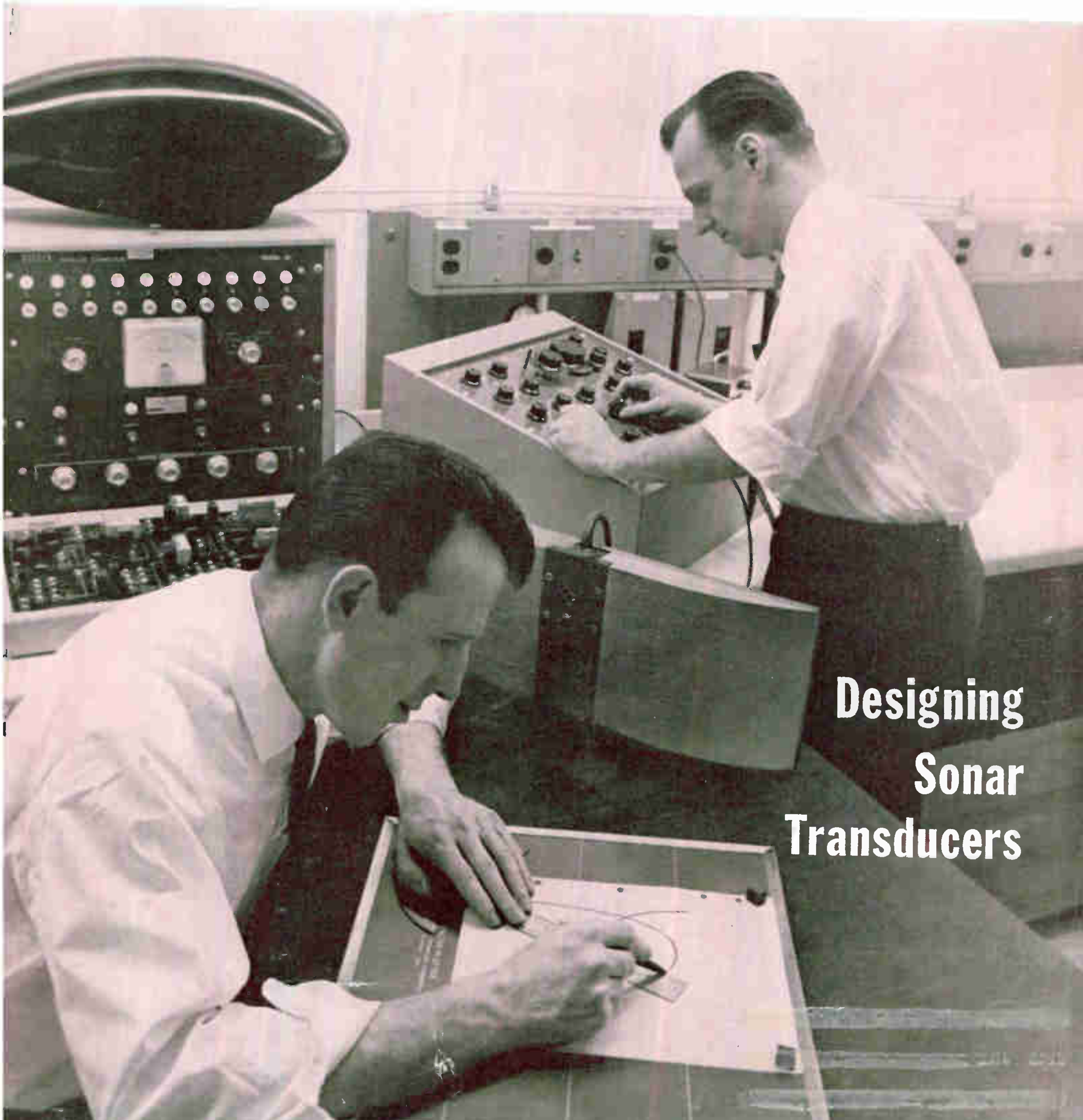
New Diodes: Commercial Implications

page 36

electronics

A McGRAW-HILL PUBLICATION FEBRUARY 26, 1960 PRICE SEVENTY-FIVE CENTS



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UTC stock hermetic units have been fully proved to MIL-T-27A, eliminating the costs and delays normally related to initial MIL-T-27A tests. These rugged, drawn case, units have safety factors far above MIL requirements, and are ideal for high reliability industrial applications. Listed below are a few of the hundred stock types available for every application. Industrial ratings in **bold**.

Typical Miniature Audios

RC-25 Case
61/64 x 1-13/32 x 1-9/16
1.5 oz.

Type No	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	Unbal. DC in Pri. MA	Response 2 db (Cyc.)	Max. level dbm
H-1	Mike, pickup, line to grid	TF4RX10YY	50, 200CT, 500CT	50,000	0	50-10,000	+ 5
H-2	Mike to grid	TF4RX11YY	82	135,000	50	250-8,000	+18
H-5	Single plate to P.P. grids	TF4RX15YY	15,000	95,000 CT	0	50-10,000	+ 5
H-6	Single plate to P.P. grids, DC in Pri.	TF4RX15YY	15,000	95,000 split	4	200-10,000	+11
H-7	Single or P.P. plates to line	TF4RX13YY	20,000 CT	150/600	4	200-10,000	+21
H-8	Mixing and matching	TF4RX16YY	150/600	600 CT	0	50-10,000	+ 8
H-14	Transistor interstage	TF4RX13YY	10K/2.5K, Split	4K/1K split	4	100-10,000	+20
H-15	Transistor to line	TF4RX13YY	1,500 CT	500/125 split	8	100-10,000	+20

Typical Compact Audios

RC-50 Case
1-5/8 x 1-5/8 x 2-5/16
8 oz.

Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	Unbal. DC in Pri. MA	Response + 2 db (Cyc.)	Max. level dbm
H-20	Single plate to 2 grids, can also be used for P.P. plates	TF4RX15YY	15,000 split	80,000 split	0	30-20,000	+12
H-21	Single plate to P.P. grids, DC in Pri.	TF4RX15YY	15,000	80,000 split	8	100-20,000	+23
H-22	Single plate to multiple line	TF4RX13YY	15,000	50/200, 125/500	8	50-20,000	+23
H-23	P.P. plates to multiple line	TF4RX13YY	30,000 split	50/200, 125/500	8 BAL.	30-20,000	+19
H-24	Reactor	TF4RX20YY	450 Hys.-0 DC, 250 Hys.-5 Ma. DC, 6000 ohms 65 Hys.-10 Ma. DC, 1500 ohms				
H-25	Mixing or transistors to line	TF4RX17YY	500 CT	500/125 split	20	40-10,000	+30

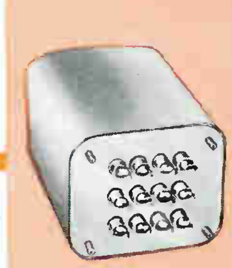
Typical Subminiature Audios

SM Case
1/2 x 11/16 x 29/32
.8 oz.

Type No	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	Unbal. DC in Pri. MA	Response + 2 db (Cyc.)	Max. level dbm
H-31	Single plate to 1 grid, 3:1	TF4RX15YY	10,000	90,000	0	300-10,000	+13
H-32	Single plate to line	TF4RX13YY	10,000	200	3	300-10,000	+13
H-33	Single plate to low imp.	TF4RX13YY	30,000	50	1	300-10,000	+15
H-35	Reactor	TF4RX20YY	100 Henries-0 DC, 50 Henries-1 Ma. DC, 4,400 ohms.				
H-36	Transistor interstage	TF4RX15YY	25,000 (DCR800)	1,000 (DCR110)	.5	300-10,000	+10
H-39	Transistor interstage	TF4RX13YY	10,000 CT (DCR600)	2,000 CT	2	300-10,000	+15
H-40A	Transistor output	TF4RX17YY	500 CT (DCR26)	600 CT	10	300-10,000	+15

Typical Power Transformers

Pri: 115V 50/60 Cyc.
*Choke/Cond. Inp.



Type No.	HV Sec. CT	DC MA*	Military Rating Fil. Secs.	DC MA*	Industrial Rating Fil. Secs.	Case
H-80	450	120	6.3V,2A	**130**	**6.3V,2.5A.**	FA
H-81	500/550	65/55	6.3V,3A-5V,2A	**75/65**	**6.3V,3A.-5V,2A.**	HA
H-82	540/600	110/65	6.3V,4A.-5V,2A.	**180/100**	**6.3V,4A.-5V,2A.**	JB
H-84	700/750	170/110	6.3V,5A.-6.3V,1A.,5V-3A.	**210/150**	**6.3V,6A.-6.3V,1.5A.-5V,4A.**	KA
H-89	850/1050	320/280	6.3V,8A.-6.3V,4A.,5V-6A.	**400/320**	**6.3V,8A.-6.3V,4A.-3V,6A.**	OA

Typical Filament Transformers

Pri: 105/115/210/220V except H-130 (115) and H-131 (115/220) 50/60 Cyc.

Type No.	Sec. Volts	Amps.	Test Volts	Case
H-121	2.5	10(12)	10 KV	JB
H-122	2.5	20(26)	10 KV	KB
H-125	5	10(12)	10 KV	KB
H-130	6.3 CT	.6(.75)	1500	AJ

Type No.	Sec. Volts	Amps.	Test Volts	Case
H-131	6.3 CT	2(2.5)	2500	FB
H-132	6.3 CT 6.3 CT	6(7) 6(7)	2500	JA
H-133	6.3 CT	7(8)	2500	HB
H-134	6.3 CT	10(12)	2500	HA

Typical Filter Reactors

Type No.	MIL Type	Ind. Hys.	@ MA DC	Ind. Hys.	@ MA DC	Ind. Hys.	@ MA DC	Ind. Hys.	@ MA DC	Res. Ohms	Max. DCV Ch. Input	Test V. RMS	Case
H-71	TF1RX04FB	20	40	18.5	50	15.5	60	10	70	350	500	2500	FB
H-73	TF1RX04HB	11	100	9.5	125	7.5	150	5.5	175	150	700	2500	HB
H-75	TF1RX04KB	11	200	10	230	8.5	250	6.5	300	90	700	2500	KB
H-77	TF1RX04MB	10	300	9	350	8	390	6.5	435	60	2000	5500	MB
H-79	TF1RX04YY	7	800	6.5	900	6	1000	5.5	1250	20	3000	9000	7x7x8

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FEBRUARY 26, 1960

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electronics

February 26, 1960 Vol. 33, No. 9

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SHOPTALK . . . editorial

ELECTRONICS AND PSYCHOLOGY. If anyone had asked us, a year or so ago, with which sciences electronics was likely to have direct interplay, we'd probably not have named psychology among the first two dozen. But there's really no holding this technology—ultimately, it gets into everyone's backyard.

