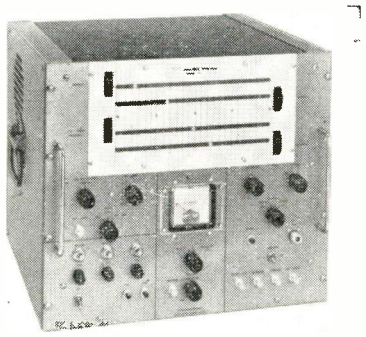
FIG. 1—Cross section of setup, showing how take-apart fixture positions internally-brazed part

INDUCTION BRAZING of internal parts can be made more precise by rotating the assembly within the coil supplying the r-f energy, according to John Gombos Co., Clifton, N. J.

The brazing fixture is inserted in a chuck which turns the work in the coil (Fig. 1). Bead uniformity is improved and warping which might result from uneven application of heat is prevented.

The type of fixture shown brazes an Invar washer inside an Invar tube, forming part of a waveguide system. With fixture modifications, more than 1 washer may be brazed. Flatness of the washer or washers is held to 0.0002 inch; bead uniformity, 0.005 inch, and spacing between washers and tube ends, 0.0003 inch.

On The Market



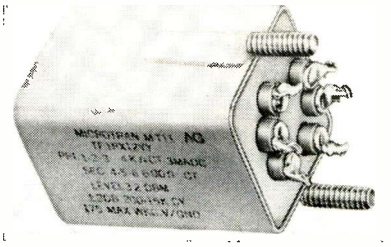
Oscillators
1 to 18 kmc

ALFRED ELECTRONICS, 897 Commercial St., Palo Alto, Calif. Series 620 microwave oscillators provide electronic sweep of r-f output, or extremely stable c-w operation. All feature linear frequency sweep coverage over all or part of each band for rapid evaluation of reflection coefficient, gain, attenuation and other network transfer characteristics. They offer two adjustable frequency markers for convenient calibration of oscilloscopes or recorders. Markers save valuable test time by indicating either band limits or intermediate frequency values. Also featured is 0.5 μsec rise and fall response to a-m.

CIRCLE 301 ON READER SERVICE CARD

Transformer
mu shielded

MICROTRAN CO., INC., 145 E. Mineola Ave., Valley Stream, N. Y., announces miniature transistor transformers in mu metal construction. Use of mu metal in place of steel cans is said to provide hum pick-up



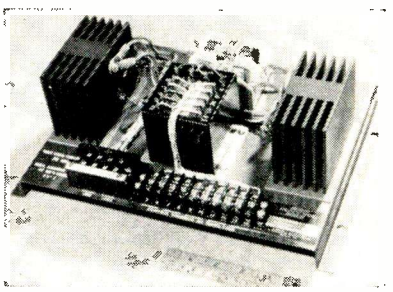
reduction of approximately 20-30 db. Available in MIL-AG construction 1 in. square by 1$\frac{3}{8}$ in. high or in cylindrical construction $\frac{13}{16}$ in. diameter by 1$\frac{3}{8}$ in. high. Manufactured to meet MIL-T-27A Grade 4 Class R with a reliable life of 10,000 hours.

CIRCLE 302 ON READER SERVICE CARD

Power Control Unit
solid state

CONTROL, a division of Magnetics, Inc., Butler, Pa., has developed a standard power control unit utilizing solid state thyratrons and its own control amplifier. The small, chassis-mounted unit requires only power and load connections, and can be controlled in an open or short circuit mode of operation from a variety of signal sources. It controls up to 3 kw, and gives circuit designers a complete solid state system from logic input to power-handling output. Application is possible at extremely high levels due to the thyratrons used.

CIRCLE 303 ON READER SERVICE CARD



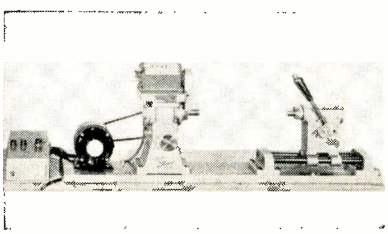
Digital Stop Clocks
a-c and d-c

THE A. W. HAYDON CO., Waterbury 20, Conn. Digital a-c and d-c stop clocks feature extreme accuracy in measuring time intervals over wide voltage and ambient temperature variations. The a-c type may be used for 60 and 400 cps operations; the d-c type, for 20-30 v d-c operation. Units are ideal for a wide variety of applications, such as calibration of intervalometers, fire control equipment, production testing of timing devices, controlling various process functions during material fabrication, and many other applications.

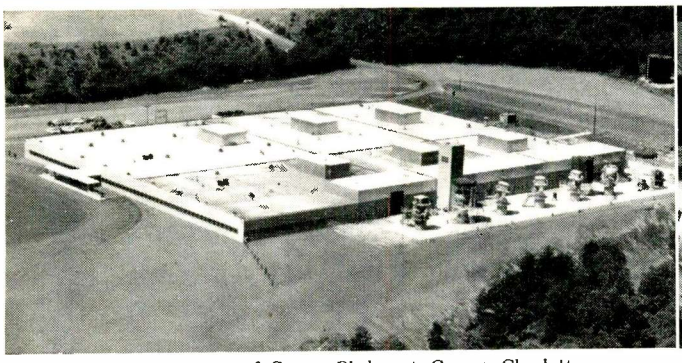
CIRCLE 304 ON READER SERVICE CARD

Hand Winder
heavy duty

GEO. STEVENS MFG. CO., INC., Pulaski Road at Peterson, Chicago 46, Ill. Heavy duty hand winder offers a choice of 6 variable speed/torque ranges. Model 610-AM winds sizes

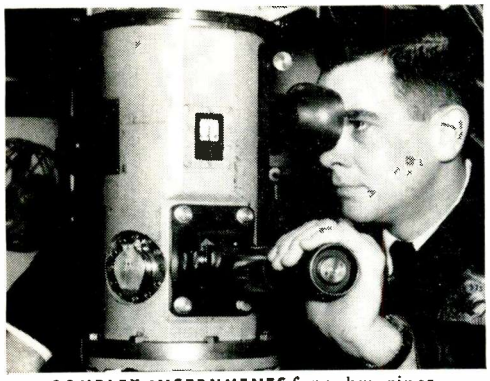


as heavy as No. 8 Awg at 12 in. diameter and even heavier gages on smaller diameters. Maximum coil o-d is 12 in., maximum loading distance between headstock and tailstock 12 in. and output end of spindle $\frac{3}{4}$ in., keyed slot. The $\frac{3}{4}$ in. diameter spindle is designed to

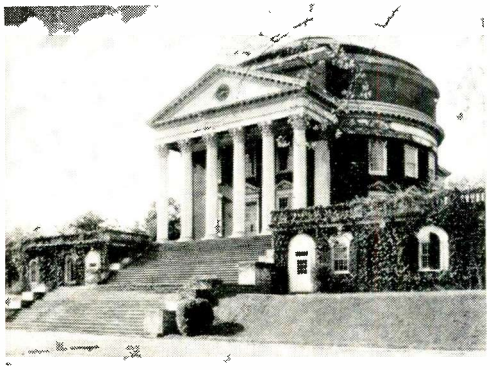


MODERN PLANT of Sperry Piedmont Co. at Charlottesville, Virginia, started with 75,000 sq. ft. of floor space in 1956, now covers 175,000 sq. ft. Over 900 people are employed . . . 83-acre tract gives ample expansion room.

COMPLETE FACILITIES include dust-free rooms for precision production . . . environmental testing equipment . . . compass-testing devices that simulate ship's pitch, yaw and roll. Plant is fully air-conditioned.



COMPLEX INSTRUMENTS for submarines, warships, cargo vessels and small craft are made by skilled Virginians. In conjunction with state government, Sperry sponsored night school programs to advance employees' knowledge in electronics and mathematics.



UNIVERSITY OF VIRGINIA at Charlottesville is a source of engineers, and its facilities are available for employees' post-graduate courses or for research projects. Virginia Polytechnic Institute and other excellent colleges and universities also supply Sperry Piedmont with recruits.

Sperry Piedmont Finds Academic Atmosphere, Adaptable Labor, and Plenty of Elbow Room in VIRGINIA

In today's competition for engineering talent, good living conditions are important. And that's one major reason why Sperry Piedmont Company built its plant at Charlottesville, Virginia. Home of the University of Virginia, this historic town provided unsurpassed recreational and cultural background . . . traditionally good living . . . plus the academic atmosphere that's so attractive to technical men and so prevalent in Virginia's numerous university towns.

Other factors influencing Sperry's choice of location were excellent transportation facilities, nearness to Washington, no shortage of housing, good hospitals and medical care, dependable, conscientious manpower.

If you're planning a new plant, let us tell you why so many companies are locating in Virginia. Phone, wire, write, or visit in complete confidence . . .

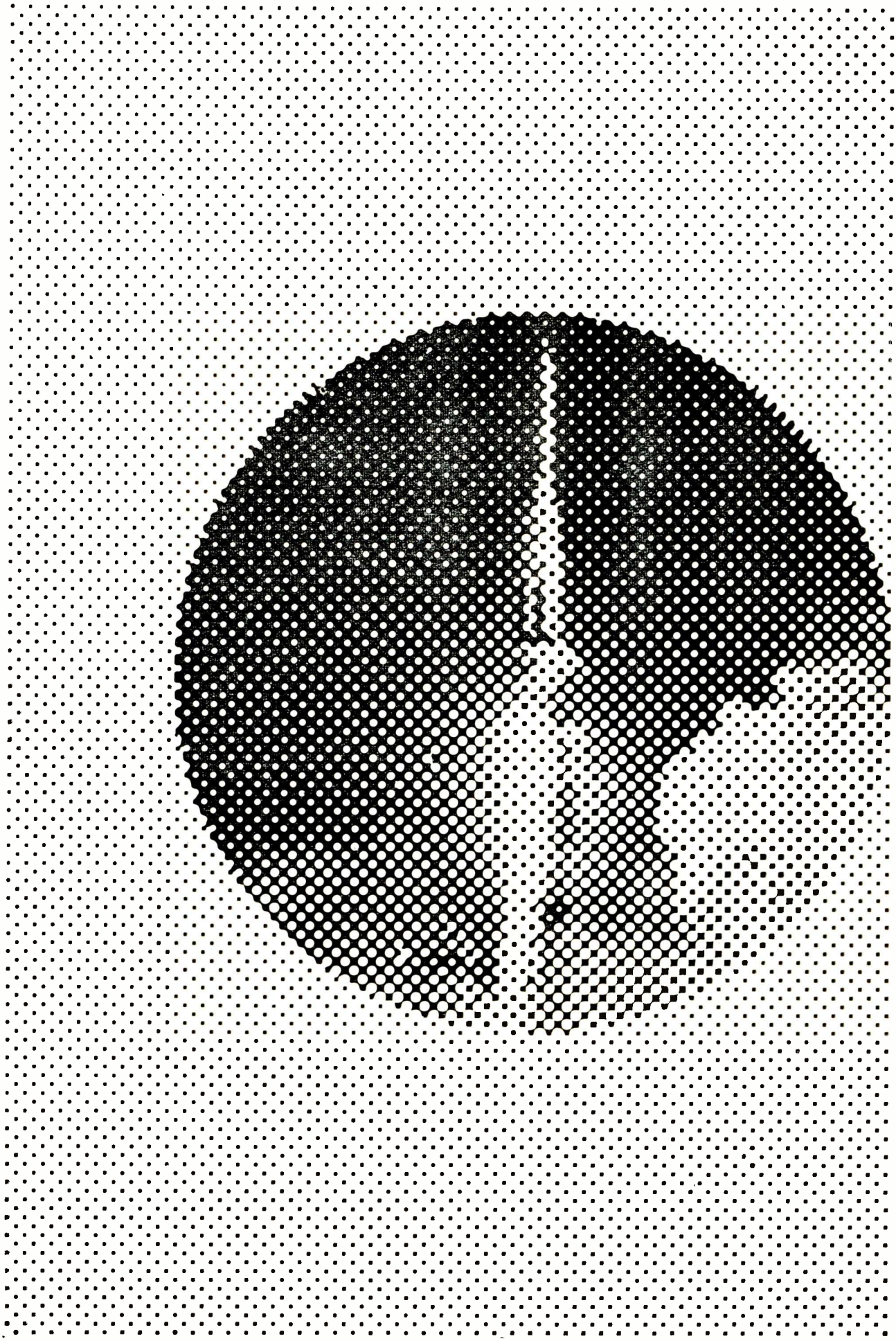
C. M. Nicholson, Jr., Commissioner
Division of Industrial Development
Virginia Dept. of Conservation and Economic Development
State Office Bldg., Richmond, Va.
Phone MIlton 4-4111 Ext. 2255

***Let These Outstanding Industries Tell You Why They Have Located in* VIRGINIA**

- General Electric Company
- ITT Corporation
- The Babcock & Wilcox Company
- Reynolds Metals Company
- The Dow Chemical Company
- Allied Chemical Corporation

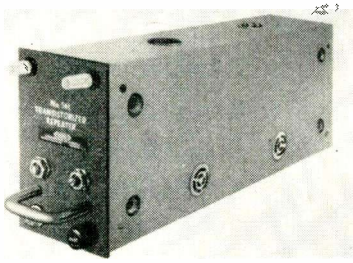
***You, too, can find these... and many other great competitive advantages in* VIRGINIA**

Virginia's a wonderful place to play or work. Send for Free Vacation Guide Book.



withstand reasonable impacts necessary to form wire and insulation over corners.

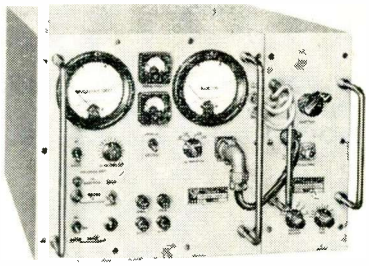
CIRCLE 305 ON READER SERVICE CARD



Repeaters transistorized

TREPAC CORP. OF AMERICA, 30 W. Hamilton Ave., Englewood, N. J. The Diamond-Trepac 560-series of solid-state repeaters clean up distorted and marginal signals; and maintenance and repair problems are practically eliminated. The repeater contains a rechargeable standby battery which enables the unit to operate independently for three months after failure of the external power source. Location of the unit with respect to battery or ground terminations or any particular part of a telegraph line or loop is not critical. Each repeater is bidirectional. Pilot lamps indicate the direction of transmission.

CIRCLE 306 ON READER SERVICE CARD



Stalo Tester multiband

PITOMETER LOG CORP., 237 Lafayette St., New York 12, N. Y. The Pitlog series 800 stalo tester is designed for use in any application where a precise measurement of frequency stability is required. Accurate and versatile, it measures long term drift and short term deviation in frequency bands between 1,100 mc to 10,000 mc, and its primary purpose is to check the

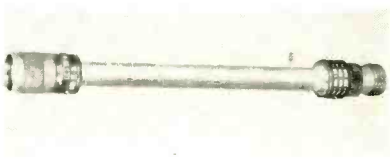
stability of radar systems components either on the production line or in the field. Unit comprises two main subassemblies: An indicator unit, model 800, houses the measuring circuitry and power supplies, and two interchangeable units, models 801 (L/S band) and 802 (X-band) are used to heterodyne the signal down to the input range of the indicator.

CIRCLE 307 ON READER SERVICE CARD

Preamplifier for telemetering

LEL, INC., 380 Oak St., Copiague, L.I., N.Y. Designed to meet severe environmental conditions, the TP-4 telemetering preamplifier is enclosed in a weatherproof housing for antenna tower mounting and is complete with self-contained power supply. Each unit is provided with a sun shield for use in tropical areas. TP-4 is designed to operate from a 50 ohm source, has 22 db minimum gain, 4 db maximum noise figure, and covers the 215 to 260 mc telemetering band. Individual test data including a plot of noise figure vs frequency are supplied.

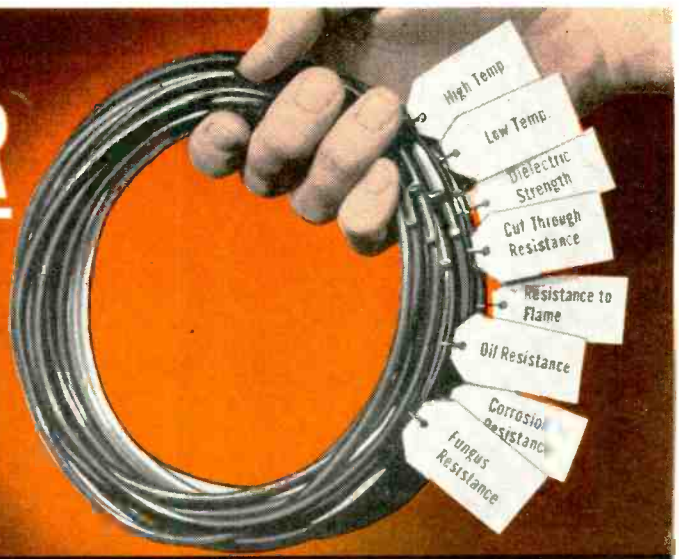
CIRCLE 308 ON READER SERVICE CARD



Coaxial Attenuators with SC connectors

WEINSCHEL ENGINEERING, 10503 Metropolitan Ave., Kensington, Md. Company's 1 to 12.4 kmc fixed coaxial attenuators are now available

WHAT'S YOUR INSULATION PROBLEM?



FOR VINYL, IT'S RESINITE

Resinite Vinyl Insulation Sleeving more than fills most applicable commercial or military specification requirements. You'll find, where dependability is imperative, that Resinite's adherence to exacting standards makes these insulations your outstanding choice.

