

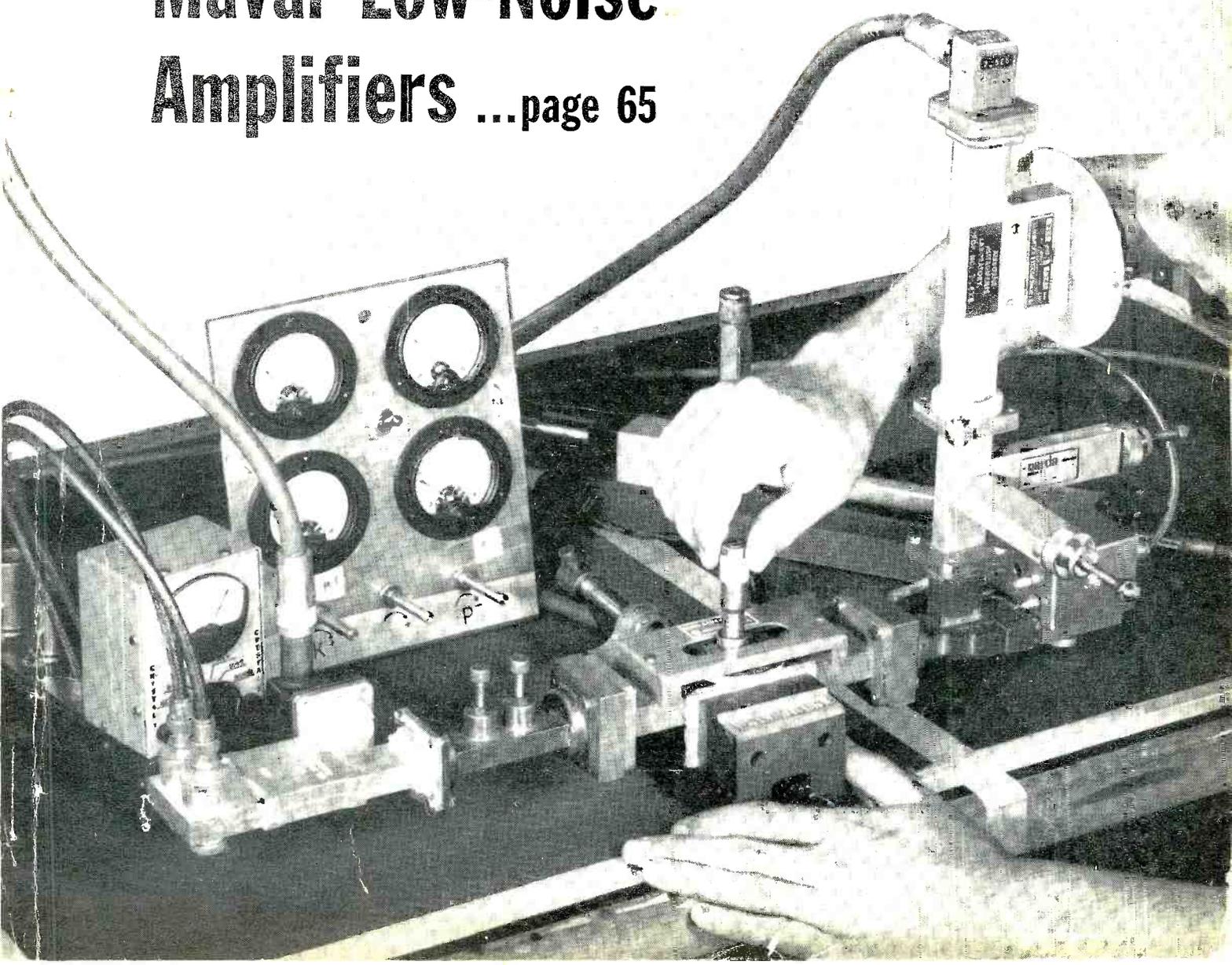
electronics

engineering issue

Detecting Flaws in Wire...p 72

High-Speed Printing...p 74

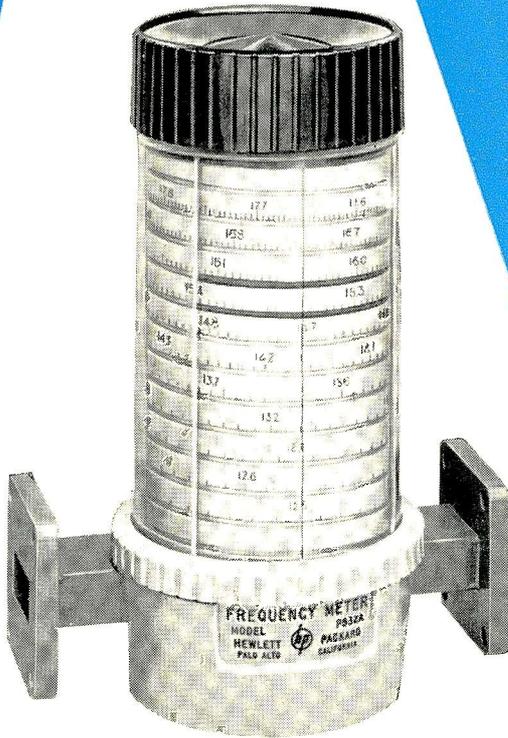
**Mavar Low-Noise
Amplifiers ...page 65**



New! Low cost! Fresh design approach!

Direct-Reading FREQUENCY METERS

8.2 to 40.0 KMC



A completely new engineering approach enables the new *-hp-* 532A series Frequency Meters to provide you with low cost, direct-reading convenience and dependability not previously available in a microwave frequency meter.

These new general-purpose test instruments avoid the out-moded and error-prone sliding contact design. Instead, the 532A series employs a high Q resonant cavity (TE₁₁₁ mode) tuned by a choke plunger. The cavity is mounted on a special wave-guide section designed so that a very small amount of power is reflected at resonance, while the major portion is transmitted. Reaction at resonance is virtually constant full range; there are no spurious modes or resonances; resonance is indicated by a dip of approximately 1.5 db in output. Scale divisions 5 MC apart insure a high order of resolution. Tuning is by a precision lead screw springloaded to eliminate backlash. Four separate models covering the X, P, K and R bands (see table) are offered.

HEWLETT-PACKARD COMPANY

4871A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
CABLE "HEWPACK" • DAVENPORT 5-4451
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

SPECIFICATIONS

	X532A	P532A	K532A	R532A
Accuracy:	0.08%	0.1%	0.1%	0.2%
Frequency range, KMC:	8.2 to 12.4	12.4 to 18.0	18.0 to 26.5	26.5 to 40.0
Waveguide size, inches:	1" x 1/2"	0.702" x 0.391"	0.5" x 0.25"	0.36" x 0.22"
Resetability:	0.01%	0.01%	0.01%	0.01%
SWR at resonance (approximate):	1.3:1	1.3:1	1.3:1	1.3:1
Price:	\$150.00	\$210.00	\$230.00	\$250.00

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

4871



offers complete coverage in microwave measuring equipment

electronics engineering issue

A MCGRAW-HILL PUBLICATION • VOL. 31, NO. 39 • SEPTEMBER 26, 1958

H. W. MATEER, *Publisher*

JAMES GIRDWOOD, *Associate
Publisher*

W. W. MacDONALD, *Editor*

Managing Editor, John M. Carroll.

Feature Editor, John Markus.

Associate Editors: John M. Kinn, Jr., Frank Leary, Michael F. Tommaino, Howard K. Janis, Sylvester P. Carter, Haig A. Manoogian, Roland J. Charest, William P. O'Brien, George Sideris, Edward DeJongh, John F. Mason, William E. Bushor, Ronald K. Jurgen, Thomas Emma, Patrick J. Lohey, Samuel Weber.

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

Art Director, Harry Phillips, Roy Thompson.

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

Research, Charles B. Graham, Marilyn Koren.

Editorial Assistants: Gloria J. Filippone, Arlene Schilp, Patricia Landers, Catherine McDermott.

JAMES GIRDWOOD, *Advertising Sales Manager, R. S. Quint, Assistant Advertising Sales Manager and Buyer's Guide Manager. Fred Stewart, Promotion Manager. Frank H. Ward, Business Manager. George E. Pomeroy, Classified Manager. Hugh J. Quinn, Acting Circulation Manager.*

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

Issue at a Glance

Low-Noise Mavar. Junction diode is used as a nonlinear capacitance to achieve wide-band, low-noise microwave amplification. This is one of three types of experimental devices using the principles of parametric or reactance amplification. See p 65. **COVER**

Business Briefs **p 7**

Electronics Newsletter	7	Costs of R&D Increase 4%	14
Figures of the Week	7	Military Electronics	14
More Process Controls	8	Radio Eases Tunnel Traffic	14
Numbers Run New System	8	Electronics Probes Missile's Fluids	16
Latest Monthly Figures	8	Financial Roundup	16
Railroads Laud Electronics Uses	12	Directing New Street Lights	16
Wavy Whiskers	12	Buy 1,385 New Players for Blind	18
Washington Outlook	12	Floating Control Booth	18
Meetings Ahead	18		

The Mavar: A Low-Noise Microwave Amplifier. New developments exploiting the principles of parametric or reactance amplification promise to expand microwave horizons. **p 65**
By Samuel Weber

Detecting Invisible Flaws in Wire. High-sensitivity eddy-current instrument reveals surface or internal cracks or voids smaller than 0.001 inch when wire is run through probe coil. **p 72**
By R. G. Myers and C. J. Renken

Electron Gun Operates High-Speed Printer. Light images from shaped-beam crt form alphabetic and numeric characters which are converted to printed records at high speed by dry-printing technique. **p 74**
By Joseph T. McNaney

Designing Transistor D-C/A-C Converters. Nomographs facilitate determination of circuit parameters for transistorized, magnetic-core d-c/a-c converters **p 78**
By Stanley Schenkerman

Broad-Band Amplifier for Radar and Scatter. Two-stage low-noise amplifier and mixer, designed for minimum noise figure, uses tubes in a cascaded grounded-grid circuit **p 81**
By J. H. Phillips and E. Maxwell

DIGEST CONTINUED ON NEXT PAGE

Stop-Go Scanning Saves Spectrum Space. Nonuniform scanning saves spectrum bandwidth by making use of the fact that picture areas of uniform black or white contain no information except that represented by location of their boundaries. p 84
By Harold E. Haynes and Donald T. Hoger

Radio System Calculator. Communication system characteristics can quickly be found from parallel-scale nomograph. p 89
By J. J. Logan

Electrons At Work p 92

- | | |
|--|---|
| Night Vision Unit Uses Starlight. 92 | Control for Filament Supply. 94 |
| Transistor Tester 92 | By John T. Keefe |
| By J. M. Tewksbury | Sky Path Display. 98 |

Component Design p 100

- | | |
|--|---|
| Three-Microsec Static Relay. 100 | Radio Has Fan-Type Design. 102 |
| Artificial Dielectrics 100 | Logic Modules Speed Programming. . 104 |
| Crystal Gives Low-Cost Stereo. 102 | Papers for Components Conference. . 105 |

Production Techniques p 106

- | | |
|---|---|
| Probe Measures Diffusion Depth. 106 | Etchant Handles Several Plates. 109 |
| By M. Beliveau | Fluidized Resin Coats Hot Parts. . . . 111 |

New Products p 112

Literature of the Week p 132

Plants and People p 134

New Books p 141

Comment p 145

Index to Advertisers p 150

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

Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y. Longacre 4-3000.

Publication Office 99-129 North Broadway, Albany 1, N. Y. See panel below for directions regarding subscription 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 Bond, Executive Vice President, Publications Division; Ralph B. Smith, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

Single copies \$1.00 for Engineering Issue and 50¢ for Business Issue in United States and possessions, and Canada; \$2.00 and \$1.00 for all other foreign countries. Buyers' Guide \$3.00. Subscription rates—United States and possessions, \$6.00 a year; \$9.00 for two years; \$12.00 for three years. Canada, \$10.00 a year; \$16 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 mail privileges authorized at Albany, N. Y. Printed in U.S.A. Copyright 1958 by McGraw-Hill Publishing Co., Inc.—All Rights Reserved. Title registered in U. S. Patent Office. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11; 68 Post Street, San Francisco 4; McGraw-Hill House, London E. C. 4; 15, Landgrat-Wilhelm, Frankfurt Main; National Press Bldg., Washington 4, D. C.; Six Penn Center Plaza, Philadelphia 3; 1111 Henry W. Oliver Bldg., Pittsburgh 22; 55 Public Square, Cleveland 33; 856 Penobscot Bldg., Detroit 26; 3615 Olive St., St. Louis 8; 350 Park Square Bldg., Boston 16; 1321 Rhodes Haverty Bldg., Atlanta 3; 1125 West Sixth St., Los Angeles 17; 1740 Broadway, Denver 2. ELECTRONICS is indexed regularly in The Engineering Index.

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

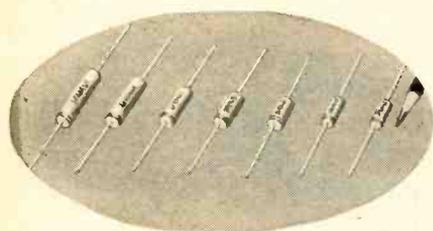
Postmaster: please send form 3579 to Electronics, 330 W. 42nd St., New York 36, N. Y.



Member ABP and ABC

TAKE YOUR PICK FROM . . . THE SPRAGUE TRANSI-LYTIC* FAMILY

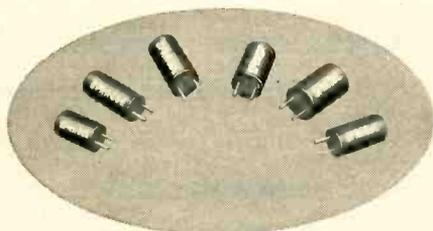
of **tiny** electrolytic capacitors
for every requirement in entertainment electronics . . .
pocket radios, wireless microphones, miniature tape
recorders, auto receivers



LITTL-LYTIC* CAPACITORS

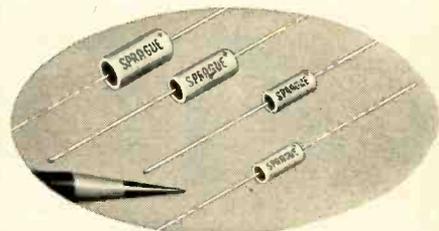
Sprague's new Type 30D hermetically-sealed aluminum-encased capacitors are the *tiniest* electrolytic capacitors made to date . . . and their performance is better than ever. Their remarkable reliability is the result of a new manufacturing technique in which *all the terminal connections are welded. No pressure joints . . . no "open circuits" with the passage of time.* And check this for ultra-low leakage current: for a 2 μf , 6 volt capacitor . . . only 1.0 μa max.; for a 300 μf , 6 volt capacitor . . . 3.5 μa max.! Engineering Bulletin No. 3110 gives the complete story. 85°C standard.

*Trademark



VERTI-LYTIC* CAPACITORS

These space-saving Type 89D 'lytics are designed for easy manual upright mounting on printed wiring boards. Keyed terminals assure fast mounting and correct polarity. No reworking on the assembly line. Sturdy pre-molded phenolic shell with resin end-fill gives excellent protection against drying-out of the electrolyte or the entry of external moisture. The phenolic case eliminates the necessity for additional insulation. Reasonably priced for mass production receivers. Engineering Bulletin No. 3060 lists standard ratings with performance data.



Cera-lytic* CAPACITORS

The ideal capacitor for applications where low cost is the primary consideration is Sprague's new Type 31D. Capacitor sections are housed in a dense steatite tube with resin end-fill to provide protection against mechanical damage and atmospheric humidity. This construction results in excellent capacitor performance for all miniature electronic circuits. Size for size, they're the smallest the industry has produced in a ceramic-cased aluminum electrolytic. Engineering Bulletin No. 3010 details standard ratings and gives performance data.

FOR ENGINEERING BULLETINS on the industry's first complete line of subminiature aluminum electrolytic capacitors, write Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

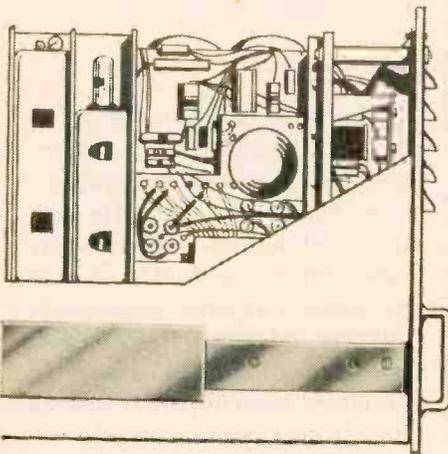
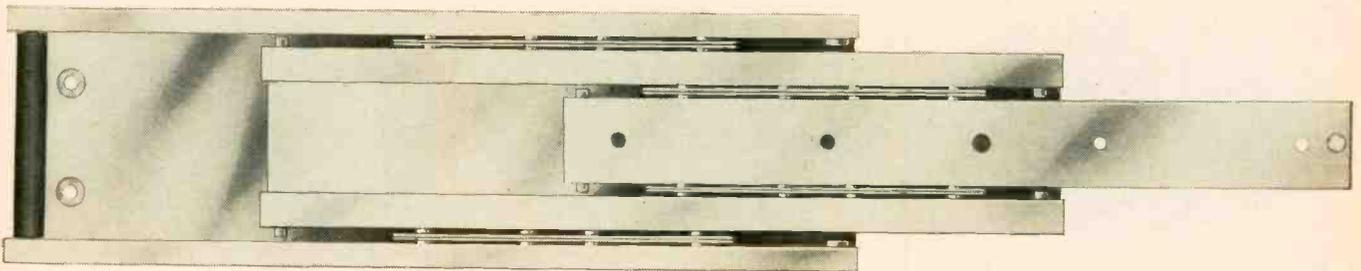


SPRAGUE COMPONENTS:

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

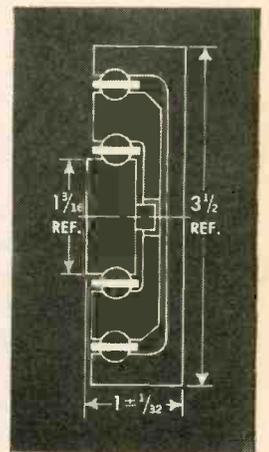
GRANT'S NEW

SLIDE

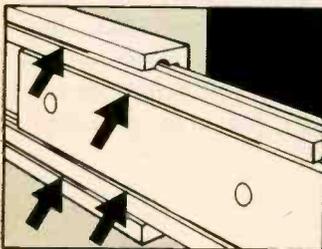


Newest of the Grant Industrial Slides. With reasons to specify a'plenty! The 4000 Slide has been subjected to the most rigorous shock, vibration, spray and life tests — and more than qualified in each category.

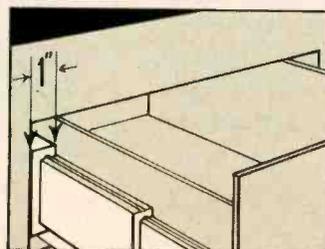
If you need a clear anodized aluminum, ball bearing slide, which is corrosion-resistant, and requires only 1" side space for up to 350 lb. load capacities yet is lightweight and structurally rigid and available in lengths from 10" to 40"—you'd do well to investigate Grant's 4000 Slide — latest product of the nation's leading slide manufacturer.



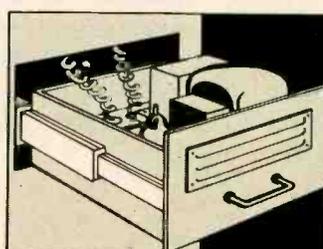
HALF SIZE SECTION



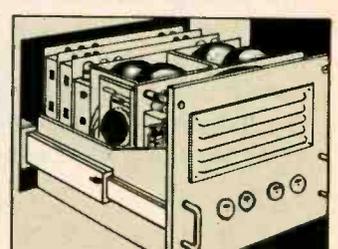
Precision-broached aluminum channels, with stainless steel balls results in smooth, silent action.



Only 1" of side-space required yet 350 lb. load carried efficiently and safely.



Full extension of sliding unit — all parts exposed for immediate servicing and maintenance.



Light, yet strong and durable, Grant 4000 slides can appreciably help your servicing and maintenance job.

Grant Industrial Slides are equipped with patented self-retaining ball spacers

We'll be happy to send you full data on the new 4000 Slide.



GRANT INDUSTRIAL SLIDES

Grant Pulley & Hardware Corporation • 23 High St., West Nyack, N. Y. • 944 Long Beach Ave., Los Angeles 21, Cal.

new High Current DC Supplies



Fast Response... High Amps... External Sensing

Model MA28-125

Output: 28 VDC nominal at 125 amps.
Regulation accuracy of $\pm 0.2\%$.
Ripple: $< 1\%$ RMS.
Response time: < 0.1 second.
Choice of input voltage: 208, 230,
or 460 VAC, 3-phase.
Weight: 225 pounds.
\$1160 in cabinet.*

Model MR36-30

Output current, 0-30 amps, output
voltage, 5 to 36 VDC continu-
ously adjustable with regulation
 $\pm 0.25\%$ against line or load
change.

Response time of 0.2 second.
Input voltage: 105 to 125 VAC,
single-phase.

Weight: 175 pounds.
\$890 in cabinet.

Also supplied, as Model MR36-15,
with output current 0-15 amps,
otherwise similar.
Weight: 100 pounds.
\$495 in cabinet.

*250 AND 500 AMP.
MODELS NOW AVAILABLE

Two new high output power-packs—with response time ranging from 0.2 second down, and with transistorized power reference and magnetic amplifier power control circuits for trouble-free performance—that's just part of the story on these Sorensen DC power supplies.

One model supplies an output of 18 to 36 VDC at 125 amperes; the other provides 5 to 36 VDC at 0 to 30 amps.

Zener diode reference circuit assures sharper regulation, and the external sensing provision puts this precise control at the load. Silicon power rectifiers and complete tubeless design increase durability with reduction in weight—and greater saving in size.

Get the full story from your Sorensen representative.

Or write for technical data.



CONTROLLED POWER FOR RESEARCH AND INDUSTRY

SORENSEN & COMPANY, INC.
Richards Avenue, South Norwalk, Connecticut

In Europe, contact Sorensen-Ardag, Eichstrasse 29, Zurich, Switzerland, for all products including 50 cycle, 220 volt equipment

YOUR COMPUTER DESIGNS ARE BETTER
 YOUR COMPUTERS PERFORM BETTER
 when you draw from this comprehensive
 range of



RELIABLE

COMPUTER TRANSISTORS

Raytheon PNP Germanium Fusion-Alloy Computer Transistors are approved for military applications. They provide:

- H_{FE} control at high currents
- High voltage ratings
- Fast switching speed
- Low saturation resistance
- Temperature range -65°C to $+85^{\circ}\text{C}$

ONE AMPERE, HIGH FREQUENCY, HIGH GAIN SWITCH

JEDEC-30 Type	Punch through Voltage min.	$f_{\alpha b}$	H_{FE1}	H_{FE2}	I_{CO}	r_b'	C_{ob}
		ave. Mc	ave. $I_B = 1 \text{ mA}$ $V_{CE} = -0.25 \text{ V}$	ave. $I_B = 10 \text{ mA}$ $V_{CE} = -0.35 \text{ V}$	at -12 V	$I_C = -1 \text{ mA}$	$V_{CB} = -6 \text{ V}$
2N658	-24	5	50	40	2.5	60	12
2N659	-20	10	70	55	2.5	65	12
2N660	-16	15	90	65	2.5	70	12
2N661	-12	20	120	75	2.5	75	12
2N662	-16	8	30 min	50	2.5	65	12

MEDIUM CURRENT, HIGH FREQUENCY, HIGH GAIN SWITCH

JEDEC-30 Type	V_{CE} max. volts	$f_{\alpha b}$ ave. Mc	H_{FE1} ave. $I_B = 1 \text{ ma}$ $V_{CE} = -0.25 \text{ V}$	H_{FE2} ave. $I_B = 10 \text{ ma}$ $V_{CE} = -0.35 \text{ V}$	Rise Time* max. μsec
2N404	-24	12	30 min.	-	-
2N425	-20	4	30	18	1.0
2N426	-18	6	40	24	0.55
2N427	-15	11	55	30	0.44
2N428	-12	17	80	40	0.33

* $I_C = 50 \text{ ma}$; $I_B = 5 \text{ ma}$; $R_L = 200 \Omega$; $I_2 = 5 \text{ ma}$; Grounded Emitter Circuit

SUBMIN Type	V_{CE} max. volts	$f_{\alpha b}$ ave. Mc	H_{FE1} ave. $I_B = 1 \text{ ma}$ $V_{CE} = -0.25 \text{ V}$	H_{FE2} ave. $I_B = 10 \text{ ma}$ $V_{CE} = -0.35 \text{ V}$	Rise Time* max. μsec
CK25	-20	4	30	18	1.0
CK26	-18	6	40	24	0.55
CK27	-15	11	55	30	0.44
CK28	-12	17	80	40	0.33

Ratings at 25°C unless otherwise indicated
 Dissipation Coefficients: For 1 Amp types, in air $0.35^{\circ}\text{C}/\text{mW}$; infinite sink $0.18^{\circ}\text{C}/\text{mW}$
 For med. current types, in air $0.40^{\circ}\text{C}/\text{mW}$; infinite sink $0.18^{\circ}\text{C}/\text{mW}$
 For submin types, in air $0.75^{\circ}\text{C}/\text{mW}$; infinite sink $0.35^{\circ}\text{C}/\text{mW}$

designed for computer service

made for computer service

tested for computer service

proved dependable in computer service

PREFERRED by computer designers

RAYTHEON SEMICONDUCTOR DIVISION
 Silicon and Germanium Diodes and Transistors • Silicon Rectifiers

Newton, Mass.....55 Chapel St., Bldg 4-7500
 New York:.....589 Fifth Ave., Plaza 9-3900
 Chicago: 9501 Grand Ave., Franklin Park, NATIONAL 5-6130
 Los Angeles: 5236 Santa Monica Blvd., NORMANDY 5-4221

ELECTRONICS NEWSLETTER

COURSES IN RADIOISOTOPE TECHNIQUES

will be given by the Atomic Energy Commission next year for industrial scientists and engineers. Six-week courses will start Feb. 9 and Apr. 6 at the Oak Ridge Institute of Nuclear Studies (ORINS). AEC says U.S. business is estimated to be saving millions of dollars a year by using radioisotopes, but that "less than one percent of the manufacturing and mining concerns in the nation now are using these materials." Commission expects increases in these industrial uses in the next few years. New courses will stress plant applications of radioisotopes, including standard techniques of wear measurement, thickness measurements and radiography, plus other techniques applicable in industry.

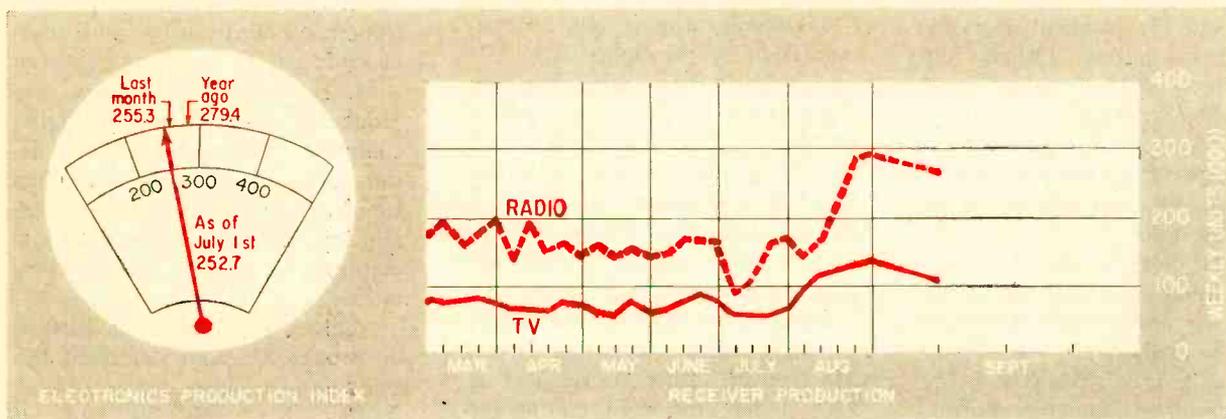
STEREOPHONIC RADIO BROADCAST

system using a single channel is being tested in Britain by the BBC and Electric and Musical Industries, the developer. EMI's Percival system, said to have undergone preliminary tests successfully, sends out a composite signal. A small part of the channel is used to convey direction information which routes the sound signal at the receiving end. Most of the channel is used to carry the regular broadcast signal. One additional unit is used along with standard transmitter. Firm says range of the transmitter

is not appreciably reduced and that stereo receiver would be "only slightly more complex" than an ordinary set. System is compatible, allowing normal reception on an ordinary home radio set. Declares EMI: "Should the BBC after further tests decide to adopt the system, it is envisaged that suitable receiving sets may be on sale to the public in about a year's time."

MOON POWER STATION

elements were recently demonstrated by Westinghouse Electric's Astronautics Institute in Baltimore. Proposed lunar power plant would take advantage of the 6,000 kw per acre that the sun at zenith pours onto the moon. It would consist of acres of thin plastic sheets coated with about one micron of photoemissive material. A thin wire mesh is placed parallel to the sheet, slightly separated and insulated from it. Load would complete the circuit between emitter and mesh. Westinghouse says weight of the plant is about three pounds per kilowatt, hopes to reach solar conversion efficiencies of 25 percent. Moon's lack of atmosphere makes possible such a grand-scale solar cell, since elements don't have to be bottled up in a tube envelope. Internal impedances of cells now being demonstrated have been cut from a megohm to about 3,000 ohms, with new structures showing promise of reductions to 0.1 ohm.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	Sept. 5, '58	Aug. 29, '58	Sept. 6, '57
Television sets, total	112,992	134,921	146,288
Radio sets, total	274,604	293,771	256,292
Auto sets	91,738	68,928	58,451

STOCK PRICE AVERAGES

(Source: Standard & Poor's)	Sept. 10, '58	Sept. 3, '58	Sept. 11, '57
Radio-tv & electronics	56.64	54.62	46.81
Radio broadcasters	68.71	67.86	58.06

FIGURES OF THE YEAR

Totals for first six months

	1958	1957	Percent Change
Receiving tube sales	190,406,000	221,175,000	-13.9
Transistor production	18,452,324	11,199,000	+64.5
Cathode-ray tube sales	3,689,587	4,814,659	-23.4
Television set production	2,167,930	2,722,139	-20.4
Radio set production	4,961,293	7,187,294	-31.0
TV set sales	2,177,652	2,810,403	-22.5
Radio set sales (excl. auto)	2,964,338	3,638,969	-18.5

MORE FIGURES NEXT PAGE



Electronics stars in ISA exhibits and tech sessions, looking towards . . .

More Process Controls

Instrument Society conference speakers delve into advantages of electronic aids

HEAVY EMPHASIS on application of electronics to process control was the feature of Instrument Society of America's annual conference and trade show in Philadelphia last week.

Speaker after speaker underlined the growing use of electronics in the automatic-control field, or pointed out ways to make electronic equipment better.

There seemed to be general agreement that computers are the handiest answer yet for optimizing processes.

Some reports, particularly on analysis of huge masses of data, pointed out the practical necessity of using computers. Others felt that instruments themselves are not the problem so much as industry's acute need for a large, semiprofessional corps of trained instrument technicians to keep the new gear in working order.

A bright note in the show, for computermen, was evidence of increasing use and greater perfection of gas chromatography. Its ready analysis of process streams is assisting adoption of automatic control. The ISA devoted one of the largest

all-day workshops to computers. It covered subjects from basic circuits to advanced applications.

There was little cause for complaining about the business climate. To the customers, instruments are a way of reducing some manufacturing costs and stretching the utility of equipment.

Prior to the show, Business and Defense Services Administration predicted a \$1.5 billion second half in 1958. Sales had slipped to \$1.3 billion in the first half after a \$3 billion annual rate in 1957. BDSA expects an average annual gain of 15 percent a year.

Conference theme was "Instrumentation in the Space Age." It was carried out by such exhibits as a model of the Navy's rocket test facilities at Lake Denmark, N. J. The Navy also showed its carrier flight-deck communications system: transceiver helmets for personnel and a tv-coordinated network of controls.

Of the more than 400 exhibitors, a fourth were electronics firms. Most of the other booths had at least a few tubes in equipment shown. There were 11 computers

on the Convention Hall floor. Exhibit space totaled 84,000 square feet. Attendance was estimated at 30,000 persons.

Numbers Run New System

DETROIT—350 MEMBERS of IRE and AIEE, here for the seventh annual conference on Industrial Electronics, heard panelists discuss new developments ranging from a numerically controlled manufacturing system to electronic inspection of beer.

The manufacturing system, described by Bendix's Fred E. Booth, includes a computer group that tapes in binary code the geometry and cutting requirements of the piece to be made. The tape then generates pulse trains, coordinated to represent cutter path in three-dimensional space. They control the machine tool.

N. W. Schubring of GM's research staff detailed a multi-channel swept-frequency casting tester used in the company's foundries. It can handle more complicated castings because swept frequency, continuous wave, forced vibration obviates mode interaction to permit evaluation by comparison of sonic energy absorption spectra.

H. L. Shoemaker showed how Hughes Products' elementary digital computer building blocks, first designed to control a small-lot production line, are suitable for constructing any special or general purpose computer of 130 to 160 kc clock rate.

Another paper by Kurt Enlein of Brooks Research described the building of a pulse-train controlled scanner that reads 500 pairs of

(Continued on p 12)

TRANSISTOR AND TUBE SALES, MONTHLY

(Source: EIA)	June, '58	May, '58	June, '57
Transistors, units	3,558,094	2,999,198	2,245,000
Transistors, value	\$8,232,343	\$7,250,824	\$6,121,000
Receiving tubes, units	36,270,000	36,540,000	35,328,000
Receiving tubes, value	\$31,445,000	\$31,406,000	\$31,314,000
Picture tubes, units	725,846	560,559	1,104,013
Picture tubes, value	\$14,203,381	\$11,237,147	\$19,981,319

EMPLOYMENT AND EARNINGS

(Source: Bur. Labor Statistics)	July, '58	June, '58	July, '57
Prod. workers, comm. equip.	339,400	339,700	395,600
Av. wkly. earnings, comm.	\$81.35	\$82.39	\$75.85
Av. wkly. earnings, radio	\$80.99	\$81.60	\$75.05
Av. wkly. hours, comm.	39.3	39.8	39.1
Av. wkly. hours, radio	39.7	40.0	39.5



Guaranteed: around-the-clock performance for five years

Freedom from worry about major maintenance or extensive replacement for *five full years*. That's the guarantee given with every Lambda power supply—the first such guarantee in the electronics industry. It proves the point engineers keep making in preference studies: When operating conditions make dependability a “must,” they specify Lambda... To check the full Lambda line yourself, send for the latest catalog.

LAMBDA POWER SUPPLIES

LAMBDA ELECTRONICS CORP., 11-11 131 STREET, COLLEGE POINT 56, N. Y.
CIRCLE 3 READERS SERVICE CARD

Arnold Magnetic Materials

... the most complete line in the industry

PERMANENT MAGNET MATERIALS

Cast Alnico

Sintered Alnico

Arnox

Vicalloy

Cunife

HIGH PERMEABILITY MATERIALS

Tape Wound Cores
of Deltamax,
Supermalloy,
Permalloy or
Supermendur

"C" and "E" Cores of
Silectron

Bobbin Wound Cores

Molybdenum Permalloy
Powder Cores

Iron Powder Cores

Sendust Powder Cores

Special Magnetic
Materials



Write for the

TECHNICAL DATA YOU NEED

Bulletin TC-101 A . . . Properties, standard sizes, etc. of Arnold Tape Wound Cores.

Bulletin PC-104 B . . . Complete data on Mo-Permalloy Powder Cores.

Bulletin GC-106 C . . . General information on Magnets and other Arnold products.

Bulletin SC-107 . . . Covers the complete range of Arnold Silectron Cores.

Bulletin TC-108 A . . . Describes properties, etc. of Arnold Bobbin Cores.

Bulletin PC-109 . . . Essential data on Arnold Iron Powder Cores.

Bulletin SDC-110 . . . Information on properties, etc. of Sendust Powder Cores.

Bulletin TC-113 A . . . Technical data on Arnold Supermendur Tape Cores.

ADDRESS DEPT. E-89

PRECISION-TESTED TO YOUR SPECS . . .

Arnold can answer all your requirements from the most complete line of magnetic materials in the industry. In addition, Arnold maintains complete control over every production step from raw materials to final performance testing.

Typical test facilities for Mo-Permalloy Powder cores are illustrated above. Precision equipment and methods such as these accurately measure the properties of all Arnold magnetic materials before shipment, insuring ultimate performance in accordance with your specifications.

As your source of magnetic materials, Arnold offers the vital advantages of long experience, undivided responsibility, and unequalled facilities for quality control throughout production. • *Let us supply your needs!*

WSW 6781 B

THE ARNOLD ENGINEERING COMPANY



Main Office & Plant: Marengo, Illinois

Repath Pacific Division Plant: 641 East 61st Street, Los Angeles, Calif.

District Sales Offices:

Boston: 49 Waltham St., Lexington. Los Angeles: 3450 Wilshire Blvd.

New York: 350 Fifth Ave. Washington, D.C.: 1001-15th St., N.W.

...where space and quality are at a premium

SUBMINIATURE DISCAPS

Type SM

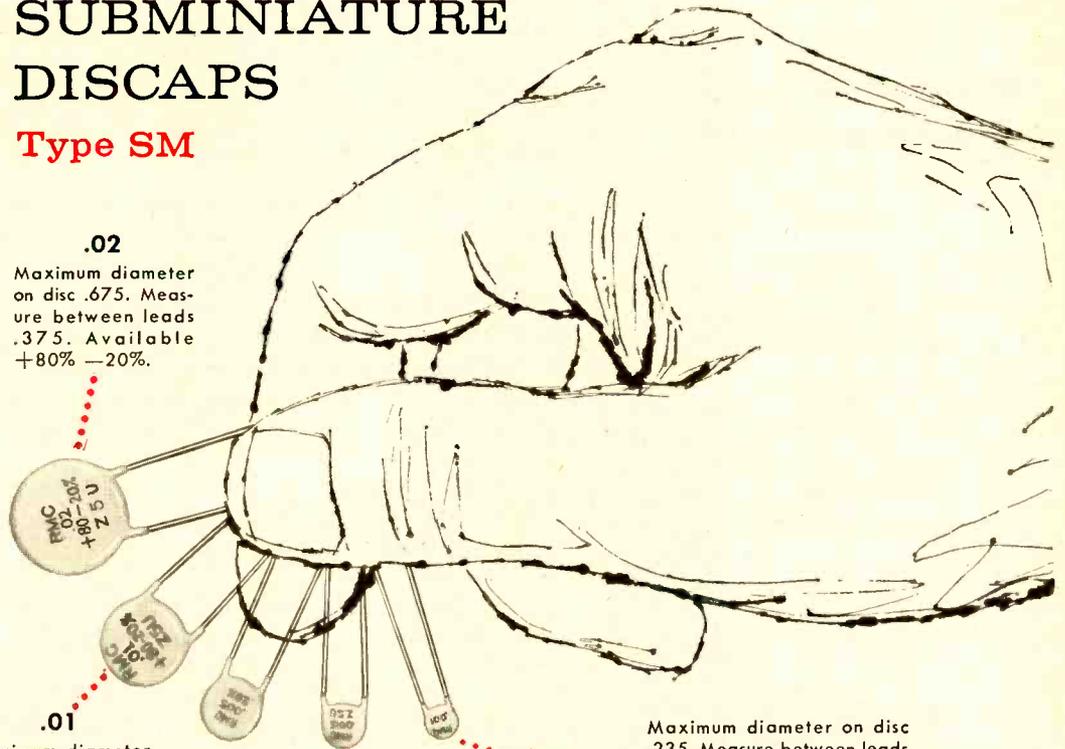
.02
Maximum diameter on disc .675. Measure between leads .375. Available +80% -20%.

.01
Maximum diameter on disc .510. Measure between leads .375. Available +80% -20% or ±20%.

.005
Maximum diameter on disc .390. Measure between leads .250. Tolerance ±20%.

.0015
Maximum diameter on disc .290. Measure between leads .250. Tolerance GMV.

.001
Maximum diameter on disc .235. Measure between leads .150. Capacities available are 800 and .001. Tolerance GMV.



Type SM DISCAPS answer the need for ceramic capacitors in the small sizes required in many applications. These miniature capacitors are manufactured without sacrifice of quality, dependability, or electrical characteristics built in all DISCAPS.

Write for information.

SPECIFICATIONS

POWER FACTOR: 1.5% Max. @ 1 KC (initial)
WORKING VOLTAGE: 500 V.D.C.
TEST VOLTAGE (FLASH): 1000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)
INSULATION: Durez phenolic (1/8" max. on leads)
—vacuum waxed
STAMPING: RMC—Capacity—Z5U
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

DISCAP
CERAMIC
CAPACITORS

RMC

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

strain gage inputs at a repetition rate of 50 per second. Output is connected to a digital voltmeter which feeds an IBM 727 tape unit. Data is processed by IBM 704.

And, oh yes, the beer. RCA's soft drink inspection system was modified to double-channel, suppressed carrier for stability to meet the additional problems inherent in beer inspection.

Railroads Laud Electronics Uses

PUBLICATION this Fall of *Proceedings* of the 34th annual session of the Communications Section of the Association of American Railroads indicates the considerable amount of electronics activity involved in running a railroad.

Statement by the association's vice president of Operations and Maintenance indicates that "capital expenditures since WW II have averaged over \$1 billion a year for modern equipment, improved signaling, automation of yards and . . . communications."

Other statements indicate that electronics is proving useful in stretching railroad dollars under present conditions of increased costs and lower revenues.

Data-processing is pointed to as

Wavy Whiskers



Air jet blowing on metal whisker formation in potentiometer causes whiskers to wave and shimmer in the backlight, allowing Boeing Airplane Co. technician to view them with stereomicroscope. Whiskers are thin crystals which grow from metal surfaces.

WASHINGTON OUTLOOK

THE ADMINISTRATION'S official forecast of a \$12.2-billion Federal budget deficit this year—and its policy of sweating the deficit down as much as possible—lies behind all the talk you hear about a new hold-down on defense expenditures and other big spending programs.

Washington expects an upturn in corporate tax receipts and other revenues. It's firmly believed here that the recession is over and a general economic recovery is underway. But the key to a future balanced budget still lies in the administration's ability to trim its expenditures.

So the decision has been made to spend little, if any, of the extra \$950 million Congress appropriated to the Defense Dept. this year for military production and development.

Included in this sum are funds for: extra Army procurement of equipment and missiles; speeding up construction of three nuclear-powered Regulus submarines; adding four nuclear-powered Polaris IRBM subs to the fleet; construction of two destroyer-escort vessels; accelerating development of the Polaris missile; expanding the Air Force's Minuteman and Hound Dog missile projects; production of additional KC-135 jet tankers and troop-carrier planes; increasing the Defense Dept.'s share of costs for VORTAC.

Just because these additional funds are not committed this year doesn't mean that the money goes down the drain. The funds could be spent next year.

- The still-increasing role of electronics producers is evident in the Pentagon's latest listing of leading defense prime contractors.

Of the 15 top companies awarded contracts during 1957, 11 are either primarily electronics manufacturers or are firms heavily involved in electronics work.

During the Pentagon's previous reporting period (January 1955 to June 1957) eight of the top 15 companies were in electronics production and development.

The top electronics makers—and their ranking: General Dynamics, no. 1, \$1.1 billion worth of new orders in 1957; GE, no. 2, \$916.4 million; AT&T, no. 5, \$471 million; North American Aviation, no. 6, \$456.1 million; Hughes Aircraft, no. 7, \$369.2 million; Martin Co., no. 9, \$322.1 million; G.M., no. 10, \$308.7 million; Northrop Aircraft, no. 12, \$263.5 million; IBM, no. 13, \$255.4 million; Sperry Rand, no. 14, \$246 million; Bendix, no. 15, \$223.5 million. (These figures include the companies' nonelectronic projects.)

- Recent Congressional overhaul of Federal excise tax legislation eliminates the knotty problem of defining what is "entertainment type" electronic consumer equipment.

All radios, tv sets and phonographs are now subject to 10 percent excise tax. Exemptions are specifically permitted for sets which are components of any articles exported or sold to state or local governments or nonprofit educational organizations. Senate committee struck out all reference to magnetic recorders, tape or wire, thus exempting them from the tax.



VERSATILE, RELIABLE DIGITAL INSTRUMENTS

*DC digital voltmeter
offers maximum reliability...
0.01% accuracy...
single-plane readout...and
many other advanced features*

*All-electronic
digital voltmeter
measures millivolt to kilovolt
with 0.1% accuracy
... costs only \$960*

The Model 401 offers four-digit display with automatic polarity indication and decimal placement... Measures .0001 to 999.9 volts with 0.01% ± 1 digit accuracy... Adjustable least digit sensitivities of .1, 1, 10 mv... Average reading time of one second... Continuous, automatic standard cell calibration... 10 megohms input impedance... Built-in printer drive... 10 times longer readout bulb life... No circuitry in readout for easy remote mounting... Extra long relay life assured by DC drive. Price: \$2100.

KIN TEL manufactures an exceptionally complete line of digital instruments. These "digital building blocks" permit measurement of AC, ohms, ratios, and automatic scanning of multiple inputs. Preamplifiers increase digital voltmeter sensitivity to 1 microvolt DC and 10 microvolts AC. Buffers permit driving typewriters, tape punches and printers. Complete digital systems for data logging, missile checkout and production testing are also available. The reliability and accuracy of these precision instruments are assured by KIN TEL's experience in designing and manufacturing more than 10,000 "standard cell accuracy" DC instruments. Sales and service are available nationwide. KIN TEL Engineering Representatives in all major cities.

Four ranges: 0.000 to 1.599; 00.00 to 15.99; 000.0 to 159.9; 0000. to 1000 volts (manual ranging and polarity)... No moving parts... Digital in-line readout... 70 millisecond conversion time... Adjustable display time... Input completely floating and isolated... 0.1% of full scale accuracy... Direct voltage conversion circuit... Wide range of models.

KIN TEL's Model 801A all-electronic digital voltmeter measures DC from 0.001 to 1000 volts with 0.1% of full scale accuracy... and in less than 1/10 second, presents the measured voltage clearly on an in-line digital readout that even unskilled personnel can read with ease. *Direct* voltage measurement by successive approximation provides accuracy and sensitivity previously obtainable only in delicate, complex and expensive instruments. Extremely stable operation—continuous calibration against an internal reference. (Input impedance of the Model 801A is 20,000 ohms per volt. The Model 802A, priced at \$1190, has an input impedance of 10 megohms on all ranges. In other models, the binary coded decimal and decimal outputs are externally available to permit driving printers and tape punches.)



Write today for descriptive literature or demonstration. 5725 Kearny Villa Road, San Diego 11, California

one area where intelligent use of existing equipment can effect substantial savings.

In addition to coverage of policy talks and speeches, the publication also contains papers presented to the session on such subjects as dataphone service, microwave transmission, automatic switching and transceiver operation.

Costs of R&D Increase 4%

RESEARCH and development costs continue to take an ever-increasing share of industry's dollar.

An American Management Association survey released early this month discloses that the 1958 all-industry average for budgeted R&D expenditures is up 4 percent over 1957. AMA uses the Census Bureau breakdown of industry, which does not consider electronics a separate industry group; but the several categories which include electronics firms give a fair indication of money spent for R&D by electronics.

Electrical machinery firms are spending 4.0 percent more this year than last—right on the all-industry mean. Last year the 62 firms in this group who responded to the survey budgeted an average amount equivalent to 4.8 percent of sales, compared to the all-industry average of 2.8 percent. AMA made a "horseback estimate" for *ELECTRONICS* that electronics firms included in this category are budgeting 4.5 to 5.0 percent more this year, and that last year's expenditure was more than 5.0 percent of sales.

Instrumentmakers are budgeting only one percent ahead of last year, but the 1957 average for the 73 firms responding was 5.2 percent of 1957 sales. This is the highest average R&D percentage reported by the AMA analysis.

Office machinery R&D is costing 5.2 percent more this year than last. Last year's average for 18 firms surveyed was 3.2 percent of sales.

According to AMA's factfinders, most R&D managers are still tying their budgets to near-term income expectations and emphasizing developments close to the shipping-room door.

MILITARY ELECTRONICS

• **Hound Dog's** aerial launching pads—pylons suspended below the left and right wing of the B-52—will carry individual star trackers for precise, on-the-spot, heading information prior to launching. Using the heading from the astro compass inside the fuselage—18 ft away—would give the missile's inertial guidance a slightly erroneous start.

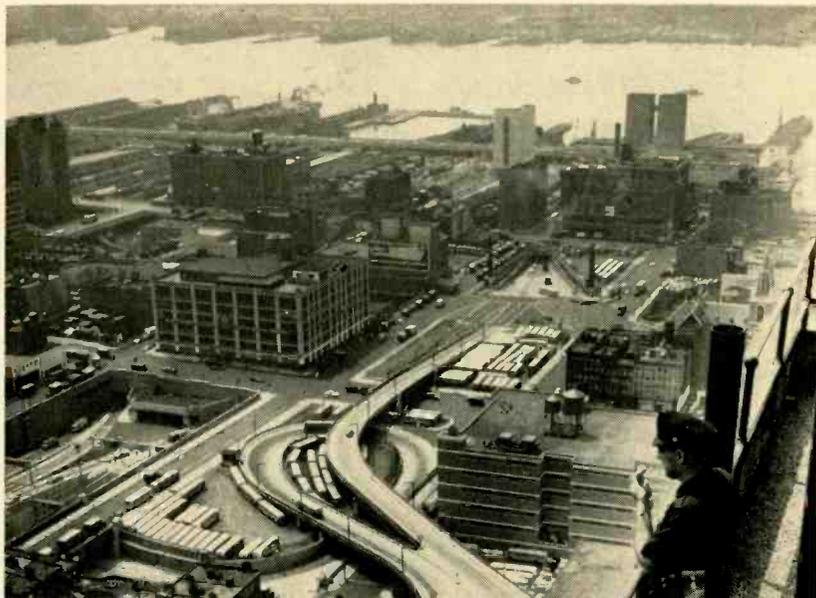
Position information is fed to the missile's computer from the bomb-nav system in the plane (*ELECTRONICS*, p 15, Feb. 21).

Successor to the Rascal and forerunner of the air-launched ballistic missile, North American's Hound Dog is currently in fabrication. Pure inertial guidance, by North American's Autonetics, is a miniaturized and adapted version of the system used in the cancelled Navaho missile. (Modification of the same system navigated submarines *USS*

Nautilus and *Skate* on their trans-polar cruise. *ELECTRONICS*, p 8, Aug. 29). The pylon star tracker, KS-120, is produced by Kollsman, as is the KS-150 astro compass in the B-52.

• **New instrument** for measuring speeds of guided missiles, rockets, projectiles, aircraft and ground vehicles with accuracies of ± 1 fps will be produced by Marconi of England.

EVA (electronic velocity analyzer) is small, portable and operates in the X-band. Range is up to nine miles. Data are obtained on moving Teledeltos paper and consist of a continuous graphical representation of events, recorded against a reference of calibration pips which occur every 0.1 sec. EVA records instantaneous changes in velocity.



From vantage point atop 35-story McGraw-Hill building, officer (lower right) uses portable 2-way f-m radio unit as . . .

Radio Eases Tunnel Traffic

NEW YORK'S Port Authority is using electronics to combat traffic congestion at the heavily traveled Lincoln Tunnel.

During the Labor Day holiday weekend, portable 2-way f-m radio

units worn by strategically deployed Port Authority patrolmen were initiated into regular service to report changing traffic patterns and dispatch police to trouble spots.

Traffic authorities reported a

FROM OUR GALLERY OF "DOUBTING THOMASES"

**redoubtable doubter, Thomas Chulbb
COULDN'T "SEE" THE
ELECTRIC BULB!**

... nor could his present-day counterparts see the Elco Varicon connector principle when it was first introduced. These unhappy souls may now be selling electric bulbs in a 5-and-10 for all we know; while you are specifying more and more Varicons with each passing day.

If, by some chance, you do not as yet have our Varicon V-2 Catalog in your library, nor information concerning Elco's most complete and reliable quality line of printed circuitry, tube-sockets and shields, we'll be happy to correct that omission if you will drop us a note on your company letterhead immediately. The same applies to Elco's new products pictured below.

IF IT'S NEW... IF IT'S NEWS... IT'S FROM

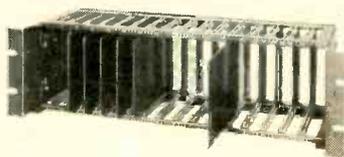
ELCO CORPORATION

"M" St. below Erie Ave., Phila. 24, Pa., CU 9-5500

Elco-Pacific: 3260 Motor Ave., Los Angeles, Cal., TEXAS 0-3000



ELCO'S "VARIPAK"



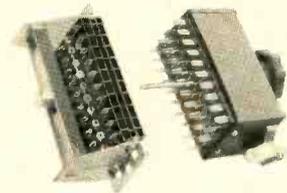
Printed circuit board enclosure for printed or etched circuitry. 78 parts may be retained with only 8 screws. For standard relay rack or standard electronic enclosure mounting. Bulletin A-1.

ELCO-PACIFIC EL SERIES



3 or 4 contact audio connector. Also available, our light-duty "B" Series. Both series are completely interchangeable with comparable units. Immediate delivery. Write for data.

ELCO'S SCREW-TYPE VARICON



Provides vibration-proof locking feature for mated connectors. Guarantees parallel insertion and withdrawal of contacts, with absolute avoidance of contact over-stress. Write for complete data.

steady flow of traffic during peak periods and the rapid elimination of bottlenecks caused by breakdowns.

The Port Authority's two-way system consists of six transistorized transmitters and receivers operating in conjunction with a fixed repeater station. The units, designed by RCA, transmit and receive in the 150-mc band.

During peak periods, one officer is stationed atop the 35-story McGraw-Hill Building, home of **ELECTRONICS**. An unobstructed view of the tunnel approaches enables the officer to relay reports of traffic conditions almost instantaneously.

Electronics Probes Missile's Fluids

CAMBRIDGE, MASS.—Electronic method of detecting cavitation in liquid oxygen and other cryogenic fluids gave promise this week of pinpointing one source of trouble in missile propulsion systems.

Method stems from claim that cavitation in various liquids coincidentally produces omnidirectional magnetic field which may be observed and recorded with electronic instrumentation.

Preliminary report on the phenomenon was made here recently at MIT to nearly 600 attending the Fourth Cryogenic Engineering Conference.

James Clark of the Garrett Corp.'s AiResearch Manufacturing Div. in Phoenix told the conference that general field of magneto-hydrodynamics is also expected to benefit from discovery that a local magnetic field is generated around certain molecules subjected to displacement relative to each other.

Varying magnetic field generated in region subject to dynamic or changing density gradients, he reported, can be picked up as an a-c voltage by sensing grids and transistorized electronic circuits.

Study of cavitation in cryogenic fluids and various hydrocarbons is also being applied to research in centrifugal pumps, turbines, marine propellers.

FINANCIAL ROUNDUP

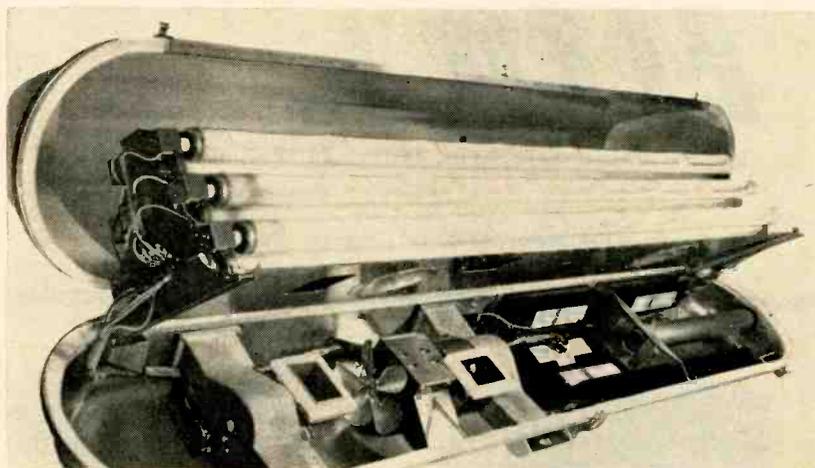
• **Marquardt Aircraft**, Van Nuys, Calif., and **Applied Radiation Corp.**, of Walnut Creek, Calif., enter into agreement for joint efforts in developing ion and other electrical propulsion systems for space flight applications. Marquardt's **ASTRO Division**, which will work with **ARCO** on electrical propulsion systems, already has several programs underway on propulsion systems for satellite-boost and other hypersonic applications.

• **Mack Truck** discontinues manufacturing electronic equipment. Machinery and equipment of former Mack unit in Plainfield, N. J., has been acquired by **Electronics Assistance Corp.** of Red Bank, N. J. **Di An Controls** of Boston, Mass., has taken over the assets of Mack's Boston unit. Both firms are headed by the former Mack electronic unit general managers. It has been reported that Mack got out of the electronics business because it felt that it could more profitably devote its efforts to making trucks. Plainfield unit made electronic counters, radar sets and computer parts. Boston unit had been engaged in military contract work. **Di An Controls**,

in addition to completing Mack contracts, is making magnetic cores and doing R&D work.

• **Servomechanisms**, Hawthorne, Calif., has been awarded \$101,672 of additional funding by **Douglas Aircraft**. Additional money is for continued research into the field of solid state physics by **Servomechanism's** research laboratory.

• **Fairchild Camera & Instrument**, Syosset, N. Y., acquires the assets of **Acme Teletronix Division of NEA Service, Inc.**, of Cleveland, Ohio. Fairchild says Acme makes telephoto and facsimile transmitters used by **United Press International** and **NEA Service** and produces similar equipment for military and general industry use. The acquisition makes possible the combining of progress made by both companies in the field of color scanning in recent years. **NEA** already has a color scanner in operation. **Fairchild Graphic Equipment Division**, which developed several black and white electronic engraving machines earlier this year, has a color engraving machine under development.



Inside look at Chicago's new State Street radio-controlled lights shows "air conditioning" system (note fan, center), used when . . .

F-M Controls Street Lights

CHICAGO—A HALF-MILLION DOLLAR street lighting system featuring a central f-m radio transmitter unit

and 70 receiver units, one each in the base of 70 fluorescent light poles, will soon be brightening



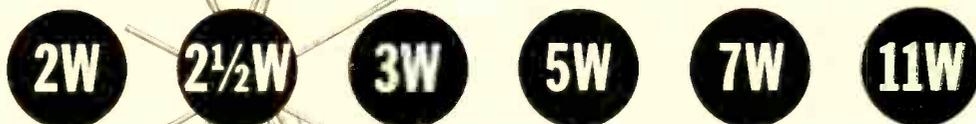
NEW

AND IMPROVED

Blue Jacket[®]

MINIATURE WIRE WOUND RESISTORS

MADE TO MEET MIL-R-26C CHAR. "V"
PERFORMANCE REQUIREMENTS



ILLUSTRATED IN
ACTUAL SIZE

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

Look at the small sizes shown in the illustrations above and you will recognize how ideal they are for use in miniature electronic equipment with either conventional wiring or printed wiring boards.

For the full technical story on these dependable miniaturized resistors, write for Engineering Bulletin 7410.

SPRAGUE ELECTRIC COMPANY • 35 MARSHALL STREET • NORTH ADAMS, MASS.

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS L (inches) D		MAXIMUM RESISTANCE
240E	2	3/8	3/16	2,700 Ω
241E	2½	1/2	3/16	5,000 Ω
242E	3	1/2	1/4	10,000 Ω
243E	5	1/2	1/4	30,000 Ω
244E	7	1 1/8	3/16	30,000 Ω
245E	11	1 7/8	3/16	50,000 Ω



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

State Street here.

The new poles in Chicago's loop will produce 15,624,000 lumens of light, or 225,672 lumens per pole. The electronics equipment will be "a sizable proportion" of the total cost, said General Electric, which is supplying the radio equipment.

This will be the first major lighting system to utilize radio for control, according to the State Street Council. Each pole's receiving set will automatically perform the following functions: turn on all lights at dusk, turn off portion of lights at midnight, turn off all lights at dawn and control festoon lighting.

Automatically controlled Calrod heating units installed at the base of each pole will maintain correct operating temperatures for the receivers so they will function properly in snow. The 70 receivers are mobile-type sets operating on a-c power. The 27-mc carrier is frequency-modulated with pulse tones to fulfill the various lighting requirements.

Each receiver is a crystal controlled double conversion superhet whose sensitivity runs 0.4 of a micro-volt, with frequency stability of 0.002 percent. A simple whip antenna will serve for the transmitter and short whip antennas will be placed on each light pole.

The input voltage of the transmitter is 117 volts a-c and the power output is 30 w, plus or minus 10 percent. Modulation on the wide band is a plus or minus 15 kc

swing with instantaneous modulation limiting. The narrow band uses a plus or minus 5 kc swing with instantaneous modulation limiting. The crystal multiplication factor is 12, and ambient temperature is minus 30 C to plus 60 C.

The audio frequency characteristics are between plus 1 to minus 3 db of a 6 db octave with preemphasis from 300 to 3,000 cps, reference 1,000 cps. Spurious and harmonic radiation is at least 80 db below rated power output at any frequency. Size of the unit is 6 in. high by 4 in. wide by 13½ in. long. Weight is 3½ lb.

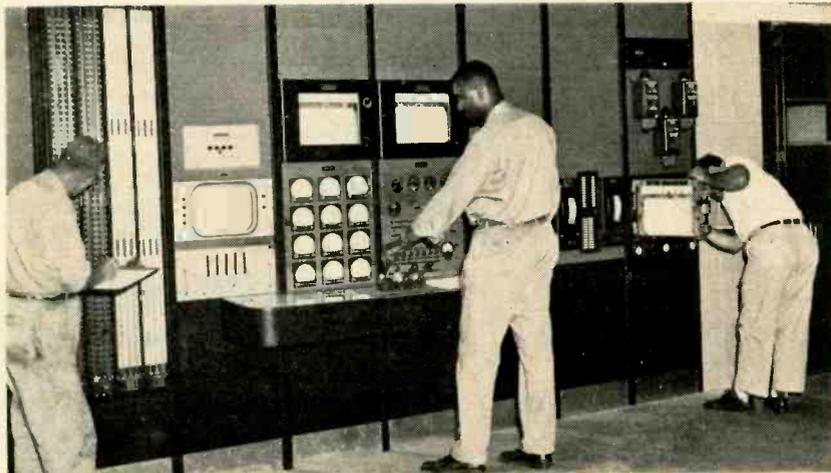
Buy 1,385 New Players for Blind

THIS WEEK saw sale of 1,385 Talking Book players to Library of Congress Division for the Blind to be distributed throughout the country.

The record players are portables especially designed for operation by the blind. They play 16½ rpm recordings of narrated books. An average size volume can be recorded on five or six 12-inch records.

The units sold this week are manufactured by Stromberg-Carlson. Player has a three-stage amplifier with 1½-w output, crystal pickup and speaker. In addition to volume and tone controls, a jack for headphones is provided.

Floating Control Booth



Windowless control room of Wright Air Development Center's new jet engine test stand floats on noise insulation. Technicians use tv and instruments to observe engine tests

MEETINGS AHEAD

Sept. 26-27: Broadcast Transmission Systems, Annual Symposium, IRE Prof. Group, Willard Hotel, Wash., D. C.

Sept. 28-Oct. 2: Electrochemical Society, 114th Meeting, Chateau Laurier, Ottawa, Canada.

Sept. 29-Oct. 3: Audio Engineering Society, 10th Annual Conv., Hotel New Yorker, N. Y. C.

Oct. 1-2: Radio-Interference Reduction, U. S. Army Signal Engineering Labs, IRE, Armour Research Foundation, Chicago, Ill.

Oct. 6-8: Symposium on Extended Range and Space Communications, IRE and George Washington Univ., Lisner Auditorium, Washington, D. C.

Oct. 8-10: IRE Canadian Convention and Exposition, Electronics and Nuclears, Exhibition Park, Toronto, Canada.

Oct. 13-15: National Electronics Conf., 14th Annual, Hotel Sherman, Chicago, Ill.

Oct. 14-15: Institute of Printed Circuits, Fall Meeting, Chicago, Ill.

Oct. 20-21: Aero Communications Symposium, Fourth National, PGCS, Hotel Utica, Utica, N. Y.

Oct. 20-21: USA National Committee, URSI Fall Meeting, Penn State Univ., University Park, Pa.

Oct. 20-24: Society of Motion Picture and Television Engineers, 84th Convention, Sheraton-Cadillac Hotel, Detroit, Mich.

Oct. 26-31: American Institute of Electrical Engineers, Fall Meeting, Penn-Sheraton Hotel, Pittsburgh, Pennsylvania.

Oct. 29-30: Fifth Annual Computer Applications Symposium, sponsored by Armour Research Foundation, Morrison Hotel, Chicago, Ill.

Oct. 30-31; Nov. 1: Electron Devices Meeting, PGED, IRE, Shoreham Hotel, Wash., D. C.

Oct. 30-31: Aircraft Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Nov. 6-7: Prof. Group on Nuclear Science, IRE, Fifth Annual Meeting, Villa Hotel, San Mateo, Calif.

Nov. 17-20: Magnetism and Magnetic Materials, Fourth Annual Conf., AIEE, APS, IRE, AIME, OHR, Sheraton Hotel, Phila., Pa.



.....**RELIABILITY**

of electronic components, however small, is vital in controlling a rocket, however large . . .

RELIABILITY

of electronic components *you* use is vital, whatever their type, size or function . . .

RELIABILITY

of electronic components is the vital advantage, unconditionally guaranteed, in any quantity you order from . . .

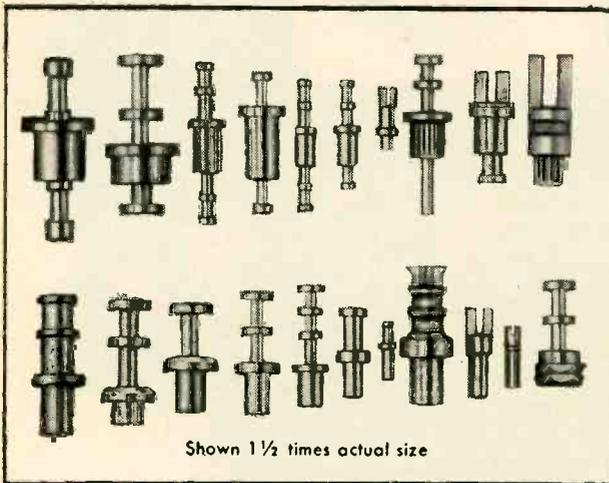
CAMBRIDGE THERMIONIC CORPORATION
CAMBION®

For Details, See Following Pages ▶

RELIABILITY.....

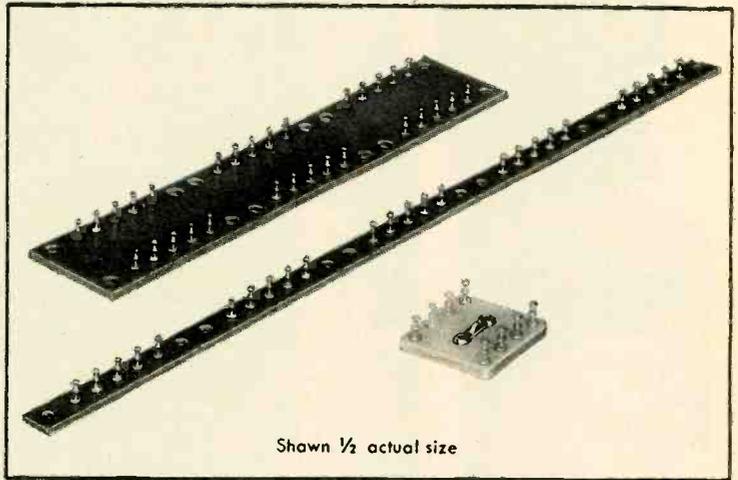
multiplied by millions

CAMBION® electronic components . . . countless in quantity, broad in variety . . . are quality-controlled, thoroughly tested and unconditionally guaranteed.



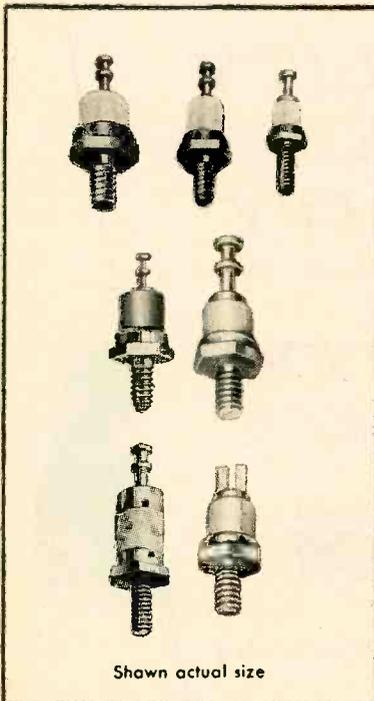
Shown 1 1/2 times actual size

Terminals



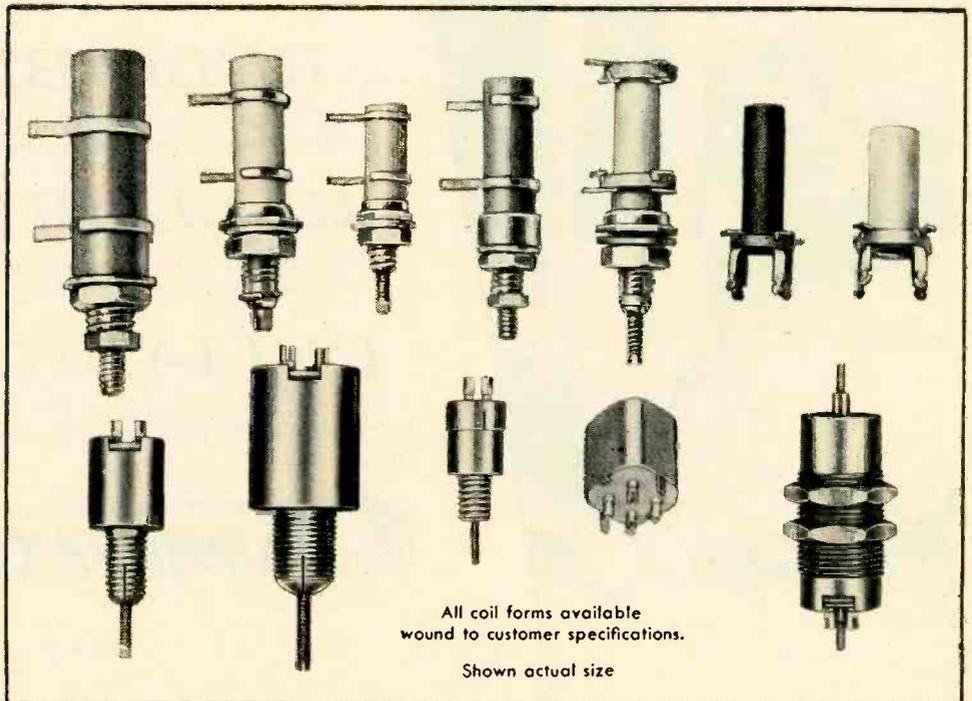
Shown 1/2 actual size

Terminal Boards



Shown actual size

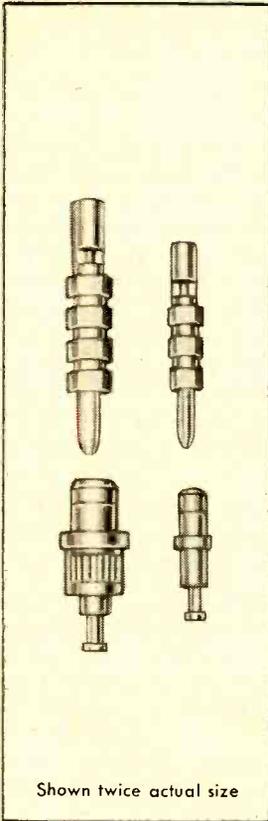
Insulated Terminals



All coil forms available wound to customer specifications.

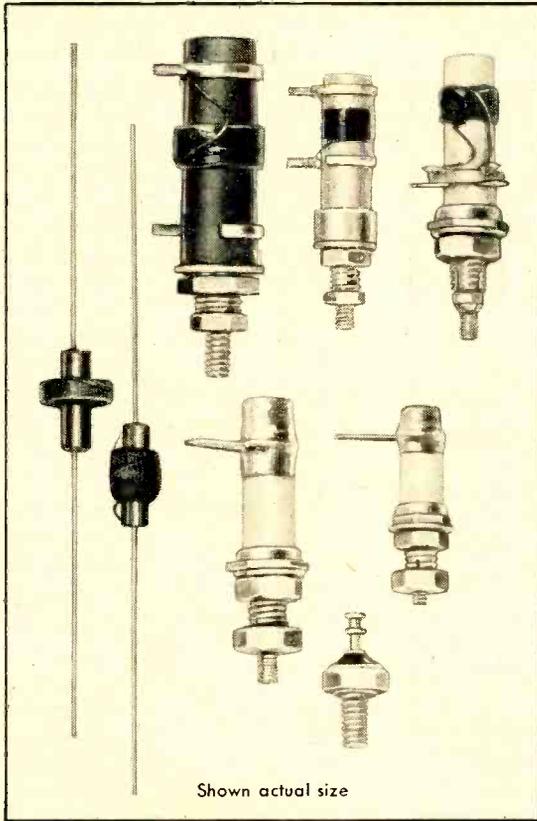
Shown actual size

Coil Forms and Coils



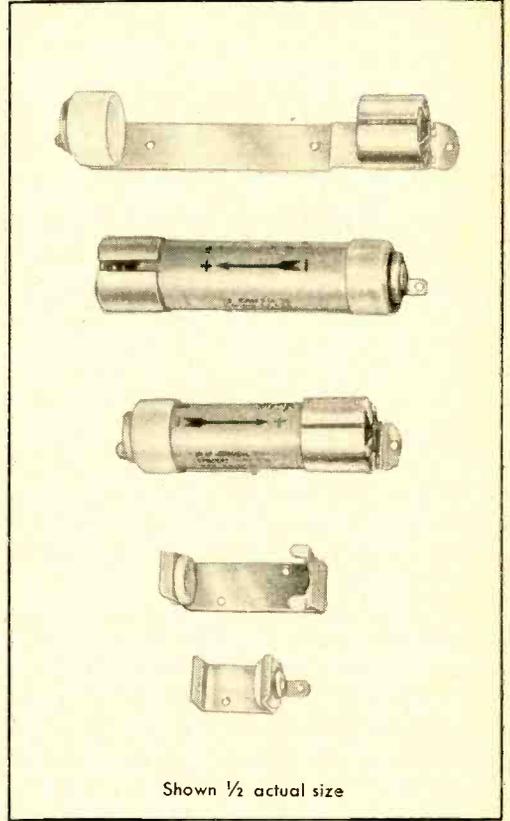
Shown twice actual size

Miniature Connectors



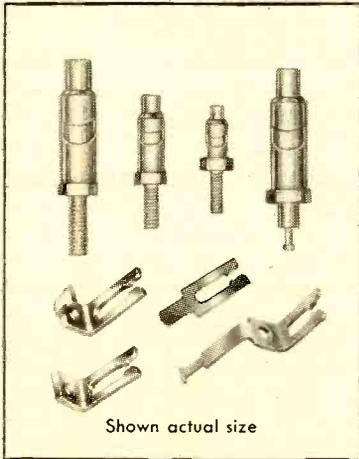
Shown actual size

Chokes and Capacitors



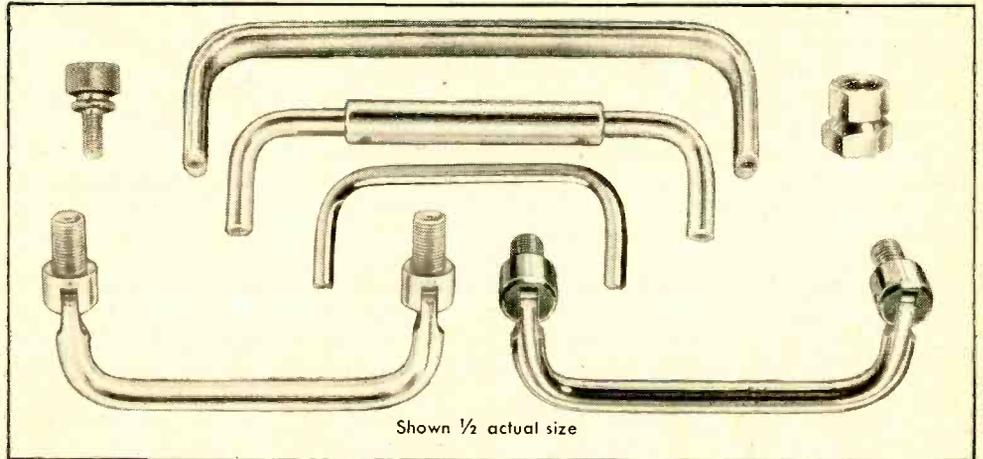
Shown 1/2 actual size

Battery Holders



Shown actual size

Diode Clips



Shown 1/2 actual size

Handles and Hardware

Any part, regardless of size, may be the most efficient, most reliable feature in an assembled product.

That's why CAMBION components, small as they are, are indispensable in many electronically equipped products — and can be equally valuable in your own. The reason is exceptional reliability — so carefully maintained that it will pay you to investigate how CAMBION components can benefit your own industry.

QUESTIONS YOU OUGHT TO ASK about these highly important little essentials are: How high in quality are their raw materials? . . . What advancements in design, and in manu-

facturing equipment and methods are evident in their production? . . . During and after manufacture, how much inspection and testing are they given? . . . How closely do they conform to government specifications? . . . How widespread is their reputa-

tion for reliability? . . . How is this reliability guaranteed — fully and convincingly?

FOR CAMBION ANSWERS to your questions, with facts that may help you to more successful, more profitable production . . .

Turn To The Next Page

CAMBRIDGE THERMIONIC CORPORATION
CAMBION®

Makers of guaranteed electronic components, custom or standard



RELIABILITY

100% Engineered
100% Guaranteed

On two previous pages you've seen some of the more prominent CAMBION electronic components. The entire family is huge, with many different types and sizes. Yet all share one family trait — *reliability*. Here are the reasons why:

CAMBION QUALITY CONTROL — Modern methods based on MIL-Q-5923C are carefully adhered to by CAMBION quality control engineers.