There is an article in this issue (p 45) which discusses the intriguing possibility that negative or positive ions in the air may affect the health and wellbeing of the breather. Since we wake up some mornings with inexplicable headaches, stuffed respiratory tract, or general malaise, we're intuitively inclined to accept some of the research findings mentioned in the story. We're also intrigued by some of the ramifications.

Some storekeepers think that ionizers in an air-conditioning system may hold down shoplifting and pilferage. If positively ionized air truly contributes to mental aberration we can extend the possible applications of ionizers far beyond the department store. How about schools and research labs, to encourage clear thinking and productivity? And in the halls of Congress, and the United Nations?

Coming In Our March 4 Issue . . .

SOLID-STATE PROGRESS. Some of the most exciting developments in our industry are taking place in the application of solid-state physics to electronic components, devices and circuits. Nowhere was the great interest in solid-state technology more in evidence than at the recent International Solid-State Circuits Conference in Philadelphia. Some 3,000 engineers attended daytime and evening sessions devoted to device applications and circuits. So great was the turnout for the first day's papers, particularly those on the tunnel diode, that the sessions had to be repeated.

To bring you highlights of this important conference, Associate Editor Perugini and Assistant Editor Lindgren teamed up to cover sessions, interview prominent visitors and probe into the possible future significance of reported developments. As a result, next week's conference roundup adds up to a red-hot progress report on solid-state circuits. You'll read about new circuit applications for tunnel diodes, the latest trends in microelectronics, results of recent investigations into the properties of thin magnetic films, and the latest information about storage techniques.

Some of the interesting developments reported in next week's article include a shift register using only tunnel diodes and passive elements, an evaporated-film cryotron shift register, an experimental solid-state neuron circuit and a semiconductor diode that might be used as an inductance.

PHASEMETER. Measuring phase in the uhf region has generally been laborious and less accurate than required for some electronic applications, such as phased antenna arrays.

In our next issue, R. T. Stevens of Electronics Systems, Inc., in Boston, Mass., describes a new phasemeter that operates in the band from 100 to 520 mc and measures the phase between two signals to within 0.2 degree for c-w and to within 0.5 degree for pulsed r-f. If the i-f is changed, the same method can be used down to 20 mc and, with suitable preamplifying equipment, operation up to X band is possible.

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Reliability in a "wrap-and-endfill" at last! . . . Sprague Yellow-Jacket Filmite "E" Capacitors. The design of these small, lightweight film capacitors is based on the most extensive life test data for polyester film dielectrics available at the present time. These capacitors will withstand a 250 hour accelerated life test of 150% of the 85 C rated voltage impressed or the equivalent derated 125 C voltage. *Not more than 1 failure is permitted in 25 samples tested.*

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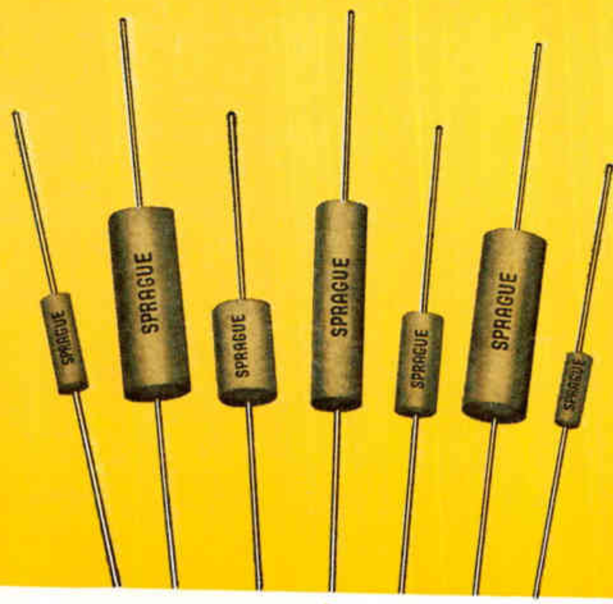

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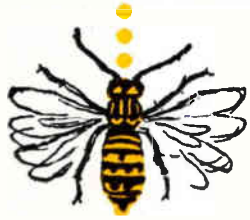

Because of their outstanding resistance to humidity, vibration, and shock, Type 158P Yellow-Jacket Capacitors are ideal for many military, computer, industrial control, and similar applications. They are particularly well-suited for potting or encapsulating in electronic sub-assemblies, filters, etc.

For complete engineering data on Military-Grade Yellow-Jacket Film Capacitors (Type 158P) write for Engineering Bulletin 2301. Data on Sprague's Commercial and Entertainment Grade Yellow-Jacket Capacitors (Types 148P and 149P) is given in Bulletin 2063A. Both bulletins are available from Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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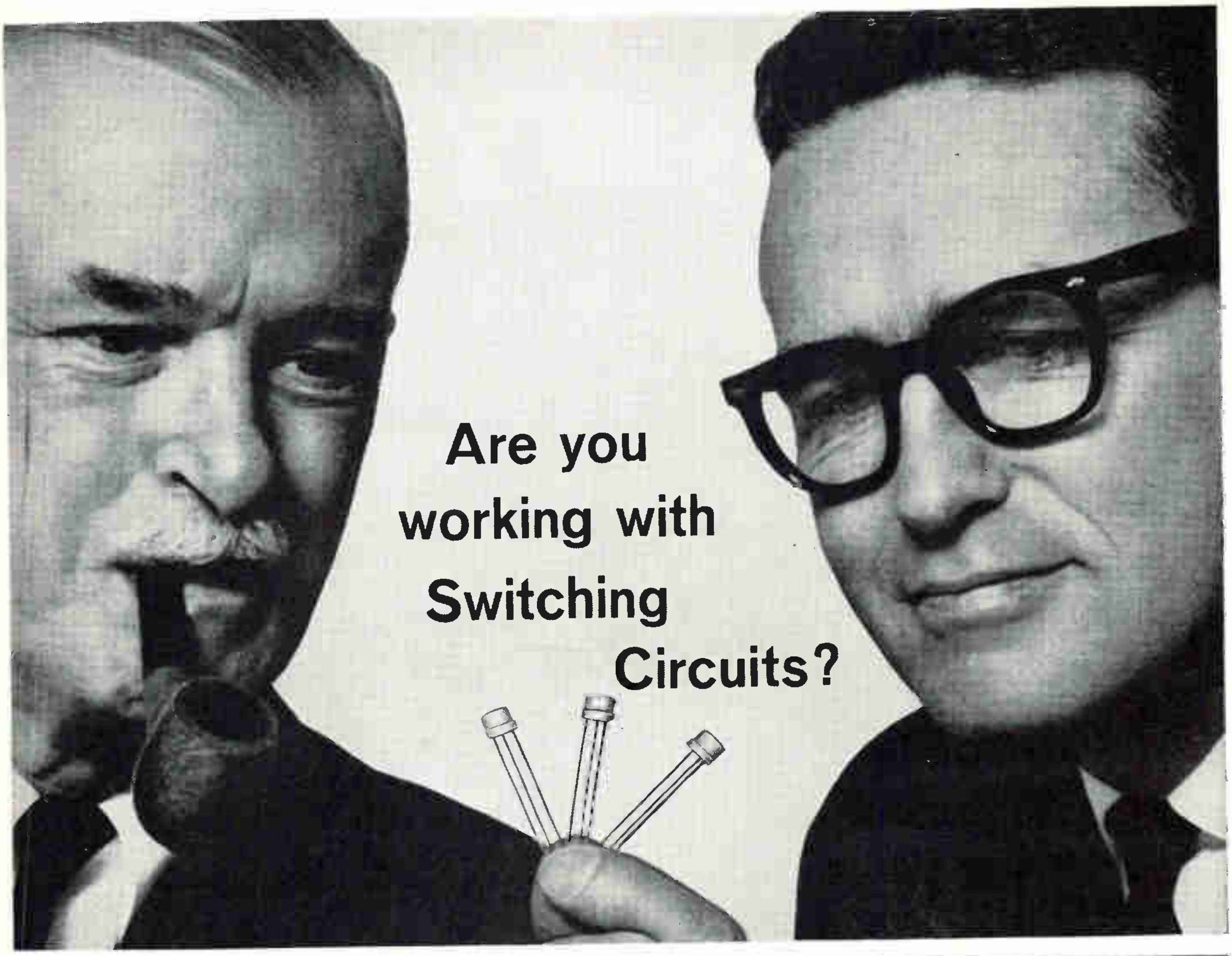

"Old timer" or "new hand" at designing transistorized switching-circuits, you'll find useful information in this 24-page Sylvania booklet now available at no charge!

"Sylvania Medium and High Speed Switching Transistors" contains practical data that will help you select the best transistor-type for a specific application. Typical switching circuits, with parts values, are included. Absolute maximum ratings and electrical characteristics under minimum, typical and maximum conditions are tabulated for many of the SYLVANIA NPN and PNP SWITCHING TRANSISTORS frequently specified for electronic computers. Given, too, are mechanical specifications for the TO-5 case in which they are supplied. Briefly described are the extraordinary SYLVANIA quality-controls and production-techniques that assure reliable performance of Sylvania Switching Transistors under severe environmental conditions.

Send for your copy today. Specify the "Sylvania Switching Transistor Booklet." Write: SYLVANIA SEMICONDUCTOR DIVISION, Dept. 223-B, WOBURN, MASS.