	EP-2	EP-14	EP-69C	EP-93	EP-93C	Hi-Heat 105 & 105A	Super-Heat 125	Vinyl Glass
Temperature Range	185°F –40°F	165°F –50°F	205°F –75°F	185°F –90°F	200°F –95°F	221°F –5°F	257°F –40°F	266°F –50°F
Dielectric Strength	900 volts/ mil av.	800 volts/ mil av.	900 volts/ mil min.	390 volts/ mil av.	400 volts/ mil av.	1,000 volts/ mil	1,000 volts/ mil	8,000 volts
Cut-Through Resistance	Good	Good	Good	Good	Good	Excellent	Outstanding	Outstanding
Oil Resistance	Slight Swelling	Slight Swelling	Slight Swelling	Slight Swelling	Slight Swelling	Excellent	Excellent	Excellent
Resistance to Flame (Self-Extinguishing)	5 sec. Max.	5 sec. Max.	6 sec. Max.	5 sec. Max.	5 sec. Max.	10 sec.	1 sec.	45 sec/ inch
Fungus Resistance			Yes Clear Fungicide	Yes Amber Fungicide	Yes Clear Fungicide	Available (105A only)		
Corrosion Resistance	Good	Good	Good	Good	Good	Good	Good	Good
Specification Conformance	MIL-I-631C Type F Form U Grade a Cl. II Cat. 1	AMS 3630	MIL-I-631C Type F Form U Grades a and b Cl. I & II Cat. 1	MIL-I-7444B Type II	MIL-I-7444B Types I & III	MIL-I-631C Type F Form U. Gr C Class I (105A only) Class II Cat. I Also U.L. 105°C	U.L. 105°C	ASTM D372-53T NEMA-VSI-1950 MIL-I-3190(4)

Also a complete range of vinyl tapes and lacing cords

Resinite Plus Values

SOFT-WOUND SPOOLING Prevents flattening of even thin wall sleeving at the spool core. All sleeving is delivered **full** round — speeds assembly time, saves material.

POSITIVE TEST NO. IDENTIFICATION Every lot of Resinite Specification Sleeving is rigidly tested for conformance. Each spool carries this test number for easy, positive reference to the permanent test record.

Write us your requirements and we'll send samples and performance data on the appropriate material.

® Resinite

VINYL INSULATION SLEEVING

THE *Borden* CHEMICAL COMPANY

Resinite Department *Santa Barbara, Calif.* • *No. Andover, Mass.*

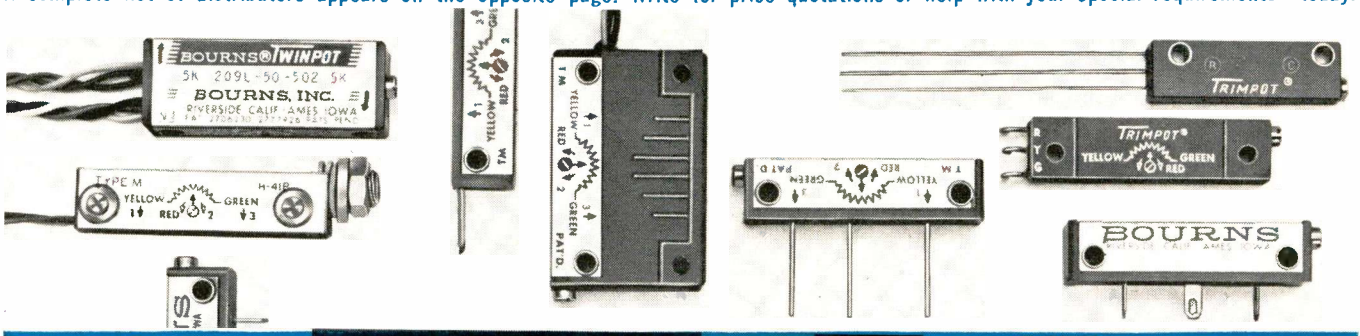
24 HOUR DELIVERY OF TRIMPOT® POTENTIOMETERS

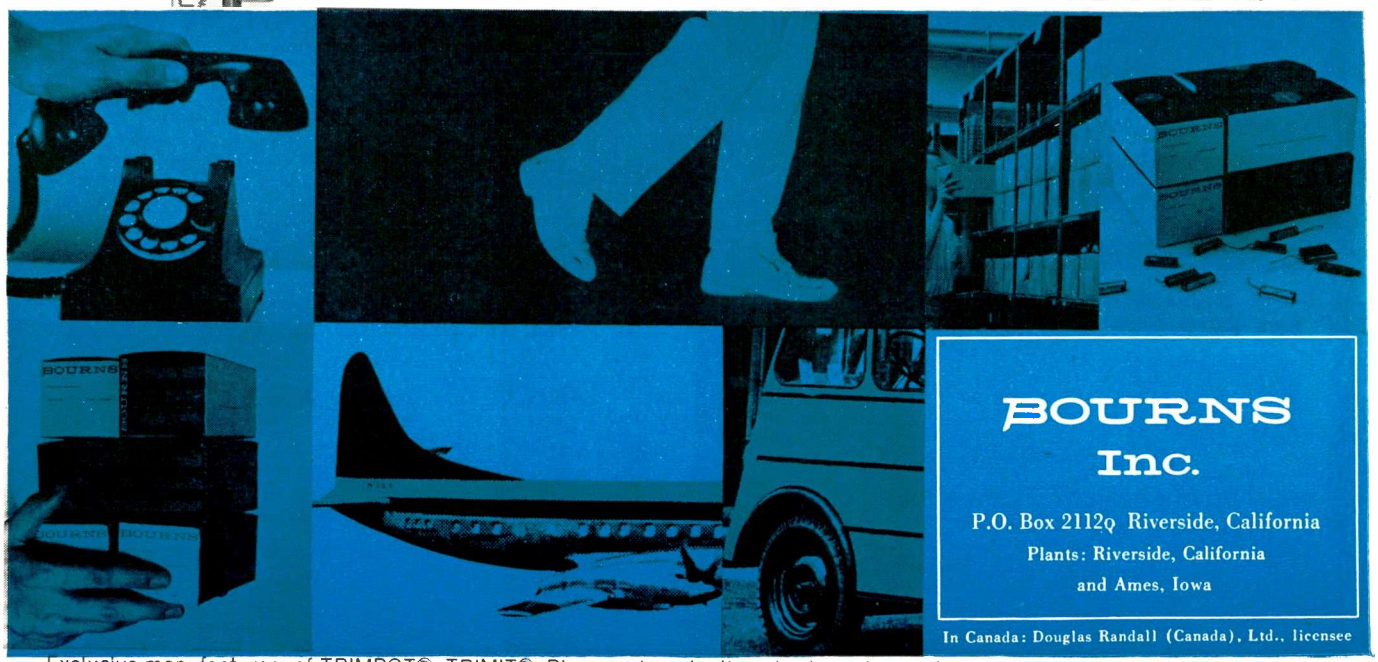
500,000 STOCKED BY DISTRIBUTORS AND FACTORIES

Immediate "off-the-shelf" delivery is available of the entire line of standard Trimpot potentiometers—20 basic models...4 terminal types... 3 mounting styles! More than ½ million units are stocked by franchised distributors across the nation and at Bourns plants in Riverside, California and Ames, Iowa. Wherever you are, whatever standard unit you need, there's a Trimpot source close at hand waiting to fill that rush order...no need to hold up your prototype or production projects.

This fast service is made possible by mechanized production processes. enlarged facilities, and greatly expanded engineering and production staffs. All this is part of our intent to provide the finest customer service program. It is another Bourns plus—in addition to the high quality, reliability, and performance that have won Trimpot potentiometers a place in major missile, aircraft and commercial electronic systems.

A complete list of distributors appears on the opposite page. Write for price quotations or help with your special requirements—today.

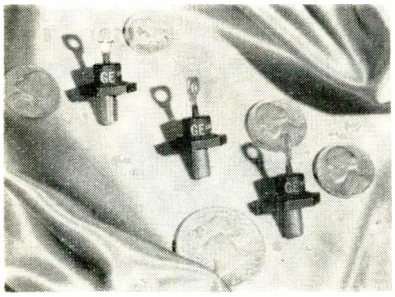




Exclusive manufacturers of TRIMPOT®, TRIMIT®. Pioneers in potentiometer transducers for position, pressure and acceleration.

with type SC connectors (male/female, double male or double female). These attenuators are made with Weinschel film resistors for maximum stability under pulse power, as well as humidity and temperature cycling. Attenuation range is 1 to 20 db. Impedance is 50 ohms.

CIRCLE 309 ON READER SERVICE CARD



Silicon Rectifier
25-ampere

GENERAL ELECTRIC CO., Syracuse, N. Y. Fourteen new silicon stud-mount medium current rectifiers—7 conventional types with the stud as the cathode and 7 reverse current types with the stud as the anode—are announced. They are available with piv ratings from 50 v through 600 v. All are rated at a forward current of 25 amperes in a single phase circuit at a stud temperature of 145 C. They have a maximum one cycle surge current rating of 300 amperes. Maximum leakage current at full load is specified as 5 ma for the 50 v units down to 2 ma for the 600 v units in a single phase circuit at a stud temperature of 145 C.

CIRCLE 310 ON READER SERVICE CARD

Linear Trimming Pot
wire wound

EASTERN PRECISION RESISTOR CORP., 675 Barbey St, Brooklyn 7, N. Y. Comp-U-Trim model F is designed to allow for mounting through the front panel of equipment or for below chassis mounting. Only $\frac{1}{8}$ in.

BOURNS TRIMPOT® DISTRIBUTORS

ALABAMA

HUNTSVILLE
Curle Radio Supply No. 2
101 Winston Street
Phone: JE 4-6511

ARIZONA

PHOENIX
Radio Specialties & Appliance Corp.
917 North Seventh Street
Phone: AL 8-6121 TWX: PX 125

TUCSON
Standard Radio Parts, Inc.
218 N. 1st Avenue
Phone: MA 3-2545

CALIFORNIA

CULVER CITY
Westates Electronic Corp.
11334 Playa Street
Phone: EXmont 1-6201

INGLEWOOD
Liberty Aircraft, Inc.
9817 Inglewood Avenue
Phone: ORegon 8-7163

Newark Electric Co.
4747 W. Century Blvd.
Phone: ORegon 8-0441
TWX: INGL 2365

LOS ANGELES
Kierulff Electronics, Inc.
820-30 W. Olympic Blvd.
Phone: RIchmond 7-0271
ZEnith 0271

OAKLAND
Elmar Electronics
140 Eleventh Street
Phone: HIgate 4-7011
TWX: OA-73

SAN DIEGO
Atlas Electronic, Inc.
4618 Santa Fe Street
Phone: BRoadway 4-3131

Western Radio and TV Supply Co.
1415 India Street
Phone: BElmont 9-0361

SAN FRANCISCO
Pacific Wholesale Co.
1850 Mission Street
Phone: KLondike 2-0700

COLORADO

DENVER
Denver Electronic Supply Co.
1254 Arapahoe Street
Phone: AMherst 6-1671
TWX: DN 941

CONNECTICUT

NEW HAVEN
Radio Shack Corp.
230-234 Crown St.
TWX: NH 466
Phone: SP 7-6871

D. C.

WASHINGTON
Capitol Radio Wholesalers, Inc.
2120-22 Fourteenth Street, N.W.
Phone: HObart 2-0800

FLORIDA

MIAMI
Electronic Supply
61 N.E. Ninth Street
Phone: FRanklin 7-2511
TWX: MM 186

MELBOURNE
Electronic Supply
Post Office Box 1655
909 Morningside Drive
Phone: PArkway 3-1441
TWX: 7138

ORLANDO
Goddard — Orlando
631 W. Central Avenue
Phone: GA 5-5531

WEST PALM BEACH
Goddard Distributors, Inc.
Post Office Box 829
1309 North Dixie
Phone: TEmple 3-5701
TWX: WP-38

GEORGIA

ATLANTA
Electro Air Corporation
645 Antone Street, N.W.
Phone: TRinity 3-1651

ILLINOIS

CHICAGO
Allied Radio Corp.
100 North Western Ave.
Phone: HAymarket 1-6800

Newark Electric Co.
223 W. Madison Street
Phone: STate 2-2944
TWX: CG 1401

INDIANA

FORT WAYNE
Ft. Wayne Electronics Supply, Inc.
3606 Maumee Ave.
Phone: EAstbrook 3431

INDIANAPOLIS
Graham Electronics Supply, Inc.
122 South Senate
Phone: MElrose 4-8488

SOUTH BEND
Radio Distributing Co., Inc.
1212 High St.
Post Office Box 1499
Phone: ATlantic 8-4779

IOWA

CEDAR RAPIDS
Deeco, Inc.
Post Office Box 1668
618 First St., N.W.
Phone: EMpire 4-2491

MARYLAND

BALTIMORE
D & H Distributing Co.
2025 Worcester Street
Phone: SAratoga 7-5100

Kann-Ellert Electronics, Inc.
Howard & Redwood Streets
Phone: SAratoga 7-4242
TWX: BA 587

SILVER SPRING
Kann-Ellert Electronics, Inc.
11222 Triangle Lane
Phone: LOckwood 5-5200

MASSACHUSETTS

BOSTON
Radio Shack Corporation
730 Commonwealth Ave.
Phone: REgent 4-1000
TWX: BKN 262

CAMBRIDGE
Electrical Supply Corp.
205 Alewife Brook Parkway
Phone: UNiversity 4-6300
TWX: CAMB MASS 429

MICHIGAN

DETROIT
Ferguson Electronic Supply Co.
2306 Puritan Street
Phone: UNiversity 1-6700
TWX: DE 803

MINNESOTA

MINNEAPOLIS
Lew Bonn Co.
1211 LaSalle
Phone: FEderal 9-6351

MISSOURI

ST. LOUIS
Interstate Supply Co.
4445 Gustine Ave.
Phone: FLanders 1-7585

NEW JERSEY

CAMDEN
General Radio Supply Co., Inc.
600 Penn Street
Phone: WOodlawn 4-8383 (N.J.)
WAlnut 2-7037 (Phila.)

CLIFTON
Eastern Radio Corp.
312 Clifton Ave.
Phone: GRegory 1-6600

MOUNTAINSIDE
Federated Purchaser, Inc.
1021 U.S. Route 22
Phone: ADams 2-8200
TWX: WSFD NJ 319

NEW MEXICO

ALAMOGORDO
Radio Specialties Co.
209 Penn Ave.
Phone: HEmlock 7-0370
TWX: 5671U

ALBUQUERQUE
Electronic Parts Co.
222 Truman St., N.E.
Phone: ALpine 6-0946

Radio Specialties Co., Inc.
6323 Acoma Street, S. E.
Phone: AMherst 8-3901
TWX: AK 561

NEW YORK

BINGHAMTON
Federal Electronics, Inc.
P. O. Box 208
Phone: PIoneer 8-8211

BUFFALO
Radio Equipment Corp.
312 Elm Street
Phone: MAdison 9676

JAMAICA
Peerless Radio Dist., Inc.
92-32 Merrick Road
Phone: REpublic 9-6080

MINEOLA, L. I.
Arrow Electronics, Inc.
525 Jericho Turnpike
Phone: PIoneer 6-8686
TWX: G CY NY 460

Schweber Electronics
Post Office Box 669
60 Herricks Road
Phone: PIoneer 6-6520
TWX: GLY NY 580

NEW YORK
Harrison Radio Corp.
225 Greenwich Street
Phone: BArclay 7-7777
TWX: NY 1-177

Harvey Radio Company, Inc.
103 West 43rd Street
Phone: JUdson 2-1500

Hudson Radio and TV Corp.
37 West 65th Street
Phone: TRafalgar 3-2900

Milo Electronics Corporation
530 Canal Street
Phone: BEekman 3-2980
TWX: NY 1-1839

Sun Radio and Electronics
650 Sixth Ave.
Phone: ORegon 5-8600
TWX: NY 1-4022

Terminal Radio Corp.
85 Cortlandt Street
Phone: WOrth 4-3311

ROCHESTER
Rochester Radio Supply Co., Inc.
600 East Main St.
Phone: LOcust 2-9900

SYRACUSE
Syracuse Radio Supply Co.
620 South Salina Street
Phone: 74-2927

NORTH CAROLINA

WINSTON-SALEM
Dalton-Hege Radio Supply Co.
912 West 4th St.
Phone: 5-8711
TWX: W-Sal 373

OHIO

AKRON
Akron Electronic Supply, Inc.
107-117 South Arlington St.
Phone: PORtage 2-8818

CINCINNATI
Herrlinger Distributing Co.
115 Corwine Street
Phone: GA 1-5282 TWX: CI 125

COLUMBUS
Thompson Radio Supplies, Inc.
182 East Long St.
Phone: CApital 1-7434

DAYTON
The Stotts-Friedman Company
108-112 North Jefferson Street
Phone: BAldwin 4-1111

OKLAHOMA

TULSA
Indel Supply, Inc.
Post Office Box 3443
538 South Lewis Avenue
Phone: WE 9-7585

PENNSYLVANIA

PHILADELPHIA
Albert Steinberg & Company
2520 North Broad Street
Phone: BAldwin 3-9400

Almo Radio Co.
913 Arch Street
Phone: WAlnut 2-5918

PITTSBURGH
Cameradio Co.
1121 Penn St.
Phone: EXpress 1-4000
TWX: PG 438
(Note: See Camden, N. J. also)

RHODE ISLAND

PROVIDENCE
Wm. Dandreta & Co.
28 Wolcott Street
Phone: UNion 1-2800

SOUTH CAROLINA

GREENVILLE
Carolina Radio Supply Co.
227 West Washington St.
Phone: CEdar 2-6740

TENNESSEE

NASHVILLE
Electra Distributing Corp.
1914 W. End Ave.
Phone: ALpine 5-8444

TEXAS

DALLAS
Engineering Supply Company
6000 Denton Drive
Phone: FLeetwood 7-6121
TWX: NNG

HOUSTON
Harrison Equipment Company, Inc.
1422 San Jacinto Street
Phone: CApitol 4-9131

UTAH

SALT LAKE CITY
Standard Supply Co.
225 East Sixth South St.
Phone: ELgin 5-2971

WASHINGTON

SEATTLE
Seattle Radio Supply, Inc.
2117 Second Avenue
Phone: MA 2345

TACOMA
C & G Radio Supply Co.
2502 Jefferson Street
Phone: BRoadway 2-3181

WISCONSIN

MILWAUKEE
Taylor Electric Co.
4080 N. Port Washington Rd.
Phone: WOodruff 4-4321
TWX: MI 118

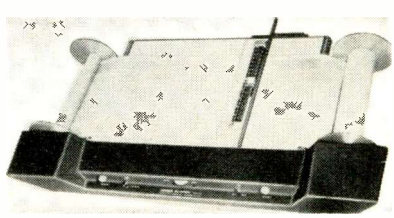
in diameter, it features an all-aluminum housing wherein the ruggedly constructed pot is encapsulated to withstand adverse environmentals. Unit meets or exceeds all the applicable specs of MIL-R-19, MIL-202 and MIL-5272. It is rated at 0.75 w at 85 C and 0.5 w at 125 C; available in resistance ranges from 10 ohms to 50,000 ohms with tolerance of ±10 percent and temperature coefficient of ±20 ppm.