CAMBION RAW MATERIALS must be certified to meet CAMBION requirements. For example, grade L5 silicone-impregnated ceramic, used in coils and coil forms, is purchased only from government certified sources and must meet specification JAN-I-10.

CAMBION SPECIAL EQUIPMENT AND FACILITIES include an up-to-date precision tool and die shop, manufacturing all needed tools and dies to standards assuring highest product quality. In addition, all plating is done in a CAMBION-approved plant, with a laboratory for checking all solutions.

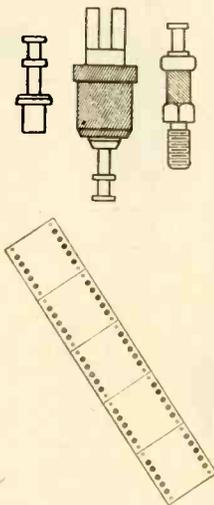
In the laboratory a Kocour electronic plating thickness tester is used. Other CAMBION testing equipment includes special electrical devices, some of them registering such delicate accuracies that they are seldom used by electronic component manufacturers. These devices cover such units as impedance, inductance and capacitance bridges to accuracies of .1%. Also included are standard oscilloscopes, synchrosopes, pulse and trigger generators; signal generators to 3,000 megacycles; sealed inductor standards; precision voltmeters; vacuum devices evacuating to microns.

Environmental testing equipment includes new electrodynamic shaker equipment, mechanical low frequencies table, humidity, temperature and salt spray chambers. Testing per MIL-E-5272A, MIL-STD-202 and MIL-E-5422 is regularly performed using this equipment.

Among CAMBION standard production equipment are optical comparators and protractors; precision microscopes; monochromatic light sources for high precision measuring to millionths of an inch; gage blocks; super-microscopes; wire systems for measuring thread pitch diameters; and Tri-Roll thread comparators.

To speed and improve its own production, Cambridge Thermionic has developed unique equipment such as the Hopper staking machines. This machine fits terminals into terminal boards with precise proper handling and eliminates cracking the boards. It is available to customers.

CAMBION TESTS — AT EVERY STEP OF THE WAY are too many to be completely described here. Let's take just a few, on some of the components, as listed below.



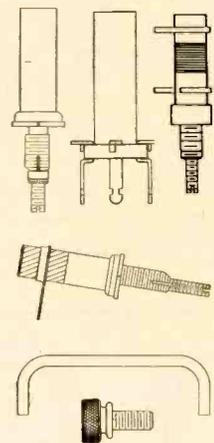
Terminals. On standard terminals a cross-sectional analysis of plating is made; dimensional and visual quality control checks are made as per MIL-Q-5923C; a salt spray test is performed and terminals are packaged in sulphur-free paper to avoid tarnishing. Insulated terminals, which get the same tests on the metallic component, are also subjected to a voltage breakdown, a humidity and insulation resistance test and a pull test — to find the strength of the insulation when tension is exerted on the terminal.

Terminal Boards. These receive all checks on terminals described above, plus pulling and twisting tests.

Coil Forms and Coils. When completed, these are checked for mechanical stability. Pull tests are also made, to assure the form is seated in the mechanical mounting. Where required, tests conforming to MIL-C-15305A are made, covering inductance, distributed capacity and other pertinent parameters.

Capacitors. Checked for vibration, temperature coefficient and tested for corona at reduced pressures equivalent to high altitudes.

Handles and Hardware. Life-tested for all movable parts, together with salt spray and general testing as per MIL-Q-5923C.



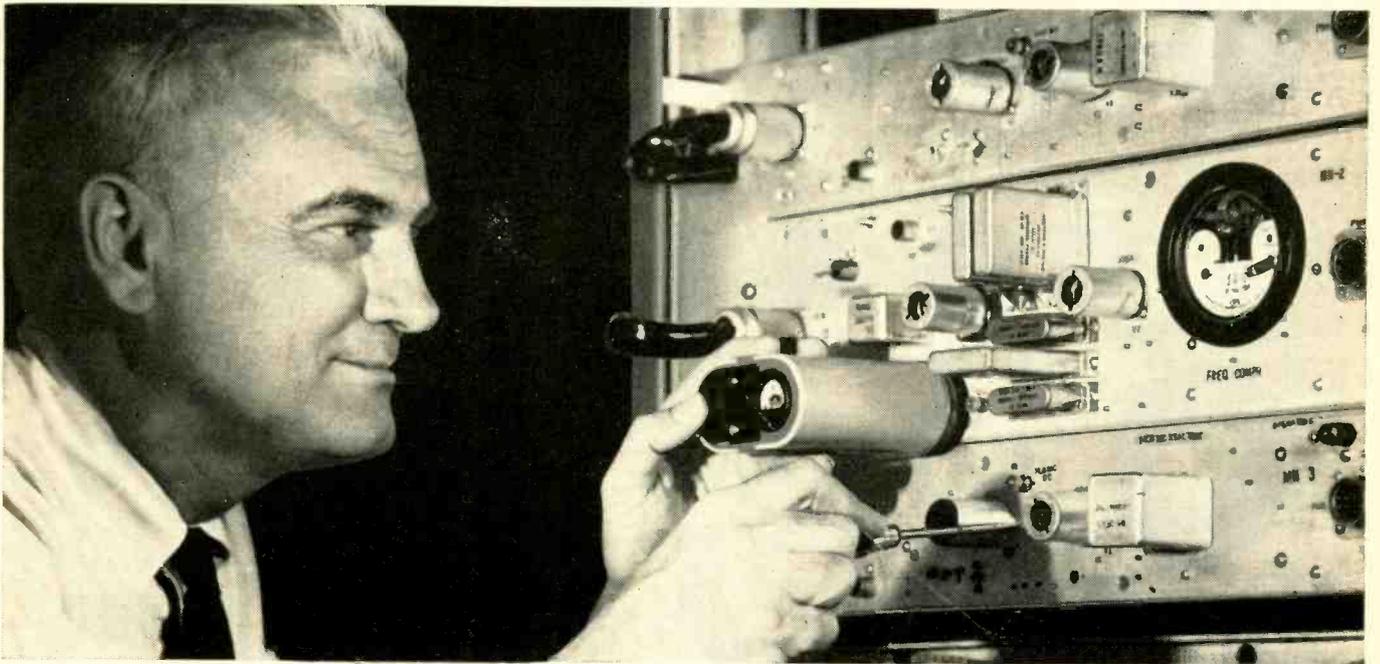
CAMBION QUALITY, RELIABILITY AND GUARANTEE form a combination unequalled for your guidance in choosing electronic components. In manufacture, CAMBION components meet or better government specifications. In testing, Cambridge Thermionic makes sure that keeping quality at its highest level is standard practice. And quality like this means CAMBION reliability is on the biggest scale *two ways*: first, because of the great breadth of the line; second, because of its nation-wide acceptance by leading manufacturers.

That's how Cambridge Thermionic provides the quality and reliability *you must have* — to help your products perform as you design them to perform. And these valuable advantages are guaranteed. That's on the biggest scale, too, because it applies *unconditionally* to all CAMBION components, in any quantity you order, from one to millions.

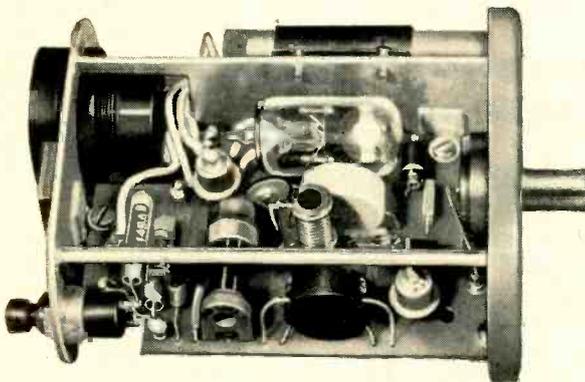
Get more details on CAMBION components. Send for samples or blueprints you need, or for the just-published Catalog Supplement. Write to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass. In Canada, Cambridge Thermionic of Canada (Ltd.), 2425 Grand Blvd., Montreal 28, P. Q. For your convenience CAMBION components are available from Authorized CAMBION Distributors throughout the United States and Canada.

CAMBRIDGE THERMIONIC CORPORATION
CAMBION®

Bell Laboratories Announces Pocket-Sized Frequency Standard for Microwave Systems



Lawrence Koerner, who developed the portable frequency standard, demonstrates how the device can be plugged in at a radio relay station to supply a checking frequency. Battery-powered, the device maintains precision calibration for several months.



Inside the portable frequency standard. Four Laboratories-developed devices make it possible: (1) transistor, which converts the power from a battery to radio frequency oscillations; (2) voltage reference diode, which maintains constant voltage; (3) piezoelectric crystal unit of superlative stability; (4) thermistor, which corrects for temperature variations.

Microwave radio relay systems depend critically on the accuracy of their "carrier" frequencies. At scores of relay stations along a route, carrier frequency oscillators must be checked periodically against a signal from a precise standard.

In the past, the maintenance man has had to obtain his checking frequency by picking up a standard radio signal from a government station. This operation takes time—and requires elaborate equipment.

With a new *portable* frequency standard developed by Bell Laboratories engineers, the job is much simplified. To check an oscillator, the portable standard is plugged in, and a button is pressed. In seconds, it supplies a checking frequency accurate to one part in a million.

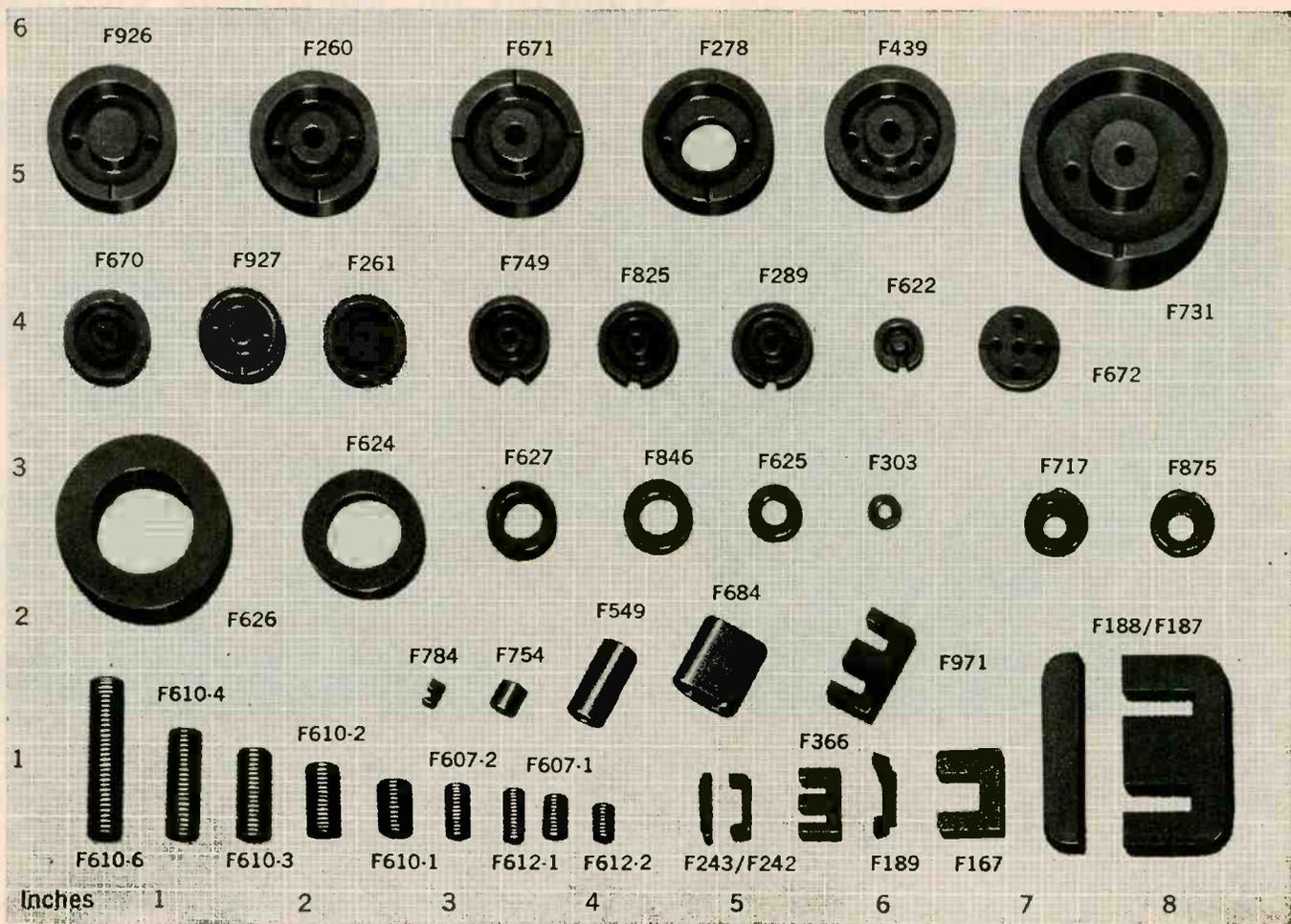
Until now, such precision in a frequency standard has been obtainable only in a laboratory. The new portable standard makes it available for routine use in the Bell System. First use of the standard will be to maintain frequency control in a new microwave system for telephone and TV, now under development at Bell Laboratories.



BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

Now, Immediate Delivery from Stock on GENERAL CERAMICS SPECIAL PURPOSE FERRITE CORES



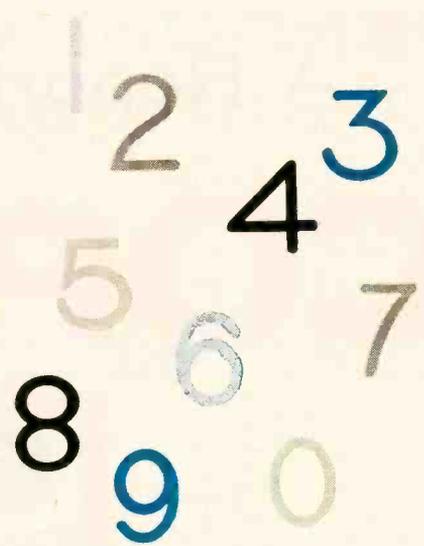
Rush service for designers - use this handy materials selector chart

Ferrite Cores available in various materials for development and design engineers to cover specific frequency bands of operation from 1 KC to 50 megacycles. General Ceramics provides extra-fast service on sample quantities for development and will make prompt delivery on production parts in reasonable quantities. Call, wire or write General Ceramics Corporation, Keasbey, New Jersey. Please direct inquiries to Dept. E.

APPLICATION	DESIRED PROPERTIES	FREQUENCY	FERRIMIC BODY	SHAPES
Filter Inductors	High μ , magnetic stability, sometimes adjustable	up to 200 kcs 200 kcs-10 mcs 10 mcs-80 mcs	"Q-3", "T-1" "Q-1" "Q-2"	Cup cores, toroids, C-cores, E-cores, slugs
IF Transformers	Moderate Q, high μ , magnetic stability, adjustable	465 mcs 40 mcs other	"Q-1" "Q-2" Materials for filter inductors apply	Cup cores, threaded cores, toroids
Antennae Cores	Moderate Q, high μ , magnetic stability	5-10 mcs 10.50 mcs	"Q-1" "Q-2"	Rods, flat strips
Wide Band Transformers	High μ , moderately low loss	1 kc-400 kcs 1 kc-1 mc 200 kcs-30 mcs 10 mcs-100 mcs	"Q-3", "T-1" "H" "Q-1" "Q-2"	Cup cores, toroids, C-cores, E-cores
Adjustable Inductors	High μ , moderately low loss	Same as Wide Band Transformers	Same as Wide Band Transformers	Rods, threaded cores, tunable cup cores
Tuners	High μ , moderate to high Q, magnetic stability, as much as 10 to 1 adjustability with mechanical or biasing methods	Up to 100 mcs	For high Q selective circuits, materials under filter inductors apply. For others, materials under wide band transformers apply	Threaded cores or rods for mechanical tuning. Toroids, C-cores, E-cores for biasing methods
Pulse Transformers	High μ , low loss, high saturation	Pulse	Materials under wide band transformers apply	Cup cores, toroids, C-cores, E-cores
Recording Heads	High μ , low loss, high saturation, resistance to wear	Audio, pulse	"H" "Q-3", "T-1"	

GENERAL CERAMICS

Industrial Ceramics for Industrial Progress... Since 1906



Presenting **hp** 524D Electronic Counter

New 8-decade numerical readout! **New $5/10^8$ per week stability!**

SPECIFICATIONS

(Basic 524D without plug-ins)

Frequency:

Range: 10 cps to 10.1 MC
Gate Time: 0.001, 0.01, 0.1, 1, 10 secs or manual
Accuracy: ± 1 count $\pm 0.000005\%$
Reads in: KC. Automatic decimal

Period:

Range: 0 cps to 10 KC
Gate Time: 1 or 10 cycles of unknown
Accuracy: $\pm 0.3\%$ (1 period)
 $\pm 0.03\%$ (10 period average)
Stan. Freq. Counted: 10 cps, 1 KC, 100 KC, or 10 MC, or external
Reads in: Secs, msec, μ sec

General:

Registration: 8 places (99,999,999 max.)
Stability: $5/100,000,000$. May be standardized with WWV or external 100 KC or 1 MC primary standard.
Display Time: Variable 0.1 to 10 secs; or "Hold"
Input Voltage: 1 v min, 1.5 v peak. Rise time 0.2 seconds max.
Input Impedance: Approx. 1 megohm; 40 μ mf shunt.
Price: \$2,150.00 f.o.b. factory.
Data subject to change without notice

plus all these frequency and time measuring advantages!

- Direct, instantaneous, automatic readings
- Frequency coverage 10 cps to 220 MC*
- Time interval 1 μ sec to 100 days
- Resolution 0.1 μ sec
- High sensitivity, high impedance
- No calculation or interpolation

New convenience of uniform 8-decade numerical readout without meters — new 5 parts in 10^8 stability simplifying standards and other micro-wave measurements — this is the capsule story of the new *-hp-* 524D Electronic Counter.

Electrically similar to the widely used *-hp-* 524B Counter, the new 524D provides for full frequency measurements from 10 cps to 10 MC and period measurements from 0 cps to 10 MC. Low cost plug-in units extend frequency measuring range to 220 MC, permit period measurements of over 10,000 periods, and increase sensitivity for precise measurement of weak signals. Still another plug-in provides for time measurements from 1 μ sec to 100 days with 0.1 μ sec resolution. When used with *-hp-* 540A Transfer Oscillator, the 524D will measure accurately to 12 KMC. For complete details, write or call your *-hp-* representative; or write direct.

HEWLETT-PACKARD COMPANY

5022A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
CABLE "HEWPACK" • DAVENPORT 5-4451
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

*with plug-ins



world's most complete line of electronic counters

A Report On

COPPER and

8

points to consider

Today, with copper readily available, a new direction in electrical and electronic design is becoming apparent. There is a growing acceptance that many of the important new design requirements *besides* conductivity can be met by copper itself — as alloys, as laminates and as the pure metal. Sometimes it is merely the method of use which is changed to achieve optimum performance. But this is not just a rediscovery of copper — it is also the creative development of new alloys and new usages.

Here are just eight of the more important design requirements, besides conductivity, which are currently being met by some form of copper:

Conductivity plus Strength and Reliability

The flexibility, resiliency and fatigue strength of certain copper alloys have long dictated their use wherever reliability was important. Some of these alloys have excellent mechanical qualities while still maintaining high conductivity. Cadmium bronze, for example, is 99% copper with tensile strengths, for hard-drawn wire, up to 90,000 psi. Excellent spring qualities with fatigue strength and wear resistance, even at high temperatures, can be obtained with beryllium copper. Superfine-grain phosphor bronze is a relatively new development useful in applications where enduring contact-point pressure is most important.

The reliability of the copper operative parts of electromechanical choppers is a basic reason for the return to these in place of electronic types in a number of missile applications.

Conductivity plus Heat Dissipation and Hot Strength

Heat conductivity, of course, usually parallels

electrical conductivity. In addition to the obvious uses of this property in heat exchange apparatus and appliances, many current applications are taking advantage of copper's heat conductivity, plus its good joining properties, to conduct heat away from more delicate components by means of cooling vanes and heat sinks.

Chromium copper's greater strength at elevated temperatures is finding new uses in mechanical-electrical parts such as commutator segments and resistance-welding electrodes. At 200C, for example, its tensile strength is about twice that of tough-pitch copper.

Conductivity plus Corrosion Resistance

Commercially pure copper affords excellent resistance to industrial, marine and rural atmospheres, and to water, steam, alcohol, fuel oil, gasoline and sewage. Alloys have been developed to withstand many of the more active reagents. Recognition of this property has led to non-electrical uses in electrical equipment.

Conductivity plus Forming Facility

The hot and cold workability of copper itself is excellent. In addition, coppers containing small amounts of tellurium have good machining properties while still retaining high conductivity. And extruded shapes can often be used to minimize the amount of forming needed.

Interesting new examples of copper's workability include cold rolling to thicknesses less than .0005 inches (for missile computer applications, foil coil transformers and flexible printed circuits). Another new development is the cold hobbing of solid copper, maintaining extremely close tolerances. With this process it is possible to produce *one-piece* magnetron cavities.

its ALLOYS

besides conductivity

Conductivity plus Joining Facility

Copper is, of course, easily and firmly soldered. Many of its alloys also lend themselves well to brazing and to oxyacetylene or gas-shielded arc welding. New methods of inert-gas metal-arc welding make it easy to weld pure copper.

Conductivity plus Bonding Facility

Copper's affinity for plating has made possible, for the first time, a really good bond with titanium, by flash coating the base metal with copper before plating with titanium. New developments in printed commutator-type circuits can take advantage of the exceptional wear resistance of rhodium because of the good bond it will form with the copper conductive layer. Continuing research is also being done on laminates of copper with other metals and plastics.

Conductivity plus Finish

Copper and most of its alloys, particularly the nickel silvers and low-zinc brasses, are useful for ornamentation and housings because of their cold-working properties and their ease of plating and finishing. The new fine-grain brasses provide a surface ideal for high finish.

Conductivity plus Availability

The copper industry's mine reserves and productive capacity are at a new high. Copper and copper alloys are now available in more shapes, sizes and material specifications than ever before. The long-range prospects are so good as to completely dispel any reservations lingering from the post-war years when stock-piling gave a surface appearance of short supply. Domestic mine capacity is scheduled to increase at an average rate of well over 20,000 tons per year. Free-world capacity, allowing for depletions,

shows a projected 15% increase during the next five years.

And a word about conductivity itself. Even this classic property of copper merits a new examination. For example — silver-bearing copper, containing only 8 to 30 ounces of silver per ton, retains the high conductivity of copper, but has higher softening temperatures—and at commercially practical prices. Speaking of price, have you compared copper lately on a cost-per-mho basis with any other conductive metal you might be considering? You will find that this cost of conductance now makes it particularly economical to take advantage of copper's other properties.

The Copper & Brass Research Association is anxious to cooperate with you in finding a better way to solve your problems with copper. Write CABRA, 420 Lexington Avenue, New York 17, New York.

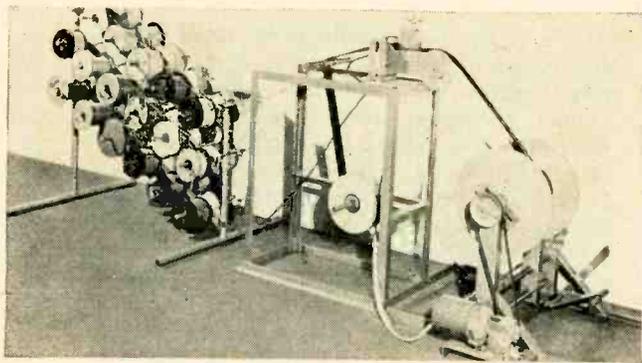
There's a new frontier in...

**COPPER
BRASS
BRONZE**

NEW Automatic Electronic Cable-making Machine Announced

(Los Angeles, California) After years of development, The Zippertubing Company announces production of a machine which automatically makes cables at speeds up to 900 feet per hour. This machine, occupying only 24 square feet of floor space, produces cables with up to 108 conductors and is so simple to operate that inexperienced personnel can make cables to any specification.

This new equipment utilizes the revolutionary Zippertubing cable jacketing, which is fed into the machine along with the required number of conductors. The Zippertubing then is automatically wrapped around the conductors, zipped closed and, if required, permanently fused with a chemical sealer. The completed cable automatically is wound on the take-up reel for storage or shipping. The machine will produce cable from $\frac{3}{8}$ " to 2 $\frac{1}{2}$ " O.D. with larger sizes on special order.



Complete unit with wire reels in place.

MULTI-JACKETED CABLES IN ONE STEP

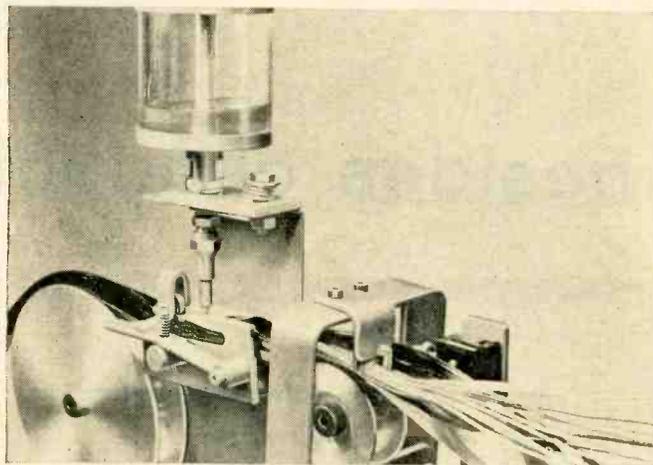
By using Zippertubing laminated materials, cables which require jackets of several different materials can be made in one step without costly re-handling. Available jackets include copper, aluminum or Co-netic steel in combination with such materials as vinyl, Mylar,* or fiber glass. Other laminates for high temperature exposure, abrasion protection, etc., also may be used in the machine.

SUBSTANTIAL SAVINGS

Up to 90% of the labor costs formerly involved in fabricating cables are eliminated through the use of the Zippertubing Cable Machine. Only limited floor space is necessary for long-run continuous lengths, and material waste, skilled labor investment and expensive extruding equipment no longer are required. Expensive "minimum" orders for custom extruded cabling as well as delay in deliveries also are eliminated. Because of the flexibility of Zippertubing, small

*Trademark of duPont.

cable runs for R & D work are economically feasible. Zippertubing cables can be re-opened for additional work on conductors, virtually eliminating the great costs formerly incurred in correcting mistakes in prototype development.



Close-up of head showing Zippertubing jacketing and conductors being formed into cable and automatically sealed.

MEET MIL SPECS

Cables produced on this new equipment meet all necessary MIL specs, depending on the jacketing material and the purpose for which it is to be used.

CABLE MACHINE FREE

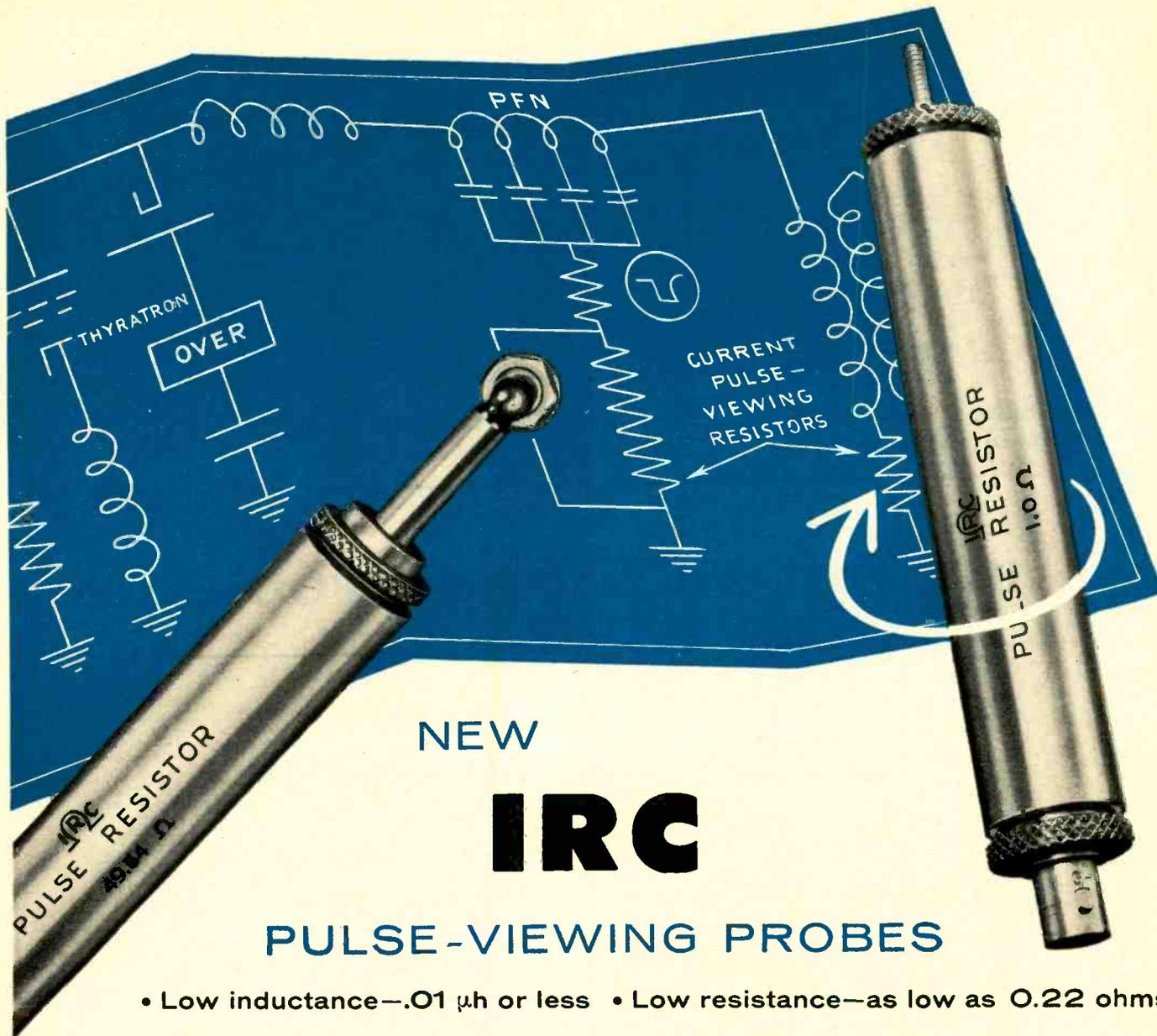
One of the purposes of this new machine is to help manufacturers reduce their capital investment and inventory in electronic cables. A special plan has been developed whereby manufacturers who use 10,000 feet or more of Zippertubing jacketing per month will be provided with one of these machines at no cost. For those with more modest requirements, the machine may be leased very inexpensively with option to buy, or it may be purchased outright. A 100% lifetime guarantee is available under all plans. When ordering, allow three weeks for delivery.

AVAILABLE IN THREE PARTS

The Zippertubing cable machine may be ordered in three units: basic unit, which includes the head and sealing device; wire payoff unit, which contains the "tree" and spindles for holding the wire reels; power unit, which has the take-up reel spindle, frame and 115 V AC/DC motor that pulls the cable through the complete process.

For complete catalog information or field engineering service, write to the manufacturer: The Zippertubing Company, 752 So. San Pedro St., Los Angeles 14, California. TWX LA 840. Sales offices and warehouses are located in all principal cities.

(advertisement)



NEW

IRC

PULSE-VIEWING PROBES

- Low inductance—.01 μ h or less
- Low resistance—as low as 0.22 ohms

Why bother with a makeshift resistor network when you want to look at pulse shapes? Especially when you can use the new convenient IRC Pulse-Viewing Resistors. Available with a phone plug which can be inserted into a standard phone jack, or a choice of coaxial connectors, both can be inserted right into the circuit . . . thereby saving engineering and test time.

END TRANSIENTS OR RINGING—Transient or ringing are eliminated by a special construction which reduces inductance to .01 μ h or less.

18 STANDARD RESISTANCE RANGES—Resistance values from 0.22 to 150 ohms in 15-watt or 75-watt sizes (DC continuous duty rating) make it easy to test a wide variety of pulse radar and similar magnetron circuits. Resistor elements are of the highly-stable film type.

INTERCHANGEABLE CONNECTORS AND ELEMENTS—IRC Pulse-Viewing Resistors are so designed that resistance values and connectors can

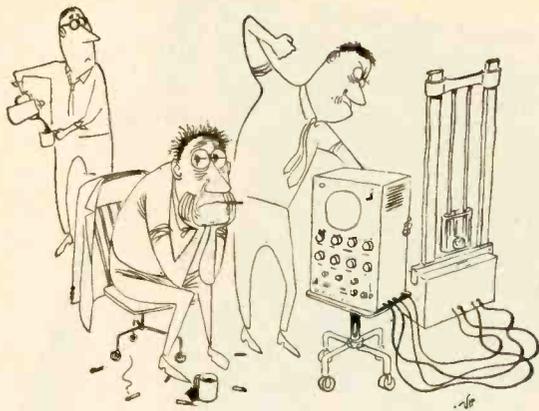
be quickly interchanged through use of a kit containing 4 sets of resistors, 4 sets of connectors (BNC-coaxial, UHF, Phone Plug, and 6-32 Stud), tools for assembly and necessary hardware.

WRITE FOR
NEW BULLETIN S-4A



INTERNATIONAL RESISTANCE COMPANY
COMPUTER COMPONENTS DIVISION

Dept. 376, 401 N. Broad St., Philadelphia 8, Pa
In Canada: International Resistance Co., Ltd., Toronto, Licensee

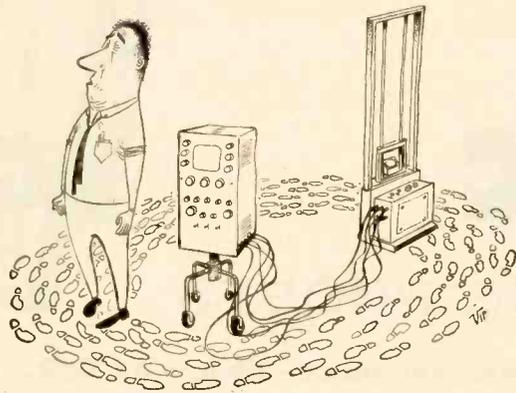


PROBLEM:
Wasted Effort in Capturing Transients

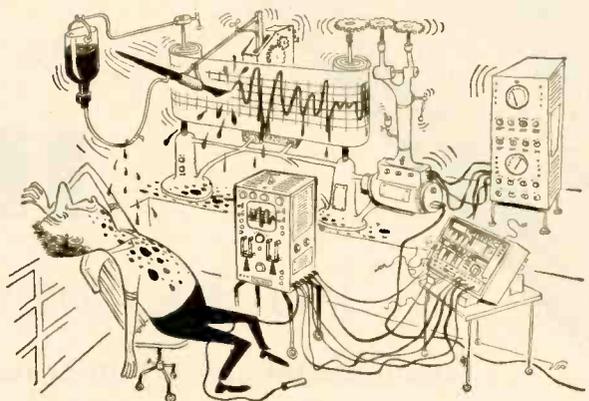


PROBLEM:
Wave-form Photography

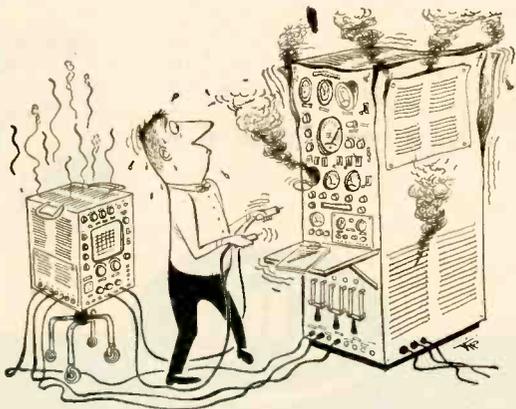
six not-so-funny problems...



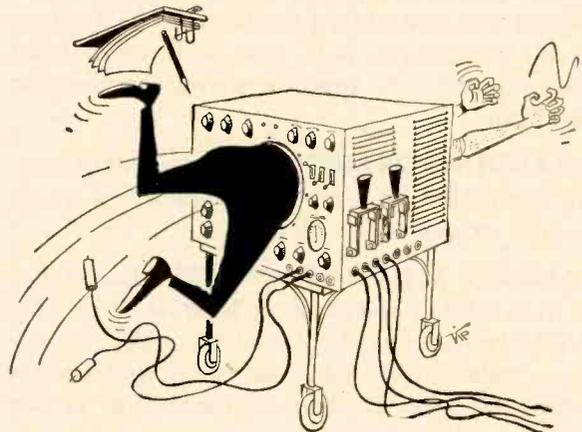
PROBLEM:
Duplication of Research Effort



PROBLEM:
Transient Analysis



PROBLEM:
Trouble Shooting



PROBLEM:
How to Capture Elusive Transients

...one happy solution

Has the analysis of non-recurring transients presented a perplexing problem to you? Are you using a conventional scope or recorder, which wastes time, money, and research dollars?

SOLUTION: The Hughes MEMO-SCOPE® oscilloscope freezes wave forms until intentionally erased. Selected transient information may be triggered externally or internally and retained for viewing. Successive wave forms may be written above, below, or directly upon the original information.

HUGHES MEMO-SCOPE OSCILLOSCOPE

SWEEP SPEED FOR STORAGE:

10 microseconds to 10 seconds per division (0.33").

FREQUENCY RESPONSE: DC to 250 KC down 3 db.

SENSITIVITY:

10 millivolts to 50 volts per division or with optional high sensitivity preamplifier 1 millivolt to 50 volts per division.

APPLICATIONS:

Trouble shooting data reduction equipment...switch and relay contact study...ballistics and explosives research...ultrasonic flaw detection...physical testing—shock—stress—strain.



If you haven't yet seen a demonstration of the MEMO-SCOPE oscilloscope, ask a Hughes representative to arrange one. He'll quickly do so—at your convenience—in your area. Please write to:

HUGHES PRODUCTS

MEMO-SCOPE Oscilloscope

International Airport Station, Los Angeles 45, California

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

© 1958, Hughes Aircraft Company

... six



... five



... four



... three



... two



... one



... fire



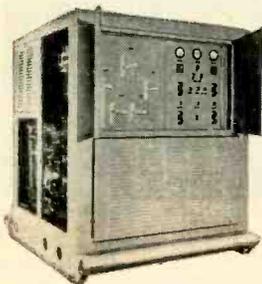
.....



SYVERSON

When the target is space and a million dollars' worth of missile rests idly on the ground—not even a long countdown helps. In a showdown situation, the successful shoot depends on the “go, no-go” type of test that pinpoints the trouble.

NEXT TIME...LOOK TO INET FOR PRECISE GROUND POWER



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



Missile men desiring a special reprint of the above cartoon should write to "Count-down", c/o Inet Division of Leach.

INET DIVISION LEACH CORPORATION

18435 SUSANA ROAD, COMPTON, CALIFORNIA
DISTRICT OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES OF U. S. AND CANADA

NLS Model 481

Four-Digit Digital Voltmeter

- Measures DC Voltages from 1 Millivolt to 1,000 Volts
- Displays Measurements on Illuminated Numerical Readout
- Scale Factor and Linearity Accurate to 0.01%
- 10 Megohm Input Impedance
- Automatic Range Changing, Decimal Placement, and Polarity Indication
- New Snap-In Readout Assembly
- Furnished Complete; No Extras to Buy



Here is the greatest value ever offered in a precision instrument! Look at the features listed above . . . features that assure higher performance, reliability, and accuracy than provided by any other voltmeter. And look at the price . . . less than one-half the price of competitive instruments. As originator of the digital voltmeter, NLS has led the way in developing new manufacturing techniques. Now, NLS is the first to mass produce digital voltmeters and make possible the unique combination of high performance and low cost in the NLS 481. See this rugged new industrial voltmeter demonstrated, and discover why electronic and servo-type digital voltmeters — as well as the most precise moving-coil voltmeters — are made obsolete by the NLS 481! Write today for complete specifications and the name of the nearest demonstrator-equipped NLS field engineer!

INSTRUMENTS TO MEET EVERY APPLICATION

NLS manufactures the most complete line of three, four, five, and six digit instruments for automatically measuring DC and AC voltages, voltage ratio, and resistance. Complete catalog available upon request.

NEW LOW-COST INDUSTRIAL VOLTMETER

FULL PRICE

\$985

F.O.B. Del Mar, California



Originators of the Digital Voltmeter

**non-linear systems,
inc.** SAN DIEGO COUNTY AIRPORT,
DEL MAR, CALIFORNIA

CIRCLE 25 READERS SERVICE CARD



Here's why you get the safest, most dependable electrical protection . . . when you specify *BUSS or Fusetron Fuses*

Each BUSS and FUSETRON fuse is designed and made to meet the highest standard of dependability. Every fuse is then tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

The dependability of BUSS and FUSETRON fuses provides equipment with maximum protection against damage due to electrical faults and — prevents useless shutdowns caused by faulty fuses blowing needlessly.

By operating as intended, BUSS and FUSETRON fuses help safeguard the reputation of your equipment for service and reliability.

To meet your needs, — there's a complete line of BUSS and FUSETRON fuses in all sizes and types, . . . plus a companion line of fuse clips, blocks and holders.

If you have an unusual or difficult electrical protection problem . . .

. . . the BUSS fuse research laboratory and its staff of engineers are at

your service. In many cases, our engineers can help you save engineering time. Whenever possible, a fuse will be selected that is readily available in local wholesalers' stocks so that your equipment can easily be serviced.

For more information on the complete line of BUSS and FUSETRON Small Dimension Fuses and Fuseholders, write for bulletin SFB.

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

BUSS fuses are made to protect — not to blow needlessly



A COMPLETE LINE OF FUSES FOR HOME, FARM, COMMERCIAL, ELECTRONIC, AUTOMOTIVE AND INDUSTRIAL USE.

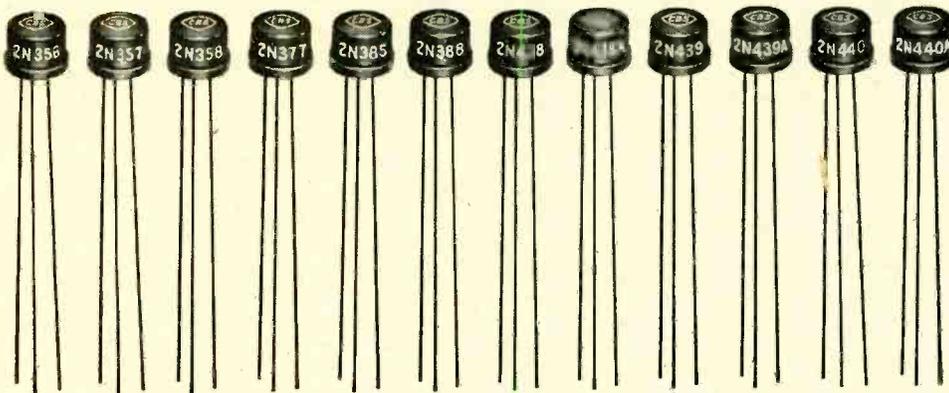
958

*
now...

most comprehensive line of NPN high-speed switching transistors

12 RELIABLE COMPUTER TYPES FEATURING:

- Faster switching
- Higher voltage
- Lower cutoff current
- Lower saturation resistance



CBS-HYTRON was first with the most flexible selection of over 100 PNP power transistors. Now, it offers the most comprehensive line of mass-produced NPN transistors for high-speed switching and high-frequency amplification.

They are NPN alloy-junction germanium for greater uniformity, higher voltage and current, flatter gain, and lower saturation resistance. They employ the JETEC TO-9 package welded for reliability. They offer *high* frequency response, switching speed, operating voltage, current amplification factor, and dissipation rating. And *low* leakage current and collector capacitance.

The handy tables let you select for application, dissipation and frequency the types you need. Call or write your regional sales office or the Lowell general sales office for technical bulletin E-293-302 and for application and delivery information...today.

TYPES AVAILABLE

FOR LOGIC CIRCUIT

Typical Frequency in Megacycles	12	2N440	2N440A
	8	2N439	2N439A
	4	2N438	2N438A
		100	150
		Maximum Dissipation in Milliwatts	

FOR CORE DRIVER

Typical Frequency in Megacycles	9	2N358	2N388
	6	2N357	2N385
	3	2N356	2N377
		100	150
		Maximum Dissipation in Milliwatts	

*More reliable products
through Advanced-Engineering



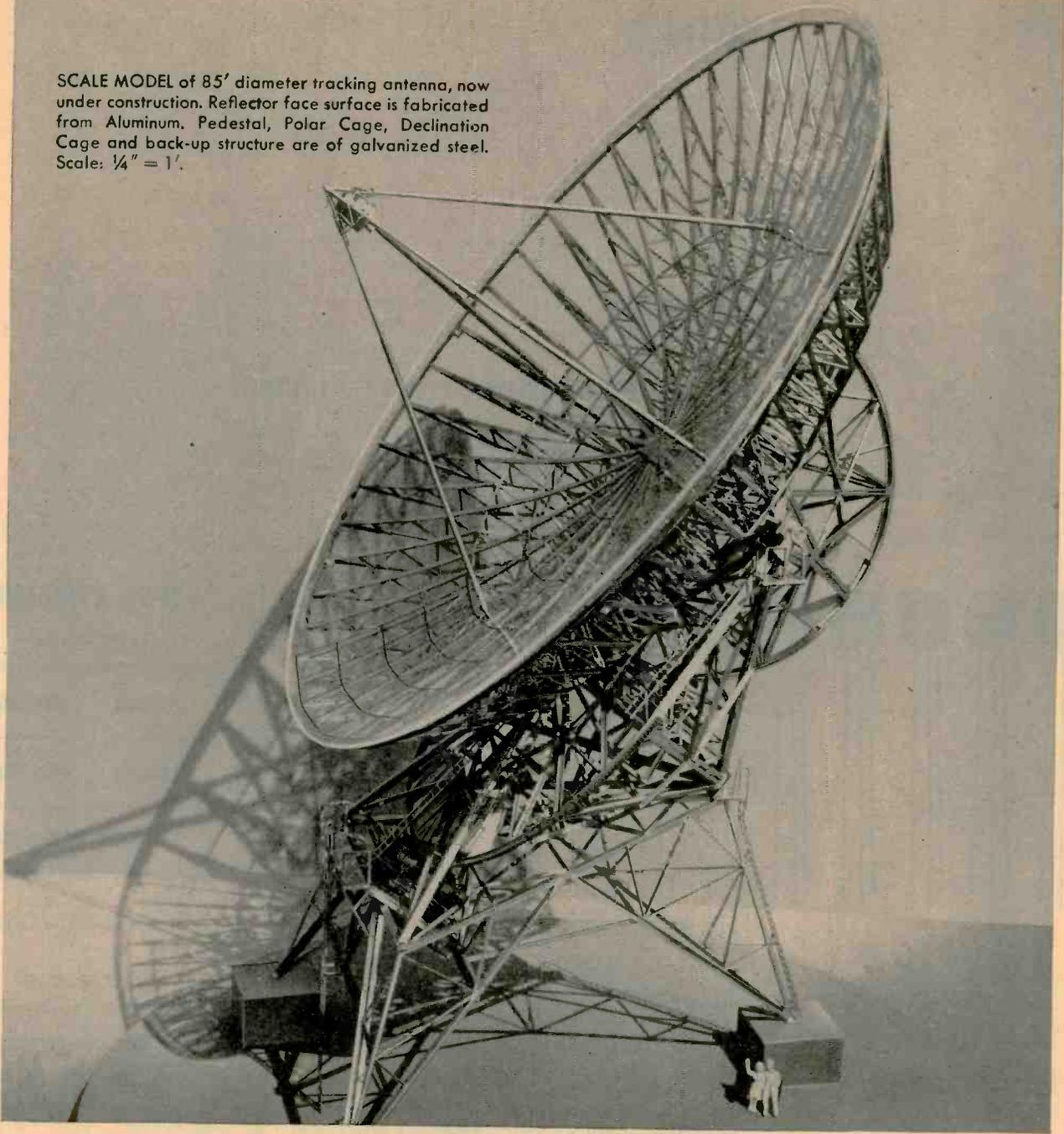
semiconductors

CBS-HYTRON, Semiconductor Operations

A Division of Columbia Broadcasting System, Inc.

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

SCALE MODEL of 85' diameter tracking antenna, now under construction. Reflector face surface is fabricated from Aluminum. Pedestal, Polar Cage, Declination Cage and back-up structure are of galvanized steel. Scale: $\frac{1}{4}'' = 1'$.



New Blaw-Knox 85' Diameter Tracking Antenna

This newest Blaw-Knox 85' Diameter Tracking Antenna will be part of a telemetering operation connected with missile and satellite development.

Its design is fully determinate. All structural members of the assembly are analyzed for stress and deflection before fabrication. Coupled with shop fabrication and field erection to rigidly accurate tolerances, it is capable of the highest gain, with a minimum of distortions or aberrations.

The entire drive system embodies such critical design requirements as infinitely variable movement with negligible creep or overrun for tracking. The slewing drives are capable of the extremely rapid acceleration and deceleration necessary to focus on supersonic targets.

Pioneering like this is the latest step in a long series of Blaw-Knox developments. Such milestones as the

Guyed Vertical Radiator design in AM radio, the first radar antenna used to bounce signals off the moon, and the Tropospheric Scatter Antenna for over-the-horizon television have marked Blaw-Knox as a world leader in advanced design, fabrication and erection techniques.

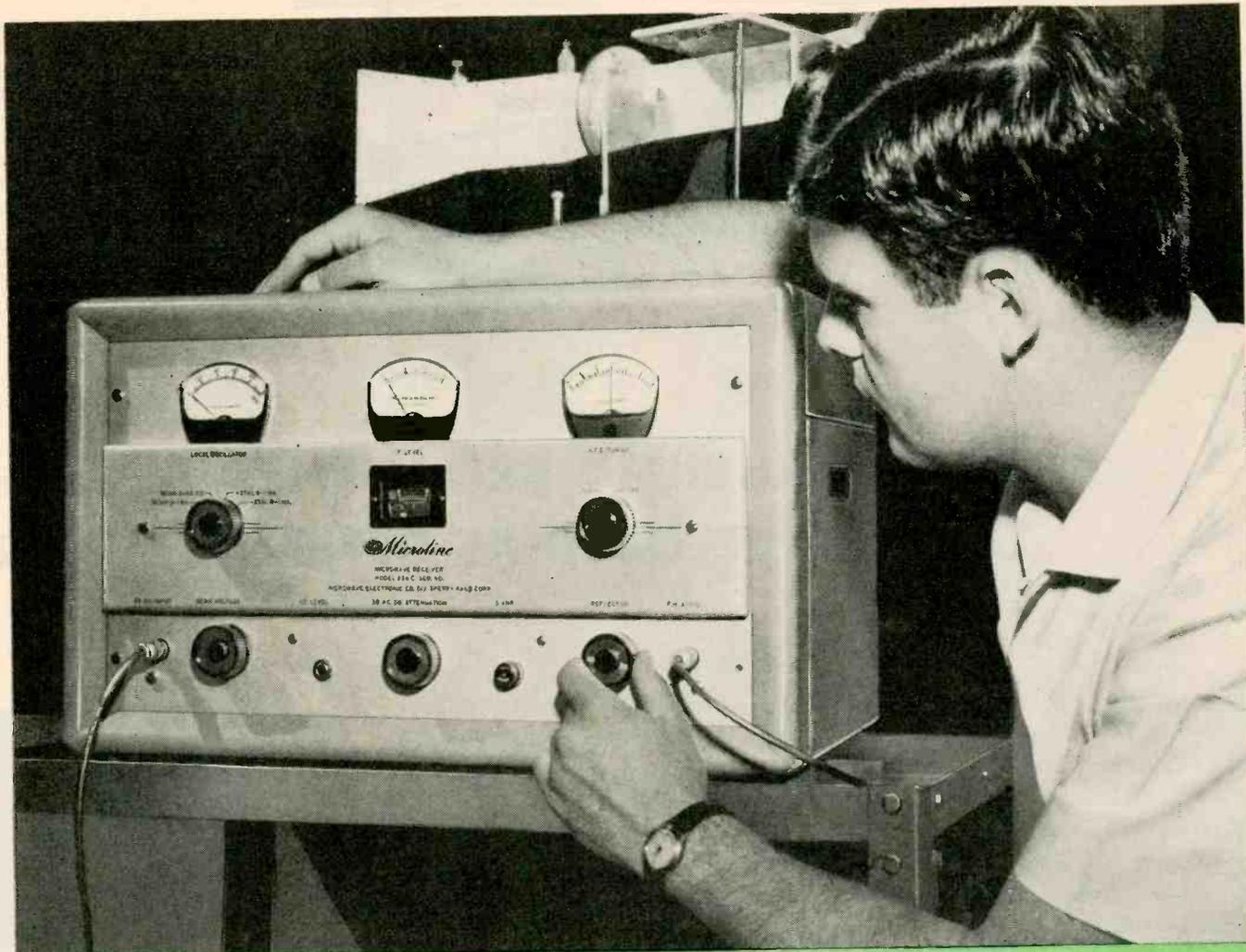
Blaw-Knox welcomes the opportunity to translate your most advanced concepts into highly reliable operating equipment. Contact the Antenna Group.

Antennas—Rotating, Radio Telescopes, Radar, Tropospheric and Ionospheric Scatter,



BLAW-KNOX COMPANY

*Blaw-Knox Equipment Division
Pittsburgh 38, Pennsylvania*



MODEL 296C MICROWAVE RECEIVER

IF frequency 30 mc

Bandwidth (overall) 1.3 mc at 3 db points

Gain IF amplifier 65 db min.

Pre-amplifier 30 db min.

Attenuation range, calibrated 0-80 db \pm 0.2 db above 5 db at 30 mc

Self-contained local osc. power supply 600-800v at 50 ma., beam supply

Self-contained AFC System. Constant IF type with a time constant of about 0.2 sec.

For highly accurate measurements

at all microwave and UHF frequencies...

SPERRY'S MODEL 296C MICROWAVE RECEIVER

This Sperry Microline* Receiver is a precision instrument of great accuracy enabling measurements at all microwave and UHF frequencies.

Model 296C can be used for measuring coupling and directivity of directional couplers, relative field strength, very high and very low VSWR, antenna patterns and as a general-purpose microwave laboratory receiver. In addition, this receiver was designed for use as a good secondary standard of attenuation.

A completely self-contained unit, it includes a 30-mc pre-amplifier, 30-mc IF amplifier, 30-mc calibrated attenuator, local oscillator power supply and AFC circuits. The 296C

requires only the use of a local oscillator and an appropriate mixer for operation at any microwave or UHF frequency.

*TM Reg. U. S. Pat. Off.

SPERRY MICROWAVE ELECTRONICS
COMPANY
CLEARWATER, FLORIDA

Division of Sperry Rand Corporation

ADDRESS ALL INQUIRIES to Clearwater, Florida or Sperry Gyroscope offices in New York, Cleveland, New Orleans, Los Angeles, San Francisco, Seattle.

CIRCLE 29 READERS SERVICE CARD

CIRCLE 30 READERS SERVICE CARD →



The G-E Power Tube Microwave Laboratory is located at Stanford Industrial Park, Palo Alto, California where it was one of the Park's pioneer installations. Its staff of scientists and engineers has the advantage of technical exchange with Stanford University faculty and research staffs, as well as with General Electric's own Research and General Engineering Laboratories.

RADAR CAPABILITY BROADENED BY HIGHTUBES DEVELOPED AT GENERAL ELECTRIC

DEVELOPMENT of advanced high-power, pulsed traveling-wave tubes at the Power Tube Department's Microwave Laboratory at Palo Alto, California, is contributing substantially to the broadening of radar frequency ranges. Vital accomplishments provided are: high pulse powers over wide instantaneous bandwidths; periodic permanent-magnet focusing; novel, light-weight, rugged tube structures. In addition to systems-oriented work at X band, developments are progressing at L, S, C, and K bands.

Traveling-wave tube pioneering is only one of a broad range of microwave activities being conducted at the G-E Microwave Laboratory. The Laboratory's fields of activities are applied research, advanced development, and product design in microwave tubes and microwave techniques. All development work is done with an eye to practical, economical manufacture—thus minimizing the time lapse between prototype development and quantity production—and to the realistic tube needs of future microwave equipment. Technical inquiries pertaining to advanced microwave tube development invited. *Power Tube Department, General Electric Company, Schenectady, New York.*

* * *

Professional opportunities available for engineering and scientific personnel. Inquiries invited.

Progress Is Our Most Important Product

GENERAL  **ELECTRIC**

9545-8481-15

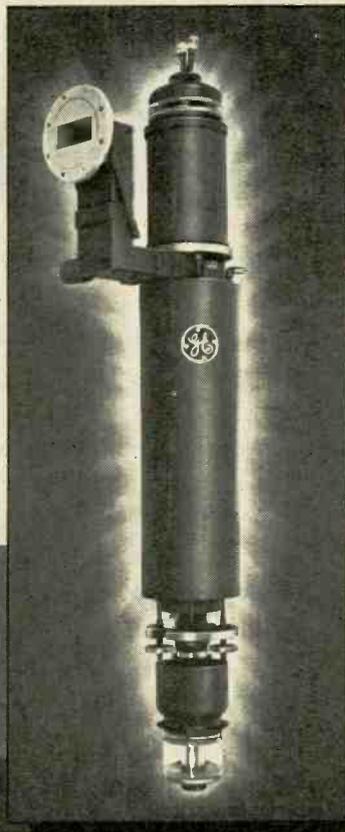


Extensive development work in the following classes of tubes is a continuing activity of the G-E Microwave Laboratory's staff of scientists, engineers and technical personnel.

Pulse klystron power amplifiers	Super-power klystrons
CW klystron amplifiers	Voltage-tunable oscillators
High-power pulsed TWT amplifiers	High-power duplexers
Medium-power CW TWT amplifiers	Microwave filters
Low-noise, broadband TWT amplifiers	Frequency multiplier TWT amplifiers

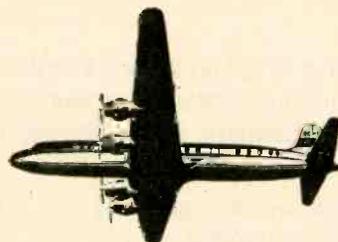
POWER TRAVELING-WAVE MICROWAVE LABORATORY

Typical of traveling-wave tubes being developed at the G-E Microwave Laboratory is this S-band tube which has operated successfully at the 2-megawatt pulse output level with 30 db gain.



Effects of high-average power tests on a multi-megawatt traveling-wave tube are described by Project Engineer K. Zublin (center). Other members of the project team (left to right): E. J. Nalos, R. M. Phillips, R. A. Craig and R. P. Eorghi.

AEROCOM'S 1046 H. F. TRANSMITTER



POWER + STABILITY

1000 WATTS

WITH

.003% STABILITY

Rugged, versatile general purpose H. F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0° to +50°C.). Excellent for point-to-point or ground-to-air communications.

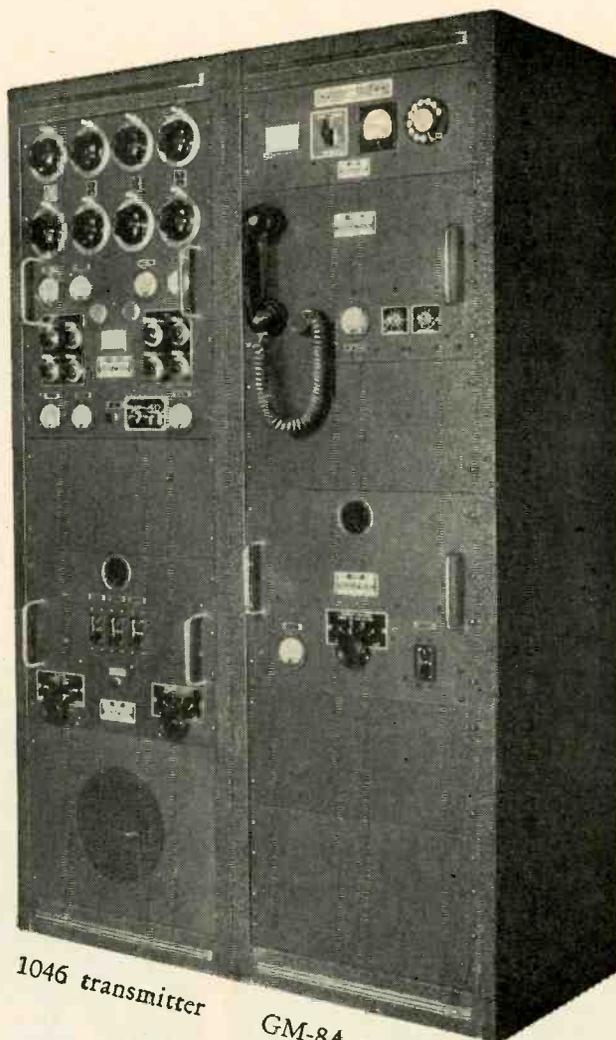
Multi-channel operation on telegraph A1, or telephone A3 with GM-8A modulator... new Aerocom 1046 can be *remotely controlled* with TMC-R at control position and uses only one pair of telephone lines. In A3 operation, the local dial control panel is located in modulator cabinet.

Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to +50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

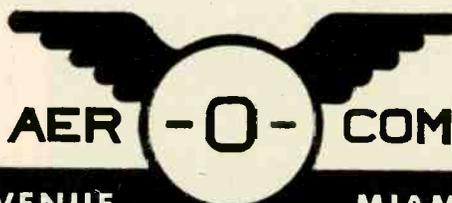
Complete technical data on request

Now! Complete-package, 192 channel, H. F., 75 pound airborne communications equipment by Aer-O-Com! Write us today for details!



1046 transmitter

GM-8A modulator

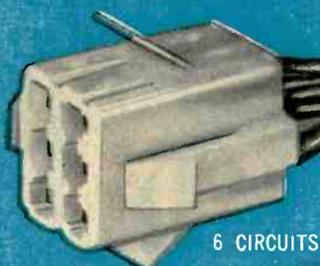


3090 S.W. 37th AVENUE

MIAMI 33, FLORIDA

The AMP logo consists of the letters "AMP" in a bold, sans-serif font, enclosed within a rectangular border.

3 CIRCUITS



6 CIRCUITS



9 CIRCUITS

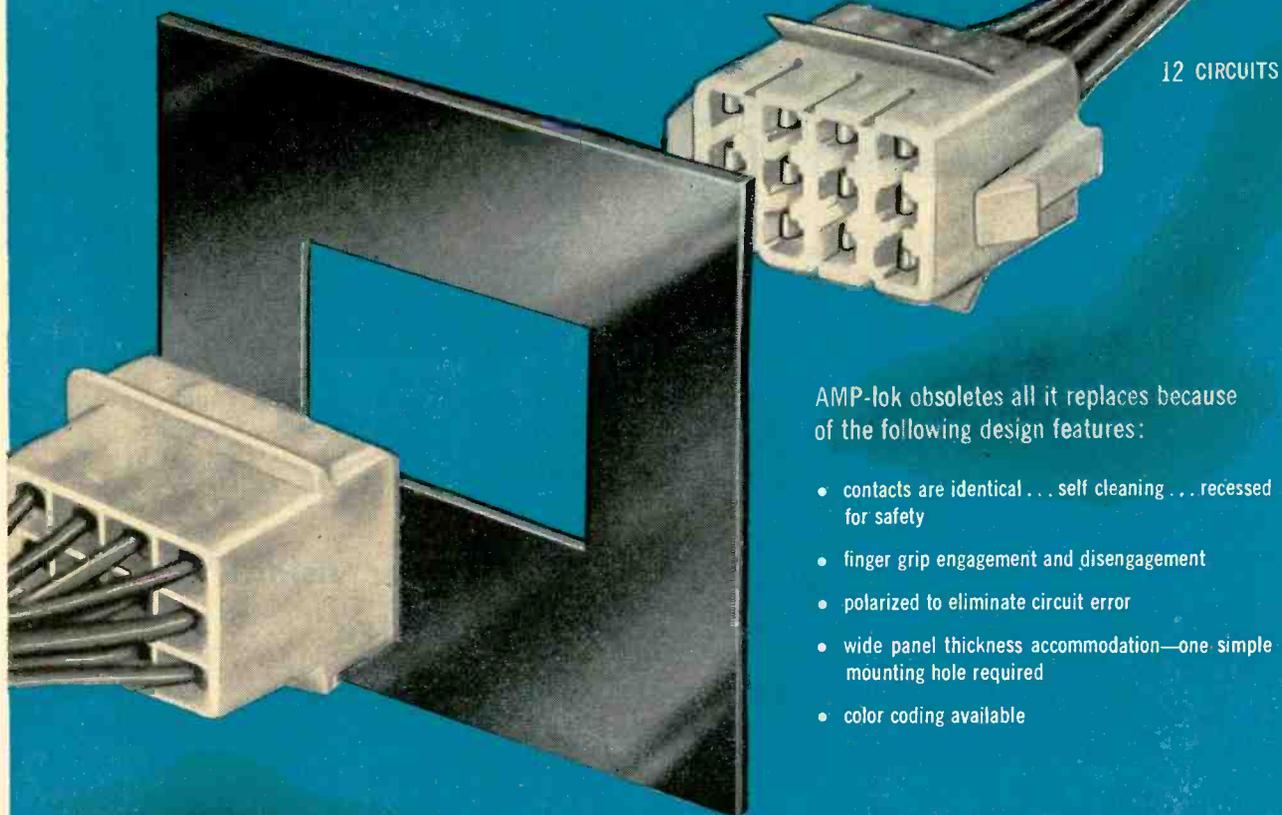


THE *NEW LOOK* IN AMP-lok

Now . . . connect 3, 6, 9 or 12 circuits simultaneously with the AMP-lok multiple connector and a simple push of the fingers.

All units are self-anchoring and require no supplementary mounting parts in through panel multiple connector applications.

AMP-lok can be used as a safe, free-hanging multiple connector also.



12 CIRCUITS

AMP-lok obsoletes all it replaces because of the following design features:

- contacts are identical . . . self cleaning . . . recessed for safety
- finger grip engagement and disengagement
- polarized to eliminate circuit error
- wide panel thickness accommodation—one simple mounting hole required
- color coding available

Additional literature and samples available on request.

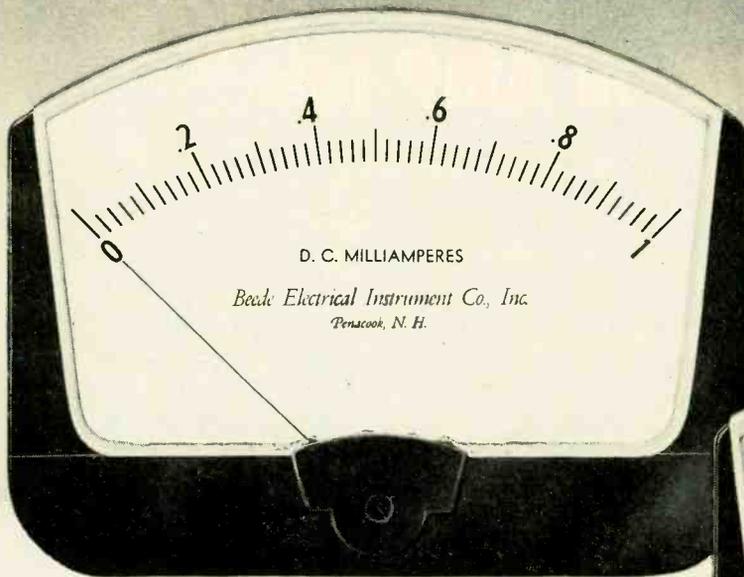
AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

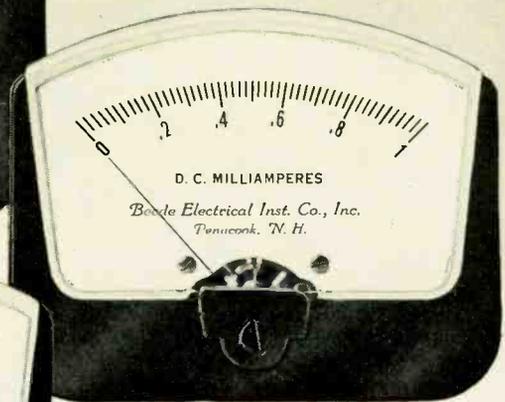
AMP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

BEEDE *Presents* the PANORAMA

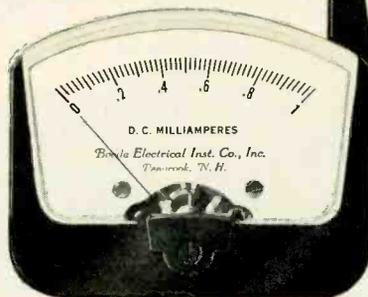
Series of
INDICATING
INSTRUMENTS



Model 70
Width 7"
Height 5 1/4"



Model 230
Width 4 5/8"
Height 3 5/8"



Model 140
Width 3 3/8"
Height 2 5/8"

The PANORAMA gives you better, clearer vision and longer scales, with easier readability.

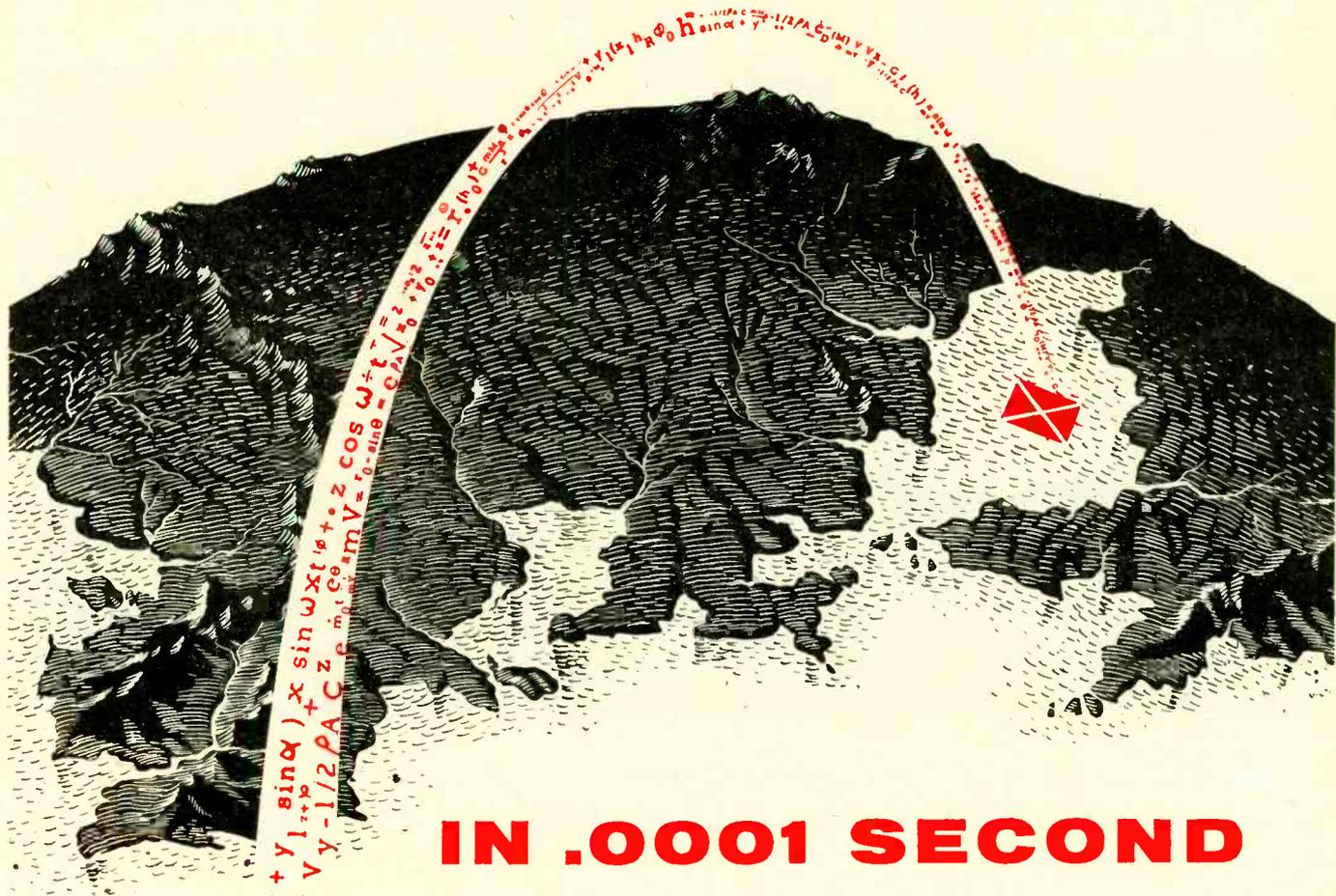
The plastic panel provides excellent natural illumination, top, sides and front.

Available with frosted portion or color of your choice.

The ultra modern beauty of the PANORAMA will add much to your product.

BEEDE ELECTRICAL INSTRUMENT CO., INC.
PENACOOK, NEW HAMPSHIRE

MISSILE IMPACT PREDICTION



IN .0001 SECOND

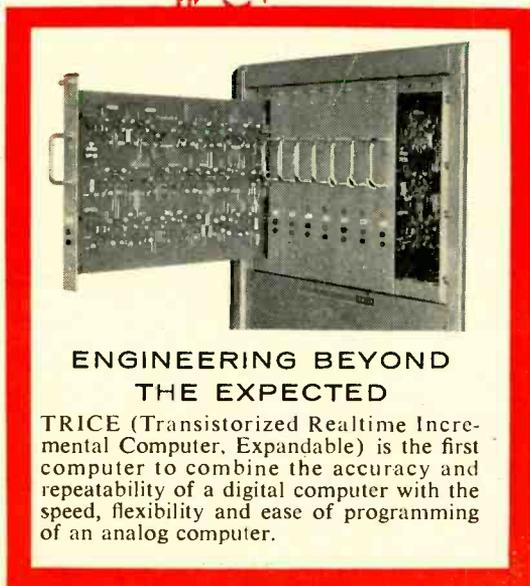
TRICE, the world's most advanced computer, saves many minutes over time currently required for ballistic missile impact prediction. TRICE modules (Integrators, Multipliers, etc.) can be assembled as a special purpose computer for dynamic systems or as a digital differential analyzer. Its incredible speed of 100,000 iterations per second *in parallel* is unaffected by the size of the problem. The first model is in operation at the U.S. Army Ordnance Missile Command, Huntsville, Ala.

Write for literature describing TRICE and its many uses: aerodynamic stability, control system stability, impact prediction, stable platform calculations, satellite orbit predictors and others.

PACKARD-BELL COMPUTER CORP.
a subsidiary of

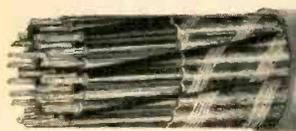
PACKARD BELL ELECTRONICS

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



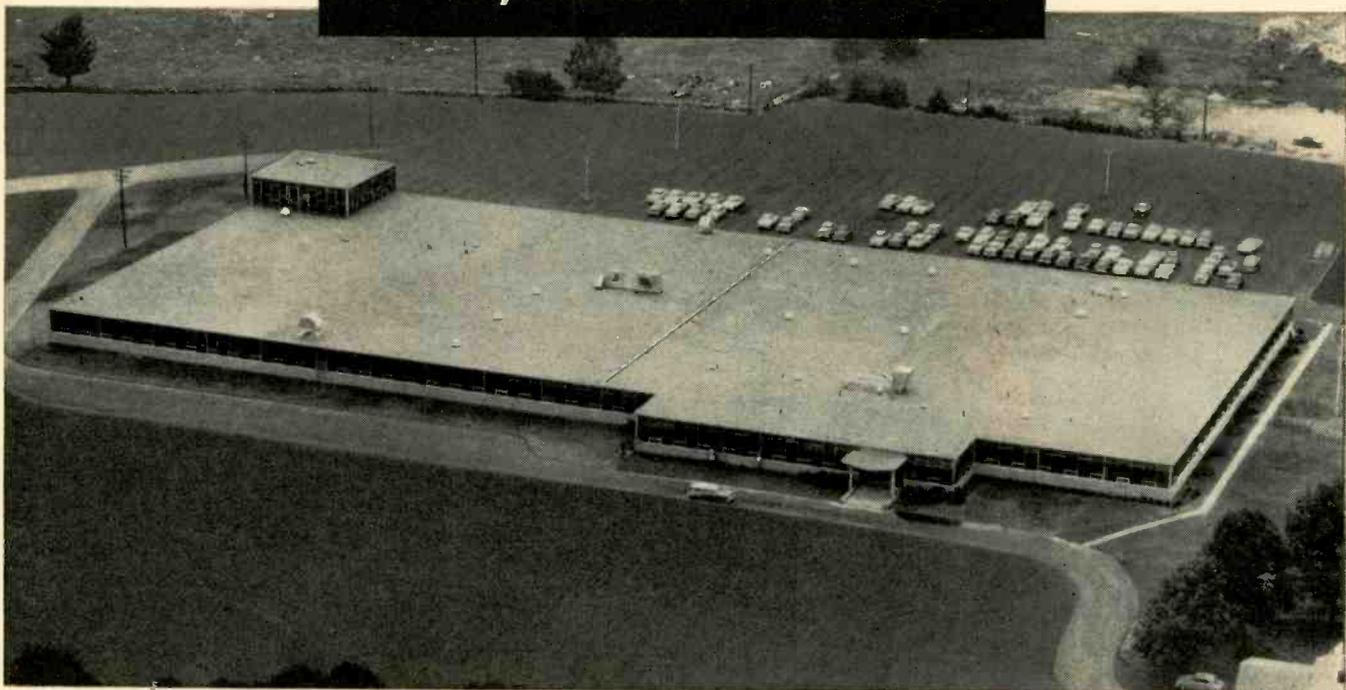
ENGINEERING BEYOND THE EXPECTED

TRICE (Transistorized Realtime Incremental Computer, Expandable) is the first computer to combine the accuracy and repeatability of a digital computer with the speed, flexibility and ease of programming of an analog computer.



PHALO

WIRES, CABLES & CORD SETS



Announce the Proudest Moment In Their History!

As histories go, ours is not ancient. This is only our fifteenth year, but we have had a progressive, action-packed fifteen years.

In July of this year, the doors of our fine new plant opened for the first time and provided our proudest moment.

This new plant of ours is a model of modern wire and cable production. From raw materials to finished product, efficiency and economy of manufacturing is the key-

note. Equipment matches the skill of our people in this broad expanse of floor space . . . providing a perfect setting for the new product developments which have marked our growth from the firm's inception.