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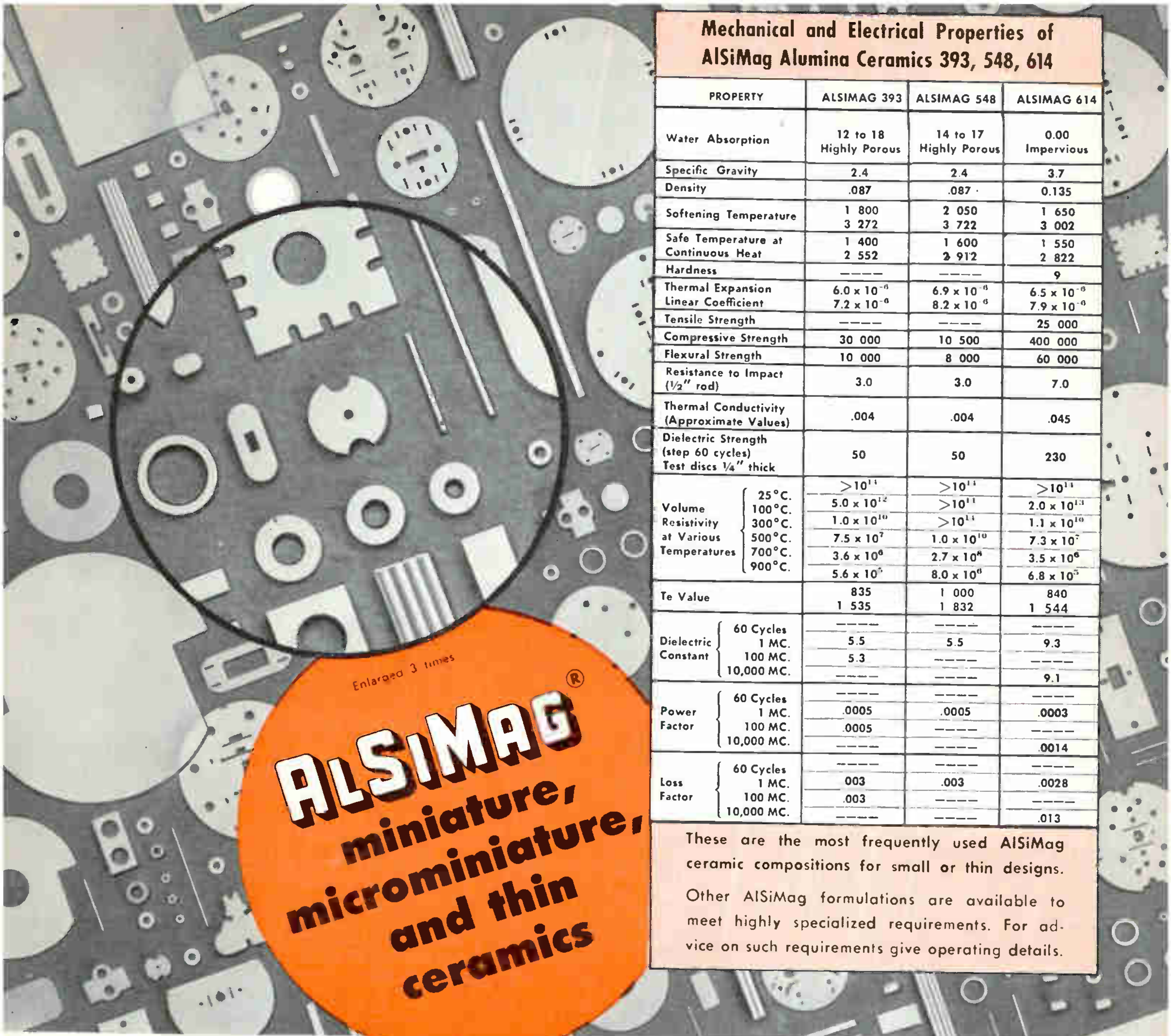

AlSiMag ceramics actual size

Mechanical and Electrical Properties of AlSiMag Alumina Ceramics 393, 548, 614

PROPERTY		ALSIMAG 393	ALSIMAG 548	ALSIMAG 614
Water Absorption		12 to 18 Highly Porous	14 to 17 Highly Porous	0.00 Impervious
Specific Gravity		2.4	2.4	3.7
Density		.087	.087	0.135
Softening Temperature		1 800 3 272	2 050 3 722	1 650 3 002
Safe Temperature at Continuous Heat		1 400 2 552	1 600 2 912	1 550 2 822
Hardness		————	————	9
Thermal Expansion Linear Coefficient		6.0×10^{-6} 7.2×10^{-6}	6.9×10^{-6} 8.2×10^{-6}	6.5×10^{-6} 7.9×10^{-6}
Tensile Strength		————	————	25 000
Compressive Strength		30 000	10 500	400 000
Flexural Strength		10 000	8 000	60 000
Resistance to Impact (½″ rod)		3.0	3.0	7.0
Thermal Conductivity (Approximate Values)		.004	.004	.045
Dielectric Strength (step 60 cycles) Test discs ¼″ thick		50	50	230
Volume Resistivity at Various Temperatures	25°C.	$>10^{11}$	$>10^{11}$	$>10^{11}$
	100°C.	5.0×10^{12}	$>10^{11}$	2.0×10^{13}
	300°C.	1.0×10^{10}	$>10^{11}$	1.1×10^{10}
	500°C.	7.5×10^{7}	1.0×10^{10}	7.3×10^{7}
	700°C.	3.6×10^{6}	2.7×10^{8}	3.5×10^{6}
	900°C.	5.6×10^{5}	8.0×10^{6}	6.8×10^{5}
Te Value		835 1 535	1 000 1 832	840 1 544
Dielectric Constant	60 Cycles	————	————	————
	1 MC.	5.5	5.5	9.3
	100 MC.	5.3	————	————
	10,000 MC.	————	————	9.1
Power Factor	60 Cycles	————	————	————
	1 MC.	.0005	.0005	.0003
	100 MC.	.0005	————	————
	10,000 MC.	————	————	.0014
Loss Factor	60 Cycles	————	————	————
	1 MC.	.003	.003	.0028
	100 MC.	.003	————	————
	10,000 MC.	————	————	.013

These are the most frequently used AlSiMag ceramic compositions for small or thin designs. Other AlSiMag formulations are available to meet highly specialized requirements. For advice on such requirements give operating details.

AlSiMag pioneered the custom manufacture of ceramics for modules and for micromodules and has long been known for its leadership in precision ceramics in small sizes and thin cross sections. Long experience has helped produce miniature and sub-miniature ceramics to tolerances generally associated with fine metal work.

Uniformity of material and dimension is necessary to reach goals of micro-miniaturization.

AlSiMag ceramics are playing their part in increasing reliability of these components and in greatly reducing sizes of sub-miniature electronic components.

Even the close tolerances required in vacuum tube insulators and spacers are maintained in these AlSiMag microminiature ceramics without grinding. Tubes with walls as thin as .010″ and flat shapes as thin as .005″ are produced regularly.

These precision ceramics are widely used as electron tube components . . . supports, spacers, envelopes, windows . . .and as micromodule wafers, transistor bases, relay components, etc.

See Booth No. 4502 at I.R.E. March 21-24.

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Specifications

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Stability:	± 2% to 100 KC, ± 3% above
Output:	15 mw or 3 v into 600 ohms; 6 v open circuit
Voltage Range:	0.00003 to 3 v
Frequency Response:	Flat within 1 db full range
Distortion:	Less than 1% to 100 KC, less than 2% to 1 MC, 5% at 10 MC
Output Monitor:	VTVM monitors attenuator input in v or db
Output Attenuator:	50 db attenuation in 10 db steps; output variable continuously from + 12 to — 50 dbm
Hum:	Less than 0.5% full scale
Price:	$490.00 (cabinet) $475.00 (rack mount)

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Special Advantages No transients, continuously variable 0.008 to 1,200 cps, electronically synthesized sine, square or triangular waves, 1% stability, 0.2 db response, less than 1% distortion on all but x 100 range.

hp 202A LOW FREQUENCY FUNCTION GENERATOR

Specifications

Frequency Range:	0.008 to 1,200 cps, 5 bands
Frequency Stability:	1%, including warm-up
Output Waveforms:	Sine, square, triangular
Output Voltage	30 v peak-to-peak across 4,000 ohms, all waveforms
Internal Impedance:	Approx. 40 ohms full range
Sinewave Distortion:	Less than 1% except 2% on x 100 range
Output System:	Floating; either side may be grounded
Frequency Response:	Constant within 0.2 db
Hum:	Less than 0.05% of max. output
Sync Pulse:	10 v peak neg., less than 5 μsec duration
Price:	$525.00 (cabinet) $510.00 (rack mount)

6008

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hp 205AG AUDIO SIGNAL GENERATOR

Specifications

Frequency Range:	20 cps to 20 KC, 3 bands	**Distortion:**	Less than 1% above 30 cps
Frequency Stability:	Better than 2% long term	**Hum:**	60 db below output voltage or 90 db below zero level
Output:	5 watts into matched load	**Input, Output Meters:**	Read direct in v or dbm
Frequency Response:	± 1 db full range to + 30 dbm; ± 1.5 db above + 30 dbm	**Input Attenuator:**	Extends meter range to + 48 dbm and 200 v rms, 5 db steps
Output Impedances:	50, 200, 600, 5,000 ohms; circuit is balanced and center-tapped; any terminal may be grounded	**Output Attenuator:**	110 db in 1 db steps
		Price:	$500.00 (cabinet) $485.00 (rack mount)

hp 206A—LESS THAN 0.1% DISTORTION TO 20 KC

Many Uses Precision, convenient audio voltage source, ideal for checking FM transmitter response and distortion; broadcast studio performance, high quality, high fidelity amplifier testing and transmission measurements.

Special Advantages Continuously variable audio frequency voltage, 0.2 db response. Represents the ultimate in voltage output accuracy and low distortion at any level, 2% frequency stability, less than 0.1% distortion. 111 db attenuator with 0.1 db steps.

hp 206A AUDIO SIGNAL GENERATOR

Specifications

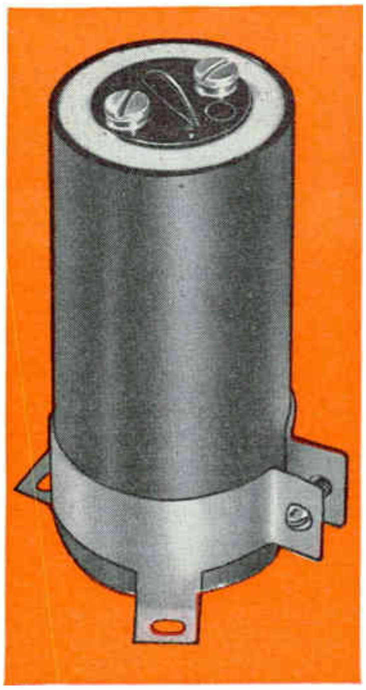
Frequency Range:	20 cps to 20 KC, 3 bands	**Frequency Response:**	Better than 0.2 db, 30 cps to 15 KC
Calibration:	Direct in cps, 20 to 200 cps	**Distortion:**	Less than 0.1% above 50 cps
Frequency Stability:	± 2% including warmup drift	**Hum:**	At least 75 db below output or 100 db below zero level
Output:	± 15 dbm into 50, 150 and 600 ohms	**Output Attenuators:**	111 db in 0.1 db steps
Output Impedances:	50, 150 and 600 ohms balanced; 600 ohms single ended	**Price:**	$750.00 (cabinet) $735.00 (rack mount)

HEWLETT-PACKARD COMPANY

1008A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U. S. A. CABLE: "HEWPACK" • DAVENPORT 5-4451
HEWLETT-PACKARD S. A., Rue de Vieux Billard No. 1, Geneva Cable "HEWPACKSA" • Telephone (022) 26.43.36

Field representatives in all principal areas

sales and service on hp instruments



Need high capacity, heavy duty electrolytics ?