CIRCLE 311 ON READER SERVICE CARD

Frequency Detector expanded-scale

AIRPAX ELECTRONICS INC., Seminole Division, Fort Lauderdale, Fla. The expanded-scale Magmeter, a frequency detector, delivers an output current directly proportional to input frequency at an accuracy of 0.1 percent. The solid-state units cover a 10 percent bandwidth at any center frequency in the audio range. Output will operate any average reading, 0 to 50 ma device. Magmeter is insensitive to changes in input amplitude and waveshape with 1 w of driving power. Uses include instrumentation, tachometry, telemetering and automatic control.

CIRCLE 312 ON READER SERVICE CARD

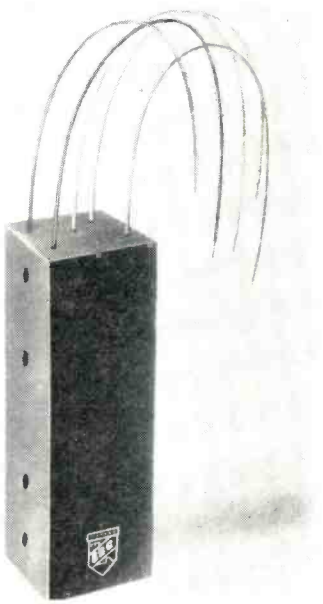


Oscillogram Scanner self-contained

THE GERBER SCIENTIFIC INSTRUMENT CO., 89 Spruce St., Hartford 1, Conn. Model S-2 oscillogram

scanner is an electrically driven record transport system with a backlighted viewing area two ft wide able to accommodate records up to 12 in. or up to 16 in. wide. The drive system consists of two independent rollers, one at either end, each containing a variable speed drive assembly. Record speed can be varied from 0 to 100 fpm. A transparent cursor is mounted on a horizontal bar for direct editing purposes.

CIRCLE 313 ON READER SERVICE CARD



Delay Line
lumped-constant

ESC CORP., 534 Bergen Blvd., Palisades Park, N. J. Model 31-6 lumped-constant delay line designed for missile application has a time delay of 3 μsec and a delay/rise time ratio of 15/1 with a characteristic impedance of 1,200 ohms. It operates in a temperature range of −55 C to +125 C. Dimensions are 3 in. by 1 in. by 1 in.

CIRCLE 314 ON READER SERVICE CARD

Microwave Components
G-band and F-band

FXR, INC., 26-12 Borough Place, Woodside 77, New York, offers a commercial line of 2-mm wavelength (G-band) and 3-mm wavelength (F-band) components. The miniature instruments have frequency ranges from 90 to 140 kmc and 140 to 220 kmc. Line is com-

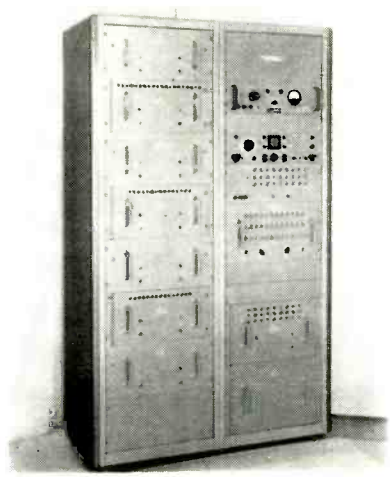
prised of waveguide and flanges, slotted sections, precision variable attenuators, detector mounts, E/H tuners, frequency meters, fixed terminations and many others.

CIRCLE 315 ON READER SERVICE CARD

Insulation Sleeve for wire ferrule

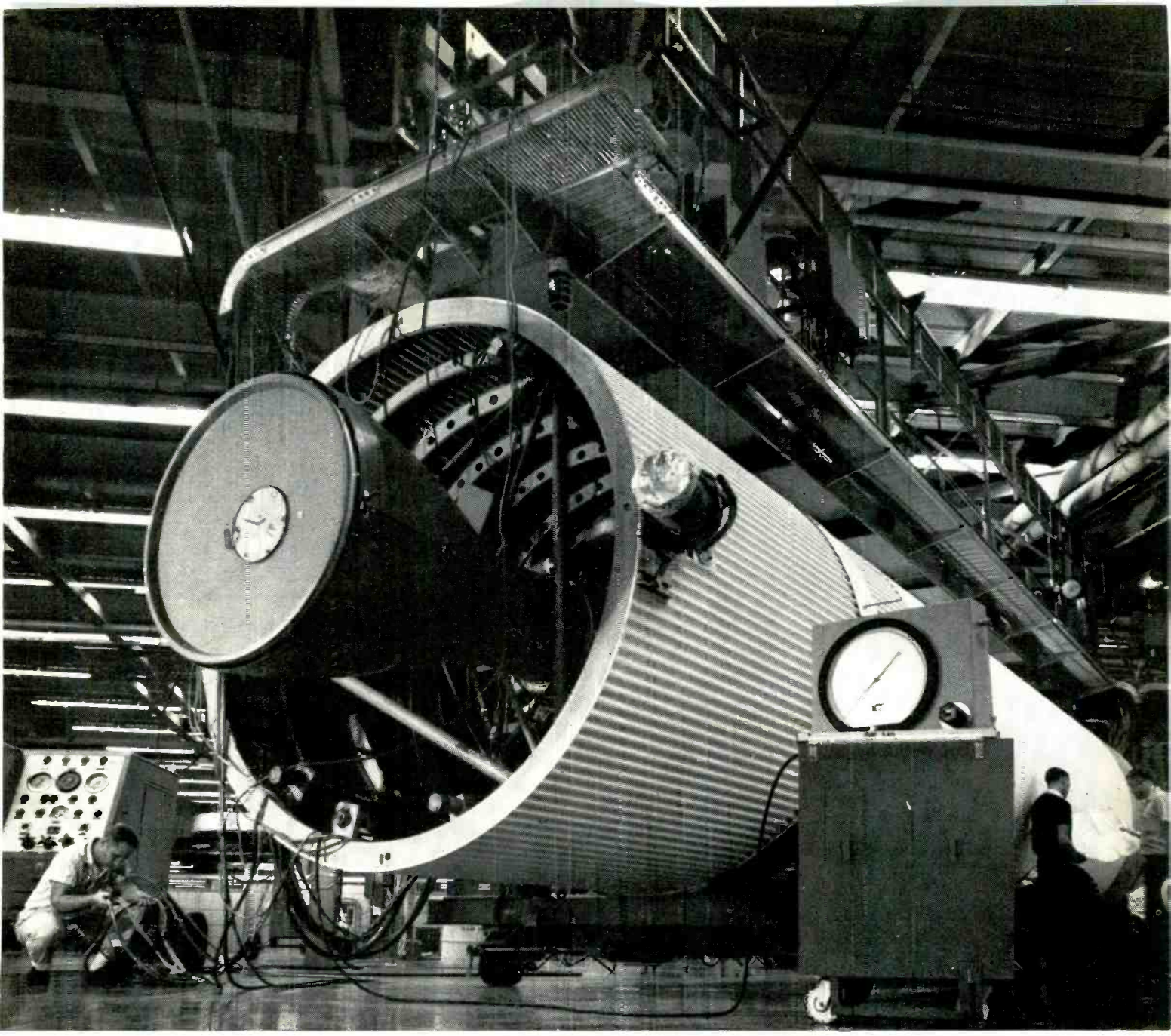
AMP INC., Harrisburg, Pa., announces a newly designed insulation sleeve for its Termashield shielded wire ferrule line. It is designed to slip on and snap in place over the previously crimped ferrule. Slipping the insulation on after crimping prevents interference of the sleeve with the insertion of ground tap leads. It also permits maximum visibility during the insertion process. The Termashield ferrule and the matching post-insulation sleeve are color coded.

CIRCLE 316 ON READER SERVICE CARD



Tracking System records radar data

DATEX CORP., 1307 So. Myrtle Ave., Monrovia, Calif. Missile tracking system accurately records dynamic radar data correlated in time to 0.001 sec. It employs servo repeater units to drive shaft position encoders for encoding range, azimuth and elevation. Range resolution is 1 yard in 10^6 yards, and azimuth and



Jupiter IRBM Missile in final test and checkout area where actual flight conditions are simulated, at the Chrysler operated U.S. Army Michigan Ordnance Missile Plant near Detroit.

IN SOUTHEASTERN MICHIGAN:
A SCIENTIFIC CLIMATE FOR THE ELECTRONICS INDUSTRY

An important aspect of Southeastern Michigan's scientific climate is the steady growth of electronics research and production activity. Here electronics firms can benefit because of the area's world-wide reputation for know-how in production technology. Here components for improved missile controls, communications systems, data processing and miniaturization are produced profitably, for economical distribution throughout the United States.

The men that manage and man this new industry have found that Southeastern Michigan is a great place in which to live and work. And it has dozens of modern communities which have provided wisely for future expansion. Many have retained professional city planners to assure optimum land use. We would welcome the opportunity to discuss communities and plant sites with you on a completely confidential basis.

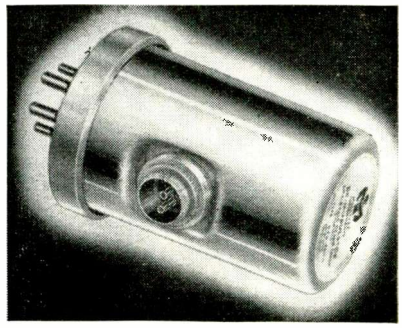
Typical of Southeastern Michigan's electronics activity are: (*Left*) Burroughs Corporation—assembly of test equipment for check-out of Atlas ICBM guidance system. (*Center*) Scientist observes formation of a vanadium crystal in Ford Motor Company Scientific Laboratory. (*Right*) Technician at Performance Measurements Company finishing a digital torque indicator.

Write Plant Location Service, Area Development Division

DETROIT EDISON

elevation 0.2 mils in 6,400 mils. Time is recorded with each sample with an accuracy of 0.001 sec. The system is capable of recording data at rates up to 10 samples per sec, via an IBM 523 card punch in IBM 704 code format.

CIRCLE 317 ON READER SERVICE CARD



D-C Modulators hermetically sealed

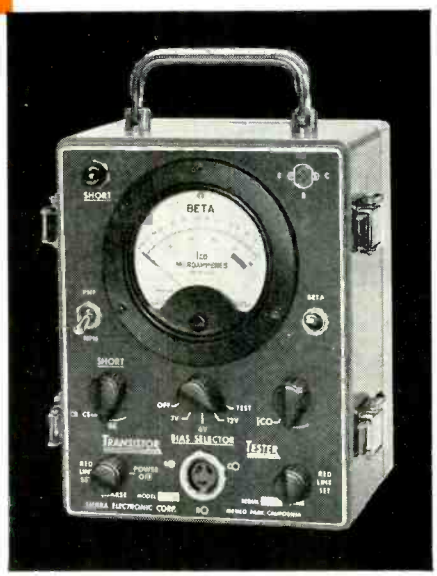
MILLIVAC INSTRUMENTS Division of Cohu Electronics, Inc., Box 997, Schenectady, N. Y. Spdt, 60 cycle, d-c modulator is designed for computer systems, servomechanism, automation, vtvm's and similar applications. Each unit has less than 1 μv d-c offset, a drift of less than 1 μv over long service periods. Normal contact dwell time is 55 percent, changing less than 2 percent during the first 1,000 hr, even less afterwards. New contact design and contact treatment holds rms noise voltage generation below 1 μv. Life expectancy is from 10,000 to 25,000 hr.

CIRCLE 318 ON READER SERVICE CARD

Silicon References subminiature

TRANSITRON ELECTRONIC CORP., 168 Albion St., Wakefield, Mass. Hermetically sealed glass encapsulated silicon voltage references, combine features of lower dynamic resistance and voltage stability exceeding that of a standard cell. Single-piece construction affords an ideal thermal connection between Zener diode and the compensating

NEW! In-Circuit Transistor Tester



Measure transistor Beta—without removing transistor from circuit—with equipment power off!

Ideal for production line testing, incoming inspection of transistorized sub-assemblies, field trouble-shooting and maintenance.

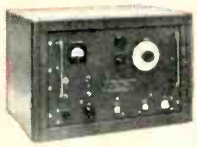
Incorporating an internal reference signal source with low impedance input and output coupling circuits, new Sierra Model 219A Transistor Tester provides, for the first time, measurement of transistor Beta on an in-circuit basis. Beta and Ico parameters may also be measured with the transistor disconnected.

Since testing may be done without energizing equipment under test, there are no spurious signals to confuse results and hours of trouble-shooting and service time are saved. Model 219A is compact, rugged, conservatively rated and built of high quality components throughout. Request Bulletin from your Sierra representative or write direct.

Other new Sierra equipment

Calorimeters, Water Loads

Sierra offers two groups of Calorimeters and Water Loads for both waveguide and coaxial measurements. Calorimeters and associated Loads provide measurements covering DC to X band.



Power Sources 25 to 1,000 MC

For fast, accurate calibration of power monitors and termination wattmeters. Output power adjustable 20% to 100% of rating; 50 watts output. Four models cover 25 to 1,000 MC in varying band spreads.

Model 218A Monitor Oscilloscopes

These new instruments are designed for continuous function monitoring of up to 7 channels simultaneously in one rack unit. Rugged and compact, they provide in the smallest possible package a convenient means for viewing and evaluating complex voltages. Ideal for measurements of stress, strain, vibration, pressure, displacement, acceleration and other quantities through a transducer.

Data subject to change without notice

SIERRA ELECTRONIC CORPORATION

A Subsidiary of Philco Corporation

5443A BOHANNON DRIVE • DAVENPORT 6-2060 • MENLO PARK, CALIF., U.S.A.
SALES REPRESENTATIVES IN ALL MAJOR AREAS

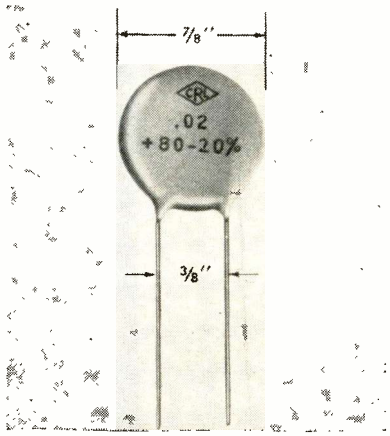
Canada: Atlas Instrument Corporation Ltd., Toronto, Montreal, Vancouver, Winnipeg
Export: Frazar & Hansen, Ltd., San Francisco

sierra

CIRCLE 127 ON READER SERVICE CARD

Stabistor, assuring that the junctions operate at the same temperature, thereby eliminating warm-up transients. The references offer temperature coefficients as low as 0.001 percent/deg C.