We are looking forward to providing you with a superior brand of service from the expansive new home of Phalo.

Visit us when you can . . . we'll be happy to show you our model plant from one end to the other.



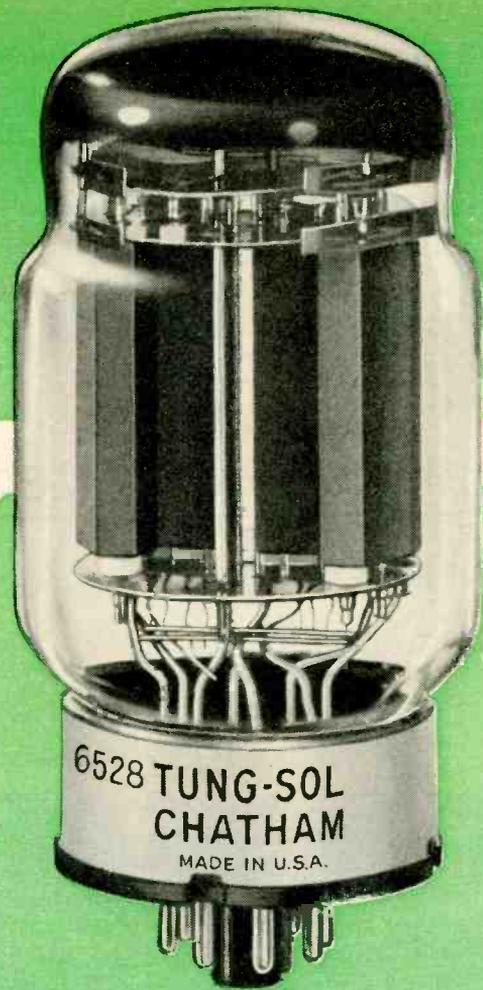
**530 BOSTON TURNPIKE
PLASTICS CORPORATION
SHREWSBURY, MASS.**

Plant Construction By Lilly Construction Company, Allston, Mass.

317-8



6528 medium μ ,
high current, twin power triode
for series regulator service!



Volume output makes Tung-Sol/Chatham 6528 available for widespread use!

Enthusiastic acceptance of the 6528 Twin Power Triode forced rapid expansion of production quotas, in turn resulting in lower manufacturing costs. These savings are reflected in lower prices to the user making Type 6528 economically practical for a vast number of new industrial and military applications.

Type 6528 requires fewer passing tube sections . . . permits lower range control circuits . . . and combines low internal tube drop with top control sensitivity — a definite advantage over previous series regulators. Also, 6528 triodes may be used in parallel or separately. This simplifies circuitry . . . saves space.

DESIGN FEATURES OF TUNG-SOL/CHATHAM TYPE 6528!

- 1 Hard glass envelope permits full out-gassing . . . takes higher temperatures without gas evolution . . . increases thermal shock resistance.
- 2 Zirconium-coated graphite anodes assure excellent gettering. Graphite virtually unaffected by heat.
- 3 Oversize cathodes provide adequate emission reserve . . . eliminate standby deterioration.
- 4 Extra-rugged grids. Sturdy chrome-copper side rods support gold-plated molybdenum lateral wires.
- 5 Overall ruggedness. Metal snubbers and ceramic insulators support mount. Heavy button-stem has rigid support leads.

Tung-Sol Electric Inc. specializes in special-purpose tube development . . . can match any design requirement you have. For full data on Type 6528 . . . to fill any power tube socket . . . contact: Tung-Sol Electric Inc., Newark 4, N. J. Commercial Engineering Offices: Bloomfield and Livingston, N. J.; Culver City, Calif.; Melrose Park, Ill.

TYPE 6528 RATINGS

Max. plate dissipation per tube	60 watts
Max. plate dissipation per section	30 watts
Max. steady plate current per section	300 ma.
Max. plate voltage	400 volts
Max. heater cathode voltage	300 volts
Amplification factor*	9
Transconductance per section*	37,000 μ mhos

*Average characteristics at $E_b = 100v$, $E_c = -4v$, $I_b = 185 ma$.

 **TUNG-SOL**[®]

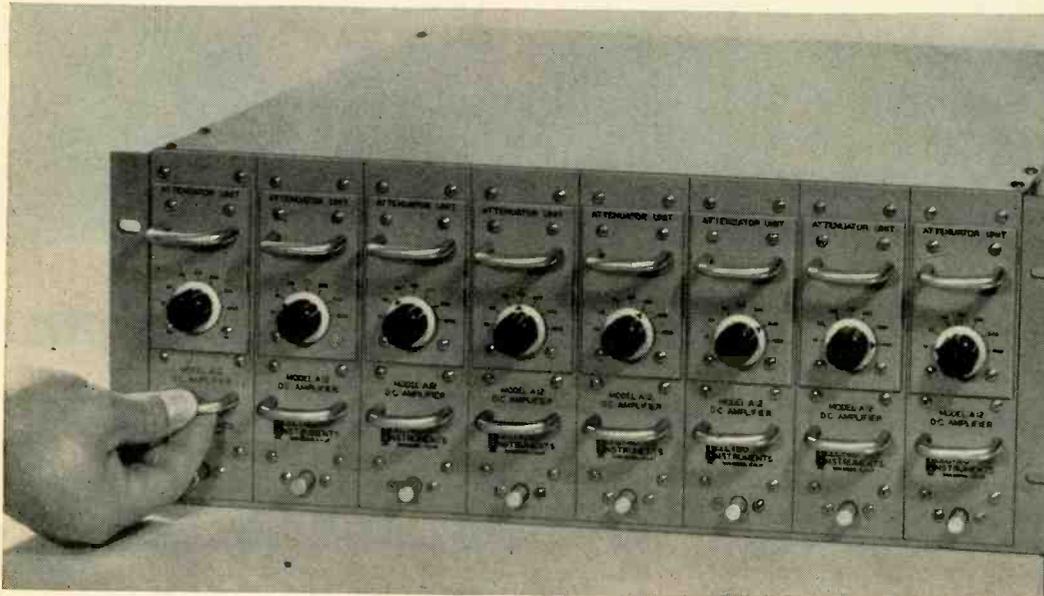
New Electro Instruments A-12 DC amplifier totally transistorized

equal to or better than the best
vacuum tube instruments!

The new Model A-12 DC Amplifier is the preferred systems link for amplification, normalization and impedance transformation. Use of solid state elements assures maximum reliability; power dissipation is only seven watts. Mil-type components are mounted on coated plug-in printed circuit boards for protection against vibration and corrosion.

versatility plus economy

Electro Instruments produces a series of plug-in mode selectors and attenuators for the A-12: single ended, differential and operational, fixed and variable gain.



Eight to a rack
The A-12 is packaged for high density use; mounts eight across in 19" relay rack panels.

SPECIFICATION SUMMARY

	Single Ended Input
Gain:	Fixed gain set to any value from 10 to 1000 inclusive by front panel plug-in units. Gain switching plug-in attenuator available with gains of 0, 10, 20, 50, 100, 200, 500 and 1,000. Adjustable upward 6db from setting with potentiometer.
Input Impedance:	100 megohms shunted by 0.001 mfd (typical).
Source Impedance:	5K or less (to meet noise specification).
Drift:	Less than 2 microvolts in 200 hours at constant ambient temperature. Less than 0.4 microvolt per degree centigrade.
Ambient Temperature:	0° to 50°C.
Noise (Referred to input):	0.3 cps 5 microvolts peak to peak 0.750 cps 4 microvolts rms. 0.50 kc 8 microvolts rms.
Frequency Response:	±3db to 50 kc (typical); ±1.0% to 2 kc
Output Capability:	±10 volts at ±100 ma DC or peak AC to 10 kc

Write today for complete specifications on single-ended, differential and operational models.



Electro Instruments, Inc.

3540 Aero Court
San Diego 11, California

extremely pure, 'Baker Analyzed' *REAGENT*

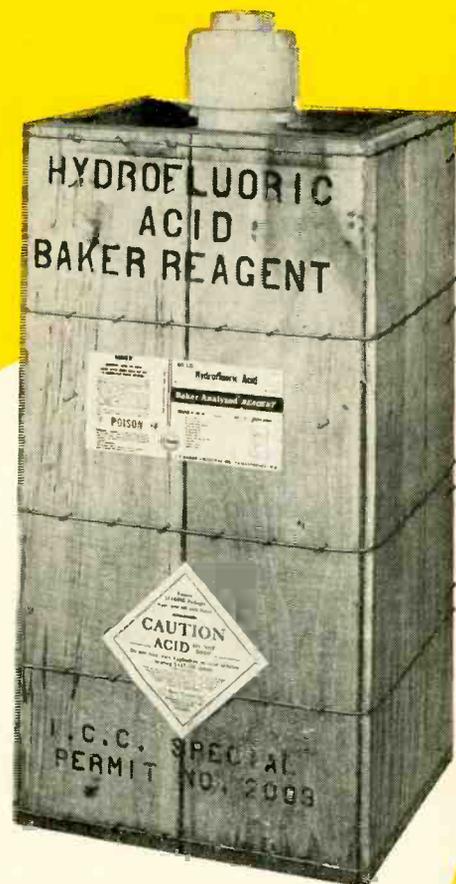
HYDROFLUORIC ACID

in your choice of

3 CONTAINER SIZES

6½ GALLON POLYETHYLENE CARBOYS

10-LB. or 1-LB. POLYETHYLENE BOTTLES



... functional,
labor-saving packaging
for your

SAFETY • CONVENIENCE • ECONOMY

HYDROFLUORIC ACID is a key processing chemical.

To meet the sharply rising demand for Hydrofluoric Acid manufactured to J. T. Baker's exceptional standards of quality, Baker has once more expanded production facilities. In addition to dependable, on-time deliveries, Baker offers you:

YOUR CHOICE OF CONTAINER SIZES: 6½ gallon polyethylene carboys, 10-lb. and 1-lb. polyethylene bottles.

SAFE, CONVENIENT, LABOR-SAVING PACKAGING: Carboys and 10-lb. bottles expedite convenient handling of large quantities of acid. The Baker 1-lb. bottle makes possible more rapid pouring

than competitive 1-lb. containers and with an added safety factor: There's no diaphragm to puncture—no danger of "acid-spurt."

PURITY: Baker manufactures in conformance with extremely high standards of purity. Specifications assure that copper and nickel each will not exceed ½ part per million.

ACTUAL LOT ANALYSIS: Each container is labeled with the actual lot analysis defining copper, nickel and eight other significant impurities.

ACTUAL LOT ASSAY: You'll appreciate this "J. T. Baker extra" especially important for your use.

FULL AVAILABILITY AND FAST SERVICE—from expanded production facilities.

FOR PRICES AND ADDITIONAL INFORMATION, WRITE OR PHONE



J. T. Baker Chemical Co.
Phillipsburg, New Jersey

CIRCLE 39 READERS SERVICE CARD

now microwave

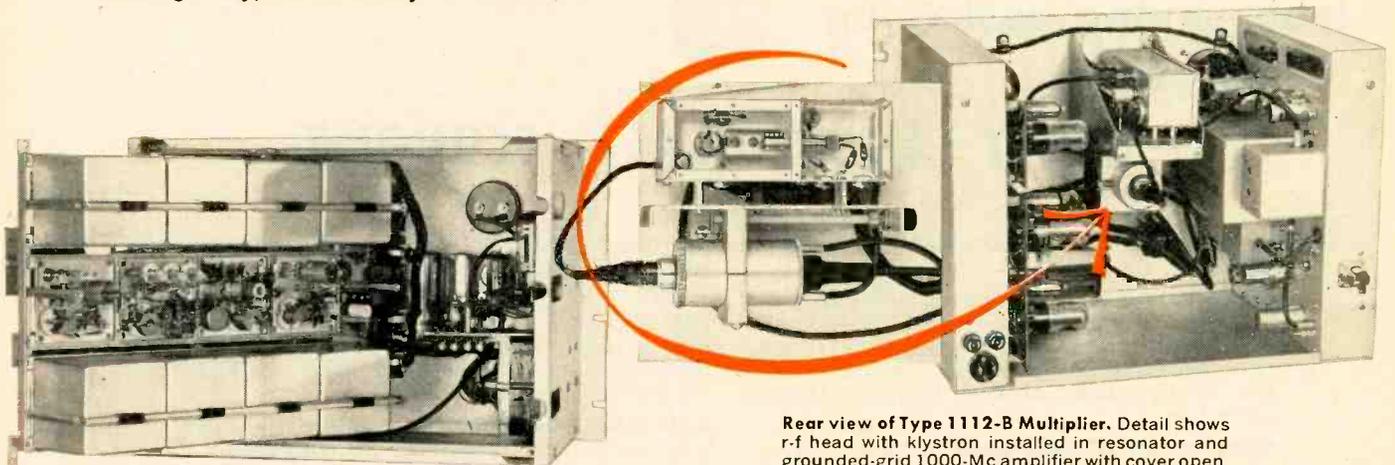
from **NEW**  **DECADE**

Two new Standard Frequency Multipliers, the Types 1112-A and 1112-B, extend the range of General Radio's line of frequency-measuring equipment to well beyond the X band.

Extremely low noise characteristics and high stability, primary objectives in the development of these instruments, permit their use for precise measuring applications. Telemetry, guided-missile tracking, spectroscopy and atomic-resonance investigations, radar and navigation-systems work are but a few of the areas where signals of this quality are needed.

Submultiples of output frequencies are missing — all spurious signals other than harmonics of the desired output are more than 100 db below the nominal output signal. Long-term frequency stability is dependent only upon the driving source. Short-term stability is actually so much better than that of other types of frequency multipliers that measurement of performance is difficult — data will be available later.

The new Multipliers are versatile and convenient in use: for example, accurate measurements of microwave frequencies may be made by using a simple distorting and mixing diode to produce higher frequency harmonics for comparison against an unknown signal. For such work, a "picket fence" of standard-frequency markers can be generated (with suitable adding network), against which the unknown can be located quickly, unambiguously, and accurately.



Rear view of Type 1112-A Multiplier with chassis assembly swung open. Covers are removed from 1 to 10-Mc multiplier stages.

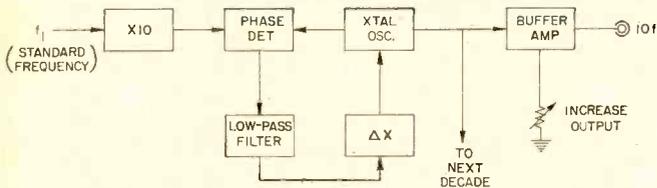
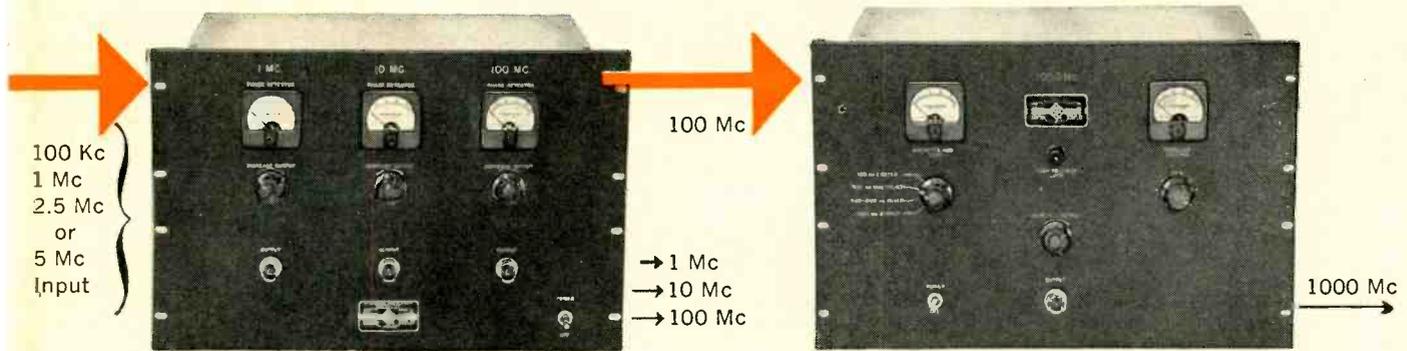
Rear view of Type 1112-B Multiplier. Detail shows r-f head with klystron installed in resonator and grounded-grid 1000-Mc amplifier with cover open.

WE SELL DIRECT. Our District Sales Offices are staffed by engineers especially trained to help you in the selection of instruments and measuring systems best suited to your needs. We welcome your inquiries — will help solve your problems.



standard frequencies

MULTIPLIERS



Type 1112-A

STANDARD FREQUENCY MULTIPLIER

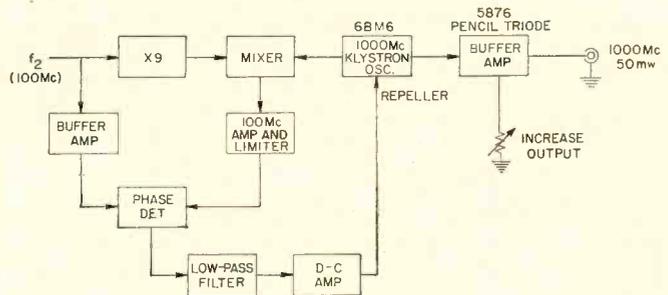
1-Mc, 10-Mc, and 100-Mc output frequencies are generated by separate crystal oscillators that are *phase locked* to the input frequency to insure extremely low f-m and a-m noise levels. (See diagram for typical decade.) Use of quartz-crystal resonators in each of these oscillators provides the highest possible Q for stabilizing amplitude and phase. With this technique, it is possible to avoid much of the noise commonly associated with multipliers that do not have such high-Q filters, and consequently, to actually improve the S/N ratio of the output signal.

INPUT: 1-volt, 100-kc sine wave from G-R Type 1100-A Frequency Standard or equivalent. Can be driven by 1-Mc, 2.5-Mc, or 5-Mc standard-frequency signal as well.

OUTPUT: 1-Mc, 10-Mc, and 100-Mc sine-wave signals; output level of each independently adjustable with maximum of 20mw into 50 ohms.

STABILITY: Long-term stability dependent only upon driving source.

PRICE: \$1450.



Type 1112-B

STANDARD FREQUENCY MULTIPLIER

1000-Mc output is generated directly by a 6BM6 klystron that is phase-locked to the 100-Mc input. Input is multiplied to 900 Mc and mixed with the 1000-Mc output from the klystron oscillator to produce a 100-Mc beat. The difference frequency is amplified and limited to reduce a-m noise, and then compared to the 100-Mc input in a balanced phase detector. The output from the phase detector controls klystron frequency by varying repeller voltage. Phase-modulated noise normally produced by a klystron is greatly reduced by a wide-band, or fast-acting automatic-phase control.

INPUT: 100-Mc sine wave from Type 1112-A or equivalent; input impedance is 50 ohms.

OUTPUT: 1000-Mc sine wave; at least 50mw into 50-ohm load.

STABILITY: Long-term stability dependent upon driving source.

PRICE: \$1360.

Write for Complete Information on G-R Frequency Standards.

GENERAL RADIO COMPANY

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

NEW YORK AREA: Tel. N. Y. WOrth 4-2722, N. J. WHitney 3-3140 CHICAGO: Tel. VIlIage 8-9400

PHILADELPHIA: Tel. HANcock 4-7419

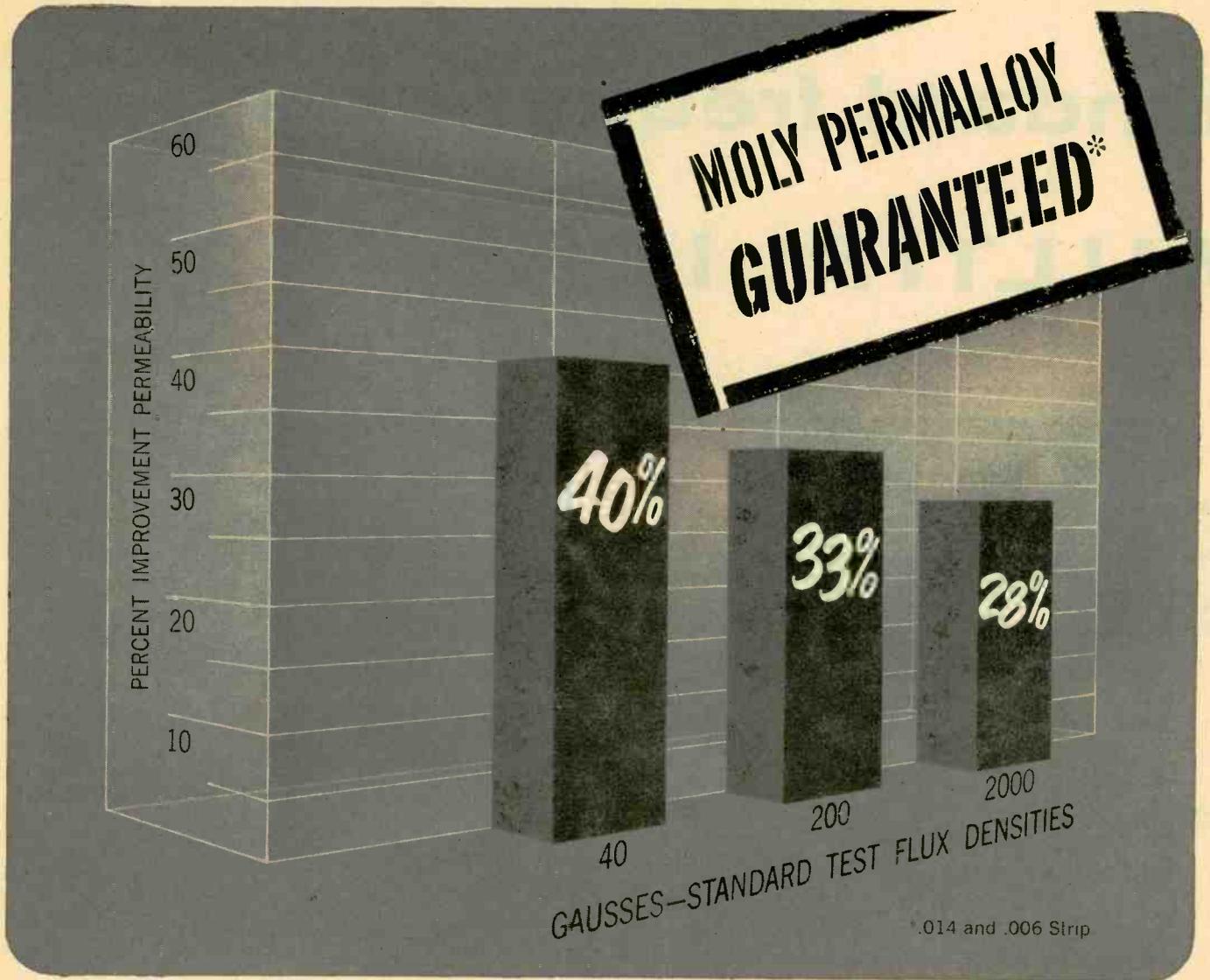
WASHINGTON, D. C.: Tel. JUNiper 5-1088

SAN FRANCISCO: Tel. WHitecliff 8-8233

LOS ANGELES 38: Tel. HOLlywood 9-6201

In CANADA, TORONTO: Tel. CHerry 6-2171

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.

WSW 7273

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-9.*

ALLEGHENY LUDLUM
STEELMAKERS TO THE ELECTRICAL INDUSTRY

Export distribution, Electrical Materials: AIRCO INTERNATIONAL INC., NYC 17
Export distribution, Laminations: AD. AURIEMA, NYC 4



← CIRCLE 41 READERS SERVICE CARD

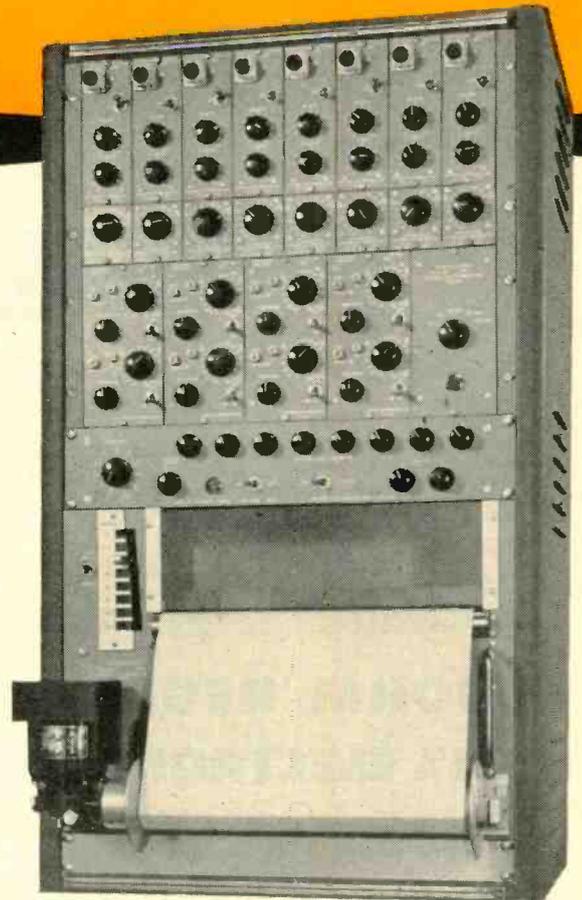
CIRCLE 42 READERS SERVICE CARD

OFFNER ALL TRANSISTOR TYPE R DYNOGRAPH

the most versatile...most sensitive direct writing unit available

Combining all these features...

- ☆ stable d-c sensitivity of one microvolt per mm
- ☆ true differential input
- ☆ high input impedance
- ☆ response to beyond 150 cps.
- ☆ reluctance, differential transformer, strain gage with a-c or d-c excitation, thermocouples, etc., used with all amplifiers
- ☆ deflection time less than 2 milliseconds
- ☆ fixed precision calibration
- ☆ instant warm-up
- ☆ precision source for d-c and 400 cycle excitation, self-contained
- ☆ zero suppression, twenty times full scale, both directions



all these features...plus 8 channels in only 33 $\frac{1}{4}$ " of rack space

Whatever your application for direct writing recorders . . . you should investigate the ability of the Offner Type R Dynograph to do the job *better* and more *simply*. Using transistor circuits* developed and tested for over two years in hundreds of channels of Offner medical equipment, the Type R Dynograph is, we believe, superior in practically every respect to *any other* direct writing oscillograph. Write on your company letterhead for literature giving details and specifications.

*Patents granted and pending

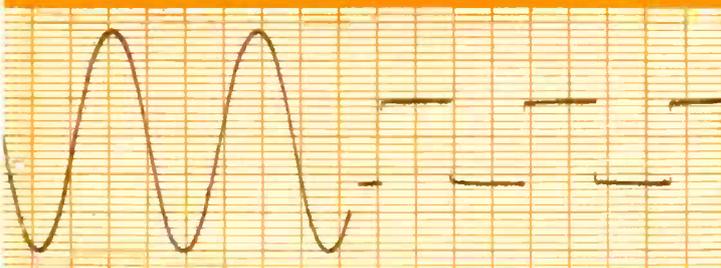


**OFFNER
ELECTRONICS INC.**

3906 River Road, Schiller Park, Ill.
(Suburb of Chicago)

CIRCLE 43 READERS SERVICE CARD

FULL SCALE, UNRETOUCHED CHARTS PRODUCED
ON THE TYPE R DYNOGRAPH



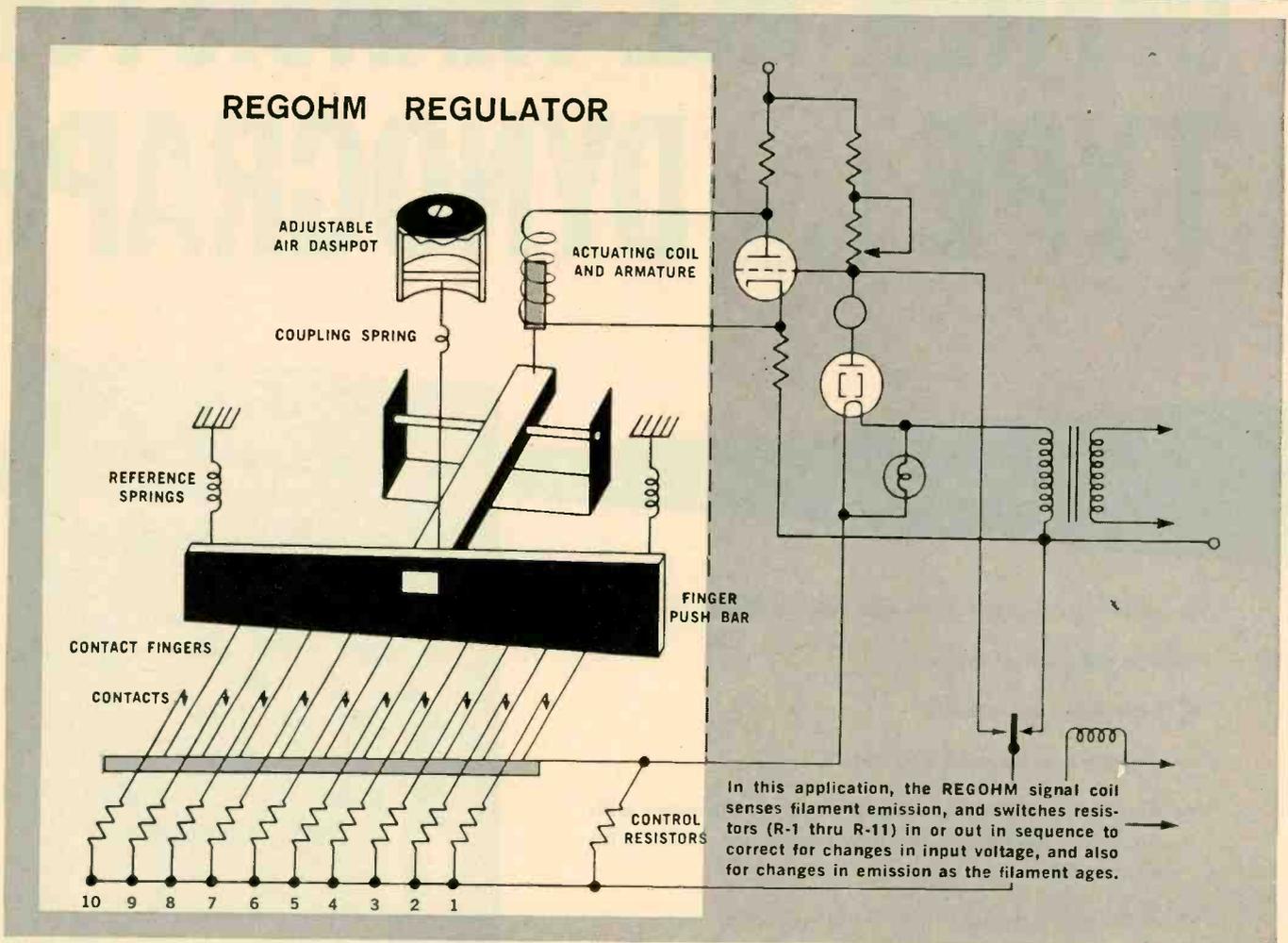
EXTREME SENSITIVITY—

10 Microvolt RMS
Sine Wave

Ten Microvolt
D-C Square Wave

Four recording media. Heat or electric rectilinear
— ink or electric curvilinear. Readily convertible.

REGOHM SOLVES Another Electronics Control Problem



REGOHM REGULATOR MAINTAINS CRITICAL 0.05% ELECTRONIC EMISSION IN DIATRION CIRCUIT

"The final design was made possible by the Electric Regulator Corporation's ten step contact finger regulator . . ."

That is the tribute paid to REGOHM'S multi-contact voltage control by Consolidated Electroynamics' engineers in speaking of their Type 24-210 Leak Detector.

The REGOHM regulator is used to provide an accurately controlled voltage to the tungsten filament in the Diatron mass spectrometer tube. It is this filament that produces the electron bombardment of the sampled gases passing through a magnetic field—causing each gas ion to assume a distinctly different path. This selective action affords the means for detection, and quantitative measurement, of the specific gas concerned.

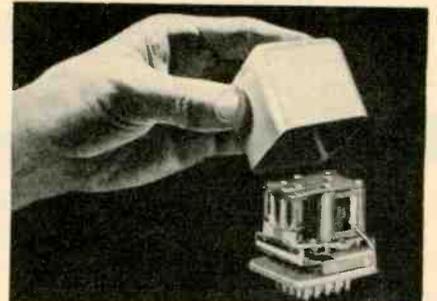
Tests with other regulating devices, such as thyatron or mercury-wetted contact relays, were unsatisfactory—either because of poor performance or excessive costs.

The following distinct advantages were acclaimed for REGOHM by Consolidated Electroynamics . . .

1. The enormous power gain provided through flat compounding; the current needed to operate all ten contacts being only 5% more than that required for the first stage.
2. Relatively low power dissipation in the parallel resistors in ratio to the power fed into the filament.
3. Adjustable dashpot to check oscillation tendency in the circuit.
4. A compensating relay by-pass provision for holding voltage in the regulator tube when relays are open—to prevent destructive surging when filament is switched on.

The REGOHM'S unique combination of advantages—flexibility, plug-in design, compact size, outstanding reliability, and low cost—is providing the answer to difficult regulation problems in many types of circuit. Why not consult our engineering staff to see how well it can fit your application? Please contact Electric Regulator Corporation, Norwalk, Connecticut.

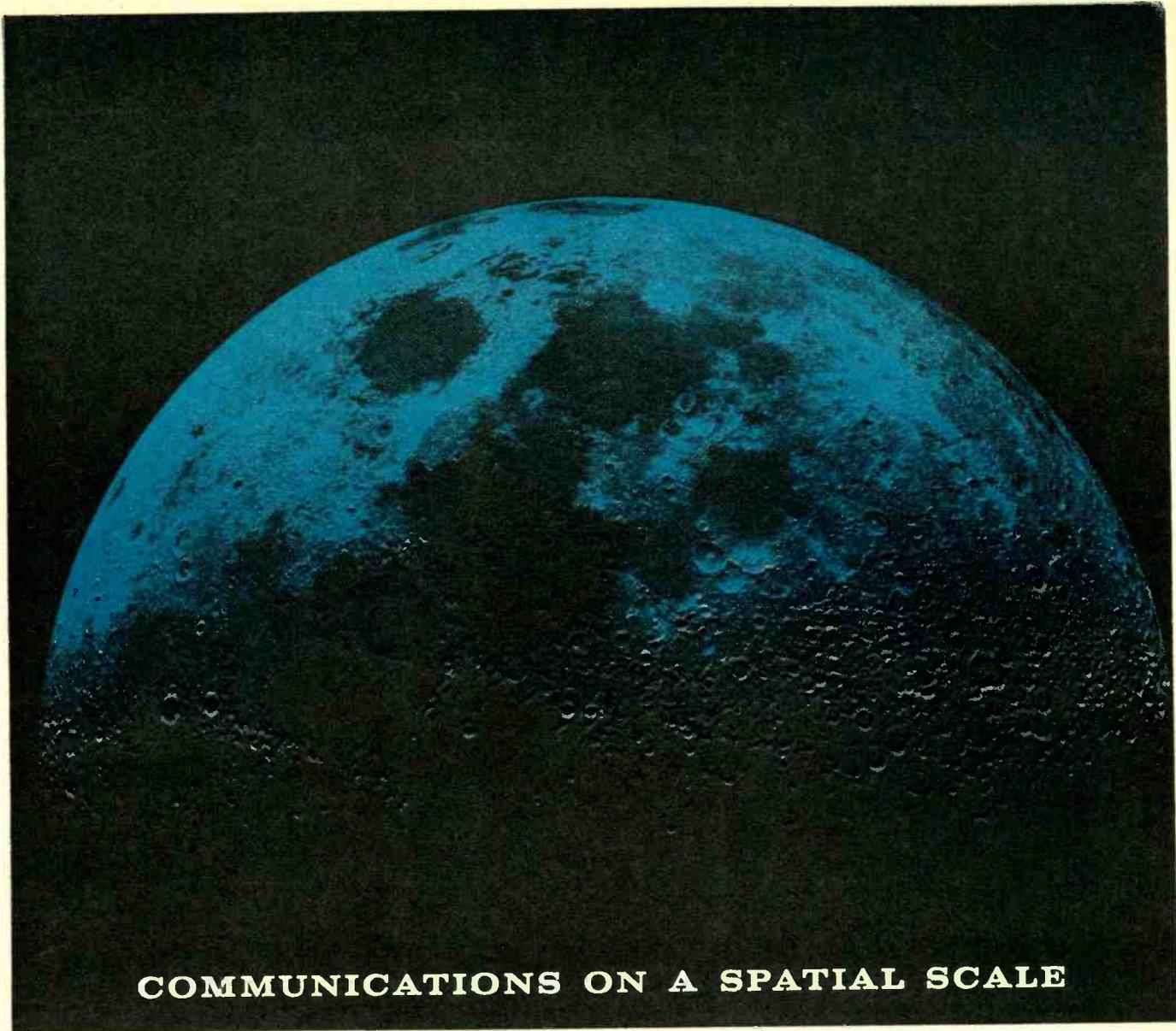
Please write for design data and performance specs on REGOHM multi-stage regulators in applications similar to this.



REGOHM



ELECTRIC REGULATOR CORPORATION
NORWALK CONNECTICUT



COMMUNICATIONS ON A SPATIAL SCALE

"SHOOTING FOR THE MOON" at the Hughes Communications Systems Laboratories is more than just a figure of speech—it's an actual goal.

The Communications Laboratories have as one long-range objective the development of communications systems capable of deflecting their signals from meteors, artificial satellites and even the moon. Yet another is the development of systems which transmit intelligence through media impervious to radio frequencies by modulating frequencies far up in the electromagnetic spectrum—light, even gamma rays.

An example of advanced Hughes methodology is the use

of digital techniques to overcome the multipath phenomenon—the tendency of radiations to be resolved by different layers of the ionosphere or other reflectors into two or more signal paths. Under certain circumstances, this situation in the past has produced a confused signal.

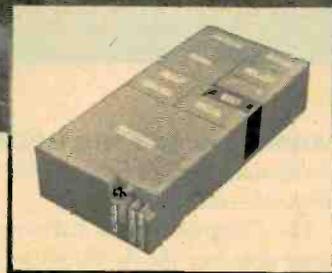
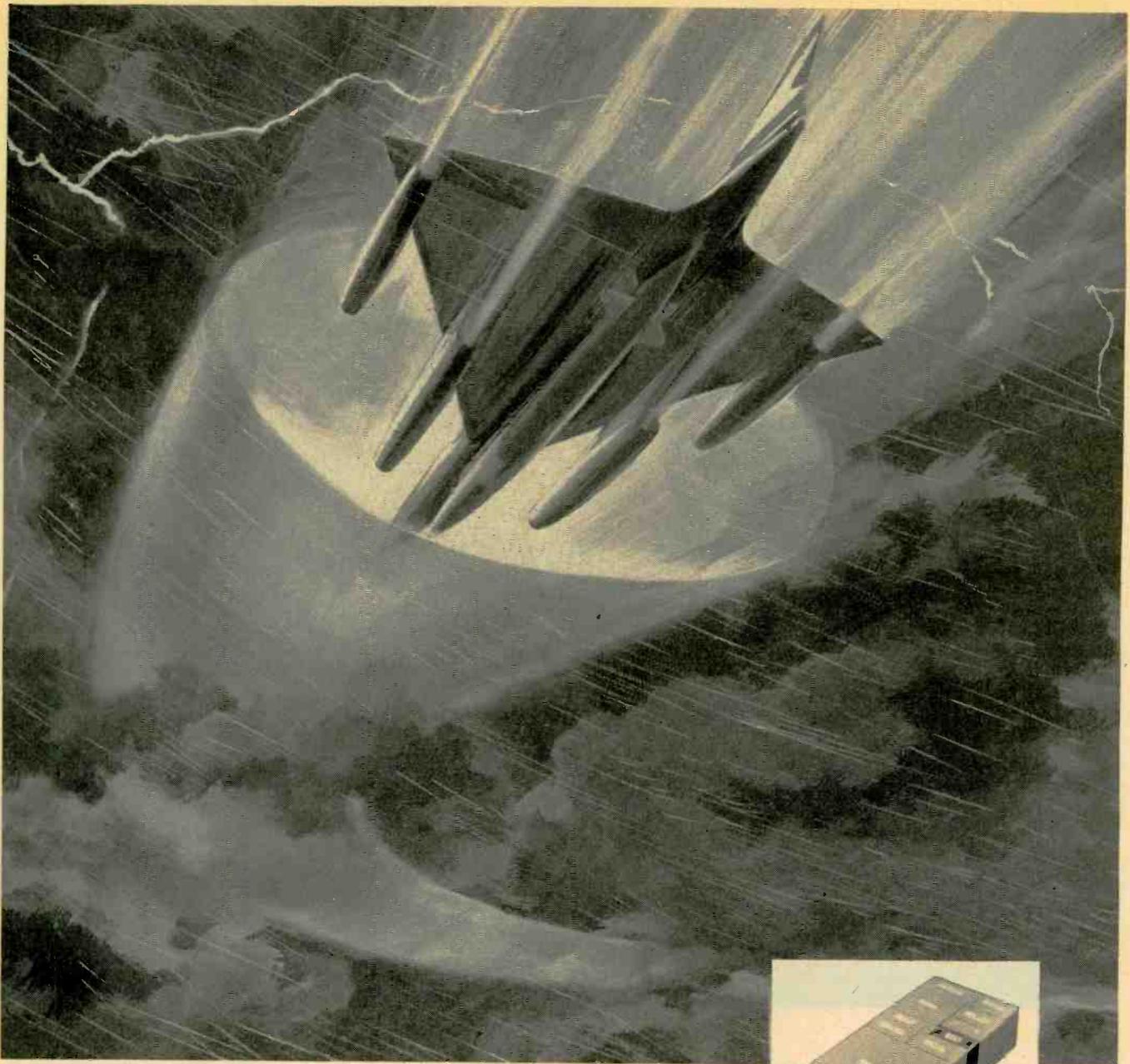
To extend its projects into advanced new areas, the Hughes Communications Laboratories must be staffed with engineers and physicists of high professional stature. Openings now exist for such personnel, and the salary structure will reflect the exceptional background required. Your inquiry is invited. Please apply directly to:

Dr. Allen Puckett, Associate Director,
Systems Development Laboratories.

the West's leader in advanced electronics

HUGHES

Hughes Aircraft Co., Culver City 32, Calif.



NAVTAC: "Pipeline" to a happy landing

The uniqueness of the new NAVTAC en route navigation and instrument landing system by Stromberg-Carlson is in its *combination* of functional modules.

The NAVTAC equipment is an assembly designed to provide high-performance aircraft with the TACAN navigational aid, plus marker beacon receiver, glide slope and runway localizer for instrument landing situations.

The entire system is packaged in a compact unit only 5" high, 10½" wide, 22" deep, and weighing only 47.5 lbs. Individual modules can be separated up to distances of several feet without any adverse effect on performance.

The equipment is designed to meet the rigorous environ-

ment of the high-performance aircraft of today and tomorrow. Its operating ambient temperature range is -60 to +125 degrees C. at altitudes up to 70,000 feet. Widespread use of semiconductors in the ILS receivers and TACAN circuitry means high reliability, small size and low power consumption.

Included in the design is the capability of performing complete preflight confidence tests with the use of a small auxiliary test set.

Complete technical details on the NAVTAC system are available on request.

There is nothing finer than a Stromberg-Carlson®



STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION

1464 N. GOODMAN STREET • ROCHESTER 3, N. Y.

Electronic and communication products for home, industry and defense



RELIABILITY

is the word



El-Menco

Dur-Micas

are
the

CAPACITORS

with

BUILT-IN RELIABILITY.

TWO WAYS...

- Highest-Grade INDIA RUBY Mica Films
 - TOTAL DEBUGGING
- Guarantee Super Dependability*

the finest of materials...

superior engineering know-how... combine to build in El-Menco Dur-Mica Capacitors the highest reliability... to give long, ever-ready, powerful service in electronic equipment — from lightning-fast giant brains to tiny transistor receivers.

* unique features in El-Menco Dur-Micas

• Specially-selected, highest-grade India Ruby mica films... pre-tested to have highest insulation resistance... greatest dielectric strength... lowest dissipation factor. Specially developed dipped coating retains the superior properties of India Ruby mica.

• Debugging — the removal of early failures by subjecting mica capacitors to short life tests at elevated voltages and temperatures... THE SCORE... DM30, 10,000 MMF, "Debugged" El-Menco Dur-Mica Capacitors... subjected to 257,000 hours of life at 85°C with 100% of the rated DC voltage applied... turned in a record computed reliability performance — APPROX. 0.6% CUMULATIVE FAILURES OR ONLY 1 FAILURE PER 43 MILLION UNIT-HOURS.

El Menco "Dur-Micas"

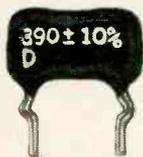
have proved their tremendous power and ability under accelerated conditions of 1½ times rated voltage at ambient temperatures of 125°C and 150°C, winning out over all others in longest life, most powerful performance, smallest size, greatest stability.

DM15, DM16, DM19, DM20, DM30, DM40, DM42, DM43... perfect for extreme miniaturization; ideal for new miniaturized designs and printed wiring circuits. New "hairpin" parallel leads insure easy applications in radio, television, guided missiles. El-Menco Dur-Micas meet all humidity, temperature and electronic requirements, including military specs.

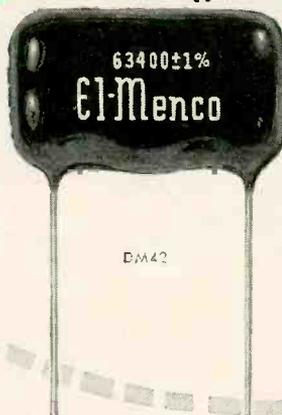


DM15

Avoid Costly Breakdowns... with Two-Way Built In Rugged Reliability.



DM20



DM42

Write for FREE sample and catalog on your firm's letterhead.

ACTUAL SIZE



El-Menco Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors

WILLIMANTIC

CONNECTICUT

- molded mica
- mica trimmer
- dipped paper
- tubular paper
- ceramic feed-thrus
- 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

3 completely new
GENISCO CENTRIFUGES
with 10 times greater accuracy,
larger centrifugal capacities,
maximum flexibility...*and*
priced lower than any other
centrifuges now available!



*The low-cost answer to fast,
accurate testing of components under
simulated operational g-forces
as required by MIL-E-5272A.*

These new precision centrifuges feature a unique, high-torque ball-disc integrator drive system which provides accuracies you would expect only from a rate-of-turn table. Constancy of boom rotation, including wow and long-term drift, is better than .05% at any speed setting—approximately 10 times more accurate than currently available machines. Boom speed is infinitely variable and is measured by an electronic counter built into the console.

The building block design concept gives the new centrifuges exceptional flexibility. Machines are assembled from six basic off-the-shelf components; drive system, drive motor, boom, test compartment, console and accessories. You simply select components which provide features needed to meet your specific requirements. Interchangeability of the components permits easy modification as requirements change. Kits are available for modification by the customer.

This new design concept also results in manufacturing economies which are reflected in the cost of the machines. *The new machines are the lowest priced centrifuges now available—in spite of their greater accuracy, flexibility and capacity.* Ask your Genisco representative for complete information today.

There are more than 400 Genisco centrifuges now in operation.

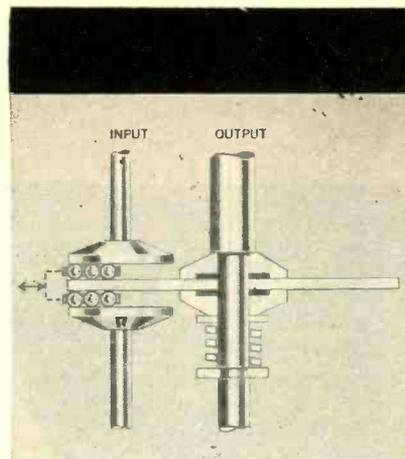


2233 Federal Avenue, Los Angeles 64, California

brief performance specifications

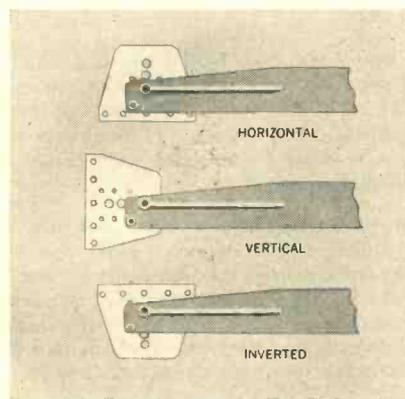
Model No.	Diameter	Test Object Weight	Capacity G-pounds	RPM Max.	G-Range Max.	Test Object Dimensions
A-1010	30" table	50 lbs. dead weight	2,500	800	.1 to 200 g's	
A-1020	60" arm	100 lb. dead weight	10,000	600	.1 to 250 g's	12" cube
A-1030	96" arm	100 lb. dead weight	10,000	400	.1 to 175 g's	18" cube

Large custom centrifuges: Genisco centrifuge experience includes the design, manufacture and installation of large custom-built machines. We invite your inquiry.



Entirely new, more efficient drive system—An integral variable speed transmission based on the new *Rouverol*® ball-galaxy principle achieves, for the first time in rotating machinery, high torque characteristics while maintaining the inherent accuracies of a hardened steel-to-steel ball-disc integrator. A novel choice of geometry among the drive elements results in a virtually linear handwheel vs rpm relationship, thus facilitating the presetting, programming and servo-controlling of output speeds. A built-in torque-limiter clutch protects the transmission from damage resulting from abuse or high inertia conditions.

*Pat. Pending



Basket-type mounting platforms, available on Model A-1020 and A-1030, may be oriented from the horizontal to the vertical or to the inverted attitude for multiple-axis testing without demounting the test object. Baskets may be raised or lowered to achieve an optimum dynamic balance and minimum angular deflections when extreme accuracies are required. When the basket is inverted the outside surface of the platform may be used to mount bulky, lightweight packages.

Available accessories include additional slip rings, servo control, microwave joints, high pressure air and hydraulic systems, TV viewing systems. Any accessory can be added *at any time* by the user. The mounting base is standard equipment.

NEW **KAY** Vari-Sweep MODEL 400



Cat. No. 867-A

**Wider Range, All-Electronic
SWEEPING OSCILLATOR, or
(with sweep off) Continuously
Tuned CW Signal Source**

HIGH Output—1.0 V rms into 70 ohms

WIDE Range—15-470 mc all at
Fundamental Frequency

CONSTANT Output—fast-acting AGC circuit

The new Vari-Sweep Model 400 is a highly versatile laboratory sweeping oscillator and signal generator. Its wide range of continuous frequency coverage from 15 to 470 mc is combined with a measure of accuracy and level of performance previously associated with limited, fixed-frequency-band oscillators only.

It provides frequency sweeps that are flat, wide, and linear. The RF output voltage is high enough for testing lossy networks without using additional amplifiers. Over the entire range, the RF output is a fundamental frequency held constant by a fast-acting AGC circuit to assure a high degree of frequency stability and the absence of spurious beat signals. The variable sweep rate goes down to 10 cps for checking high-Q circuits.

In addition, the Vari-Sweep Model 400 is a source of accurately calibrated CW signal with the same high-level output AGC'd to be constant over the frequency band. This eliminates the need for readjusting output voltage when changing frequency, and permits the rapid testing of diverse frequency circuit elements under CW conditions.

- New Wider Range—15-470 mc in 10 Bands
- Fundamental Frequency—Stable Narrow Band Sweeps
- Direct Reading Frequency Dial
- Highly Accurate Attenuators
- Sweep Repetition Rates Down to 10 cps

SPECIFICATIONS

Frequency Range (CW or Sweeping Operation): Fundamental frequency, 15-470-mc, continuously variable in 10 switched, overlapping bands with direct-reading frequency dial.

Sweep Width: 60% of center frequency to 50 mc; at least 30 mc max from 50-400 mc; approx. 20 mc max above 400 mc.

Sweep Rate: Continuously variable, 10 to 40 cps; locks to line frequency.

RF Output: 1.0 V rms (metered) into nom 70 ohms (50 ohms on request) to 220 mc; 0.5 V rms to 470 mc. Output held constant to within ± 0.5 db over widest sweep and frequency range by AGC circuit.

Attenuators: Switched 20, 20, 10, 6 and 3 db, plus continuously variable 6 db.

Sweep Output: Regular sawtooth, synchronized with sweeping oscillator. Amplitude 7.0 V approx.

Power Supply: Input approx. 100 watts, 117-V ($\pm 10\%$), 50-60 cps ac. B+ electronically regulated.

Dimensions: 9 $\frac{1}{8}$ " x 19 $\frac{1}{2}$ " x 13".

Weight: 34 lbs.

Price: \$795.00, f.o.b. factory.



Cat. No. 386

NEW **KAY** Rada-Sweep 300

**Single Unit Sweeping Oscillator in 10 Switched Bands
For Sweeping Radar IF's Between 1 and 350 mc Center**

SPECIFICATIONS

Frequency Range: Any 10 fixed center frequencies set to customer specification between 1 and 350 mc. Ten switched bands; fundamental frequency; all-electronic sweep.

Sweep Width: 70% of center frequencies selected between 1 and 100 mc; 60 to 70 mc for frequencies between 100 and 350 mc.

Sweep Rate: Variable around 60 cps. Locks to line frequency.

RF Output: 0.5 V rms into nom 70 or 50 ohms, higher for lower frequency units. Output held constant to within ± 0.5 db over widest sweep by AGC circuit.

Zero Reference: A true zero-base line is produced on oscilloscope during retrace time.

Attenuators: Switched 20, 20, 10, 6 and 3 db plus continuously variable 6 db.

Markers: Up to 30 crystal-controlled positive pulse markers at customer-specified frequencies. Accurate to $\pm 0.05\%$. Up to three markers per band (more at lower frequencies) are available; no individual switches on markers.

Marker Amplitude: Continuously variable, zero to 10 V approx.

Sweep Output: Regular sawtooth synchronized with sweeping oscillator.

Power Supply: Input approx. 150 watts, 117 V ($\pm 10\%$) 50-60 cps ac. B+ electronically regulated.

Dimensions: 8 $\frac{3}{4}$ " x 19" rack panel, 13" deep. Supplied with cabinet; suitable for rack mount.

Weight: 34 lbs. approx.
Price: \$695.00, f.o.b. factory. Add \$15.00 per crystal marker ordered.

Write for 1958 Kay Catalog

KAY ELECTRIC COMPANY

Dept. E-9

Maple Avenue, Pine Brook, N. J.

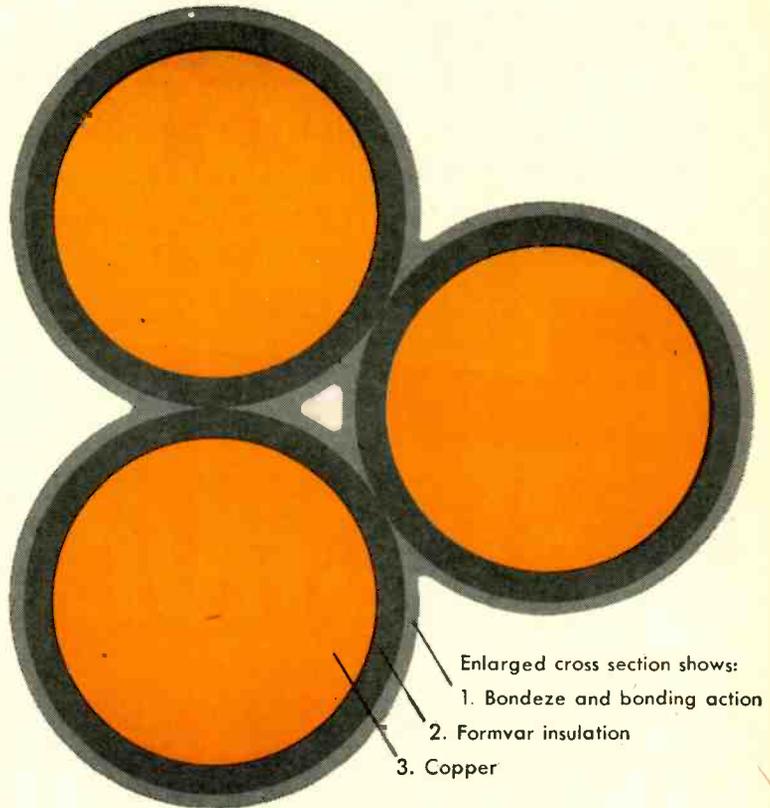
Capital 6-4000

For quick bonding, turn to turn, with a single application of heat or solvent . . .

Specify

PHELPS DODGE BONDEZE®

MAGNET WIRE



These successful uses of Bondeze suggest unlimited new redesign possibilities, often at overall savings.



COILS

Random-wound, layer, paper-section and solenoid coils for brakes and clutches, instruments, television, radio and other applications.

TRANSFORMERS

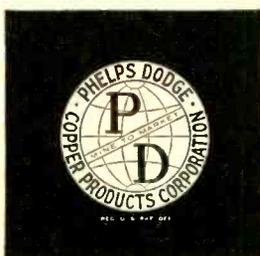
Paper-section, random-wound, oil-filled, air-cooled and high voltage for distribution, current, X-ray, television, radio and other applications.

MOTORS

Windings for shaded pole, series fields, instruments, induction and others.

Any time your problem is magnet wire, consult Phelps Dodge for the quickest, easiest answer!

FIRST FOR
LASTING QUALITY—
FROM MINE
TO MARKET!



PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

Special Introductory Offer

(GOOD FOR NEXT 30 DAYS)

To new members of the
ELECTRONICS and CONTROL ENGINEERS' Book Club

ANY ONE FREE

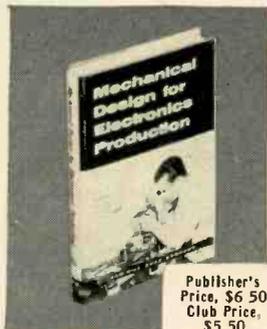
GIVEN TO YOU WITH A CHARTER MEMBERSHIP
AND SENT WITH YOUR FIRST SELECTION

VALUES FROM
\$6.00 to \$18.00



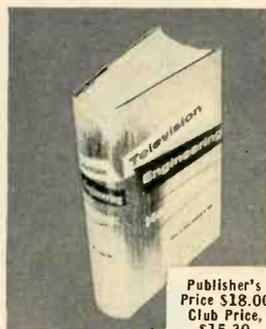
Publisher's Price, \$7.50
Club Price, \$6.40

Servomechanism Practice by W. H. Ahrendt. How to solve problems of servo design, manufacture, test, and adjustment.



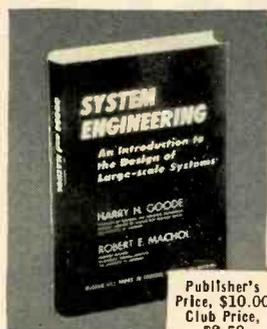
Publisher's Price, \$6.50
Club Price, \$5.50

Mechanical Design for Electronics Production by J. M. Carroll. Vital mechanical factors in building electronic equipment.



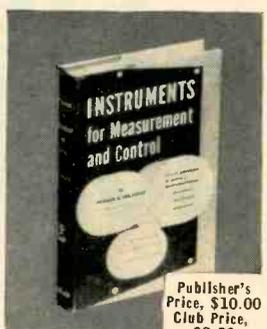
Publisher's Price \$18.00
Club Price, \$15.30

Television Engineering Handbook by D. G. Fink. Full reference of modern data needed to design and operate TV equipment.



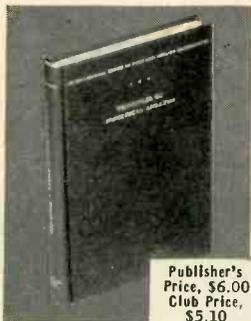
Publisher's Price, \$10.00
Club Price, \$8.50

System Engineering by H. H. Goode and R. E. Machol. Helps you solve complex design problems of large-scale systems.



Publisher's Price, \$10.00
Club Price, \$8.50

Instruments for Measurement and Control by W. G. Holzbock. Gives you latest advances in process instrumentation.



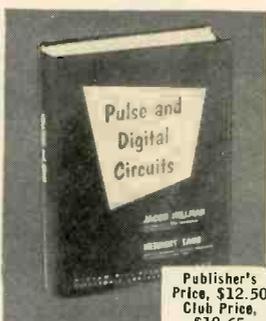
Publisher's Price, \$6.00
Club Price, \$5.10

Principles of Numerical Analysis by A. S. Householder. Mathematics for setting up and evaluating computing routines.



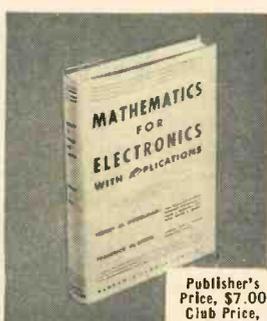
Publisher's Price, \$8.75
Club Price, \$7.45

Handbook of Industrial Electronic Control Circuits by J. Markus and V. Zeluff. Over 300 tested control circuits.



Publisher's Price, \$12.50
Club Price, \$10.65

Pulse and Digital Circuits by J. Millman and H. Taub. Explains circuits for effective electronic system design.



Publisher's Price, \$7.00
Club Price, \$5.95

Mathematics for Electronics with Applications by H. M. Nodelman and F. W. Smith, Jr. For solution of practical problems.



Publisher's Price, \$8.00
Club Price, \$6.80

Modern Physics for the Engineer by L. N. Ridenour. Examines physical science on which modern engineering is based.

How many of the books shown here do you wish you had immediately at hand?

Select one AS A GIFT! Choose from *Servomechanism Practice*, *System Engineering*, *Pulse and Digital Circuits*, and seven other valuable books . . . your introduction to membership in the *Electronics and Control Engineers' Book Club*.

If you're missing out on important technical literature—if today's high cost of reading curbs the growth of your library—here's the solution to your problem. *The Electronics and Control Engineers' Book Club* was organized for you, to provide an economical technical reading program that cannot fail to be of value to you.

All books are chosen by qualified editors and consultants. Their thoroughgoing understanding of the standards and values of the literature in your field guarantees the authoritativeness of the selections.

How the Club operates. Every second month you receive free of charge *The Electronics and Control Engineers' Book Bulletin* (issued six times a year). This gives complete advance notice of the next main selection, as well as a number of alternate selections. If you want the main selection you do nothing; the book will be mailed to you. If you want an alternate selection . . . or if you want no book at all for that two-month period . . . notify the Club by returning the form and postage-paid envelope enclosed with your *Bulletin*.

We ask you to agree only to the purchase of three books in a year. Certainly

out of the large number of books in your field offered in any twelve months there will be at least three you would buy anyway. By joining the Club you save yourself the bother of searching and shopping, and save in cost about 15 per cent from publishers' prices.

Send no money now. Just check any two books you want—one FREE and one as your first Club selection—in the coupon below. Take advantage of this offer now, and get two books for less than the regular price of one.

THIS COUPON IS WORTH UP TO \$18.00

The McGraw-Hill Electronics and Control Engineers' Book Club, 330 West 42nd Street, New York 36, N. Y. P. O. Box 97E-9-26
Please enroll me as a member of the Electronics and Control Engineers' Book Club. I am to receive FREE the book I have indicated along with my first selection checked below. You will bill me for my first selection only at the special club price, plus a few additional cents for postage and handling. (The Club assumes this charge on prepaid orders.)
Forthcoming selections will be described to me in advance and I may decline any book. I need take only 3 selections or alternates in 12 months of membership.

PLEASE PRINT

Name

Address

City Zone State

NO RISK GUARANTEE. If not completely satisfied, shipment within 10 days, you may return your first book and your membership will be canceled.

Check 2 Books: #1 for FREE book and #2 for Club selection

- Servomechanism Practice
- Mechanical Design for Electronics Production
- Television Engineering Handbook
- System Engineering
- Instruments for Measurement and Control
- Principles of Numerical Analysis
- Handbook of Industrial Electronic Control Circuits
- Pulse and Digital Circuits
- Mathematics for Electronics with Applications
- Modern Physics for the Engineer

E-9-26



Optical comparator measures Eimac ceramic envelope component.

Exact Dimensional Uniformity... Is an Eimac Ceramic Tube Extra

Electrode spacing is critical in modern high-performance vacuum tubes. Dimensional uniformity of the material used for the vacuum envelope has a direct effect on the accuracy of this spacing. The high alumina ceramic rings used in Eimac stacked-ceramic tubes can easily be held to tolerances of ± 50 millionths of an inch at production speeds. This degree of accuracy is not possible with glass techniques in high speed production.

Accurate control of ceramic envelope materials results in greater tube-to-tube uniformity of both mechanical and electrical characteristics. It permits close control of small electrode spacings necessary in the production of reliable tubes for UHF operation.

Sixth in a series describing the advantages of ceramics in electron tubes. Previously discussed: impact, heat, vibration, compactness, dielectric loss.

Other important advantages of Eimac ceramic tubes are: resistance to damage by shock or high temperature; compactness without sacrifice of power; ability to withstand rigorous processing techniques that lead to exceptional tube reliability, uniformity and longevity.

Write our Application Engineering Department for a copy of the booklet "Advantages of Ceramics in Electron Tubes."

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

Eimac First with ceramic tubes that can take it



Products Designed and Manufactured by Eimac

Negative Grid Tubes
Reflex and Amplifier Klystrons
Traveling Wave Tubes

Vacuum Tube Accessories
Vacuum Switches
Vacuum Pumps

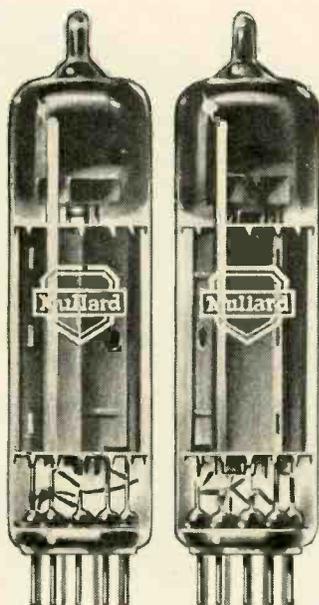
Includes the most extensive line of ceramic electron tubes.

**ELECTRONICS
IN
BRITAIN**



STEREO STEREO STEREO STEREO

EL84



**12W high slope
miniature pentode**

This medium power, high fidelity tube is particularly suitable for stereo equipment. Its high slope of 11,300 μ mhos allows two EL84s in push-pull to give over 10W output power at less than 1% distortion—all achieved for only 16V of grid to grid drive.

The EL84 may also be used for the more economical higher powered equipments. Two tubes will provide an output of up to 17W at an overall distortion of 4%.

A single EL84 will provide an output of nearly 6W. It has a maximum plate dissipation of 12W.

Typical performance details for this tube are given here—for further information and supplies write to one of the distributors listed below.

MEDIUM POWER

Distributed load conditions (screen grid taps at 43% of primary)

V_a	300	V
V_{g2}	300	V
$I_{k(o)}$	2×40	mA
I_k (max. sig.)	2×45	mA
R_k (per valve)	270	Ω
$V_{in(g1-g1)r.m.s.}$	16	V
R_{a-a}	8.0	k Ω
P_{out}	11	W
D_{tot}	0.7	%

HIGHER POWER

Two valves in class AB push pull

V_a	300	V
V_{g2}	300	V
R_k	130	Ω
R_{a-a}	8.0	k Ω
$I_{a(o)}$	2×36	mA
I_a (mag. sig.)	2×46	mA
$I_{g2(o)}$	2×4.0	mA
I_{g2} (max. sig.)	2×11	mA
$V_{in(g1-g1)r.m.s.}$	20	V
P_{out}	17	W
D_{tot}	4.0	%

Supplies available from :

In the U.S.A.

International Electronics Corporation
Dept. E9, 81 Spring Street, N.Y.12,
New York, U.S.A.

In Canada

Rogers Electronic Tubes &
Components
Dept. II, 116 Vanderhoof Avenue,
Toronto 17, Ontario, Canada.

Mullard

ELECTRONIC TUBES used throughout the world

"Mullard" is the Trade Mark of Mullard Limited and is registered
in most of the principal countries of the world.



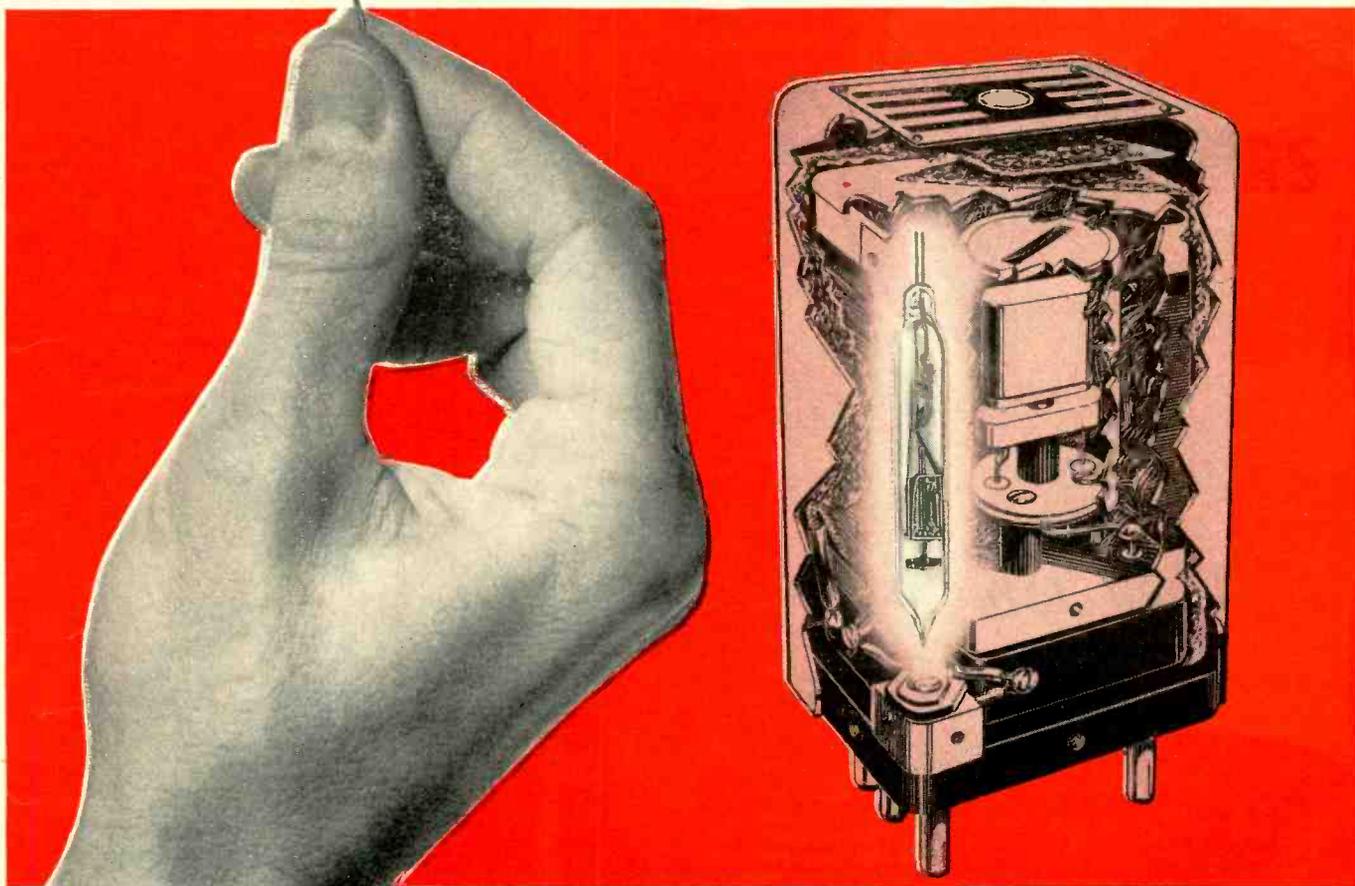
MULLARD OVERSEAS LTD, MULLARD HOUSE, TORRINGTON PLACE, LONDON, ENGLAND

MEV70

THOMAS A.

EDISON

**sealed thermostats
feature close control,
lasting stability**



Edison Sealed Thermostats are widely used in crystal ovens, electronic ovens and oscillator compartments—and many other electronic components adversely affected by temperature variations. Capable of maintaining temperatures within 0.2°C , Edison sealed thermostats offer these special features:

- Slow-make, slow-break principle, insures small temperature differential.
- Protective gas atmosphere minimizes effects of contact arcing under heavy loads, resulting in high stability.
- Radiant energy, and conducted or convected heat is rapidly transmitted to the bimetal by the highly conductive gas fill.
- Long bimetal arm is highly sensitive to temperature changes and assures accurate control, predictable performance.

For complete data on Edison Sealed Thermostats, write for Bulletin No. 3009B.

Thomas A. Edison Industries
INSTRUMENT DIVISION

54 LAKESIDE AVENUE, WEST ORANGE, N. J.





When Time is Precious

...Call Your Mallory Distributor

Your local Mallory distributor is prepared to deliver short orders quickly. He can save you valuable production or research time on repair work, experimental circuits, short production runs, or any of a dozen other applications that call for the *finest* in electronic components . . . and call for them *fast*.

His stocks include the complete range of Mallory capacitors, resistors, controls, rheostats, vibrators, mercury and zinc-carbon batteries . . . as

well as other related components by well known companies. And you can be assured of quality as well as fast service on your "rush" orders . . . because these are the same superior-performance Mallory products chosen by leading manufacturers for use in original equipment.

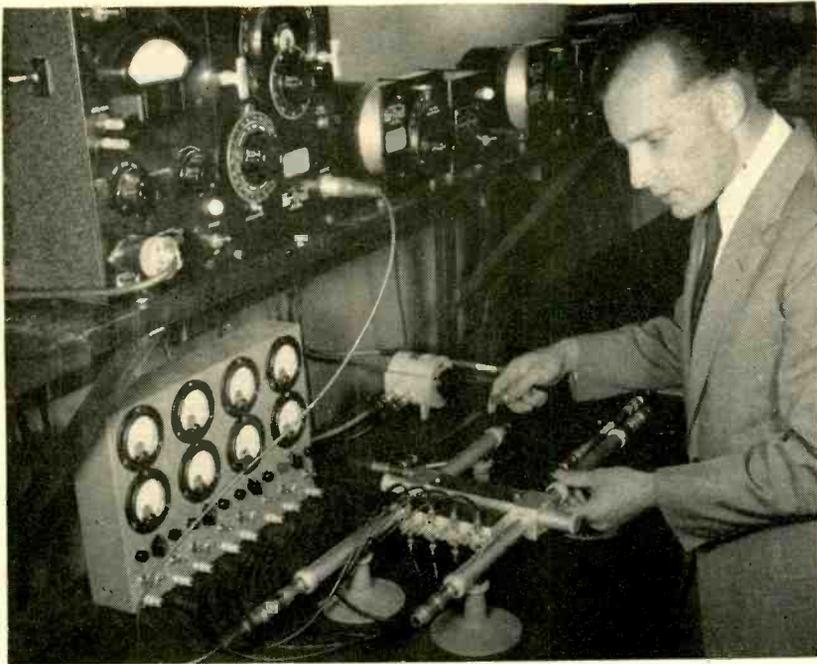
For details about this program and the name of your nearest distributor . . . call our local district office, or write to us in Indianapolis.

Depend on MALLORY for Service!

P. R. MALLORY & CO. INC.
Distributor Division, Dept. A
 P. O. Box 1558, Indianapolis 6, Indiana



SEPTEMBER 26, 1958



A traveling wave version of a diode mavar. It consists of four semiconductor diodes arranged to produce a growing wave as signal travels down successive stages

The Mavar: A Low-Noise Microwave Amplifier

In the quest for methods of low-noise amplification at microwave frequencies, the principles of parametric or reactance amplifiers are being exploited in increasing measure. Investigation of these principles has resulted in the development of three major types of mavar which rival the supercooled maser in low-noise performance. Unlike the maser, the mavar requires no cooling, is capable of wide bandwidths at substantial gain

By SAMUEL WEBER Associate Editor, ELECTRONICS

MICROWAVE AMPLIFIERS using variable nonlinear reactances as the active elements constitute a significant trend in electronics research. Recent intensive activity in the development of these devices has revealed an unlimited potential in applications requiring extremely low noise at room temperatures. Such fields as radar, radio astronomy, microwave relay and uhf television will be major beneficiaries of the new amplifiers.

Reactance or parametric amplifiers, as they are popularly called, derive their name from the fact that

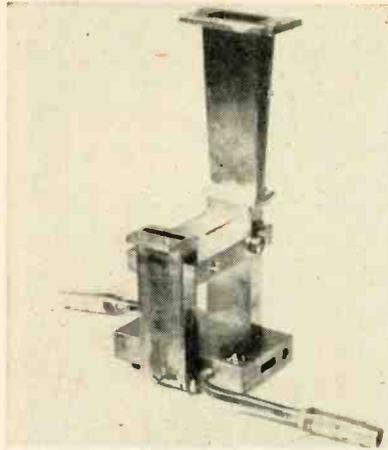
the differential equation governing their behavior has one or more reactive parameters varying with time. More descriptive perhaps, is a recently coined acronym MAVAR (Mixer Amplification by Variable Reactance) which is gaining accepted usage.

The mavar bears a superficial resemblance to the solid-state maser (ELECTRONICS, Apr. 25, 1958) in that it requires an r-f energy source or pump, but unlike the supercooled maser, the mavar achieves low-noise amplification at room temperature.

Operation of the mavar depends upon the fact that a lossless nonlinear reactance exhibits a negative resistance characteristic under certain conditions, or can perform as an up-converter with gain under other conditions. Because the reactance is lossless, no thermal noise is generated. Consider the circuit shown in Fig. 1A. This is a modulator circuit in which a low-frequency source V_1 and a higher frequency source V_2 drive a nonlinear reactance represented in this case by the inductance L . Its nonlinearity might be in the form of a flux



Bell Labs scientists Suhl and Weiss examine development model of a ferromagnetic mavar. Device was built by Weiss (right) after theoretical investigation by Suhl showed feasibility. At far right, closeup of ferromagnetic mavar assembled to waveguide



density which is a quadratic function of the current through the coil. The reactance might also be represented by a capacitor whose charge is a nonlinear function of the voltage across it. The analysis is essentially the same.

Because of the nonlinearity, many upper and lower sideband frequencies are generated. In this circuit it is assumed that power at only four frequencies is permitted to flow through reactor L . These frequencies are f_p the pump frequency, f_s the signal frequency, and the first upper and lower sidebands which are $f_h = f_p + f_s$ and $f_l = f_p - f_s$, respectively. To all other frequencies the reactor represents a short circuit.