...see Mallory!

Premium performance without premium price . . . is what you get with Mallory HC (high capacity) and NP (non-polarized) plastic-case electrolytic capacitors. Developed especially for heavy duty industrial applications, they offer you design features developed during 28 years of Mallory leadership in capacitor engineering.

leak-proof seal . . . new silicone vent protects against explosion due to overloads or accidental reverse polarity, yet maintains correct electrolyte level. Optional epoxy end seal gives greatest protection and life.

cool operation . . . Rated for high ripple currents, HC and NP capacitors run 5 to 10 degrees cooler than aluminum case, cardboard sleeve capacitors under identical conditions.

compact size . . . fit standard mounting arrangements, interchangeable with other style capacitors of same ratings.

self-insulated . . . needs no further external insulation, not sensitive to moisture.

high stability . . . proved by tests to 30,000 hours.

For complete information, write to Mallory. For prompt delivery, call the nearest distributor listed in the column at right.

Maximum capacity available in each case size at indicated voltage rating (additional voltage ratings available as required):

	HC Type				NP Type			
Case Size	3 V	15 V	150 V	450 V	3 V	15 V	150 V	450 V
1 7/16 x 2 3/4	6,700	2,720	322	46	3,200	1,190	128	19
1 7/16 x 3 3/8	8,700	3,550	418	60	4,150	1,550	166	25
1 7/16 x 4 3/8	11,800	4,780	568	82	5,700	2,080	225	34
1 13/16 x 3 3/8	15,900	6,500	760	110	7,700	2,860	308	46
1 13/16 x 4 3/8	21,800	8,820	1,030	150	10,400	3,900	415	62
2 1/16 x 3 3/8	22,500	9,050	1,060	154	10,750	4,000	430	65
2 1/16 x 4 3/8	30,500	12,300	1,430	208	14,500	5,400	580	88

Popular and standard values available on the shelf. Other values available on special order.

P.R. MALLORY & CO. Inc.

MALLORY

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

MALLORY HC and NP capacitors are stocked by these distributors:

Baltimore, Md.
Radio Electric Service Co.

Binghamton, N. Y.
Federal Electronics, Inc.

Boston, Mass.
Cramer Electronics
DeMambro Radio Supply

Buffalo, N. Y.
Wehle Electronics

Camden, N. J.
General Radio

Chicago, Ill.
Allied Radio Corp.

Cleveland, Ohio
Pioneer Electronics Supply Co.

Clifton, N. J.
Eastern Radio

Dallas, Texas
Engineering Supply

Indianapolis, Ind.
Graham Electronics

Los Angeles, Calif.
California Electronic Supply
Federated Purchaser, Inc.
Kierulff Electronics
Radio Product Sales

Miami, Fla.
Electronic Equipment

Mountainside, N. J.
Federated Purchaser, Inc.

New York, N. Y.
Electronic Center
Harrison Radio
Harvey Radio
Hudson Radio
Lafayette Radio Electronics
Terminal Radio

Oakland, Calif.
Brill Electronics
Elmar Electronics

Oak Park, Ill.
Melvin Electronics

Palo Alto, Calif.
Zack Radio

Paramount, Calif.
Elwyn W. Ley

Pasadena, Calif.
Electronic Supply

Philadelphia, Pa.
Almo Radio

Reading, Pa.
Geo. D. Barbey Co.

Syracuse, N. Y.
Morris Distributing Co.

Washington, D. C.
Capitol Radio
Electronic Industrial Sales

Whippany, N. J.
State Electronics

BUSINESS THIS WEEK

New Machine Converts Computer Data Into Visual Form on Microfilm

Direct conversion of magnetic tape computer output to microfilm for storage or for subsequent hard-copy processing is now speeded by electronic techniques. New system being marketed by Recordak Corp. was developed by parent Eastman Kodak, uses monoscope tubes as intermediary between taped data and visual form. The system is called Dacom (for DAtascope Computer Output Microfilmer), can operate on or off line, will be used first with an IBM 705 computer.

Matrix decoder translates the tape-recorded data; monoscope tubes for all letters, numerals and special characters spell out the message. Scan rate is 2.5 microseconds for each of 14 lines which are fed from the monoscopes through video amplifiers to a cathode-ray tube.

An electronically-controlled camera photographs the face of the crt automatically on 16-mm film. A page containing 66 lines of 130 characters each occupies less than half a square inch on the film. Recordak says the system has an input rate of 15,000 characters a second or more (depending on the computer with which it's used), and an output rate of 6,923 lines a minute or more. Company says 1,000 ft of Dacom film contains the decoded information from more than 35 2,400-ft reels of magnetic tape.

Russia's Setun Computer Operates On Ternary Rather Than Binary Code

Soviet Setun computer developed by graduate students at Moscow Power Engineering Institute operates on ternary rather than binary code, uses 4,000 high-speed magnetic amplifiers. Institute spokesmen claim the new computer—developed as an engineering aid—is faster than binary systems and uses fewer components.

Only three stages would be needed to register a decimal digit in ternary code, where four are needed to express the same digit in binary code. Shifting, memory readout and other data transfers would be faster. **U. S. computer engineers have generally preferred the binary system because of the greater reliability of standard bistable devices over tristable ones.** Magnetic amplifiers and phase-locked oscillators are among newer developments with reliable tristable modes of operation.

The Setun computer uses a buffered input and storage technique. Main magnetic drum transfers data and instructions onto a smaller but faster secondary memory of 162 words, which in turn feeds the magnetic-amplifier arithmetic units. The system occupies about 215 sq ft.

Highly Sensitive Strain Sensing Element Of Whisker Size and High Strength Developed

Semiconductor strain sensing element a thousandth of an inch in diameter and about one-fourth of an inch long has been developed by Electro-Optical Systems, Inc. and the Army Ordnance Corps' Picatinny Arsenal, Dover, N. J. **The new element could provide aircraft or missiles with strain gauges of 50 times greater sensitivity than present metallic devices, EOS** says. Whisker elements are either grown through vapor deposition or made by slicing slivers from silicon bars, then lapping and etching them. They are said to have an ultimate gage factor of 175 compared to less than five for present wire strain elements.

ELECTRONICS NEWSLETTER

New cadmium sulphide field-effect transistor is being developed by General Motors Research Laboratories and has been successfully demonstrated in such electronic circuits as an oscillator, multivibrator, amplifier and radiation detector.

Gerald M. Rassweiler, head of GM's research physics department, said the new amplifying photosensitive element is an outcome of work in growing single crystals of pure cadmium sulphide. The company claims that field-effect phototransistors have unique characteristics which permit them to "perform new and combined circuit functions which are not practicable with conventional circuit elements."

New BMEWS contract award of $474,831,000 to RCA, detection system prime contractor, pushes the total for the ballistic missile early warning system to more than $700 million. The Western Electric Co., prime contractor for the communications system, has received a contract for $66,768,000.

Soviet remote-controlled farm tractors are scheduled to start large-scale tests next year. Control device weighing a few pounds is said to control guidance, speed, brakes and fuel intake of an unmanned tractor from a second tractor some 40 yards behind the first.

NASA administrator T. Keith Glennan noted in a speech recently that his agency's request to Congress for the next fiscal year totals $938 million, then added: "And you should know that our long range planning suggests the expenditure of a total of 12 to 15 billion dollars for space exploration over the next 10 years."

Federal Aviation Agency has ordered $983,746 worth of additional test monitoring control equipment from ITT's Federal division to check out the VORTAC air navigation system. Gear is used to monitor and control ground beacons of VORTAC (vhf omnirange-Tacan). Tacan gives military pilots their distance from a ground station and their heading. Commercial pilots require additional distance measuring equipment to obtain distance and bearing.

SEPTEMBER 1957

Eight scientists with a big idea...

FEBRUARY 1960

A staff of fourteen hundred and still growing! The idea has become a demonstrated reality...volume production of diffused silicon semiconductors, the most advanced in the electronics industry.

FAIRCHILD
SEMICONDUCTOR CORPORATION

545 WHISMAN ROAD / MOUNTAIN VIEW, CALIFORNIA / YORKSHIRE 8-8161

CIRCLE 13 ON READER SERVICE CARD

WASHINGTON OUTLOOK

FUTURE VOLUME of military electronics contracting is almost certain to be affected by the furious debate over defense policy now raging on the banks of the Potomac. But the precise strength of the impact on the industry is still an open question.

As the debate shapes up now, the odds are that Congress will tack an extra $1 billion or so onto the Eisenhower administration's military requests. Electronics procurement and R&D figure strongly in just about all the projects most likely to be favored: the B70, Polaris-launching submarines, the Minuteman ICBM, and reconnaissance and early-warning satellites.

There's little likelihood that Atlas or Titan ICBM output will be boosted beyond present plans (a total of 270 is now scheduled). The Air Force has told Congress that unless additional orders are placed by April, the extra missiles could not be delivered before the more sophisticated Minuteman is in full production. And there's little chance for more contracting in the next two months.

In the past, the Eisenhower administration has purposely delayed or neglected to spend extra defense funds voted by Congress. But the fiscal 1961 military funds will be at the disposal of a new administration. A Democrat in the White House would be virtually committed to stepping up military outlays; some Washington observers feel that a Republican administration headed by Richard Nixon would be almost as favorably inclined toward a costlier defense program.

- **Development of stereo broadcasting** for a-m radio and television will be delayed considerably by the Federal Communications Commission's decision to go ahead first with f-m stereo instead of backing a study of all three together.

  The National Stereophonic Radio Committee (an industry group set up by Electronic Industries Association) asked FCC last September to sponsor the group officially, as it had the Television Allocations Study Group (TASO). RCA and CBS felt they could not participate in the Committee unless the government sponsored it, since an industry-controlled effort to work out a standard system of stereo broadcasting might run either of the two big networks onto the reefs of the antitrust laws.

  Last week FCC declined to chair the group, deciding to go ahead with just f-m instead on the grounds that f-m is further developed than either a-m or tv. Hearings on a standard system for f-m stereo will start about March 15; consideration of a-m or tv stereo systems will be delayed indefinitely.

- **Bureau of the Census** is cranking up for the first all-electronic nose-count in the nation's history. Data collected in the 1960 Decennial Census will be tabulated from start to finish by computing systems and by special equipment designed specifically for the Bureau.