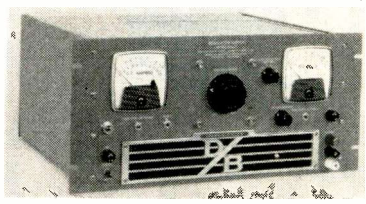
CIRCLE 319 ON READER SERVICE CARD



Ceramic Capacitors three models

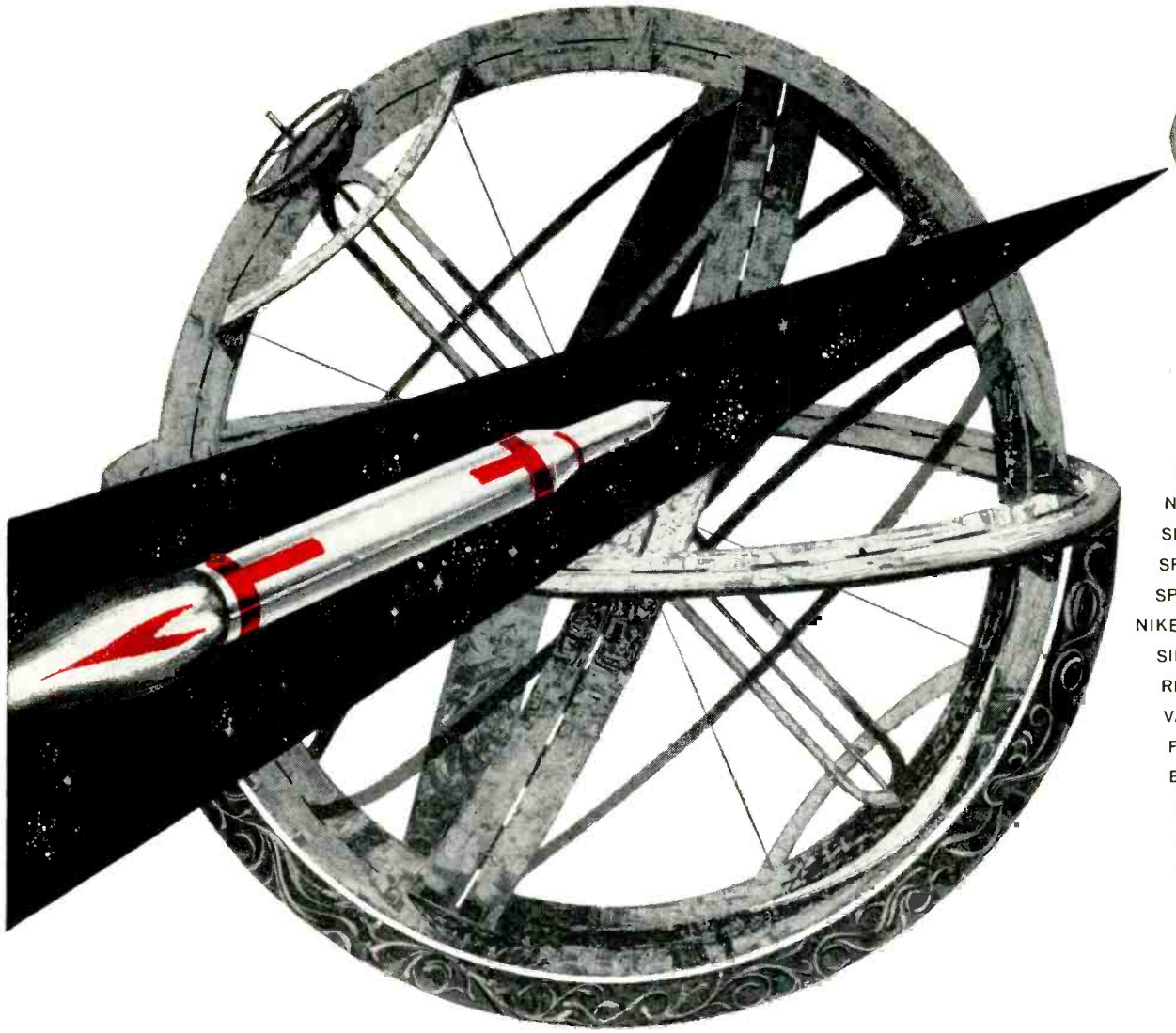
CENTRALAB DIV., Globe-Union, Inc., 9144 E. Keefe Ave., Milwaukee 1, Wisc. Three new ceramic disk capacitors have capacitances of 0.03, 0.04 and 0.05 μf, 600 vdcw. They are Durez coated and impregnated with high melting point wax to withstand extremes of temperature and humidity. No. 22 tinned copper leads are 1½ in. long. Units are primarily designed for by-pass, coupling and filter applications.

CIRCLE 320 ON READER SERVICE CARD



D-C Power Supplies transistorized

DRESSEN-BARNES CORP., 250 No. Vinedo St., Pasadena, Calif. Models 62-141 and 62-142 power supplies are rated 5 and 10 amperes, respectively. Both are rated ½ to 32 v d-c output. Regulation, for either line or load, is less than 18 mv; ripple, less than 1 mv. The 5 ampere unit is 19 in. wide by 7 in. high by 16 in. deep; the 10 ampere unit, 19 in.



THOR
MACE
TITAN
HAWK
ATLAS
SNARK
NIKE B
BOMARC
NIKE ZEUS
SPARROW I
SPARROW II
SPARROW III
NIKE HERCULES
SIDEWINDER
REGULUS II
VANGUARD
PERSHING
BULL PUP
POLARIS
CORVUS
FALCON

N.D. Adds New Dimensions To High Speed Gyro Rotor Bearings!

At speeds up to 24,000 RPM precision rotor bearings in inertial guidance and navigational systems are highly critical components. Early research and development in design and manufacturing at New Departure is solving the problem and thus winning vital roles for N.D. integral rotor bearings in missile projects. For example, "B" Series bearings with separable inner ring developed by N.D. are helping set performance records in such inertial guidance systems as the AChiever.

New Departure is also supplying high-precision rotor bearings for the inertial guidance system in Polaris.

These bearings, through advanced manufacturing techniques, exacting inspections and controlled environmental tests, backed by 50 years of laboratory testing experience, give precision and uniformity far above the most precise industry standards. They promise new performance and *reliability* for the submarine-launched IRBM.

You can look to improved *performance* and *reliability* when you include an N.D. Miniature/Instrument Bearing *Specialist* in early design level discussions. Call or write Department L.S., New Departure Division, General Motors Corporation, Bristol, Connecticut.

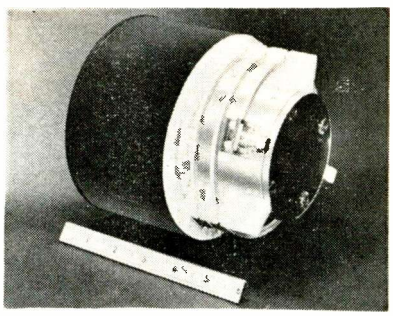
NEW DEPARTURE

MINIATURE & INSTRUMENT BALL BEARINGS

proved reliability you can build around

wide by 8¾ in. high by 16 in. deep. Push buttons are provided for meter low-range and for overload trip reset. Calibrated adjustable overload protection is a feature of the bench or rack mounted units.

CIRCLE 321 ON READER SERVICE CARD



Delay Lines
S-band

RAMO-WOOLDRIDGE, a division of Thompson Ramo Wooldridge Inc., P. O. Box 90534 Airport Station, Los Angeles 45, Calif. Low-loss, wideband, compactly packaged microwave delay lines weigh only 25 oz and can replace more than 100 ft of coaxial cable each. The S-band helical microwave delay line provides a time delay of 0.1 μsec for signals nominally in the 2.2 to 4.2 kmc range.

CIRCLE 322 ON READER SERVICE CARD

Silicon Transistor
mesa type

TEXAS INSTRUMENTS INC., P.O. Box 312, Dallas, Texas. The TI 2N696 and 2N697 silicon mesa transistors are equally suited for medium power and small signal amplifier as well as switching applications. Both are capable of 2 w dissipation at 25 C case temperature and are available with a collector-base voltage of 60 v. Both have a guaranteed beta spread—20 to 60 for the 2N696 and 40 to 120 for the 2N697—and a maximum saturation resistance of 10 ohms.

CIRCLE 323 ON READER SERVICE CARD

Reactance Computer
slide rule

JFD ELECTRONICS CORP., 6101 Sixteenth Ave., Brooklyn 4, N. Y. New reactance computer slide rule

interfering

electromagnetic energy •

within the frequency range of

30 cps to 10.7 kmc

...can be investigated, analyzed, monitored and measured to the highest practical degree of accuracy with Stoddart Radio Interference & Field Intensity Measuring Systems.

Stoddart RFI Measuring Equipment is approved for use by all departments of the Department of Defense. Military and commercial equipments are identical . . . were designed and manufactured to Military Equipment Specifications to meet the requirements of Military Measurement Specifications. Equipments are portable, dripproof, dustproof, and ruggedized for all-weather field use . . . precise and dependable for sensitive-selective laboratory measurements.

Applications include interference measurement and location, frequency conservation and allocation studies, spectrum signatures, antenna propagation studies, field intensity surveys, RF energy surveillance and monitoring, and verification of the electronic compatibility of modern weapons systems, i.e., missile firing and guidance, computer, telemetering and communications; the measurement of all rotating electrical devices, transmitting and receiving equipment, or any system or equipment capable of producing unwanted radiated or conducted electrical disturbances.

Stoddart instruments are available as individual self-contained units covering specific frequency ranges, or in rack-mounted console systems for laboratory, mobile, airborne and marine use.

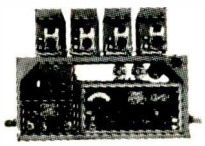
NM-40A (AN/URM-41)
30 cps to 15 kc

NM-10A (AN/URM-6B)
14 kc to 250 kc

NM-20B (AN/PRM-1A)
150 kc to 25 mc

NM-30A (AN/URM-47)
20 mc to 400 mc

NM-50A
(AN/URM-17)
375 mc to 1000 mc



NM-60A
(AN/URM-42)
1 Kmc to 10.7 Kmc

our sales engineering department

will give you individual consideration and information in the areas of interference problems or measurement with which you are particularly concerned . . . provide engineering bulletins, military specification information, descriptions of new measurement techniques and applications . . . class or individual instruction in the operation, calibration, and maintenance of Stoddart instruments. For prompt service please call "Sales Engineering", HOllywood 4-9292.

Lease-purchase and lease-rental agreements available
Immediate delivery

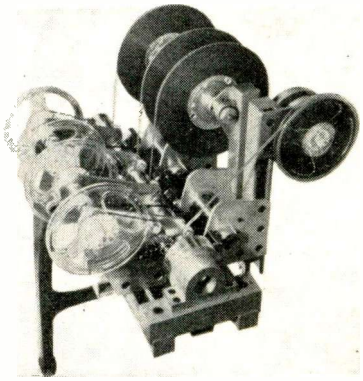
Send for complete literature

STODDART
AIRCRAFT RADIO CO., INC.
6644 Santa Monica Blvd., Hollywood 38, Calif., HO 4-9292

serving 33 countries in radio interference control

enables design engineers to determine the resonant frequency of a circuit knowing inductance and capacitance or to select various inductances and capacitances for a desired frequency. The slide rule also has provision for computing inductive and capacitive reactance as well as inductance and capacitance of resonant circuits from 1 mc to 1,000 mc. Price is one dollar.

CIRCLE 324 ON READER SERVICE CARD



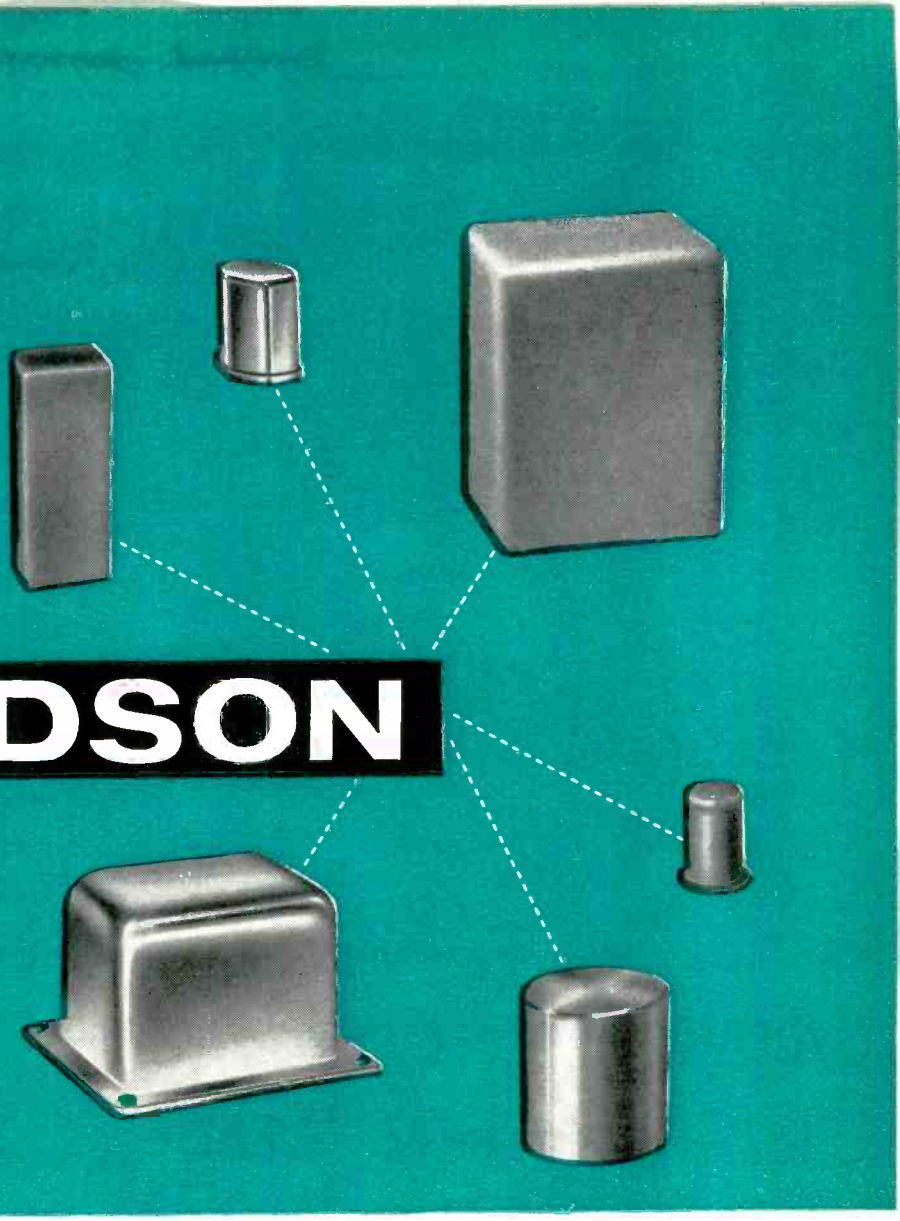
Tape Duplicator professional type

MAGNETIC RECORDING INDUSTRIES, 126 Fifth Ave., New York 11, N. Y. Model 10 tape duplicator is capable of producing 150 perfect copies in a single 8-hr day. Utilizing the common, horizontal mandrel principle, it makes three high-speed duplicate copies simultaneously. Model 10's amplifier is of all-solid-state rectifier design. The preamp is all-transistorized. Operating at 30 ips model 10 can duplicate a 1200-ft tape in 7½ minutes. Unit has a frequency response of 50 to 10,000 cps with a signal to noise ratio within 2 db of a magnetic tape recording system's theoretical limit. Price is $4,950; lease-purchase plans also available.

CIRCLE 325 ON READER SERVICE CARD

Fuel-Gage Tester ruggedized unit

GENERAL RADIO CO., West Concord, Mass. Type 1428-A fuel-gage tester meets military specifications. It contains a pair of 3-terminal air capacitors, continuously variable linearly from 20 to 220 $\mu\mu$f; one to simulate the jet-fuel compensator, the other, in conjunction with fixed-

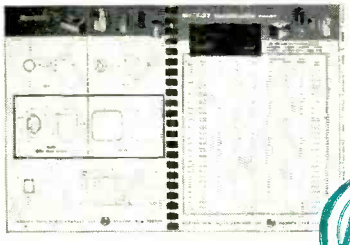


HUDSON

–the Standard Line that's Deep-Drawn to Precision Standards*

*The Most Complete Line in the Industry, too!

DESIGNERS!
For precision quality at commercial prices, consult the new HUDSON catalog. Call or write for this cost and time-saving handbook, today!



HUDSON STANDARD CASES AND COVERS offer a quick, economical solution to your military and commercial closure problems. Components of mu metal, nickel-silver, aluminum, brass, copper, steel and stainless steel are available in any required finish.

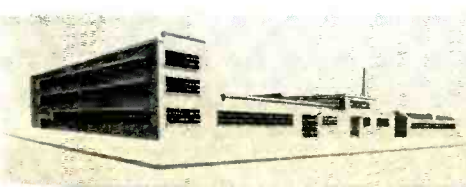
HUDSON STANDARD TOOLING saves you time and money on all but the most unusual closure applications. Check your requirements with HUDSON engineers, now!

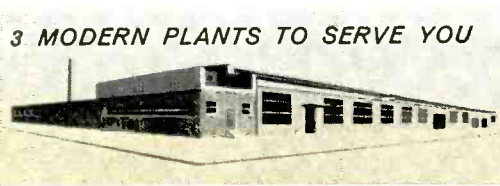
Hudson Tool & Die Co • Inc
18-38 Malvern St., Newark 5, New Jersey

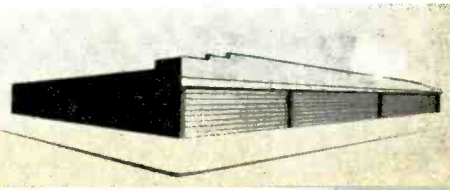
Telephone: MArket 4-1802
Teletype: NK 1066

Precision Metal Components for Electronics, Nucleonics, Avionics and General Industrial Applications

3 MODERN PLANTS TO SERVE YOU

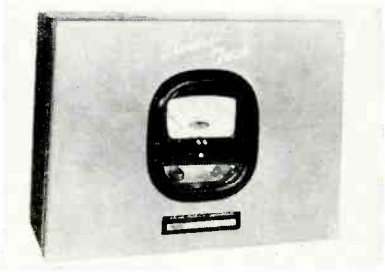






silvered mica units, to simulate the main sensing capacitor of the fuel gage. The main capacitor can be extended to 6,200 $\mu\mu$f using two sets of switched, solder-sealed precision silver micas; one provides five steps of 200 $\mu\mu$f; the other five steps of 1,000 $\mu\mu$f. For compensation there is an additional capacitor, continuously variable linearly from 10 to 210 $\mu\mu$f. Air dielectric losses are almost negligible since solid insulation is largely outside the electric field. Capacitor scale length is 19.2 ft; settings are accurate to 1 part in 25,000.

CIRCLE 326 ON READER SERVICE CARD



Tachometers transistorized

ELECTRO PRODUCTS LABORATORIES, Chicago, Ill., announces Electro-Tach Multiple 7120 series, a line of transistorized tachometers that measure speed without physical loading and provide overspeed/underspeed control. Unit illustrated is housed in a JIC-type enclosure.