Power Relationships

Under these conditions, analysis of the power relationships in the reactor for the frequencies involved shows that the following expressions are valid:

$$\frac{P_p}{f_p} = -\frac{P_h}{f_h} - \frac{P_l}{f_l} \quad (1)$$

$$\frac{P_s}{f_s} = -\frac{P_h}{f_h} + \frac{P_l}{f_l} \quad (2)$$

where positive P represents power leaving the reactor at the frequency denoted by the subscript, and negative P represents power absorbed. From these equations, it is apparent that the reactance always absorbs pump power, but under proper conditions, signal power can be emitted from the reactance.

To illustrate, if only the upper sideband is permitted to exist in the circuit, then Eq. 2 becomes $P_s = -f_s P_h / f_h$. Hence power flows from the reactor at the upper sideband frequency and is amplified by a fac-

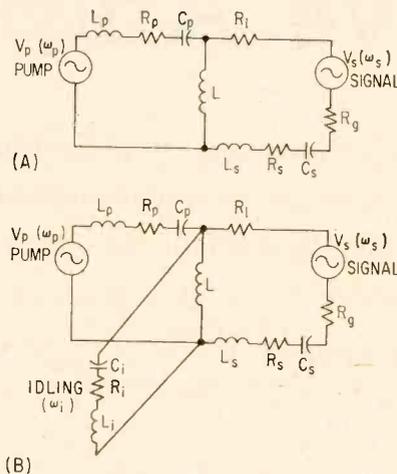


FIG. 1—Equivalent circuit of reactance amplifier (A). Idler circuit added in (B) absorbs difference frequency

tor f_h/f_s , as long as signal power is supplied. This is the up-converter type of operation which may be employed in both amplifier and modulator applications.

On the other hand, if the upper sideband is completely suppressed, Eq. 2 becomes $P_s = f_s P_l / f_l$. Since both P_s and P_l are positive, power is emitted from the reactance at both the signal frequency and the lower sideband. Amplification of the signal is obtained directly with-

out demodulation, with a gain limited only by the circuit configuration and with a constant gain-bandwidth product.

Idler Circuit

Because of the necessary condition that the difference frequency f_l be sustained for power to flow at the signal frequency, an idler circuit capable of absorbing power at f_l is required in this type of operation. This is illustrated in Fig. 1B.

Gain in this type of mavar is equivalent to a negative resistance being introduced into the signal circuit. It can be shown that the equivalent negative resistance is a function of the applied pump power and hence is controllable.

Application of these general principles has resulted in the successful development of three major types of mavars. These differ mainly in the form taken by the nonlinear element. Mavars yielding promising performance, at least in the laboratory, have been built using ferrites, reverse biased semiconductor diodes, and modulated electron beams.

I—Ferromagnetic Mavar

To understand how a ferrite is used as the nonlinear reactance element in a reactance amplifier, it is necessary to discuss the concept of magnetostatic modes.

In a ferrite crystal, unpaired electrons are spinning about their own axes with angular velocity ω_s . The spinning motion of the electron gives rise to an angular momentum and a magnetic moment along the axis of rotation. If the ferrite is subjected to a d-c magnetic field, the axis of the electron spin tries to line up with the applied field, since this is the position of minimum potential energy. Because the electron has finite mass, it cannot move to this position instantaneously, but begins to precess with an

Table I—Pump Power Required For Ferromagnetic Mavar

Mode of Operation	Approx. Pump Power
Electromagnetic	15 kw
Semistatic	10 w
Magnetostatic	100 mw

angular velocity ω_p , as shown in Fig. 2A. The angular velocity with which the precession takes place is given by the expression $\omega_p = \gamma H_{dc}$ where γ is a quantity known as the gyromagnetic ratio of the electron, and H_{dc} is the effective value of the applied magnetic field.

Energy Absorbed

Because of damping factors in the material, the electron spin axis gradually aligns itself with the d-c field. If now a small uniform r-f field is applied to the system so that the resultant field oscillates between points P_1 and P_2 as shown in Fig. 2B, the electron is perturbed and precession takes place again. If the rate of oscillation of the field just equals the frequency corresponding to the precession rate, energy is absorbed by the ferrite.

This absorption manifests itself as a single symmetrical peak which takes place at a particular frequency for a given value of d-c field. A typical plot of absorption as a function of field is shown in Fig. 3A. For a long time this single resonance peak was the only one observed by experimenters. More recently, it has been found that if the ferrite is placed in an r-f field which is nonhomogeneous throughout the ferrite region, a multiple series of less intense resonant absorption peaks occur. Two such series are typified in Fig. 3B. The new absorption peaks are caused by the fact that the axes of the electron spins are no longer precessing in synchronism throughout the ferrite region, but are out of phase in various parts of the sample because of the uneven distribution of magnetic flux.

Magnetostatic Modes

With each resonant peak is associated a particular spatial configuration of the r-f field within the ferrite known as a magnetostatic mode. Magnetostatic modes are distributed in an almost continuous frequency spectrum. Their frequencies depend only on the shape of the sample and the applied d-c magnetic field, but are always greater than, or equal to $\gamma(H_{dc} - 4\pi M)$ where γ is the gyromagnetic ratio, H_{dc} is the applied field, and M is the saturation magnetization of

the ferrite. One of the magnetostatic modes is the uniform precession with frequency $\omega_p = \gamma H_{dc}$.

Theoretical investigations suggested that magnetostatic modes could be utilized in the construction of a parametric amplifier^{3, 5} and three possible types of operation were found to be feasible with such a device.

Energy can be coupled between

quency, resulting in dissipation of pumping power in those modes which are uncoupled to the load.

Semistatic Operation

A second mode of operation, known as "semistatic", is more practical. In this mode, the ferrite sample is placed in a cavity made resonant to f_s or f_i . The other required frequency is derived by

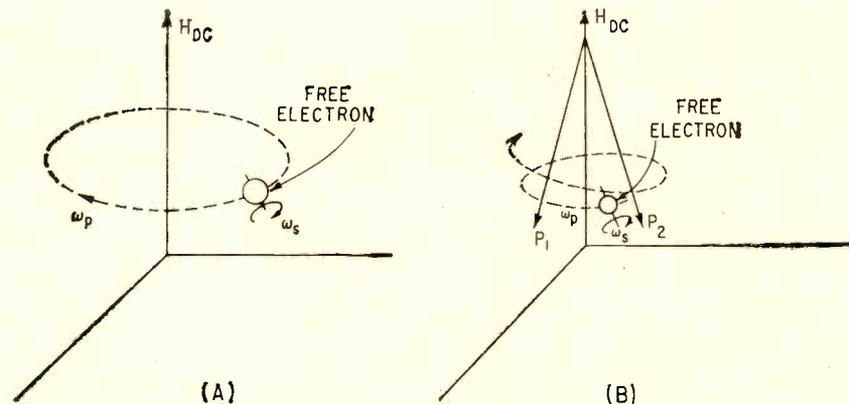


FIG. 2—Precessional path of electron spin axis under influence of (A) d-c magnetic field and (B) uniform r-f field

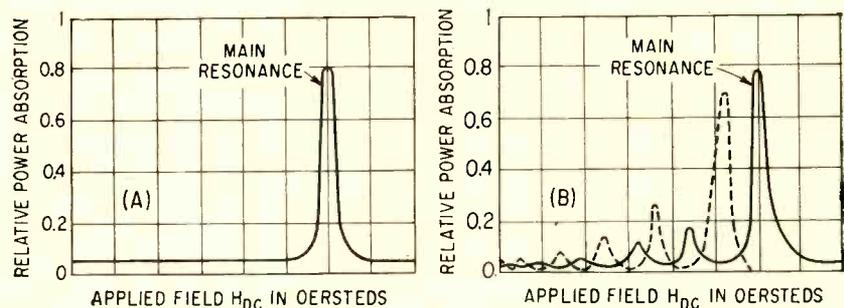


FIG. 3—Typical plot of power absorption as a function of magnetic field in a ferrite crystal. Single resonance peak as in (A) occurs when ferrite is uniformly magnetized. In (B) series of smaller peaks is manifestation of magnetostatic modes

the uniform precession mode and the other magnetostatic modes. If the pump frequency is selected to equal the uniform precession frequency f_p and two additional magnetostatic modes whose frequencies are f_s and $f_p - f_s = f_i$ are excited, the necessary conditions for parametric amplification are fulfilled. This type of operation is called "magnetostatic" because it depends only upon resonances characteristic of the ferrite and the field, independent of the external structure.

Practical use of magnetostatic operation is made difficult by the large number of pairs of modes adding up to the uniform precession fre-

quency, resulting in dissipation of pumping power in those modes which are uncoupled to the load.

In the third mode of operation, known as "electromagnetic", a doubly resonant microwave structure is tuned to both f_s and f_i . The only magnetostatic mode present is that of the uniform precession frequency f_p .

Based upon the theoretical proposals an amplifier utilizing the electromagnetic mode of operation was constructed at Bell Labs. This approach was used because electromagnetic modes are easily excited

and measured, and the microwave structures necessary to sustain them are readily constructed.⁴

Experimental Amplifier

Figure 4 is a sketch showing the construction of the experimental ferromagnetic amplifier. In this system, the pumping oscillator frequency is 9,000 mc.

Both f_s and f_i are made equal to 4,500 mc. The microwave structure consists of a shielded stripline, a half-wavelength long with a Q of 500.

A coaxial probe couples the signal to the cavity. The ferrite sample consists of two disks of single-crystal manganese ferrite, 0.125 in. in diam. and 0.050-in. thick. These are placed at the center of the stripline, one on top and bottom. The pumping power enters the device through a TE_{10} mode waveguide orthogonal to the stripline.

With a d-c magnetic field applied at a 45-deg angle to the stripline, and 3- μ sec pulses of 20-kw peak pumping power, oscillations at 4,500 mc are observed having an output power of 100 w. When the pumping

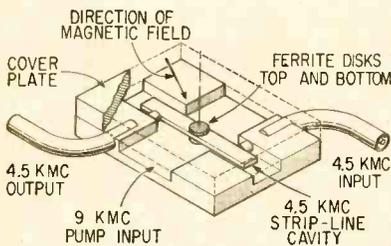
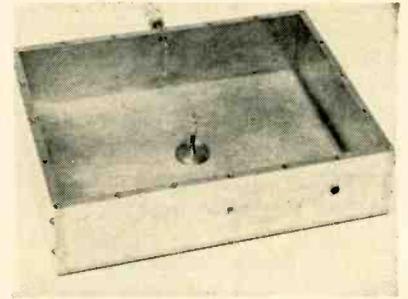
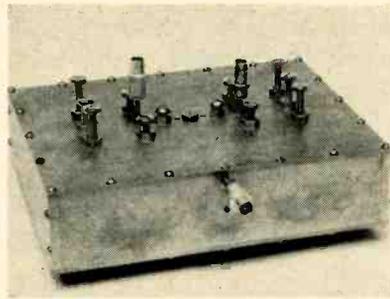


FIG. 4—Sketch of ferromagnetic mavar operating in the electromagnetic mode

power is reduced below the threshold level, amplification of the 4,500 mc signal may be observed. When the pump oscillator output is reduced about 1 db below the value required for sustaining oscillation, a gain of 8 db is realized. The high level of pump power required for electromagnetic operation seems to preclude it from practical application. Further experiments with semistatic and magnetostatic operation indicate that successful development of the ferrite mavar lies in this direction. Table I is a chart of the various modes of operation and the order of magnitude of the pumping power



Deceptive simplicity of this "diode-in-a-box" is revealed by these views of a mavar developed at Stanford University. Tuning screws in cavity lid provide multiple resonance, essential if mavar operation is to take place

required for each, as derived from laboratory experiments.

II—Variable Capacitance Mavar

It has long been known that a *pn* junction exhibits the characteristics of a nonlinear capacitance when biased in the reverse direction.⁶

At the junction there is a region known as the depletion layer, in which there are few holes or electrons. Within the depletion layer, the net fixed charge is not neutralized by mobile carriers, whereas outside the region, there are enough holes and electrons present to neutralize the fixed charges. This situation, pictured in Fig. 5A, is analogous to a parallel-plate capacitor with plates oppositely charged.

When the reverse bias of the junction is increased, the depletion layer widens. This corresponds to separating the plates of the capacitor with an accompanying decrease in capacitance. Hence the *pn* junction may be represented as a variable capacitor whose value depends on the voltage applied. Figure 5B is a graphical representation of the depletion layer capacitance as a function of the back voltage. A typical dynamic capacitance characteristic for a germanium *pn* junction is a 3:1 change in capacitance for a 15-v change in bias.

An equivalent circuit of a back-biased junction or point contact diode is shown in Fig. 5C. The depletion layer capacitance C_d is shown in series with a constant spreading resistance R_s , and C_0 is the junction static capacitance.

Diode Amplifier

The variable reactance represented by the depletion layer capacitance is the mechanism which can

be utilized in mavar construction.

Figure 6 shows a block diagram of a negative resistance type experimentally set up at Bell Telephone Laboratories.⁷ Here the diodes employed are silicon and germanium diffused junction types or welded contact gold-bonded germanium types mounted in a suitable waveguide structure. A circulator is used to isolate the input from the output signals and also prevents thermal noise from the load from being amplified. Pump power is supplied at 12 kmc and stable power gain of 45 db is measured at the signal frequency of 6 kmc. As predicted by theory, constant gain-bandwidth product is achieved. With gain adjusted to about 18 db, a bandwidth of 8 mc is possible at a noise figure of about 5 db. Pump power is 50 to 500 mw.

In a negative resistance type mavar constructed at Stanford Uni-

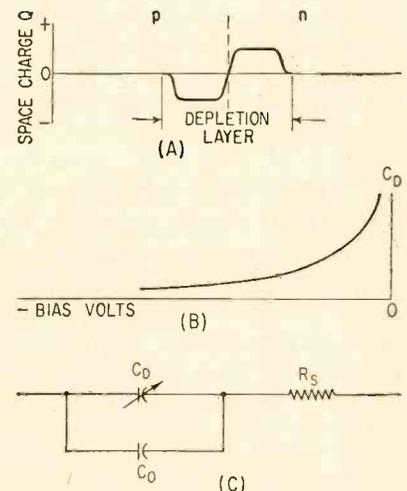


FIG. 5—Space charge distribution at a *pn* junction (A) results in a nonlinear capacitance which varies with reverse bias (B). Equivalent circuit of diode is shown in (C)

versity,⁸ a cavity is made simultaneously resonant to frequencies of 3,500, 2,300 and 1,200 mc. The diode, a special type with a low frequency zero-bias capacitance of 1 $\mu\mu\text{f}$ and a spreading resistance of about 5 ohms is placed within the cavity. Pump power of about 100 mw at 3,500 mc causes oscillations to occur at both lower frequencies. When pump power is reduced slightly below this level, amplification at either 1,200 or 2,300 mc is obtained. Bandwidth at 19 db gain is 1 mc, at a power output of 1.5 mw. Preliminary noise figure is less than 4.8 db.

Disadvantages

The negative resistance mode of operation suffers from the disadvantage that by its very nature it is difficult to achieve stability. In some cases, adjustment of the threshold pump power is critical, and the device is sensitive to load variations unless a circulator or other isolation device is used. Furthermore, placing a negative resistance in the signal circuit is equivalent to raising the Q . This results in a limitation of the bandwidth capable of being achieved at substantial gains.

The up-converter mode of operation overcomes some of these disadvantages although at the expense of requiring a demodulator to recover the signal frequency f , from the amplified sum frequency f_n . Scientists at Airborne Instrument Lab, have successfully developed a

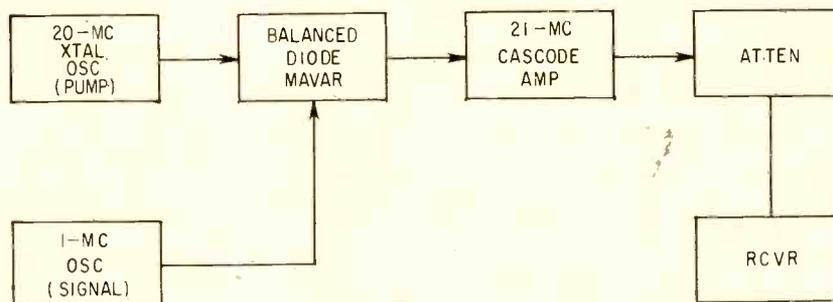


FIG. 7—Setup for up-converter low frequency mavar. This type is generally more stable, capable of greater bandwidth than negative resistance type

low frequency amplifier of this type with a view to extending the technique to higher frequencies." Figure 7 illustrates the method.

In this system, a balanced mixer arrangement using two identical 1N470 silicon diodes constitutes the mavar section. The balanced configuration provides ease of tuning, eliminates local oscillator noise and cancels the local oscillator current through the input and output circuits. Available power gain is 10 db with a 10 percent bandwidth at the signal frequency. The overall effective input noise temperature is 40 K, which corresponds to a starting noise figure of 0.5 db.

Traveling Wave

Many variations of these basic circuits have been devised. One of these is an experimental traveling-wave amplifier using four stages of diodes arranged in tandem and in such a phase relationship that a growing wave is generated as the

signal travels down the line of successive stages. The advantage of such an arrangement is an increase in the available bandwidth. R. S. Engelbrecht of Bell Labs has obtained a 100-mc bandwidth at a signal frequency of 400 mc. The pump power of 10 mw was at 900 mc. Gain of 10 db at a noise figure of only 3.5 db was achieved.

The implication of the properties of diodes in mavar applications are clear. The cost is potentially low, reliability high. No external magnetic fields or refrigeration are required. One basic type covers a wide frequency range since there are no abrupt internal resonances in the properties of a pn junction. Probably it is the diode type mavar that will have the most immediate impact on communications.

III—Electron Beam Mavar

Parametric amplification of a signal may also be achieved by using the properties of a modulated electron beam as the variable reactance.

One method varies the reactance of a microwave cavity with a pump oscillator.¹⁰ Figure 8 illustrates the system. A beam of electrons is produced by the electron gun and accelerated toward the collector. The signal cavity has two equal gaps separated by a drift space L . As the electron beam passes through the cavity, it enters the field-free drift region. An effective impedance is produced by the beam across the cavity which is a function of the drift angle α as plotted in Fig. 8. As seen in the figure, if L is adjusted so that α is $n\pi$ radians, where n is any integer, then the impedance across the cavity becomes a pure reactance.

To produce mavar action, the

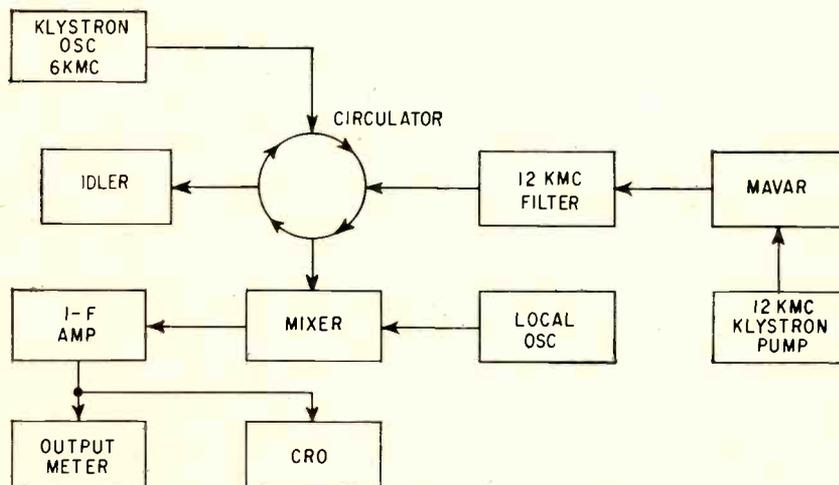


FIG. 6—Block diagram of negative resistance mavar setup. Diodes employed are silicon and germanium diffused junction types or welded contact gold-bonded germanium

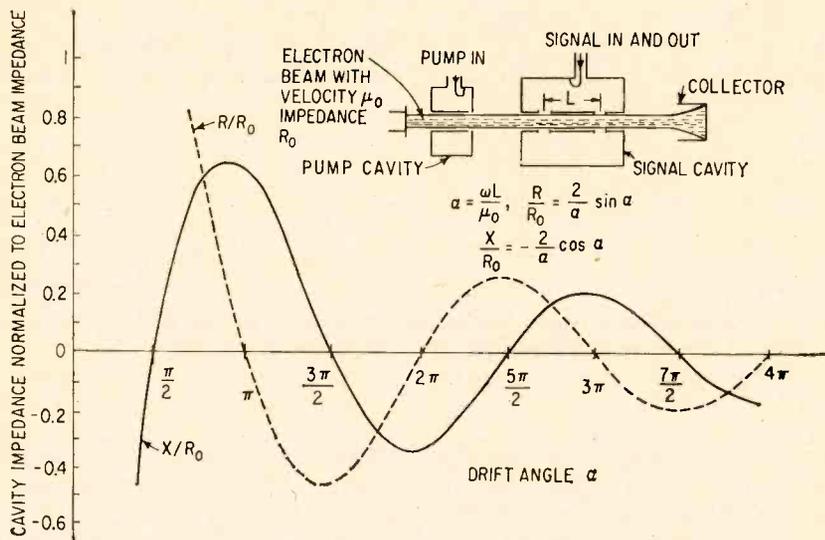


FIG. 8—Resistive and reactive components of impedance across cavity as a function of drift angle. Pure reactance is obtained when $\alpha = n\pi$ radians

electron beam, and hence the reactance, is modulated by injecting pump power into another cavity resonant to the pump frequency. For simplicity the pump frequency is made equal to twice the signal frequency.

If the drift angle is $(2n + 1)\pi$ radians, corresponding to a positive reactance, any noise currents of signal frequency coupled onto the beam at the cathode will cancel at the signal cavity by virtue of their being equal in amplitude but out of phase at the two gaps.

An experimental tube based on this principle was successfully operated, although no noise figures are

as yet available. With a pump frequency of 8,300 mc at a power level of 140 mw, 20-db gain was observed at the signal frequency of 4,150 mc.

Space Charge Waves

Another mavar employs space charge waves imposed on a modulated electron beam. When a beam is modulated by an r-f signal, either of two traveling waves of space charge can propagate along the beam. One wave, called the "slow" wave travels at a velocity less than the d-c velocity of the beam, and the other "fast" wave travels at a greater velocity. Hence the slow wave may be thought of as repre-

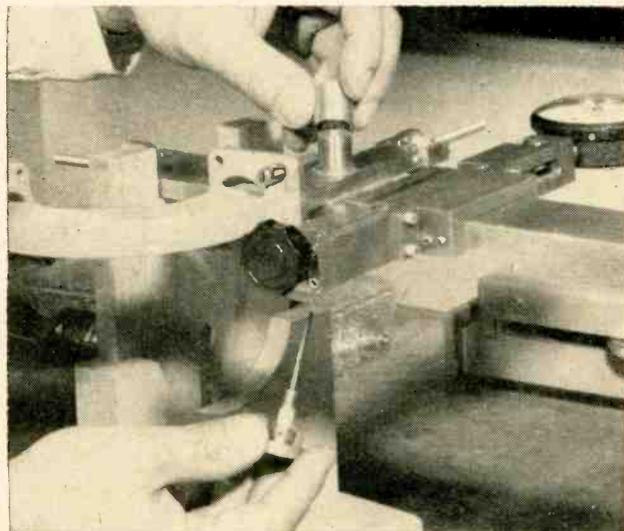
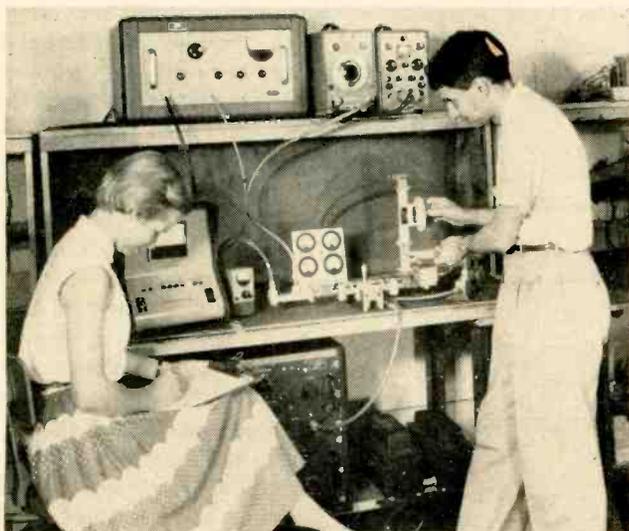
senting a negative power with respect to the d-c beam power, and the fast wave may be considered as positive power. Therefore, to excite the slow wave, r-f power must be extracted from the beam, while the fast wave is excited by adding power to the beam.

In a conventional traveling wave tube, gain is achieved by amplification of the slow wave. This is accomplished by a slow-wave structure such as a helix which extracts r-f power from the beam at the expense of the d-c power. Noise imposed on a slow wave at the cathode would require for its removal the addition of r-f power to the beam of proper phase and amplitude to cancel it out. Because of the random nature of noise, this is clearly impossible. On the other hand, noise imposed on a fast wave represents an excess of power on the beam that need merely be extracted and absorbed.

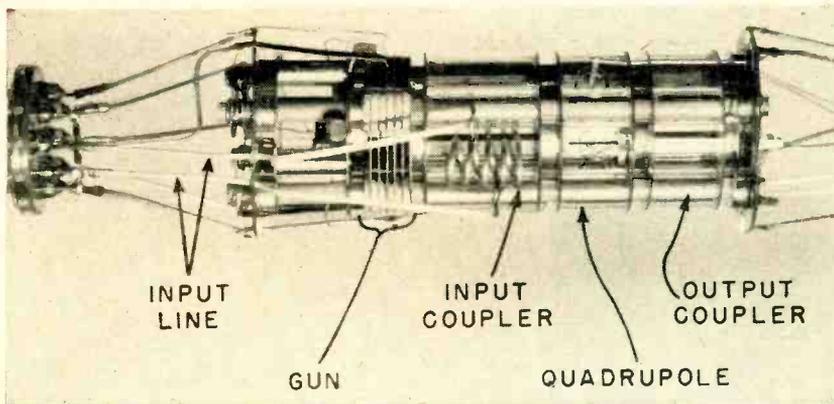
The fast wave, once launched on the beam, can be amplified by parametric action if the beam is modulated by a pump oscillator. Under these conditions the fast wave grows exponentially with distance along the beam at the expense of the pump power.

Practical Version

A low-noise tube embodying these principles was first developed at Zenith Radio Corporation. The latest version of this tube (see cut)



Technicians at Airborne Instruments Lab (left) measure noise in up-converter mavar. Special techniques are required to measure such low levels of noise accurately. At right, closeup of semiconductor diode being inserted in waveguide structure in a negative-resistance mavar application



Electron beam maver developed at Zenith Radio Corporation. This is an experimental model, made demountable for ease of component adjustment

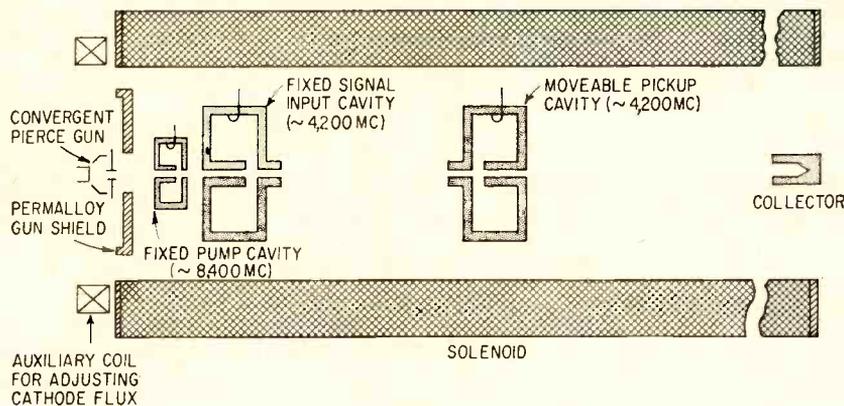


FIG. 9—Cross-section of experimental fast-wave parametric amplifier under development at Bell Labs. Solenoid is used to focus beam to desired width

uses an electron gun which generates an electron beam of about 35 μ A. The beam drifts at a low velocity along the lines of a magnetic field of about 200 gauss. Input and output couplers are pairs of deflection plates tuned to the signal frequency of 560 mc by built-in coils.

At the input coupler, signal power is transformed into spiraling electron motion. The beam absorbs power from the signal and carries it in the form of a transverse fast wave. At the same time, the input coupler is designed to absorb the fast wave component of noise which is already present on the beam. Thus beam noise and input signal are interchanged.

Parametric amplification of the fast wave is accomplished during passage of the beam through a non-homogeneous transverse electric field produced by a structure resembling the stator of a 4-pole generator. The structure, called a quadrupole, is excited by pump power of about 10 mw at a frequency of 1,120 mc. The alternating field thus pro-

duced causes the radius of the orbits of the spiraling electrons to increase or decrease exponentially. On averaging, exponential growth always exceeds exponential decay, resulting in gain. At the output coupler, the electrons spiral inward, giving up their kinetic energy in the form of amplified signal to the load circuit.

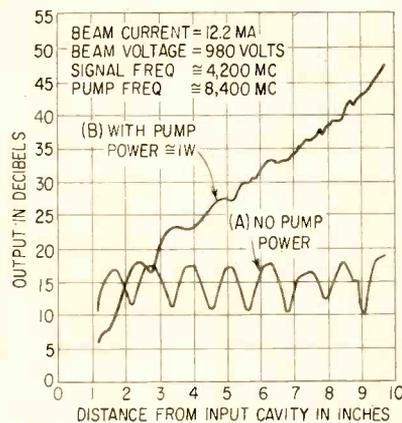


FIG. 10—Plot of signal amplitude measured as a function of distance from input cavity. Growth of signal is evident when pump is applied

Typical performance data for this tube are: bandwidth of 50 mc at a center frequency of 560 mc; gain of up to 30 db at an approximate noise figure of 1 db. The tube is unconditionally stable and gain is controlled by adjusting the pump power.

Cavity Coupling

A demountable tube similar in principle to that just described has been built and operated at Bell Laboratories.¹² The setup is sketched in Fig. 9. Here the input and output coupling as well as modulation of the beam by the pump is accomplished by resonant cavities.

In this tube, the pump cavity is resonant at 8,400 mc. The signal cavity is tuned to half the pump frequency and excites a fast wave of space charge on the beam. Simultaneously noise is coupled out and absorbed.

The third cavity is tuned to the signal frequency and can be moved axially so as to measure the variation of space charge with distance along the beam. Figure 10 shows the variations when approximately 1 w of pump power is used. In this case a parametric gain of about 41 db was achieved with the tube, but internal losses cut this figure to a realizable 21 db. Although noise performance data is unavailable, the figure should be well below that of conventional twt's which is limited to about 4 db.

REFERENCES

- (1) J. M. Manley and H. E. Rowe, Some General Properties of Nonlinear Elements, *Proc IRE*, 44, p. 904, Jul. 1956.
- (2) L. R. Walker, Magnetostatic Modes in Ferromagnetic Resonance, *Phys Rev*, 93, p. 72, Jan. 1954.
- (3) H. Suhl, Proposal for a Ferromagnetic Amplifier in the Microwave Range, *Phys Rev*, 105, p. 384, Apr. 1957.
- (4) M. T. Weiss, Solid-State Microwave Amplifier and Oscillator Using Ferrites, *Phys Rev*, 107, p. 317, Jul. 1957.
- (5) H. Suhl, Theory of the Ferromagnetic Microwave Amplifier, *J. of App Phys*, 28, p. 1225, Nov. 1957.
- (6) A. Uhlir, Jr., Two-Terminal P-N Junction Devices for Conversion and Computation, *Proc IRE*, 44, p. 1183, Sept. 1956.
- (7) G. F. Herrmann, M. Uenohara, and A. Uhlir, Jr., Noise Figure Measurements on Two Types of Variable Reactance Amplifiers Using Semiconductor Diodes, *Proc IRE*, 46, p. 1301, Jun. 1958.
- (8) H. Heffner and K. Kotzebue, Experimental Characteristics of a Microwave Parametric Amplifier Using a Semiconductor Diode, *Proc IRE*, 46, Jun. 1958.
- (9) B. Salzberg and E. W. Sard, A Low-Noise Wide-Band Reactance Amplifier, *Proc IRE*, 46, p. 1303, Jun. 1958.
- (10) T. J. Bridges, A Parametric Electron Beam Amplifier, *Proc IRE*, 46, p. 494, Feb. 1958.
- (11) R. Adler, Parametric Amplification of the Fast Electron Wave, *Proc IRE*, 46, p. 1300, Jun. 1958.
- (12) A. Ashkin, Parametric Amplification of Space Charge Waves, Paper Submitted to *J. of App Phys*.

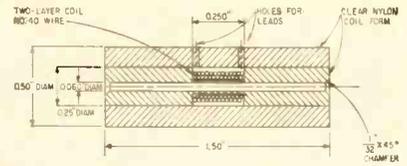
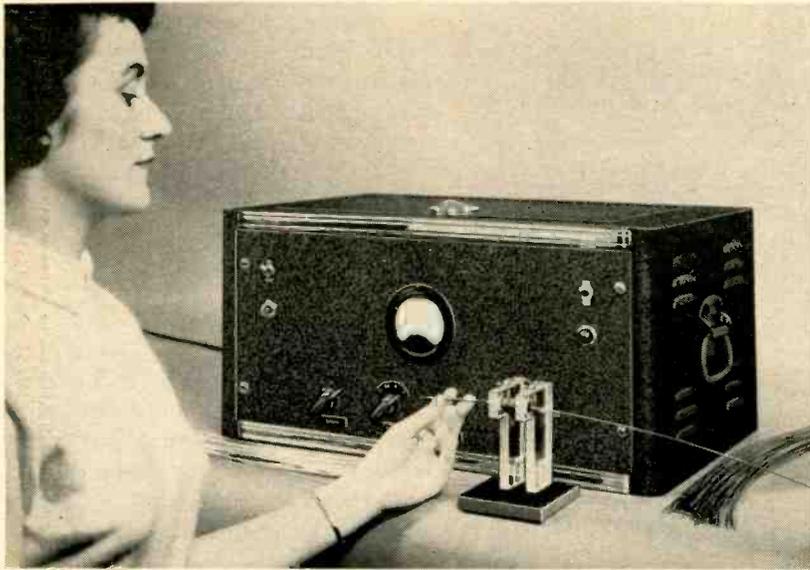


FIG. 1—Probe dimensions for 0.055-inch diameter wire under test

FRONT COVER—When wire is pulled through probe coil mounted on clear plastic stand, meter on panel indicates size of each flaw. Meter reads full-scale for perfect wire

Detecting Invisible

ONE CRITICAL NUCLEAR reactor application called for a large quantity of 0.055-inch-diameter-zirconium wire having exceptionally high quality. Cracks or internal voids less than 0.001 inch in depth or length were sufficient cause for rejection. The instrument described here reliably detected these defects. Speed of inspection is limited by the band width of the recording system used to make a permanent record of the wire quality; however, if a permanent record is not necessary, an electronic relay circuit can be used to indicate flaws in the wire. Inspection speeds of many feet per second then become possible. Both paramagnetic and ferromagnetic wire can be inspected.

Theory of Operation

The wire to be tested is run through a small probe coil which establishes an a-c magnetic field that induces eddy currents in the wire. Flaws cause a change in the magnitude and direction of the eddy currents, thereby causing changes in the impedance of the probe coil. Measurement of the change in impedance can thus provide information on wire quality.

To obtain a maximum change in coil impedance for a given flaw, the

probe coil must fit tightly around the wire. Coil length should be the minimum that will still give an adequate coil impedance. For testing zirconium wire 0.055 inch in diameter the optimum coil geometry as determined experimentally is shown in Fig. 1.

Factors Affecting Accuracy

Wire defects are usually cracks and internal voids, the size of which

determine the magnitude of the change in coil impedance. The impedance value also depends on the electrical properties of the wire. With zirconium wire, however, the conductivity and permeability were sufficiently uniform so they did not interfere with flaw detection.

Variations in coil-to-wire spacing change the impedance of the coil. To minimize this change, the diameter of the center hole of the coil form was made only 0.005 inch

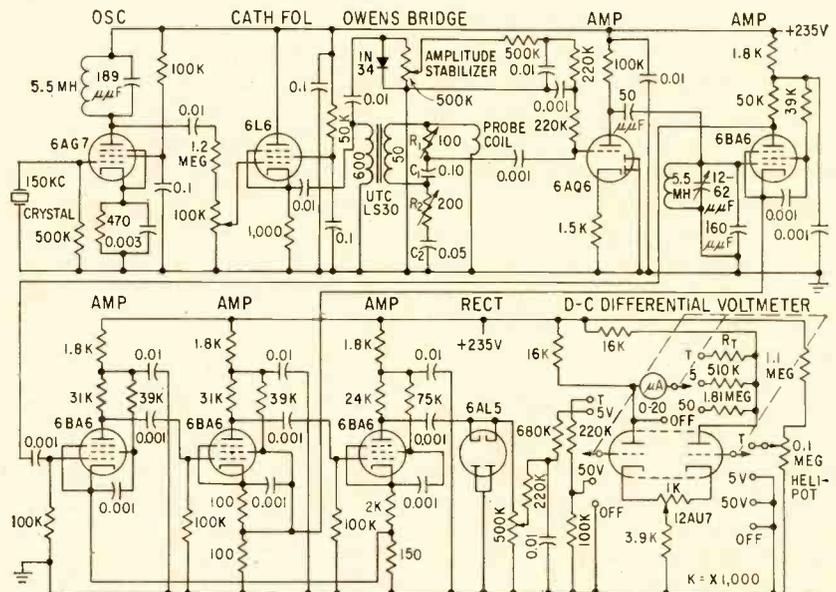
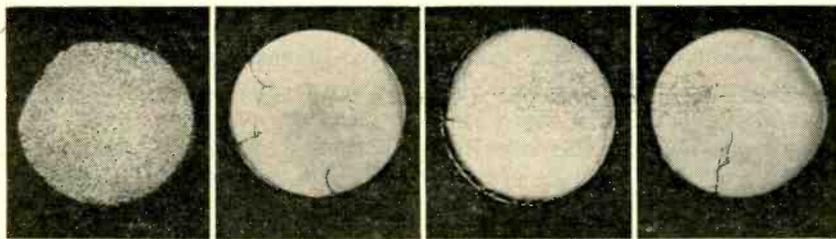


FIG. 2—Circuit of instrument. Electronic relay or recorder may be connected across microammeter in d-c differential voltmeter circuit if desired

Zirconium wire for positioning fuel elements of nuclear reactors is run through probe coil of high-sensitivity eddy-current instrument that gives permanent record of surface or internal cracks and voids smaller than 0.001 inch. Result is measure of integrated wire quality because several small cracks give same indication as one large crack. Instrument is readily calibrated for other kinds of wire. With meter or relay in place of recorder, speeds of several hundred feet per minute can be achieved for production

By R. G. MYERS and C. J. RENKEN, Argonne National Laboratory, Lemont, Illinois

Flaws in Wire



Cross-sections of 0.055-inch zirconium wire used for calibrating instrument. Output was adjusted so meter gave reading of 5 for standard acceptable wire at left. Next sample, with at least four major flaw areas, gave reading of 0.0, third sample gave 0.5, and sample at right with only one surface crack gave 2. For nuclear reactor application, acceptable wire had to read over 4.25 at all points

greater than the nominal wire diameter. Wire diameter varied only ± 0.003 inch, which was not enough to interfere with detection of flaws.

Changes in the operating temperature of the coil vary its impedance. If these temperature changes are too drastic, the calibration of the instrument will be affected. These changes in temperature may come from changes in the ambient temperature or from excess coil current.

The operating frequency is not critical, hence a wide range of frequencies can be used for detecting flaws in wire. This range can be determined theoretically or experimentally, and varies with the permeability, conductivity and diameter of the wire to be tested.

The circuit diagram is shown in

Fig. 2. The impedance of the probe coil is measured with a modified Owens bridge circuit consisting of R_1 , R_2 , C_1 and C_2 . The crystal-controlled oscillator supplies a 150-kc, 20-volt peak-to-peak sinusoidal voltage to the primary of the audio transformer through a cathode follower. Probe coil heating is negligible with this voltage. An amplitude-stabilizing circuit practically eliminates the effects of oscillator voltage drift.

Output Voltage

Bridge output voltage is amplified in five stages, then rectified for measurement by a d-c differential voltmeter. A tuned circuit connected from the grid of the second amplifier stage to ground eliminates undesirable harmonics. Degenera-

tive feedback loops in the last amplifier stages assure high stability.

To calibrate the instrument, several wires were tested at many points, the wires were sectioned at these points, and wire quality was determined by microscopic inspection. This gave output voltages of 0 to 4.25 v for unacceptable wire.

To set up the instrument for operation, the bridge is first balanced without a wire in the coil by adjusting R_1 and R_2 for zero output voltage, using first the 50-v range and then the 5-v range. With the meter on the 5-v scale, the standard flawless wire is placed in the probe coil and the 500,000-ohm potentiometer across the 6AL5 rectifier output is adjusted until the meter reads 5 v. The meter is then switched to the test scale and the 0.1-megohm meter balance potentiometer is adjusted to obtain a full-scale deflection. The instrument is then ready.

When the meter is set on the test position, the variable resistance in the grid circuit of the 12AU7 balances out a portion of the d-c voltage. This allows the remaining d-c voltage to cover the entire meter range and increases the sensitivity of the meter to defects. To obtain a full-scale reading for 2.5 v, a 0.2-megohm resistor is used for R_7 .

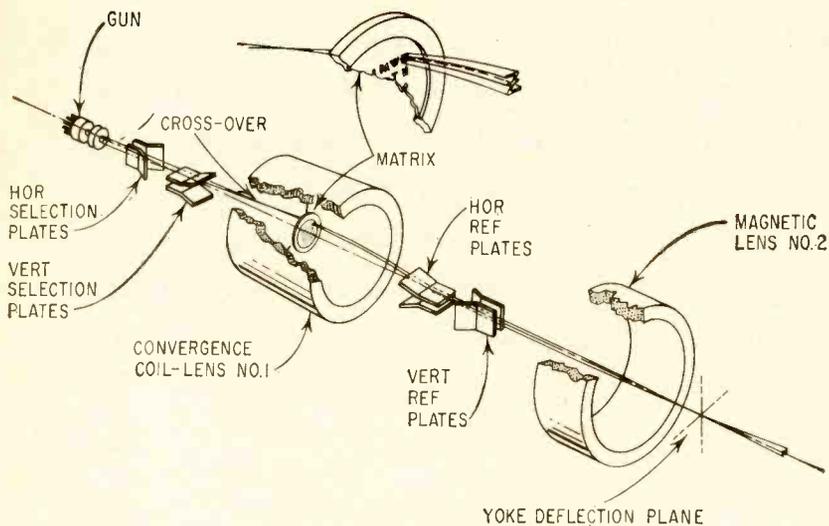


FIG. 1—Diagram illustrates how the electron beam is shaped to select individual characters from the matrix. The shaped-beam tube, part of the computer readout, represents a method of writing on a cathode-ray screen. Selection plates direct the beam at the desired character in the matrix whence it is deflected to face of crt



Operator is shown checking final adjustments prior to actual operation of the high-speed electronic printer. The character-forming tube is in the top panel

Electron Gun Operates

SUCCESSFUL MARRIAGE of the Charactron computer readout, employing the shaped-beam tube for code conversion and character display, with the Copyflow Xerographic printer, now makes it possible to record one-million type-written characters per minute.

Pulse-code data of electronic processors can be converted to printed records in the form of letters, numerals, charts and graphs on ordinary untreated paper.

The shaped-beam tube effects code conversion and character display by first transforming pulse-codes into light rays of predetermined configurations. The printer transforms these light rays into printed records. Each system is unique in its respective method of operation and in combination they are expected to make worthwhile contributions to the growing read-out speed requirements of data processors.

Electron Optics

Shaped-beam tube C7C11 is used as the code converter. A simplified diagram of the electron optical system of this tube is shown in Fig. 1. The optics are similar to that of the C19K, developed for use in air-

craft surveillance systems, except that a second magnetic lens has been added to the C7C11 tube. This lens is located between the deflection yoke and the reference plate system.

Characters are formed by directing a beam from the electron gun at a thin metal disk which may have as many as 64 different characters arranged in an 8-by 8-character matrix, cut out like a stencil. Beam diameter is sufficient to cover the largest character in the matrix. Selection plates, located between the electron gun and the matrix, are supplied with d-c control voltages which direct the beam at the desired character.

The characters and their matrix alignment conform with the common language of the computer. There is, therefore, a direct relationship between a given set of identifying codes, the type and arrangement of characters in the matrix and the characters displayed on the screen of the tube.

Magnetic lens No. 2 in Fig. 1 permits the characters displayed on the screen of the tube to be varied in height from 0.035 in. to 0.07 in. in accordance with instructions from the data-processing equipment. The 0.035 in. character-dis-

play dimensions permit an information density (characters-per-unit-area) of more than 10,000 characters within the $4\frac{1}{2}$ in. sq area of a 6-in. useful screen diameter of the tube. This is nine times the information density possible when employing, for example, 0.1-in. high characters on the 19-in. diam screen of the C19K tube. The use of 0.035-in. high characters in many computer read-out applications vastly reduces the number of pictures needed in the conversion of output data to permanent records. In line-at-a-time printing of the output of data processors, there is ample room to display 128 or more 0.035-in. characters in a single line across the useful screen diameter of the tube.

A simplified diagram of the computer readout and printer, is shown in Fig. 2. The control elements of the shaped-beam tube are shown as block diagrams. Figure 3 shows the actual physical layout of the components.

Xerography

Operation of the printer is centered around an aluminum drum having a photoconductive surface of vitreous selenium which has

Electronic printer converts pulse-code data from shaped-beam crt into printed records on ordinary untreated paper at the rate of one-million characters per minute. Characters are formed by passing a magnetically controlled electron beam through a thin metal stencil-cutout matrix which contains alphabetic and numeric characters. High-speed printed readout is solved by using xerographic electronic dry-printing technique

By **JOSEPH T. McNANEY,**

Technical Director, Stromberg-Carlson-Sah Diego, A Division of General Dynamics Corporation, San Diego, California

High-Speed Printer

been deposited by vacuum evaporation. There are five processing steps involving this drum: Uniform charging of the drum's photoconductive surface renders it light sensitive; Exposure of the uniformly-charged drum surface to light images from the shaped-beam tube; Development of exposed areas by allowing them to collect oppositely charged and finely-divided

powder particles; Transfer of the powder image to a record medium, such as untreated paper; Removal of any remaining powder particles prior to the succeeding charging cycle.

After the powder is transferred to the paper, the characters are heat-fused to the paper and are available immediately as a permanent record.

The photoconductor surface of the drum is charged by spraying the surface with positive ions formed by corona discharge. A corona-charging unit consists of two sets of fine wires, supported adjacent to the surface of the drum and at right angles to the direction of drum rotation. A flat plate conductor is supported on the opposite side of the wires. To generate corona discharge, the upper and lower wire sets are connected respectively to positive potentials of a few thousand volts and several hundred volts with respect to the drum and plate which are at ground potential. These potentials cause air molecules to become ionized and positive ions deposited on the surface of the drum, thereby, charging the photoconductor to a potential of several hundred volts.

Exposure

After the surface of the drum has been charged, the potential difference between the surface of the photoconductor and the aluminum base may be neutralized by exposing the surface to visible light rays. When exposed to character shapes having the blue light illumination of the fluorescent screen of a C7C11

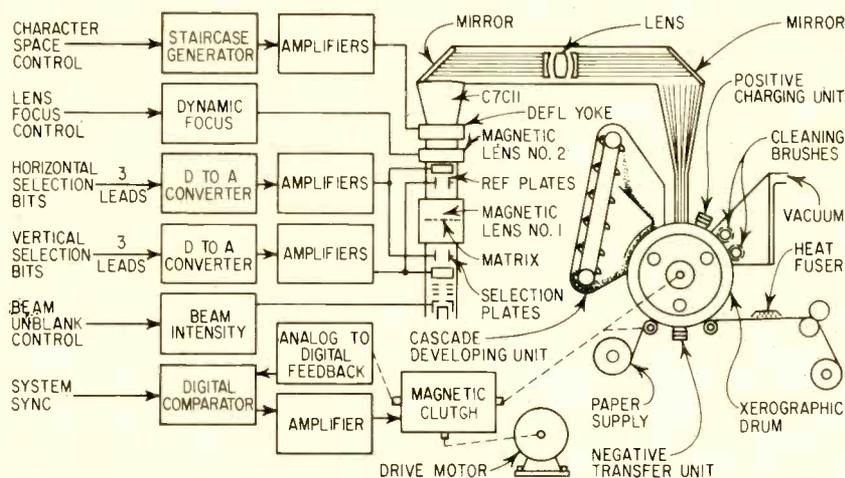


FIG. 2—Simplified diagram of the computer readout circuitry and the printer. Much of the circuitry is of conventional design. Message displays on the screen of the shaped-beam tube are focused on the light-sensitive surface of the drum through an optical system of surface-reflecting mirrors and lenses

tube, only those areas of the photoconductor which have been exposed will decay to the ground potential.

When the charged photoconductor is exposed to light, electron-hole pairs will be generated near the surface of the selenium layer when incident photons are absorbed and, thereby, produce sufficient excitation to raise electrons from the valence band to the conduction band. The positive holes, thus created, are then free to migrate through the selenium lattice toward the base and so contribute to discharging the illuminated area. Electrons can move only the short distance to the surface, hence their contribution to the discharge of the plate is negligible.

Perhaps the most important characteristic of the selenium photoconductor, which allows the process to resolve the character presentations of the C7C11 tube, is the absence of lateral conduction. This is due to the fact that the lateral electric field component is small compared to the strong perpendicular component within the photoconductive layer.

Development

To develop the latent images on the surface of the drum, a finely-ground pigmented resinous powder known as toner, combined with a relatively large granular material which acts as a carrier, is cascaded over the exposed surface. The carrier adds mass to the developer as it cascades over the drum and also charges the powder particles to the correct polarity by frictional electrification. This phenomenon, also called triboelectrification, is responsible for the electrical bond which exists between the carrier and the toner.

As the toner-laden carrier particle passes over an electrical discontinuity of the drum's surface, the vertical component of the fringing field exerts a sufficiently large force on the toner particles to overcome the carrier-to-toner bond. Thus the toner particles attach themselves to the drum within the image area.

Image Transfer

After the images have been developed on the surface of the drum

the toner is transferred to the record medium, such as paper, and made permanent by heat fixing.

The paper is fed past the transfer unit at the surface speed of the drum and in actual contact with the drum's surface. The ion charge which is deposited on the paper by the corona unit sets up an electric field of sufficient magnitude to overcome the attraction between the toner and the discharged surface areas of the drum. Thus, the positively charged toner is drawn from the drum and attracted onto the paper which is then subjected to heat that melts the resinous toner and fixes it to the paper. The pigmented image is permanently bonded to the paper by this process, making printed copy available for immediate viewing.

Pulse Code Data

In the simplified diagram of the high-speed readout device shown in Fig. 2, message displays on the screen of the shaped-beam tube are focused on the light-sensitive surface of the drum through an optical system of surface reflecting mirrors and lenses. Illuminations appearing on the screen are in accordance with pulse-code data coupled to control circuitry of the shaped-beam tube. These data may be derived from a variety of informa-

tion sources such as scientific electronic computers, automatic data processors, central filing systems and telecommunication networks.

The staircase generator, which is a 7-stage binary counter and a 7-bit digital to analog converter, controls the horizontal spacing of symbolic data across the 11-inch wide paper, while a servo-controlled paper drive regulates the vertical spacing of data on the paper as it is fed through the printer. The staircase generator provides a maximum of 128 display positions across the paper which, as in the mechanical typewriter, may be referred to as character spacing. In each of these display positions symbolic data from the matrix may be printed corresponding to letters, numerals, symbols, or horizontal and vertical line making data. Line making data is programmed to print the desired business form along with the recorded message. Larger type size of the fixed form is controlled from the input equipment by coupling the necessary control signals to the dynamic focus circuitry of the printer.

Forming Characters

The character matrix of the shaped-beam tube is positioned along the axis of the tube, normal to the direction of electron flow,

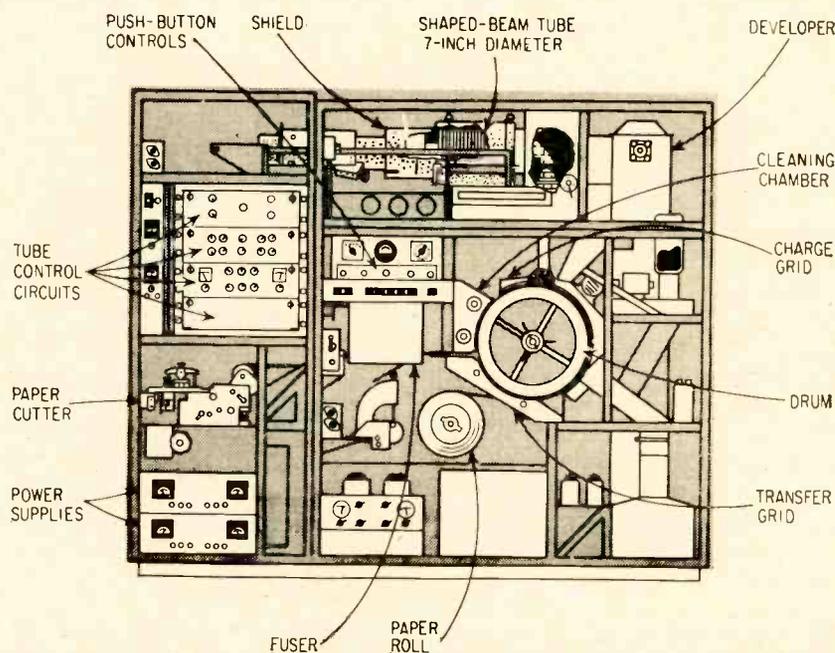


FIG. 3—Cross sectional view of the high-speed electronic printer shows the physical configuration of the complete system

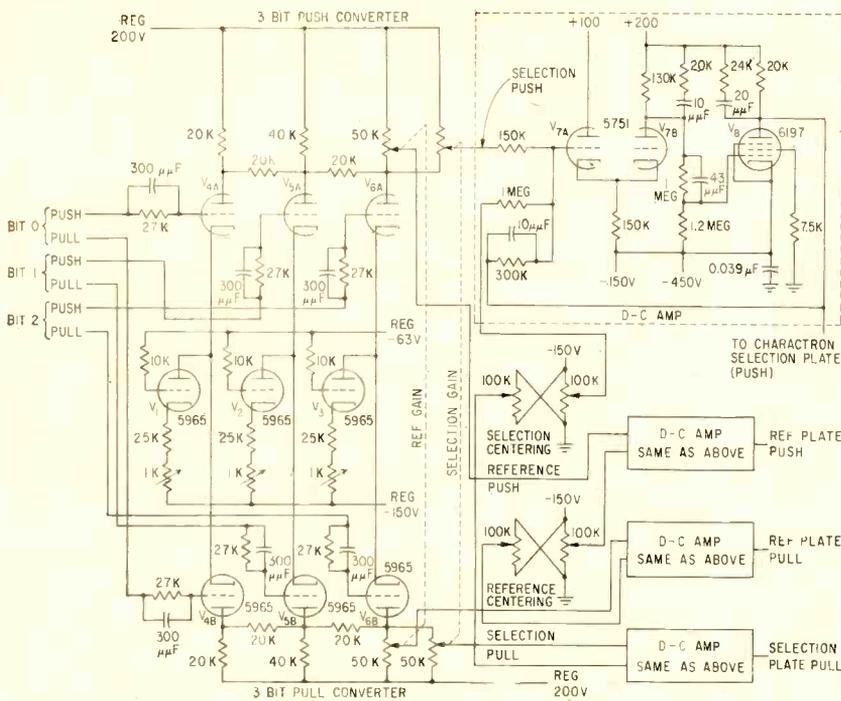


FIG. 4—Circuit diagram of the 3-bit digital-to-analog converter, used to select any one of the 64 matrix positions

and about midway of the field of the magnetic lens. A beam of electrons from the electron gun is directed at the matrix upon the excitation of an intensity circuit by a beam unblank control signal. Before the application of an unblank signal and prior to the display of a character, the three horizontal selection bits and the three vertical selection bits are coupled to their respective digital to analog converters and d-c voltages derived from the converters are amplified and applied to the reference and selection plates of the tube.

Upon the application of a beam unblank signal, the selection plates will direct the beam toward the desired character in the matrix, and, after the No. 1 magnetic lens has returned the shaped beam to a cross-over point on the axis of the tube, the reference plates will redirect the beam back onto the axis. A 6-bit code permits the cross-section of the beam to assume the shape of as many as 64 different characters which are engraved in less than a 0.25-sq in. area of the matrix.

The size of the displayed character may then be controlled in height by the No. 2 magnetic lens just prior to final deflection.

It is not necessarily a requirement to regulate drum rotation and paper feed in accordance with control data from a computer or data processor except in those applications where data coupled to the printer is subject to variations in the character-per-second display rate. In such cases a special servo-regulated drive mechanism is incorporated in the printer.

Selection Bits

The selection of any one of the 64 matrix positions is accomplished by two 3-bit digital to analog converters: three bits for vertical selection and three for horizontal selection. The two function identically. Three bits are channeled to each converter, where they are decoded (or converted) in two current ladders that provide push-pull signals.

Each converter functions on the principle of three equal currents being electronically switched in and out of a network of precision resistors. These resistors weight the inputs according to the significance of the bits so that one current causes a voltage change of E , the second a change of $\frac{1}{2}E$, the third a change of $\frac{1}{4}E$.

If the current through the plate

load resistance of V_{6A} in Fig. 4 is assigned a value of I , then the current through this same load as a result of V_{5A} conducting will be $\frac{1}{2}I$, and the current through this same load as a result of V_{4A} conduction will be $\frac{1}{4}I$.

A constant voltage on the grid of V_1 causes the cathode of V_1 to rise to the same voltage plus the tube bias voltage; thus a constant voltage on the cathode is established. The cathode bias resistor of V_1 is a precision resistor. Current flowing through V_1 must flow through either V_{4A} or V_{4B} to reach plus 200 v.

Assuming an input signal of 111 hence all three tubes are conducting, the voltage developed across the plate load resistance of V_{6A} is $1.75 IR$. With an input condition of V_{5A} and V_{6A} conducting and V_{4A} nonconducting, the voltage developed across the output will be $1.5 IR$ v. Thus binary combinations of the 3-bit information (23) can be converted into 8 different voltage levels at the output of the ladder.

Final Amplifiers

Two d-c amplifiers are used to amplify the decoded push-pull signals from the decoder. The resulting amplifier push-pull signals are then applied to the selection plates of the display tube for correct character selection. The output signals from the horizontal and vertical decoders are also fed into four additional amplifiers, these are reference amplifiers used to amplify the push-pull signals before the signals are applied to the reference plates of the display tube to reference the shaped electron beams back onto the axis of the tube. Each set of amplifiers, both selection and reference, are provided with an independent signal gain control and centering adjustment.

These potentiometer adjustments provide compensatory control for variations in tube sensitivity and computer readout circuitry.

BIBLIOGRAPHY

J. H. Dessauer, G. R. Mot, and H. Bogdonoff, *Xerography Today*, Research Division, The Haloid Company, *Photographic Engineering*, 6, No. 4, 1955

J. T. McNaney, The Type C19K CHARACTRON Tube and its Application to Aircraft Surveillance Systems, Stromberg-Carlson—San Diego, A Division of General Dynamics Corporation, IRE Convention Record 1955

Designing Transistor

Transistorized, saturable-core relaxation oscillators are finding increased application as d-c to a-c converters. This article presents a rapid means for determination of necessary circuit parameters. The technique is applicable to many variations of the basic, two-transistor symmetrical circuit

By **STANLEY SCHENKERMAN**,

Senior Engineer, Missile Development Division, Ford Instrument Company, Long Island City, N. Y.

DETERMINATION of circuit parameters in transistorized d-c to a-c converters is simplified greatly by use of the accompanying nomographs.

A symmetrical form of converter¹ is shown in Fig. 1. It consists of transistors Q_1 and Q_2 operating as controlled switches, a battery E , and a core with square-loop characteristics.

Circuit Operation

Assume that Q_1 begins conducting. Current flowing into the top or dot end of L_1 causes all windings to be positive at the dotted end. The voltage across L_3 increases con-

duction still further, causing regeneration until Q_1 saturates. This switching occurs rapidly. The induced voltage across L_1 keeps Q_2 cut off.

When Q_1 saturates, almost all of the battery voltage appears across L_1 . The core flux, ϕ , increases linearly with time until positive core saturation is reached. At core saturation, the transistor current increases rapidly in an attempt to maintain constant $d\phi/dt$, but the transistor current is limited by the base voltage developed by L_3 .

When the current and the resultant flux can no longer increase, the induced voltages drop to zero and

Q_1 is cut off. Cessation of current in L_1 allows the flux to decrease toward its remanance value, inducing voltages of the opposite polarity in all windings. This action holds Q_1 off and turns Q_2 on. The battery is now connected across L_2 and the flux builds up linearly to its negative saturation level.

The core oscillates between positive and negative saturation. If Q_1 and Q_2 are similar and $L_1=L_2$ and $L_3=L_4$, a square wave is induced in the output.

Design Procedure

Usual design procedures involve initial-core selection, completion of necessary design calculations, and a check to make certain that the required windings fit into the available area. The designer may then accept the initial core size or repeat the procedure with a larger or smaller core as influenced by his preceding calculations.

Core size may be dictated by factors such as window area available for windings, cost, weight, and overall size. Cores wound from thin tape and with high ratios of inside to outside diameter, give fast switching and steep waveforms.

Core materials such as Orthonol and Hymu "80", with narrow rectangular hysteresis loops, contribute to frequency stability and low core losses. Unfortunately, all desirable features are not available simultaneously. The narrower the loop, the lower the saturation flux density and the less rectangular the

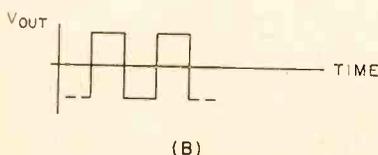
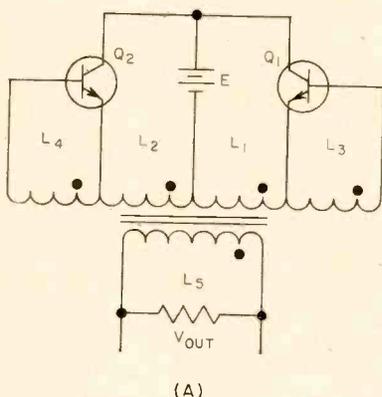


FIG. 1—Symmetrical converter circuit (A) and ideal output waveform (B),

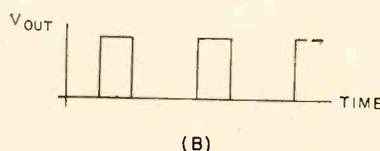
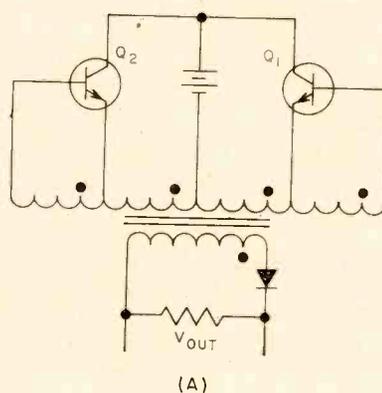
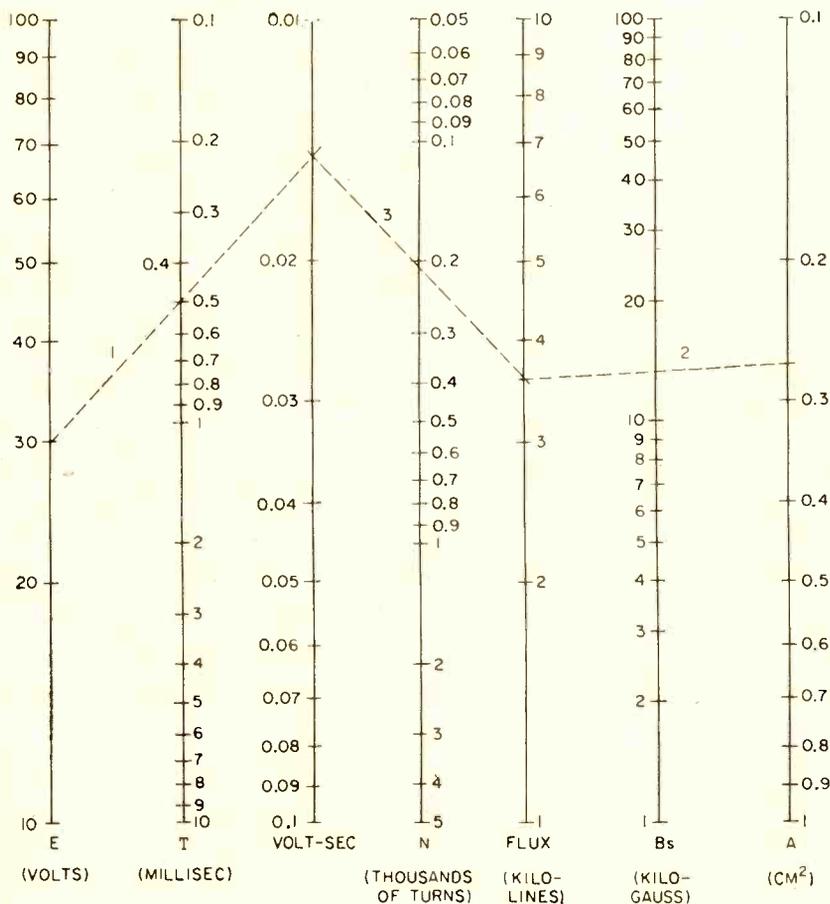


FIG. 2—Asymmetrical circuit (A) and its ideal output waveform (B)

D-C to A-C Converters



Timing Nomograph

loop. The material selected must be a compromise of all factors.

Timing Nomograph

With a trial core in mind, the number of turns for L_1 and L_2 may be found from the timing nomograph. This is based on the relation governing the change in core flux:

$$N = \frac{ET}{2 B_s A} 10^8 \quad (1)$$

where T is time in seconds during which battery voltage is applied to the core winding; E is the battery voltage; N is the number of turns on the core; A is cross-sectional area of the core in sq cm; and B_s is saturation flux density in gauss. The factor of 2 is necessary because the core change from negative to positive saturation, or vice versa, is a change of $2B_s$.

For a specified load voltage, the number of output turns resulting from application of the ideal transformer equation must be increased by ten percent. This increase is necessary to compensate for leakage impedances and the transistor saturation voltage. The latter is normally less than one volt for germanium transistors but may be higher for silicon units. The voltage nomograph for output turns assumes that this ten percent factor is sufficient. The equation is

$$N_{out} = 1.1 N \frac{V_{out}}{E} \quad (2)$$

where V_{out} is the peak output voltage during one-half cycle.

At this point, the transistor may be selected. Although it must supply one-half the required load power and core and copper losses, its operating point passes through the high

dissipation region quickly. As long as switching time occupies a negligible portion of the cycle, the transistor may be assumed 95-percent efficient. Copper and core losses total about 15 percent. Overall conversion efficiency is 0.95×0.85 or about 81 percent.

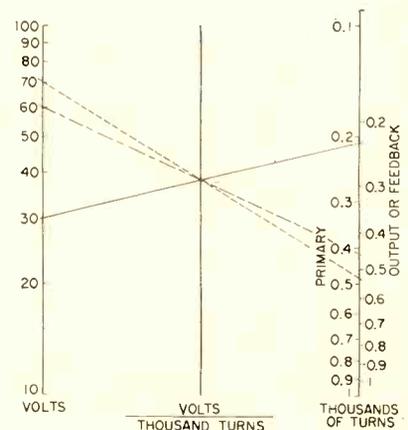
The transistor must deliver current to a fictitious load whose resistance is about 85-percent of the reflected converter load. In addition, the transistor must deliver about 130 percent of the current required by the fictitious load. This value is necessary to insure that the core is driven well into saturation.

Peak voltage appears across the transistor when it is cut off. Assume zero saturation voltage for the transistors and ideal windings. Peak inverse voltage from collector to emitter of Q_1 is then the battery voltage plus the voltage induced in L_1 by current in L_2 . In this case, peak inverse voltage is $E + E$ or $2E$ volts.

Feedback

Feedback turns of L_3 may be determined from the voltage nomograph once the required base voltage is found from the transistor output and input characteristics. The applicable formula is similar to Eq. 2 with the feedback voltage substituted for V_{out} and the number of turns on L_3 and L_1 for N_{out} .

Design now continues as in stand-



Voltage Nomograph

ard transformer practice. Appropriate wire sizes are picked and the fit of the windings checked. It is important to employ a winding sequence that will result in close coupling between L_1 and L_2 . Close coupling minimizes ringing caused by interprimary leakage reactance.

Regulation and internal heating are affected by the same factors that apply in standard transformer design. However the converter is one device that cannot be damaged by overload. Overloading causes the oscillation to cease and not resume until the overload is removed.

Example

As an example, assume a 1,000-cps symmetrical converter operating from a 30-v source is to deliver 120 v to a resistive load of 200 ohms.

Duration of each pulse is half the period of the 1,000-cps wave or 0.5 millise. Using the timing nomograph, connect $E = 30$ and $T = 0.5$ with a straight line. Extend the line until it intersects the volt-sec axis.

As an initial core selection, try a 2-mil Orthonol core, Magnetics Inc., type 50018-2A. Cross-sectional area for this core is 0.257 sq cm. Saturation flux density is 14 kilogauss.

Connect $A = 0.257$ and $B_s = 14$ with a straight line that intersects the flux axis. Connect this intersection with that previously found on the volt-sec axis. This results in an intersection with the N axis at 0.21. Both L_1 and L_2 of Fig. 1, therefore, should have 210 turns.

To determine the number of turns for L_3 for an output of 60-v peak (120 v peak-to-peak), use the voltage nomograph. Connect battery voltage $E = 30$ with the primary

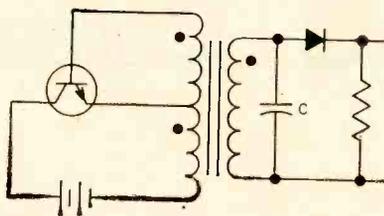


FIG. 3—Simple converter circuit using a single transistor

turns, $N_1 = 210$, as read on the left scale. Note the intersection with the volts-per-thousand-turns axis. Connect this intersection with the peak output voltage (60 v) and extend the line until it intersects the turns axis. Read the value of N_o , the number of output turns, from the right scale as 460.

The fictitious reflected load to each transistor is $0.85 \times (210/460)^2 \times 200$ or 35.6 ohms. Transistor current during the pulse is 30/35.6 or 0.845 amp. Peak transistor current must be 1.3×0.845 or 1.1 amp.

Voltage and current requirements may be met by the type H-7 transistor. As determined from the transistor output characteristics, a base voltage of 0.7 v is necessary for an output current of 1.1 amp.

Bias Windings

Return to the voltage nomograph and connect the 70-v point with the intersection on the volts-per-thousand-turns axis found previously. Extend the line until it intersects the turns axis. The value 540 turns is read from the right scale. Since 0.7 v rather than 70 v is required, L_3 and L_4 should each have 5.4 or say 6 turns.

Wire sizes may now be selected and the winding fit checked. Table I shows the wire selection and re-

quired winding area for the coils.

Window area of the type 50018-2A core is 1.82 sq in. but space must be allowed for the winding-machine shuttle. The RW II toroidal-core winding machine uses a 13/16-in. diam shuttle for number 22 wire. Shuttle area is 0.518 sq in. Utilizing a 70-percent space factor, effective window area is $0.7 \times (1.82 - 0.518)$ or 0.9114 sq in. This value leaves ample room for winding and insulation.

Admittedly, a generous amount of hindsight was used in formulating this example. In general, a few tries are necessary before a satisfactory design is achieved.

Circuit Variations

Two important variations of the basic circuit are shown in Figs. 2 and 3. In the circuit of Fig. 2,² power is delivered to the load only when the power transistor Q_1 conducts. Transistor Q_2 resets the core by driving it to negative saturation. During reset, the induced voltage in the output winding is such that the diode is cut off and no power is delivered to the load. Transistor Q_2 may be a low-power unit. It need only supply the core saturation current and any current required by the diode's finite back resistance.

Figure 3 shows the circuit for a single transistor converter.³ Here, resetting action is caused by the capacitor. Again, the diode isolates the load during the reset interval and power is delivered to the load only when the transistor conducts. Value of the capacitor is chosen experimentally to provide a waveform with any degree of symmetry.

It has been assumed that the circuits under discussion are self-starting. At room temperature, germanium transistors usually have sufficient leakage current to start oscillation. This is not always true, however, and auxiliary starting circuits may be required.

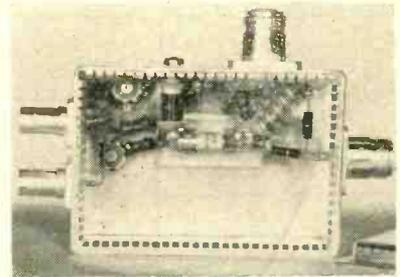
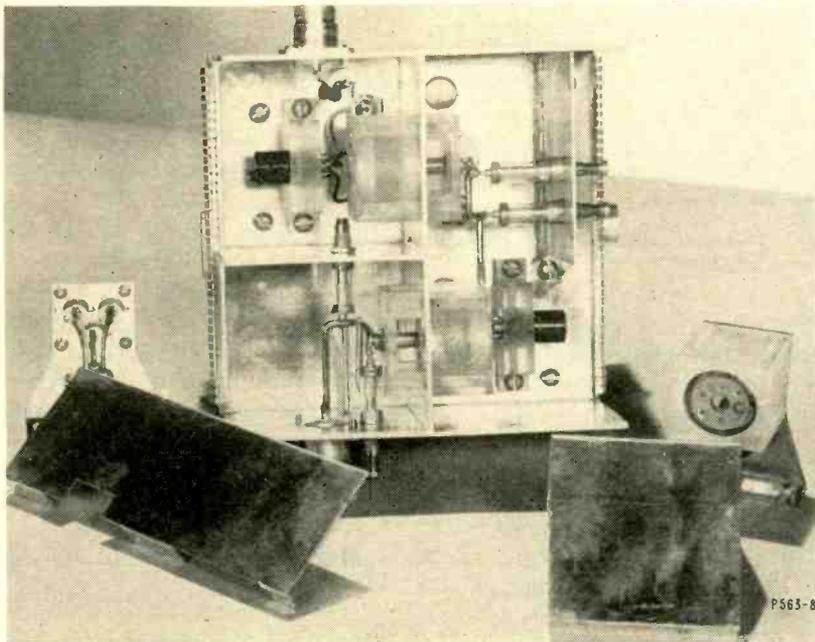
REFERENCES

- (1) Bright, Pittman, Royer, Transistors as On-Off Switches in Saturable-Core Circuits, *Electrical Manufacturing*, p 79, Dec. 1954.
- (2) D. A. Paynter, An Unsymmetrical Square-Wave Power Oscillator, *IRE Trans. CT-3*, p 64, Mar. 1956.
- (3) Chen, Schiewe, A Single Transistor Magnetic Coupled Oscillator, *AIEE Trans. Pt. I*, p 396, Sept. 1956.

Table I—Wire Selection and Required Winding Area

Coil	Turns	RMS Current	Wire Size (Awg)	Coil Area (sq in.)
L_1	210	423	22	0.17
L_2	210	423	22	0.17
L_3	6	15	38	0.000156
L_4	6	15	38	0.000156
L_5	460	600	22	0.355

Winding area required = 0.6953 sq. in.



Mixer is constructed as a separate unit to simplify alignment and trouble shooting in the field

Broad-band amplifier developed for the 400- to 450-mc band

Broad-Band Amplifier for Radar and Scatter

Low-noise two-stage broad-band amplifier and mixer covers 400 to 450 mc and can be designed for 200 to 300 mc or 700 to 800 mc. Amplifier uses tubes in cascaded grounded-grid circuit. Overall power gain is 29 db with noise figures ranging from 3.6 to 4.5 db at band center and 4.5 to 5.5 db at edges

By J. H. PHILLIPS and E. MAXWELL,

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

DESIGN OF UHF amplifiers and mixers can become critical owing to the circuit tolerances involved. To produce circuits that are inherently low in noise adds even more of a design burden. The two-stage broad-band amplifier and mixer design described here shows one way to design low-noise uhf circuits using the 6280 electron tube.

Circuit construction is a mixture of lumped and distributed elements. In preferred form, the interstage and output coupling networks are double-tuned circuits that

give good flat-top response. Where a single-tuned band-pass characteristic is acceptable, simpler single-tuned circuits may be used.

Overall power gain is 29 db. With one group of 16 tubes, noise figures ranging from 3.6 db to 4.5 db were obtained at band center and from 4.5 to 5.5 db at band edges. In obtaining these data, the input circuit was retuned for each tube. Without individual tuning, the noise figure might be degraded as much as 0.5 db.

Input noise of an n -stage ampli-

fier is expressed by the equation

$$F = F_1 + \frac{F_2 - 1}{W_1} + \dots + \frac{F_n - 1}{W_{n-1}},$$

where F is the overall noise figure, F_n is the n th stage noise figure, and W_n is the gain of the first n stages.

With two 6280 stages, at least 27 db of gain may be realized with a 50-mc bandwidth, and consequently the overall noise figure depends little on the mixer noise figure. It is desirable to pad the mixer with from 3 to 10 db, to make sure that the amplifier output looks into a

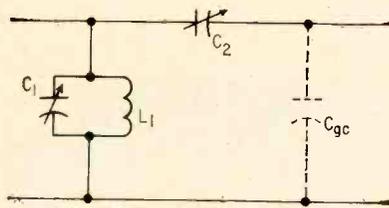


FIG. 1—Input network used to determine optimum source impedance

load flat with respect to frequency. This prevents degradation of the overall band-pass characteristic of the receiver because of improper mixer impedance at any point in the passband.

The design of the input network is crucial in any low-noise uhf amplifier. A minimum noise figure is obtained only when the source impedance is optimum and this optimum source impedance must be preserved throughout the entire band.

Optimum Source

If the circuit losses and the tube cold losses are assumed to be zero, the optimum source admittance is¹

$$G_{e \text{ optimum}} = \sqrt{\frac{\beta G_e}{R_{eq}}}$$

where β is a constant depending on the cathode material and construction, R_{eq} is the equivalent noise resistance of the tube, and G_e is the transit-time conductance loading.