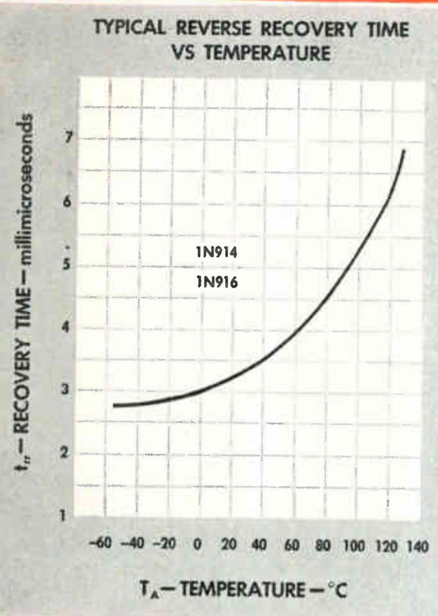
  Three steps are involved in the census tabulation. The raw data will be microfilmed at Jeffersonville, Ind., in an abandoned Army depot taken over for this census. The film will then be developed, and the pencil-mark information will be transferred onto magnetic tape by the Bureau's FOSDIC (film optical sensing device for input to computers). FOSDIC, installed at the Bureau headquarters in Suitland, Md., was developed by Census and Bureau of Standards in 1954.

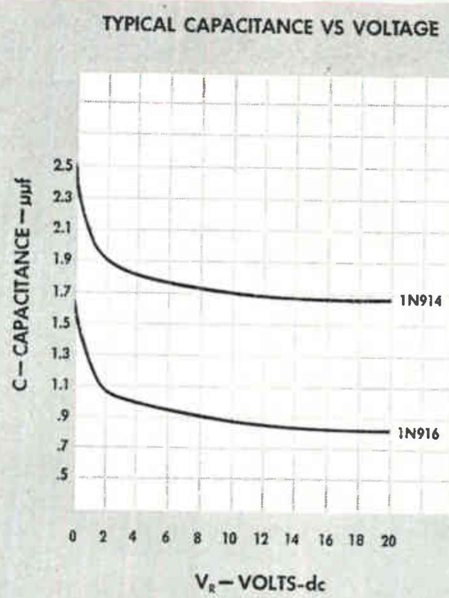
  The tapes will then become input to two Univac 1105 systems now operating at Suitland. Two other 1105's—at the Armour Research Institute in Chicago and at the University of North Carolina—will be used for peak-load scheduling and as standby systems.

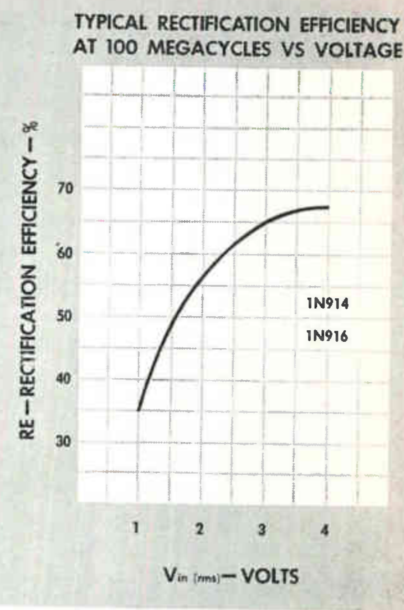
NEW FROM TI...

4-millimicrosec silicon mesa computer diodes

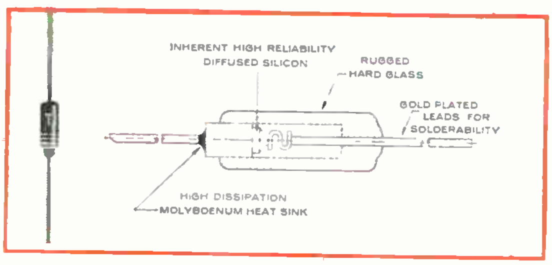
...INDUSTRY'S FASTEST!







- **High maximum average rectified forward current (75 ma)**
- **Low maximum capacitance (2 μμf or 4 μμf at zero volts bias)**
- **High minimum forward conductance (10 ma at 1 v)**
- **Maximum reliability (TI mesa process, TI hard-glass case)**

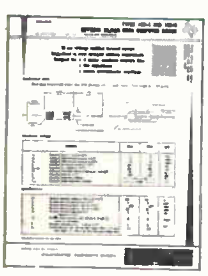


Design NOW with industry's *fastest* high-voltage computer diodes and benefit from the speed of 4-millimicrosecond switching* and the design safety provided by 75-v PIV.

TI 1N914 and TI 1N916 silicon mesa computer diodes also feature high rectification efficiency (45% at 100 mc), ruggedness and reliability through the combination of the TI mesa process and the TI hard-glass package. Both types meet or exceed MIL-S-19500B, withstanding acceleration of 20,000 G's, shock of 1,000 G's for 1.5 msec, and vibration of 30 G's.

Put them to work NOW in your high-speed computer circuitry for missiles and space vehicles. They are ready in production quantities through your nearest TI sales office, or in 1-999 quantities off-the-shelf at factory prices from your authorized TI distributor.

*10-ma forward, 6-v reverse, recover to 1-ma reverse



Contact your nearest TI sales office today for complete specifications on the 1N914 and 1N916 (Bulletin DL-S 1203).

ANOTHER NEW DIODE/RECTIFIER PRODUCT FROM TI!

GENERAL PURPOSE DIODES • PHOTO DIODES • VOLTAGE REFERENCE DIODES • COMPUTER DIODES • VOLTAGE REGULATORS • RESISTORS AND CAPACITORS • CONTROLLED RECTIFIERS • HIGH-CURRENT RECTIFIERS • SPECIAL POTTED MODULES, NETWORKS, BRIDGES & COMPLETE CIRCUIT FUNCTIONS • ECONOMY RECTIFIERS • MEDIUM- & HIGH-VOLTAGE RECTIFIERS

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

For original equipment, direct replacement

NEC tubes with new doped-nickel cathode

Both tube series described here use NEC's new doped-nickel cathode core material. This 10-year development increases emission without raising operating temperature. Oxide evaporation rate is lower than any known core material. Operating data show tube life is extended up to 50%.

6R-P10

6R-R8

WIDE-BAND AMPLIFIER TUBES: Development began seven years ago with the 6R-R8, which was used in Japan's first microwave link. A modification, 6R-R8C, with very low distortion factor, is used in coaxial amplifiers. 6R-P10 Power Amplifier Pentode, with high mutual conductance and small capacitance, is designed for larger power output.

Type	Name	Cathode Rating		Screen and Plate Supply Voltage Eb (V) Ec2 (V)	Plate Current Ib (mA)	Trans-conductance Gm (μΩ)	Capacitances		Interchangeable Tubes
		Volts Ef (V)	Amp. If (A)				Input μμF	Output μμF	
6R-R8	Sharp-Cutoff Pentode	6.3	0.3	150	13	12,500	7.8	3.2	with WE404A
6R-R8C	Sharp-Cutoff Pentode	6.3	0.3	150	13	12,500	7.3	3.2	with WE404A
6R-P10	Power Amplifier Pentode	6.3	0.5	150	36	13,500	10.5	2.7	—

2C40

2C39B

Type	Use	Cathode Rating		Maximum Plate Voltage Ev (V)	Maximum Plate Dissipation Pp (W)	Power Po (W)	Maximum Frequency f (MC)
		Voltage Ef (V)	Current If (A)				
2B22	Detector	6.3	0.75	150	—	—	1200
2C39A	Amplifier Oscillator (Continuous)	6.3	1.0	1000	100	15	2500
2C40	Amplifier Oscillator (Continuous)	6.3	0.75	500	4	0.75	3370
2C43	Amplifier Oscillator (Continuous & Pulse)	6.3	0.9	3500*	12	1.0	3370
5861	Amplifier Oscillator (Continuous)	6.3	0.4	350	10	0.5	3700

* Pulse plate Voltage (eb)

DISC-SEALED TRIODES: NEC designed the first disc-sealed tube in 1939, giving NEC many years of experience in the design and manufacture of this type of microwave tube. Each is a direct replacement under all circumstances for the corresponding type. The NEC tube will give longer life, an especially important advantage in repeater stations.

Please write for specifications sheets.

NEC *Nippon Electric Company Ltd.* Tokyo, Japan

COMPONENTS / SYSTEMS

CIRCLE 17 ON READER SERVICE CARD→

Silicon
General Purpose Diodes

ACTUAL SIZE

EIA TYPE NUMBER	Minimum Saturation Voltage @ 100 μa @ 25°C (volts)	Minimum Forward Current @ +1.0 VDC @ 25°C (mA)	Maximum Inverse Current at Maximum DC Operating Voltage (μa @ volts)		Maximum Average Rectified Current (mA)	
			@ 25°C	@ 150°C	@ 25°C	@ 150°C
1N456 1N456A	30 30	40 100	.025 @ 25 .025 @ 25	5 @ 25 5 @ 25	90 200	70
*1N457 1N457A	70 70	20 100	.025 @ 60 .025 @ 60	5 @ 60 5 @ 60	75 200	70
*1N458 1N458A	150 150	7 100	.025 @ 125 .025 @ 125	5 @ 125 5 @ 125	55 200	70
*1N459 1N459A	200 200	3 100	.025 @ 175 .025 @ 175	5 @ 175 5 @ 175	40 200	70
1N461 1N461A	30 30	15 100	.5 @ 25 .5 @ 25	30 @ 25 30 @ 25	60 200	70
1N462 1N462A	70 70	5 100	.5 @ 60 .5 @ 60	30 @ 60 30 @ 60	50 200	70
1N463 1N463A	200 200	1 100	.5 @ 175 .5 @ 175	30 @ 175 30 @ 175	30 200	70
1N464 1N464A	150 150	3 100	.5 @ 125 .5 @ 125	30 @ 125 30 @ 125	40 200	70

*JAN Types

OTHER ABSOLUTE MAXIMUM RATINGS:
Power Dissipation 0.5 Watts @ 25°C. Power Dissipation 0.25 Watts @ 150°C. 1 Second Surge Current 1.5 Amperes 25°C. Storage and Operating Temperature Range −80°C to 200°C.