CIRCLE 327 ON READER SERVICE CARD

Servo Amplifiers 400 cps units

MAGNETICO, INC., T. A. Division, 6 Richter Court, East Northport, L. I., N. Y., announces a line of 400 cps transistorized servo amplifiers. The T1000 measuring 1⅝ by 1⅝ by 3 in., with a voltage gain of 2,500, has a power output capability

Simplified, Accurate Broadband Measurements

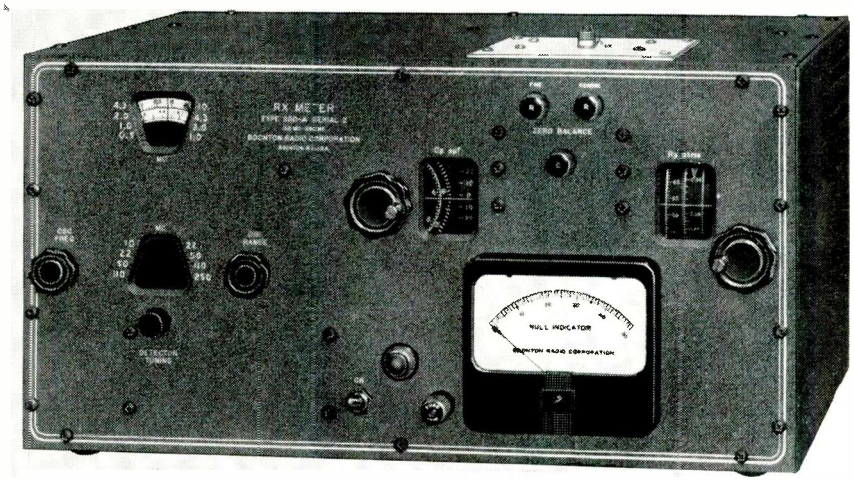
Frequency Range 500 KC to 250 MC

The integral design of this RF bridge eliminates difficulties from leakage, hand effects or improper matching that can occur when several units must be interconnected to make measurements. Integrated within the 250-A are an accurate, continuously tuned RF oscillator, high frequency bridge, amplifier-detector and null indicating meter. Connections to the unknown impedance are arranged for practically zero lead length. Equivalent parallel resistance and capacitance are read directly from the calibrated dials over the entire range.

Typical Applications

The RX meter provides a quick accurate means of measuring the RF resistance and reactance of a wide variety of materials, components and circuits. Measurements can also be made of the dynamic parameters of transistors, vacuum tubes and diodes under selected conditions of D.C. bias and operating levels. Measurements of antennas and antenna systems are readily convertible to series equivalents or VSWR. Transmission line characteristic impedance, attenuation and velocity of propagation are easily determined.

BRC Type 250-A RX Meter... Complete, Integrated, Self-contained— No External Units Required



Specifications

Frequency Range: 500 KC to 250 MC

Frequency Accuracy: ±1%

Resistance Range (Rp): 15 to 100,000 ohms (28" scale length)

Resistance Accuracy: $\pm\left[2+\frac{F^*}{200}+\frac{R^*}{5000}+\frac{Q^*}{20}\right]\% + 0.2\ \Omega$

*F = frequency (MC); R = RX Meter Rp reading (Ω);
$Q=\frac{R}{\omega C \times 10^{-12}}$, where C = RX Meter Cp reading (μμf)

Resistance Calibration: Increments of approx. 3% throughout most of range.

Capacitance Range (Cp): 0 to 20 μμf (0.1 μμf increments)

Capacitance Accuracy: ± (0.5 + 0.5F²* C* x 10⁻⁵)% ± 0.15 μμf
*F = frequency (MC); C = RX Meter Cp reading (μμf)

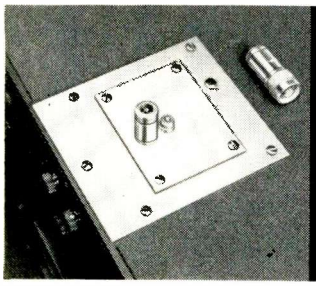
Capacitance Calibration: 0.1 μμf increments.

Inductance Range (Lp): .001 μh to 100 mh

Inductance Accuracy: Basic accuracy is capacitance accuracy given above.

Test Voltage: 0 volts D.C. (50 ma permissible thru unknown terminals)
0.1 to 0.5 volts RF (conveniently reducible to 20 mv)

Price: $1525.00 F.O.B. Boonton, N. J.



CO-AX ADAPTER KIT TYPE 515-A
Permits connection to the RX Meter bridge circuit of any coaxial transmission line or fixture fitted with a type "N" male connector.
PRICE: $38.50 FOB Boonton, N. J.

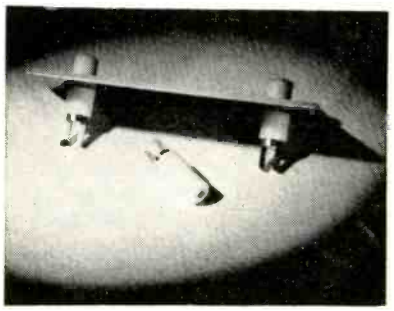
25th ANNIVERSARY

Precision Electronic Instruments since 1934

BOONTON RADIO CORPORATION
BOONTON, NEW JERSEY, U.S.A.

of 3.5 w at 40 v rms. The T4000 measuring 1⅞ by 1⅝ by 3½ in., with a voltage gain of 1,500, has a power output capability of 6.2 at 40 v rms. The T7000 measuring 2⅜ by 1⅞ by 3¾ in., with voltage gain of 3,000 has a power output capability of 9.3 w at 40 v rms. They are designed to drive any standard size 11, 15 or 18 servo motor with a 40 v center tapped control winding. Without any type of heat sink mounting they are capable of delivering rated power continuously in an ambient temperature of −55 C to + 75 C.

CIRCLE 328 ON READER SERVICE CARD



Teflon Terminal slotted-lug

SEALECTRO CORP., 610 Fayette Ave., Mamaroneck, N. Y. Convenience of the slotted or bifurcated lug, coupled with a through-center hole bringing the connecting lead from one side to the other of a chassis or casing, and wrapping the lead on the external lug, is offered by type FT-1025 SL Press-Fit Terminal. Terminal is ideally suited for assemblies requiring potting, or for other sealed-in equipment requiring handy external connections. The Press-Fit feature—simply pressing into a hole, without need of nuts, washers, lockwashers or other hardware—provides an excellent seal, particularly with potted units.

CIRCLE 329 ON READER SERVICE CARD

Power Transistor military-type

BENDIX AVIATION CORP., Long Branch, N. J. The 2N297A germanium power transistor meets the MIL-T-19500/36A (Sig C) specification. It can be used in numerous military applications, such as in missiles and supersonic aircraft,

CIRCLE 136 ON READER SERVICE CARD
CIRCLE 137 ON READER SERVICE CARD →

AN ACHIEVEMENT IN DEFENSE ELECTRONICS

NEW AMPLIFIER PACKS 90 DB IN HALF CUBIC INCH VOLUME

New 455 kc three-stage amplifiers developed by the U.S. Army Signal Corps utilizing the facilities and competence of General Electric produce up to 90 db gain with 5 kc bandwidth in one-half cubic inch volume. This degree of miniaturization evolved from sustained research and development in solid state filters, delay lines and transformers at the Electronics Laboratory, Electronics Park.

The unique bar-shaped transformers developed for these amplifiers, combined with improvements in existing ferro-electric ceramics, permits the most compact packaging with extreme gain. This achievement in research and development is indicative of General Electric's technical competence in defense electronics.

227-2B

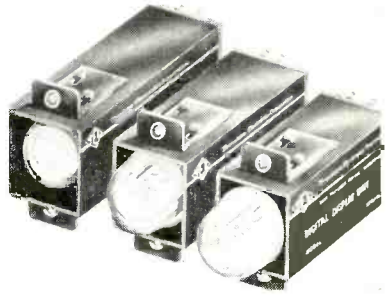
Progress Is Our Most Important Product

GENERAL ELECTRIC

DEFENSE ELECTRONICS DIVISION
HEAVY MILITARY ELECTRONICS DEPARTMENT
SYRACUSE, NEW YORK

and also in many commercial fields for high-current switching, audio amplification, regulators, power supply circuits, and oscillator circuits. Maximum collector voltage rating is 60 v, and maximum collector current rating, 5 amperes. It has a dissipation of 35 w at 25 C and 10 w at 75 C.

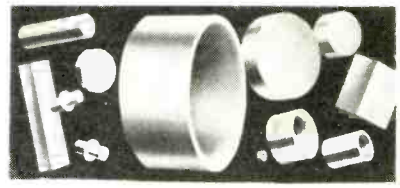
CIRCLE 330 ON READER SERVICE CARD



Nixie Tube Driver
transistorized

TRANSISTOR ELECTRONICS CORP., 3357 Republic Ave., Minneapolis 26, Minn. The TND series may be driven by low level signals, such as are commonly available from transistor circuitry, without need for driver relays or external drive amplifiers. Unit includes standard Nixie tubes and up to ten transistor drive circuits. Signals required are +4 for the "ON" condition, 0 volts for "OFF" and both are referenced to the common terminal. This signal may be shifted up or down by the use of an external bias on the common terminal. Circuit may be modified to fit any exact signal and supply voltages, including negative "ON" and positive "OFF" conditions.

CIRCLE 331 ON READER SERVICE CARD



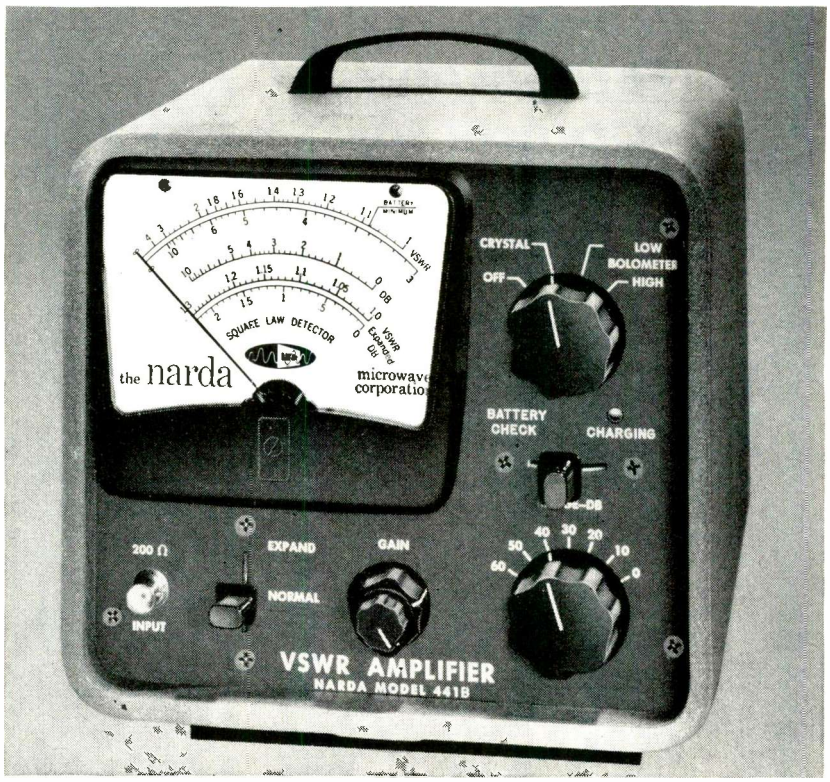
Transducer Element
high temperature

U. S. SONICS CORP., 625 McGrath Highway, Somerville, Mass. A new type of ceramic transducer element (US 500) exhibits high stability at temperatures up to 300 C. It is very active and has a high linear cou-

SIX VSWR AMPLIFIER FEATURES

...available only from NARDA

1. Battery-operated (rechargeable nickel-cadmium).
2. Completely transistorized for low current drain.
3. Independent of line voltage variations.
4. Complete bolometer protection during switching.
5. Most compact unit available.
6. Completely portable.



Model 441B — $225

Now you can get a completely portable battery-operated VSWR Amplifier offering complete protection against bolometer burnout at the same time!

Narda's Model 441B is supplied with nickel-cadmium batteries, providing complete freedom from line voltage deviations. Batteries recharge automatically when unit is plugged in; provision is built-in to show state of battery charge. A special protective circuit permits switching and connect-disconnect with no danger of bolometer burnout. Provision is made for both crystals and high **and** low current bolometers.

Full sensitivity is provided over both normal and expanded scales; eliminates switching attenuation range. Other features are shown on this page; for complete information and a free copy of our latest catalog, write to us at: Department E-10.

FEATURES:

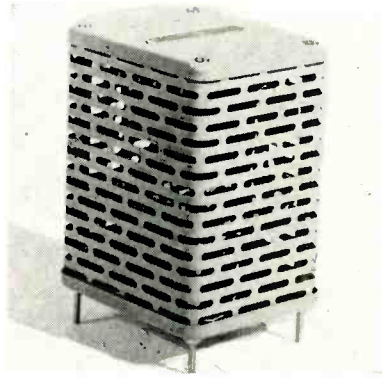
- **SENSITIVITY:** 0.1 microvolts at 200 ohms for full scale.
- **FREQUENCY:** 1,000 cps ± 1% (plug-in frequency networks available for 315-4,000 cps and broad-band applications)
- **BANDWIDTH:** 25-30 cps
- **RANGE:** 72 db (60 db in 10 db steps, 11 db continuous)
- **ACCURACY:** ± 0.1 db per step • ± 0.2 db maximum cumulative • meter linearity: 1% of full scale

the narda microwave corporation

118-160 HERRICKS ROAD, MINEOLA, L. I., N. Y. • PIONEER 6-4650

pling coefficient. It is ideally suited for use either as a sensor, or as a high power driver. Typical applications include underwater sounding, depth and liquid level sensing gages.

CIRCLE 332 ON READER SERVICE CARD



Power Supplies plug-in

MID-EASTERN ELECTRONICS, INC., 32 Commerce St., Springfield, N. J. Designed for use with computing systems or strain gage apparatus, the PI series of power supplies have a capacity of 15 w output with 0.1 percent regulation. Voltage ranges are available from 0 to 300 v d-c; such as, 100 v d-c at 50 ma, or 50 v d-c at 100 ma. Recovery is less than 50 μsec; ripple, 0.01 percent, and overshoot, less than 1.0 percent of the voltage setting. The supply is programmable over a narrow voltage range. Unit measures 4$\frac{1}{16}$ in. by 4$\frac{7}{8}$ in. by 6$\frac{1}{2}$ in.; weighs 3 lb.

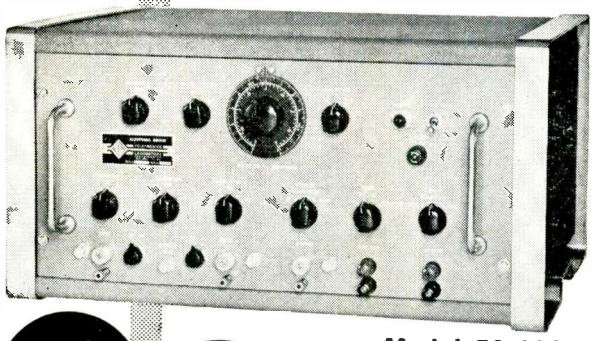
CIRCLE 333 ON READER SERVICE CARD

Coax Termination low power

EMPIRE DEVICES PRODUCTS CORP., Amsterdam, N. Y. Model TE-80 termination was designed for both field and lab use over the range from d-c to 10 kmc. Consisting of a resistive center conductor within a coaxial housing, the unit affords an accurately matched termination for vswr measurements of coax

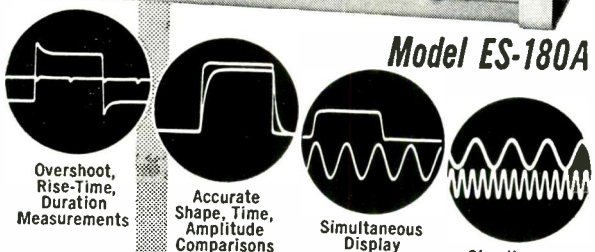
WIDE BAND ELECTRONIC SWITCH

DC to 15 MC DUAL TRACE OSCILLOSCOPE PRESENTATIONS



Model ES-180A

- Alternate-sweep or alternate-sample displays, switching rate up to 400 kc
- Amplifier rise-time .023 microseconds, megohm input, 93 ohms load impedance
- Unity-gain, feedback, regulated power supplies for linearity and stability
- Index trace calibrated in volts and % amplitude eliminates parallax errors
- Time-signal input allows accurate and rapid measurement of pulse parameters



Overshoot, Rise-Time, Duration Measurements

Accurate Shape, Time, Amplitude Comparisons

Simultaneous Display of Related Waveforms

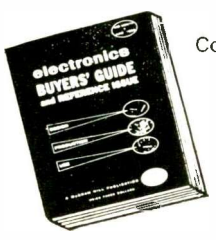
Simultaneous Display of Non-Sync. Signals

TELETRONICS LABORATORY, INC. 54 KINKEL STREET WESTBURY, L. I., N. Y.

CIRCLE 202 ON READER SERVICE CARD

Look in the new

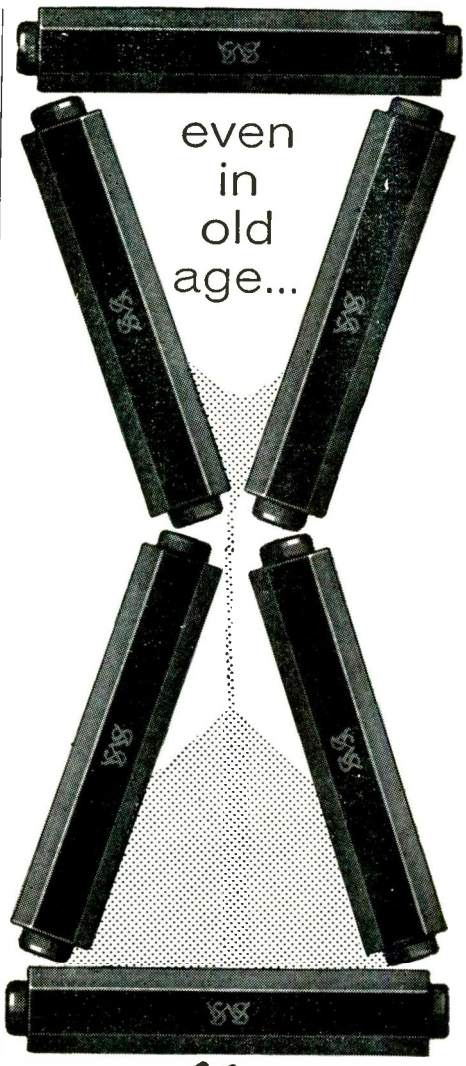
electronics BUYERS' GUIDE



Complete list of government buying agencies, specs and applications in 64 page reference section of the '59-'60 issue.