The noise figure (ratio) obtained using this optimum value of the source conductance is¹

$$F_{\text{optimum}} = 1 + 2\sqrt{\beta G_e R_{eq}}$$

The factor β is generally taken equal to 5 for oxide-coated cathodes². Quantity G_e may be calcu-

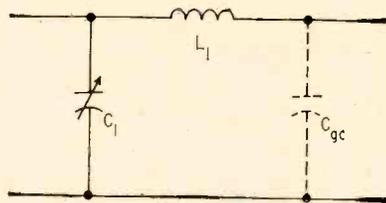


FIG. 2—Input network used in broadband amplifier

lated from the following equation, derived for plane-parallel geometry³:

$$\frac{G_e}{G_m} = \frac{45 \times 10^3 (a/\lambda)^2}{V_1} \left[1 + \frac{3.3b/a}{1 + (V_a/V_1)} \right]$$

where λ is the wavelength, G_m is the transconductance, V_1 equals $5.69 \times 10^3 a^{4/3} J_c^{2/3}$, a is the grid-to-cathode spacing, b is the grid-to-anode spacing, V_a is the cathode voltage, and J_c is the cathode current density. Quantity G_e for the 6280 tube is calculated to be 0.915×10^{-3} mho. Using this value at 425 mc, 0.01 mho is obtained for $G_{e \text{ optimum}}$ and 3 db for F_{optimum} .

Verification

The correctness of this approach is verified by simple tests. A narrow-band amplifier was constructed using the input circuit of Fig. 1, which was designed to transform a source impedance of 50 ohms up to the calculated 100 ohms. With this arrangement, the noise figure was in excess of the calculated figure. The network transformation ratio was then varied systematically until the minimum noise figure was obtained which occurred with a transformed source impedance of 67 ohms. The noise figure was

then measured as 4 db.

This noise figure is in reasonable agreement with the calculation, since circuit losses and tube cold losses are not zero, as assumed, and the value of 5 taken for β is merely an approximation. With selected tubes, noise figures as low as 3.6 db have been observed.

The input circuit of Fig. 2 was used for the broadband amplifiers. The Q of this network is low and impedance transfer is fairly constant across the band. Capacitor C_1 is tuned to accommodate various values of G_e . The physical construction is shown in Fig. 3A.

Interstage and Output Networks

The interstage and output networks may be regarded as double-tuned band-pass circuits. The physical form of these networks approximates a pair of coupled transmission lines. Amplifier construction, arrived at largely by an empirical process, is shown in Figs. 3B, 3C and 4.

The interstage is capacitively coupled and the output network is inductively coupled. In both cases the load is heavily coupled to the plate of the 6280 tube to achieve the required 50-mc bandwidth. As a consequence, the output impedance of the amplifier represents a mismatch of about three or four to one with respect to the 50-ohm mixer load. This property must be kept in mind when designing the mixer.

The amplifier has a center gain of 29 db and a bandwidth somewhat greater than 50 mc between

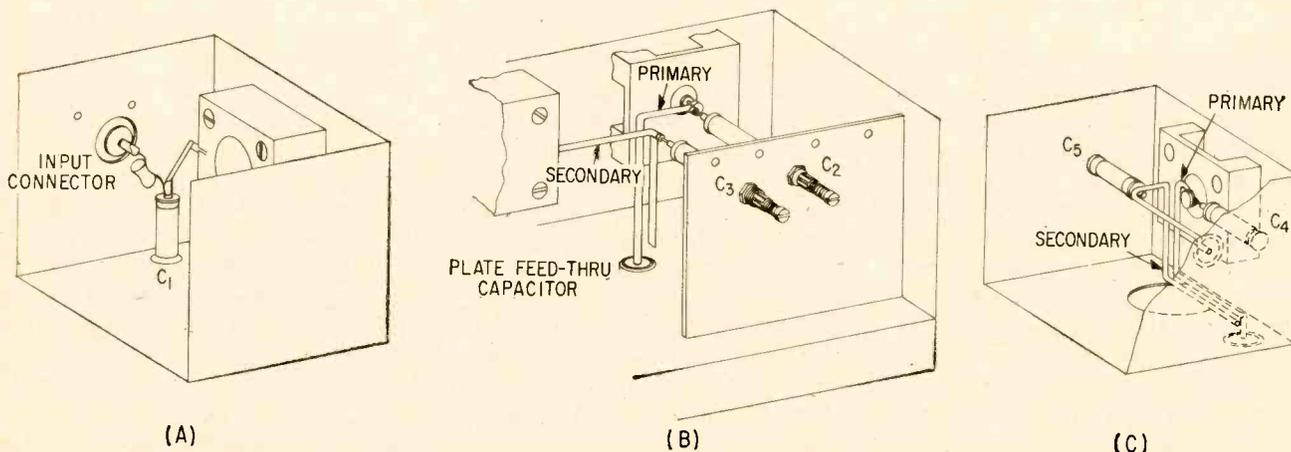


FIG. 3—Physical construction of input (A), interstage coupling (B) and output network (C)

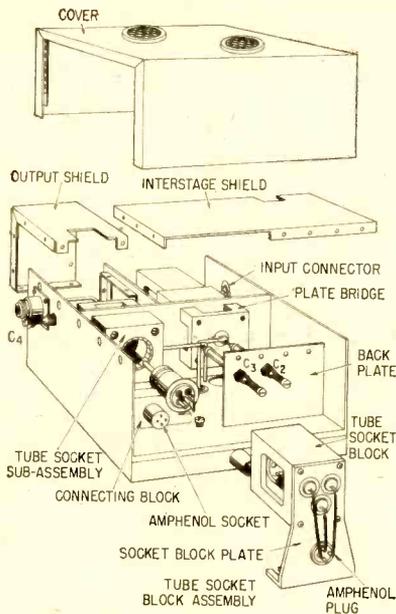


FIG. 4—Exploded view of broad-band amplifier derived empirically

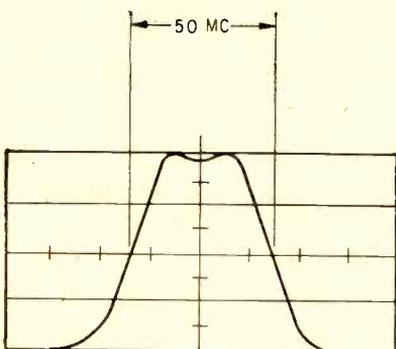


FIG. 5—Response curve of broad-band amplifier shows slight overcoupling

the 3-db points. A typical plot of the gain-bandwidth characteristic is shown in Fig. 5. In Fig. 6, the noise figure is plotted as a function of frequency. This characteristic was measured with a low-noise receiver following the amplifier. With a gain of 29 db, the noise figure of the mixer that follows the amplifier is not critical.

Figures 7 and 8 show this type of amplifier construction schematically.

Mixer Circuit

To simplify both alignment and trouble shooting, the mixer was constructed as a separate unit with a nominal 50-ohm input and operated at 1-ma crystal current. Mixers have been designed to work with both 60-mc and 104-mc inter-

mediate-frequency amplifiers.

The mixer circuit for a 60-mc i-f amplifier, given in Fig. 9, uses either a 1N21E or 1N25 crystal. The local-oscillator is terminated and is loosely coupled to the crystal by a resistive L-pad. The signal input is tapped on the inductance at a point selected to give an approximate match.

A resistive pad, not shown, is used in front of the mixer. This pad maintains a constant load impedance and avoids irregularities in the band-pass characteristic which might otherwise arise because of interactions between the mismatched output impedance of the amplifier circuit and the mixer.

Using a 1N21E crystal, as much as 10 db padding will not seriously affect the overall receiver noise figure. If there is no rejection of image noise, a 9-db noise figure is obtained. The overall noise figure is deteriorated by about 0.2 db, with 10 db padding, but this results in a smooth passband and provides additional crystal protection.

Noise Figure Life

Best noise-figure life is obtained with 6280 tubes if no cathode current is drawn during the warmup process. Accordingly the power supply is designed such that the tube is initially cut off. Bias is removed after the heater power has been applied for about one minute. When the power is turned off, cut-off bias is applied again until the tube has cooled, and then both the bias and the plate voltage are removed.

Because of the uncertainty of diode noise sources, a gas discharge device is used to make noise measurements in this frequency range¹. The noise generated in an argon

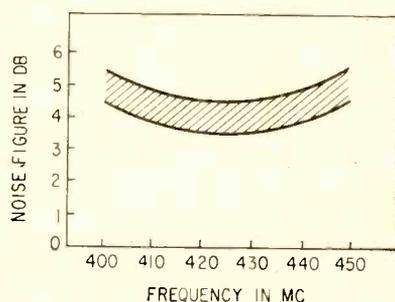


FIG. 6—Amplifier noise figure plotted against frequency

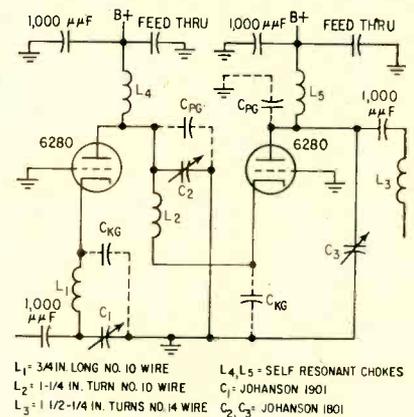


FIG. 7—Single-tuned low-noise amplifier schematic

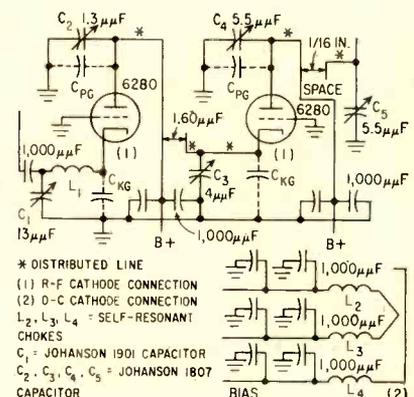


FIG. 8—Double-tuned low-noise amplifier schematic

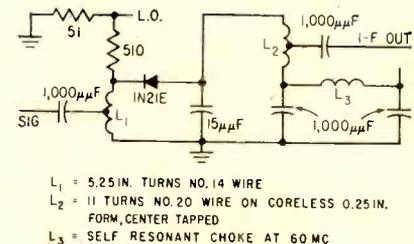
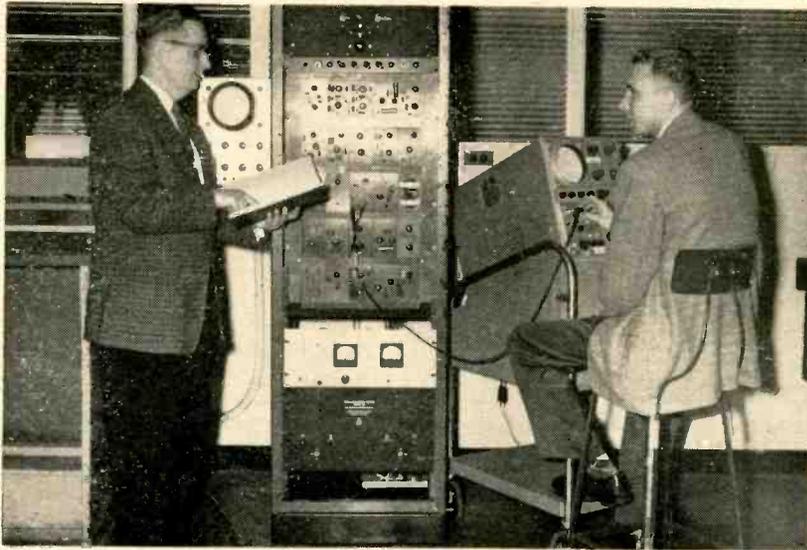


FIG. 9—Mixer circuit for a 60-mc i-f amplifier used in many radars

discharge is coupled to the output by a matched helical winding. These noise generators are calibrated by comparing their outputs against a calibrated hot source. Accuracy to measurements is estimated to be 0.2 db.

REFERENCES

- (1) G. E. Valley Jr. and H. Wallman, "Vacuum Tube Amplifiers," *Rad Lab Ser.*, 18, p. 640, McGraw-Hill Book Co., Inc., N. Y., 1948.
- (2) *Ibid.*, p. 625.
- (3) L. J. Giacchetto and H. Johnson, *Proc IRE*, 41, p. 51, 1953.
- (4) E. Maxwell and B. J. Leon, Absolute Measurement of Receiver Noise Figures at UHF, *IRE Trans., MTT-4*, No. 2, Apr., 1956.



Entire bandwidth-saving system is rack-mounted as shown

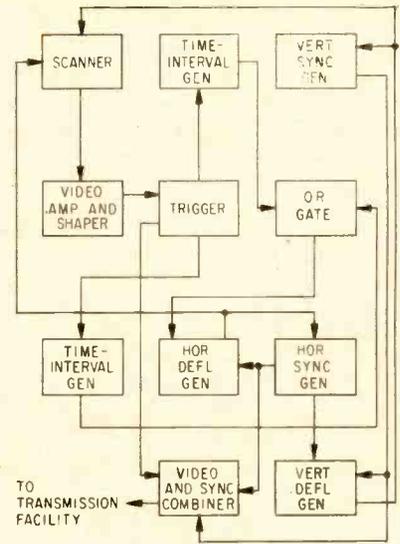


FIG. 1—Major circuits of the transmitter

Stop-Go Scanning Saves

MOST INFORMATION SOURCES occupy more bandwidth than is represented by their true information rate or average number of bits of information produced each second. According to the Shannon-Hartley Law¹, the information capacity of a channel is fixed if bandwidth and signal-to-noise ratio do not vary with time. A coding system can make it possible for the output of a source to represent a more uniform rate of information flow and use the fixed information capacity of the channel more fully.

In the case of image transmission, storage already exists in the space domain and useful statistical coding can be carried out by non-uniform scanning velocity. In the type of application in which the time consumed in transmitting an image is not restricted except that for any given image it is a minimum, a nonuniform scanning technique is applicable.

In the system to be described, a nonuniform scanning system suitable for facsimile-type transmission is used where frame rate need not be constant. Only black and white brightness levels are considered. Line-raster scanning is used.

Picture areas of uniform black or white contain no information except that represented by the loca-

tions of their boundaries. For this reason, it is permissible to scan rapidly in uniform areas and slowly in the vicinity of transitions. In a stop-go system, the slow speed is zero; that is, the scanning is halted at transitions. The fast rate is chosen on the basis of available signal-to-noise ratio since system vulnerability to noise is a function of

this speed. In the system described, velocity chosen was about 10 times greater than that which the particular channel could have handled with conventional scanning.

System Operation

System operation is as follows: A scanning spot travels at its fast uniform rate until a boundary is en-

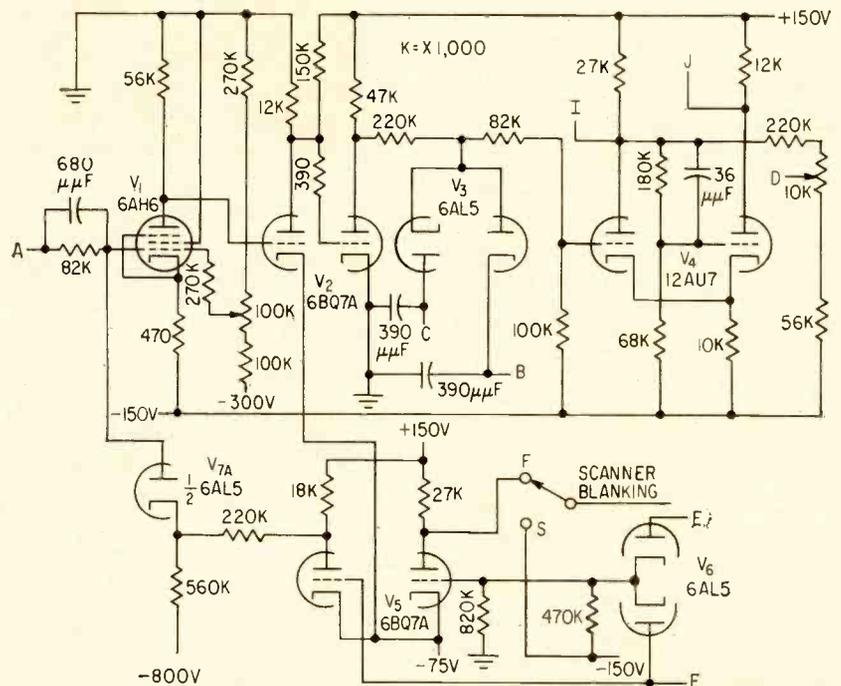


FIG. 2—Detailed schematic of the transmitter video generator

For facsimile-type transmission, where graduations between black and white are not vital, spectrum utilization can be increased by use of stop-go scanning. Scanning is halted at transitions from black to white and white to black. Scanning velocity for nontransition portions is determined by available signal-to-noise ratio of the transmission channel

By **HAROLD E. HAYNES,**

Development Engineer, Industrial Electronic Products,

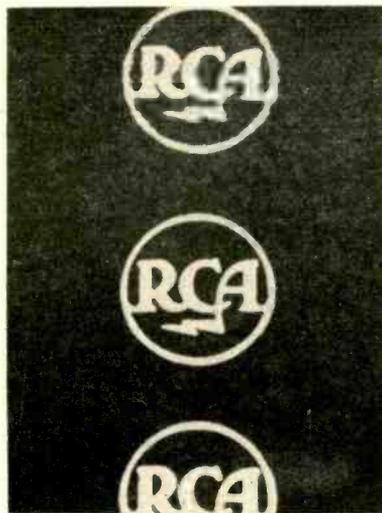
and **DONALD T. HOGER,**

Development Engineer, Defense Electronic Products, Radio Corp. of America, Camden, N. J.

Spectrum Space

countered. It then stops within a distance which is a small fraction of its own diameter. The spot remains stopped for a precisely controlled time interval. The interval is such that the response of the channel to a step function will reach substantially steady-state within the interval. The exact relationship depends on the cutoff characteristic of the channel. With the simulated channel used, a single T-section low-pass filter, a value of $0.8/f_c$ for the stop interval was found suitable where f_c is the three-db point. At the end of the interval, the spot just as abruptly resumes its fixed scanning speed and proceeds to the next transition. The process is repeated.

Basic waveform transmitted is a series of step functions of alternating directions, each associated with the beginning of a stop interval. At the receiver, the stop interval is initiated by the received signal. It is terminated by a timing circuit in the receiver precisely adjusted to duplicate the stop interval of the transmitter. With this system, terminations of the stop intervals are not transmitted. This leaves a minimum time spacing of transmitted steps. The spacing is always greater than the stop interval itself, regardless of the closeness of transitions to each other in

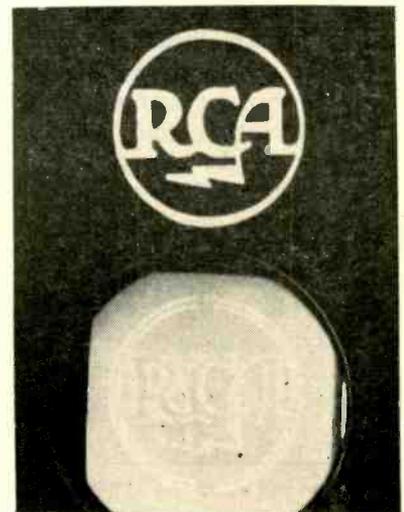


Effect of random noise upon transmission of a simple image. From top to bottom, two signal-to-noise ratios of 10 db and 20 db are depicted as well as essentially noise-free operation

the image. The channel is never called upon to handle information faster than its capabilities.

Transmitter

Figure 1 shows the transmitter deflection and video generator circuit arrangement. The scanner could have been any type that lent itself to having the scanning process halted whenever a transition in the scanned material is encountered. Actually, a simple flying-spot



Medallion as it appears when the kinescope beam is modulated with type of signal shown in Fig 3D (top). At bottom, medallion appears as shown when intensity modulation is disconnected

scanner for transparencies was employed. Electrostatic deflection was used in the scanner as well as the monitor. In later work, magnetic deflection was used successfully.

The signal derived from the scanner appears at point A, Fig. 2. It is amplified and shaped to operate a trigger circuit, V_1 , which reconstructs the video signal into two waveforms which are pulse trains of opposite polarities (points I and J). The trigger output also acti-

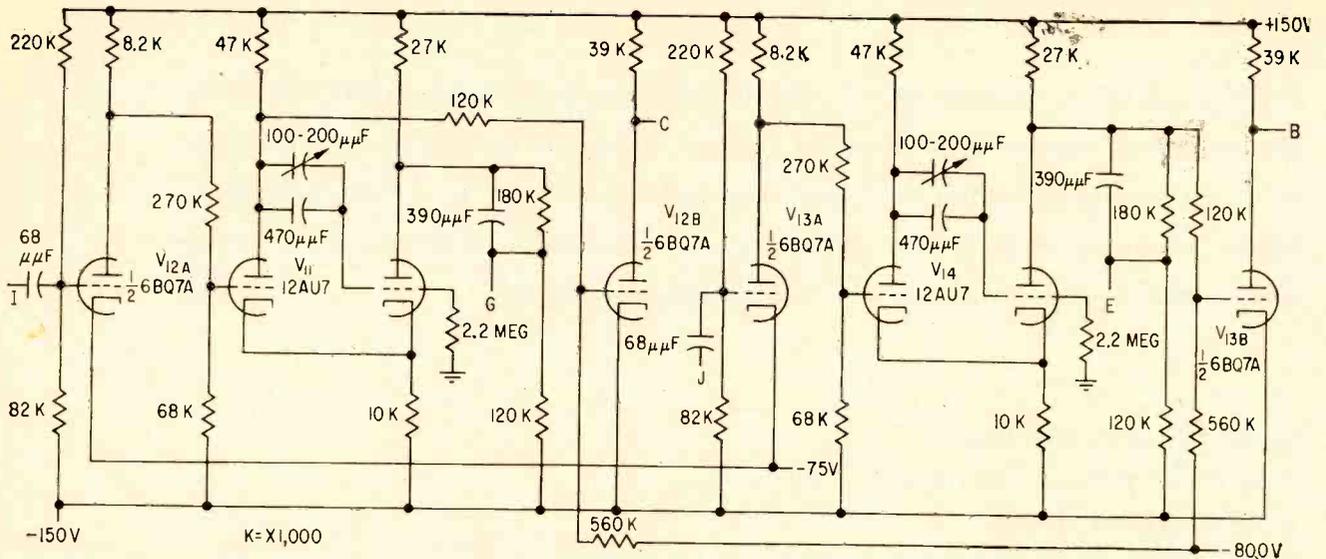


FIG. 3—Time-interval-generator circuits for the transmitter

vates the identical one-shot multi-vibrator time-interval generators of Fig. 3, which function at alternate transitions to stop the horizontal deflection. Length of the time interval is specified by the characteristics of the transmission channel as explained previously.

Noise and spurious signals in the video waveform that rise above the trigger threshold would be capable of activating the transmitter scanning circuits. This action would create pulses too narrow to be transmitted and would cause the receiver to lose synchronism with the transmitter until the next horizontal sync pulse occurred. For this reason, it is necessary to insure that once trigger V_i (Fig. 2) goes from

one stable to the other it does not return until a pulse of minimum transmittable duration has been generated.

Timing generators supply signals through diode V_s in Fig. 2 that activate clamp circuits which produce synthetic inputs to the trigger. In effect, this mechanism is a regenerative circuit. It operates rapidly as soon as the trigger changes state and continues to supply a constant trigger input so that input is maintained for the minimum duration.

To prevent signals generated during flyback from operating the timing circuits, the scanning beam is switched off by V_s , Fig. 2, during this interval. The beam is blanked also during all stop intervals to

avoid burning of the phosphor. The input signal to the video circuits is clamped to black artificially through diode V_{7A} (Fig. 2) so that noise and spurious signals generated during retrace cannot operate the timing generators.

Horizontal deflection is produced by a sawtooth generator consisting of a simple R-C circuit— R_1 , R_2 , and C_1 in Fig. 4. The gate made up of V_{18} and V_{21A} interrupts the generator whenever a transition is encountered. When the sawtooth voltage reaches a predetermined value, representing the end of a scanning line, it is returned rapidly to its zero value. Amplitude is sensed by V_{23} which also generates a pulse at point F' to produce horizontal fly-

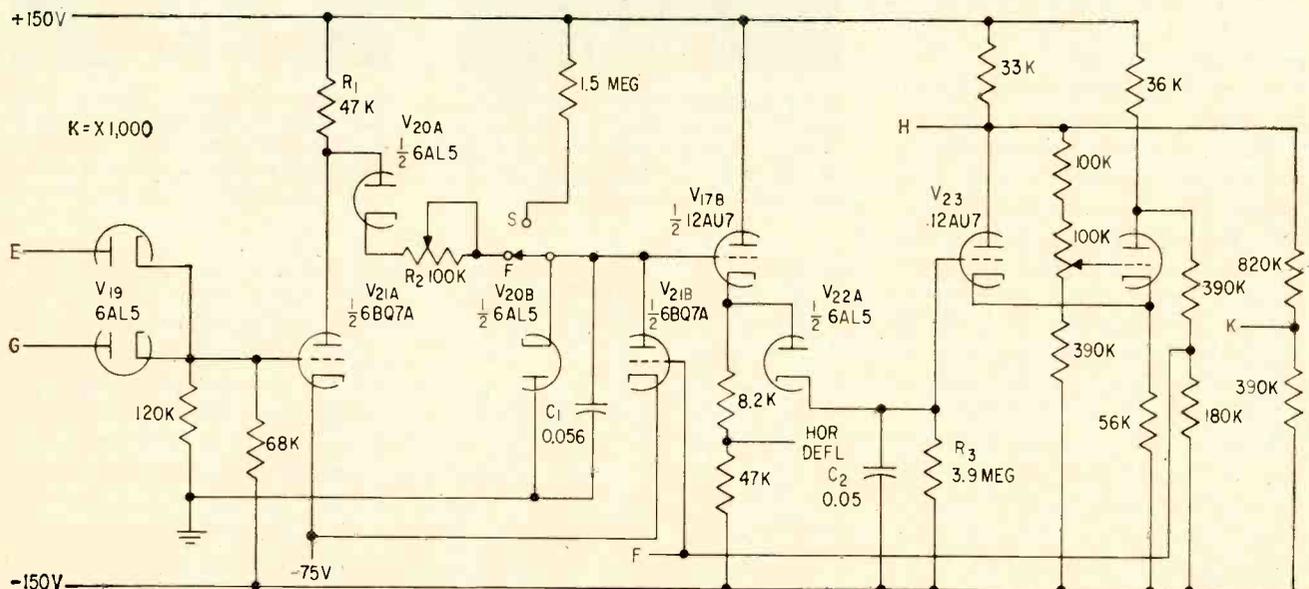


FIG. 4—Horizontal deflection and sync circuits of the transmitter



Sample of reproduced copy as shown on display screen

chronizing generator. Fig. 5, operates in the same manner as the horizontal sync generator.

Horizontal and vertical sync pulses are added to the video and timing information to form a composite waveform. The signal can then be sent over the transmission channel if d-c transmission is available or used to modulate a carrier if it is not.

Receiver

In Fig. 6, the received video signal is sent into a Schmitt trigger circuit to reshape the band-limited signal. This circuit also limits the effects of noise so that positive operation of the timing generator may be accomplished.

Negative sync signals are coupled through diode V_{44} of Fig. 7 to the Schmitt trigger, V_{55} . This circuit ignores the positive video signals and reshapes the horizontal and vertical sync pulses for use in the receiver. Vertical sync pulses, which are more than 10 times the duration of the horizontal sync pulses, are separated by filtering at the plate of V_{54} .

Operation of the receiver horizontal deflection system is identical to that of the transmitter except that termination of scan at the receiver is determined by the sync pulses sent out by the transmitter. Horizontal sync pulses serve also to operate the vertical staircase generator. Vertical sync is derived from the received waveform.

Output of the trigger contains timing as well as video information. To intensity-modulate the display device, video must be extracted from the signal. This action is accomplished by subtracting the output of the time-interval generators from the composite waveform with the Rossi gate V_{34} and V_2 of Fig. 7. A signal at the input of V_{34} , indi-

cating white, keeps V_{34} cut off and holds V_{24} in conduction. Negative voltage appearing at the plates of V_2 is sufficient to cut off the display device. When the signal at V_{34} indicates black, the plates at V_2 will rise to turn on the monitor video (provided no signal indicating that deflection is halted appears at point A). If a signal appears at point A, then conduction of V_{24} will keep the common plates of V_2 at a low potential to keep the video signal cut off.

Accuracy

Accuracy with which an image may be reproduced by the system depends upon several factors. If the system transmits the fundamental components of the signal

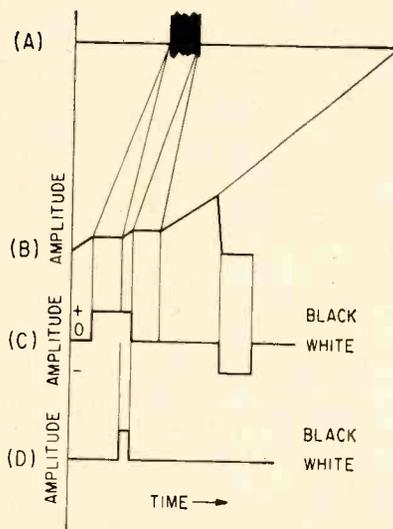


FIG. 8—Some important waveforms in system are shown here

undistorted and has a suitable signal-to-noise ratio, reproduction depends upon the combined resolution of the pickup and display devices and the electrical circuits in the transmitter and receiver.

The most critical circuits are the time-interval generators. If the transmitter and receiver stop times are not identical, there will be an error in placement for each transition of the receiver. Magnitude of this error is a function both of the error in timing and the velocity of scanning. Errors for a given line are cumulative for that line but are erased when the horizontal sync pulse is received. In practice, it was found desirable to use two timing operations at the transmitter

and two at the receiver. This resulted from the particular circuits used. It stemmed from the fact that the circuits did not have sufficiently fast recovery time to generate the time intervals for two closely spaced transitions. Actually, from the standpoint of maintaining identical time intervals at both transmitter and receiver, it would be preferable to use only one generator in each place.

Figure 8B shows a typical horizontal scanning line deflection waveform for the single black bar on a white background shown in Fig. 8A. Sloping portions of the waveform represent the times when the scanner is scanning rapidly while seeking a transition. Flat sections correspond to the stop intervals at the transitions.

The waveform of Fig. 8C depicts the type of signal that is derived from the trigger circuits for transmission. The first positive step indicates that a transition from white to black has been sensed. Length of the pulse is equal to the stop time plus the time required to scan to the next transition. Zero level indicates that the scanner is looking at white areas in the copy. The negative pulse is the horizontal sync pulse indicating the end of the scanning line.

After the sync has been separated from the video waveform, the stop interval must be subtracted from the signal to give the waveform of Fig. 8D. This waveform is used to key the writing operation of the display device.

Results

In operation with a simulated narrow-band transmission channel (values of 1 to 3 kc were used), the system has demonstrated time reductions approaching 10 to 1 for simple images. This figure decreases to about three to one for highly detailed images such as printed matter or a moderately complex map. The time ratio cannot exceed the ratio of the fast scan speed to that constant scan speed which would be suitable for the bandwidth involved.

REFERENCE

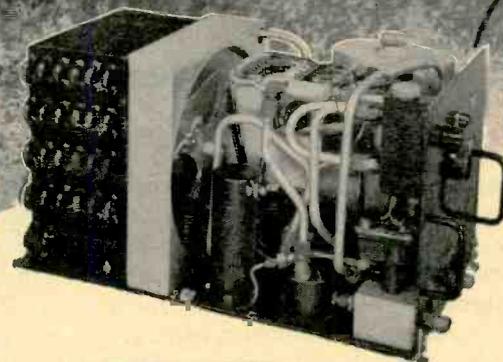
- (1) C. E. Shannon, A Mathematical Theory of Communication, *BSTJ*, July and Aug. 1948.

cooling avionic systems

During World War II, Eastern Industries pioneered cooling systems for aircraft electronic systems. Now, thousands of installations later, and as the leader in this challenging field, Eastern is still pioneering.

Experience has been a springboard to new developments . . . compactness, simplification, refrigeration cycles. Research and development continue to play their vital parts in perfecting systems to overcome the new problems as expanded aircraft performance produces fantastic rises in temperatures.

If you have a challenging problem, come to the leader in the field for complete and creative engineering help.



COOLING UNIT



REFRIGERATION-TYPE

ELECTRONIC TUBE COOLING UNITS

Custom-made units, with or without refrigeration cycles, provide a method of maintaining safe operating temperature limits in electronic equipment. Standard sub-assemblies and components normally are used to create a custom-made design to fit your exact needs. Costs are minimized for these completely self-contained units by combining heat exchangers, fans or blowers, liquid pumps, reservoirs, flow switches, thermostat, and other common components.

Write for Eastern AVIONICS BULLETIN 340

PIONEER OF THE THERMAL FRONTIER

Eastern INDUSTRIES, INC.

100 Skiff St., Hamden 14, Conn.

West Coast Office: 1608 Centinela Avenue • Inglewood 3, California

EASTERN
AVIATION PRODUCTS

Eastern

Night Vision Unit Uses Starlight

TROOPS may be able to see military objectives at night with a new type light intensifier. Extension of the range and sensitivity of astronomical telescopes, low radiation level X-rays and viewing minute light flashes emitted by nuclear particles are other expected uses.

Called a cascaded photosensitive image intensifier, the device was developed by the U. S. Army Engineer Research and Development Laboratories and RCA.

The new development differs from other night vision devices. No artificial sources of radiation such as radar or infrared are required. It is also said to be much less complex than low-level light intensifier tv systems.

This unit gathers reflected starlight and diffused light from sky-

glow falling on the objective. The intensity of light furnished by the stars is so low that it is of limited value to the unaided eye in seeing military objectives at night. With the new intensifier, however, it will be possible to see objects at greatly increased ranges.

Heart of the instrument is a cascaded image tube—actually two tubes. They operate through an optical system that focuses the light reflected from objects in the field. The first tube acts as a preamplifier. The second tube further amplifies the light and presents the image on a viewing surface.

The image tube operates at approximately 25,000 volts. A six-volt battery is the primary power source with transformers and transistors used to step it up.

cal transistor is shown in Fig. 1. These curves show that circuits with low resistance between base and emitter have a negative-resistance characteristic that becomes evident near the initial breakdown point. This characteristic varies in magnitude among transistors, and some transistors do not have it under any circumstances. Lack of the negative-resistance effect can usually be attributed to the geometry of the particular transistor.

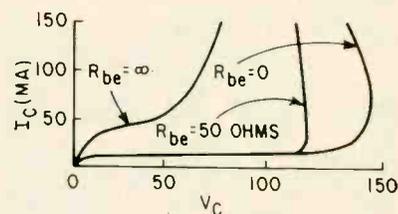


FIG. 1—Collector current versus collector-emitter voltage show negative-resistance characteristic when resistance between base and emitter is low

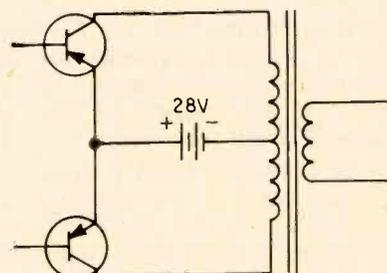


FIG. 2—Negative-resistance characteristics in transistors used in audio output stage can cause oscillations that can destroy the transistors

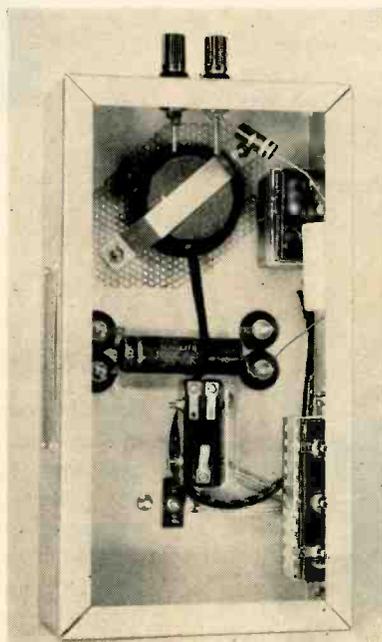
Transistor Tester Predicts Failures

By J. M. TEWKSBURY Bendix Aviation Corp., Baltimore, Md.

TRANSISTOR failure can be expensive, time-consuming and irritating. Greater knowledge of transistor characteristics enables the designer to select a transistor for a particular application with more assurance that it will perform satisfactorily.

A tester is described that provides audible and visual indications of variations in characteristics of transistors of the same type. Prior knowledge of the circuit in which the transistor will be used coupled with information gained from the tester enable the designer to predict very closely the voltage at which a given transistor will be subject to failure.

In typical transistor circuits, the collector-base junction is reverse biased. The mobile carriers are swept away from the collector-base junction, forming a depletion region. The ionized impurity atoms left behind are locked in the crystal lattice and are therefore immovable. As collector voltage is increased, the depletion region extends in the direction of the emitter-base junction.



Bottom view of breakdown tester shows how earphone is used as speaker

When it reaches the junction, punch-through occurs.

A plot of collector current versus collector-emitter voltage for a typi-

A class B power output stage is shown in Fig. 2. Assuming a power supply potential of 28 volts, collector-emitter potential approaches 56 volts on signal peaks because of the autotransformer action in the output transformer primary.

If this voltage exceeds punch-through, large reverse currents flow, impairing efficiency. Current flow after punch-through is limited by the resistance of the associated circuitry, and in many circuits there is enough built-in resistance to prevent transistor damage. However, if the transistor has a negative-resistance characteristic, oscillation will result, and the attendant high currents will destroy the transistor.

Transistors without a negative-resistance characteristic should therefore be selected for operation

REGULATION and STABILITY **0.1%**

VOLTAGE REGULATED POWER SUPPLIES

MODEL	OUTPUT VOLTS DC	OUTPUT AMPERES DC	OUTPUT IMPEDANCE		SIZE		
			DC-1KC	1KC-100KC	W	H	D
SC-18-0.5	0-18	0-0.5	.04	.4	8 1/4"	4 1/2"	13 5/8"
SC-18-1	0-18	0-1	.02	.2	8 1/4"	4 1/2"	13 5/8"
SC-18-2	0-18	0-2	.01	.1	8 1/4"	4 1/2"	13 5/8"
SC-18-4	0-18	0-4	.005	.05	19"	3 1/2"	13"
SC-36-0.5	0-36	0-0.5	.08	.8	8 1/4"	4 1/2"	13 5/8"
SC-36-1	0-36	0-1	.04	.4	8 1/4"	4 1/2"	13 5/8"
SC-36-2	0-36	0-2	.02	.2	19"	3 1/2"	13"
SC-3672-0.5	36-72	0-0.5	.15	1.0	8 1/4"	4 1/2"	13 5/8"
SC-3672-1	36-72	0-1	.08	.8	19"	3 1/2"	13"

Patent Pending

(TUBELESS) TRANSISTORIZED SHORT CIRCUIT PROTECTED

- **REGULATION:** 0.1% for line changes 105-125 volts at any output voltage in the range minimum to maximum.
0.1% or 0.003 volt for load changes 0 to maximum (whichever is greater) at any output voltage in the range minimum to maximum.
- **RIPPLE:** 1 mv. RMS.
- **RECOVERY TIME:** 50 microseconds.
- **STABILITY:** (for 8 hours) 0.1% or 0.003 volt (whichever is greater).
- **AMBIENT OPERATING TEMPERATURE:** 50°C maximum. Over-temperature protection provided. Unit turns off when over-temperature occurs. Power-on-off switch on front panel resets unit.
- **TEMPERATURE COEFFICIENT:** Output voltage changes less than 0.05% per °C.
- **SHORT CIRCUIT PROTECTION:** No fuses, circuit breakers or relays! Designed to operate continuously into a short circuit. Returns instantly to operating voltage when overload is removed. Ideal for lighting lamps and charging capacitive loads.
- **OVER-CURRENT CONTROL:** Can be set from 0 to 120% of full load. Current is limited to preset value for any load including short circuit.

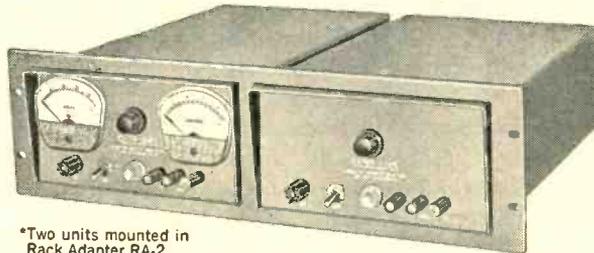
KEPCO LABORATORIES, INC.

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

INDEPENDENCE 1-7000



Model SC-18-2-M



*Two units mounted in Rack Adapter RA-2



Model SC-18-4-M

- **REMOTE PROGRAMMING** at 1000 ohms per volt is provided. Remote programming allows mounting a voltage control at a remote point.
- **REMOTE ERROR SIGNAL SENSING** is provided to maintain stated regulation directly at load.
- **CONSTANT CURRENT OPERATION:** These units can be set up for constant current operation without internal modification.
- **POWER REQUIREMENTS:** 105-125 volts, 50-65 cycles. 400 cycle units available.
- **OUTPUT TERMINATIONS:** DC terminals are clearly marked on the front panel. All terminals are isolated from the chassis. Either positive or negative terminal of each DC output may be grounded. A terminal is provided for connecting to the chassis. The DC terminals, the remote programming terminals and the remote error signal sensing terminals are brought out at the rear of the unit.
- **CONTROLS:** Power-on-off switch, one turn voltage control, on front panel. Over-current control on rear of unit. Ten turn voltage control available on special order.
- Continuously Variable Output Voltage. No voltage switching.
- Suitable for square wave pulsed loading.
- Either positive or negative can be grounded.
- Units can be series connected.
- High efficiency ■ Low heat dissipation.
- Compact, light weight ■ For bench or rack use.
- Color: Gray hammertone. (Special finishes available).

ORDERING INFORMATION:

Units without meters use model numbers indicated in table. To include meters add M to the Model No. (e.g. SC-18-1-M).

*Rack adapter for mounting any two 8 1/4" x 4 1/2" units is available. Model No. RA2 is 5 1/4" high 19" wide.

*Rack adapter for mounting any one 8 1/4" x 4 1/2" unit is available. Model No. RA3 is 5 1/4" high 19" wide.

AN 0.01% SERIES IS AVAILABLE IN 13 NEW MODELS
KEPCO OFFERS MORE THAN 120 STANDARD VOLTAGE REGULATED POWER SUPPLIES COVERING A WIDE RANGE OF MAGNETIC, TUBE AND TRANSISTOR TYPES. MOST MODELS AVAILABLE FROM STOCK. SEND FOR BROCHURE B-587

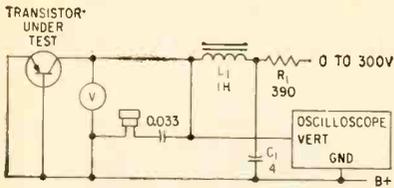


FIG. 3—Oscillations are heard from earphone when collector voltage is increased to breakdown point if transistor has negative-resistance characteristic

at voltages close to punch-through. A transistor breakdown tester for selecting such transistors is shown in Fig. 3.

Collector voltage of the transistor under test is increased slowly until the point of breakdown is reached. If the transistor has a negative-resistance characteristic, an oscillation will be heard in the earphones. An oscilloscope connected to the collector permits analysis of the type audio voltage present.

Inductor L_1 limits current flow out of capacitor C_1 into the collector

circuit after breakdown. However, L_1 and C_1 also constitute a tuned circuit that is resonant at an audible frequency. Transistors with a pronounced negative-resistance characteristic break into an interrupted sine-wave oscillation. The frequency of interruption is a function of the R_1 - C_1 time constant. Transistors not highly active but with a negative-resistance characteristic produce a triangular wave with a frequency dependent on the degree of activity.

Transistors that do not oscillate produce breakdown noise that is random in nature and of relatively low intensity. It can be heard in the earphone and is readily identified on an oscilloscope.

A voltmeter connected between collector and ground indicates punch-through voltage directly. Voltage during oscillation is an indication of transistor activity and is a direct measure of the negative-resistance characteristic.

Rate-of-Rise Control for Filaments

By JOHN T. KEEFE

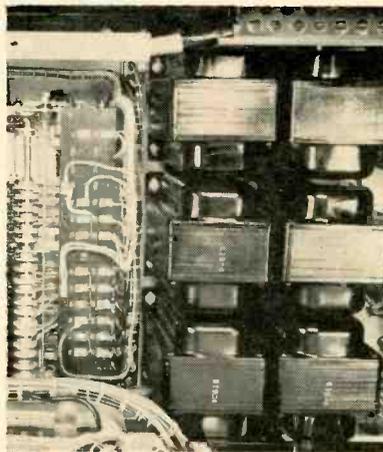
Sola Electric Co., Div. of Basic Products Corp., Chicago, Ill.

PROTECTION of cold tube filaments against excessive inrush currents during the warm-up period is necessary for maximum tube life and equipment reliability. Ideally, initial filament current and power should be held substantially below rated values.

As the filaments warm and their resistance increases, current and power should be gradually increased to full rating. During warm-up, protection against surges caused by line voltage changes is also desirable.

A simple method will be described for using special-type constant-voltage transformers for both controlled warm-up and regulation against line changes. The basic system is shown in the block diagram in Fig. 1.

Constant-voltage transformers T_1 through T_n are identical. They are similar to standard constant-voltage transformers except that output is 40 volts a-c. The constant-voltage transformers are connected with the primaries in parallel but



Constant-voltage transformers and stepping switch are installed in computer power supply to increase tube life

with individual switch contacts for each primary. The secondaries are connected in series. Since total output is 240 volts, a standard 240 to 6.3 or 240 to 12.6-volt filament transformer is required to provide the correct filament voltage.

All primaries are initially open. Contacts in the motor-driven stepping switch energize the primaries

FLIGHT DATA and CONTROL ENGINEERS

Cross new frontiers in system electronics at The Garrett Corporation.

High-level assignments in the design and development of system electronics are available for engineers in the following specialties:

1. ELECTRONIC AND FLIGHT DATA SYSTEMS AND CONTROLS A wide choice of opportunities exists for creative R & D engineers having specialized experience with control devices such as: transducers, flight data computers, Mach sensors, servo-mechanisms, circuit and analog computer designs utilizing transistors, magamps and vacuum tubes.

2. SERVO-MECHANISMS AND ELECTRO-MAGNETICS Requires engineers with experience or academic training in the advanced design, development and application of magamp inductors and transformers.

3. FLIGHT INSTRUMENTS AND TRANSDUCERS

1) DESIGN ANALYSIS Requires engineers capable of performance analysis throughout preliminary design with ability to prepare and coordinate related proposals.

2) DEVELOPMENT Requires engineers skilled with the analysis and synthesis of dynamic systems including design of miniature mechanisms in which low friction freedom from vibration effects and compensation of thermo expansion are important.

4. PROPOSAL AND QUALTEST ENGINEER For specification review, proposal and qualtest analysis and report writing assignments. Three years electronic, electrical or mechanical experience required.

Forward resume to:
Mr. G. D. Bradley

THE GARRETT CORPORATION

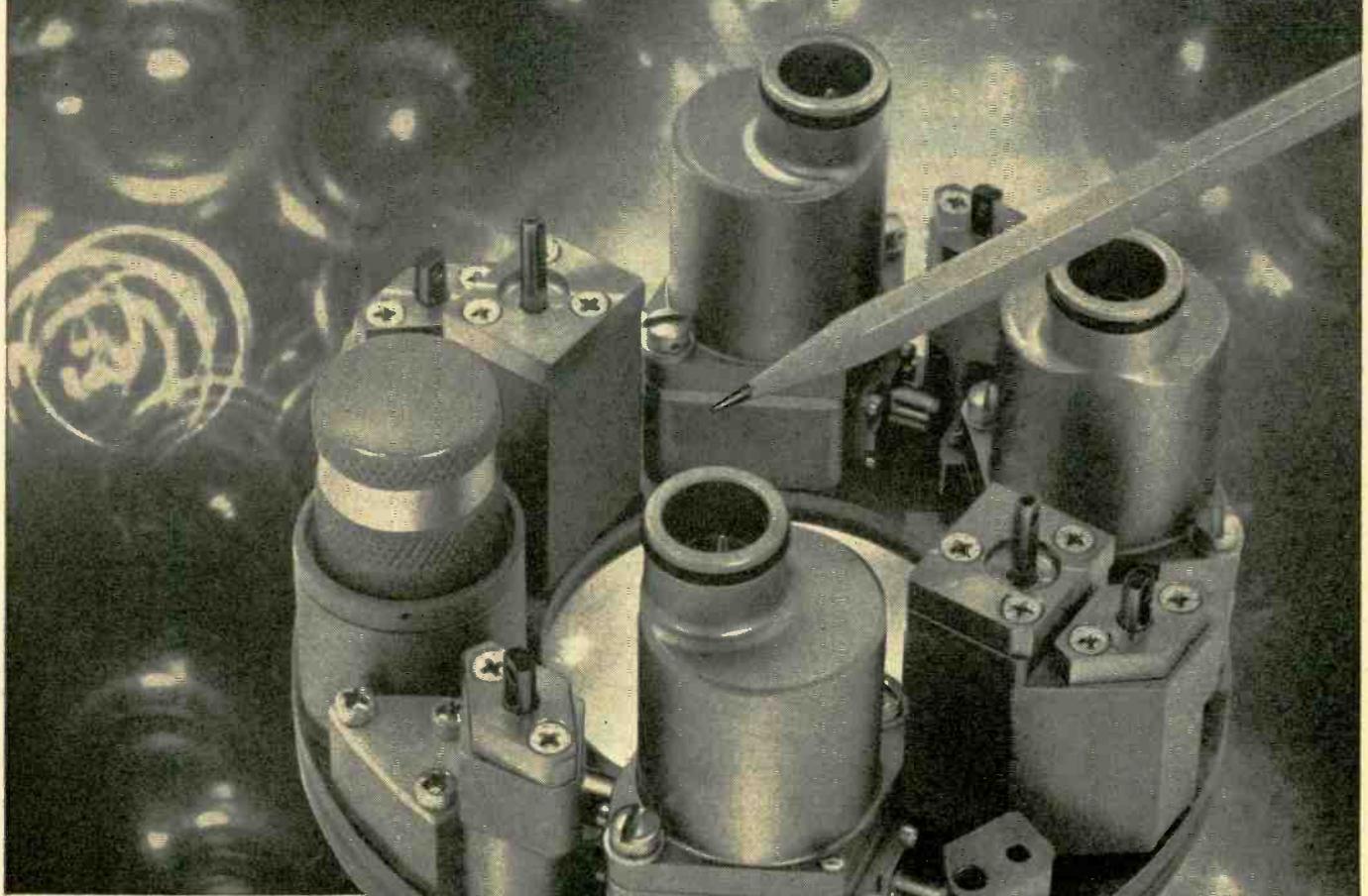
9851 S. Sepulveda Blvd.
Los Angeles 45, Calif.

DIVISIONS:

AiResearch Manufacturing—Los Angeles
AiResearch Manufacturing—Phoenix
AiResearch Industrial
Rex • Aero Engineering
Airsupply • Air Cruisers
AiResearch Aviation Service

CIRCLE 59 READERS SERVICE CARD

NEW AiResearch steering control system



Combines Acceleration Switching Valves And Hydraulic "Printed Circuit"

More reliable and responsive... this lightweight electro-hydraulic steering control system converts low-level electronic signals from the main guidance system into hydraulic energy which actuates the mechanisms steering the missile.

Packaged as an integrated unit, the three servo valves and six control actuators are mounted on a common manifold and powered by fluid or hot gases. The simplified "printed circuit" system of integral passageways within the manifold eliminates all external plumbing

and leakage.

The acceleration switching servo valves provide positive control of spool velocity, thereby achieving greater resolution, reliability and response even at extreme temperatures.

Easily installed and removed as a complete, interchangeable unit, acceptance testing of this compact system can be accomplished prior to missile installation. Suggested applications are: missile surface controls, jetavator controls, and vector and nozzle steering controls. Your inquiries are invited.

Specifications

Actuator load (range)	90 to 150 <i>Et.</i> lbs.
Electrical input (nominal)	28 volts DC—10 Milliamperes
Pressure range	500 to 3000 psi
Rated flow	1/2 to 2 gpm
Mounting	Manifold
External leakage	None
Proof Pressure	4500 psi
Burst Pressure	7500 psi
Temperature operating range	
Fluid	-65°F to 450°F
Ambient	-65°F to 750°F
System filtration	10 microns

THE GARRETT CORPORATION

ENGINEERING REPRESENTATIVES: AIRSUPPLY AND AERO ENGINEERING, OFFICES IN MAJOR CITIES

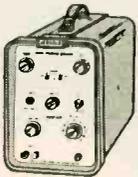
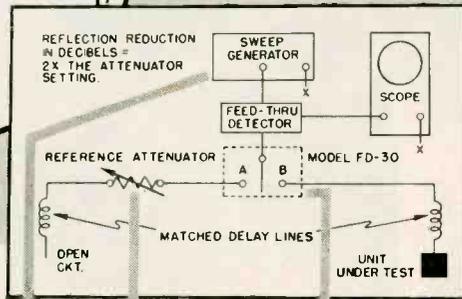
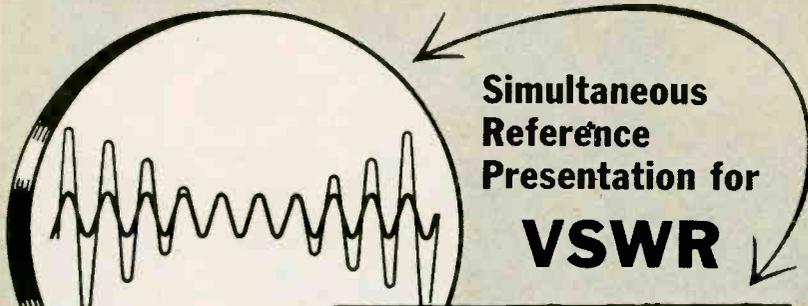
AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

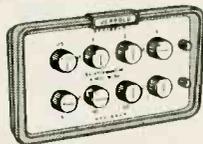
Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

JERROLD

ACHIEVES A NEW STANDARD OF ACCURACY IN RF Measurements by Comparison



Model 601 Sweep Frequency Generator \$395



Model AV-50 Variable Precision Attenuator \$150



Model FD-30 High Speed Coaxial Switch \$250

Equipment shown provides test set up for measurements from 12 to 225 mcs. Other equipment available from 15 kc to 1200 mcs, sweep widths up to 400 mcs.

Measurements Unaffected By:

1. Variations of oscilloscope gain or linearity
2. Variation of generator output
3. Square law characteristics of detector
4. Delay line losses

SEND FOR TECHNICAL NEWSLETTER

Fully illustrated—describes test set ups for measuring Gain, Losses, and VSWR.

Jerrold Electronics Corporation
Dept. TED 24
Gentlemen: Please send me Technical Bulletin on MBC procedures.

Name _____ Title _____
Company _____
Address _____

JERROLD

ELECTRONICS CORPORATION
The Jerrold Building, 15th and Lehigh
Philadelphia 32, Pa.

Jerrold Electronics Corp., Ltd., Toronto, Canada • Export—Rocke International, New York, New York

of each transformer individually starting with T_1 . Output is applied to the filament transformer. However, the secondary of T_1 is also in series with the secondaries of the remaining transformers.

Since the primaries of the other transformers are open, their secondaries act as high reactance chokes. Total impedance is so high that current is limited to approximately 23 percent of full load. The 40-volt output is only 16 percent of rated voltage, and power delivered to the filaments is less than 4 percent of rated filament power.

After equal predetermined time intervals, the stepping switch energizes the remaining transformers individually. With each succeeding step, total output voltage increases 16 percent, series impedance decreases and filament resistance increases. The net result is a progressive increase of filament current and power until all the constant-voltage transformers are energized and full-load current is delivered.

Output voltage at any step is held to one percent against a 15-percent change in line voltage, since the transformers regulate as constant-voltage transformers individually and collectively. The reactance in the circuit controls steady-state current during each step and also prevents current surges during switching of the primaries.

Power is removed from the fila-

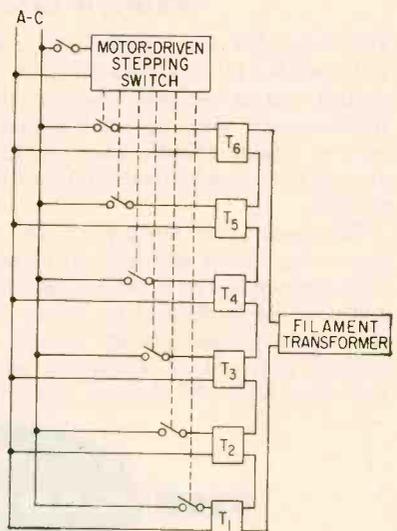
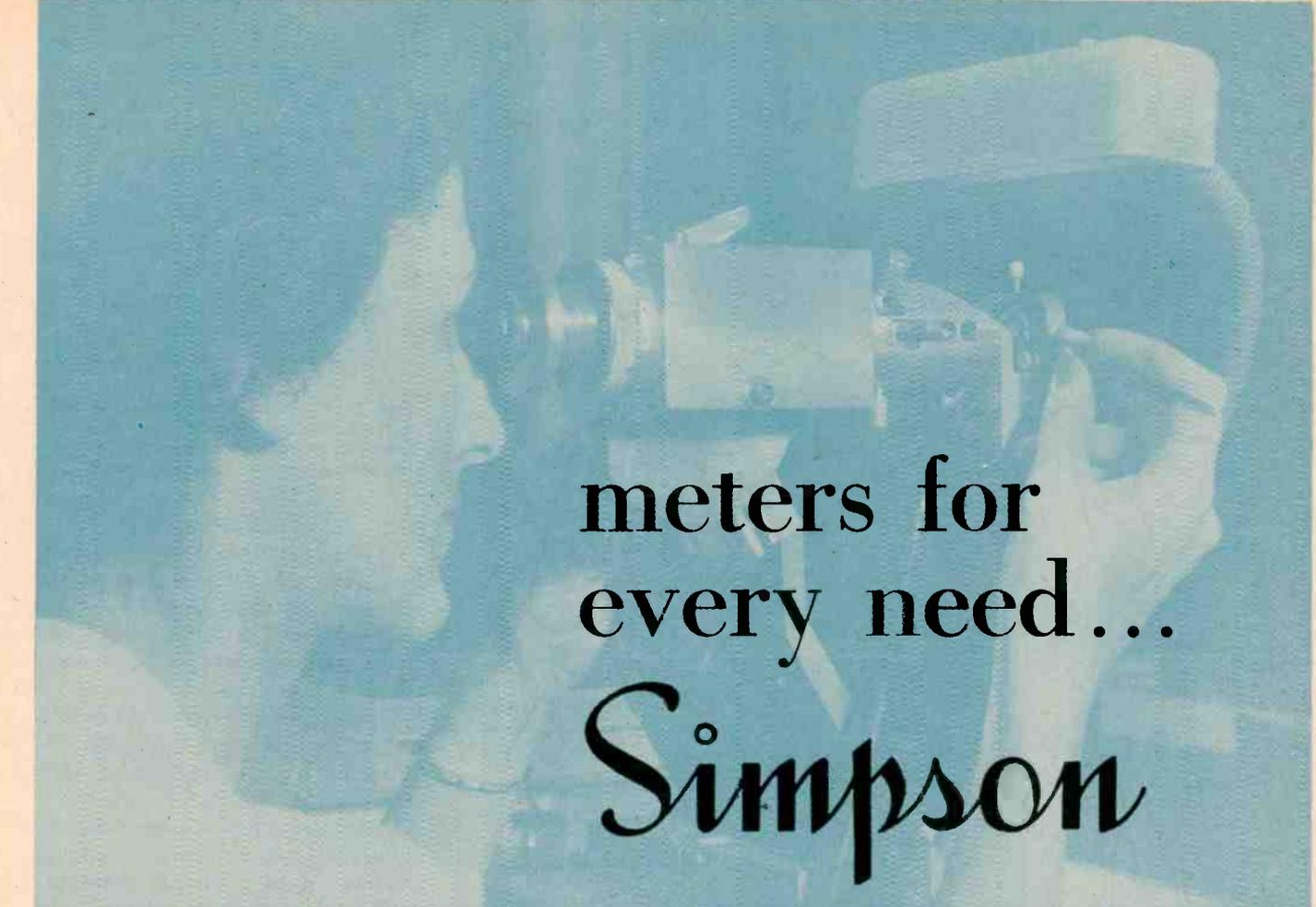


FIG. 1—Stepping switch energizes constant-voltage transformer primaries in sequence. Secondaries of unenergized transformers provide high reactance to limit current in filament transformer



meters for
every need...
Simpson

**Custom-built or Stock,
Simpson Offers a Complete Line**

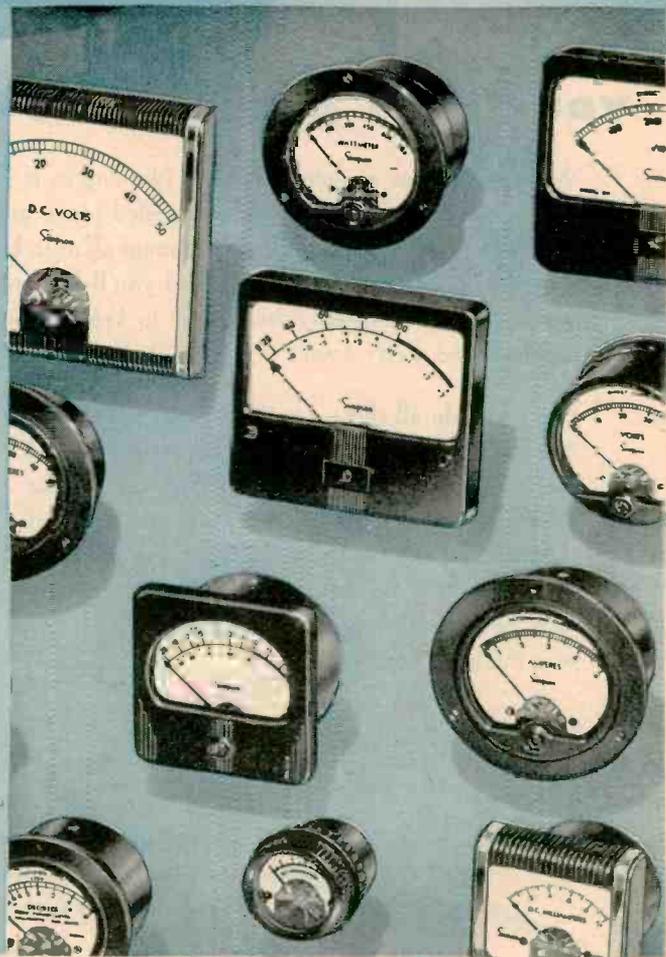
To meet your special requirements, Simpson can build electrical panel meters in many combinations of size, range, type, and style. For meters in small quantities, you can select from 60,000 stock units (over 900 sizes and types) available for *immediate delivery* through your Electronic Distributor. Many stock models now have the *self shielded Core Magnet Meter Movement*.

These fine panel instruments are known throughout industry for their ruggedness and long-lived accuracy. Write today for Technical Manual No. 17.



SIMPSON ELECTRIC COMPANY
5203 W. Kinzie St., Chicago 44, Ill.
Phone: EStebrook 9-1121
In Canada:
Bach-Simpson Ltd., London, Ontario

instruments that stay accurate



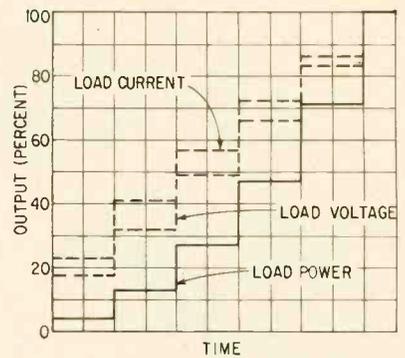
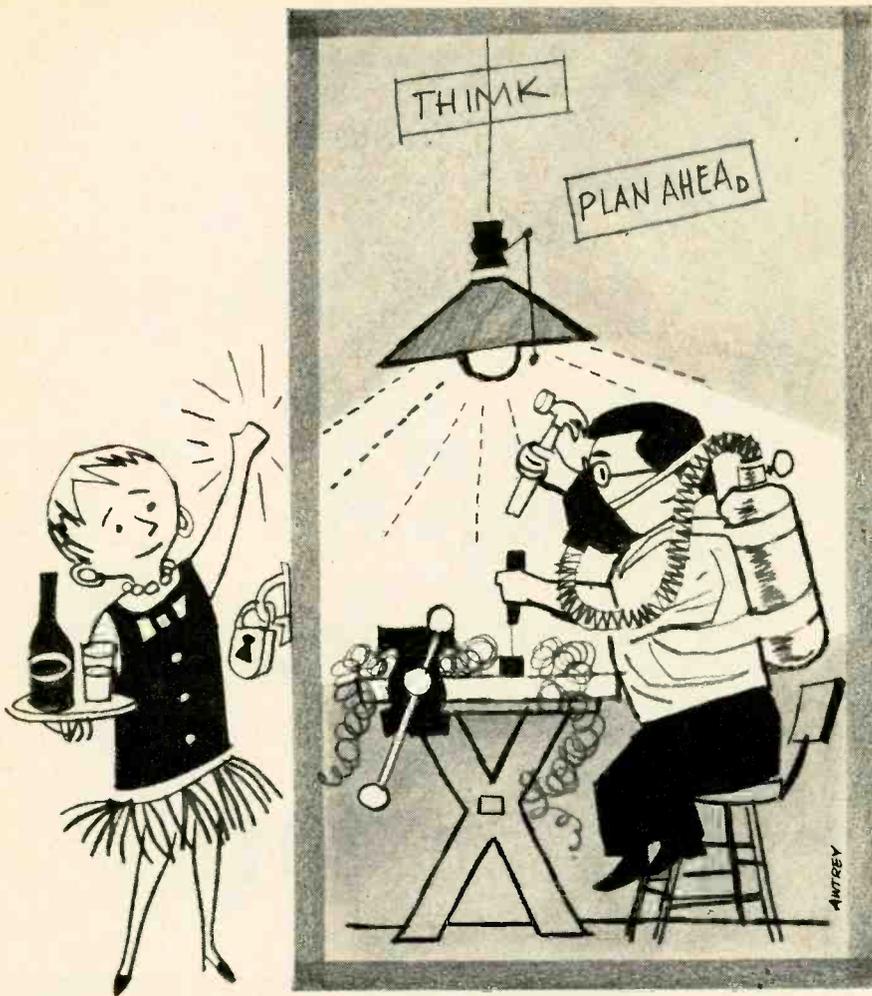


FIG. 2—Plot shows percentage of full current, voltage and power provided to filaments as each of six constant-voltage transformers is switched into circuit

ments in a similar manner.

Typical results are shown in Fig. 2. The plot is for a system of six standard 500 v-a constant-voltage transformers. Total load was 2,400 watts, and percentages were computed on this basis.

The number of transformers in a system can be varied to suit requirements. The duration of each step can also be changed easily.

In the installation described, the motorized switch had a spring mechanism to open all constant-voltage transformer primaries in the event of a power failure.

System Gives Pilots Sky Path Display



Sky path on tv screen provides airplane pilots with integrated display of flight-orientation information. Kaiser Aircraft & Electronics has been awarded prime contract for developing system incorporating display by Naval Air Development Center, Johnsville, Pa. Forward, vertical and lateral motion and aircraft attitude are some of the variables used in creating the display.

your own pots — 100% pure!

Want the purest in potentiometers? Nothing to it — just put on a surgical mask, lock yourself up in a sealed room, and start winding! Of course, you'll need an air conditioning plant to keep the moisture controlled, and the air dust-free. And you'll have to work out some pretty elaborate assembly techniques to keep the whole works uncontaminated. Petty details . . .

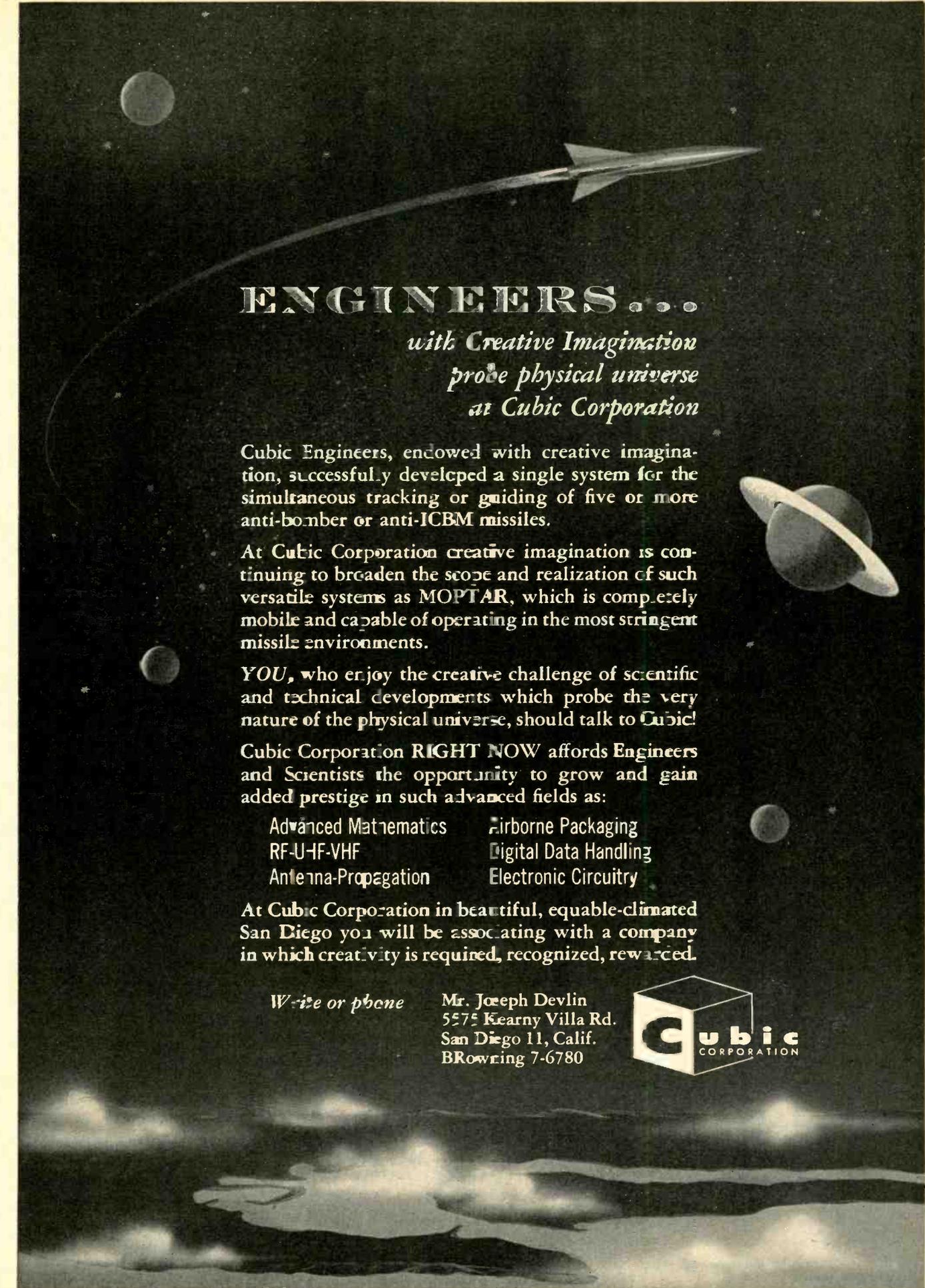
You could do all this — but you don't have to — Ace goes to all these extremes of quality control and more! So why not take advantage of our sealed room and our advanced techniques — and eliminate all the fussin'? You'll get the accuracy and reliability you have a right to expect from Ace. So do it the easy way — get Ace pots. See your ACErep now!



Here's one of our pure pots: the 500 Acepot.® Highest resolution, 0.3% independent linearity. 1/2" size, sub-miniature. Special prototype section insures prompt delivery.

ACE ELECTRONICS ASSOCIATES, INC.
99 Dover Street, Somerville 44, Mass.
SOMerset 6-5130 TXM SMVL 181 West. Union WUX

Acepot® Acetrim* Aceset® Aceohm® *Reg. Appl. for



ENGINEERS . . .

*with Creative Imagination
probe physical universe
at Cubic Corporation*

Cubic Engineers, endowed with creative imagination, successfully developed a single system for the simultaneous tracking or guiding of five or more anti-bomber or anti-ICBM missiles.

At Cubic Corporation creative imagination is continuing to broaden the scope and realization of such versatile systems as MOPTAR, which is completely mobile and capable of operating in the most stringent missile environments.

YOU, who enjoy the creative challenge of scientific and technical developments which probe the very nature of the physical universe, should talk to Cubic!

Cubic Corporation **RIGHT NOW** affords Engineers and Scientists the opportunity to grow and gain added prestige in such advanced fields as:

Advanced Mathematics	Airborne Packaging
RF-UHF-VHF	Digital Data Handling
Antenna-Propagation	Electronic Circuitry

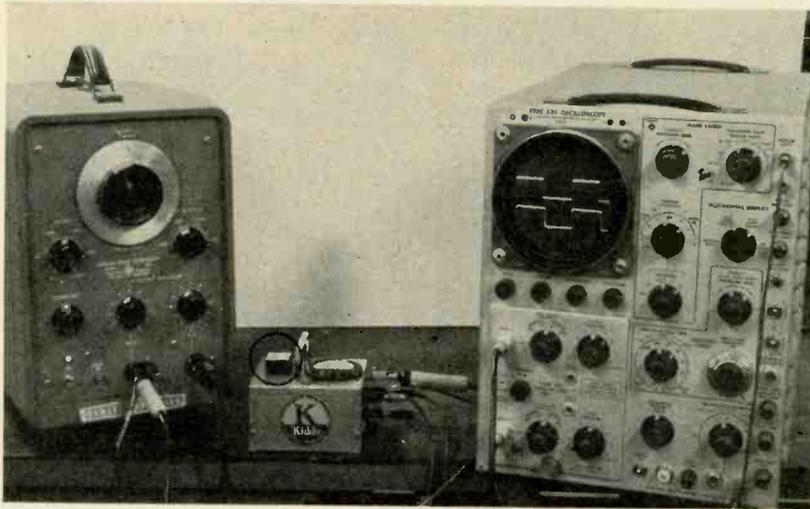
At Cubic Corporation in beautiful, equable-climated San Diego you will be associating with a company in which creativity is required, recognized, rewarded.

Write or phone

Mr. Joseph Devlin
5575 Kearny Villa Rd.
San Diego 11, Calif.
BRowing 7-6780



Static Relay Is Actuated in Three Microsec



Test setup with relay (circle) in operation

CONSTRUCTED ENTIRELY of semiconductor and magnetic devices, a new static relay developed by Walter Kidde and Co., Inc., Belleville, N. J., has a life expectancy of 10,000 hours or one billion operations. Actuation time is measured in microsec and the unit is virtually insensitive to shock and vibration.

A schematic diagram of the relay is shown in Fig. 1. Functionally, it consists of an actuating circuit and one or more contact circuits. The actuating circuit is a blocking oscillator normally turned off. When the signal voltage exceeds the Zener diode rating, the base of Q_1 is taken into the conducting region and the blocking oscillator operates.

Output of the high-frequency oscillator is coupled to the contact circuit through a pulse transformer. The circuit rectifies, filters and applies the oscillator output power to the base circuit of the contact transistor. This action keeps transistor

Q_2 in a saturated condition as long as the signal voltage is applied. When this voltage is reduced slightly below the Zener voltage (about one volt), oscillation stops abruptly and the contact opens.

The relay requires 24 mw of power to actuate and can switch 600 mw at speeds up to 50 kc. Since no power other than the signal power is required, it can be incorporated in equipment with the same utility

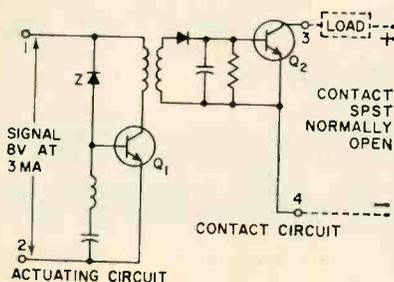


FIG. 1—Schematic diagram of static switching relay

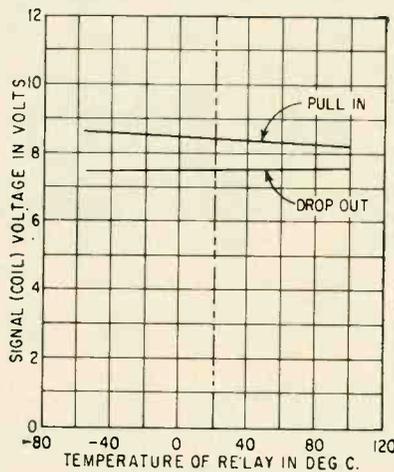


FIG. 2—Nominal performance of relay with change in temperature

as an electromechanical relay.

When utilized properly, the relay is highly reliable. But it is not always a perfect substitute for a mechanical relay. Inherent characteristics of semiconductor devices differ from coils and metal contacts. Both the control circuit and the

actuation circuit are susceptible to burnout with overvoltage and/or overcurrent. Contact ratings given in Table I, together with other pertinent characteristics, are maximum ratings and should not be exceeded. Current in the actuation circuit is determined by the signal voltage and the source impedance.

Although the original model WK-BYN-4XA is a d-c unit, the relay can be modified for a-c loads utilizing a bridge rectifier around the contact. Higher-temperature operation (above 100 C) can be achieved if the specification on contact leakage is relaxed.

Stability of pull-in and drop-out voltages with ambient temperature is evidenced in Fig. 2.