Silicon
High Conductance Diodes

ACTUAL SIZE

PSI or EIA TYPE NUMBER	Minimum Saturation Voltage @ 100 μa @ 25°C (volts)	Maximum Forward Voltage DC @ 25°C (volts)		Maximum Inverse Current at Maximum DC Operating Voltage (μa @ volts)		Maximum Average Rectified Current (mA)	
		@ 100 mA	@ 200 mA	@ 25°C	@ 150°C	@ 25°C	@ 150°C
1N482	40	1.1		.250 @ — 30v	30	125	50
1N482A	40	1.0		.025 @ — 30v	15	200	70
1N482B	40	1.0		.025 @ — 30v	5	200	70
PS603	40		1.0	.250 @ — 30v	30	200	100
PS604	40		1.0	.025 @ — 30v	15	200	100
PS605	40		1.0	.025 @ — 30v	5	200	100
1N483	80	1.1		.250 @ — 60v	30	125	50
1N483A	80	1.0		.025 @ — 60v	15	200	70
1N483B	80	1.0		.025 @ — 60v	5	200	70
PS609	80		1.0	.250 @ — 60v	30	200	100
PS610	80		1.0	.025 @ — 60v	15	200	100
PS611	80		1.0	.025 @ — 60v	5	200	100
1N484	150	1.1		.250 @ −125v	30	125	50
1N484A	150	1.0		.025 @ −125v	15	200	70
1N484B	150	1.0		.025 @ −125v	5	200	70
PS615	150		1.0	.250 @ −125v	30	200	100
PS616	150		1.0	.025 @ −125v	15	200	100
PS617	150		1.0	.025 @ −125v	5	200	100
1N485	200	1.1		.250 @ −175v	30	125	50
1N485A	200	1.0		.025 @ −175v	15	200	70
1N485B	200	1.0		.025 @ −175v	5	200	70
PS621	200		1.0	.250 @ −175v	30	200	100
PS622	200		1.0	.025 @ −175v	15	200	100
PS623	200		1.0	.025 @ −175v	5	200	100
1N486	250	1.1		.250 @ −225v	50	125	50
1N486A	250	1.0		.050 @ −225v	25	200	70
1N486B	250	1.0		.050 @ −225v	10	200	70
PS627	250		1.0	.250 @ −225v	50	200	100
PS628	250		1.0	.050 @ −225v	25	200	100
PS629	250		1.0	.050 @ −225v	10	200	100
1N487	330	1.1		.250 @ −300v	50	125	50
1N487A	330	1.0		.100 @ −300v	25	200	70
PS632	330		1.0	.250 @ −300v	50	200	100
PS633	330		1.0	.100 @ −300v	25	200	100
1N488	420	1.1		.250 @ −380v	50	125	50
1N488A	420	1.0		.100 @ −380v	25	200	70
PS636	420		1.0	.250 @ −380v	50	200	100
PS637	420		1.0	.100 @ −380v	25	200	100

OTHER ABSOLUTE MAXIMUM RATINGS:
Maximum Power Dissipation 0.5 Watts @ 25°C. Maximum Power Dissipation 0.25 Watts @ 150°C. Maximum 1 Second Surge Current 1.5 Amperes @ 25°C. Storage and Operating Temperature Range −80° to 200°C.

Please Note: All specifications and information contained herein are current as of:

February 15, 1960.

* *NEW!*
Fast Recovery Low Capacitance Computer Diodes

ACTUAL SIZE

Type Number	Min. Sat. Voltage @ 100 μa (v)	Min. Fwd. Current @ 1.0v (mA)	Maximum Reverse Current (μa)		Reverse Recovery Characteristics	
			25°C	100°C	Reverse Res. (ohms)	Max. Recov. Time (μs)
1N925	40	5	1.0 (10v)	20 (10v)	20K	0.15
1N926	40	5	0.1 (10v)	10 (10v)	20K	0.15
1N927	65	10	0.1 (10v) 5.0 (50v)	10 (10v) 25 (50v)	20K	0.15
1N928	120	10	0.1 (10v) 5.0 (50v)	10 (10v) 25 (50v)	20K	0.15

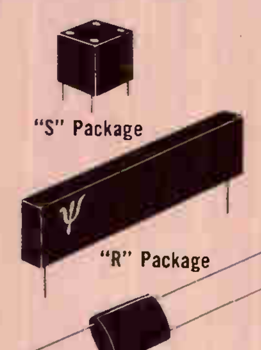
Inverse Capacitance: Maximum 4.0μμf @ 0 volts
Typical 1.1 μμf @ —10 volts

Standard Encapsulations

A variety of assemblies can be furnished for matched pairs and quads, ring modulators, full wave and bridge rectifiers and many other applications.

Numerous lead arrangements are possible in these three basic configurations. Up to four diodes or rectifiers can be encapsulated in the "S" or "T" packages. Up to 12 units can be contained in the "R" package. The number of units contained determines its maximum length.

Leads .020" diameter,
1" minimum length.
Spaced on .1" grid centers.



DIMENSIONS

	"R" Package	"S" Package	"T" Package
Length	.375" to 1.75"	.45"	.50"
Width	.25"	.39"	—
Height	.50"	.40"	—
Diameter	—	—	.375"

***Since preparation of these pages, many *new* and exciting devices and types have been added to the PSI line *and are now available.* Call your nearest PSI sales office for latest information!** *Standard Modulator Quads . . . Bridge Rectifiers and Rings . . . 10 to 20 KV High Voltage Cartridge Rectifiers . . . and many others!*

* *NEW!*

Multipurpose Millimicrosecond N-P-N Triple-Diffused mesa types

Switching Transistors

2N1409 2N1410

MILLIMICRO SWITCHING—Typical 70 mμs. rise time.

EXTREMELY LOW COLLECTOR SATURATION VOLTAGE—Typical .25 volts.

CONTROLLED DC BETA RANGE—15 to 45 (2N1409), 30 to 90 (2N1410).

SUPERIOR PERFORMANCE OVER A WIDE RANGE OF COLLECTOR CURRENTS.

HIGH POWER DISSIPATION—2.8 watts @ 25° C case temperature.

JEDEC 30 (TO-16) PACKAGE.

Immediately Available!

Phone, wire or write for detailed specifications and curves.

* *NEW!* VHF Silicon Power Transistors

N-P-N Triple-Diffused mesa types

2N1335 2N1336 2N1337

Power Amplifiers

2N1339 2N1340 2N1341

Power Oscillators

HIGH FREQUENCY 170 mc Alpha Cut-off

HIGH VOLTAGE 160v Peak Collector—Base Voltage

HIGH POWER 2.8 watts @ 25°C case temperature

LOW OUTPUT CAPACITANCE 4μμf typical

Available in the JEDEC 30 (TO-16) package, these units are particularly well suited for general VHF use. Applications include power output stages, high level video amplifiers, power oscillators, and many others requiring the unique combination of high frequency, high voltage and high power.

Silicon Subminiature Rectifiers

ACTUAL SIZE

MEOIUM POWER TYPES

EIA TYPE NUMBER *	MAXIMUM RATINGS: Peak Inv. Voltage (v)	MAXIMUM RATINGS: Maximum Avg. Rectified Current (mA)[1] @ 25°C	@ 150°C	ELECTRICAL CHARACTERISTICS: Minimum Saturation Voltage @ 100°C	Maximum Reverse Current @ PIV (μA) @ 25°C	@ 100°C	Max. Fwd. Voltage Drop @ Ib = 400 mA @ 25°C (v)
1N645	225	400	150	275	0.2	15	1.0
1N646	300	400	150	360	0.2	15	1.0
1N647	400	400	150	480	0.2	20	1.0
1N648	500	400	150	600	0.2	20	1.0
1N649	600	400	150	720	0.2	25	1.0

* ***All*** *above types available as Air Force Approved Units.*

400 MILLIAMPERE PSI TYPES

400 mA @ 25°C—150 mA @ 150°C

PSI TYPE NUMBER	MAXIMUM RATINGS: Peak Recurr. Inverse Voltage (volts)	Maximum RMS Input Voltage[1] (volts)	Maximum Average Rectified Current[1] (mA)	ELECTRICAL CHARACTERISTICS: DC Forward Voltage @ Specified Current @ 25°C (volts @ mA)	Maximum Average Inverse Current[2] @ 100°C (μa)
TYPE				@ 25°C	@ 150°C
PS 405	50	35	150	1.5 @ 500	500
PS 410	100	70	150	1.5 @ 500	500
PS 415	150	105	150	1.5 @ 500	500
PS 420	200	140	150	1.5 @ 500	500
PS 425	250	175	150	1.5 @ 500	500
PS 430	300	210	150	1.5 @ 500	500
PS 435	350	245	150	1.5 @ 500	500
PS 440	400	280	150	1.5 @ 500	500
PS 450	500	350	125	1.5 @ 500	500
PS 460	600	420	125	1.5 @ 500	500

250 MILLIAMPERE PSI TYPES

250 mA @ 25°C—140 mA @ 100°C

PS 005	50	35	140	1 @ 100	100
PS 010	100	70	140	1 @ 100	100
PS 015	150	105	140	1 @ 100	100
PS 020	200	140	140	1 @ 100	100
PS 025	250	175	140	1 @ 100	100
PS 030	300	210	140	1 @ 100	100
PS 035	350	245	140	1 @ 100	100
PS 040	400	280	140	1 @ 100	100
PS 050	500	350	140	1 @ 100	100
PS 060	600	420	140	1 @ 100	100

1. Resistive or inductive load.
2. Averaged over one cycle for half wave resistive or choke input circuit with rectifier operating at full rated current and maximum RMS input.

Storage and Operating Temperature Range—65°C to 200°C.

500 MA TYPES IN MINIATURE PACKAGE ALSO AVAILABLE.

New Types! Silicon HighVoltage Rectifiers

⅔ ACTUAL SIZE

EIA TYPE NUMBER	Peak Inverse Voltage (volts)	Average Rectified Current (mA) @ 25°C	@ 100°C	MAX RMS Input Voltage (volts)	MAX DC Fwd Voltage Drop @ 100 mA DC 25°C	Dimensions (Inches) L.	Dia.
1N1730	1000	200	100	700	5	.5	.375
1N1731	1500	200	100	1050	5	.5	.375
1N1732	2000	200	100	1400	9	1.0	.375
1N1733	3000	150	75	2100	12	1.0	.375
1N1734	5000	100	50	3500	18	1.0	.5
1N2382	4000	150	75	2800	18	1.0	.5
1N2383	6000	100	50	4200	27	1.5	.5
1N2384	8000	70	35	5600	27	1.5	.5
1N2385	10000	70	35	7000	39	2.0	.5

Maximum DC Reverse Current @ Rated PIV 10μA @ 25°C, 100μA @ 100°C.
Maximum Surge Current (8msec.): 2.5 Amps.
Continuous DC Voltage same as PIV.
Operating temperature range —55°C to 150°C.