A McGRAW-HILL PUBLICATION

ABP 330 W. 42nd Street ABC
New York 36, N. Y.



S. S. White

MOLDED RESISTORS retain their values!

S. S. WHITE Molded Resistors retain their original values and never deteriorate due to age!

S. S. WHITE resistors serve dependably in hundreds of commercial . . . industrial . . and scientific applications. They are characterized by low noise level . . . precision . stability . . . negative temperature and voltage coefficients. Non-hydroscopic base withstands temperature and humidity They are compact, have excellent stability and mechanical strength.

For full details, write for our Bulletin 5409. We'll be glad to help you apply these high-quality, "all-weather" resistors to your product. Just drop us a line.

FIXED RESISTANCE VALUES RANGE FROM 1000 OHMS TO 10,000,000 MEGOHMS!

65X Molded Resistor ..... 1 watt
80X Molded Resistor ..... 3 watts

S. S. White

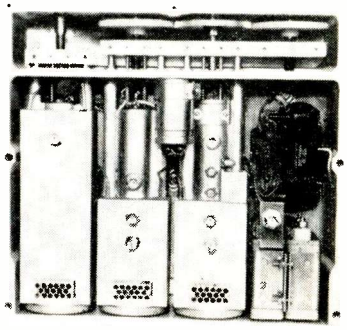
S. S. WHITE INDUSTRIAL DIVISION
10 East 40th Street, New York 16, New York

Western Office: Dept. R
1839 West Pico Blvd., Los Angeles 6, Calif.

CIRCLE 141 ON READER SERVICE CARD

components; a standard impedance termination for coax devices such as directional couplers or filters; or it may be used as a laboratory impedance standard. Center conductor is a precision film resistor rated at 1 w. Impedance is 50 ohms. Vswr is less than 1.07:1 from d-c to 4 kmc and less than 1.15:1 from 4 to 10 kmc.

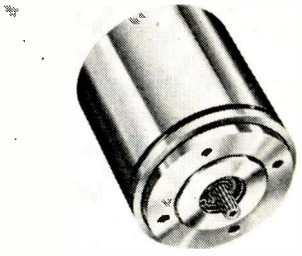
CIRCLE 334 ON READER SERVICE CARD



Stalo Driver for radar system

BJ ELECTRONICS, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif. New stalo exciter driver provides a stable frequency power source in radar systems or as a klystron driver source. It is designed for applications where 5 to 10 w c-w or pulsed r-f are required over S band. Model 86 consists of an L band cavity oscillator, cavity doubler to S band and cavity r-f amplifier. The amplifier stage may be pulsed at any repetition rate. IFM is less than 150 cycles throughout the frequency range.

CIRCLE 335 ON READER SERVICE CARD

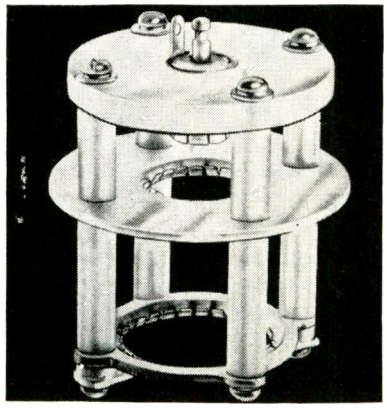


Servomotor weighs 15 oz

HELIPOT DIVISION OF BECKMAN INSTRUMENTS, INC., Fullerton, Calif. The 18SM691 servomotor is a precision control component engineered to provide the high torque and instantaneous acceleration re-

quired for rapid, precise response to minimum control signals. It can be wound for any standard carrier voltage supply, and requires a power input of 9 w/phase with 0.64 power factor. Unit features no-load speed of 3,200 rpm, torque at stall of 4 oz-in., and acceleration at stall of 70,000 rad/sec². It will operate continuously at stall to unit temperatures of 200 C.

CIRCLE 336 ON READER SERVICE CARD



UHF Socket for 2C39 tubes

JETTRON PRODUCTS, INC., 56 Route 10, Hanover, N. J. The CD-7620 uhf socket is completely assembled and ready to solder into the customer's chassis. It features very low capacitance from cathode to ground and from anode to ground. Rexolite 1422 insulators are employed for their extremely low loss and low dielectric constant characteristics at vhf and uhf. Heat treated, heavily silver plated beryllium copper finger springs make multiple peripheral contact with the tube elements. The socket construction prevents undue strain on the tube and the tube is not clamped in the socket, but held captive by two lugs at the anode end.

CIRCLE 337 ON READER SERVICE CARD

Capacitors ultra low leakage

RADIATION RESEARCH CORP., 1114 First Ave., New York 21, N. Y., announces development of a capacitor using polystyrene dielectric having a d-c resistance in excess of 10^9 megohm-μf or a leakage time constant greater than 100 years. Individual 0.1 μf capacitors charged to

One of a series of advertisements prepared by the ASSOCIATED BUSINESS PUBLICATONS

When you've got big plans for the future – you have good reasons for reading your businesspaper mighty carefully. This is where a man who means business gets facts, news, ideas . . . information he needs to do business. Issue after issue you find meaty stuff to keep your job and your business growing – in both the advertising and editorial pages of . . . your businesspaper.

PHOTO ON LOCATION BY EHRENBERG

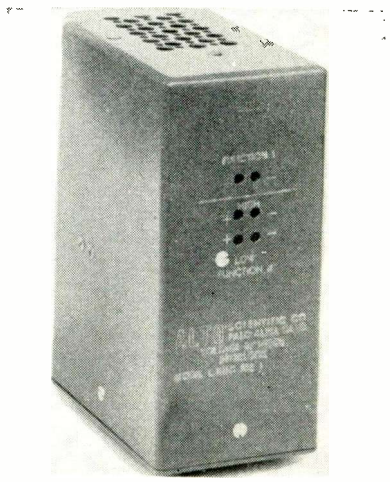
Where there's business action, there's a businesspaper . . . where there's electronics business, there's

electronics

A McGRAW-HILL PUBLICATION • 330 WEST 42nd STREET, NEW YORK 36, N.Y.

1,990 v (99.5 percent of initial charge) after 2 years. Uncased developmental models with voltage ratings from 1,000 v to 10,000 v are available for test and evaluation.

CIRCLE 338 ON READER SERVICE CARD



Voltage Monitors
solid state

ALTO SCIENTIFIC CO., INC., 855 Commercial St., Palo Alto, Calif. Model L102 monitors are solid state sensors followed by amplification to either close or open relays, thereby indicating automatically when the voltage exceeds preset limits. Typical applications are for voltage comparators in incoming inspection, voltage indicators for automatic checkout and voltage detection in ground power systems. Units have a range of 5 v to 40 v d-c and a response time of 100 millisec. Repeatability of trip is within 0.1 percent of voltage setting. Output relay rating is 2 amperes resistive load, and the trip point changes by less than ±3 percent (from 25 C) over a temperature range of −29 to +54 C.

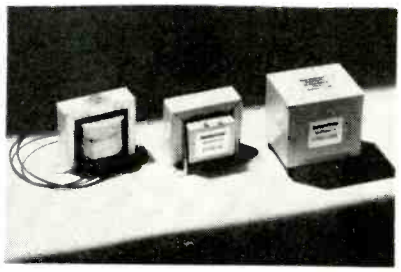
CIRCLE 339 ON READER SERVICE CARD

Transistors
silicon mesa type

RHEEM SEMICONDUCTOR CORP., 327 Moffett Blvd., Mountain View, Calif. These *npn*, double diffused silicon mesa transistors have very fast switching time, as low as 25 millimicrosec. Saturation resistance is typically 5 ohms. Units are designed to meet the most rigid mili-

tary specifications. They are available now in the JEDEC TO-5 package.

CIRCLE 340 ON READER SERVICE CARD



Swinging Inductors
wide selection

MAGNETIC CIRCUIT ELEMENTS INC., 3722 Park Place, Montrose, Calif., has 172 different models of swinging inductors, each in three basic forms—open construction, encapsulated and can-type. Encapsulated and can-type, with their unique internal construction, are designed to meet or exceed applicable sections of MIL-T-27A.

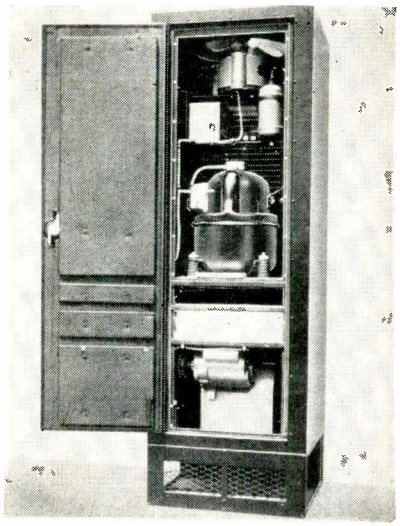
CIRCLE 341 ON READER SERVICE CARD

Sensing Device
extreme resolution

BRUSH INSTRUMENTS, division of Clevite Corp., 37th and Perkins, Cleveland 14, Ohio. New motion sensing device, known as Metrisite, features minute operating force with negligible reactive force; very accurate linearity—even close to null point; high, stable electrical output; wide range of possible configurations from subminiature up; and exceptional ruggedness. In addition to broadening the whole concept of control technology in military, industrial and scientific fields, the Metrisite will further the

applications of direct writing recording systems.

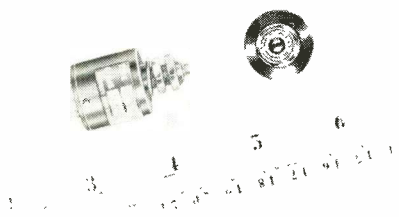
CIRCLE 342 ON READER SERVICE CARD



Refrigerated Blower
66½ in. high

WESTERN DEVICES, INC., 600 W. Florence Ave., Inglewood 1, Calif. The BR-36 blower is designed for cooling of electronic equipment and maintenance of a preset temperature simultaneously within from four to six completely equipped cabinets. It is factory-set to maintain cabinet temperature at 70 F, has a 36,000 Btu capacity, 220 v a-c operating voltage. Heated air from instrumentation cabinets is drawn in at top of unit, then cooled and recirculated via a plenum chamber which is connected to each of the cabinets to be cooled.

CIRCLE 343 ON READER SERVICE CARD

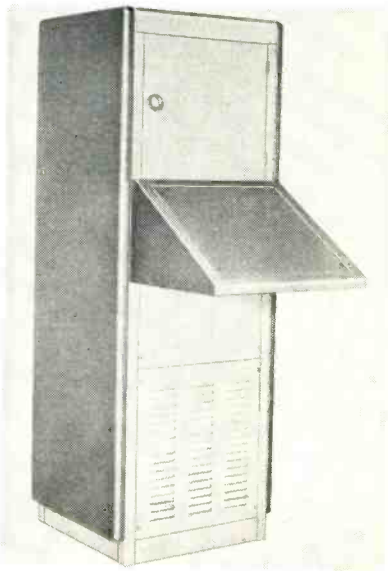


Trimmer Pot
wirewound

MAUREY INSTRUMENT CORP., 7924 S. Exchange Ave., Chicago 17, Ill. Model 75-M48 is a ⅜ in. diameter wirewound trimmer potentiometer developed primarily for military applications where a rugged envi-

ronmental condition is required. It is available from 25 ohms to 50,000 ohms resistance; sealed type construction for encapsulation; built to applicable sections of MIL-R-19A, MIL-E-5272A, MIL-R-19518, MIL-R-12934B, NAS 710.

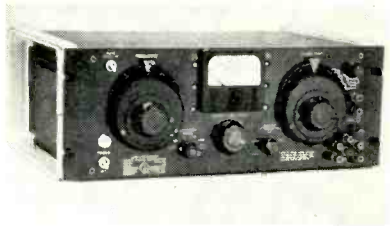
CIRCLE 344 ON READER SERVICE CARD



Transmitter Racks
22-in. wide frames

PREMIER METAL PRODUCTS CO., 337 Manida St., New York 59, N. Y. A new line of Prem-O-Rak modular transmitter racks is designed for multiple installations and for use with the Prem-O-Rak console cabinets. The F series have front and rear rounded tops, 22 in. wide frames made of 14 gage steel, and two adjustable panel mounting angles.

CIRCLE 345 ON READER SERVICE CARD

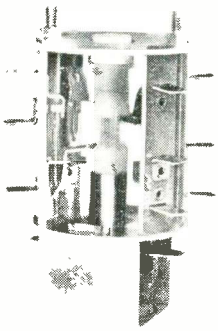


L-F Oscillator
polyphase

GENERAL RADIO CO., West Concord, Mass. Type 1305-A oscillator can be used for gain and phase measurements at low frequencies (0.01 to 1,000 cycles) on geophysical prospecting and sonar systems,

servomechanisms, and power-system analogs. A feature of the unit is an output circuit continuously variable in phase and calibrated from 0 to 360 deg.

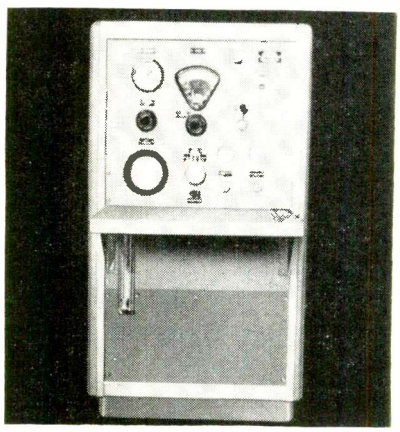
CIRCLE 346 ON READER SERVICE CARD



Snap Switch Relay
solenoid operated

WARCO INDUSTRIES, INC., 6625 Delmar Ave., St. Louis 30, Mo. The SS-101 multipole solenoid operated snap switch relay is well suited to the control of several circuits handling inductive loads. It is available in contact arrangements up to 6 pdt. Each snap action contact is rated at 10 amperes, ½ h-p, at 125 v a-c or 5 amperes, ½ h-p, at 250 v a-c. Plunger clears through top of frame for convenient push button-self holding operation where desired. Overall dimensions are 3¼ in. long by 1⅝ in. diameter.

CIRCLE 347 ON READER SERVICE CARD

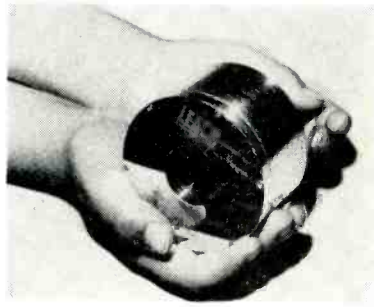


Cooling Systems
for microwave tubes

INDUSTRIAL CONTROL PRODUCTS, INC., 12 Clinton Road, Caldwell, N. J. Hydraulic cooling systems employing fluoro chemicals are custom designed for traveling wave

tube, magnetron, klystron and solenoid cooling applications. The chemical is circulated around the tube whose temperature is to be stabilized.

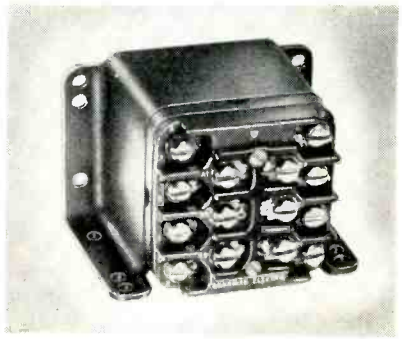
CIRCLE 348 ON READER SERVICE CARD



Tape Recorder weighs 10½ oz

LEACH CORP., Los Angeles, Calif., announces an airborne tape recorder weighing 10½ oz and occupying 14 cu in. of space. It will register information about air or space flights on one to 16 channels on a continuous tape, which will then play it back to earth receivers. It has a high resistance to shock, over 2000 g's, and extremely low power consumption, 1½ w.

CIRCLE 349 ON READER SERVICE CARD

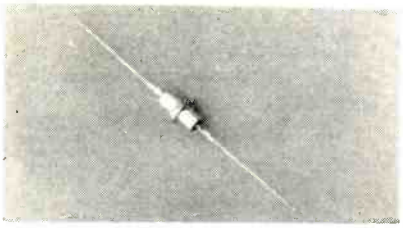


Sealed Relay minimum current

GUARDIAN ELECTRIC MFG. CO., 1621 W. Walnut St., Chicago 12, Ill. Series 3005 hermetically sealed relay meets overload rupture, vibration and minimum current requirements of MIL-R-6106-C. It operates with 4 pdt contact switch combinations at 10 amperes. Unit has vibration resistance of 15 g's to 1,000 cycles plus 10g's from 1,000 to 2,000 cycles; is applicable for operation in temperature ranges of — 65 C to + 120 C. It has standard coil volt-

age of 24 to 28 v d-c, is also available with rectification network for a-c operation up to 400 cps.

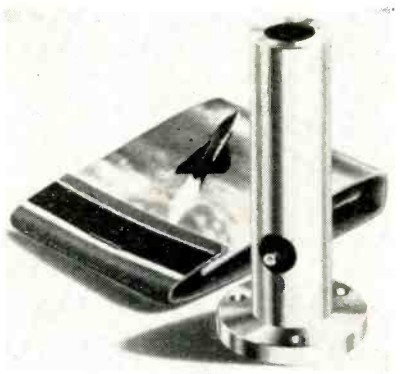
CIRCLE 350 ON READER SERVICE CARD



Silicon Rectifier
high voltage

BRADLEY SEMICONDUCTOR CORP., 275 Welton St., New Haven 11, Conn. Silicon tophat rectifier Siamese series BR/1N2772-2781, has peak inverse voltages ranging from 700 to 1,600 v, with a maximum d-c output of 750 ma (25 C). Maximum forward voltage drop is 1.8 and reverse leakage factor, 4 μa (25 C). Recovery time is 5 μsec. Body length is 19/32 in.; maximum overall diameter, approximately $\frac{3}{8}$ in. All units are hermetically sealed to meet MIL specs.