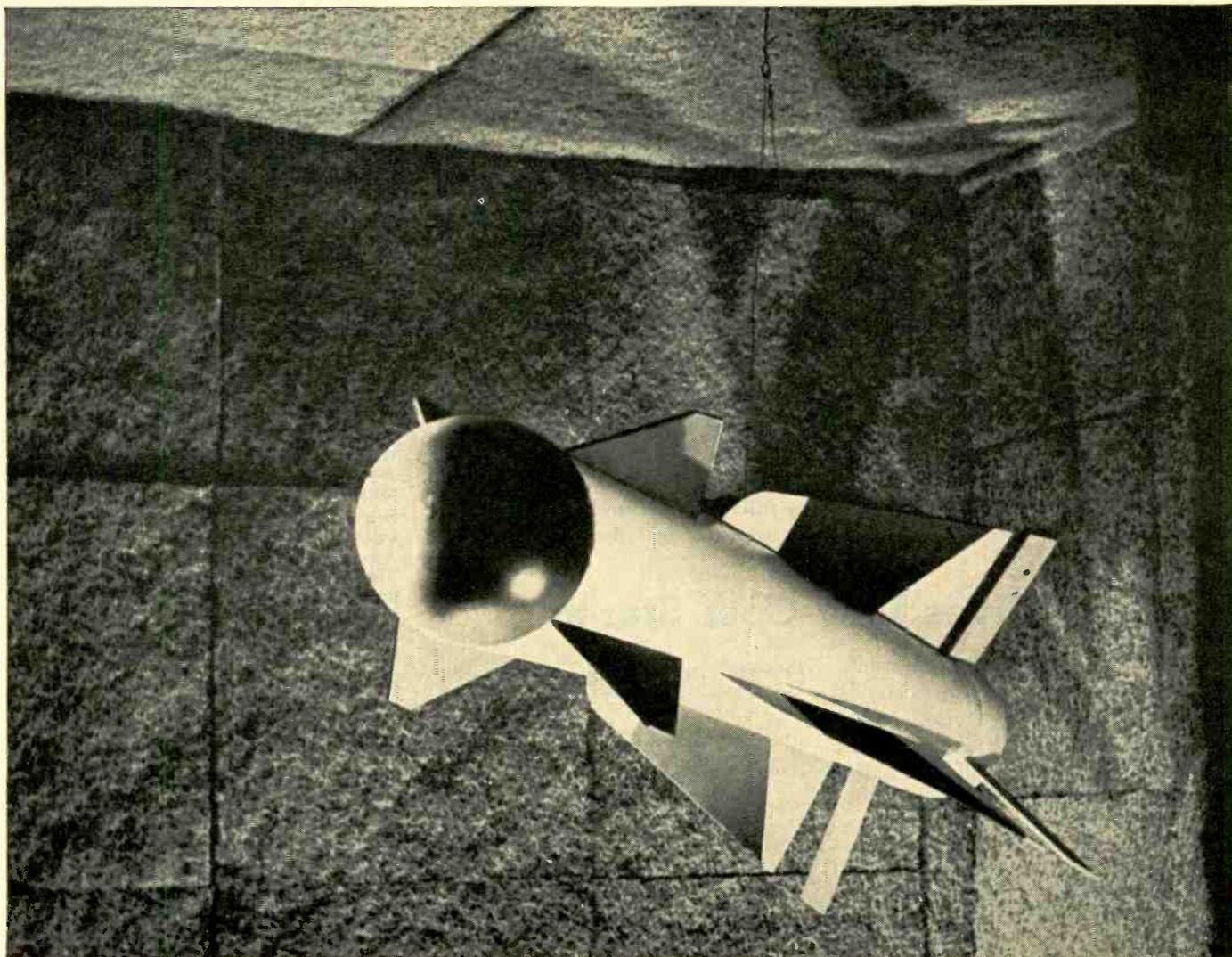
Table I—Relay Specifications

Pickup time	— 3 μ sec
Dropout time	— 6 μ sec
Contacts	— spst, normally open
Contact rating	— 30 v, 20 ma d-c
Pickup volts	— 8–9 v at 3 ma
Dropout volts	— 6.5 v
Contact resistance	— 150 ohms, closed 10 megohms, open
Shock	— 150 g
Vibration	— 25 g to 2,000 cps
Temperature	— -55 to +100 C
Weight	— 1.1 oz
Epoxy encapsulation	

Artificial Dielectrics for Microwave Lenses

IN MICROWAVE WORK, it is often necessary to change phase velocity of electromagnetic waves by transmission through a medium with a permittivity and/or a permeability different from that of air. Need for a light-weight material with a controllable refractive index led to development of artificial dielectrics. This development was described in a 1958 WESCON paper by Ming-Kuei Hu and David K. Cheng of Syracuse University.

Basic design approach used is random arrangement of identical artificial-dielectric elements with



New low reflective absorbents makes free space tests more reliable

Ten times *lower* reflection is now available with all B. F. Goodrich Microwave Absorbents. This 0.1% material gives reliability to measurements previously unattainable for testing of guided missiles in a free space chamber.

You can now be sure, by selecting the proper B. F. Goodrich material, that you will get this 0.1% performance at any point on the microwave frequency spectrum.

In addition to this outstanding quality, the B. F. Goodrich absorbent is light-weight, fire-retardant, easy to install. It will not deteriorate in performance when walked upon and has excellent water and weather resistant

List of B. F. Goodrich Broadband Absorbents

Designation	Lowest Frequency*	Thickness	Maximum Reflection
12 CM	2500 mc	1½"-2"	2%
12 CM - 1%	2500 mc	1½"-2"	1%
12 CM - 30db	2500 mc	1½"-2"	0.1% at X-band. 2% elsewhere.
6 CM	5000 mc	1"	2%
30 CM	1000 mc	3½"-4"	2%
30 CM - 1%	1000 mc	3½"-4"	1%
60 CM	500 mc	7"-8"	2%
60 CM - 1%	500 mc	7"-8"	1%
100 CM	300 mc	10"-11"	2%
200 CM	150 mc	26"	2%
600 CM	50 mc	69"	2%
8 CM-glass fiber	3600 mc	1"-1½"	2%
4 CM-glass fiber	7500 mc	¾"	2%

Most of the above absorbents can be furnished with 0.1% maximum reflection at selected points in the frequency band.

*All perform up to 30,000 mc

properties. For darkroom use, a special white compound can be applied to the surface of the pads to increase light reflectance.

When you're investing thousands, start right—specify B. F. Goodrich—the company with the longest experience and record for *consistently* high quality microwave material. For new booklet on these absorbents write The B. F. Goodrich Company, 486 Derby Place, Shelton, Connecticut.

B.F. Goodrich
microwave absorbents

each element in direct contact with a number of adjacent ones. The elements are supported by one another.

Figure 1A shows a basic construction technique—two thin shells with one completely enclosing the other. Spherical shape for the shells, as shown, is generally preferred to any other. Thickness of the outer shell is determined mainly by strength of the dielectric material used and by maximum mechanical load that may occur on a single element in the final assembled structure.

The inner shells control the refractive index by change in their size or shape. Thickness of the inner shells is determined by required refractive index, allowable loss of the resulting dielectric and properties of the conductive material used.

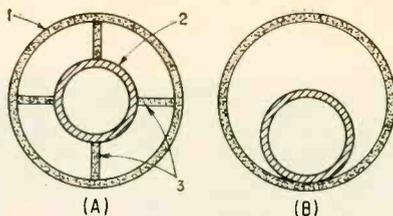


FIG. 1—Basic concentric double-shell element (A) has outer dielectric shell (1); inner conducting-material or non-conducting-material with conductive-coating shell (2) and supporting devices (3). Double-shell element with freely enclosed inner shell is shown in (B)

In a variation of the basic design, as shown in Fig. 1B, the inner shells can be enclosed freely within the outer shells.

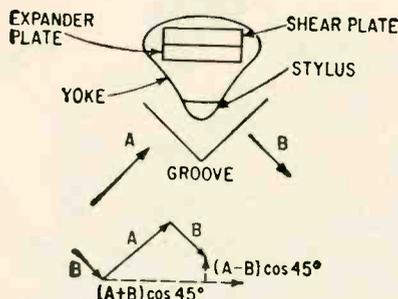
An artificial dielectric of any given size and of a specified refractive index can be assembled easily by filling the volume with shell-type elements as described.

Crystal Gives Low-Cost Stereo

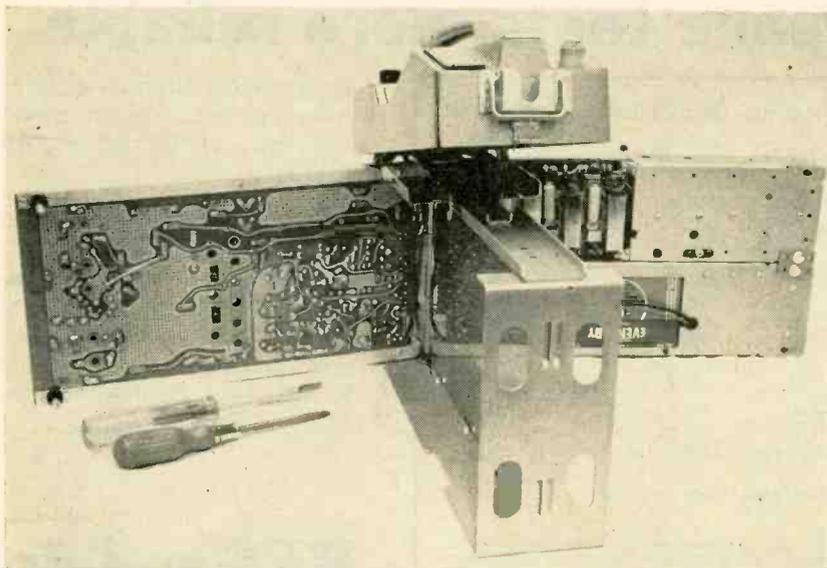
IN PRODUCTION at the Electronic Components Div., Clevite Corp., is a new twister-bender crystal, the 1LK35-S, designed for stereo applications using unscrambling circuits.

The shear plate (twister), Fig. 1,

FIG. 1—Shear and expander plates react to horizontal and vertical components of groove motion



Radio Has Fan-Type Design



Servicing is no problem because of the unique swing-out chassis employed in this transistorized, portable two-way radio by General Electric



KEY ENGINEERING OPENINGS AT VOUGHT

ADVANCED WEAPONS

This Vought division is planning, analyzing and proposing new concepts in missile and fighter weapon systems. Here, tactical requirements are established for new weapons, feasibility studies conducted, and proposals prepared.

Select openings exist in both the Advanced Missile Technical Group and the Advanced Aircraft Technical Group. These are responsible positions for engineering specialists and for design engineers up through lead level. Following are requirements for 4 openings which are typical of others in these groups:

Radar System Engineer or Specialist. A.E., or E.E. (M.S. preferred) with at least 7 years experience in systems and/or design for radar and fire control. To make high-level studies of advanced guidance and control systems.

Advanced Weapons Staff Engineer. Ph. D. preferred, with at least 10 years background in guidance or navigation and control systems. To develop completely new concepts in guidance, navigation, or control systems.

Electro-mechanical Systems Engineer or Specialist. A.E., E.E., or M.E. (advanced degree preferred) with at least 7 years experience in autopilot, flight control, stability systems and inertial guidance systems and design work. To make high-level technical studies of various control and stabilization systems for advanced weapons.

Advanced Weapons Engineer. A.E., E.E., or M.E. (M.S. desirable) able to develop methods for dynamic stability and stabilization studies. To join in, or direct, studies in stabilization, dynamic stability, missile and airframe configurations, and to make flight path and trajectory analyses. All in supersonic and hypersonic range.

To arrange for a personal interview, or for a prompt report on these or other current openings, return coupon to:

C. A. Besio
Supervisor, Engineering Personnel
CHANCE VOUGHT AIRCRAFT, Dept. R-5
Dallas, Texas

I am a _____ Engineer,
interested in the opening for _____
Name _____
Address _____
City _____ State _____

Cru·sad'er III: *Navy's new automated fighter is a flying missile base*

Automation multiplies the efficiency of the pilot of Chance Vought's new all-weather fighter.

Its armament battery of guided missiles puts him in command of a missile base that flies at more than twice the speed of sound. Its advanced equipment provides him electronic vision, instant reactions. Freed by automation from cockpit routine, he focuses on strategy. Multiplied in power and judgment, the Navy pilot of this *Crusader III* becomes a *multiple man*.

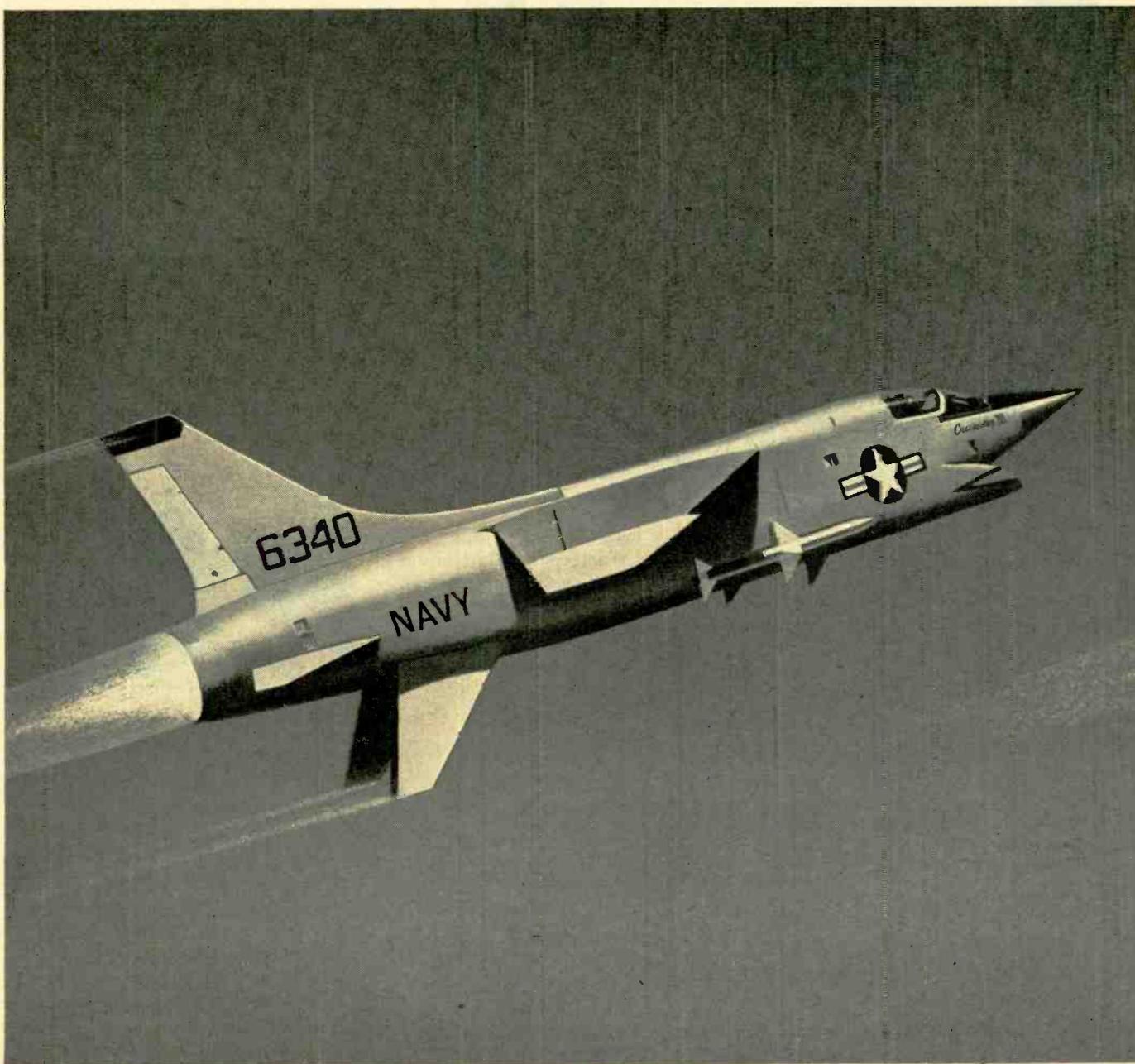
One of the most versatile weapon systems ever devised for America's defense, this new interceptor can fight at altitudes above 95 percent of the earth's atmos-

phere. It will operate — under all weather conditions — from carrier decks or advanced airbases.

Crusader III will give the U. S. Navy the *lowest cost*, all-weather Mach 2-plus fighter available.

Scientists and engineers: pioneer with Vought in new missile, manned aircraft, and electronics programs. For details on select openings write to: C. A. Besio, Supervisor, Engineering Personnel, Dept. R-5.

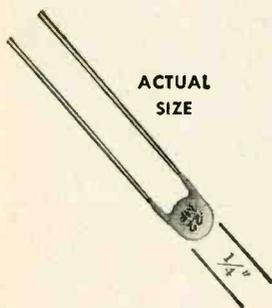
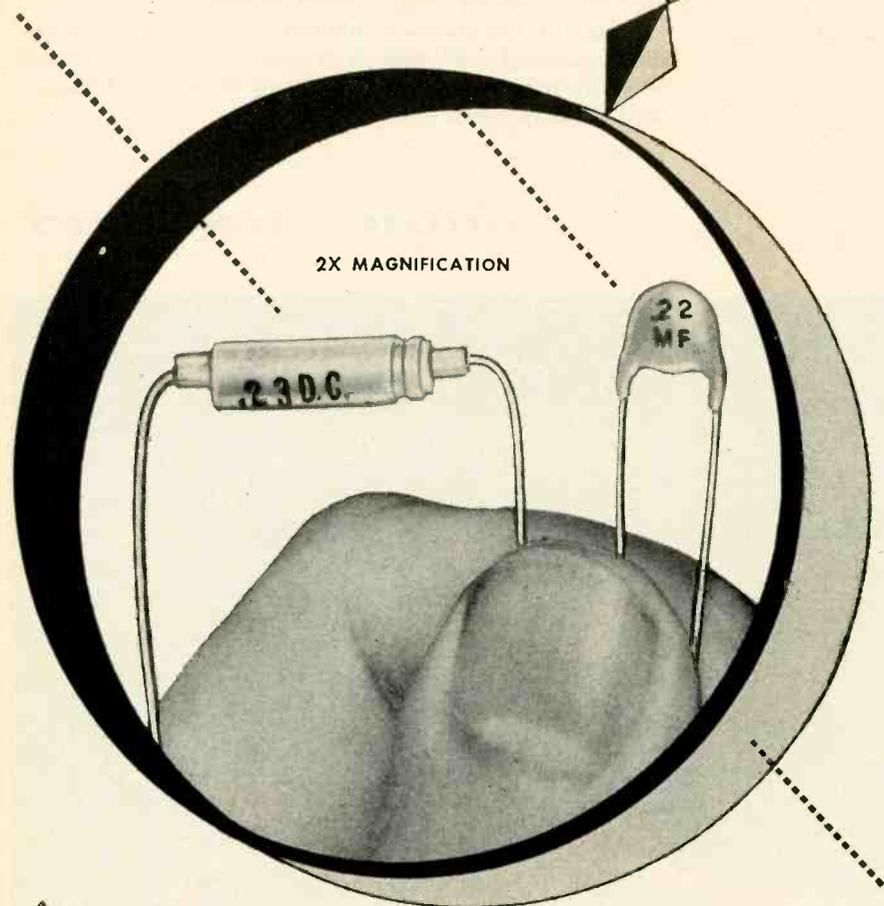
CHANCE  **VOUGHT AIRCRAFT**
INCORPORATED · DALLAS, TEXAS



Ultra-Miniature Low Cost Capacitors for Transistor Circuits

Centralab[®]

ULTRA-KAP*



2X MAGNIFICATION

ACTUAL
SIZE

...with performance characteristics that equal or exceed much larger or more costly components. Excellent temperature stability: plus or minus 25% from 10° to 85° C. Extremely low power factor. Working voltage, 3 VDC. GMV tolerances. Maximum thickness, 0.156".

TYPICAL SIZES

.22 mfd	1/4" diameter
.47 mfd	3/8" diameter
1.0 mfd	9/16" diameter
2.2 mfd	3/4" diameter

IN STOCK FOR IMMEDIATE DELIVERY

from your local CENTRALAB distributor. For detailed information write for CENTRALAB Engineering Bulletin EP-562.

D-5845

Centralab[®]

A DIVISION OF GLOBE-UNION, INC.
914J E. KEEFE AVE. • MILWAUKEE 1, WIS.
In Canada: 804 Mt. Pleasant Rd. • Toronto, Ontario

VARIABLE RESISTORS • PACKAGED ELECTRONIC CIRCUITS • ELECTRONIC SWITCHES
CERAMIC CAPACITORS • ENGINEERED CERAMICS • SEMI-CONDUCTOR PRODUCTS

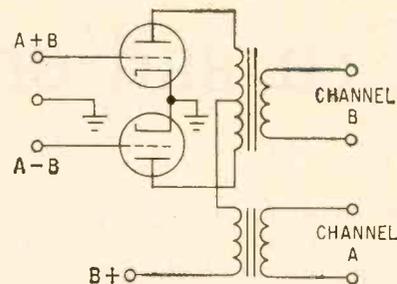
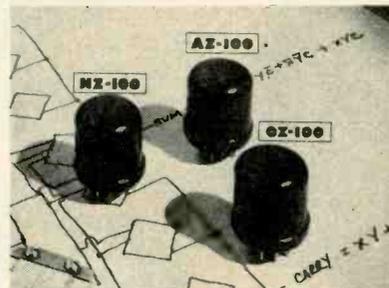


FIG. 2—Typical unscrambling circuit for use with crystal pickup

generates a voltage proportional to the horizontal components of groove motion. The length expander (bender) generates a voltage proportional to the vertical components. Components of both channels are present in each crystal plate as sums and differences. The circuit shown in Fig. 2 represents a simple method for unscrambling.

Basic Logic Modules Speed Programming

THREE BASIC seven-pin plug-in modules, energized by a 100-kc r-f power supply, have been developed by the Semiconductor Division, Hoffman Electronics Corp., Evanston, Ill. The new units make it possible to go directly to logic programming without necessity for individual circuit design.



Three logic-system modules are seven-pin miniature units

First of the three modules in the Magnalog system, Type NZ100, is a NOT unit consisting of a series-type pulse magnetic amplifier. The second, Type OZ100, is an OR unit containing three silicon, double-anode Zener diodes with appropriate Zener breakdown voltages. The third, Type AZ100, is an AND unit also containing three Zener diodes but with different breakdown voltages than those used in the Type

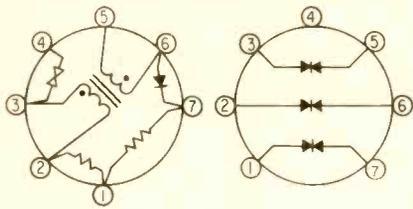


FIG. 1—Wiring of NZ100 module (left) and AZ100 and OZ100 modules (right)

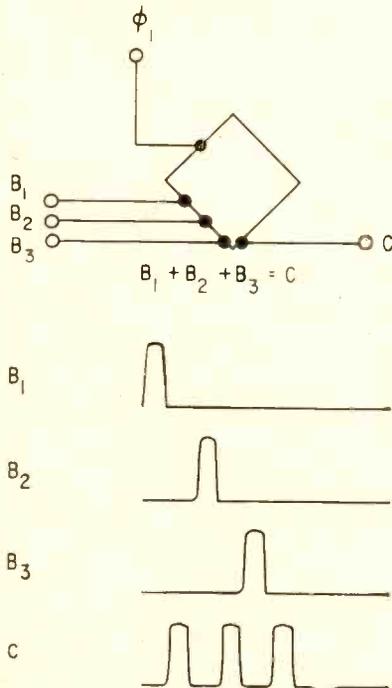


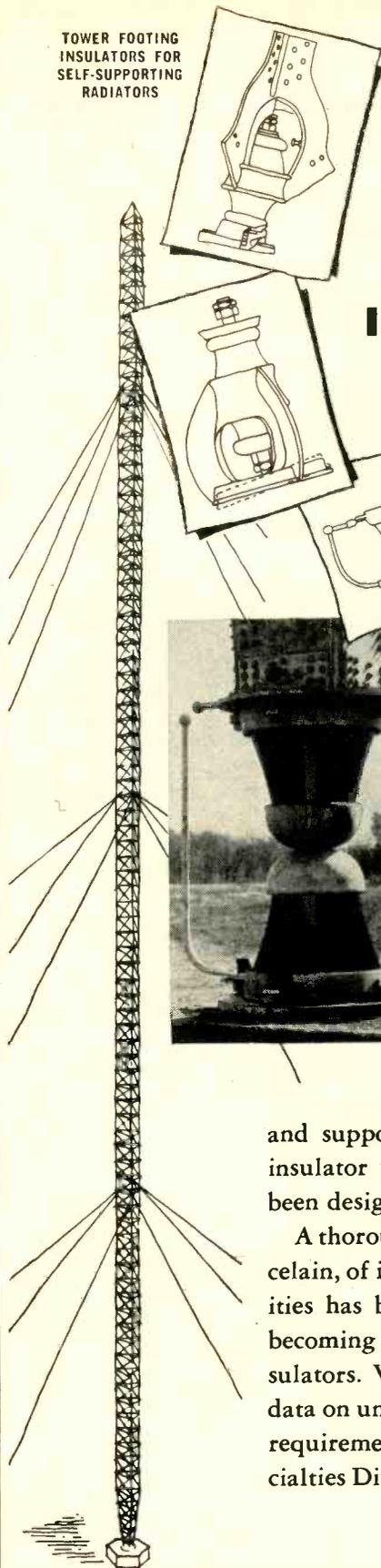
FIG. 2—Configuration for an OR circuit with waveshapes for Boolean expression illustrated

OZ100 module. Figure 1 shows wiring diagrams of the internal structures of the modules. Figure 2 illustrates an OR circuit made up from an NZ100 and an OZ100 module. The three Zener diodes of the OZ100 module are connected to pin 2 of an NZ100 module. Wave-shapes illustrate the Boolean expression, $B_1 + B_2 + B_3 = C$ for the circuit operation.

Papers Wanted for Components Meeting

PROSPECTIVE AUTHORS are invited to submit titles of papers and 150 to 200 words abstracts to the Program Committee of the 1959 Electronic Components Conference. Deadline is October 15, 1958. Address: Brig. Gen. Edwin R. Petzing, AGEP, Secretariat, University of Pennsylvania, 200 S. 33rd St., Philadelphia 4, Pa. Deadline for completed papers will be February 15, 1959.

TOWER FOOTING INSULATORS FOR SELF-SUPPORTING RADIATORS



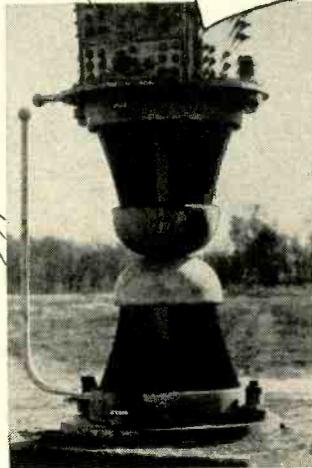
LAPP

ANTENNA TOWER

INSULATORS

MAST BASE INSULATORS

RADIO GUY INSULATOR



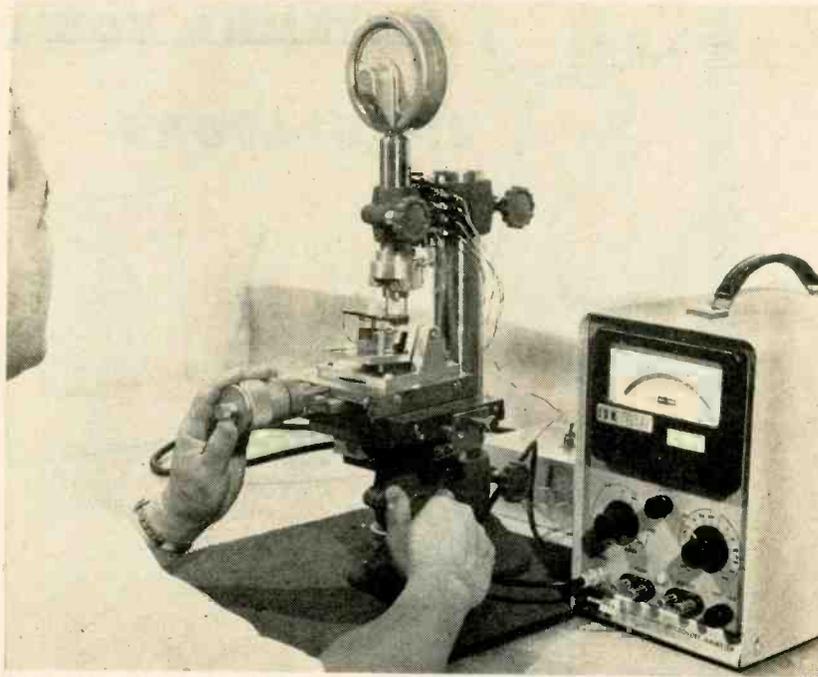
We at Lapp are mighty proud of our record in the field of tower insulators. Over 30 years ago, the first insulated broadcasting tower was erected—on Lapp insulators. Since then, most of the large radio towers in the world have been insulated and supported by Lapp insulators. Single base insulator units for structures of this type have been design-tested to over 3,500,000 pounds.

A thorough knowledge of the properties of porcelain, of insulator mechanics and electrical qualities has been responsible for Lapp's success in becoming such an important source of radio insulators. Write for description and specification data on units for any antenna structure insulating requirement. Lapp Insulator Co., Inc., Radio Specialties Division, 146 Sumner Street, LeRoy, N. Y.

Lapp

Hot Probe Measures Germanium Diffusion Depth

By M. BELIVEAU, International Business Machines Corp., Poughkeepsie, N. Y.



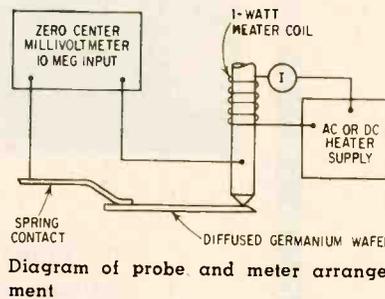
Sensitive gage provides depth reading when zero-point on meter indicates junction

METAL DIFFUSION depth in germanium may be measured within a few millionths of an inch by using the thermoelectric effect in semiconductors to detect the change in impurity type and level. Sample preparation takes only a few minutes time.

Apparatus consists of a sensitive height gage, a hot stylus mounted on the gage's spindle, a sample mounting block, a microscopic cross slide and a zero-center millivoltmeter or microammeter.

Variable reluctance or capacitor type gages with light actuating forces are suitable. In this case, a Johansson Mikrokator was modified to give a force of 20-30 grams for its entire range. A small permanent magnet is mounted to the barrel and an armature mounted to the spindle. Fine adjustment of the clearance between them, a few thousandths of an inch, gives the desired force.

The hot probe is rigid and constructed to avoid heat-caused dimensional changes. The heater coil, of thin resistance wire, is powered with a filament transformer to produce 125 F to 150 F temperature at



the probe shank. A large gap is left between the coil's top and the spindle. Insulating material in the gap is beneficial.

Fused quartz tubing is used for heater and probe support. The stylus holder is Invar. The stylus has an Invar shank and tungsten carbide tip, or may be all-carbide if shorter than $\frac{1}{4}$ inch. Tip radius is 0.004 inch.

The mounting block is steel and matches the size of the wafer used. A bevel cut in one edge extends into the mounting face for an inch or more. The bevel face guides the beveling of the wafer edge.

The leveling platform, permanently mounted to the micrometer-equipped cross slide, assures the

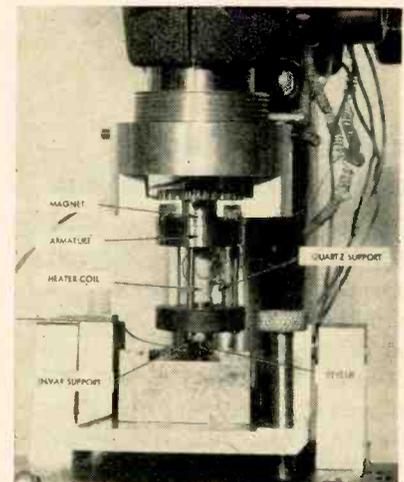
wafer surface is parallel to the slide ways. The ways are perpendicular to stylus motion. The platform pivots are in line with the top surface of the germanium near the beveled edge.

Thermal output of the probe is read with the meter. Electrical connections are made to the hot probe and to a pressure contact anywhere on the germanium surface.

The germanium sample is placed on the metal block, which has a built-in guide for lapping a small-angle bevel (5 degrees) on one edge of the sample. Since only vertical distance will be measured, it is not necessary to know the exact angle or starting point of the bevel.

The block with sample is placed on the leveling platform. Contact between sample and probe is made and the depth gage read. Cross slide and block are moved and the platform adjusted to level the top surface of the sample so that the gage shows little or no variation. The reading is recorded.

As the cross slide is moved so that the stylus starts down the bevel, thermal output is observed, or plotted, against depth. When output changes from negative to positive, or vice-versa, a junction has been located. To obtain junction depth, the depth reading obtained as the thermal output crosses the



Hot probe assembly is mounted on gage spindle over sample block

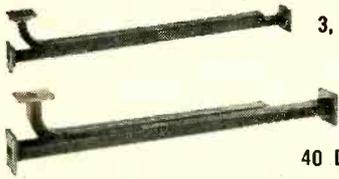


DUAL HIGH DIRECTIVITY COUPLERS

Narda Dual High Directivity Directional Couplers are designed for reflectometer measurements in waveguide systems, and exhibit the same flat response (± 0.4) and high directivity (40 db min.) as Narda's single units. Primary line VSWR: 1.05 max. (1.10 for M1027); secondary line VSWR: 1.15 max.

Coupling structures are on opposite broad walls of the primary line; secondary output arms are on the same side. Detector mounts can be attached readily to facilitate connecting detector mounts.

BAND	FREQUENCY (kmc)	WAVEGUIDE O.D. (in.)	NARDA Model	PRICE
S	2.60-3.95	3 x 1 1/2	1034	\$650.
C	3.95-5.85	2 x 1	1033	400.
XN	5.40-8.20	1 1/2 x 3/4	1032	255.
XB	7.05-10.0	1 1/4 x 3/4	1031	220.
X	8.20-12.4	1 x 1/2	1030	175.
KU	12.4-18.0	.702 x .391	1029	180.
K	18.0-26.5	1/2 x 1/4	1028	295.
V	26.5-40.0	.360 x .220	V1027	330.
M	50.0-75.0	.228 x .154	M1027	900.



3, 6, 10 and 20 DB

40 DB HIGH POWER

HIGH DIRECTIVITY COUPLERS

The 40 db High Power Coupler is another exclusive Narda product. Similar to standard types, except that coupling irises are in the narrow wall, it may be used at full rated power of the waveguide size. Nominal coupling value is 40 db; directivity 40 db. Directivity for 3, 6, 10 and 20 db couplers is also 40 db. Standard cover flanges on primary line; low VSWR termination and standard cover flange on secondary. All bands—2600 to 90,000 mc.



STANDARD REFLECTIONS

Narda offers five values of reflections for each of six different waveguide sizes... the most complete choice we know of! Provides calibrated reflections or VSWR's for use in standardizing reflectometers or calibrating slotted line impedance meters.

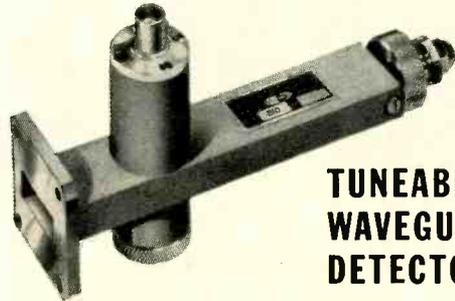
SPECIFICATIONS

Reflection Coefficient	0.00	0.05	0.10	0.15	0.20
Accuracy	0.002	0.0025	0.0035	0.0045	0.007
VSWR Equivalent	1.00	1.105	1.222	1.353	1.50

Models for 2.60 to 18.0 kmc, from \$125 to \$300

Microwave engineers—

Where can you use these exclusive features offered by NARDA?



TUNEABLE WAVEGUIDE DETECTORS

Narda's tuneable waveguide detectors are designed for broadband operation with small reflections and maximum versatility. Detected output is from a standard BNC female fitting, and the detectors may be used with a variety of crystal, bolometer, or thermistor elements, for absolute power measurements, as well as detection of relative power levels.

Although VSWR is low, impedance match can be improved by means of additional tuning such as E-H or slide-screw tuners. All models are designed for optimum VSWR with Narda model N610B bolometers, but good impedance matches can frequently be obtained with other bolometers and thermistors.

Data on VSWR with various elements is available from Narda, as well as a wide range of suitable detecting elements and crystals.

BAND	FREQUENCY (kmc)	WAVEGUIDE O.D. (in.)	NARDA MODEL	DETECTING ELEMENTS					MAX. VSWR WITH N610B	CRY-STALS	PRICE
				BOLOMETERS			THERMISTORS				
C	3.95-5.85	2 x 1	513	N610B	N821B	N605	N333D or N333	N334	1.25	IN21 or IN23	\$95.
XN	5.30-8.20	1 1/2 x 3/4	512	N610B	N821B	N605	N333D or N333	N334	1.25	IN23	90.
XB	7.05-10.0	1 1/4 x 3/4	511	N610B	N821B	N605	N333D or N333	N334	1.25	IN23	85.
X	8.20-12.4	1 x 1/2	510	N610B	N821B	N605	N333D or N333	N334	1.25	IN23	75.
KU	12.4-18.0	.702 x .391	509	N610B		N605	N333D or N333		2.00	IN78 or IN23	110.

Tuneable Detectors for use with crystals only, available for millimeter bands 18,000 to 90,000 mc., from \$125

Complete Coaxial and Waveguide Instrumentation for Microwave and UHF — including:

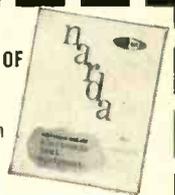
DIRECTIONAL COUPLERS
TERMINATIONS
FREQUENCY METERS
HORNS
VSWR AMPLIFIERS

200 to 90,000 mc.
TUNERS
ECHO BOXES
SLOTTED LINES
BENDS
COAXIAL HYBRIDS

ATTENUATORS
STANDARD REFLECTIONS
BOLOMETERS
THERMISTORS
LOW PASS FILTERS

MAIL COUPON TODAY FOR FREE 1959 CATALOG AND NAME OF NEAREST REPRESENTATIVE

The Narda Microwave Corporation
118-160 Herricks Road
Mineola, L. I., N. Y.
Dept. E-10



NAME _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

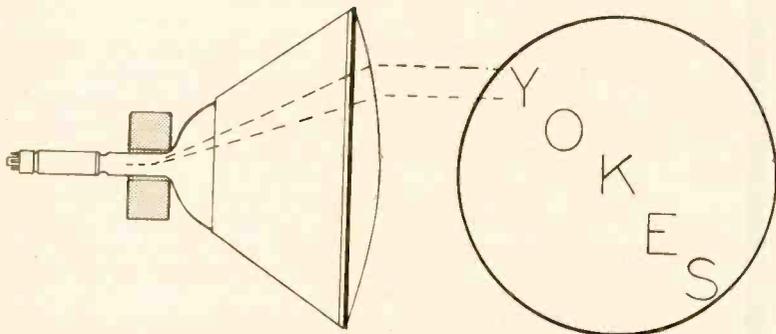
 the **narda**
microwave corporation

118-160 HERRICKS ROAD, MINEOLA, L. I., N. Y. • PIONEER 6-4650

CELCO Specialized

YOKES

FOR CHARACTER DISPLAYS



YEARS AHEAD IN DESIGN PERFORMANCE

For critical applications, many of our customers have saved years of trial and error in YOKE selection by specifying Celco YOKES.

The construction of our yokes makes it possible to achieve sensitivities, linearities, responses and distortion-free deflecting fields not possible with the usual types of yoke.

For precision military and commercial displays, Celco also offers standard yokes in 7/8", 1", 1 1/8", 2", & 2 1/2" CRT neck diameters.

Write for CELCO DEFLECTION YOKE Catalogue & Design Sheets or for immediate engineering assistance Call your nearest CELCO Plant:



Constantine Engineering Laboratories Co.

Mahwah, N. J.
Davis 7-1123

Miami, Fla.
Plaza 1-9083

Cucamonga, Calif.
Yukon 2-2688



zero point is subtracted from the first or reference gage reading.

The bevel angle selected, while not critical, is a function of surface waviness, diffusion depth and accuracy desired. Deep diffusions (0.001 inch) and wavy surfaces require larger angles. Figure 1 shows how errors due to waviness and inaccurate leveling are reduced by a greater bevel angle B, perhaps 8 degrees.

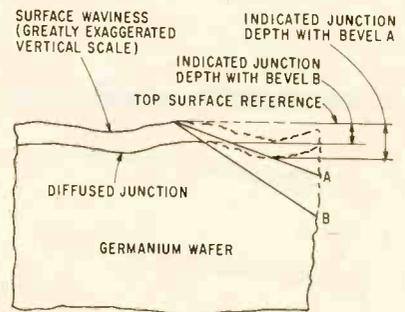
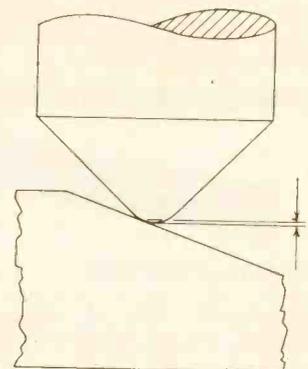


Fig. 1—Deeper bevel avoids errors due to irregular sample surface



BEVEL ANGLE (DEGREES)	TIP RADIUS	
	.003 IN.	.004 IN.
4	7.3	9.8
5	11.4	15.2
6	16.4	21.9
7	22.4	29.7
8	29.2	38.9

Fig. 2—Correction (in millionths inch) for tip radius and bevel angle

The wavy surface technique is as follows: Level the block until the gage pointer oscillates about a point on the scale. Take a reference reading at the jump-off point to the beveled surface. Subtract from the reference reading the reading at the junction and a correction for tip radius and bevel angle (Figure 2).

There are 3 checks for the apparatus. For thermal stability: warm up the probe for 1/2 hour. When probe temperature is 140 F, contact the germanium and allow 1/2 minute for stabilization. The change in depth

reading must not exceed 10-millionths per minute. Mechanical stability: readings must not be erratic when the probe is moved left to right over a level sample or polished surface. Probe contact force and radius: a variation in junction depth readings, after the probe has been moved several times over the bevel in the same trace, indicates the germanium is being scored. The scoring can be observed with a metallurgical microscope.

One Etchant Handles Several Metal Plates



Unetched board is inserted in paddle etcher

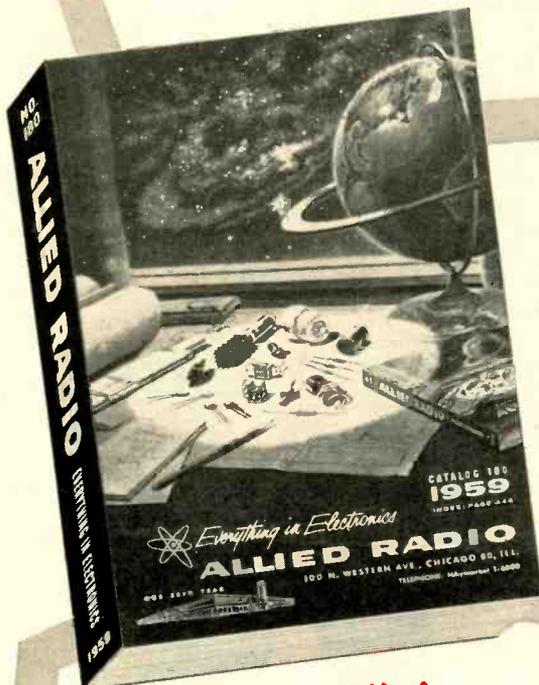
RECENTLY introduced process for etching printed copper circuits employs an aqueous solution of ammonium persulfate as the etchant, rather than ferric chloride or chromic acid.

Advantages claimed for the process by Becco Chemical Division, Food Machinery and Chemical Corp., Buffalo, N. Y., are: plain, solder-plated and plated circuits may be etched in one system, the etchant is relatively non-corrosive, does not produce fumes, does not form sludge, produces only water-soluble reaction products, allows copper recovery and sewerage of wastes.

Comparative costs per gallon of etching solution, according to Becco, 36 to 42 cents for ammonium persulfate, 50 to 75 cents for ferric chloride and \$1 to \$1.25 for chromic acid. Overall process time for all three are reported as comparable.

Conventional tank, paddle or spray etchers may be used. The ammonium persulfate solution requires activation by operating at

depend on
ALLIED
for everything in
electronic supplies



free

on request

the most widely used
 electronic supply guide
**ALLIED'S 452-PAGE
 1959 CATALOG**

world's largest stocks

- Receiving Tubes
- Power & Gas Tubes
- Diodes & Transistors
- Relays & Switches
- Electronic Parts for Every Industrial Need
- Knight-Kit Test Instruments in Low Cost Kit Form
- Knight Paging and Public Address Equipment
- Test Instruments
- Meters & Supplies
- AN Connectors
- Metal Chassis Bases

Simplify and speed your purchasing of electronic supplies and equipment at ALLIED. We make fast, expert shipment from the world's largest stocks of *everything* in Electronics. Our expert Industrial supply service saves you time, effort and money. Manufacturers' prices available on quantity purchases. Send today for your FREE 1959 ALLIED Catalog—the *complete* Buying Guide to Electronic supplies for Industrial and Communications use.

ALLIED RADIO

100 N. Western Ave., Dept. 11-J8
 Chicago 80, Illinois



OUR
 38th
 YEAR

one complete dependable source for everything in electronics

SEMICONDUCTOR PLUS MICROWAVE COMPETENCE

Since 1952, Microwave Associates, Inc., has demonstrated a unique and effective effort combining solid state devices and microwave techniques. We have been the leader in the design and production of very low noise, reliable microwave mixer and video diodes to the extent that our silicon products are essential elements in almost all high performance microwave systems in use today.

For your future use, programs are now in progress which will soon make available diffused junction mesa silicon varactors for microwave amplification, detection, harmonic generation and low noise duplexing. If your microwave system planning will require a component involving sophisticated solid state and microwave techniques, why not avail yourself of our skilled team of physicists, metallurgists, and engineers now most active in this field.



temperature of about 130°F, or by using catalytic activation at room temperature. Tank etching requires agitation by board motion or air bubbling.

The bath is prepared by mixing 2 to 2.5 pounds of stable ammonium persulfate powder to each gallon of hot water. This 25% solution may be stored 8 to 10 days. A 50 to 60% head tank solution may be stored 2 to 3 days. All vessels must be thoroughly cleaned of residues left by other processes.



Etched board is washed in rinse tank

Copper capacity of the 25% solution is 8 ounces of copper per gallon. Typical etching time in a paddle etcher is 7 to 8 minutes, 2 ounce copper; 5 to 6 minutes, 1.5 ounce copper, and 3 to 4 minutes, 1 ounce copper in heat activated solution is about half these times in catalyst activated solution. Etching time will be approximately double over the useful life of the solution. No precipitate or sludge will form in the etching tank.

Water rinse, rather than water wash or scrubbing, will clean the water soluble residues left on etched boards. Lead sulfate will form on solder-plated boards, but may be removed by buffing, hot water or chemical dip.

Spent solution will contain essentially only ammonium sulfate, copper sulfate and a trace of sulfuric acid. Copper may be recovered practically by plating it out electrolytically. If copper is not to be recovered, liming the waste solution in a settling tank will precipitate a copper-bearing sludge. In either case, the remaining solution can be sewered in most localities after dilution.

The process can be used with all



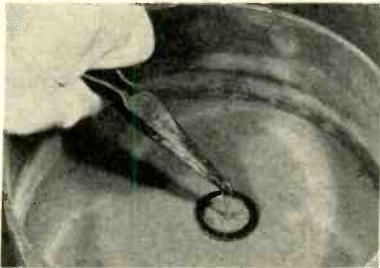
MICROWAVE ASSOCIATES, INC.
BURLINGTON, MASSACHUSETTS • Telephone: BRowning 2-3000

←CIRCLE 73 READERS SERVICE CARD

conventional resists. With modifications, it can be used to clean copper or remove copper flash.

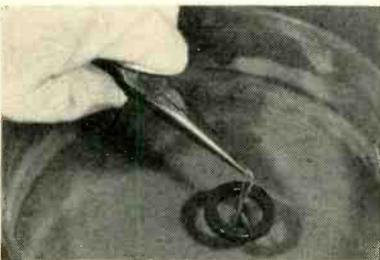
Fluidized Resin Coats Hot Parts

SMALL PARTS may be readily encapsulated by plunging them when hot in dry resin. The photos illustrate a technique recommended by Minnesota Mining & Manufacturing Co. for encapsulating toroids.



Pliers serve to plunge hot part in powdered resin

The toroid, held by a wire spring, is heated to 350 F. It is dipped into powdered epoxy resin until completely submerged and kept submerged for 2 or 3 seconds. The heat of the part causes the powder to melt and adhere to its surface in an even coating. On withdrawal, the part will show a slightly granular surface until the internal heat of the toroid melts the resin grains clinging to its surface.



Melting resin grains give a smooth, shiny coating

The resin is held in a container which fluidizes, or aerates, it by compressed air so that it has the properties of a simmering liquid. The air enters through a membrane of glass, cloth and paper under the resin. One foot of resin was used under about ½ to 1 pound of air pressure.

KLEIN PLIERS

make wiring faster
...easier

301 301-6P *207-5C

301-6-SCP

307-5½ 304

202 302

209 *203-6C

Many Klein Pliers are available with a coil spring to keep jaws in open position. Spring is guaranteed for the life of the plier.

Klein Pliers may be ordered with dipped-on plastic-coated handles.

There's a lot to like in Klein Pliers. There is a size and style for every job, even the toughest wiring assembly. All are made of finest alloy

steel, individually tempered and tested. They are backed by the Klein name, serving industry for more than 100 years.

* PAT. APPLIED FOR



Yours for the asking—
free copy of the new
Klein Pocket Tool Guide.

ASK YOUR SUPPLIER

Foreign Distributor: International Standard Electric Corp., New York



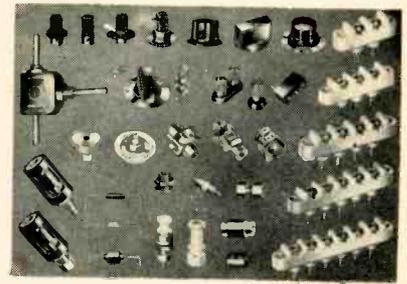
Mathias **KLEIN** & Sons
Established 1857 Chicago, Ill., U.S.A.
7200 McCORMICK ROAD • CHICAGO 45, ILLINOIS

NEW PRODUCTS

Tiny Components wide variety

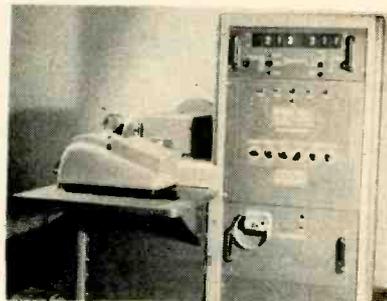
THE JAMES MILLEN MFG. CO., Malden, Mass., announces a complete line of miniature components approximately $\frac{3}{4}$ the size of the standard units. Such components include i-f transformers, dials,

knobs, dial locks, shaft locks, flexible couplings (in 7 types), ceramic terminal strips, binding posts, gear drives, insulated potentiometer mountings and all other components in the company's standard line that lend themselves to miniaturization. Circle 300 on Reader Service Card.

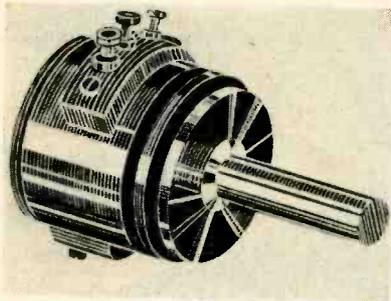


Cable Evaluator self programming

JAMES CUNNINGHAM, SON & CO., INC., 33 Litchfield St., Rochester 8, N. Y. The self-programming automatic cable evaluator (SPACE) is a console-mounted testing instrument which automatically checks for leakage (hi-pot)



and continuity between any and all wire ends or terminations of a cable harness or device being tested. SPACE, employing a computer type memory, progresses through a series of tests in a logical manner at a maximum rate of 10 tests per second and has a capability of generating its own tape program. Circle 301 on Reader Service Card.



Miniature Pot two voltage outputs

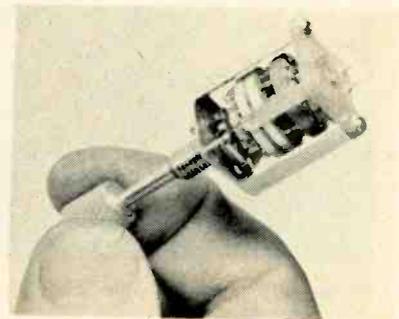
WATERS MFG., INC., Wayland, Mass. Type WPSC is a miniature nonlinear sine-cosine precision pot that provides two accurate and entirely separate 360 deg sinusoidal voltage outputs. The two output signals are displaced 90 deg in phase

and represent the sine and cosine of the shaft rotation angle. Standard servo-type mounting is provided, but tapped hole mounting can be specified in this precision-wound unit. The new potentiometer is particularly useful in radar ppi displays and for various types of computers. Circle 302 on Reader Service Card.

Attenuator two switch sections

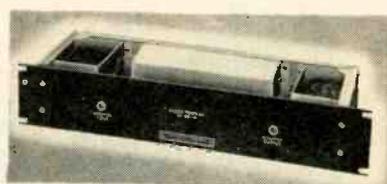
THE DAVEN CO., Livingston, N. J., has a subminiature attenuator whose dimensions are only $\frac{3}{4}$ in. square by $1\frac{1}{4}$ in. long. Diameter of the shaft is $\frac{1}{8}$ in. with $\frac{1}{4}$ in.-28 mounting bushing. Inside the unit are two switch sections with slip

rings and 22 fixed resistors. It is designed to surpass applicable MIL specifications such as MIL-STD-202A by temperature cycling, moisture resistance, vibration up to 2,000 cps at 15 G, and 50 G acceleration. The unit is available as an 11-position bridged T, 20-position ladder, or 20-position pot. Circle 303 on Reader Service Card.



Unique Network improves a-m/f-m power

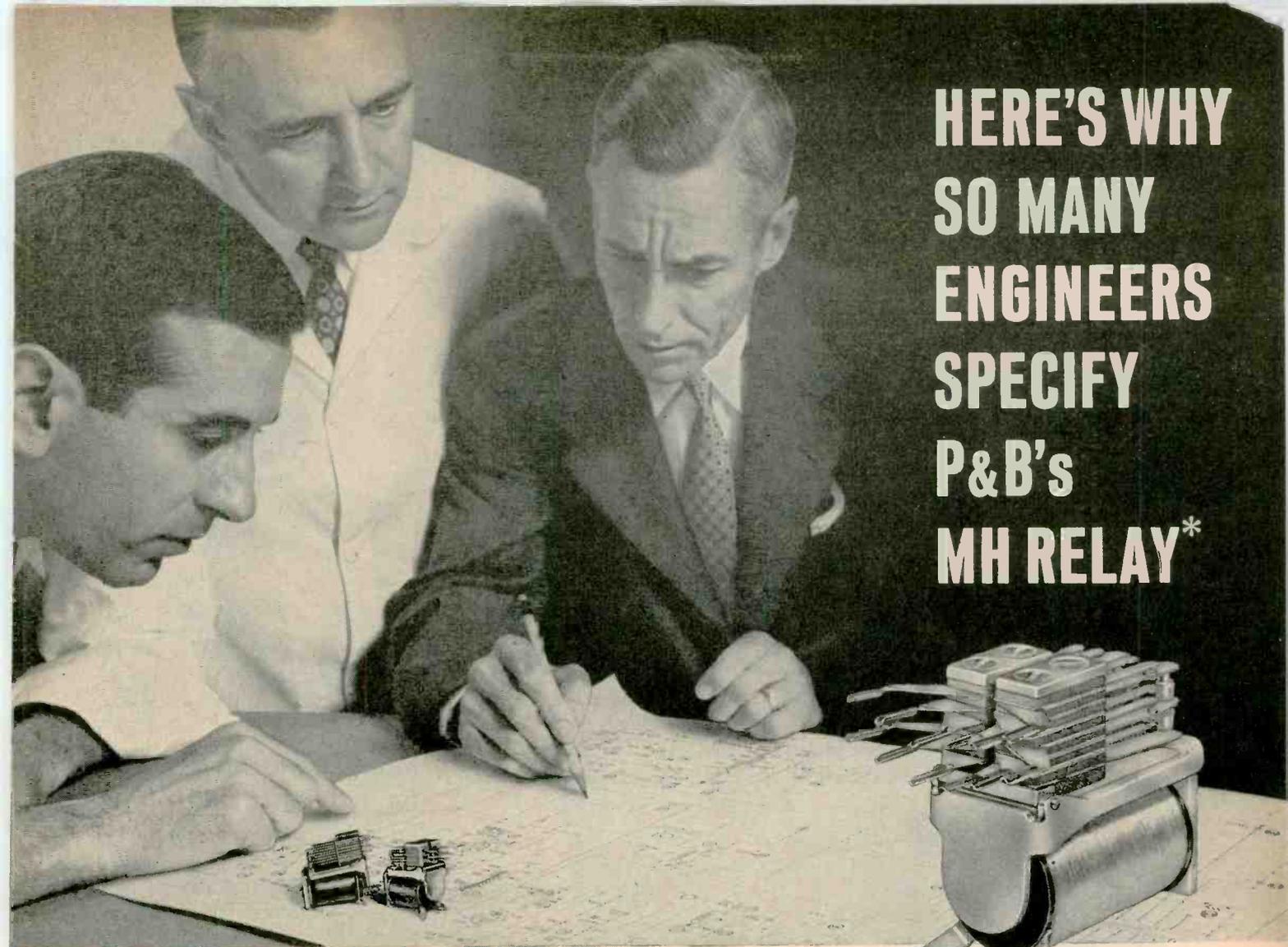
KAHN RESEARCH LABORATORIES, INC., 22 Pine St., Freeport, N. Y. Specifically designed for a-m, f-m, tv audio, and h-f communications transmitters, the model SP-58-1A



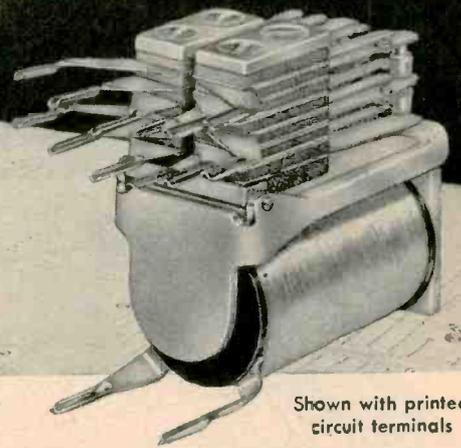
"Symmetra-peak" network redistributes unequal positive or negative

peak energy of audio waves symmetrically about the zero axis. Thus, any asymmetry resulting from certain voice characteristics, improperly phased microphones, or switching between local and distant program sources is eliminated. With peak energy considerably re-

HERE'S WHY SO MANY ENGINEERS SPECIFY P&B's MH RELAY*



*AND VARIATIONS OF THIS BASIC STRUCTURE SHOWN BELOW



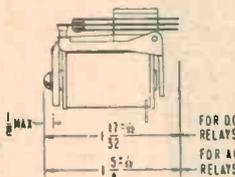
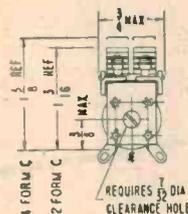
Shown with printed circuit terminals

VERSATILITY

and adaptability are prime reasons why designers have made the MH a P&B best seller. This relay series, for example, does yeoman duty in such diverse applications as jet aircraft, street lighting equipment, computers and missile ground controls.

When multiple switching is required... when size, weight, long life and reliability are critical... our MH relay can usually fill the bill. It's RIGHT for countless jobs, often at countable savings.

Let us send you complete information about this miniature telephone-type relay and the variations we've evolved for special applications. Write or call today.



ENGINEERING DATA/MH RELAY

Insulation: Laminated phenolic.
Insulation Resistance: 100 meg-ohms minimum.
Breakdown Voltage: 500 volts RMS between all elements.
Shock: Up to 30g.
Vibration: Up to 10g from 55 to 500 cps.; .065" max. excursions from 10 to 55 cps.
Ambient Temperature: -45°C. to +85°C. -(65°C. to +125°C. on special order).
Weight: 2 1/2 oz. max. (open relay)
Pull-In: Approx. 75% of nominal voltage.
Pull-In Speed: Approx. 15 ms.
Drop-Out Speed: Approx. 10 ms.
Terminals: Pierced solder lugs; special lugs for printed circuits, taper tab (AMP #78).

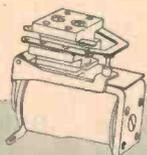
CONTACTS:

Arrangements: Up to 9 springs per stack.
Material: 1/8" silver; also Palladium or gold alloy.
Load: Dry circuits to 5 amps @115V AC resistive.

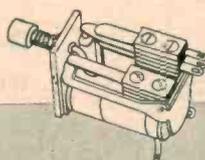
COILS:

Resistance: 22,000 ohms max.
Power: 100 milliwatts per movable minimum to 4 watts at 25°C. max. (200 mw. min. to meet max. shock/vibration spec.)
Duty: DC: Continuous. AC: Intermittent (2 pole relay max.)
Voltages: DC: Up to 110 volts. AC: Up to 230 v. 60 cycles.
Current: 2.5 ma to 10 amps DC.

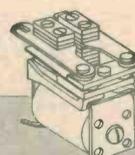
P&B STANDARD RELAYS AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



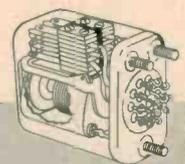
MC FOR RF SWITCHING
 For RF switching where intercontact capacitance losses must be minimized. Ceramic contact spacers.



MA LATCHING
 Electrical latch; mechanical reset. Small, versatile and offered with selection of contact arrangements.



MB CONTACTOR
 Contacts rated 60 amp. 28 volts DC non-inductive. Will carry 150 amp. surge for a duration of 0.3 seconds.

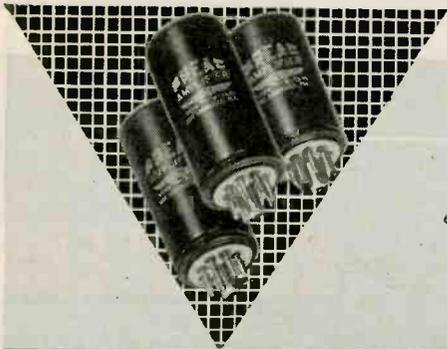


MH SEAL-TEMP
 Features sealed coil to minimize contact contamination. Available as hermetically sealed relay only.



POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

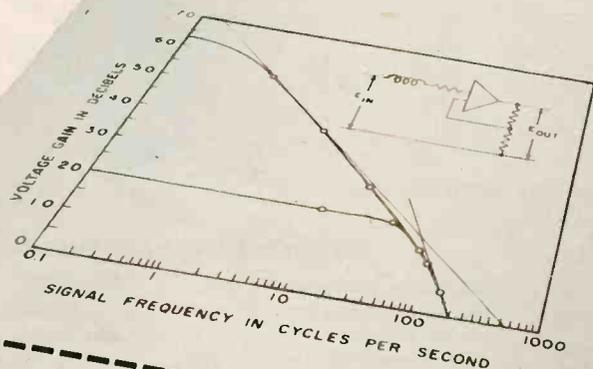


INSTRUMENT AMPLIFIERS

designed for amplification of low-level signals have exceptional sensitivity. Input of .0025 microwatts produces full output of 4 DC volts into 5000 ohms.

Low-Level Preac Magnetic Amplifiers

For sensitive thermocouples, strain gauges, and similar data sensing applications, Preac amplifiers provide low null drift. Power gain is so high (up to 60 db) that inverse feedback can readily be used to achieve special desired characteristics.



AMPLIFIER CHARACTERISTICS

Airpax Preac amplifiers are highly stable low-level magnetic amplifiers.

INPUT: DC polarity reversible. Below are input control powers in microwatts for full-scale outputs.

Type	Full-Scale Input
M-5249	0.0026 (both windings in series)
M-5250	0.011 (internal choke)
M-5251	0.025 (either winding)

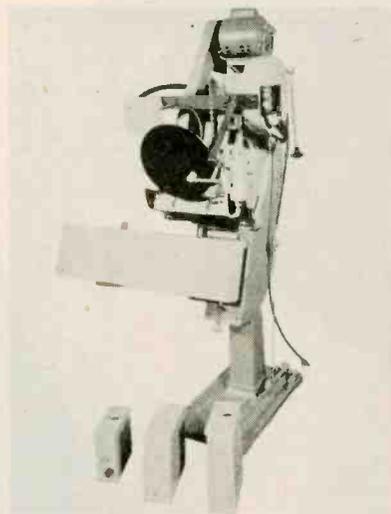
OUTPUT: DC polarity reversible ± 4 DC volts into 5,000-ohm load, deviation from linearity less than 100 millivolts.

POWER SUPPLY: Less than 2 watts, about 2.5 VA, at 400 ± 40 CPS and 115 ± 11 RMS volts.



Airpax Products Company, Seminole Division, Fort Lauderdale, Florida

duced, average modulation level can be increased, permitting potential power improvement of up to 4 db on voice transmission. Circle 304 on Reader Service Card.



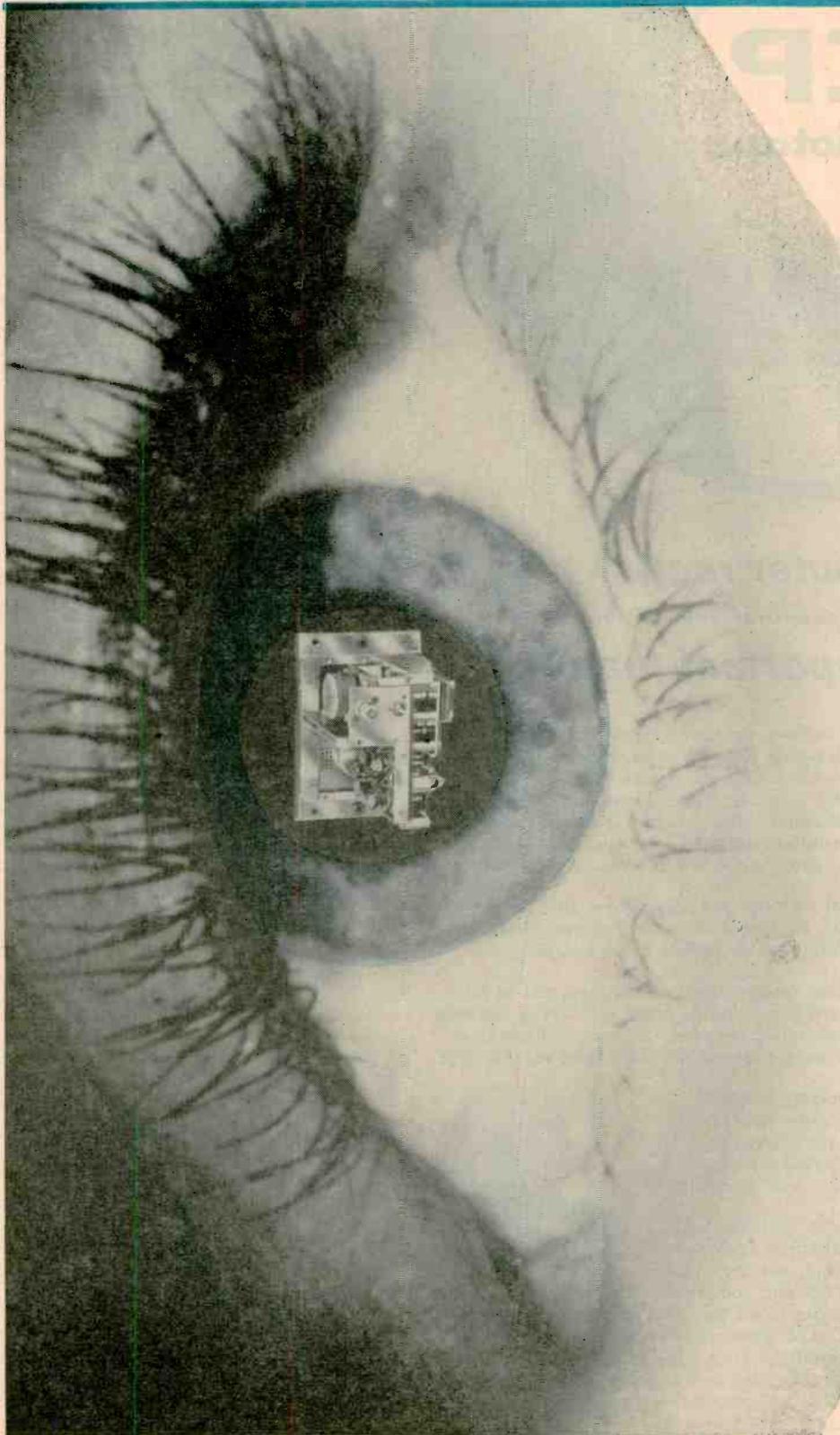
Marking Machine for flat items

MARKEM MACHINE CO., Keene 55, N. H. Flat or rectangular meter sockets and similar flat items may be marked directly with UL approval seal and issue number by the model 25AU machine. The machine uses a sealed, recording, non-reset counter mechanism and manifest printing plates purchased from and issued through Underwriters Laboratories, Inc. Speeds up to 60 imprints per minute may be achieved on a full range of sizes of meter sockets, with rapid change-over from size to size. Imprint size of the UL label section is $2\frac{1}{2}$ in. by 3 in. Circle 305 on Reader Service Card.



D-C Supplies transistorized

SORENSEN & CO., Inc., Richards Ave., South Norwalk, Conn. Added to the Q-Nobatron line of transistorized low-voltage high-current d-c supplies is the model Q28.5, with



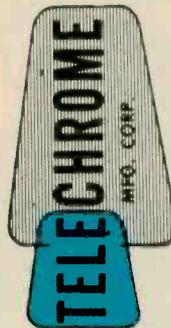
HIGH POWER

in Small Packages

Unhampered by traditional thinking, TELECHROME engineers have developed an entirely new concept in telemetering equipment — unequalled in compactness, ruggedness and dependability. Write for Specifications & Details

TELEMETERING TRANSMITTERS

by



The Nation's Leading Supplier of Color TV Equipment

28 RANICK DRIVE, AMITYVILLE, N. Y. • Lincoln 1-3600

Western Engineering Division — 13635 Victory Blvd., Van Nuys, Calif., State 2-7479

Direct FM Transmitters Crystal controlled 215-235 megacycles. 125kc deviation.



Model 1462

6" x 4 1/4" x 3 3/4" 50 to 80 Watts



Model 1463

5 1/2" x 3 1/4" x 4" 15 to 30 Watts



Model 1472

4" x 1.5" x 2.7" 2 Watts



Model 1466A
6.5" x 4" x 3.25" RF Amplifier
2 watts in — 100 watts out

SUB-CARRIER OSCILLATOR.



Model 800C — 1.5" x 1.9" x 2.45"
Deviation stability ± 1%
of band width. Deviation
linearity less than 1% of
band width under all con-
ditions measured from a
straight line drawn be-
tween end points.

FOR MESSAGES FROM OUTER SPACE



... on the computer reel

FOR HIGHEST-PRECISION COMPUTER APPLICATIONS...

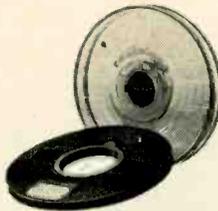
has three important features*

Type EP Audiotape is the extra-precision magnetic instrumentation tape that is guaranteed defect-free. Now EP Audiotape is available in a form particularly suited to electronic computers. It is made on both 1.5-mil cellulose acetate and polyester film. Tapes are 2500 x 1/2". Every reel is tested by a 7-channel certifier before it leaves the factory and is guaranteed to have absolutely no "dropouts" (microscopic imperfections causing test signal to drop below 50% of average peak output).

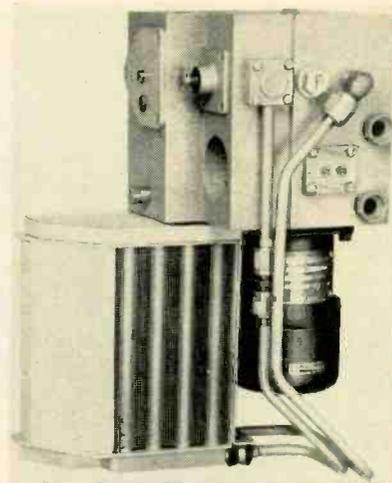
- * Reel is Audio's computer reel — an opaque polystyrene 10 1/2" reel with a hub diameter of 5.125". Each reel comes with pressure-sensitive identification labels and a yellow polyethylene drive slot plug.
- * Two photo-sensing markers are accurately placed on the tape, one 14 feet from the hub end, the other ten feet from the other end. These markers are vaporized aluminum sandwiched between the base and low flow thermosetting adhesive. Both markers are firmly placed and wrinkle-free.
- * Container is of transparent polystyrene and made especially for the computer reel. A center-lock mechanism and peripheral rubber gasket seal the reel from external dust and sharp changes in temperature and humidity.

EP Audiotape on the computer reel has been used in large computer installations with perfect results. Although the reel, markers and container are designed for specific computers, the tape is the same precision EP Audiotape that has stood the tests of time and operation on hundreds of applications in automation, petroleum seismology, telemetering, and electronic computing. To get the complete specifications for type EP Audiotape on the computer reel — or for a Company representative to call — write on your company letterhead to Dept. TE.

AUDIO DEVICES, INC., 444 Madison Avenue, New York 22, N. Y.



an output range of 18-36 v d-c at 0-0.05 ampere. It is ideal for use in such applications as computer circuits or strain gage bridges. Unit is available in single or dual rack mounting models or in cabinets. Circle 306 on Reader Service Card.



Tube Cooler for missile use

EASTERN INDUSTRIES, INC., 100 Skiff St., Hamden, Conn., produces a unit for cooling high powered electronic tubes in the guidance systems of missiles. Model E/HT-200, type 204, is a complete assembly, weighing 10 lb and with dimensions of only 10 1/2 in. by 6 in. by 7 1/4 in. It has an operating temperature range from - 65 F to + 160 F. It has a capacity of 1,600 w and operates on 28 v, d-c power supply. Coolant is ethylene glycol-water solution delivered at 0.6 gpm flow rate and 35 psi pressure at maximum temperature. Circle 307 on Reader Service Card.



Resistance Bridge high precision

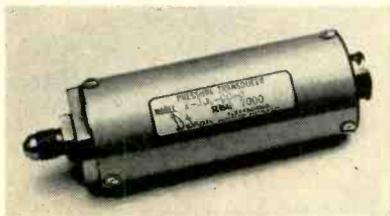
ELECTRO-MEASUREMENTS, INC., 7524 S.W. Macadam Ave., Portland 1, Ore. Model 230-R Wheatstone resistance bridge offers a

combination of accuracy, speed and convenience for precise resistor checking, temperature coefficient measurements, strain gage calibration and other critical resistance measurements. It features an accuracy of better than 0.02 percent for most measurements from 0 to 12,000 megohms. The lowest range has a resolution of 10 micro-ohms per dial division. Circle 308 on Reader Service Card.



Power Supplies transistorized

LAMBDA ELECTRONICS CORP., 11-11 131st St., College Point 56, N. Y. The L-T series transistorized power supplies feature convection cooling. They are designed to operate at maximum rating of 50 C ambient temperature without internal blowers or other moving parts. First two models in the series, LT2095 and LT2095M (metered), are priced at \$365 and \$395, respectively. Ranges are 0-32 v d-c, 0-2 amperes. Input rating is 105-125 v a-c at 50-400 cps. Circle 309 on Reader Service Card.



Pressure Transducer good repeatability

DATRAN ELECTRONICS, 1836 Rosecrans Ave., Manhattan Beach, Calif. A new pressure to frequency transducer is completely self-contained with only d-c current required as input power. The basic pressure sensing is accomplished by a variable inductance a-c transducer, the transducer coil being

The most miniaturized tuning capacitor in the broadcast range



ERIE Ceramicon®
Dual-Tuning
Capacitor

produced
for

PHILCO

by
ERIE



ERIE achieves a new standard in miniaturization for transistor radios with the new ERIE Ceramicon Dual-Tuning Capacitor.

It is a time proven ERIE Ceramicon Trimmer Capacitor, designed to be used as a dual section tuning device.

The ERIE Ceramicon Dual-Tuning Capacitor has a minimum expected life of 25,000 tuning cycles of 180° for each cycle. The range of capacitance adjustment is greater than 9 to 1.

The tuning control, which provides precise tracking through a mechanical coupling arrangement, is comprised of two interlocking parts, custom molded by ERIE Plastics Division. The completely packaged station selector is assembled by ERIE for quick, easy installation.

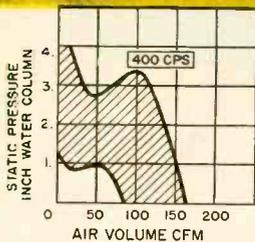
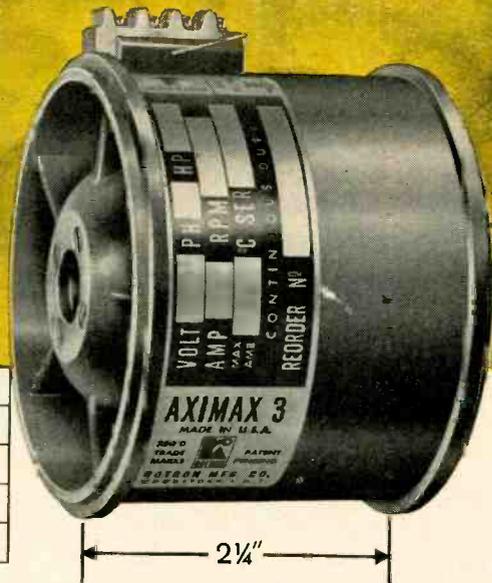
The ERIE Dual-Tuning Capacitor is a result of close cooperation between the customer and ERIE engineers. Consult with ERIE for further miniaturization in your transistor radios. Write for additional information.



For 400 CPS Cooling Applications



AXIMAX-3



For airborne and missile cooling applications, the AXIMAX-3 when turning at 20,000 rpm will deliver 165 cfm at free delivery. This performance is possible although the fan is only 2.8" in diameter, 2.3" in length and weighs a mere 14 ounces.

Variation in driving motors include constant speed and Altivar designs. The latter automatically vary their speeds inversely with density and thereby approach constant cooling with a minimum of power drain and noise.

Mounting is simplified by the provision of "servo" clamping rims at either end of the barrel. Airflow can be reversed by turning the fan end-for-end. Electrical connection is made to a compact terminal block. Power requirement is 400 cps, 1 or 3 phase.

Write today for complete technical details to . . .



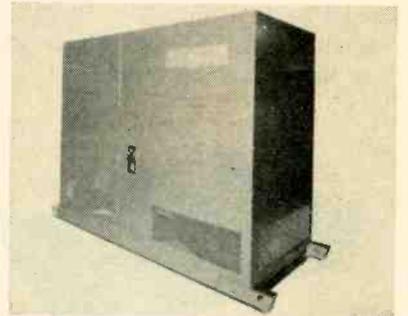
ROTRON

mfg. co., inc.