Silicon Very High Voltage Cartridge Rectifiers

¼ ACTUAL SIZE

EIA Type	Length Inches	Absolute Max. Rtgs. H/W Res. Load at 75°C Ambient: Peak Inverse Voltage Volts	Max. Rectified DC Output Current MA	Electrical Characteristics at 25°C Ambient: Forward DC Volt Drop at Rated DC Current Volts	Reverse DC Current at Rated PIV MA
IN1139	4 9/16	3600	65	27.0	.025
IN1140	2½	3600	65	18.0	.025
IN1141	4 9/16	4800	60	36.0	.025
IN1142	2½	4800	50	24.0	.025
IN1143	4 9/16	6000	50	45.0	.025
IN1143A	4 9/16	6000	65	30.0	.025
IN1144	6 1/16	7200	50	54.0	.025
IN1145	4 9/16	7200	60	36.0	.025
IN1146	6 1/16	8000	45	60.0	.025
IN1147	6 1/16	12000	45	60.0	.025
IN1148	6 1/16	14000	50	52.0	.025
IN1149	6 1/16	16000	45	60.0	.025

Storage and Operating Temperature Range—55°C to 150°C

Physical Characteristics

HERMETICALLY SEALED—Glass-to-metal fused and metal-to-metal welded seals.

TERMINALS—Tinned copper leads .020 inches diameter. Lead length 1¼ inch minimum.

MARKING—Wide color band indicates cathode end. (Wide band indicates positive bias on Varicaps.) Type number designated by color bands reading from cathode.

ALL DIMENSIONS SHOWN IN INCHES—Patented under one or more of the following United States Patents: No. 2815474, No. 2827403. Other patents pending.

PSI®

PSI Pacific Semiconductors, Inc.

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LITHO IN U.S.A.

* NEW!

PD-100 Series microdiode™

(Super miniaturized Silicon Diode)

1. **HIGH POWER DISSIPATION**—250 milliwatts.
2. **HIGH CONDUCTANCE**—up to 100 mA @ 1 volt.
3. **HIGH VOLTAGE**—200v operating voltage.
4. **FAST RECOVERY**—200K @ .3 microseconds.
5. **HIGH TEMPERATURE**—Operating range -65° C to 150° C.
6. **HIGH RELIABILITY.**

PSI PD-100 Series microdiode™

ACTUAL SIZE

Type Number	Min. Sat. Voltage @ 100 μA (v)	Min. Fwd. Current @ +1.0v (mA)	Maximum Reverse Current (μA) 25°C	Maximum Reverse Current (μA) 100°C	Reverse Recovery Characteristics: Reverse Res. (ohms)	Reverse Recovery Characteristics: Max. Recov. Time (μs)
PD-101	50	5	1.0 (10v)	25 (10v)	100K	1.0
PD-102	50	20	.5 (10v)	25 (10v)	100K	0.3
PD-103	50	100	.5 (10v)	25 (10v)	100K	0.3
PD-104	100	5	.5 (10v)	25 (10v)	100K	0.3
PD-105	100	20	.5 (10v)	25 (10v)	100K	0.3
PD-106	100	50	.5 (10v)	25 (10v)	100K	0.3
PD-107	100	100	.5 (10v)	25 (10v)	100K	0.3
PD-108	200	10	.5 (10v) 5.0 (100v)	25 (10v)	200K	0.3
PD-109	200	10	.025 (10v) 1. (100v)	5 (10v)	200K	0.3

RATINGS

Maximum Power Dissipation: 250 mw @ 25°C (derate linearly to 150°C)

Maximum Storage & Operating Temperature Range. -65°C to 150°C

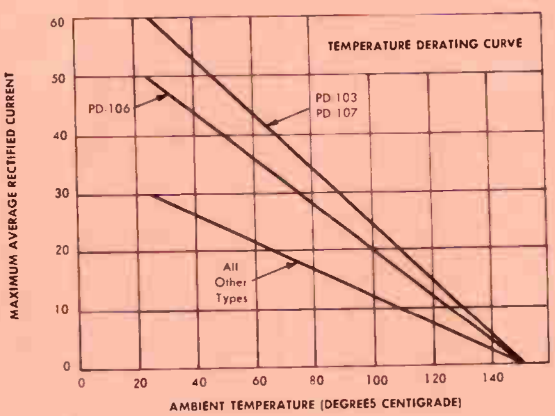
Peak Pulse Current 1 μsec., 1% duty cycle: 2.0 amperes

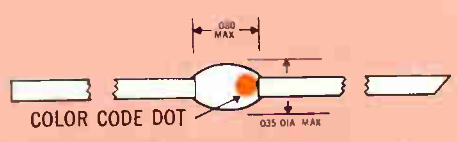
Typical Inverse Capacitance @ — 10V: 2μμf.

Handling Instructions: Lead Bending — Do not bend closer than .030" from body.

Color Code: Color dot system reading from cathode or pointed lead end.

Soldering: Heat sink diode body during soldering.





PHYSICAL CHARACTERISTICS:

HERMETICALLY SEALED—Bonded Surface films.

TERMINALS—.004x.019 gold plated leads. Lead length ½ inch minimum.

MARKING—Cathode end designated by dot on the body and also by pointed lead. Type number designated by color of the body and color of dot on the cathode end.

ALL DIMENSIONS SHOWN IN INCHES.

Zener Diodes
500 mW Power Dissipation

ACTUAL SIZE

PSI Type Number	Elect. Equiv.	Zener Voltage @ 5 mA @ 25°C: E_z Min. (v)	E_z Max. (v)	Maximum Dynamic Resistance (ohms) 1	Maximum Inverse Current: I_b @ 25°C (μA)	I_b @ 100°C (μA)	At Inverse Voltage (v)
PS6465	1N465	2.0	3.2	60	75	100	1
PS6466	1N466	3.0	3.9	55	50	100	1
PS6467	1N467	3.7	4.5	45	5	100	1
PS6468	1N468	4.3	5.4	35	5	100	1.5
PS6469	1N469	5.2	6.4	20	5	100	1.5
PS6470	1N470	6.2	8.0	10	5	50	3.5

1. Measured at 10mA DC Zener current with 1mA RMS signal superposed.

Also Available PS6313-6327 covering 7.5_v to 145_v Zener Voltages.

EIA TYPES	Zener (Breakdown) Voltage @ 5 mA: Ez Min. (v)	Ez Max. (v)	Maximum Inverse Current: I_b @ 25°C (μA)	I_b @ 100°C (μA)	At Inverse Voltage (v)	Maximum Dynamic Resistance (ohms) 1
1N702	2.0	3.2	75	100	−1	60
1N703	3.0	3.9	50	100	−1	55
1N704	3.7	4.5	5	100	−1	45
1N705	4.3	5.4	5	100	−1.5	35
1N706	5.2	6.4	5	100	−1.5	20
1N707	6.2	8.0	5	50	−3.5	10

1. Measured at 10 mA OC Zener current with 1 mA RMS signal superposed.

Also Available 1N708-1N725 covering 5.6_v to 30_v Zener Voltages.

EIA Type[1]	Zener Voltage E_z (Volts)[2]	Max. Inverse Current E_B = −1V μa: 25°C	150°C	Max. Dynamic Resistance I_Z = 20mA I_{AC} = 1 mA Ohms) (Max.)
1N746	3.3	10	30	28
1N747	3.6	10	30	24
1N748	3.9	10	30	23
1N749	4.3	2	30	22
1N750	4.7	2	30	19
1N751	5.1	1	20	17
1N752	5.6	1	20	11
1N753	6.2	0.1	20	7
1N754	6.8	0.1	20	5
1N755	7.5	0.1	20	6
1N756	8.2	0.1	20	8
1N757	9.1	0.1	20	10
1N758	10.0	0.1	20	17
1N759	12.0	0.1	20	30

1. ±10% Zener Voltage Tolerance
2. E_z measured at Test Current I_z = 20mA

All of the above types can be supplied in ±5% Tolerance. Add "A" suffix to indicate units with ± 5% Tolerance of center Zener Voltage Value.

* NEW!

VOLTAGE REFERENCE DIODES

½ ACTUAL SIZE

EIA Type Number	Reference Voltage @ 7.5 m.a. @ 25°C. (volts): Min.	Avg.	Max.	Max. Voltage change from 25°C Reference Voltage (volts) −55°C to + 100°C	Max. Dynamic[1] Resistance (ohms)
1N2765	6.46	6.80	7.14	±0.050	20
1N2766	12.92	13.60	14.28	±0.100	40
1N2767	19.38	20.40	21.42	±0.150	60
1N2768	25.84	27.20	28.56	±0.200	80
1N2769	32.30	34.00	35.70	±0.250	100
1N2770	38.76	40.80	42.84	±0.300	120

1. Measured with 1 mA AC superposed on 7.5 mA DC
Max. Operating Temp. @ I_Z = 7.5 mA: −65°C to +175°C.

PSI® High-Q Varicap®

ACTUAL SIZE

VARICAP TYPE	Capacitance* @ 4VDC 50MC (μμf)	Quality Factor Min. (Q) @ 4VDC 50MC	Max. Working Voltage (VDC)	Minimum Saturation Voltage @ 100 μADC (VDC)	Maximum Inverse Current @ 50VDC (μADC)
PC-112-10	10	50	80	90	1.0
PC-113-22	22	50	80	90	1.0
PC-114-47	47	50	80	90	1.0

CAPACITANCE CHANGE: From 2VDC to 80VDC, 4.0 to 1 Min.

VARICAP TYPE	Capacitance* @ 4VDC 50MC (μμf)	Quality Factor Min. (Q) @ 4VDC 50MC	Max. Working Voltage (VDC)	Minimum Saturation Voltage @ 100μADC (VDC)	Maximum Inverse Current @ 75VDC (μADC)
PC-115-10	10	100	100	110	1.0
PC-116-22	22	100	100	110	1.0
PC-117-47	47	100	100	110	1.0

CAPACITANCE CHANGE: From 2VDC to 100VDC, 5.2 to 1 Min.

*All capacitance values are ±20% All values at 25°C

"VARICAP" is the registered trade-mark of silicon voltage-variable capacitors manufactured by Pacific Semiconductors, Inc.

An entirely new approach to the design of electronic tuning, automatic frequency control, harmonic generation and numerous other circuits is made possible by the introduction of these new silicon voltage-variable capacitors. The Q specifications of 50 and 100 at 4VDC at 50 mc. for the first time combine wide tuning range and high Q. Twenty-three other Varicap types ranging from 7 to 100 μμf also available. Details on request.

All High Q Varicap types are available on good delivery schedules.