CIRCLE 351 ON READER SERVICE CARD

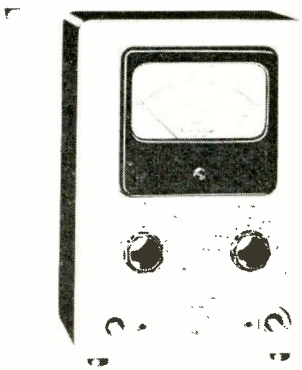


Latching G Switch
timed-action

INERTIA SWITCH, INC., 311 W. 43rd St., New York 36, N. Y. A timed-action latching switch is designed to activate automatically many critical operations aboard a soaring rocket or missile. The 6U0-115 has just one moving part—a precision ground steel ball held in place by a two-pole magnetic field. The switch can be set to respond to acceleration forces from 1 to 40 g's within a tolerance of $\pm$ 5 percent of the setting. Time delays can be ad-

justed between 0.5 and 1.5 sec. When an axial acceleration force exceeds the pull of the magnet the ball is released and moves to close the 6U0-115's normally open electrical contact.

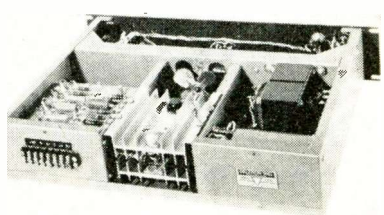
CIRCLE 352 ON READER SERVICE CARD



Voltmeter highly accurate

B & K INSTRUMENTS, INC., 3044 W. 106th St., Cleveland 11, Ohio, marketing agency for the manufacturer, Bruel & Kjaer of Denmark, offers model 2409 electronic voltmeter. It measures either the true rms, peak or average values of voltages over the frequency range from 2 to 200,000 cps. An accuracy of 0.5 db is obtained for true rms indication of signals with crest factors up to 5 and over a 20 db dynamic range. Unit may serve as a calibrated decade amplifier with 60 db gain as well as a vtvm.

CIRCLE 353 ON READER SERVICE CARD

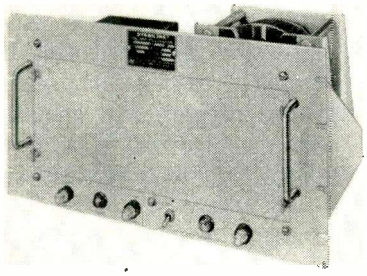


Power Supply solid state

DELTRON INC., 2905 N. Leithgow St., Philadelphia 33, Pa. Series LH transistor regulated power supplies are available with output over any 2 v band from 1 up to 100 v, in all even numbered steps up to 20 amperes. Regulation is less than 0.1 percent from no load to full load; line regulation, less than 0.1 percent for changes from 105-125

v a-c; temperature stability, better than 0.05 percent available to 0.01 percent; response time, better than 50 μsec; ripple, below 1 mv.

CIRCLE 354 ON READER SERVICE CARD



Voltage Regulator militarized

THE SUPERIOR ELECTRIC CO., 83 Laurel St., Bristol, Conn. Designed to meet MIL-E-4158B, this Stabiline electromechanical automatic voltage regulator type EM4108MR maintains a constant output voltage regardless of line or load changes. Efficiency is 99 percent. Unit features zero waveform distortion, 0.1 sec per v speed of response, accuracy of ± 1.0 percent, advanced control circuit and all under-chassis wiring. Input is 105-135 v, 45-66 cycles; output, 120 v rms nominal, adjustable from 115-125 v with proportional shift in input voltage range; output current, 66.6 amperes.

CIRCLE 355 ON READER SERVICE CARD

Transistor medium-power

BENDIX AVIATION CORP., 200 Westwood Ave., Long Branch, N. J., announces a medium-power transistor series for applications in single-ended Class B drivers, output amplifiers for portable radios and tv, and other commercial units. The transistor, called Yeoman and designated the 2N1176, A and B series, features low cost. It has a low saturation voltage of 0.3 v d-c, and can be supplied in 15, 40, and 60 voltage ratings with a 300 ma d-c maximum collector current rating. Its linear current gain characteristics permit efficient switching and low distortion output.

CIRCLE 356 ON READER SERVICE CARD

NEW BOOKS

Materials and Processes of Electron Devices

By M. KNOLL assisted by B. KAZAN.
Springer-Verlag, Berlin, Germany, 1959, 484 *p, DM* 66.

THOROUGHLY covers theoretical and practical considerations involved in choosing and testing materials and production processes for vacuum tubes and semiconductor devices. For example, metals are also described in terms of their annealed, outgassed and work-hardened states and their specific application as tube elements.

Topics include the various tube metals and alloys, glass and glass working, semiconductors, organic and inorganic compounds, cements, gases and vapors, working and outgassing tube parts, gettering, welding, exhausting and sealing. Both American and European practice is reviewed. The text is backed up with 411 figures, four color plates and 2,300 references.—G.S.

THUMBNAIL REVIEWS

From Microphone to Ear. By G. Slot, Macmillan Co., New York, 1959, 258 p. This second and enlarged edition, like the original Philips' Technical Library volume, presents a complete survey of modern sound recording and reproduction techniques. Though the author does not go into circuit details, he offers an excellent system treatment that should make this book of interest to every engineer concerned with the recording and reproduction of sound.

Molecular Science and Molecular Engineering. By A. R. von Hippel, The Technology Press of MIT and John Wiley and Sons, Inc., New York, 1959, 446 p, $18.50. This volume is the third in a series on modern materials research. Written for the professional engineer and scientist, it is an up-to-date book which presents theory and applications of the fundamental molecular properties of matter. Many frontier topics such as masers and parametric amplifiers, ferromagnetic devices and other subjects of interest to electronic engineers are discussed by noted contributors.

Electronic Communication. By Robert L. Shrader, McGraw-Hill Book Co., New York, N. Y., 1959, 937 p, $13.00.

Book presents a wide coverage of the electronic communication field for both commercial and amateur operators.

Proceedings of the Extended Range and Space Communications Symposium. J. J. Renner, c/o Jansky & Bailey, 1735 DeSales St., N.W., Washington 6, D. C., 1959, 119 p, $2.00. These proceedings of the Oct. 1958 symposium include papers on space transmission problems, space vehicle television, space satellite and ionospheric scatter communications, and the like.

An Introduction to Electronics for Physiological Workers. By I. C. Whitfield, St. Martin's Press, Inc., New York, N. Y., 1959, 263 p, $3.75. Though primarily intended to acquaint workers in the electrophysiological aspects of biological research with electronics and electronic circuits, some chapters of this book, such as the one on biological amplifiers, should also be of interest to the electronics engineer.

Electronics Industry Fact Book. Electronics Industries Assn., 1721 De Sales St., N. W., Washington 6, D. C., 28 p, $0.50. This book presents sales and production figures on television and radio sets, phonographs, military and industrial electronics expenditures and component and tube sales. Information covers exports, excise tax collections, etc.

Ceramic Fabrication Processes. Edited by W. D. Kingery, Technology Press, MIT and John Wiley & Sons, Inc., New York, 235 p, $9.50. Applicable to ferrites, ferroelectrics and other high-temperature materials, this book covers traditional and new ceramic fabrication methods.

High Fidelity: A Biblography of Sound Reproduction. Compiled by K. J. Spencer, Iota Services Ltd., London, England, 325 p, 30s. Approximately 2,600 entries are listed under subject headings and also in chronological order. Books are listed alphabetically by author and trade literature by company. In the U. S., this book is available from High Fidelity, Great Barrington, Mass.

New Forces in American Business. By D. M. Keezer and Associates, McGraw-Hill Book Co., Inc., New York, 1959, 278 p, $4.75. This is an unusually readable and forthright book on the forces that are shaping our economic future. According to the authors, the business outlook for the sixties is for steadily sustained growth and prosperity. A technical development that got underway during World War II—the planned application of scientific research to develop new products on a foreseeable schedule—provides much of the support for the authors' conclusions.

Literature of

MATERIALS

Dielectric Materials. Emerson & Cuming, Inc., Canton, Mass. A colorful chart gives properties of dielectric materials at microwave frequencies over a wide range of dielectric constant and dissipation factor.

CIRCLE 360 ON READER SERVICE CARD

Magnetostrictive Ferrites. Kearfott Co., Inc., 1500 Main Ave., Clifton, N.J. A 14-page booklet covers magnetostrictive ferrites for transducer applications.

CIRCLE 361 ON READER SERVICE CARD

COMPONENTS

Pulse Transformers. Technitrol Engineering Co., 1952 E. Allegheny Ave., Philadelphia 34, Pa., has published three new technical brochures to help circuit design engineers accurately specify the design of low power pulse transformers.

CIRCLE 362 ON READER SERVICE CARD

Variable Fixed Attenuator. Waveline Inc., Caldwell, N. J. A single-page bulletin covers the type 609 shielded, rugged, lightweight, inexpensive variable fixed attenuator.

CIRCLE 363 ON READER SERVICE CARD

Tantalum Capacitors. Mallory Capacitor Co., Indianapolis 6, Ind. A 16-page catalog contains complete information on 15 different types of solid, foil and sintered anode tantalum capacitors.

CIRCLE 364 ON READER SERVICE CARD

EQUIPMENT

Equipment Carts. Northeastern Engineering, Manchester, N. H. A data sheet lists prices and condensed specifications of different models of scope and test equipment carts.

CIRCLE 365 ON READER SERVICE CARD

Power Control Units. Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y. A line of power control units utilizing mag-

the Week

netic gating amplifiers driving silicon controlled rectifiers is described in bulletin S-1075.

CIRCLE 366 ON READER SERVICE CARD

Digital Frequency Meters. Kay Electric Co., Maple Ave., Pine Brook, N. J. A mailing piece fully describes direct-reading digital frequency meters which cover the spectrum from 1.1 to 18.0 kmc in 9 models.

CIRCLE 367 ON READER SERVICE CARD

Frequency Response Sliderule. Boonshaft and Fuchs, 994 Byberry Road, Huntingdon Valley, Pa. Technical bulletin 81407 describes a new direct reading frequency response sliderule.

CIRCLE 368 ON READER SERVICE CARD

Computer Typewriter. Bendix Computer Division, 5630 Arbor Vitae St., Los Angeles 45, Calif., has issued a single-page data sheet describing its new alphanumeric typewriter used in conjunction with the Bendix G-15 digital computer.

CIRCLE 369 ON READER SERVICE CARD

Digital Tape Transport. Data-Stor, a division of Cook Electric Co., 8100 Monticello, Skokie, Ill., has published a bulletin on the model 59 digital tape transport which is suited for use in computer, instrumentation and control applications.

CIRCLE 370 ON READER SERVICE CARD

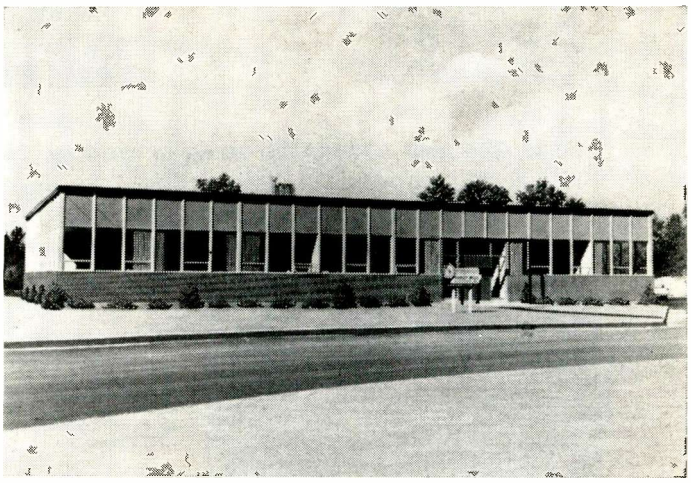
FACILITIES

Environmental Testing. Tele-Dynamics Inc., 5000 Parkside Ave., Philadelphia 31, Pa. The complete environmental test facilities located at the company's plant are covered in bulletin 859.

CIRCLE 371 ON READER SERVICE CARD

Construction Services. Panellit Service Corp., 7401 No. Hamlin Ave., Skokie, Ill., offers a 16-page brochure illustrating and describing its complete installation through start-up service for automation and instrumentation systems.

CIRCLE 372 ON READER SERVICE CARD



Harvey-Wells Expands R&D

THE RESEARCH AND DEVELOPMENT DIVISION of Harvey-Wells Electronics, Inc., now occupies a new building in the East Natick (Mass.) Industrial Park, reports Richard A. Mahler, president of the New England electronics firm.

Situated about 15 miles west of Boston in a recently-created industrial development area, the new facility will contain research, engineering, manufacturing and marketing offices of the expanding R&D division.

"Increasing demand and sales of both high-speed digital computer components and nuclear magnetic resonance equipment have made expansion necessary," Mahler says.

In addition to digital building block components, this division markets a line of precision gaussmeters, nuclear magnetic field control equipment and high-resolution magnets.

The new facility, which will afford expanded manufacturing space, is designed to accommodate production of the new magnet line. Some high-resolution magnets weigh up to five tons and require exacting production and testing techniques.

Designed into the plant layout are demonstration and consultation rooms where customers can actually operate Harvey-Wells equipment, and discuss their specific engineering problems with the firm's engineers.

The company founded in 1940, is one of New England's earlier electronics firms. It joined the Whitin Machine Works in 1957. This merger enabled the electronics firm to manufacture heavy equipment for its expanding markets.

The Research and Development Division founded in 1957, has enabled the company to broaden considerably its product mix. The division is convenient to MIT, Harvard and other centers, placing supplemental research and consultation within easy access.

Phillips Takes New Post

R. ANDREW PHILLIPS has joined Trans Electronics, Inc., Canoga Park, Calif., as sales manager.

In joining the company, he leaves Osborne Electronics, Inc., Hawthorne, Calif. Prior to this, he was on the sales staff at Servomechanisms, Inc., also in Hawthorne.

In his new post, Phillips will be responsible for the expansion of sales of an already established power supply line, and instruments for testing transistors and diodes, in addition to introducing the company's growing capabilities in the inverter and converter field.

Goldsmith Heads Nytronics Inc.

THE BOARD of directors of Nytronics Inc., Berkeley Heights, N. J., has announced the appointment of Bernard M. Goldsmith as president. The corporation manufactures custom built and stock delay lines, r-f chokes, coils, transformers, and electromechanical devices.

Goldsmith was formerly president of Essex Electronics, a post he held from 1943 until now.

Leavitt Joins Burnell Staff

MICHAEL LEAVITT recently joined the staff of Burnell & Co., Pelham,

FREE BULLETIN...
TURN TRASH INTO CASH

Just produced by Handy & Harman—this new Refining Bulletin describes the great cash potential in precious metals industrial waste . . . lists many possible sources. Types and forms of refinings are illustrated photographically and described in text. Equally important, the bulletin calls attention to the fact that much of industry's valuable waste is truly wasted.

For your free copy of this new and cash-provoking bulletin, write to Refining Division, Handy & Harman, 82 Fulton Street, New York 38, N. Y. Your biggest dividend will come when you send a refining lot to Handy & Harman and see for yourself the cash benefits you get from the country's leading refiner of precious metals waste.

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

Refining Plants & Collecting Stations:

Bridgeport 1, Conn.

Chicago 22, Ill.
1900 W. Kinzie Street

Providence 3, R. I.
425 Richmond Street

El Monte, Calif. (Los Angeles)
330 North Gibson Road

New York 38, N. Y.
82 Fulton Street

Toronto 2B
141 John Street

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

N. Y., as supervisor of operations.

Prior to taking his new post, he had been with Laboratory for Electronics eight years as a manager of the reliability group in charge of materials and processing. Leavitt has also served on the standards engineering staff of the Raytheon Co. and as plant manager for Electrolab.

Plant Briefs

Wallson Associates, Inc., recently moved to new quarters in Elizabeth, N. J. The new 13,000 sq ft building expands the company's facilities for design, development and manufacture of its complete line of semiconductor test equipment, power supplies, and high vacuum exhaust equipment.

International Radiant Corp., manufacturer of environmental test equipment has moved from Westbury, N. Y., to new expanded quarters in New York City.

Hazeltine Research Corp., a research subsidiary of Hazeltine Corp., is opening a new research and development center in Plainview, L. I., N. Y. Plans call for engineers and administrative personnel to move into the new facility during November and December.

Kahn Research Laboratories, Inc., recently moved to new, larger office and plant facilities in Freeport, N. Y.

Kearfott Co., Inc., Little Falls, N. J., has opened new engineering, sales and service offices in Cambridge, Mass.

Hannibal Glass Products, Santa Ana, Calif., is a new company manufacturing precision drawn glass tubing and rod primarily for electronic applications.

Three of the member companies of the Nytronics Group, formerly operating under individual identities, were recently united and are now called **Nytronics, Inc.** The three companies were formerly named Essex Electronics, Berke-

ley Heights, N. J.; Essex Electronics of Canada, Trenton, Ontario; and Sutton Electronics, Lexington, Ky.

News of Reps

Conway Electronics Enterprises of Toronto, Canada, has been appointed to represent Acton Laboratories Inc., Acton, Mass., in Canada.

Roy H. Cooley Associates, Seattle, Wash., has been appointed manufacturer's rep for Washington and Oregon by Task Corp., Anaheim, Calif.

Appointment of **Elliott-Sarles Co.,** Westlake, Ohio, as sales rep for systems components in Ohio, Michigan, and western Pennsylvania is announced by the Systems Division of Beckman Instruments, Inc., Anaheim, Calif.