WOODSTOCK, NEW YORK

In Canada: The Hoover Co., Ltd., Hamilton, Ont.

part of an integral oscillator tank circuit. The instrument therefore has infinite resolution and provides repeatability of 1 percent or better. Unit measures 1½ in. in diameter by 3¼ in. long and weighs 8½ oz. Circle 310 on Reader Service Card.



Silicon Power Supply heavy duty unit

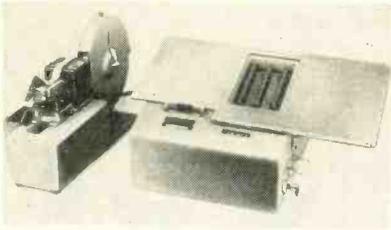
PERKIN ENGINEERING CORP., 345 Kansas St., El Segundo, Calif. A new heavy duty silicon rectifier type d-c power supply has an output of 75 to 750 v at 200 kw. Regulation accuracy is 1 percent and ripple 2 percent rms. The unit is controlled remotely by a self saturating magnetic power amplifier which permits smooth continuous adjustment between 75 and 750 v. Complete description is given in bulletin MS708 available on letterhead request.



Power Supplies transistorized

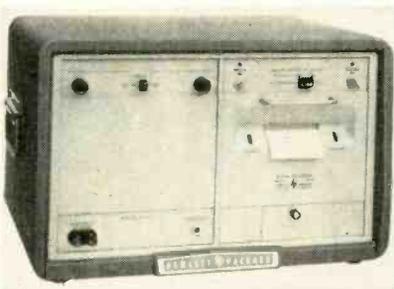
ELECTRONIC MEASUREMENTS CO., Inc., Eatontown, N. J. A new series of transistorized power supplies feature three-way short circuit protection, including a high-speed, all-electronic circuit breaker. Additional features are remote control and remote sensing. The remote sensing provision eliminates voltage changes at the load due to voltage drops in the leads. This

feature is of special value when leads are long or the load draws high currents. Regulation is 0.1 percent or 0.01 v for extremes of line and load. Ripple is less than 0.001 v. Circle 311 on Reader Service Card.



Data Processor desk-top type

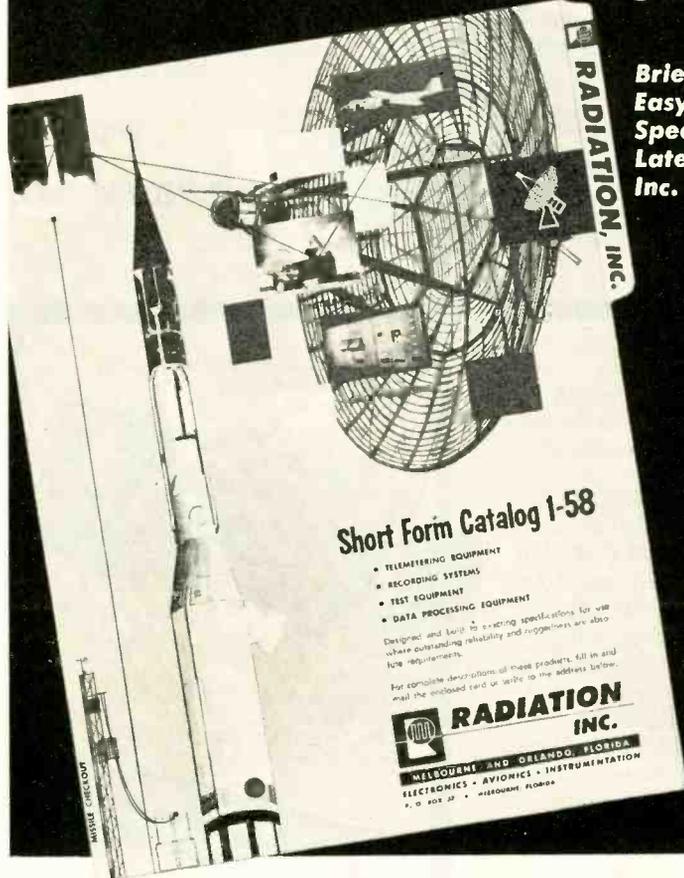
TALLER & COOPER INC., 75 Front St., Brooklyn 1, N. Y. A new data processor for use with tabulating equipment and systems, and computers, cuts tabulating card files by 50 percent and increases productivity by 100 percent. The device accepts fixed data from tabulating or edge-punched cards and variable data through its simple keyboard. The two data inputs are automatically combined and punched out on tape. The tape output can be fed directly to a computer, or to a tape-to-card converter for use in tabulating machines and systems. Circle 312 on Reader Service Card.



Digital Recorder 11 column entry

HEWLETT-PACKARD CO., 275 Page Mill Road, Palo Alto, Calif. Model 560A digital recorder prints 11 column digital information at rates to five prints per sec. Although primarily designed to make a permanent record of electronic counter read-outs, it can be used with two or more counters simultaneously, digital voltmeters, time recorders,

NOW AVAILABLE! new RADIATION, INC. Short Form Catalog 1-58



Brief,
Easy-to-Read
Specifications on
Latest Radiation,
Inc. Equipment

SEND FOR
YOUR COPY
TODAY!

- TELEMETERING EQUIPMENT • RECORDING SYSTEMS
- TEST EQUIPMENT • DATA PROCESSING EQUIPMENT

Designed and built to exacting specifications for use where outstanding reliability and ruggedness are absolute requirements.

Use coupon below to send for your Radiation, Inc. Short Form Catalog 1-58 and to receive future mailings.



Personnel
Inquiries
Invited

RADIATION, INC.
P. O. BOX 37, MELBOURNE, FLORIDA EL9

Send Catalog Send me future bulletins

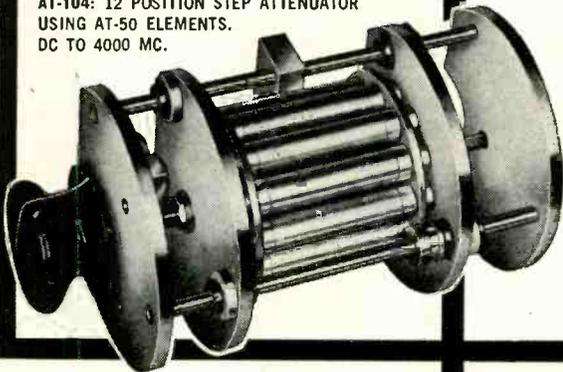
NAME _____ TITLE _____

COMPANY _____ ADDRESS _____

CITY _____ STATE _____

WHATEVER YOUR UHF ATTENUATION NEEDS...

AT-104: 12 POSITION STEP ATTENUATOR USING AT-50 ELEMENTS. DC TO 4000 MC.



**A COAXIAL UNIT FROM
EMPIRE DEVICES
WILL MEET
YOUR REQUIREMENTS**

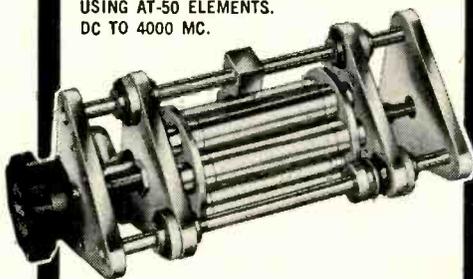
Empire's UHF attenuators are resistive coaxial networks for the frequency range from DC to 4000 MC.

Accuracy is held to $\pm 1/2$ DB, VSWR is better than 1.2 to 1. Any attenuation values up to 60 DB (120 DB for Model AT-106), are available. Deposited carbon elements are used for stability and operations at higher pulse levels. Standard impedance is 50 ohms, other values upon request. These units have excellent temperature characteristics and are vibration and shock resistant. Standard connectors are type "N", attenuator pads are also available with type "C".

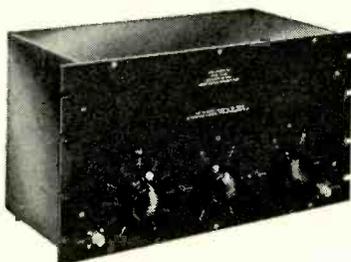
The attenuators may be obtained as individual pads (AT-50, AT-60), or as multi-position step attenuators AT-103 (six positions) and AT-104 (twelve positions). For even greater flexibility, Attenuator Panels, Model AT-106 (two or three step attenuators in series connected) are recommended.

For complete technical information about attenuators for your laboratory or production needs, write for free catalog.

AT-103: 6 POSITION STEP ATTENUATOR USING AT-50 ELEMENTS. DC TO 4000 MC.



ATTENUATOR PADS.
DC TO 4000 MC.
AT-50: 1 W AVERAGE, 1 KW PEAK.
AT-60: 2 W AVERAGE, 2 KW PEAK.



AT-106: ATTENUATOR PANEL.
TYPICAL COMBINATION: AT-106H,
0-120 DB IN 1 DB STEPS.

NEW YORK—Mount Vernon 4-7530 • SYRACUSE—Granite 4-7409 • PHILADELPHIA—Sherwood 7-9080 • BOSTON—Twinbrook 4-1955 • WASHINGTON, D. C.—Oliver 4-6400 • ORLANDO, FLA.—Cherry 1-2128 • ATLANTA—Cedar 7-7801 • DETROIT—Broadway 3-2900 • CLEVELAND—Hilcrest 2-8080 • PITTSBURGH—Atlantic 1-9248 • ST. LOUIS—Evergreen 5-7228 • CHICAGO—Esterbrook 9-2700 • MINNEAPOLIS—Federal 5-7172 • DENVER—Main 3-0343 • FT. WORTH—Walnut 6-4444 • ALBUQUERQUE—Albuquerque 5-9632 • LOS ANGELES—Texas 0-7771 • PALO ALTO—Davenport 3-4455 • SEATTLE—Emerson 2-4812 • HAWAII—Honolulu 50-2901 • CANADA: STITTSVILLE, ONT.—Hazeldean 56 • SCARBORO. (TORONTO)—Alminster 3-7806 • EXPORT: NEW YORK—Murray Hill 2-3760

**EMPIRE DEVICES
PRODUCTS CORPORATION
AMSTERDAM, NEW YORK**

Telephone: Victor 2-8400

manufacturers of

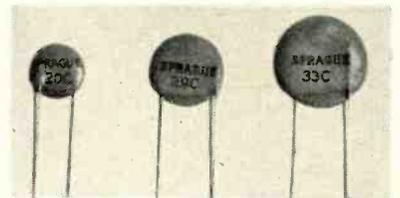
FIELD INTENSITY METERS • DISTORTION ANALYZERS • IMPULSE GENERATORS • COAXIAL ATTENUATORS • CRYSTAL MIXERS

flowmetering equipment and systems, such as telemetering installations and engine test stands. In addition to the printed tape record, model 560A provides an analog current or voltage output to drive a galvanometer or potentiometer strip chart recorder or to provide a servo control. Circle 313 on Reader Service Card.



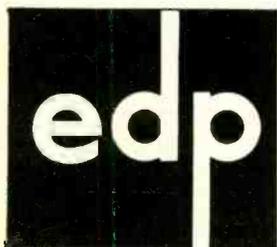
Power Supply transistorized

QUAN-TECH LABORATORIES, Morristown, N. J. Model 104 is a dependable d-c power supply for all applications requiring excellent regulation and low ripple. It is completely transistorized and has a low internal impedance of less than 0.03 ohm, d-c to 10 kc. The three voltage and current ranges are accurately metered. Overload protection is provided for the current meter, with automatic reset. Coarse and fine voltage controls facilitate precision settings. Circle 314 on Reader Service Card.



Ceramic Capacitors for p-c boards

SPRAGUE ELECTRIC Co., North Adams, Mass. Snug-mount Ceramic capacitors are designed so that there is no coating material on the leads below the final encapsulation. Since the final coating is always a minimum of 1/32 in. above the bottom tangent line of the disk, these capacitors can be used on two-sided or plated-through boards. At the same time, this technique



Get out your pencil and . . .

Help yourself to

electronics' READER SERVICE

it's free—it's easy—it's for your convenience

Each Advertisement and New Product item is numbered.

For more information, simply . . .

- (1) Circle number on postpaid card below that corresponds to number at the bottom of Advertisement, or New Product item.
- (2) Print your name, title, address, and firm name carefully.
It is impossible to process cards that are not readable.

* FOR SPECIFIC ITEMS IN MULTI-PRODUCT ADVERTISEMENT

Certain multi-product advertisements contain Reader Service numbers for each product.

For multi-product advertisements that are not keyed for Reader Service, indicate in box on postcard marked with asterisk (*) ad circle number(s) and specific product(s) on which you want more information.

Additional postage MUST be added to cards for all FOREIGN MAILINGS

An occasional Advertisement cannot be numbered for the READER SERVICE CARD due to lack of space and must be indicated by writing the Advertisers' name in the space at the bottom of the card...



SEPT 26·58

CARD EXPIRES
NOV 26.58

electronics • ENGINEERING EDITION • READER SERVICE CARD

(NAME) _____ (POSITION) _____

(COMPANY) _____ (ADDRESS) _____

CIRCLE THESE NUMBERS ONLY WHEN YOU ARE INTERESTED IN ALL ITEMS SHOWN OR DESCRIBED

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114
115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133
134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152
153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171
172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190
191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209
210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228
229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247
248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266
267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285
286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304
305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323
324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342
343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361
362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380
381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399
400	401																	

INSIDE FRONT COVER

INSIDE BACK COVER

Circle No.	Product	*

SEPT 26·58

CARD EXPIRES
NOV 26.58

electronics • ENGINEERING EDITION • READER SERVICE CARD

(NAME) _____ (POSITION) _____

(COMPANY) _____ (ADDRESS) _____

CIRCLE THESE NUMBERS ONLY WHEN YOU ARE INTERESTED IN ALL ITEMS SHOWN OR DESCRIBED

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114
115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133
134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152
153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171
172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190
191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209
210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228
229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247
248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266
267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285
286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304
305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323
324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342
343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361
362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380
381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399
400	401																	

INSIDE FRONT COVER

INS-DE BACK COVER

Circle No.	Product	*

An occasional Advertisement cannot be numbered for the READER SERVICE CARD due to lack of space and must be indicated by writing the Advertisers' name in the space at the bottom of the card...



MEMO:

NEW PRODUCTS RELEASES

TO: ALL MANUFACTURERS

FROM: electronics

electronics publishes all new product items of interest to makers and users of electronic and allied equipment.

The reverse side of this card provides a service to subscribers by facilitating the flow of additional information between manufacturers and our readers.

Take advantage of Reader Service--and the readership of electronics...keep the industry informed about your New Products and New Literature via their mention in the editorial pages of electronics.

FIRST CLASS
PERMIT NO. 64
(SEC. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

6¢ Postage Will Be Paid By

ELECTRONICS
Reader Service Dept.
330 West 42nd Street
New York 36, N. Y.

FIRST CLASS
PERMIT NO. 64
(SEC. 34.9 P.L.&R.)
NEW YORK, N. Y.

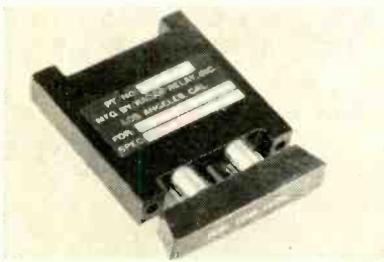
BUSINESS REPLY CARD

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

6¢ Postage Will Be Paid By

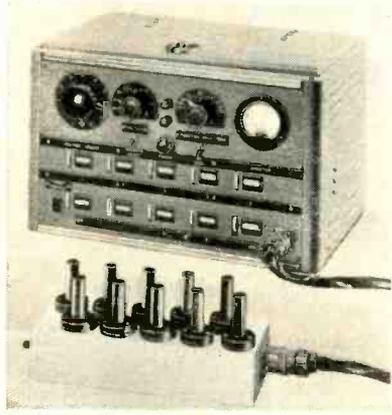
ELECTRONICS
Reader Service Dept.
330 West 42nd Street
New York 36, N. Y.

avoids lead breakage under severe mechanical vibration which has occurred with the hooked-lead capacitors used on printed wiring boards. Snug-mount Ceramites do not have any exposed electrode or ceramic. Circle 315 on Reader Service Card.



Lighted Push-Bar magnetic hold-in

RADAR RELAYS, INC., 2120 Pontius Ave., Los Angeles 25, Calif., has developed a lighted-nomenclature push-bar with magnetic hold-in provisions. When lamps in the switch are lighted, they may be de-energized by depressing the bar which is then held in position magnetically. The bar returns to its original position by spring action when the circuit is de-energized. The magnetic hold-in provision may be manually overridden if desired. Circle 316 on Reader Service Card.

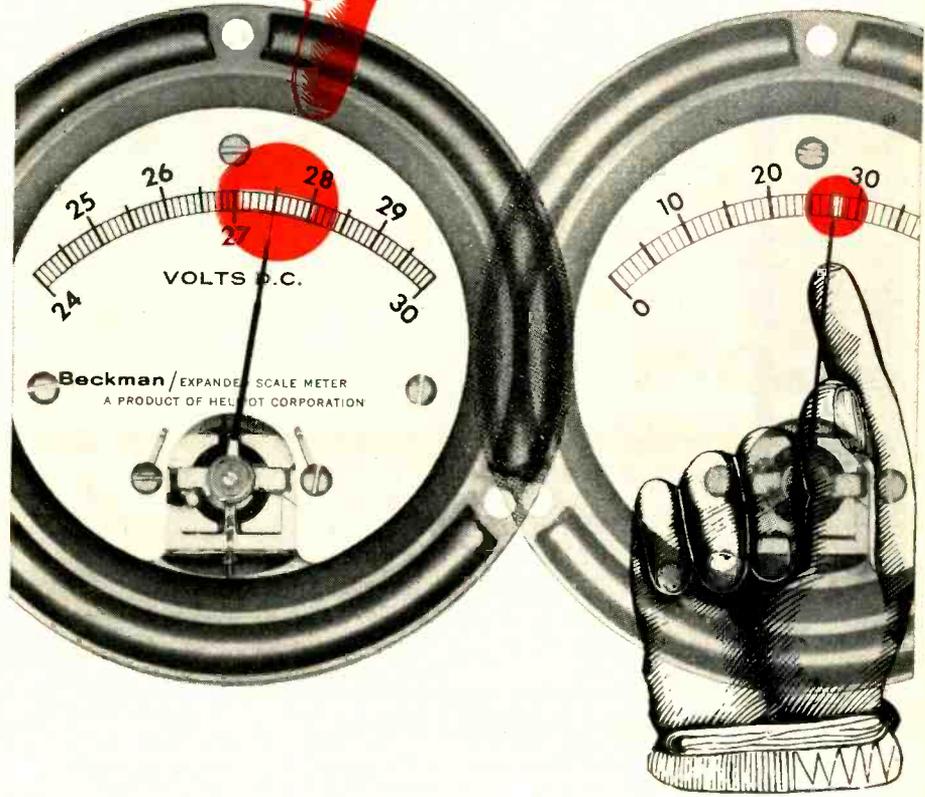


Test Set for timing relays

G-V CONTROLS INC., Hollywood Plaza, East Orange, N. J. A timing relay test set testing up to ten relays simultaneously is designed for users who make receiving inspection or lab tests in moderate



Here's a volt!



Here's a volt?

Two ways to look at voltage — only one way to read it accurately, *to the fraction!* When volt-splitting is vital, you need a BECKMAN Expanded Scale Voltmeter.

Why expanded? To make accuracy meaningful. Look at the BECKMAN meter above. It's accurate to ± 0.16 volt! And you can *read* it, easily, to 0.05 volt... because resolution of the expanded scale is ten times that of its conventional competitor.

Choose from 126 standard models... AC or DC... commercial or ruggedized... in a variety of shapes, sizes and voltage ranges. Need color coding, special ranges, assemblies? Yours for the asking. *Send for data file A 94.*

Beckman

Helipot

Helipot Corporation, Newport Beach, California
a division of Beckman Instruments, Inc.
Engineering representatives in 27 cities

potentiometers... dials... delay lines... expanded scale
meters... rotating components... breadboard parts

W A N T E D

at
**Bendix-
Pacific**
in Southern California

**MISSILE GUIDANCE
ENGINEERS**

**AIRBORNE RADAR
ENGINEERS**

TELEMETERING ENGINEERS

**SONAR &
ANTI-SUBMARINE
WARFARE ENGINEERS**

**MARINE HYDRAULIC
ENGINEERS**

There are important positions available in these small, independent engineering groups at Bendix-Pacific for engineers at all levels. Bendix-Pacific is particularly interested in strong, analytical engineers who have the calibre and capabilities to advance into systems engineering programs.

Please write W. C. Walker your qualifications or fill in the coupon and mail it today.

W. C. Walker, Engineering Employ'mt Mgr.
Bendix-Pacific, Bendix Aviation Corp.
11600 Sherman Way, No. Hollywood, Calif.

I am interested in (check one)
 Electrical Mechanical Engineering
I am a graduate engineer with _____
_____ degree.

I am not a graduate engineer but have
_____ years experience.

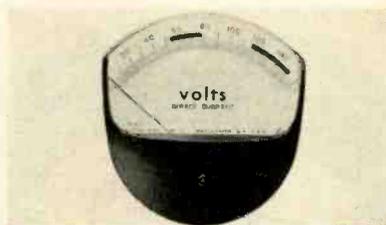
Name _____

Address _____

City _____

Zone _____ State _____

or high volume. Tests of normal operate time, saturate release time, or release time after predetermined heating can be made on either normally open or normally closed timing relays. The test, once started, proceeds automatically and the operator is released for other duties. Circle 317 on Reader Service Card.



Panel Meter antiparallax scale

MARION ELECTRICAL INSTRUMENT Co., Grenier Field, Manchester, N. H. A new antiparallax scale that places dial markings in the same plane as the pointer has been designed for use with the MM-3 3 1/4 in. Medalist meters. The calibrated portion of the scale is raised from the dial face and is in the same plane as the pointer. The pointer tip swings under the scale so that calibration marks, from any angle, appear to be a continuation of the pointer, thereby eliminating any errors due to parallax. Circle 318 on Reader Service Card.



Rectilinear Pot small, compact

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. Series RP-125 miniature trimming pot meets environmental specifications of MIL-R-19. It measures only 1 1/4 in. in length and is available in a complete range of resistances. A multifinger contact brush travels along the wirewound resistance element which is permanently bonded to the card to eliminate loose turns or shifting

CEC CUSTOM & STANDARD Delay Lines

Control Electronics Co. Inc. is a leading designer and mass producer of electromagnetic Delay Lines. A representative group is shown here with the available ranges of delays, bandwidths and impedances. Further information is readily available from our Engineering Dept.

**BUILT TO MIL SPECS. FAST PROTOTYPE
'SERVICE . . . DELIVERY 1 TO 3 WEEKS.**

Distributed Constant Delay Lines



CEC DISTRIBUTED CONSTANT DELAY LINE FEATURES

- Lowest cost — reliable performance
- Maximum delay to rise time ratios
- Maximum delay per cubic inch
- Delays to 30 μ secs.
- Impedances: 200 to 10,000 Ω ,
- Bandwidths to 20 mcs
- Linear phase shift



Variable Delay Lines

Infinite, incremental or decade variable delay lines available in any range of delays and impedances.



Lumped Constant Delay Lines

DELAYS TO 20,000 MICROSECONDS,
BANDWIDTHS to 500 MCS.
Z₀ FROM 50 TO 10,000 OHMS.



Multi-tapped Lumped Constants available in many configurations

System Delay Lines

Complete delay and pulse systems designed to your needs.



NOTE: Data Sheets on request!

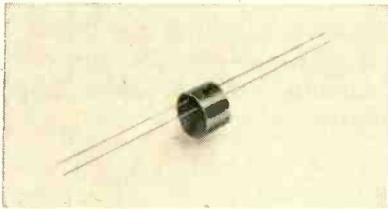


**CONTROL ELECTRONICS
CO., INC.**

10 Stepar Place
Huntington Station, New York

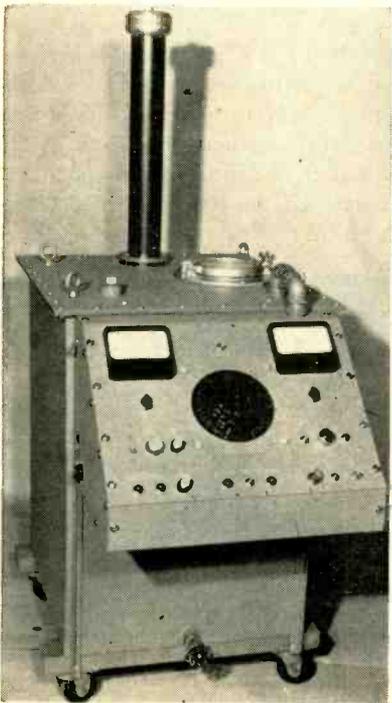
CIRCLE 85 READERS SERVICE CARD

wires. Insulation on wire is removed by a unique process without altering cross-section or winding resistance. Circle 319 on Reader Service Card.



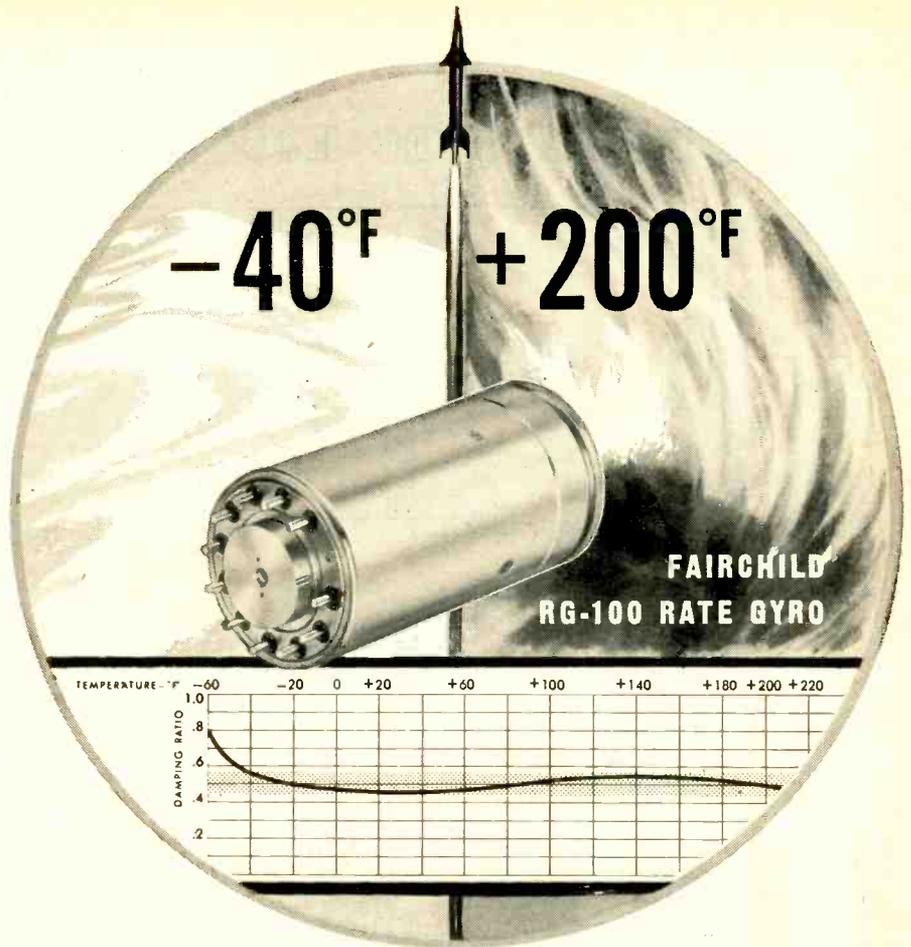
Pulse Transformer miniaturized

ESC CORP., 534 Bergen Blvd., Palisades Park, N. J. A new series of miniature pulse transformers are only $\frac{3}{8}$ in. long with an o.d. of $\frac{1}{2}$ in. They are available as blocking oscillator pulse transformers covering a range of pulse widths from 0.05 μ sec to 2.0 μ sec, and pulse coupling transformers covering a wide range of impedance ratios and pulse widths. Circle 320 on Reader Service Card.



Insulation Tester completely mobile

PESCHEL ELECTRONICS, INC., R.F.D. No. 1, Patterson, N. Y., announces a 120 kv high voltage d-c test set, a completely mobile one



Fairchild's Sub-Miniature Rate Gyro Has FULLY CONTROLLED DAMPING

Only Fairchild's Rate Gyro—has uniform, constant damping for any required percentage of critical within $\pm 15\%$ and over the entire operating temperature range of -40° to $+200^\circ$ F. This is accomplished by varying the damping area, using the damping medium as a sensing device which varies with temperature changes.

TAKES 100 g's OF SHOCK

Only Fairchild's Miniature Rate Gyro takes 100 g's of shock and 15 g's at 2000 cps vibration even at rates as low as 20° per second. This high shock resistance is due in part to Fairchild's exclusive design feature which does not require the torsion bar to act as a supporting medium.

OTHER FAIRCHILD OUTSTANDING CHARACTERISTICS

INPUT RATES (Full Scale)	± 20 to ± 800 degree/second	OUTPUT	6 volts, 400 cps, phase sensitive
SIZE & WEIGHT	15/16" dia. x 2" long — 2 ounces	LINEARITY	0.1% to half scale 3.5% to full scale
MOTOR	2 or 3 phase; 6.3V or 26V AC	NULL	15 to 40 mv total depending upon maximum rate and damping.

Write To Dept. 22E



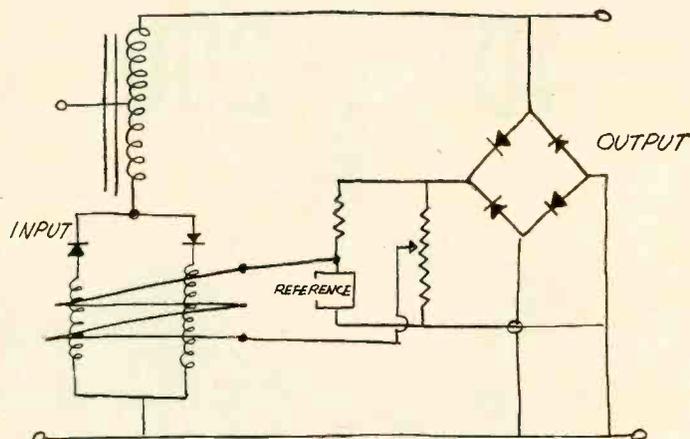
FAIRCHILD
CONTROLS CORPORATION

COMPONENTS DIVISION

225 Park Avenue 6111 E. Wash
Hicksville, L. I., N. Y. Los Angeles

Potentiometers • Gyros • Pressure Transducers • Accelerometers

MEET MIL SPEC E4970



SIMPLIFIED MAGNETIC AMPLIFIER REGULATOR

Meeting military specifications is practically an everyday occurrence at Raytheon. But each one has a special interest.

We thought you might be interested in how a magnetic-amplifier regulator met MIL SPEC E4970. The details are available to the more academically inclined. We will simply relate the results:

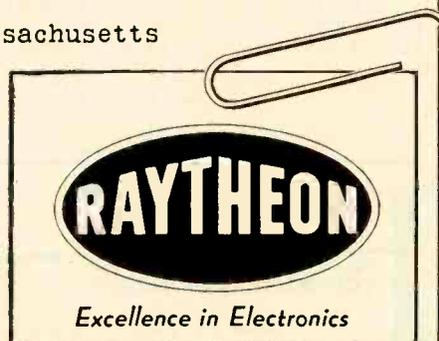
Service:	400 cycles
Power:	900 watts
Input:	95 to 125 volts
Output:	115 volts $\pm 1/2\%$
Harmonic distortion:	$\pm 3\%$

The next time you have to meet military or your own rigid specifications, we'll be happy to go along.

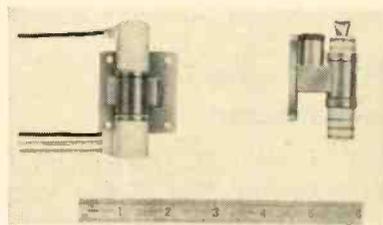


Our slide rule and tuxedo are ready at a moment's notice. Simply contact:

VOLTAGE REGULATOR MAN
Raytheon Manufacturing Company
Magnetic Components Department
Section 6120
Waltham 54, Massachusetts

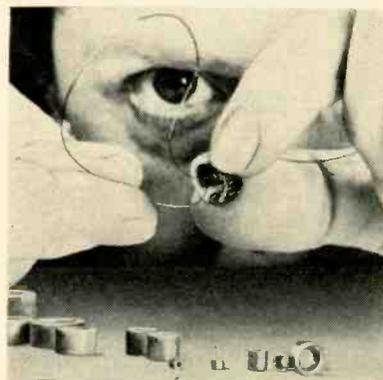


piece unit which can be rolled to the job, for lab or production dielectric testing of insulation on large motors, generators, transformers, bushings, cable. It is used for nondestructive evaluation of insulation quality—for quantitative tests to determine nature and degree of fault and possible life expectancy of insulation. **Circle 321 on Reader Service Card.**



Reflex Klystrons for X and K band

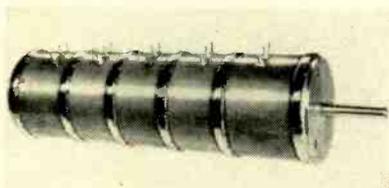
EITEL-McCULLOUGH, Inc., San Bruno, Calif. The 1K20 series of ceramic-metal X-and K-band reflex klystrons consists of four light-weight, ruggedized tubes that cover the 8,500 to 11,700 mc range at output power levels to 50 mw. They will withstand vibration levels of 15 g in any reference plane, with less than 100 kc frequency deviation. Rated for use at any altitude they are conservatively rated at + 250 C seal temperature. **Circle 322 on Reader Service Card.**



Bobbin Cores new type cap

MAGNETICS, INC., Butler, Pa., has available tape wound bobbin cores capped with a tough glass polyester which offers complete core protection. "Poly Cap" bobbin cores offer economies in handling and pro-

duction since the rigid structure of the cap, which will not distort with temperature changes, allows complete freedom of handling on the assembly line without the use of tweezers or special tools. High permeability, along with the small core's ability to switch from positive to negative saturation in a very few microseconds, makes the cores highly suitable for use in pulse applications in electronic computers. Circle 323 on Reader Service Card.



Precision Pot low-capacitance

PRECISION LINE INC., 63 Main St., Mavhard, Mass. Model RP20 precision pot has been designed especially to reduce the element-to-ground and element-to-element capacitance to the minimum. Isolation of the slip ring and resistance winding by design and the use of phenolics where metal is normally used has resulted in interelement capacitance and capacitance-to-ground of approximately 11 $\mu\mu\text{f}$ with low inductance. The pot is available in linear and 3 to 1 taper and resistance to 100,000 ohms. It may be ganged up to 5 units. Circle 324 on Reader Service Card.



Moisture Monitor 0-20,000 ppm range

CONSOLIDATED ELECTRODYNAMICS CORP., 300 N. Sierra Madre Villa, Pasadena, Calif. Type 26-302 moisture monitor will measure water content accurately down to 10 ppm full-scale and permit precise

PROJECT:

QUALITY CONTROL

TARGET:

EVEN BETTER PERFORMANCE!

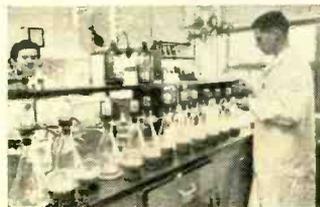


RESISTANCE ALLOYS

Wilbur B. Driver
Precision
RESISTANCE ALLOYS



Experimental Vacuum Melting Furnace



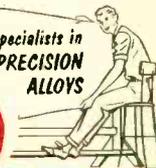
Chemical Laboratory

Better Performance — on every electrical and electronic application because... from ingot to final inspection, every test known to science safeguards the quality of Wilbur B. Driver Precision Alloys. These tests assure performance as specified! Why not consult a Wilbur B. Driver sales engineer for recommendations on precision alloys for your applications.

Wilbur B. Driver Co.
NEWARK 4, NEW JERSEY



Specialists in
PRECISION ALLOYS



marion
 advancement
 in instrument
 design



**VERSATILE
 MULTI-RANGE
 METER TESTER**

Model M-2

... POWER SUPPLY ... LIMIT BRIDGE

Precise, self-contained unit for laboratory and production use. For DC instrument calibration from 25 ua full scale to 10 ma full scale, and 0-100 VDC; sensitivity and resistance measurement; DC current-voltage source; limit or bridge measurements from 0-5000 ohms. Regulated power supply. Stepless vacuum tube voltage control. Accuracy exceeds 1/4% (current), 1/2 ohm or 1/2% (resistance). For 115V, 60 cycle AC. Complete — needs no accessories. Bulletin on request. Marion Electrical Instrument Co., Manchester, N. H., U. S. A.

Copyright © 1958, Marion
 U. S. Patent 2,740,093

marion
 "WHERE ELECTRONICS MEETS THE EYE"
meters



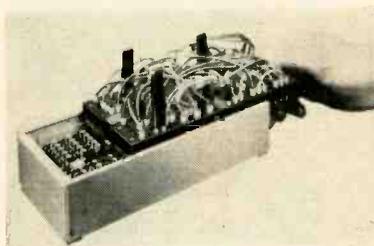
CIRCLE 89 READERS SERVICE CARD

meter readings over the range of 0-20,000 ppm, by means of a 6-position attenuator. The output of the analyzer can be telemetered to a remote recorder for monitoring or control. The new instrument can help solve many problems in research, quality control, and process efficiency studies. Circle 325 on Reader Service Card.



**Electric Counter
 with six digits**

GENERAL CONTROLS CO., 8070 McCormick Blvd., Skokie, Ill. Two hundred million count life, full wave rectification for a-c operation and complete dustproof enclosure are featured in the new CE-800 electric counter. A built-in silicone diode full wave bridge rectifier with capacitor makes possible maximum reliability and service life through all a-c voltages to 230 with 25, 40 and 60 cycle frequencies. Rated at 1,000 counts per minute, the new Wizard operates reliably at much higher speeds with electronic actuation. Circle 326 on Reader Service Card.



**Programming System
 light-weight**

AMP Inc., Harrisburg, Pa., has released a new light-weight patchcord programming system designed for split second reprogramming of air-

work in the fields of the future at NAA



**ELECTRONICS
 ENGINEERS**

Work on America's most advanced weapon systems

The WS-110A and WS-202A are typical of the top-level projects currently under way at North American. NAA's work on these far-advanced weapon systems has created outstanding career opportunities for engineers qualified in Flight Control Analysis, Reliability Analysis, Flight Simulation, and Systems Analysis.

We have immediate openings in applied research on radome development, antenna development, infrared, and acoustics.

Minimum requirements are actual experience plus B.S. and advanced degrees in E.E. and Physics.

For more information please write to: Mr. F. J. Stevenson, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF

**NORTH
 AMERICAN
 AVIATION, INC.**



WEINSCHEL

**PRECISION
 10 WATT POWER
 PADS**



**50 OHM
 IMPEDANCE**

**DC to 1 KMC
 FREQUENCY RANGE**

**1 to 10 DB
 ATTENUATION**

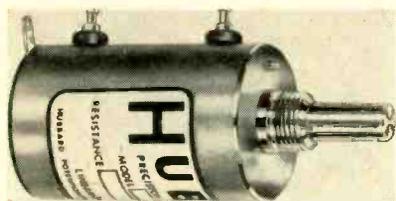
Connectors: "N"
 Model 10: bilateral.
 Model 11: female input.
 Model 12: male input.

- Maximum Input VSWR. 1.15.
- Resistors: Artificially aged.
- Maximum Deviation of Insertion Loss from Nominal: ±0.2 DB (includes frequency sensitivity and DC inaccuracy).
- Calibration Frequencies: DC; 400 MC; 750 MC; 1000 MC.

**Weinschel Engineering
 KENSINGTON, MARYLAND**

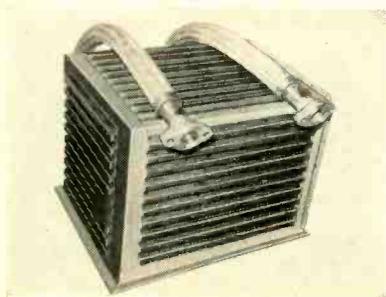
CIRCLE 90 READERS SERVICE CARD

borne circuitry. The A-MP240 weighs 3¼ lb and is miniaturized to conserve space. Removable, pre-patched boards make complete circuitry reprogramming possible in a matter of seconds. Seating of patchcord pins are designed for shock resistance. Patented wiping action assures pre-cleaning of contact springs and taper pins. Circle 327 on Reader Service Card.



Miniature Pot 15-turn unit

HUB-POT INC., 1242 E. Transit St., Pomona, Calif. Model HP-151 15-turn miniature pot is 1 in. in diameter with a case 1 39/64 in. long and with a 1/8 in. or 1/4 in. slotted shaft that is 11/16 in. long. It features low torque and better resolutions. Standard resistance values are from 50 ohms to 150 K ohms. Unit will dissipate 4 w at 40 C and will perform perfectly under shock, vibration, acceleration and temperatures, from -65 to +85 C. Circle 328 on Reader Service Card.



Heat Exchangers high capacity

TENNEY ENGINEERING, INC., 1090 Springfield Rd., Union, N. J., has developed a new line of high capacity heat transfer surfaces. They are designed to operate under reduced pressure with a high degree of heat exchange for cooling and heating purposes. Units are

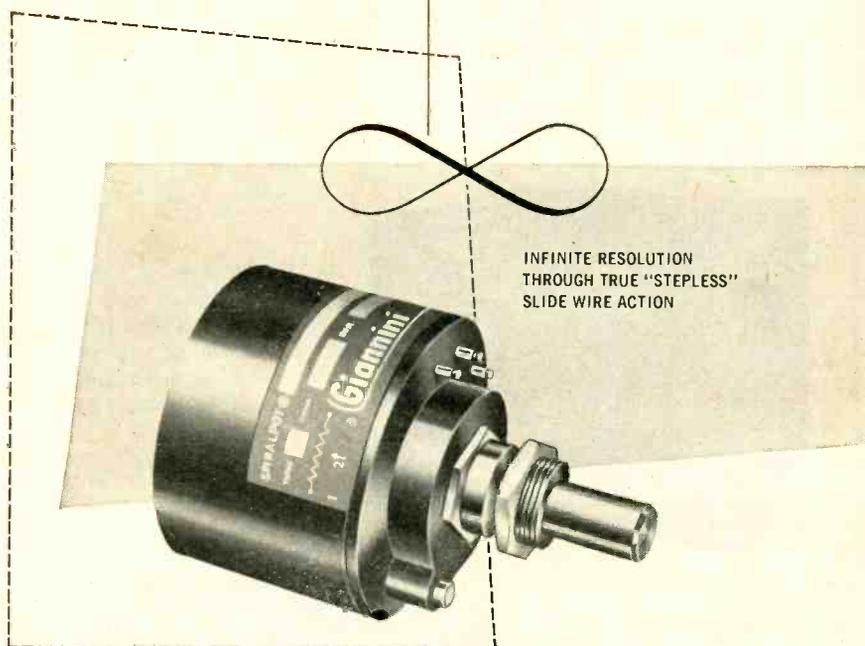
INFINITE RESOLUTION SPIRALPOT®

IMMEDIATE DELIVERY

± 0.1% Linearity

10 TURNS

1,000 OHMS



INFINITE RESOLUTION
THROUGH TRUE "STEPLESS"
SLIDE WIRE ACTION

Quantity production now makes the popular 10 turn 1000 ohm Model 85175 Spiralpot available for immediate delivery.

Designed to eliminate hunting in sensitive servo systems, the Spiralpot finds many applications where infinite resolution and precise linearity are required. Only 1.5 inches in length and 1.5 inches in diameter, this rugged instrument mounts identical to wire-wound types and can be used as a direct replacement in many cases. Low inductance and capacitance effects make it ideal for AC as well as DC applications.

Standard 85175 Spiralpots are available in three or ten turn models with resistance ranges from 50 to 250 ohms per turn. For special applications, the unit can be supplied with resistance ranges as low as two ohms per turn and linearity to ±0.05%. Other Spiralpot models are available with synchro mounting, in resistance ranges to 625 ohms per turn, and for use at elevated temperatures.

For complete information on these versatile infinite resolution potentiometers, write for Spiralpot Bulletins.



NEW JERSEY DIVISION

G. M. GIANNINI & CO., INC. • PASADENA, CALIFORNIA

MARCONI

TEST SETS FOR MOBILE RADIO TESTING

Designed for precision performance in

- * Receiver alignment
- * Signal-to-noise measurement
- * Discriminator testing
- * Checking rf and audio outputs
- * Deviation measurement

... All you need for fast field testing of fm transmitters and receivers is here in these two complementary instruments, tailored for mobile radio measurements.



The 1064/2 provides high-grade fm outputs in the ranges 30 to 50, 118 to 185, and 450 to 470 mc; crystal-controlled i-f outputs at five spot frequencies; and a 1 kc af output.

The 1065 has an rf power meter and 0-15 kc deviation indicator for use up to 500 mc; a dual-impedance af power meter; and a multi-range volt/ammeter.



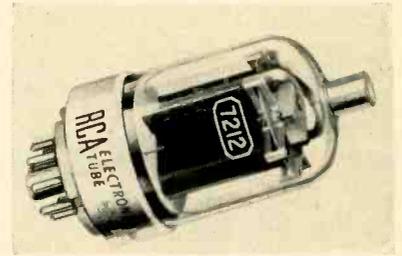
Each is lightweight, portable, and quality-engineered throughout. Tubes and crystals are all American types. Send for leaflet B117/B.

MARCONI INSTRUMENTS

*Marconi
for f.m.
test gear*

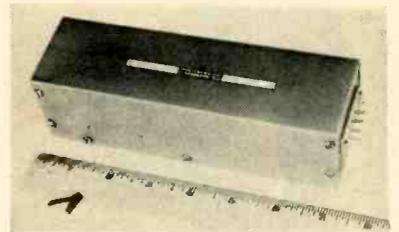
111 CEDAR LANE • ENGLEWOOD • NEW JERSEY • Tel: LOwell 7-0607
CANADA: CANADIAN MARCONI CO • 6035 COTE DE LIESSE • MONTREAL 9
MARCONI INSTRUMENTS LTD • ST. ALBANS • HERTS • ENGLAND

expected to find increased utility in a wide range of industrial and military applications as oil and fuel coolers, air to air exchangers, liquid to air exchangers, liquid to liquid exchangers, saturated vapor to air exchangers, and as evaporators and condensers for compartment cooling. Circle 329 on Reader Service Card.



Beam Power Tube small in size

RADIO CORP. OF AMERICA, Harrison, N. J. The 7212 is a small beam power tube designed specifically for applications where dependable performance under severe shock and vibration is essential. It is useful as an r-f power amplifier as well as an a-f power amplifier and modulator. Maximum plate dissipation is 25 w under ICAS conditions in modulator service and in c-w service. In the latter service, it can be operated with full input to 60 mc and with reduced input to 175 mc. Circle 330 on Reader Service Card.



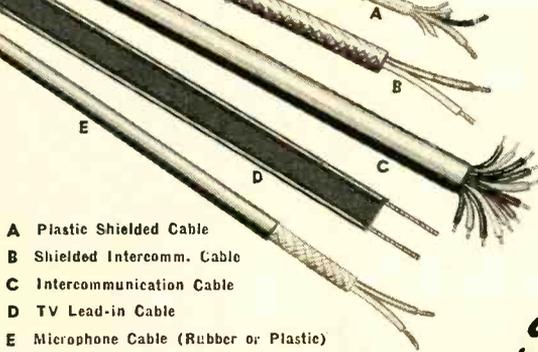
Power Supply high temperature

THE DAVEN CO., Livingston, N. J., has developed a new high-temperature, regulated transistor power supply, series 60A, for missile and aircraft applications. Units have been proven during lengthy test procedures ideally suited to provide the power required for highly sensitive command, guidance and

for Engineers"

CORNISH

"Made by Engineers



- A Plastic Shielded Cable
- B Shielded Intercomm. Cable
- C Intercommunication Cable
- D TV Lead-in Cable
- E Microphone Cable (Rubber or Plastic)

*Wires
and
Cables*

*Since the
Infancy
of Radio*

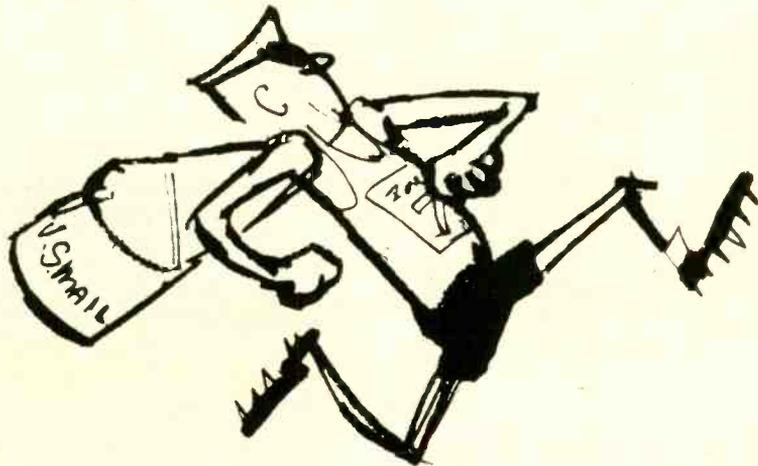
As the fabulous Electronics industry advances, CORNISH Wires and Cables stride along in cadence. For superior electrical characteristics, brute stamina and all-around satisfaction — be SURE — specify CORNISH. We welcome inquiries

CORNISH WIRE CO., INC. 50 Church St., New York 7, N. Y.

REPRESENTATIVES

- | | | | | |
|---------------|---------------|-----------------|--------------|----------------|
| ◆ ATLANTA | ◆ BRIDGEPORT | ◆ CHARLOTTE | ◆ CHICAGO | ◆ CINCINNATI |
| ◆ CLEVELAND | ◆ DALLAS | ◆ DENVER | ◆ DETROIT | ◆ KANSAS CITY |
| ◆ LOS ANGELES | ◆ MINNEAPOLIS | ◆ PHILADELPHIA | ◆ PITTSBURGH | |
| ◆ ROCHESTER | ◆ ST. LOUIS | ◆ SAN FRANCISCO | ◆ SEATTLE | ◆ WILLIAMSTOWN |
- ◆ Stock carried

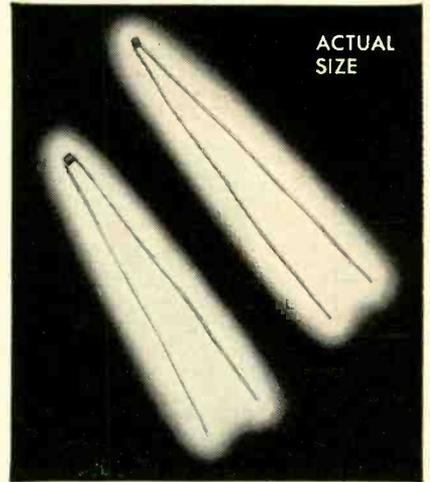
CIRCLE 94 READERS SERVICE CARD



**after the city, before the state
the ZONE keeps your mail from being late**

The Post Office has divided 106 cities into postal delivery zones to speed mail delivery. Be sure to include zone number when writing to these cities; be sure to include *your* zone number in *your* return address — after the city, before the state.

NEW GENERAL ELECTRIC BEAD SIZE THERMISTORS



ACTUAL
SIZE

New G-E "Bead Size" Thermistors —
D-054 (1000 ohms at 25° C) and
D-051 (20,000 ohms at 25° C)

**BETTER TOLERANCES
... FOR LESS COST**

G.E.'s new "bead size" D-050 series thermistors are available with resistances from 1,000-20,000 ohms at 25° C. These .05-inch diameter disc thermistors provide lower thermal time constants and are available for 250° C maximum operating temperature (standard, 150° C). You can buy them economically with resistance tolerances of only $\pm 5\%$ (standard, $\pm 10\%$).

NEW THERMISTOR MATERIALS

Extensive research has added many new thermistor materials to the G-E line. These can now be used in a wide variety of design applications not previously covered by grade 1 and 2 materials.

COMPLETE RESISTANCE RANGE

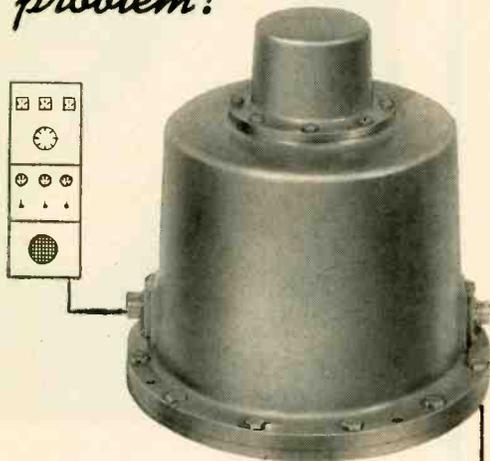
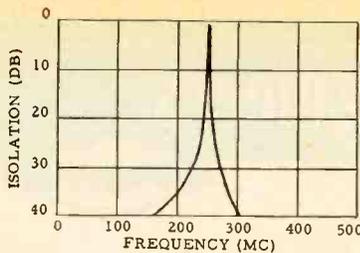
G-E thermistors can be supplied in sizes from .05 up to 3 inches with resistance values from 1 to 10,000,000 ohms, and temperature coefficients of resistance from -1% to -5% at 25° C. For more technical information or the assistance of a G-E engineer, write: *Magnetic Materials Section, General Electric Company, 7806 N. Neff Blvd., Edmore, Michigan.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 96 READERS SERVICE CARD

*Will this solve
your UHF interference
problem?*



TUNABLE UHF CAVITY FILTER

Model 310

FREQUENCY: 200-420 Mc.
POWER: 300 watts C.W.
INSERTION LOSS: Approx. 0.5 db
"Q" FACTOR: Approx. 150
VSWR: 1.3 (in 50 ohm system)
SIZE: 9½" dia. x 9" high
PRICE: \$475 (quantity prices on request)

**TUNABLE 200-420 MC
300 WATT RATING**

The Model 310 Tunable UHF Filter is a cast aluminum cavity, silver-plated for low loss and pressure-tight to prevent the entrance of moisture and dust.

Special units are available with narrower passbands and for other frequency ranges. Also available are dual units which comprise two model 310's in cascade. These dual units have a much steeper cut-off characteristic for a given bandwidth. Write for technical data.

- REDUCE INTERFERENCE between adjacent transmitter-receivers operating in same location.
- PROVIDE PRESELECTION for receivers. Reduce images and other spurious responses.
- REDUCE HARMONIC RADIATION from transmitters. (40 db typical for second harmonic)
- MULTIPLEX several receivers or transmitters into a common antenna.

RF POWER DIVIDERS

The 150 and 300 series broadband RF power Dividers are rated at 500 watts and cover either 100-200 or 200-400 Mc range. Standard units are available to split power into 3, 4, 5, 6, 7, 8, 9, 10, 11 or 12 parallel outputs. Source mismatch is kept low through the use of three-section matching transformer within the divider. Units are sealed and weather-proofed. Write for technical data.

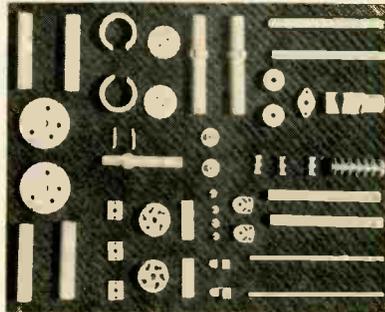


ADAMS-RUSSELL COMPANY, INC.

292 Main Street, Cambridge 42, Mass.

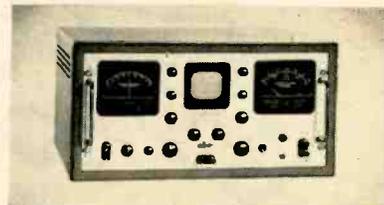
Telephone: UNiversity 8-8040

destruction receivers; or for any other electronic gear. The units permit continuous operation at full load in an ambient temperature of 85 C without heat sink. Circle 331 on Reader Service Card.



Steatite Ceramic low loss

D. M. STEWARD MFG. Co., Chattanooga, Tenn., announces production of a new steatite, S-500 material classed as L-5, Jan Specs 1-10. It is an extremely dense, low loss, steatite ceramic which can be fabricated to close tolerance in pressed or extruded machined shapes. Glazing can be very easily added and grinding facilities are available to achieve tolerances of ± 0.0005 . Circle 332 on Reader Service Card.



Flutter Meter wide-band unit

D&R, LTD., 402 E. Gutierrez St., Santa Barbara, Calif. Model FL-4B wideband flutter meter is designed for precision measurement of flutter and wow components on high speed tape transports. Features include improved linearity, input band-pass filters, built in oscilloscope for visual flutter presentation, internal band-pass filters, drift and rms flutter meters, and provisions for external recording of flutter information. Circle 333 on Reader Service Card.

TOUGH
and tiny

save SPACE
and WEIGHT with
The **A. W. HAYDON COMPANY'S**
Unique Line



**RELIABLE SUB-MINIATURE
TIME DELAY RELAYS**

TINY!
1 x 2 inch cross section
7 1/2 ounce basic weight

TOUGH!
Temperature: -54° C. to 85° C.
Vibration: 500 CPS, 10g
Shock: 30g
Hermetically Sealed Housings!
Direct Current or 400 Cycle Operation!
Standard or Reverse Clutching!
Custom Designed to Meet Military Specifications!
Write for Bulletin AWH-TD-502.



The **A.W. HAYDON Company**
235 NORTH ELM STREET, WATERBURY 20, CONNECTICUT
Design and Manufacture of Electro-Mechanical Timing Devices

CIRCLE 98 READERS SERVICE CARD

IF THIS IS YOUR PROBLEM

If you need effective, highly readable, smartly illustrated company literature (booklets, pamphlets, manuals) to display your products, inform the public of your operations, attract key personnel to your plant, train employees, and perform any of the other communicative functions that are vital to your business . . .

THIS IS YOUR ANSWER

The McGraw-Hill TECHNICAL WRITING SERVICE has a staff of more than 150 highly-trained writers, editors, and illustration specialists whose job it is to create technical and general literature for industry. We write, illustrate, design, and print Equipment Manuals, Product Bulletins, Handbooks, Company Histories, Annual Reports, and other specialized material. Save money and time. Let our staff be your staff for Technical and Business publications.

This service is available through ad agencies.

Write • Phone
TECHNICAL WRITING SERVICE
McGraw-Hill Book Co., Inc.
330 W. 42nd St., N. Y. 36, N. Y.
LOngacre 4-3000

work in the fields of the future at NAA



ELECTRO- MECHANICAL ELECTRONIC ENGINEERS

A BS or advanced degrees in EE, ME, or Physics, may qualify you for a rewarding career at North American Aviation, in one of these fields:

Flight Control Analysis, Reliability Analysis, Flight Simulation, Systems Analysis.

Electrical Systems Analysis and Design, Mission and Traffic Control, Fire Control, Bombing Systems, Electronics Systems Integration, Flight Controls, Ground Support Equipment, Airborne and Electronic Test Equipment.

Applied Research in Radome Development, Antenna Development, Infrared, and Acoustics.

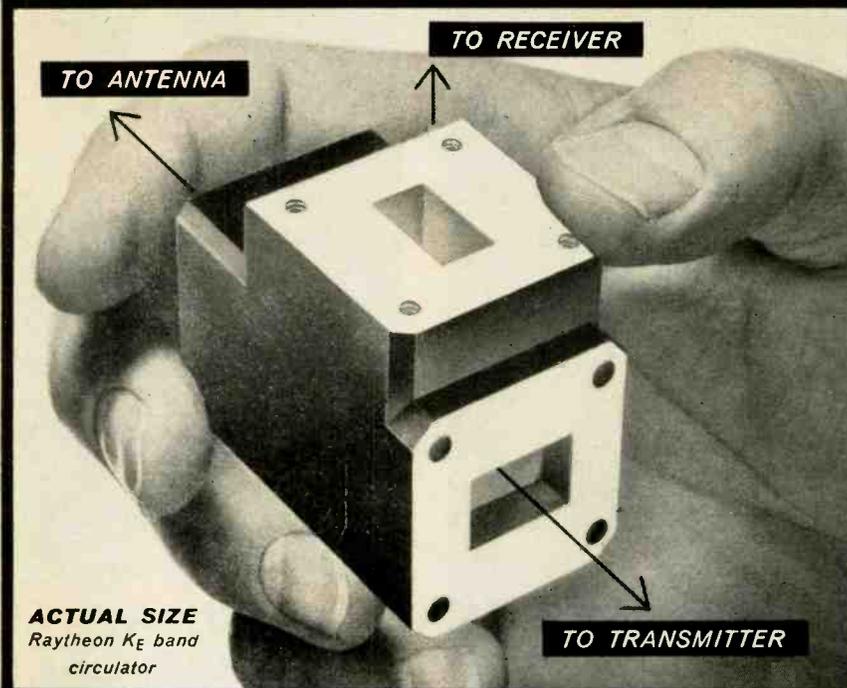
Please write to: Mr. F. J. Stevenson, Engineering Personnel, North American Aviation, Los Angeles 45, California.

THE LOS ANGELES DIVISION OF

**NORTH
AMERICAN
AVIATION, INC.**



Another new Raytheon development in microwave ferrite devices...



ACTUAL SIZE
Raytheon K_E band
circulator

Specifications and Performance Data—Low-Power K_E Band Ferrite Circulators	
FREQUENCY RANGE.....13 to 14 KMC/S	AVERAGE POWER 5 WATTS
MAXIMUM VSWR.....1.2 IN ANY PORT	WEIGHT..... 6.2 OZ.
INSERTION LOSS..... 0.5 DB MAX.	LENGTH $2\frac{3}{4}$ IN.
ISOLATION..... 20 DB MIN.	TEMPERATURE RANGE....-55 to 130 C

5-Watt K_E band circulator weighs only 6 oz.

Microwave system designers:

Raytheon's new line of three-port circulators has now been extended to meet the rapidly growing need for K_E band components and equipment.

Like other Raytheon circulators, this $2\frac{3}{4}$ -inch K_E -band unit of permanent magnet design reduces requirements for filters and klystron isolation common to systems using T-junction duplexers.

You'll want to learn about this and other new microwave ferrite devices including isolators, ferrite switches, modulators and side-band generators.



..... FOR COMPLETE DATA FILE
giving specifications and performance data on 12 isolators, 2 circulators, new X-band switch and ferrite materials, please write today to address below.

RAYTHEON MANUFACTURING COMPANY
Special Microwave Device Group
River Building No. 2, Waltham 54, Mass.



Excellence in Electronics

Literature of

MATERIALS

Epoxy Glass Laminate. The Mica Corp., 4031 Elenda St., Culver City, Calif., has issued a 21-page technical data manual containing test values and curves, plus specification data, on high reliability epoxy glass copper clad and unclad laminates. Circle 350 on Reader Service Card.

Nuclear Fuel Elements. Sylvania-Corning Nuclear Corp., Bayside, L. I., N. Y. A 64-page bibliography contains 306 references on problems concerning solid fuel elements, such as fabrication and properties. Copies, limited to one per company, may be obtained by writing on company letterhead.

Making Magnetic Tracks Visible. Reeves Soundcraft Corp., 10 E. 52nd St., New York 22, N. Y., announces a technical bulletin describing Magna-Sce, a non-toxic chemical solution which makes visible the sound track recorded on magnetic tape and can be used for editing and splicing video recording tape. Circle 351 on Reader Service Card.

COMPONENTS

Chokes. National Co., Inc., 61 Sherman St., Malden, 48, Mass. A four-page folder describes a full line of chokes. It contains illustrations and complete specifications on 17 types including ferrite bead chokes, ferrite core chokes, MIL-inductance chokes and r-f chokes. Circle 352 on Reader Service Card.

Subminiature Delay Lines. NYT Electronics, Inc., 2979 N. Ontario St., Burbank, Calif. Bulletin 140 describes a small-size new series of standard delay lines which meet requirements of MIL-C-15305A, grade 1, class B. Circle 353 on Reader Service Card.

Deflection Systems and Components. Radio Corp. of America, Camden, N. J. A full line of precision deflection systems, and components designed for itv and broadcast cameras and other crt applications are described and illus-

the Week

trated in a six-page brochure, Form 3R-3295. Circle 354 on Reader Service Card.

EQUIPMENT

Power Supplies. Kepco Laboratories, Inc., 131-38 Sanford Ave., Flushing 55, N. Y. Catalog B587 describes a complete line of voltage and current regulated power supplies including transistorized, magnetic and vacuum tube types. Circle 355 on Reader Service Card.

Electronic Apparatus Racks. Par-Metal Products Corp., 32-62 49th St., Long Island City 3, N. Y. Catalog No. 58 lists and illustrates a complete line of relay racks, cabinets, panels and other accessories. Circle 356 on Reader Service Card.

Particle Accelerators. High Voltage Engineering Corp., Burlington, Mass. A 12-page booklet describes the many known and potential applications of both Van de Graaff and linear accelerators, utilizing photographs and line drawings to point up significant design and performance features. Circle 357 on Reader Service Card.

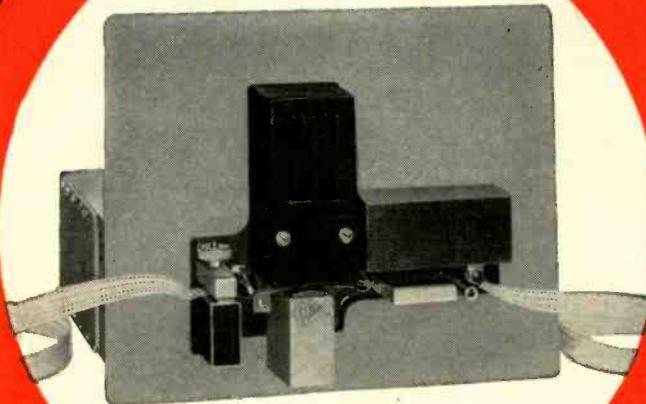
Military Power Supplies. General Electric Co., Schenectady 5, N. Y. Bulletin GEC-1496 provides information on a 28-v, 200-ampere, ground support d-c power supply. Circle 358 on Reader Service Card.

FACILITIES

Coil Windings. The Dano Electric Co., 93 Main St., Winsted, Conn., has available a 2-color catalog covering its various coil departments and facilities. Incorporated into the catalog is a handy 9-page reference section dealing with technical coil designing data. Circle 359 on Reader Service Card.

Forced Air Cooling. McLean Engineering Laboratories, P. O. Box 228, Princeton, N. J. Purpose of a recent 6-page technical booklet is to supply engineering information on thermal design and to survey methods of cooling electronic components. Circle 360 on Reader Service Card.

another Potter First



THE
NEW POTTER "909"

Now...

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

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

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

- Character reading speeds up to 1000 char/sec.
- Simple In-Line threading
- 3 Millisec starting time
- Stops on STOP Character, (0.2 millisec) and will read next character after start
- 100 x 10⁶ operation pinch roll
- Photo Diode Head reads any tape (including oiled yellow teletype tape)
- Reads 5, 6, 7 or 8 level tape with sprocket channel
- Ambient temperature up to 125° F. with 10,000 hour life
- Built to meet requirements of MIL-E-4158A

Specifications

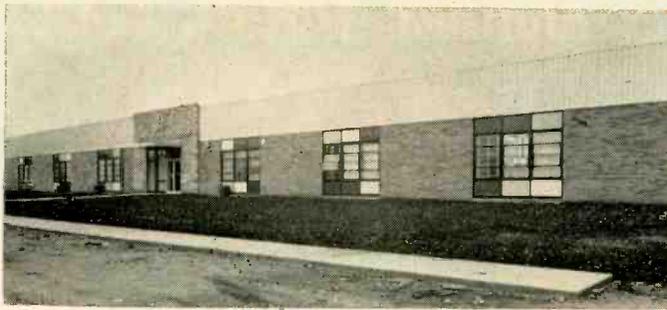
- Tape Speed:**
10 to 100 ips
- Tape Width:**
Any Standard Width
- Power Requirements:**
115V, 60 Cycle, 1 Phase
- Control:**
Remote/Level Inputs

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



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

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



IFI Settles in New Plant

AFTER busting out of its old shell in Mineola, N. Y., Instruments for Industry is now settling into a new plant in the Hicksville, L. I., industrial park.

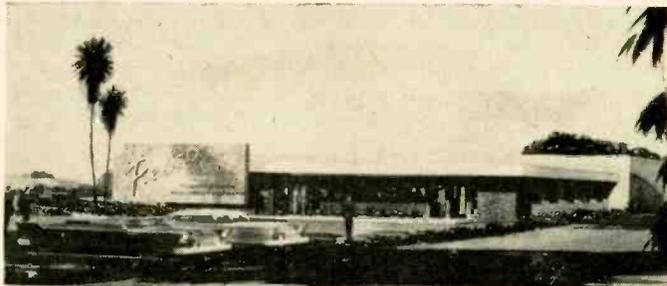
The ultramodern 38,000-sq ft building is equipped to comfortably house IFI's research and engineering activities, and at the same time phase in an increasing volume of equipment production.

IFI was founded in 1951 by Elston H. Swanson around a nucleus of engineers and administrators. The firm is largely devoted to countermeasures work, with prime contracts in this area from all three services. IFI worked in the development of the repeater type of active countermeasure, in which hostile

radar signals are received, delayed and retransmitted to give the appearance of many targets instead of only one.

Engineering work on this and other systems was IFI's major endeavor for some time. Now, with the systems phasing into production, the firm was pushed into expanding to make room for the assembly benches.

Commercial proprietary products outgrowing from the government work are a line of wideband amplifiers using traveling-wave tubes. The firm has also developed a novel—but still classified—delay-line storage device. Director of engineering for the young company is Eugene B. Novikoff.



New Pesco Branch in Action

VOLUME production of precision generators and inverters for aircraft and missiles is already under way in the new \$1 million plant of Western Branch, Pesco Products Division, Borg-Warner Corp.

Situated on a large expandable site in Burbank, California, the new plant, with Allen T. Puder as operations manager, will house offices, engineering laboratory and manufacturing facilities. Important products now in manufacture

include the Pesco permanent magnet alternator and rotary inverters used in many of the major missiles and supersonic aircraft. As a result of extensive development work, static inverters, meeting rigid space age requirements, will be in production by the end of the year.

The new facility brings together, in one location, the three segments of the company previously situated in Sherman Oaks, North Hollywood, and Azusa, California, and

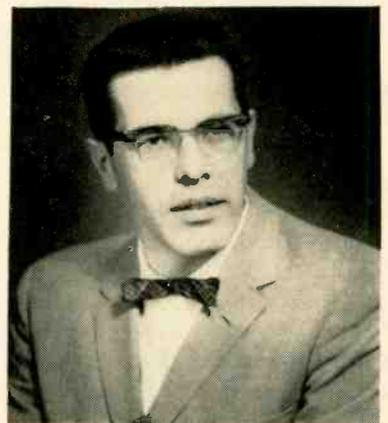
will permit the closely integrated production operation required by governmental and commercial precision standards.



Name Patterson Chief Engineer

THE newly-created post of chief engineer of Sierra Electronic Corp., Menlo Park, Calif., goes to Guy K. Patterson. He will direct Sierra's engineering and laboratory programs, including product development. He previously was a project engineer with the company.

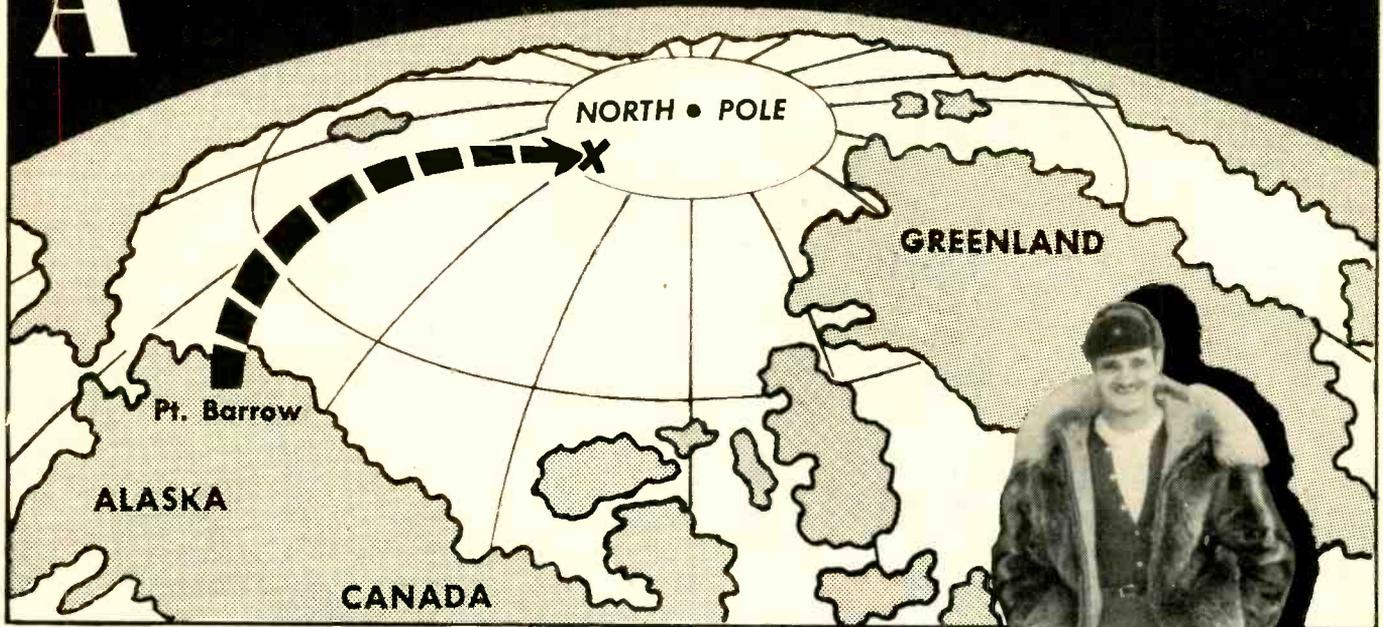
Prior to joining Sierra in 1948, Patterson was on the engineering staff of the Federal Telecommunication Laboratories in New York City.



Hock Advances At Technitrol

APPOINTMENT of Roy Hock as chief engineer is announced by Technitrol Engineering Company, Philadelphia, manufacturer of

ADVENTURES in ELECTRONICS



AT THE TOP OF THE WORLD ON AN ISLAND OF ICE

**"TechRep" Floats 8 Months
On Arctic Ocean Ice Floe**

by C. F. Graebe

Seven men adrift on an island of ice twelve feet thick, a mile above the Arctic Ocean floor, floating just 450 miles from the North Pole in bone-chilling minus-40-degree temperatures: that was the hazardous setting for Project Ice Skate — one of America's significant contributions to the International Geophysical Year.

On this isolated team of adventurous volunteers was Field Engineer Mike Swiercz — the group's communications expert and only civilian. With him were three Army polar specialists, two Eskimos, and a Jesuit priest who doubled as an Arctic veteran.

Flown from Pt. Barrow, Alaska, to

their wind-whipped ice floe on April 5th last year, this hand-picked crew was left to observe and measure Arctic phenomena. With special instruments they studied Arctic conditions of geomagnetism, gravity, oceanography, meteorology and seismology. For eight months their sole contact with the outside world was by radio.

"Radio communication was better than anyone had thought possible," reported Mike. "I had an antenna up four days after we landed on the ice, and that same day we were talking to the men at the South Pole and later listened to Sputnik's 'beep-beep' as it passed overhead."

Asked if the dangers of the icy wilderness and the fight against

endless cold didn't grate on the men's nerves, Mike replied, "No, that's Hollywood stuff; we all got on just fine. Remember, there was plenty of interesting work to be done, and the food was very good. I'm glad I asked for the assignment."

We, at the Philco TechRep Division in Philadelphia, are proud of Mike Swiercz's contribution to the IGY. His experience as a Philco TechRep doing an exciting job is, however, only the first of a series profiling the fascinating and unique adventures of our TechRep engineers and technicians to be published here in the months ahead.

Mike Swiercz, well-traveled Philco Field Engineer, is a veteran of 6 years in Japan and Alaska. He is now in Tripoli, North Africa.

WANTED: Ambitious Engineers & Technicians for choice locations in U.S.A. & throughout the world with electronics and communications experience in the following fields

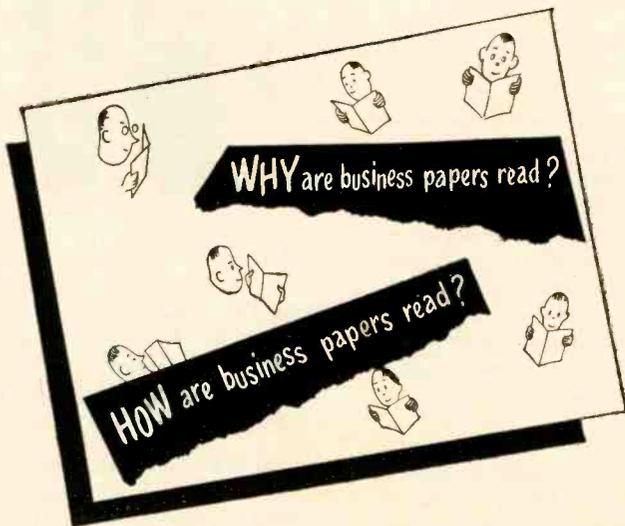
ELECTRONICS: Communication, Radar, Sonar, Navigational Aids, Guided Missiles, Antenna Systems, Microwave, Computers, Telemetry, Technical Writing.

ELECTROMECHANICAL: Power Distribution, Diesel Generators, Electrical Controls.
TELEPHONE: Central Office, Installers, Traffic Engrs., Switchboard, Outside Plant.

WRITE NOW FOR AN INTERVIEW

... in your city and a copy of our full color booklet—"PHILCO ... FIRST in Employment Opportunities." Write to Mr. C. P. Graebe, Personnel Mgr., Dept. 19-C, PHILCO TECHREP DIVISION, 22nd & Lehigh Ave., Phila. 32, Pa.

YOURS for the ASKING



A copy of this quick-reading, 8-page booklet is yours for the asking. It contains many facts on the benefits derived from your business paper and tips on how to read more profitably. Write for the "WHY and HOW booklet."

McGraw-Hill Publishing Company, Room 2710, 330 West 42nd St., New York 36, N. Y.

pulse transformers, delay lines and computer systems.

Joining Technitrol in 1956, Hock became a senior supervisory engineer responsible for the complete design and construction of data processing systems and digital control mechanisms. In his new position as chief engineer he will assume the technical direction of all engineering projects.