Menlo Park Engineering, Menlo Park, Calif., manufacturer of microwave instrumentation, has named **Airep Engineering Co.** of Dallas as sales rep in the Texas, Oklahoma, Arkansas, and Louisiana area.

McCarthy Associates, Inc., Pasadena, Calif., is named to represent Cubic Corp., San Diego, Calif., and Wayne Kerr Corp., Philadelphia, Pa. Rep firm will handle sales of Cubic's digital instruments in southern California, Arizona and Nevada, and a complete line of precision electronic instruments for Wayne Kerr in California, Arizona and Nevada.

William Menezes has joined the sales staff of **Hutmacher Associates, Inc.,** electronic rep firm covering the Illinois-Wisconsin territory. He was formerly in the marketing division of Allied Radio Corp., Chicago, Ill.

Scientific Sales Engineering Co. has opened a new divisional office in Huntsville, Ala. This brings the rep firm's total number of offices to five. Others are in St. Petersburg and Orlando, Fla.; Winston-Salem, N. C.; and Atlanta, Ga.

COMMENT

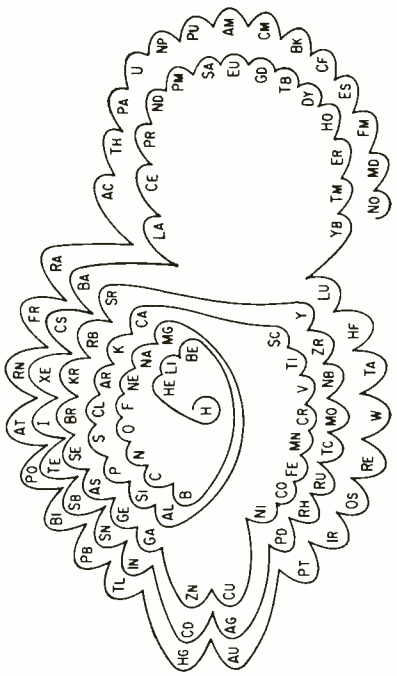
Polar Periodic Table

While attending a "Continental Classroom" lecture earlier this year, I thought it a gesture of resigned futility when Professor White laid aside a piece (the lanthanide and actinide series) broken out of the Mendelev table.

Then and there the inspiration struck me that I must experiment with making a new look for the table. The sketch here shows the result of my efforts.

ESTEN MOEN
CROOKSTON, MINN.

For another version of a Mendelev periodic table, see the cover of our July 17 issue. Best we can do with reader Moen's version is to print it sidewise; to wit:



The Communications Special

In the Oct 23 issue of ELECTRONICS there is an article (on p 93) entitled "Modern Communications Methods," by your associate editor Samuel Weber.

I should like to congratulate Mr. Weber on a most outstanding article. This department will furnish each of the 12 instructors who teach communications electronics an individual copy of this article . . .

MAJ. H. A. SCHULKE JR., SIGC
U. S. MILITARY ACADEMY
WEST POINT, N. Y.

Magnetic-Core Counter

(Ref. "Magnetic Core Operates Counter," in Research & Development, p 130, Oct. 23) . . . the story in print looks very good, but apparently the gremlins were at work at the printing plant. It looks as if one line of the byline was omitted. Unfortunately, this is the line containing the name of this company. In its present form, we have a fictitious company name in the byline.

Can you arrange to publish a correction notice in a subsequent issue? This has important legal implications since, as the item appears in print, the work is not credited to IBM . . .

Furthermore, in Fig. 1 the emitter of the transistor should appear at the bottom rather than at the top as shown . . .

RONALD K. JURGEN
INTERNATIONAL BUSINESS MACHINES
NEW YORK

Reader Jurgen knows his type. The byline should have read:

By E. H. Sommerfield, Product Development Lab., International Business Machines Corp., Endicott, N. Y.

One line dropped out—the second line—and then there was trouble.

Radar Fishfinder

The enclosed clipping (from *Newsday* Oct. 7 '59) concerns an important use of radar aboard our 40-ft sports fisherman *Knickerbocker's Pacemaker.*

The brewery uses this craft to further the cause of marine recreation and makes daily trips during the season to the best fishing spots in the four-state area which our Knickerbocker Salt Water Fishing Contest covers: New York, New Jersey, Connecticut and Rhode Island.

Your readers might be interested in hearing the use to which our Capt. Walter Drobecker puts his radar unit . . .

CY MANN
JACOB RUPPERT CO.
NEW YORK

We were interested, too. The skipper uses his radar unit to find fish. He can pick up marlin-size fish on the surface, can also detect white-water tide rips wherein lurk blues, pollack and stripers.

Job Security in a Dynamic Industry . . .

SENIOR ELECTRONICS ENGINEER

you: B.S.E.E. with at least 5 years experience in instrumentation and electronic equipment used in chemical, paper, or plastics industries. Looking for secure position with excellent growth potential.

the job: Primary responsibility design and development of electronic equipment at project level. Occasional travel. Will evaluate new plastic films on packaging equipment. Chicago is home base.

the future: Secure with excellent opportunity for recognition and advancement. Will grow with THE pioneer of the industry. All large company benefits plus advantages of a small group atmosphere.

resume to:

W. P. Engelking

VISKING COMPANY

DIVISION OF UNION CARBIDE CORP.

6733 West 65th Street Chicago 38, Illinois

REliance 5-1234

ENGINEERS

Interested in Becoming a Speciolist in

PRECISION ROTATING COMPONENTS?

Ketay Department offers immediate opportunities in Design and Developments of:

SYNCHROS & RESOLVERS
MOTORS & TACHOMETERS
TRANSISTORIZED AMPLIFIERS

U. S. Citizenship Required

If you take pride in fine engineering, and are looking for an opportunity to grow professionally, contact KETAY

Send your resume to:

TECHNICAL PERSONNEL DEPT.

KETAY DEPT
NORDEN DIVISION
UNITED AIRCRAFT CORP.

Jericho Tpke & Larkfield Road
Commack, Long Island, New York

ELECTRICAL ENGINEERS

Challenging positions open for high caliber Electrical Engineers with some experience to work in interesting research and development programs in instrumentation and circuitry.

We offer you an opportunity to do non-routine research and use your initiative and creative ability.

Excellent employee benefits, including liberal vacation policy and tuition-free graduate study. Please send resume to:

E. P. Bloch
ARMOUR RESEARCH FOUNDATION
of Illinois Institute of Technology
10 West 35th Street
Chicago 16, Illinois

ENGINEERS

for

COMMERCIAL CONSUMER PRODUCT DESIGN

Diversified Development Programs

Move up to New Levels of professional achievement with **GRAFLEX**

Permanent positions with unusual opportunities for personal recognition and growth are offered to qualified applicants with B.S., E.E. and with experience in one or more of the following areas:

AMPLIFIER DESIGN
Vacuum Tube or Transistor

MAGNETIC RECORDING SYSTEMS

SERVO SYSTEMS

ELECTRONIC FLASH
Including Transistor Power Supplies

Opportunity for Post Graduate study at University of Rochester

Will also consider men who have had mainly military design experience

You'll enjoy the pleasant environment and conditions in our brand new completely equipped plant, located on 50 acres of scenic land, minutes from downtown Rochester.

Liberal benefits and comprehensive retirement plan

Send complete resume including salary requirements to
MR HERBERT WATKINS

GRAFLEX, Inc.
3750 Monroe Ave.
Rochester, New York

Since 1887 synonomous with the finest photographic and precision equipment

---

SECTION HEAD . . . $18,000

Will be responsible for design & acceptance of Communications eqpt. Will assist Chief Eng. in administration of all projects. B.S.E.E. min. 3 or more years exp. in above will warrant an interview. Client location ideal. Agency fee, interviewing and moving expenses paid by client. Send resume in complete confidence.

ESQUIRE PERSONNEL
202 State St. Chicago 4, Ill.

TECHNICAL DIRECTOR—$25,000

Plan and coordinate the work of scientists, engineers and technicians in fast expanding firm with solid financial background. R&D in advance military electronics of the most challenging nature. Profit sharing.

MONARCH PERSONNEL
28 E. Jackson Chicago 4, Illinois

POSITION VACANT

Electronics Engineer, design, development or sales. Good opportunity for advancement. Send resume to AD-YU Electronics, 249 Terhune Ave., Passaic, New Jersey.

EMPLOYMENT SERVICE

Engineers—Write today for job opportunities —Mid-West. Baker Employment, Decatur, Ill.

SELLING OPPORTUNITY WANTED

Offering to represent manufacturer of industrial electronics or electromechanical components. Expert facilities and personnel including servicing in N. Y. metropolitan area. RA-3007, Electronics. Class. Adv. Div., P.O. Box 12, N. Y. 36, N. Y.

Need Engineers?

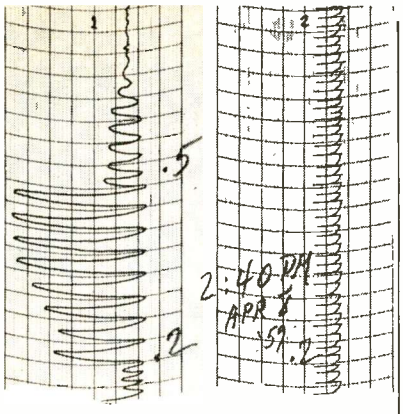
Contact them through this

EMPLOYMENT OPPORTUNITIES section

INDEX TO ADVERTISERS

● See advertisement in the June, 1959 Mid-Month ELECTRONICS BUYERS GUIDE for complete line of products or services.

● See advertisement in the June, 1959 Mid-Month ELECTRONICS BUYERS GUIDE for complete line of products or services.



Recorded Events,

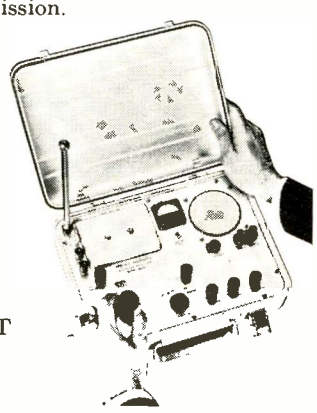
only when referred to

Time...

have significance!

...and with today's accelerating technology, the need for the most accurate time reference available becomes more acute. It *is* available ...and free; the standard time and frequency transmissions of the National Bureau of Standards radio stations WWV and WWVH are accurate to better than 1 part in 50 million and are placed at the disposal of anyone having a receiver capable of tuning to one or more of the transmitting frequencies.

The new Model WWVT receiver, designed especially for remote operations under extreme environmental conditions, is a highly-sensitive crystal-controlled instrument capable of utilizing WWV and WWVH transmission.



Model WWVT

A 6-position dial switches *instantly* to any Standard Frequency — 2.5, 5, 10, 15, 20 or 25 mc. It is small, light-weight and rugged — sealed metal case and potted components, all transistorized and battery operated, and has better than 2 mv sensitivity. Priced at $545.00

Send for bulletin #159A which details many free services available from WWV & WWVH.

SPECIFIC PRODUCTS
Box 425, 21051 Costanso, Woodland Hills, Calif.

ADVERTISERS INDEX

● See advertisement in the June, 1959 Mid-Month ELECTRONICS BUYERS GUIDE for complete line of products or services.

ARE YOU MAKING THE SAME MISTAKE IN DEPOSITED CARBON RESISTORS?

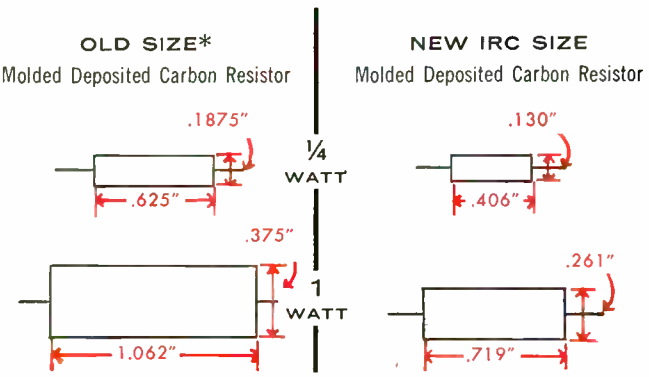
Switch to IRC Molded Deposited Carbon Resistors—"PRE-SHRUNK" for miniaturization.

If you have anything to do with miniaturizing components, be prepared for a pleasant surprise.

IRC has reduced the size of Molded Deposited Carbon Resistors in the 3 most popular wattage ratings at the same ambient, an improvement made possible through the use of a unique IRC alloy film and a new high-temperature coating.

This means that you can now choose a smaller unit with wattage equivalent to the one you formerly specified. Weight and space savings, as it happens, are especially significant in the most-used sizes.

COMPARE



*MIL NOMINALS

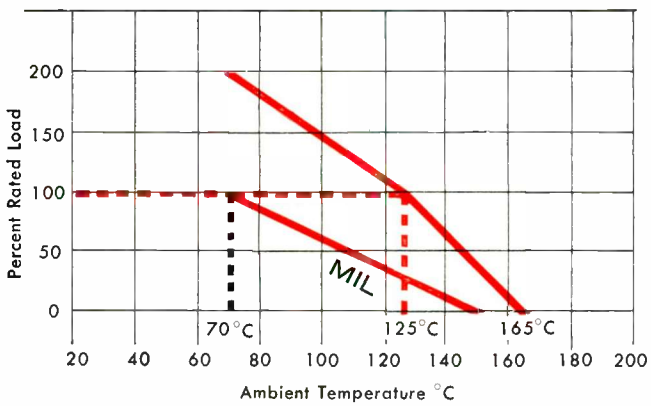
These SIZE REDUCTIONS also result in nearly corresponding weight reductions.

MIL Type	IRC Type	Length Nominal	Diam. Nominal	Min. Ohms	Max. Ohms	Max. Volts Continuous	WATTAGE MIL 70°C	WATTAGE IRC 70°C	WATTAGE IRC 125°C
RN60	MDA	.406	.130	10	5M	300	⅛	¼	⅛
RN65	MDB	.594	.203	10	5M	350	¼	½	¼
RN70	MDC	.719	.261	5	25M	500	½	1	½

IRC EXCEEDS MIL SPECIFICATIONS

IRC Resistors are designed for MIL-R-10509C Characteristic B requirements.

DERATING CURVE FOR IRC MOLDED RESISTORS



IRC HAS GREATER LOAD LIFE RESERVE

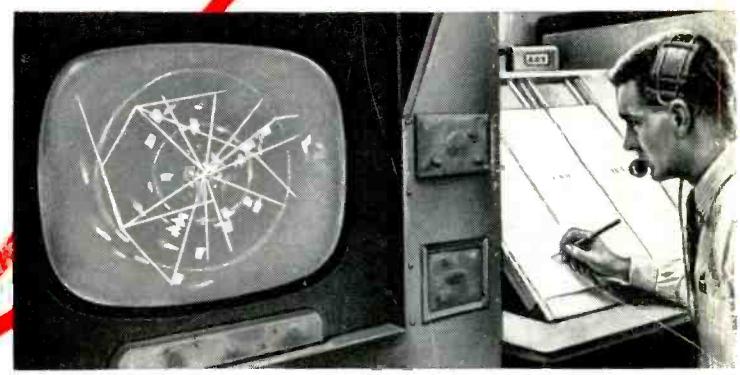
IRC Molded Deposited Carbon Resistors exhibit excellent heat dissipating characteristics. Size for size, IRC Resistors will run cooler under any load condition and take sudden overloads with very low permanent change. Load life is superior to that of hermetically sealed resistors which cost three times as much!

IRC HAS DOUBLE-BARRIER INSULATION

Resistance element is coated with a moisture-resisting material, then encased in a molded, break-resistant dielectric case which, though heavy-duty, is well within MIL size.

Write for Bulletin B-9C

INTERNATIONAL RESISTANCE CO., Dept. 379, 401 N. Broad St., Phila. 8, Pa. • *In Canada:* International Resistance Co., Ltd., Toronto, Licensee



New RCA Scan-Conversion Tube

Makes Possible Brighter and Larger Air-Traffic-Control Displays

Once again RCA Tube Engineers have provided another practical answer to the long-standing problem of large-screen radar display in brightly lighted rooms. The answer . . . RCA-7539 Scan-Conversion Tube.

The 7539 is designed to transform signal information continuously from one time base to another. For example, PPI information generated by a conventional radar system can be processed by this tube for display on a high-resolution, large-screen TV monitor for comfortable viewing in a brightly lighted room.

Depending on system requirements, the persistence of information in the display is adjustable from several seconds to more than a minute. Moreover, writing and reading may take place simultaneously without recourse to rf carrier techniques of signal separation.

The resolution capability of the 7539 is 150 range rings per display radius with a response of 50% or better. To utilize fully the resolution capability of the 7539, the TV monitor system must be designed for resolution in excess of 1000 TV lines.

For complete information about RCA-7539 and its possible applications, contact the RCA Field Office nearest you. Technical bulletin for the 7539 will be available about January 15. For a free copy, write RCA Commercial Engineering, Section K-19-Q-3, Harrison, N. J.

ANOTHER WAY RCA SERVES YOU THROUGH ELECTRONICS

RADIO CORPORATION OF AMERICA *Electron Tube Division* *Harrison, N. J.*

Government Sales: **Newark** 2, N.J., 415 S. Fifth St., HUmboldt 5-3900; **Dayton** 2, Ohio, 224 N. Wilkinson St., BAldwin 6-2366; **Washington** 6, D.C., 1625 "K" St., N.W., DIstrict 7-1260
Industrial Tube Products Sales: **Newark** 2, N. J., 744 Broad Street. HUmboldt 5-3900; **Detroit** 2, Mich., 714 New Center Building, TRinity 5-5600; **Chicago** 54, Ill., Suite 1154, Merchandise Mart Plaza, WHitehall 4-2900; **Los Angeles** 22, Calif., 6355 E. Washington Blvd., RAymond 3-8361