Taylor Assumes New Position

PROMOTION of Ray Taylor to chief engineer of Varo Mfg. Co., Garland, Texas, is announced. During his three years with the company as project engineer he has designed communications equipment, both airborne and ground power conversion equipment, and frequency meters and standards.



Tube Plant Opens

LITTON Industries recently opened the first unit of its new 60,000 sq ft tube plant in Salt Lake City, Utah.

The plant, newest production arm of the company's Electron Tube Division with headquarters

in San Carlos, Calif., will be managed locally by Vinton D. Carver. It is located on a ten-acre site opposite the Salt Lake airport. It will ultimately employ more than 600 persons manufacturing magnetrons, klystrons and other microwave tubes.



Creighton Heads Motorola Group

A COMBAT SURVEILLANCE GROUP has been established in Phoenix, Ariz., by Motorola's Western Military Electronics Center. Purpose is to focus increased R&D efforts on the rapidly expanding airborne surveillance field.

Selected to manage the new organization is Allen M. Creighton, former head of the communications section of W.M.E.C. The new group, which is responsible directly to R. E. Samuelson, manager of engineering, has a two-fold function—to exercise systems planning and coordination over all Motorola Military Electronics Division airborne surveillance projects, and to carry out projects directly assigned to the group.

Before appointment to his present position, Creighton was in charge of all Signal Corps communications projects at Motorola's Phoenix laboratories.

Burroughs Fills Three New Jobs

THREE new positions at Burroughs Research Center, Paoli, Pa., were recently announced by R. V. D. Campbell, deputy director.

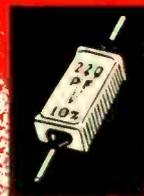
U. C. S. Dilks, formerly man-

Because **HIGH RELIABILITY** Is A "Must" . . .

Missile Engineers Specify *Vitramon* CAPACITORS

"Vitramon" Capacitors for high reliability applications are tested to meet the most stringent requirements for performance. Every capacitor ordered under the new High Reliability Specification S-1002 undergoes tests encompassing 300,000 UNIT HOURS OF LIFE AT 125° C to assure an A. Q. E. 12 times higher than Mil Specifications — and every shipment against an S-1002 order is accompanied by tabulated results to verify extreme reliability.

Inherent characteristics are built into "Vitramon" Capacitors through the fusing of quality porcelain enamel and fine silver, to produce a dense, homogenous, truly monolithic unit that requires no case or hermetic seal. If you have capacitor applications requiring high reliability, write for High Reliability Specification S-1002, describing materials used, manufacturing process, as well as all tests and failure rates.



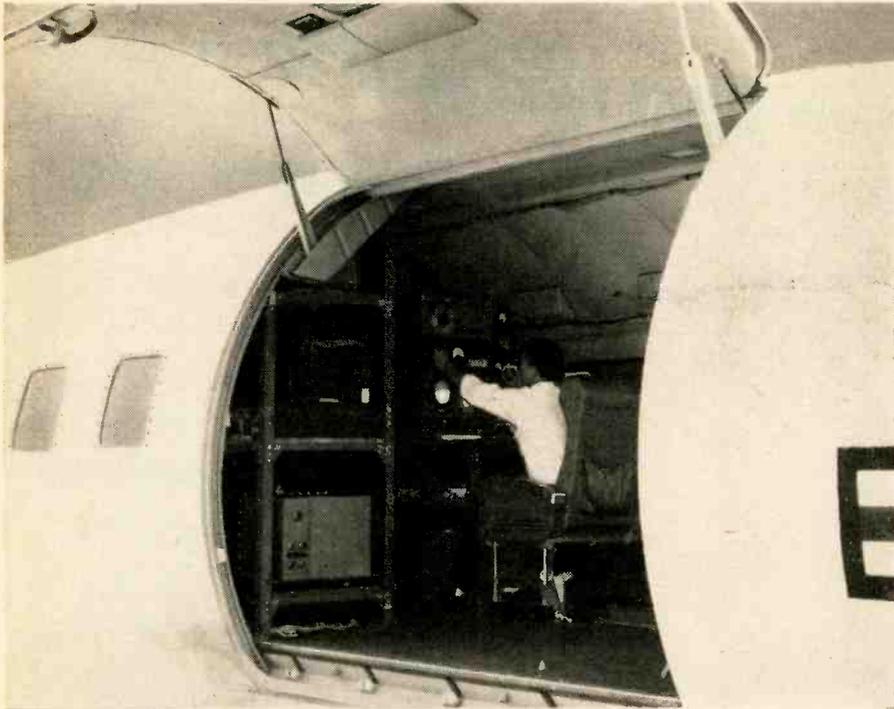
**"VITRAMON" CAPACITORS
OF PROVEN QUALITY
ARE USED IN
THESE MISSILES:**

JUPITER	TALOS
LACROSSE	TARTAR
NIKE-ZEUS	ATLAS
BULLPUP	BOMARC
CORVUS	FALCON
POLARIS	MACE
REGULUS II	SNARK
SPARROW II	TITAN
SPARROW III	VANGUARD
	EXPLORER

Vitramon
INCORPORATED

BOX 548E • BRIDGEPORT 1, CONNECTICUT

ENGINEER OPPORTUNITIES AT RAYTHEON



DOPPLER NAVIGATION EQUIPMENT is readied for flight testing under operational conditions. Engineers at the Maynard Laboratory hold responsibility for program from initial study phase through prototype production.

Newly formed project groups solve complex airborne radar problems

Engineers like the project-type organization at Raytheon's Maynard Laboratory. It gives them maximum diversification in their work on the most advanced radar navigational and control problems of the day.

At Maynard, you'll find projects involving many areas of aircraft navigation and guidance systems . . . doppler navigation, velocity check systems, night-fighter operations systems, flight-control systems, altimeters. There is also interesting new work on counter-measures equipment.

Career opportunities for men at all levels now exist in the following areas:

MICROWAVE COMPONENT DESIGN	SYSTEMS ANALYSIS & ENGINEERING
ANTENNA DESIGN	TECHNICAL WRITING
ELECTRONIC PACKAGING	SPECIFICATIONS WRITING
ADVANCED CIRCUIT DESIGN	

For complete details on engineering positions in any of Maynard's project groups, please write John J. Oliver, P.O. Box 87E, Raytheon Maynard Laboratory, Maynard, Mass.

RAYTHEON MANUFACTURING COMPANY
Maynard, Massachusetts

Are you the
ONE MAN IN THREE?



Excellence in Electronics



MAYNARD LABORATORY

ager, research division, is new associate director-commercial products; while Edward Lohse, former manager, ballistic missile division, is new associate director-defense products, a parallel position.

The positions, established to strengthen commercial and military technical planning, will be directed by Campbell.

At the same time Campbell announced the promotion of J. H. Howard, with Burroughs since 1950, to manager, research and development division. The new division is a merger of all commercial research and development efforts.



Rixon Hires J. A. Elliott

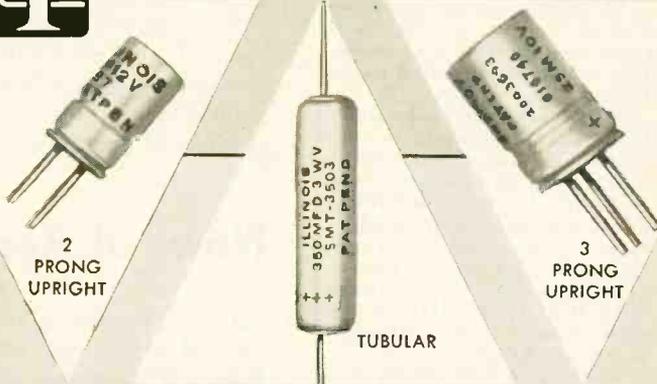
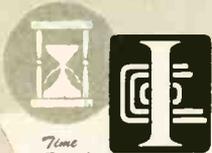
JAMES A. ELLIOTT has joined Rixon Electronics, Inc., as engineer in charge of quality control at its plant in Silver Spring, Md. He was formerly with Collins Radio Co., Cedar Rapids, Iowa, where he was engaged in design, component testing and component application.

Plant Briefs

Don Romine Associates, Westbury, N. Y., has been organized to design and construct environmental simulation equipment for testing space vehicles and components according to specifications.

Cushman Precision Industries, Princeton Junction, N. J., is a new company formed for the development, test and manufacture of electromechanical precision rotat-

ILLINOIS SUB-MINIATURE ELECTROLYTIC CAPACITORS



Here is a complete line of sub-miniature electrolytics which are especially desirable for low voltage D.C. circuits.

Advantages include: patented construction; hermetically-sealed; immersion proof; excellent life characteristics; low leakage currents; shock and vibration-resistant; plus many others.

Available in tubular and upright types, as illustrated, ILLINOIS SUB-MINIATURE CONDENSERS are ideal for applications requiring minimum size and weight.

Write for new, illustrated SMT catalog.

ILLINOIS CONDENSER COMPANY
 Telephone: EVerglade 4-1300
 1616 N. Throop Street Chicago 22, Illinois

CIRCLE 207 READERS SERVICE CARD

Electrical Coil Windings

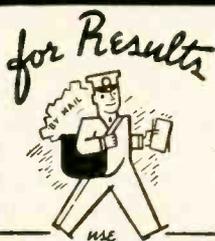
For 40 years . . . specializing in all types of coils to customers' specifications. Design or engineering assistance available on request.

COTO-COIL CO., INC.

SINCE 1917
 65 Pavilion Avenue Providence 5, Rhode Island

CIRCLE 208 READERS SERVICE CARD

McGraw-Hill Mailing Lists Will Help You



Mc Graw-Hill
 DIRECT MAIL LIST SERVICE

- Merchandise your advertising
- Conduct surveys
- Get inquiries and leads for your salesmen
- Pin-point geographical or functional groups
- Sell Direct
- Build up weak territories
- Aid Dealer relations

Direct Mail is a necessary supplement to a well rounded Business Paper advertising program.

Most progressive companies allocate a portion of their ad budgets to this second medium at the same time as they concentrate on the best business publications.

600,000 of the top buying influences in the fields covered by the McGraw-Hill publications make up our 150 mailing lists. Pick Your prospects out of our Industrial Direct Mail catalogue.

Write for your free copy of our Industrial Direct Mail catalogue with complete information.

GE VITREOUS-ENAMELED RESISTORS



"SNIP OR CLIP" TAB TERMINALS

Snip the lead, or clip the tab . . . get the exact terminal type you need! Save space and eliminate the need to stock two types of resistors. This unique feature is on General Electric 5-, 10-, and 20-watt resistors. For your vitreous-enameled resistor catalog, follow reader service instructions below. General Electric Co., Roanoke, Va.

784-12

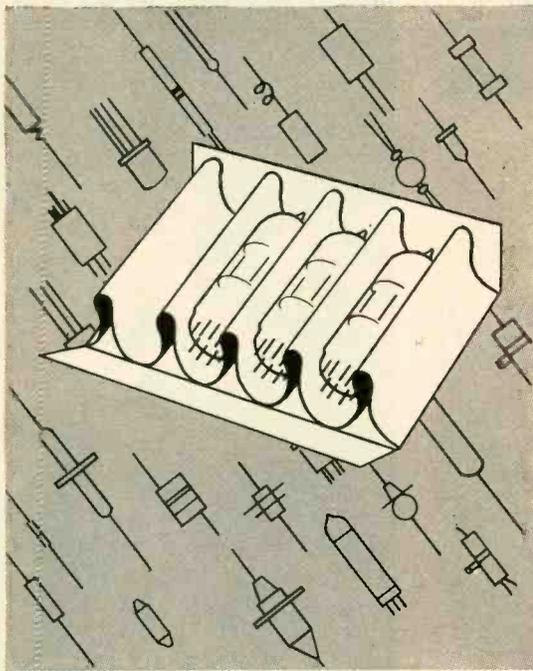
Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 210 READERS SERVICE CARD

RONDO

"the pack with the built-in shock absorber"



PROTECTS SMALL, DELICATE ELECTRONIC COMPONENTS IN PRODUCTION AND SHIPMENT

RONDO, a unique handling and packaging system, holds inserted objects by a spring-clip action of its fluted partitions.

Miniature and sub-miniature tubes, capacitors, diodes, resistors, and other electronic components are "snapped" into RONDO flutes. Convenient in production, inspection, storage, shipment, and also on the receiving end. The same RONDO unit will serve throughout all the different stages of handling.

RONDO IS A PAPER PRODUCT,
SOLD AT PAPER PRICES

Holds objects from 5/16" to 1" in diameter. Tooling for larger sizes possible. More information and our suggestions sent on request.

Please specify your requirements.

RONDO PROCESS AND DESIGNS PATENTED IN ALL MAJOR COUNTRIES



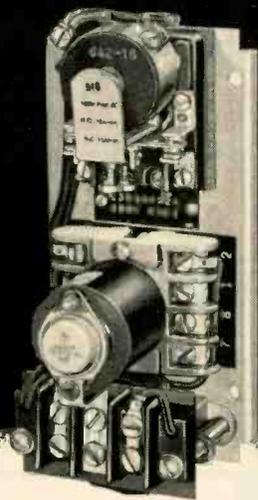
AMERICAN RONDO CORPORATION 100 A SANFORD ST., HAMDEN 14, CONN.

Representatives: C. S. Shotwell, 527 S. Alexandria Ave., Los Angeles 5, Cal., Phone: DUankirk 8-8879
Brown & Scratch, 664 N. Michigan Ave., Chicago 11, Ill., Phone: SUPERIOR 7-2973

CIRCLE 95 READERS SERVICE CARD

NEW Transistorized Relay Combines Fine-Sensitivity with Heavy-Duty Construction

Cutler-Hammer has developed a heavy-duty transistorized A-c relay which will respond to either an A-c or D-c signal between .0028 and .025 amperes. The heart of this compact relay is the plug-in type signal-amplifying module which contains all the electronic parts. This tough module is practically indestructible, and the plug-in design simplifies maintenance . . . cuts downtime to a minimum. The Bulletin 13535 transistorized relay requires no warm up time and it is exceptionally quick in operation. 600 volt model offers a wide selection of contact arrangements . . . rated 15 amperes. 110 volt model rated 10 amperes. Prices unusually low. Cutler-Hammer also offers conductive liquid level probes, and photo-cell units for use with the transistorized relay.



Write today for
Bulletin 13535-S220
CUTLER-HAMMER Inc.,
Milwaukee 1, Wisconsin



CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wis. Division: Airborne Instruments Laboratory. Foreign: Cutler-Hammer International, C. A.
Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation, Inc.

ing components for the electronic, missile and aircraft industries.

Delta-f Inc., Batavia, Ill., manufacturer of frequency control systems and equipments, has been introduced to the electronics field by recently elected president John A. Cunningham, formerly division manager of Hamilton Watch Co.

News of Reps

SALES rep organizations recently appointed by Chester Cable Corp. are Robert W. Gray, Inc., of New England, and Ringland M. Krueger Co. for Illinois and Wisconsin.

DeMornay-Bonardi, Pasadena, Calif., manufacturers of microwave test instruments, appoint Instrument Dynamics, Inc. as their new sales and engineering representatives in New England.

The Columbus Electric Mfg. Co., Columbus, Ohio, makers of precision snap switches, name Kahant Associates as exclusive reps for eastern New York State and northern New Jersey.

Bach Sales Co., a new rep organization in Old Bethpage, L. I., N. Y., will handle the high fidelity component line of Fairchild Recording Equipment Corp. in the N. Y. area.

Aero Sales Co. of Caldwell, N. J., now handles cooling and ventilating fans for electronic equipment cabinets for Kooltronic Fan Co., Princeton, N. J.

Industrial Test Equipment Co. appoints the Broger Instrument Sales Co., Inc., to handle the sales of its Phazor and Iteco product lines of electronic test equipment in the New England area.

Penta Laboratories, Inc., Santa Barbara, Calif., names three new sales reps to handle its line of power tubes. T. J. Ray Co. will cover Oklahoma; L. F. Florence Co., western Iowa and the states of Nebraska, Kansas and Missouri; and Nortel Engineering Service Co., Ontario, Quebec and the Maritime Provinces.

NEW BOOKS

Atmospheric Explorations

By HENRY G. HOUGHTON.

Technology Press of the Massachusetts Institute of Technology and John Wiley and Sons, 1958, 125 p, \$6.50.

THE lectures which comprise the five chapters of this entertaining book were given in 1956 by leaders of research in their respective fields to commemorate the 250th anniversary of the birth of Benjamin Franklin. All chapters are written in semitechnical language both understandable and meaningful to readers of *ELECTRONICS*. All chapters have good bibliographies.

Dr. Ross Gunn, for years the Director of Physical Research for the U. S. Weather Bureau, known to electronic engineers for his work on precipitation static and for his fabulous 28-page paper on thunderstorm electrification in the *Proceedings of the Institute of Radio Engineers* last October, describes some of his many researches on the electrification of cloud and raindrops.

Dr. J. P. Kuettnner, of the Geophysical Research Directorate, Air Force Cambridge Research Center, one of the country's leading glider pilots, discusses the Electrification of Thunderstorms with emphasis on his unmasking theory of charge separation.

Professor L. B. Loeb, who has had a lifetime of research in gaseous electronics and probably has written more on the subject than any man alive, contributes an excellent summary including very recent work on the positive streamer spark and its relation to lightning. Radar engineers may be interested to read how millimicrosecond techniques have been applied to the study of spark discharge.

Dr. Harry Wexler, Director of Meteorological Research for the U. S. Weather Bureau, "Looks at the Upper Atmosphere" from the ionosphere on down and discusses the physical processes such as absorption of solar radiation, that have such an important but not immediately obvious relationship to

For Fast, *SAFE*, Easy Printed Board Rework



5 assorted tips for every de-soldering operation

Ungar®

DE-SOLDERING KIT

Now you can rework and salvage printed circuit boards by removing defective components quickly and easily with Ungar's amazing De-Soldering Kit. Save time and save headaches with specially designed tiplets that will not break off lugs or ruin printed circuit boards. Cut your labor and material costs substantially with this truly indispensable kit.

#270 Kit contains:

Ungar Handle with full length extra-flexible, insulated cord.

Super Hi-Heat Unit, 47½ Watts, delivers 600° to 850° F.

Slotted Tip that melts solder and straightens bent or folded tube tabs.

Bar Tip for de-soldering and removing capacitors and other straight line components.

Cup Tips, in three different sizes, that de-solder tube sockets in one simple operation.

In goldtone metal case, the Ungar De-Soldering Kit regularly lists at \$7.95. **Special Introductory Sale Price, \$5.95.**

Order from your jobber now
Ungar Electric Tools, Inc.

4101 Redwood Avenue, Los Angeles 66, California



STIFF DOSE OF SALT



Exposure . . . to the equivalent of a stiff sea spray . . . on a hot, humid day—one more test the G-M Servos take in stride.

Not just a promise—but a tested fact.

G-M Servo Motors are built to deliver the ultimate in performance. The salt spray test shown above is just one of a battery of tortures designed to prove G-M Servos under all extremes of humidity, temperature, altitude, vibration and salt spray.

At G-M "Designed to Meet Mil. Environmental Specifications" is backed by production testing that does just that!

4 GOOD REASONS WHY G-M SERVO MOTORS SERVE YOU BEST!

- 1 G-M Servo Motors are available in standard sizes.
- 2 Standard G-M Servo Motors can also be modified to meet specific requirements.
- 3 Creative engineering in designing special servo motors with special characteristics.
- 4 Fast production—better service.

Write Now for information, or send for complete G-M charts and specifications. No obligation, of course.



CIRCLE 212 READERS SERVICE CARD

our weather at the ground.

Professor Henry Booker of Cornell University discusses some currently interesting phenomena of radio scattering in the ionosphere. Should there be an electronics engineer (perhaps a computer man) who does not have an understanding of ionospheric echoes, meteor echoes, auroral echoes, vhf scatter, spread F and sporadic E phenomena, this chapter with its very good summary of these effects is one to read.—SEVILLE CHAPMAN, Director, Physics Division, Cornell Aeronautical Laboratory, Buffalo, N. Y.

The Ultra High Frequency Performance of Receiving Tubes

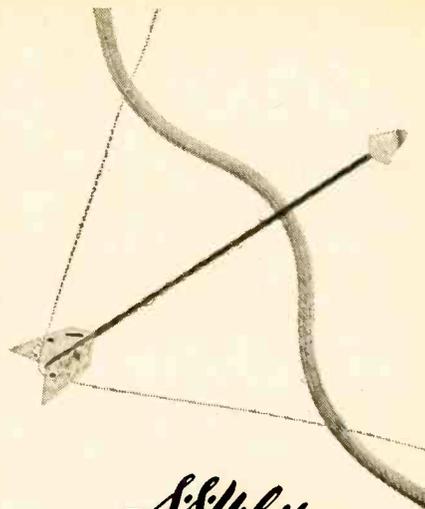
By W. E. BENHAM AND I. A. HARRIS.
 McGraw-Hill Book Company, Inc., New York, 1957, 173 p, \$6.50.

ONE purpose of this book is to present the theory of operation of ulf receiving tubes with emphasis on the equivalent circuits valid for small signal operation. A second purpose is to give a simple, detailed account of the electronic processes occurring in the tube which will provide the mathematical background required for the investigation of new problems in this field.

The book should appeal to engineers interested in the applications of receiving tubes at ulf and to engineers engaged in ulf vacuum tube research and development. The authors have carefully selected portions of the works of such leaders in this field as Muller, Llewellyn, Bakker, Devries, North as well as that of their own excellent research. The result is a particularly good, high level and concise book.

Scope and Special Features—The book starts with a general survey of space-charge control tubes including the internal action of a tube, the interaction between the tube and the circuit, and the high-frequency equivalent circuit of practical tubes.

The next three chapters deal with current in an interelectrode space, the small-signal high-fre-



S.S. White

FLEXIBLE SHAFTS

are the answer where simplicity is the aim

Simplicity in Use—Selecting an S.S. WHITE flexible shaft and applying it to any remote control or power drive application is a quick, easy job. S.S. WHITE has reduced flexible shaft selection to a relatively simple task through the use of standard flexible shaft combinations, clear-cut, quick reference selection tables and expert engineering and technical advice.

Simplicity in Design—Because an S.S. WHITE flexible shaft takes power or control around turns and obstacles—eliminates excessive parts—you save space and weight . . . and help improve product efficiency.

Consider S.S. WHITE flexible shafts for driving or controlling parts in your own equipment. We'll be glad to help you work out any application problems you may have. Write, wire or call.

USEFUL DATA on how to select and apply flexible shafts! Write for Bulletin 5601.



S.S. White

FIRST NAME

IN FLEXIBLE SHAFTS

S.S. WHITE INDUSTRIAL DIVISION
 Dept. E; 10 East 40th Street
 New York 16, N. Y.

Western Office:
 1839 West Pico Blvd., Los Angeles 6, Calif.

CIRCLE 213 READERS SERVICE CARD

quency characteristics of idealized basic diodes and the small-signal high-frequency characteristics of ideal triodes and tetrodes. These chapters start with a discussion of fundamental concepts of the tube theory. A basic equation describing the motion of an electron in the presence of space-charge is then developed. At this point the small-signal admittance of the parallel-plane diode is derived. By considering gridded tubes as a series of planar diodes, the parallel plane triode and tetrode characteristic are determined. Equivalent circuits for these tubes are discussed.

A very interesting chapter follows on the differences between actual and ideal tubes in which effects of initial electron velocity, nonuniform cathode fields and secondary anode emission are discussed. The characteristics of tubes operating in retarding fields are then discussed in the two chapters that follow.

The chapter on the tube as a linear active two-terminal-pair circuit element is of particular interest to engineers interested in tube applications. Analysis of the grounded cathode and grid triodes are discussed. A chapter on large signal theory is mostly qualitative as much work remains in developing a satisfactory large signal theory.

The final chapter, and one of the most interesting, is on calculation of noise factor. The fundamental principles are discussed including the high-frequency shot-noise reduction factor, the calculation of noise factor and the effect of reflected electrons on the induced noise currents. An excellent discussion on the agreement of theory with experimental result is included.

Analysis—The authors have prepared a very readable book on uhf tubes. Development of the text material is very good and excellent use of the seven mathematical appendices is made to supplement the text material. For the purposes intended by the authors, the degree of completeness of the material appears to be about right. While there are other books avail-

NEW TWIN CONTACT MINIATURES

DC-AC CHOPPERS

Eleven types, both single and double pole.

Long life.

Low noise level.

Extreme reliability.

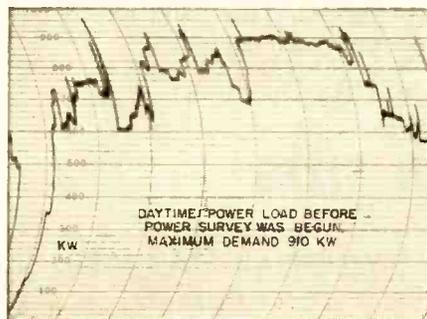
Write for Catalog.

STEVENS-ARNOLD, INC.
7 ELKINS STREET
SOUTH BOSTON 27, MASS.

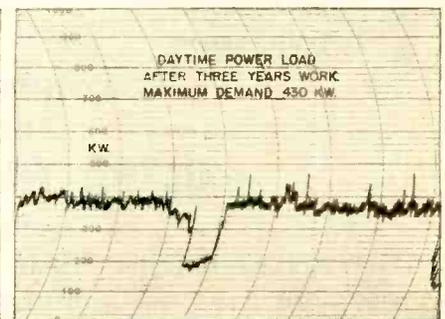
S/A-11A

CIRCLE 214 READERS SERVICE CARD

\$10,000 a Year Saved with Graphic Instruments



BEFORE



AFTER

Power Savings of \$10,000 a year were made, as the result of a power survey, at the same time that output increased 25%. You too can make similar savings in your plant.

Bulletin 537-A describes this survey } Ask for
Bulletin 856 tells How to Make a Plant Survey } Them

"The Meter With a Record" For Over 50 Years

The ESTERLINE-ANGUS Company, Inc.
Pioneers in the Manufacture of Graphic Instruments
Dept. E, P. O. Box 596, INDIANAPOLIS 6, INDIANA

Vector

TUBE SOCKET TEST ADAPTERS

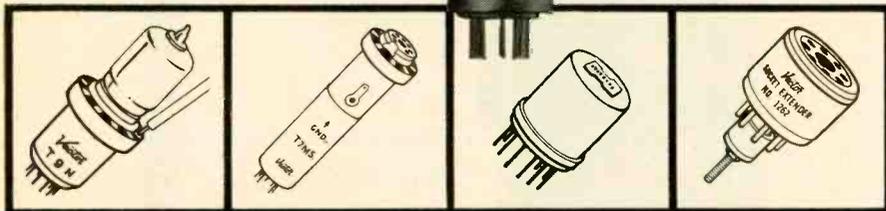
Test Circuits In Operation



ROTOPROBE—

Switching type tube socket test adapter—with permanently attached test lead, and numbered stop positions for each pin.

Measurements are made on each contact by turning the shell of the Roto-probe to the corresponding number on the index.



TUBE SOCKET TEST ADAPTERS
With radial test tabs

TUBE SOCKET TEST ADAPTERS
Long type for tight spots

SOCKET CHANGE ADAPTERS
Change tube types without rewiring

SOCKET EXTENDERS
Replaceable socket extends life of test equipment



Write for catalog—

VECTOR ELECTRONIC COMPANY

1100 FLOWER STREET, GLENDALE 1, CALIFORNIA

TELEPHONE CLinton 7-8237

CIRCLE 216 READERS SERVICE CARD

RIBBONS · STRIPS

- ★ PURE TUNGSTEN
- ★ MOLYBDENUM

of

- ★ THORIATED TUNGSTEN
- ★ SPECIAL ALLOYS

and OTHER METALS

IN

ULTRA THIN SIZES

to

TOLERANCES CLOSER THAN COMMERCIAL STANDARDS

by

OUR SPECIAL ROLLING TECHNIQUE

Note: for highly engineered applications—strips of TUNGSTEN and some other metals can be supplied

ROLLED DOWN TO .0003 THICKNESS

- Finish: Roll Finish—Black or Cleaned
- Ribbons may be supplied in Mg. weights if required

For HIGHLY ENGINEERED APPLICATIONS

DEVELOPED AND MANUFACTURED BY

H.CROSS CO.

15 BEEKMAN ST., N. Y. 38, N. Y.

TELEPHONE

WOrth 2-2044

COrthlandt 7-0470

able on vacuum tubes, this one includes more detail on the high-frequency performance of receiving tubes. An excellent feature of the book is that it provides the reader not only with an authoritative source of information but with a state of the art review.

This reviewer is pleased to endorse this book as an excellent up-to-date reference on uhf tubes. It should be of particular interest to persons engaged in active networks using vacuum tubes, to engineers interested in perfecting the tubes themselves and to graduate students engaged in research in ultra high frequency tubes and circuits.—G. C. DALMAN, School of Electrical Engineering, Cornell University, Ithaca, N. Y.

THUMBNAIL REVIEWS

Better Report Writing. By W. H. Waldo, Reinhold Pub. Corp., New York, 1957, 231 p, \$4.75. This desk guide presents facts on the details of composition, style, dimension of reports, tables, illustrations and use of words in a format calculated to provide the engineer with a quick reference to turn to for answers to his impromptu questions concerning writing.

Aeronautical Electronics Conference Proceedings. The National Conference on Aeronautical Electronics, 53 Park Ave., Dayton 9, Ohio, \$4.00. Complete texts and illustrations of 10 papers on equipment applications, 18 on component parts, 10 on navigation, six on communications, six on electronic equipment, nine on management research and production, 15 on environment and six on air safety given at 1957 conference in Dayton.

Design of Free-Air Ionization Chambers. By H. O. Wyckoff and F. H. Attix, Superintendent of Documents, U. S. Government Printing Office, Washington: 25, D. C., 1957, 16 p. \$.20 (paper). This National Bureau of Standards publication presents general design characteristics for standard free-air type ionization chambers for X-rays from 50 to 500 kv. Accuracy of free-air chamber measurements is given in a table which lists the estimated maximum error for each experimental factor.

Programs for an Electronic Digital Computer. By M. V. Wilkes, D. J. Wheeler and S. Gill, Addison-Wesley Publishing Co., Inc., Second Edition 1957, 238 p, \$7.50. A general introduction to programming for any machine of the stored-program type. Emphasis is placed, however, on the single-address binary machine.

COMMENT

The Solid-State Switch

We just saw the Aug. 1 issue of *ELECTRONICS*, which contained (p 108) your note on our solid-state switch, including the two photographs . . .

While we appreciate the publication of that note, we are quite disappointed that you have failed to mention the name of the organization where the new device originated.

The solid-state switch was developed by Kurt O. Otley, Robert F. Shoemaker and Philip J. Franklin of the Diamond Ordnance Fuze Laboratories in Washington, D. C. You might also want to add the information that the switch is described in somewhat greater detail in the 1958 Conference Proceedings of the 2d National Convention on *Military Electronics*, June 16-18, 1958.

PHILIP J. FRANKLIN
DIAMOND ORDNANCE FUZE
LABORATORIES
WASHINGTON, D. C.

So many questions have come in from readers asking about the rugged solid-state switch that uses the operating principles of an electrolytic capacitor that we're delighted to be able to provide this additional information.

Spikes

The comments by Messrs. Simmons and Todd (Comment, p 190, Sept. 12) on the mechanism by which spikes are formed in the transistor inverters described in my recent article ("Magnetic Inverter Uses Tubes or Transistors," p 158, Mar. 14) are very interesting. My main concern was with the salient features of the differential common-base type of inverter, as compared with the common-emitter inverter. No very detailed investigation of the cause of the spikes was conducted by me.

Tight coupling between the various windings is obviously desirable even if only the gross features of circuit operation are considered. For this reason the magnetic cores used in the circuits described in the article were of toroidal form and

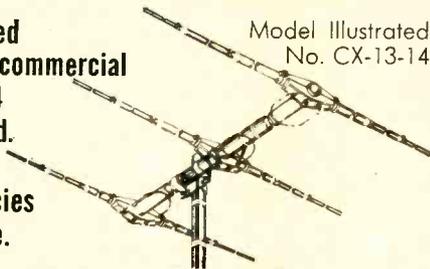
TELREX LABORATORIES

Designers and Manufacturers of

COMMERCIAL SERVICE "BEAMED-POWER" ARRAYS

Calibrated
for the commercial
13 to 14
mc. band.
Other
frequencies
available.

Model Illustrated
No. CX-13-14



Precision Tuned, Matched and Calibrated for easy assembly and repetition of our Specifications at your site, providing optimum gain per element and hi-signal-to-noise, hi-signal-to-interference "Balanced Pattern."

Electrical Specifications: Gain 8 db, F/B ratio 28 db, V/S/W/R 1.2/1 or better! Impedance, 52 ohm thru coaxial halfwave "Balun" (supplied). Power capacity 5 KW — Higher power models available at extra cost.

Mechanical Specifications: Wt. 60 lbs., 3" OD x 26 ft. boom, taper swaged elements, tapering from 1 3/8" OD to 1/2" OD, incorporating stainless steel hardware, "Borg-Warner" Cyclocac moldings, 1/4-20 S.S. junction terminals and heavily cadmium plated mounting plate. Wind surface area: 7 sq. ft. Wind load at 100 mph: 210 lbs.

Price \$338.00 f.o.b. Asbury Park, New Jersey
Available three (3) days after receipt of order.
Descriptive literature on request.

Telrex is equipped to design and supply to our specifications or yours, Broad-band or single frequency, fixed or rotary arrays for communications, FM, TV, scatter-propagation, etc.

Consultants and suppliers to communication firms, universities, propagation laboratories and the Armed Forces.



ASBURY PARK 25
NEW JERSEY, U.S.A.

Tel. PRspect 5-7252

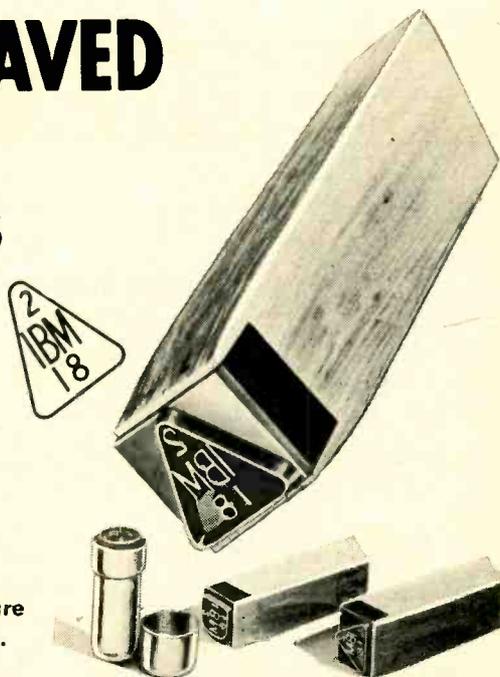
CIRCLE 218 READERS SERVICE CARD

NEW! ENGRAVED Deep-Kut[®]

PIN & PEG STAMPS
are better than
ordinary rubber
3 ways

- ★ ENGRAVED Deep-Kut is Acid-Proof
- ★ ENGRAVED Deep-Kut Stamping gives Razor-Sharp impressions every time
- ★ ENGRAVED Deep-Kut has cushion-like resilience

Engraved Deep-Kut stamp faces are adaptable to any marking device. They can be used to stamp on every surface, metal, wood, fabric, paper, plastic, etc.



THE KRENGEL

INSPECTION POCKET STAMP

THE PIN & PEG

KRENGEL MANUFACTURING CO., INC. Tel. CO 7-5714
227 Fulton St., New York 7, N. Y.

Dept. 1

Please check the following:
FREE ENGRAVED Deep-Kut
Sample & Price List
Please have salesman call
for appointment

NAME.....
COMPANY.....
STREET.....
CITY..... ZONE..... STATE.....

PRECISION DEFLECTION WITH COSSOR YOKES



Slip Ring Yoke

Two-Axis Fixed Yoke

Component Development Engineering at its BEST!

- ADVANCED ELECTRICAL DESIGN
- PRECISION MECHANICAL DESIGN
- ACCURATE PRODUCTION METHODS

Custom Built to the most
Exacting Specifications
by Cossor Engineers

In Mumetal Cores for Optimum Geometry
In Ferrite Cores for Speed and Sensitivity
In Non-magnetic Cores for Perfection of Response

Any of Cossor's Three Core Types can be made in single or double axis with single or push-pull windings, and encapsulated for fixed or slip ring (rotating) use.

Normal characteristics of yokes for 1-1/2 in. neck tubes are:

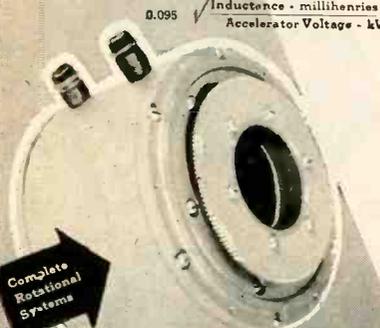
Positional accuracy - the spot position will conform to the yoke current co-ordinates within 0.25% of tube diameter. For deflection angles less than $\pm 25^\circ$ better accuracy can easily be achieved.

Memory - 0.5% max. without overswing.
0.1% or less with controlled overswing.

Complete encapsulation in epoxy (stycast) or silicone resins is standard for all Cossor deflection yokes, and is done with special moulding tools ensuring accurate alignment of the yoke axis. When slip rings are added, solid silver rings are mounted in encapsulating resin. The finished slip ring yoke is precision turned to centre bore, and can include bearing mounting surfaces with dimensional tolerances approaching those associated with high quality metal parts.

Settling Time (Micro sec.) = $120 \sqrt{\text{Inductance in Henries}}$

Sensitivity degrees/milliamperes = $0.095 \sqrt{\frac{\text{Inductance} \cdot \text{millihenries}}{\text{Accelerator Voltage} \cdot \text{kV}}}$



Complete Rotational Systems

COMPONENTS DIVISION COSSOR CANADA LIMITED

301 Windsor St., Halifax, N. S.
8230 Mayrand St., Montreal, Que.
648A Yonge St., Toronto, Ont.
Corporation House, 160 Laurier West, Ottawa, Ont.

CIRCLE 220 READERS SERVICE CARD

of high-permeability magnetic material. The windings were placed one on top of the other and uniformly distributed around the whole core periphery as shown in the illustrations in the article. Further improvement in coupling would certainly be obtained by using twisted pair, and of course spacing the windings at discrete intervals around the core periphery would loosen the coupling.

Whether it is desirable to use only a small portion of the core periphery for the windings is open to question, however. This measure does not greatly tighten the coupling and, besides making uneconomical use of the winding space available, it has the effect of lowering somewhat the permeability of the magnetic circuit as a whole since more flux will escape to the air. In some cases the use of twisted pair may be open to objection on the grounds of voltage stress in the windings, since the voltage across the nonconducting element may be appreciable when high-voltage transistors or vacuum tubes are used.

The comments by Messrs. Simmons and Todd do show, however, that the transformer coupling is intimately connected with the nature and magnitude of the spikes, and even more conclusively . . . show the effect of load upon the damping of these transients. Nevertheless the measures suggested do not eliminate completely the spikes from the no-load output waveform.

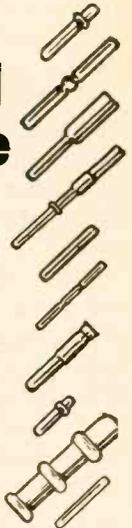
There is probably more to be learned about the switching process. Many earlier articles on the subject have ignored the matter. Little or no mention of spikes in the output waveform has appeared, and the absence of waveform photographs in many cases does little to give assurance that they have not been present. In the writer's experience the spikes in some cases are of extremely short duration compared with the period of the square wave and are likely to be missed altogether if waveforms are observed with anything but a wide-band oscilloscope.

C. H. R. CAMPLING
DEPT. OF ELECTRICAL ENGINEERING
QUEEN'S UNIVERSITY
KINGSTON, ONT.

YOU CAN SAVE UP TO 50% ON SMALL PARTS LIKE THESE

by using
TRADEMARK

BEAD CHAIN Multi-Swage PRODUCTS



Every year Bead Chain produces billions of tubular metal parts for electronic and mechanical applications. Multi-Swage eliminates costly turning, drilling, stamping and forming—automatically swages from flat stock into strong precision forms with positive, tight seams. If you're a volume user of such parts, in any metal, up to 1/4" diam. x 1 1/2" long, find out how much Multi-Swage can save you. Send sketch or standard parts for prompt estimate. Write for catalog today.



THE BEAD CHAIN MANUFACTURING CO.,
88 Mountain Grove St., Bridgeport, Conn.

CIRCLE 221 READERS SERVICE CARD

Here's how you can MERCHANDISE YOUR ADVERTISING

with these handy 9" by 12" folders



Keep your sales, management and distribution people informed on your advertising. Circulate pre-prints, reprints, schedules and other material in these folders, and make your advertising dollars work over and over for you.

Write for illustrated folder and price list

Promotion Dept., Room 2700
McGraw-Hill Publishing Co., Inc.
330 West 42nd Street, New York 36, N. Y.

3" Round Elapsed Time Meter

PHOTO ELECTRIC SWITCH. Darkness throws the switch—turns light on at dusk . . . off at dawn. Pools burglars who watch for signs of an empty house. . . . \$10.94

\$1275

TELECHRON Motors

1 RPM . . . \$3.95	60 RPM . . . \$4.85
2 RPM . . . 2.90	3 RPHR . . . 2.85
4 RPM . . . 3.90	1 RP.2HR. . . 2.80
3.6 RPM . . . 3.15	1 RP12HR. . . 3.25

1 RPM—50 Cycles, \$1.85
Laboratory Special 1 of Each Motor \$25

GLEASON-AVERY 1800 synchronous motor
115v 18 watt . . . \$4.50
same motor 8 RPM . . . 8.50

HAYDON TIMING MOTORS

1 Rev 4 hours 115v . . . \$1.70
1 RPM 115v 60cy . . . 2.60
1 RPM 230v 60cy . . . 1.00
2 RPM 230v 60cy . . . 1.00
3 RPM 115v 60cy . . . 2.60
30 RPM 115v 60cy . . . 2.60
450 RPM 115v 60cy . . . 1.30
HANSEN 4RPM 115v 60cy. 4.24
CRAMER 4 RPM 115v 60cy. 4.65

Laboratory special 1 of each motor . . . \$16.50

RELAY CONTACT BURNISHERS .59—2 for \$1.00

PM MOTORS
Made by DELCO or DIEHL \$375
Removed from equipment

MOST POWERFUL TELECHRON MOTOR MADE—6 watts—

1 RPM 115 v 60 cy . . . \$6.75
4 RPM 115 v 60 cy . . . 11.50

CRAMER 44 SPI. 45 sec.
6 switch Timer with clutch using 4 RPM 6 w TELECHRON Motor . . . \$17.50

We are the oldest and one of the 200 authorized Micro Switch Distributors. We have the largest stock of Potter & Brumfield Relays in the Country.

BLAN

EST. 1923

INCLUDE POSTAGE
64 E Dey St.
New York 7,
N. Y.

550
RADIO RESEARCH INSTRUMENT CO.
FIFTH AVE.
NEW YORK
JUDSON
6-4691

F-28/APN-19 FILTER CAVITY
Jan. spec: Tuneable 2700-2000mc. 1.5db max. loss at cur freq. over band. Details: Insertion loss variable. Single tuned filter for freq. channeling in radar beacon. Silver plated coax resonator. Invar center tuning conductor 3/4 wavelength. New \$57.50 each.

3CM. Precision Tube Mount. Waveline model 088. X band shielded klystron mount P10D signal generator type. Complete with variable glass vane attenuator. Brand new. \$205. Catalog Price. Our Price, \$64.50.

TS 130/UP "L" band slotted line. Equipped with type N fitting. Mig. Western Electric, new, \$150. E & H Bands: RG52 X band, \$14.50 ea. RG48 S band, \$25.00 ea.

SPEARY KLYSTRONS
SMX-32 two watts at 9-10.5KMC \$425.
SMC-11A one watt at 4640-4670mc. \$495.
All brand new with 90 day guarantee.

AN/APS-10 RF HEAD
3cm. 10kw output, hydrogen thyratron mod. .8 microsec., revr 30 mc IF 5.5 mc bandwidth. Uses 30 tubes 3xtals plus 2442 magnetron. \$375 ea. Full desc. MITT. Rad. lab. series Vol. 1 pg 616-625.

3KW 400 CYCLE SOURCE
Complete generator set 115vdc 411P motor (easily swapped for standard GE or other 115v 60 cycle AC motor) speed regulated. Generator output 115 volts 400 cycle single phase 17.4 amps continuous duty. Output electronically regulated. Built to rigid US Navy spec. In excellent used condition. A new special price \$285.00. With 115VAC 60 cycle single phase motor \$385 incl. comp. regulator **THIS IS NOT A STRIPPED SET AS SOLD ELSEWHERE.** Complete with THYR regulator, motor, as supplied to U. S. Navy.

FOR SALE: COMPLETE RADAR SYSTEMS

SCR-584 30 ft. trailer Skysweep antenna system. 100 FT indicator + 10 ft. 10 cm. High power for airway control missile-satellite tracking, radio astronomy R & D. Good as new. Complete.

AN/APS-10 Complete airborne Radar Mig. by G.E. 3cm. using 2442 Magnetron for Navigation, Mapping, Weather, Collision Avoidance. Like New.

2.5 KW PRESS WIRELESS XMTR. Type 1W-981A 2-23 mc. cw and freq. shift (teletype) MO 25 XTAL channels. Complete.

3CM KLYSTRON MOUNT
2K25-723A/B mount with epig. to waveguide mm and a/c. Shielded incl. tuning rod. Matching tuneable output slugs. Dual crystal mount. 1/2w cable w/min plug. Brand new, \$28.50.

2 Watt X Band Power Source: mfg. Sperry. Delivers 2 full watts RF at X band. 6 ft. rack 115v ac input. Brand new. Also delivers 1 watt at C band (4000mc) and 750 mc rf. Price complete with all tubes, atd. \$2500.

7/8" RIGID COAX. 50 ohm, standard fittings. 10cm stub supported. 12 ft. lengths. Silver plated. New \$34.50 each. 12 ft. length. Right angle bends \$8 ea.

7/8" COAX MAGNETRON COUPLING. Gold plated less M nut, \$18.50. Brand New.

SCR 584—SKYSWEEP ANTENNA PEDESTAL
Full azimuth and elevation sweeps, 360 degree azimuth, 205 degree elevation. Accuracy ± one mill or better in angle. 6 ft. dish, fully desc MIT. Radiation Lab Series Vol. 1 pg 284 and 209, Vol. 26, pg 233. For full tracking response. Includes pedestal drives selsyns, etc. Excellent used condition. This is the first time these pedestals have been available for purchase. Control consoles also in stock.

CRYSTAL MOUNT X band. Broad banded RNC (teflon) output UG30 Flange Input. Mig. Airtron. New, \$24.50.

TOPWALL HYBRID JUNCTION. 8500-9600 mc 1x5 wg. size. Broad banded better than 16%. Aluminium casting, \$15.00 new. Cross-over output, 1x.5 wg. size, \$5.00 new.

BROAD BAND BAL MIXER using short slot hybrid. Pound type broad band dual balanced crystal holder, 1x.5 wg. size, \$25.00 new.

FLEXIBLE WAVEGUIDE. 1x.5 X band 9" Tech-nical. New \$10.00. 1x.5 X band 24" Airtron. New \$21.50. 1 1/4 x 3/4" X band 12" Western Elec. New \$19.50.

COAX MIXER ASSEMBLY IN21 type crystal detector RF to IF. "N" fittings, matching slug, duplex couplings, mfg G.E. New, \$18.50.

TAPER RG51 to RG52 (1 1/4" x 3/4" to 1 x 1/2") Smooth Electroform. Standard Flanges. New \$16.50.

AN/MPN-1A (GCA) Ground Control Approach Radar, 30 ft trailer with 3cm precision and 10cm Search Radars as used by GAA. Full desc. Vol. 11 MIT Rad Lab Series Sec. 8.12.

SO-9 275 kw Compact wt. 488 lbs. rotating yoke 115V 4. 20. 80 mile ranges, ideal for weather forecasting. Brand new. FCC approved \$950.

BLOWERS — MOTORS:

115 VAC 60 Cycle SINGLE TYPE — as pictured — 100 CFM; 2 1/4" intake, 2" outlet. Complete size: 3" x 0" — No. 1C939B. \$9.95

115 VAC 60 Cycle DUAL TYPE—100 CFM; 4" intake, 2" Dis. each side. Complete size: 3" x 0" — No. 1C880B. \$14.95

115 VAC 60 Cycle COMPACT TYPE—108 CFM; Motor build inside squirrel cage; 4 1/2" Intake, 3 5/8" x 3" Dis. Complete size: 4 1/2" W x 8 3/4" H x 8 3/4" D. No. 2C067B. \$15.95

115 VAC 60 Cycle FLANGE TYPE—140 CFM; 3 1/2" Intake 2 1/2" Dis. Complete size: 7 1/2" W x 7 1/4" H x 6 3/4" D. No. 1C807B. \$14.95

115 VAC 60 Cycle FLANGE TWIN 275 CFM; 4 1/2" Intake, 3 1/2" x 3" Dis. Complete size: 11 3/4" W x 2 3/4" H x 8 1/16" D. No. 2C069B. \$22.95

10 CFM BLOWER—27.5 VDC; 1/100 HP; 7000 RPM; Oster Motor; C21BT-1A; L-R Mfg. Co. Bakelite Blower #2—Overall size: 3 1/2" x 1 1/2" — \$5.95

115 V 400 CYCLE—10 CFM; Eastern Air Devices Motor 431A; 7200 RPM; 1/100 HP. L-R #2 Blower Assy. Overall size: 4 1/2" x 3 1/2" — \$5.95

10 CFM BLOWER—28 VDC .6 A; 5000 RPM; Pioneer Motor SS-2345. Aluminum Blower Housing. Overall size: 4 1/2" x 3 1/4" — \$5.95

DELCO 5068571 Blower Assy.—27 VDC 1M. Motor Reversible, 10,000 RPM. 1" Intake; 3/4" x 1" outlet. Size 2 1/2" x 2 1/4" x 3" — \$4.50 Each

DELCO MOTOR only—size: 1 1/2" x 1 1/2" x 2 1/4" — \$3.95

MAGNETRON MAGNETS Approx. 1800 Gauss, similar to left illustration — \$12.95 Square Type — similar to right illustration — \$20.00

Gauss. . . \$14.95. Horseshoe Type Magnets, as used on Magnetron Tubes; 25 lb. lift—size: 2 1/2 x 2 1/2 x 1 1/2. . . \$2.95. 75 lb. lift—SEND FOR FREE CATALOG! size: 4 x 3 1/2 x 3". \$4.95

FAIR RADIO SALES
132 SO. MAIN ST. • LIMA, OHIO

TECHNICAL SYSTEMS CORP.
12-01 43rd Ave., L. I. C. 1, N. Y.
RA 9-0652-3

TEST EQUIPMENT

AN/URM-25 10K-50MC Signal Generator
AN/URM-41 400-1000 MC Signal Generator
AN/URM-61 1.800-3000 MC Signal Generator
AN/URM-19-23 Power Bridges
AN/URM-64 900-2100 MC Signal Generator
AN/UPM-11 X-Band Range Calibrator
AN/UPM-12 X-Band V.S.W.R. Test Set
AN/UPM-15 Pulse Generator
AN/UPM-17 10-11,000 Spectrum Analyzer
AN/UPM-23
AN/UPM-33 X-Band Spectrum Analyzer
TS-62 X-Band Echo Box
TS-147 X-Band Signal Generator
TS-155 S-Band Signal Generator
TS-186 100-10,000 Precision Heterodyne Freq. Meter, 0.02% accuracy

TS-270 S-Band Echo Box
TS-132 150KC-20MC Noise Field Meter
TS-488 X-Band Echo Box
TS-587 15-400MC Noise Field Meter
TS-600, TS-606, TS-670, TS-857
LAE 520-1300 MC Signal Generator
LAF 90-600MC Signal Generator
LAG 1200-4000 MC Signal Generator
AN/APR-4 38-4000 MC Receiver
AN/ASQ-1 Magnetometer
AN/APN-3-CPN-2 Sheran
AN/ARC-27 200-400 MC Trans.-Rec.
AN/ARC-33-31 200-400 MC Trans.-Rec.
AN/ARN-13 Omni-Range
AN/ARN-6 100-1750 KC Direction Finder
AN/ARN-7 100-1750 KC Direction Finder
AN/CP5-5 Airport Search Radar
AN/TPS-10 3 CM Height Finder
AN/APS-10 3 CM Airbourne Nav. Radar
AN/APS-33 3 CM Airbourne Nav. Radar
AN/TRC-1-3-4 70-100 MC F-M. Radio Sets
AN/TRC-8 230-250 MC F.M. Radio Sets
AN/CRD-2 540 KC-30 MC Direction Finder

MANY OTHER TEST EQUIPMENTS AVAILABLE

AN/ARC-3 100-156 MC Trans.-Rec.
SCR-399 1.5-18 MC Hi-Power Mobile Radio
RC-132-342 1.5-18 MC Communication Receivers

RADIO - RADAR - JAMMING EQUIPMENT
Microwave Plumbing-R.F. Sources-Etc. If you Need Electronic Equipment, Contact us. Many Late Equipments Available.

ANTENNA PEDESTALS AVAILABLE
WRITE FOR OUR CATALOG

FOR SALE AND WANTED—Write for List
Used Radio Broadcast and TV Stations. Powers from 250 Watts Up. Studio Equip. Write for List.

GROUND INSTRUMENT LANDING SYSTEMS
We can supply complete I.L.S. Ground Stations. Including Glide Slope, Localizer, Marker Beacon Transmitting Systems with Complete Antenna Systems. These can be supplied at a nominal price. Write.

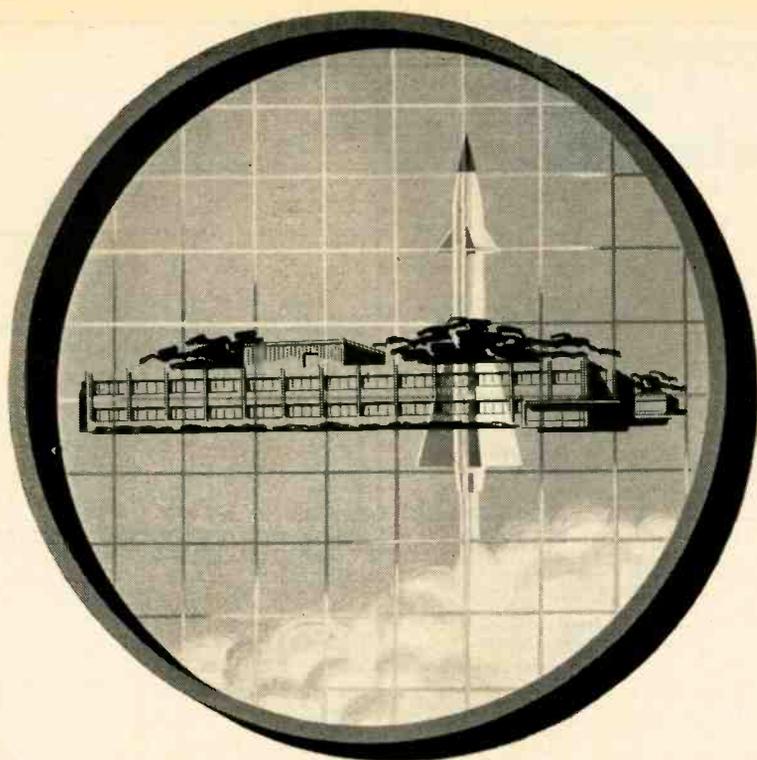
AN/TPS-1B
SEARCH RADAR WITH OR WITHOUT M.T.I. Modern transportable radar that will detect aircraft to 200 miles. A moving target indicator attachment can be supplied that will eliminate ground clutter and display only targets in motion. Min. range 1/2 mi. Both P.P.I. and "A" scope. 600 KW peak power. Oper. freq. 1300 MC. Can be supplied with gas or 110V 400 Cyc. power equip. Weight 2450 lbs. Occasionally we have AN/TPS-1D Sets.

MISC. EQUIP.
RC-120 7x10 Page Printing Facsimile Transceiver. Can be used on a wire or radio circuit. . . \$150
CPN-6 X-Band R.F. Source 40 KW 110V 60 Cyc Input complete . . . \$150
CPN-17 S-Band R.F. Source 40 KW 110V 60 Cyc Input complete . . . \$150
BC-1269 150-600 MC Communication Recvr. AM & FM 300 DC & 12V DC Input. . . \$150

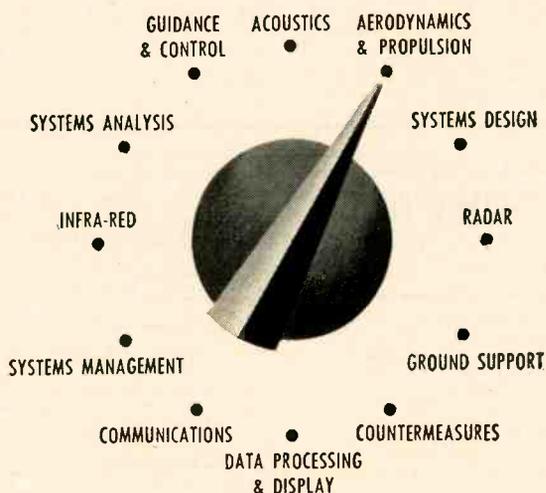
If there is anything you want that other readers can supply
OR . . . something you don't want— that other readers can use—
Advertise it in the
SEARCHLIGHT SECTION

RESISTORS & CAPACITORS
Any Types - Any Quantities
FULLY GUARANTEED
ALEXIMMA
4650 Livingston Ave. New York 71, N. Y.

Money saving prices on tubes. TV, Radio, Transmitting, and Industrial Types. New, 1st quality guaranteed. Top name brands only. Government surplus and commercial test, lab, and communications equipment in stock. Sell your excess tubes and equipment. Unused, clean tubes of all types wanted. Send specific details in first letter. Write for "Green Sheet" catalog 25c.
BARRY ELECTRONICS CORP.
512 Broadway WA 5-7000 New York 12, N. Y.



FOCAL POINT FOR SYSTEMS PLANNING



The Bendix Systems Division is located in a new two-story structure situated adjacent to the Engineering campus of the famed University of Michigan in Ann Arbor. Its new home, built this year, is divided equally between laboratory and office space. The first among several new units planned for the Division, this building is designed and completely equipped for the research and development of weapons systems.

The Systems Division, staffed with qualified engineers and scientists, is devoted to the exploration of new approaches to the development of military weapon systems. Serving as a focal point for the entire Bendix Corporation, it assures harmonious transition from beginning weapon concept to final system production.

If you are seeking an opportunity to engage in the development of advanced weapon systems and are a qualified engineer or scientist, you are invited to write the Bendix Systems Division, Dept. B926, Ann Arbor, Michigan. While working, you will be able to advance your education by attending daytime classes at the University of Michigan. And both you and your family will enjoy the many benefits of living in a noted university town in the heart of Michigan's "Water Wonderland."

Bendix Systems Division

ANN ARBOR, MICHIGAN



AGENTS

REQUIRED FOR BRITISH MANUFACTURER

Well known British Manufacturer of Radio Valves (Tubes) requires live agents for promotion of their sales in U. S. A. Applicants must be long established in the tube business as their sole interest, with a current and continuing knowledge of tubes in short supply, and be able to advise on types most in demand and the current prices for large buyers.

Write and give details why you consider you would be best suited for this live appointment.

RW-8821, Electronics
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

Sales engineer-manager, electrical or electronic engineering background for established manufacturer of electrical insulating materials. Must make Chicago area home office contacts. Unusual opportunity to right man interested in eventual part ownership of the business. In reply give complete resume.

P-8839, Electronics
520 N. Michigan Ave., Chicago 1, Ill.

CHIEF ENGINEER
PRECISION ELECTRO-MECHANICAL EQUIPMENT
\$15,000.00 to \$20,000.00
Dynamic Growing Midwest Company.
Contact in confidence.

HERBERT HALBRECHT ASSOCIATES
332 South Michigan Avenue Chicago 4, Illinois
HA 7-2876

IDEAL LOCATION

Growing concern located in large college town in Southwest needs engineers with one to four years experience in electronics, servo-mechanisms, computers and data handling. Profit sharing possibilities. Work on advanced degrees.

DORSETT LABORATORIES, INC.
401 East Boyd Street Norman, Oklahoma

ENGINEERS

If you have been looking for an Employment Agency that is skilled in the STATE OF THE ART of Technical Recruitment and RELIABILITY OF INFORMATION concerning positions, why not communicate with us at once!

ALL POSITIONS FEE PAID.
FIDELITY PERSONNEL SERVICE
1218 Chestnut St. Phila. 7, Pa.
Specialist in Aviation, Electronics and Nucleonics

POSITION VACANT

Electronic Circuit Design Engineers—Several years experience and graduate training desirable (but not required) for challenging circuit design problems. Ability to work in small, outstanding group on varied high caliber design projects e.g. computer techniques application, data accumulation and reduction, pulse amplifier and discriminator design. Phillips Petroleum Company, Atomic Energy Division, P.O. Box 1259-C.R. Idaho Falls, Idaho.

Your Inquiries to Advertisers Will Have Special Value . . .

—for you—the advertiser—and the publisher, if you mention this publication. Advertisers value highly this evidence of the publication you read. Satisfied advertisers enable the publishers to secure more advertisers and—more advertisers mean more information on more products or better service—more value—to YOU.

ELECTRONIC ENGINEERS

needed at

MARTIN

New long-term developments at Martin in the field of electronics have created exceptional opportunities for top electronic engineers. At least 5 years experience required. Salaries from \$9,000 to \$15,000.

Openings

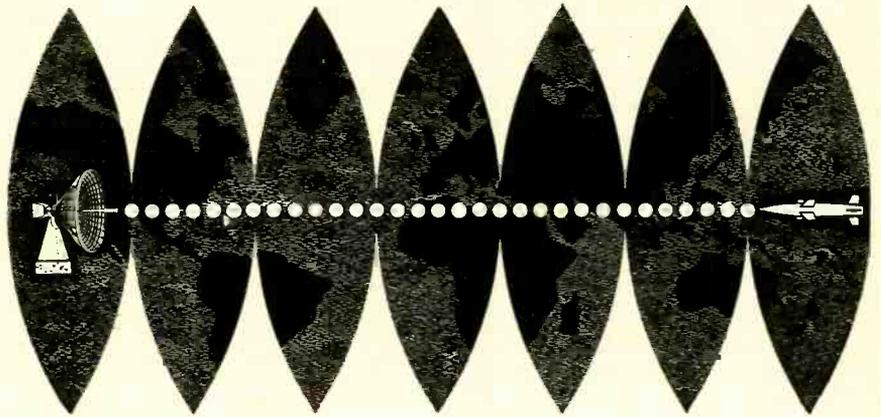
In these areas:

- Circuit Design
- Systems
- Inertial Guidance
- Countermeasures
- Digital Computers
- Test Equipment Design

WRITE TO:

William Spangler, Manager
Professional Employment
Department E-9
The Martin Company
Baltimore 3, Md.

MARTIN
BALTIMORE



BMEWS

BALLISTIC MISSILE EARLY WARNING SYSTEM

Now . . . RCA challenges engineers with positions in this project, involving • Prime importance to national security • Advanced work in the ICBM field • World's most advanced radar system • Work in small, creative RCA engineering groups . . . with RCA Moorestown's modern facilities . . . in pleasant suburban surroundings, easily accessible. Receive liberal RCA benefits . . . fine starting salaries . . . and enjoy every advancement possibility.

*RCA's Moorestown Engineering Laboratories
need EE's, ME's and Physicists for . . .*

- SYSTEMS ENGINEERING • DESIGN & DEVELOPMENT
- PROJECT ENGINEERING • ENGINEERING MANAGEMENT

You should have experience in one of these areas . . .

- Hi Power Transmitters • Receivers • Servomechanisms • Computers • Radar Antennas • Microwave Components • Pulse Circuitry • Cathode Display Devices

FOR INTERVIEW WITH ENGINEERING MANAGEMENT

Call collect or write: Mr. W. J. Henry—BELmont 5-5000
Engineering Employment, Dept. V-10-J
Radio Corporation of America, Moorestown, New Jersey
Only 8 miles from Philadelphia



RADIO CORPORATION of AMERICA

MISSILE AND SURFACE RADAR DEPARTMENT

Tmk(s) ©

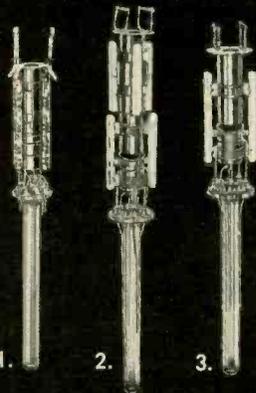


Why do I favor
**SUPERIOR
ELECTRONICS**
for electron
GUN MOUNTS?

Because this firm

- ★ Has pioneered many new manufacturing techniques
- ★ Is constantly improving the quality of its gun mounts
- ★ Offers uniform product performance and dependable service
- ★ Assures me of fair prices

- 1 -
New! 110°
deflection
gun
- 2 -
Electro-
static
focus gun
- 3 -
Electro-
magnetic
gun



*World's oldest and largest
exclusive manufacturer of
quality electron gun mounts*

- 4 -
Electro-
static
deflection
gun
- 5 -
Special
purpose
gun
- 6 -
New!
Short neck
90° gun



WRITE FOR DESCRIPTIVE MATERIAL

SUPERIOR
EE
ELECTRONICS
CORPORATION

Gregory 2-2500

210 PIAGET AVE., CLIFTON, N. J.

CIRCLE 223 READERS SERVICE CARD

INDEX TO ADVERTISERS

AMP Incorporated	41	Eitel-McCullough, Inc.	61
Ace Electronics Associates, Inc.	98	Elco Corporation	15
Adams-Russell Co., Inc.	130	Electric Regulator Corp.	52
Aeronautical Communications Equipment Inc.	40	Electro Instruments Inc.	46
Airpax Products Co.	114	Electro Motive Mfg. Co., Inc.	55
Allegheny Ludlum Steel Corp.	50	Empire Devlees Products Corporation ...	120
Allied Radio Corp.	109	Erie Electronics Division, Erie Resistor Corp.	117
American Rondo Corp.	140	Esterline-Angus Company, Inc.	143
Arnold Engineering Co., The.	10		
Audio Devices, Inc.	116		
		Fairchild Controls Corp., Components Division	123
Baker Chemical Co., J. T.	47		
Bead Chain Mfg. Co.	146		
Beede Electrical Instrument Co., Inc.	42	G M Laboratories, Inc.	142
Bell Telephone Laboratories.	23	Garrett Corporation, The	94, 95
Bendix-Pacific Div. of Bendix Aviation Corp.	122	General Ceramics Corp.	24
Blaw-Knox Company	36	General Electric Co. Apparatus	139, 151
Bussmann Mfg. Co.	34	Tube Dept.	38, 39
		Magnetic Materials Section	129
		General Radio Co.	48, 49
C B S Hytron, A Div. of Columbia Broadcasting System, Inc.	35	Genisco, Inc.	56, 57
Cambridge Thermionic Corp.	19, 20, 21, 22	Giamini & Co., Inc., G. M.	127
Celco-Constantine Engineering Labora- tories Co.	108	Goodrich, Company B. F.	101
Centralab, A Division of Globe-Union, Inc.	104	Grant Pulley & Hardware Corp.	4
Chance Vought Aircraft Inc.	102, 103		
Cohn Corp., Sigmund	152	Haydon Co., Inc., A. W.	131
Control Electronics Co., Inc.	122	Helipot Div. of Beckman Instruments ...	121
Constantine Engineering Laboratories Co.	108	Hewlett-Packard Company ...	25, 2nd Cover
Copper & Brass Research Associa- tion	26, 27	Hughes Products, a Div. of Hughes Aircraft Co.	30, 31, 53
Cornish Wire Co., Inc.	129		
Cossor (Canada) Limited	146	Illinois Condenser Co.	139
Coto-Coil Co., Inc.	139	International Resistance Co.	29
Cross Co., H.	144		
Cubic Corp.	99	Jerrold Electronics Corp.	96
Cutler-Hammer Inc.	140		
		Kay Electric Co.	58
Driver, Wilber B.	125	Kepeco Laboratories, Inc.	93
		Kintel A Division of Cohn Electronics, Inc.	13
Eastern Industries, Inc.	91		
Edison Industries, Thomas A.	63		

Klein & Sons, Mathias.....	111
Krengel Manufacturing Co.....	145
Lambda Electronics Corp.....	9
Lapp Insulator Co., Inc.....	105
Leach Corporation.....	32
Mallory and Co., Inc., P. R.....	64
Marconi Instruments, Ltd.....	128
Marion Electrical Instrument Co.....	126
McGraw-Hill Book Company, The.....	60
Microwave Associates, Inc.....	110
Mullard Overseas, Ltd.....	62
Narda Corporation.....	107
Nems-Clarke, Inc.....	152
Non-Linear Systems, Inc.....	33
North American Aviation Inc.....	126, 131
Offner Electronics, Inc.....	51
Packard Bell Electronics.....	43
Phalo Plastics Corp.....	44
Phelps-Dodge Copper Products Corp., Inca Mfg. Div.....	59
Philco Corporation.....	135
Potter & Brumfield, Inc.....	113
Potter Instrument Co., Inc.....	133
Radiation, Inc.....	119
Radio Corporation of America.....	14th Cover
Radio Materials Company.....	11
Raytheon Mfg. Company.....	6, 124, 132, 138
Rotroff Manufacturing Co., Inc.....	118
Simpson Electric Company.....	97
Sorensen & Co.....	5
Sperry Microwave Electronics Co., Divi- sion of Sperry Rand Corp.....	37
Sprague Electric Co.....	3, 17
Stevens Arnold, Inc.....	143
Stromberg-Carlson A Division of General Dynamics Corporation.....	54
Superior Electronics Corp.....	150

From General Electric . . .

PLAIN TALK ON TANTALYTIC* CAPACITOR AVAILABILITY

It's time for plain talk on the facts of tantalum electrolytic capacitor availability. There is no "availability" problem as far as General Electric is concerned.

Here's why:

- No metal shortage—Stocks of capacitor-grade tantalum have doubled within the past year.
- No production capability shortage—General Electric's production facilities have tripled in the past year.
- No delivery bottlenecks—General Electric's improved manufacturing processes and techniques have virtually eliminated production rescheduling.
- Few military directive priorities—Since the supply of Tantalytic capacitors has met demand, the military requirements can be met without directive priorities.

This is why we say—now and in the future, General Electric will continue to provide Tantalytic capacitors in the types and ratings you want—when you want them.

For specific information on Tantalytic capacitor ratings, prices, deliveries, contact your nearest General Electric Apparatus Sales Office or write to General Electric Co., Section 449-4, Schenectady 5, N. Y.

*Registered trade-mark
of General Electric Co.

**Trade-mark of
General Electric Co.



SOLID TANTALYTIC CAPACITORS
—for transistorized circuit applications—rated up to 60 volts, polar units only—sizes down to 0.125 inches by 0.250 inches.

125C TANTALYTIC CAPACITORS—for aircraft electronic systems—ratings 10-180 mfd, 30 to 100 volts. Sizes 1/2 to 1 1/8 inches in height. Also tubular, double-cased units.

KSR TANTALYTIC CAPACITORS**—for missiles, radar, airborne electronic equipment applications—ratings up to 3500 mfd—three case sizes 1.375, 2, 2.5 inches in height.

85C TANTALYTIC CAPACITORS
—for applications requiring high quality but where temperatures are less severe.

GENERAL  ELECTRIC

For the finest in **RECEIVERS** Specify **NEMS • CLARKE**



TYPE 1401-A RECEIVER—SPECIFICATIONS

Type of Reception	FM/FM and PWM/FM
Frequency Range	216-245 Megacycles determined by plug-in crystals.
Noise Figure	Less than 7 db.
IF Bandwidth	Wide band—500 KC bandwidth at 3 db points. Attenuation \pm 500 KC from center frequency greater than 60 db. Narrow band—100 KC band-width at 3 db points. Attenuation \pm 250 KC from center frequency greater than 60 db.
Video Output	Sensitivity —0.16 volts peak-to-peak per KC of deviation. Frequency response within 3 db. AC coupled—10 CPS to 100 KC per second. Adjustable output control on front panel.
Vu Meter in Video Output Circuit	Frequency response, flat over frequency range of 400 cycles to 80,000 cycles. Provided with front panel adjustable reference level control.
Spectrum Display Output	Provisions for connecting a 30 MC Spectrum Display Unit (NEMS-CLARKE, Inc., SDU-200)
Frequency Monitor Output	30 MC
Frequency Deviation Meter	Peak reading over frequency range from 400 to 80,000 CPS. Three scales 25, 75 and 150 KC.

NEMS • CLARKE COMPANY

A DIVISION OF VITRO CORPORATION OF AMERICA
919 JESUP-BLAIR DRIVE • SILVER SPRING, MARYLAND
CIRCLE 225 READERS SERVICE CARD

Telechrome, Inc. 115
Telrex Laboratories 145
Texas Instruments Incorporated... 3rd Cover
Tung-Sol Electric, Inc. 45

Ungar Electric Tools, Inc. 141

Vector Electronic Co. 144

Vitramon Inc. 137

Weinschel Engr. & Mfg. Corp. 126

White Dental Mfg. Co., S. S. 142

Zippertubing Company, The ... 28

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES. 148-149

EQUIPMENT
(Used or Surplus New)
For Sale..... 147

ADVERTISERS INDEX

Aleximma 147
Barry Electronics Company..... 147
Bendix Systems Division..... 148
Blan 147
Dorsett Laboratories Inc..... 148
Fair Radio Sales..... 147
Fidelity Personnel Service..... 148
Halbrecht Associates, Herbert..... 148
Martin Company 149
Radio Corp. of America..... 149
Radio Research Instrument Co..... 147
Technical Systems Corp..... 147

This index is published as a service. Every care is taken to make it accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.

Specialists in the Unusual

Anodized Aluminum Wire

.0008" TO .030" DIAM.

HIGH DIELECTRIC COATING

INSULATION AT 800° F.

To fill a need for high temperature insulation in a high conductivity wire. Precision drawn to close resistance control in the smaller sizes.

Write for List of Products

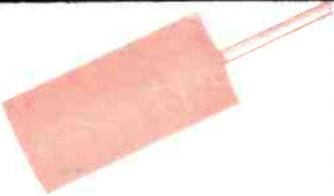
Since  1901

SIGMUND COHN CORP. INC.

121 SOUTH COLUMBUS AVE., MOUNT VERNON, N. Y.



High capacitance value in small package provided by TI precision formed pellet.



Safe dielectric stress is determined by anodized coating of tantalum pentoxide.



Solid MnO₂ electrolyte cannot leak.



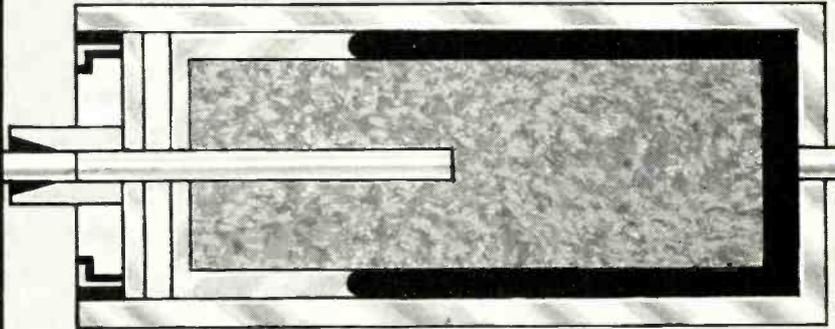
Positive bond to solder base for cathode connection assured by copper coating.

3x Actual Size



Mounts in any position . . . hermetically sealed, metal case is shock resistant.

YOU GET STABLE PERFORMANCE



...with precision built

tan-TI-cap*

solid tantalum capacitors

You are assured of precision electrical performance throughout extra long storage and service life by TI advanced construction techniques and high purity materials in *tan-TI-cap* capacitors.

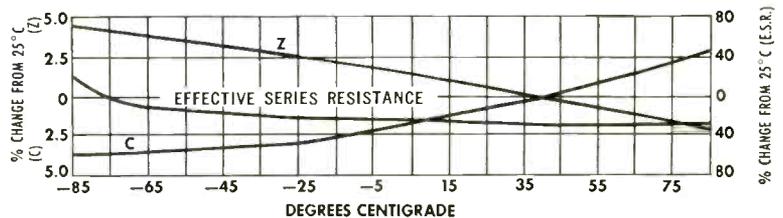
tan-TI-cap capacitors are ideally suited for use in transistor and other miniature circuit applications . . . firmly anchored leads can be bent sharply close to the case for easy mounting.

Stable electrical characteristics remain within narrow limits throughout temperature range (-80° to +85°C).

*Trademark of Texas Instruments Incorporated

SELECT FROM 17 RATINGS . . .

6-Volt	22 μ f	33 μ f	47 μ f	60 μ f	200 μ f
15-Volt	10	15	22	33	100
25-Volt	5	10	15	35	55
35-Volt	4	8			



AVAILABLE OFF THE SHELF FROM YOUR NEARBY DISTRIBUTOR



NEW 310,000 sq ft SEMICONDUCTOR-COMPONENTS DIVISION HOME



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



Preferred
Tube Type

RCA-6L6-GB offers



RECORD PERFORMANCE

to designers of "juke" box, public address and home phonograph equipment



Twenty-two years ago RCA introduced the 6L6 beam-power tube and a new era in high power audio system designs was born. Today, the modern version of this famous prototype, the 6L6-GB is one of 62 Preferred Tube Types available to meet your TV, AM and FM receiver requirements.

As a Preferred Tube Type, the 6L6-GB receives thorough and continuous evaluation for performance, quality and low cost. For example, the RCA-6L6-GB was developed with a smaller envelope than the 6L6-G to meet the need for compact modern design. The cathode is made of a specially selected alloy to provide increased strength

and rigidity...plate and mica supports are thicker and sturdier for increased heat dissipation.

Ask your RCA Field Representative for full information on the RCA Preferred Tube Types. Or write for technical data to RCA Commercial Engineering, Section I-19-Q-4, Harrison, N. J.

FREE! SLIDE GUIDE TO PREFERRED TUBE TYPES helps you quickly select the tube needed for a specific service. Puts base diagrams and other important characteristics at your fingertips. Call or write your RCA Field Office for your free Slide Guide.



RADIO CORPORATION OF AMERICA

Electron Tube Division

Harrison, N. J.

RCA Field Offices:

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

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

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