Fast Recovery Silicon Diffusion Computer Diodes

ACTUAL SIZE

Type Number	Minimum Saturation Voltage * @ 100 μa (volts)	Minimum Forward Current @ + 1.0 volt (mA)	Maximum Reverse Current (μa) 25°C	Maximum Reverse Current (μa) 100°C	Reverse Recovery Characteristics: Reverse Resistance (ohms)	Reverse Recovery Characteristics: Maximum Recovery Time (μs)
MILITARY TYPES						
1N643†	200	10	.025 (10v) 1 (100v)	5 (10v) 15 (100v)	200K	0.3
1N662‡	100	10	1 (10v) 20 (50v)	20 (10v) 100 (50v)	100K	0.5
1N663*	100	100	5 (75v)	50 (75v)	200K	0.5

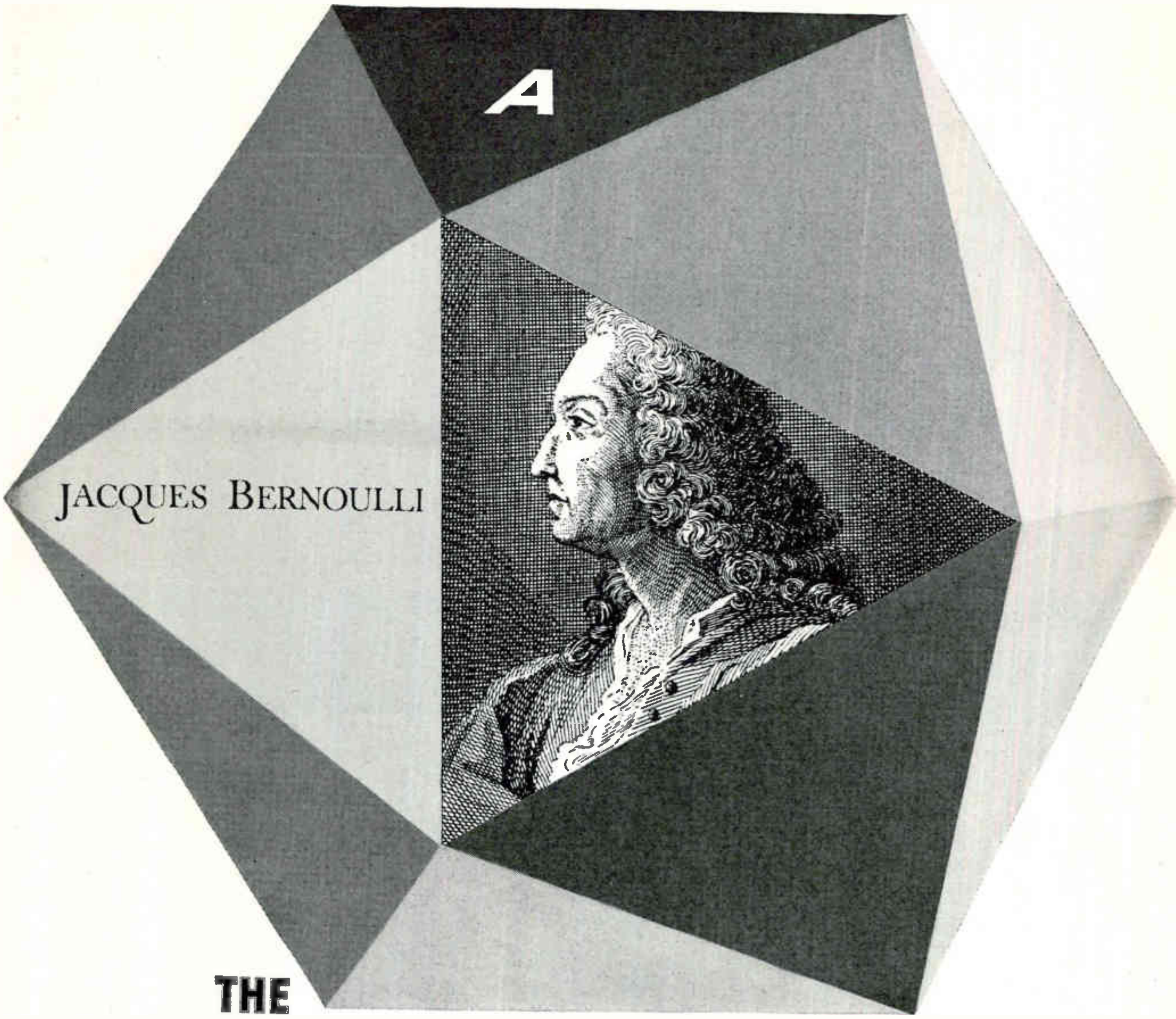
†Mil-E-1 1171 (SigC) ‡Mil-E-1 1139 (SigC) *Mil-E-1 1140 (SigC)

Type Number	Minimum Saturation Voltage * @ 100 μa (volts)	Minimum Forward Current @ + 1.0 volt (mA)	Maximum Reverse Current (μa) 25°C	Maximum Reverse Current (μa) 100°C	Reverse Resistance (ohms)	Maximum Recovery Time (μs)
1N789	30	10	1 (20v)	30 (20v)	200K	0.5
1N790	30	10	5 (20v)	30 (20v)	200K	0.25
1N791	30	50	5 (20v)	30 (20v)	200K	0.5
1N792	30	100	5 (20v)	30 (20v)	100K	0.5
1N793	60	10	1 (50v)	30 (50v)	200K	0.5
1N794	60	10	5 (50v)	30 (50v)	200K	0.25
1N795	60	50	5 (50v)	30 (50v)	200K	0.5
1N796	60	100	5 (50v)	30 (50v)	100K	0.5
1N797	120	10	1 (100v)	30 (100v)	200K	0.5
1N798	120	10	5 (100v)	30 (100v)	200K	0.25
1N799	120	50	5 (100v)	30 (100v)	200K	0.5
1N800	120	100	5 (100v)	30 (100v)	100K	0.5
1N801	150	10	1 (125v)	30 (125v)	200K	0.5
1N802	150	50	5 (125v)	50 (125v)	200K	0.5
1N803	200	10	5 (175v)	50 (175v)	200K	0.5
1N804	200	50	10 (175v)	50 (175v)	200K	0.5
1N659	60	6	5 (50v)	25 (50v)	400K	0.3
1N660	120	6	5 (100v)	50 (100v)	400K	0.3
1N661	240	6	10 (200v)	100 (200v)	400K	0.3
1N625	30	4 @ 1.5v	1 (20v)	30 (20v)	400K	1 μsec
1N626	50	4 @ 1.5v	1 (35v)	30 (35v)	400K	1 μsec
1N627	100	4 @ 1.5v	1 (75v)	30 (75v)	400K	1 μsec
1N628	150	4 @ 1.5v	1 (125v)	30 (125v)	400K	1 μsec
1N629	200	4 @ 1.5v	1 (175v)	30 (175v)	400K	1 μsec

*Maximum DC working inverse voltage is 85% of minimum saturation voltage.

OTHER SPECIFICATIONS:
Peak Pulse Current, 1 μsec, 1% duty cycle: 3.0 Amps.
Storage and Operating Temperature Range: −65 C to 200 C.


ADVANCED
SEMICONDUCTOR PRODUCTS
FROM PSI



THE WIZARD OF ODDS

He solved a telephone traffic problem two centuries ago

Jacques Bernoulli, the great Swiss mathematician, pondered a question early in the 18th century. Can you mathematically predict what will happen when events of chance take place, as in throwing dice?

His answer was the classical Bernoulli binomial distribution—a basic formula in the mathematics of probability (published in 1713). The laws of probability say, for instance, that if you roll 150 icosahedrons (the 20-faced solid shown above), 15 or more of them will come to rest with side "A" on top only about once in a hundred times.

Identical laws of probability govern the calls coming into your local Bell Telephone exchange. Suppose you are one of a group of 150 telephone subscribers, each of whom makes a three-minute call during the busiest hour of the day. Since three minutes is one-twentieth of an hour, the probability that you or any other subscriber will be busy is 1 in 20, the same as the probability that side "A" of an icosahedron will be on top. The odds against 15 or more of you talking at once are again about 100 to 1. Thus it would be extravagant to supply your group with 150 trunk circuits when 15 are sufficient for good service.

Telephone engineers discovered at the turn of the century that telephone users obey Bernoulli's formula. At Bell Telephone Laboratories, mathematicians have developed the mathematics of probability into a tool of tremendous economic value. All over the Bell System, the mathematical approach helps provide the world's finest telephone service using the least possible equipment. The achievements of these mathematicians again illustrate how Bell Laboratories works to improve your telephone service.

BELL TELEPHONE LABORATORIES

World center of communications research and development

Stock Tally Reveals Growth

	SHARES (in 100's)	HIGH	LOW	CLOSE (Jan. 29)	PER-FORMANCE
Avco Corporation	26,890	16¾	11½	13	−1⅜
Sperry Rand Corp.	26,325	27½	21⅛	22¾	−3¼
Int'l. Tel. & Tel.	20,285	42½	30⅛	36¼	−3
Universal Controls	17,676	21⅝	15¾	16¼	−1⅝
Raytheon	17,021	58⅛	43½	47⅝	−4⅜
General Electric	16,503	99⅞	74	85½	+4⅛
Radio Corp. of Amer.	16,246	73¼	54¾	59½	−6⅝
General Dynamics	13,765	54⅞	41⅞	56⅞	−7¼

THIS TABLE shows the eight electronics stocks which have consistently been among the 25 most actively traded stocks in the period from Aug. 3, 1959, to Jan. 29, 1960.*

A listing made last year (ELECTRONICS, p 21, Nov. 6, 1959) contained substantially the same companies in the following order: Sperry Rand, Avco, IT&T, General Tel. & Elec., Raytheon, GE, RCA, General Dynamics and Universal Controls.

Although volume trading for electronics stocks in general has fallen off in recent weeks, volumes for the stocks listed above are higher than they were in the November listing. At that time Sperry Rand's figure for SHARES in 100's was 12,432—the high score. The lowest count was made by Universal Controls, 6,429. For the most part, stocks listed have increased in value since the last tally.

• **Motorola Inc.,** Chicago, reports a preliminary tally of its 1959 record year shows sales well above $280 million. Net profits exceed $14 million, an estimated rise of 30 percent. The rise is attributed to increased sales and earnings in entertainment products, as well as two-way mobile radio gear.

• **Control Data Corp.,** Minneapolis, announces net sales of $3,889,273 for the six-month period ended Dec. 31, 1959. Net income after taxes was $249,518. This compares with net sales of $1,462,685 and net earnings of $31,697 for the first half of 1959. Earnings for the last six-month period were equivalent to 27 cents a share on the 899,344 shares of common stock outstanding.

• **Polarad Electronics,** Long Island City, N. Y., reports sales of $6,544,676 for the first half of its fiscal year as compared with $5,818,858 for the same period a year ago. Net income for the first half of the present fiscal year was $374,778, as compared with $148,335 in the first half of the preceding year. Company attributes the rise to continued growth in sales of industrial products.

*Tabular information prepared by statistical research department of Ira Haupt & Co., New York, investment bankers.

25 MOST ACTIVE STOCKS

WEEK ENDING FEBRUARY 12

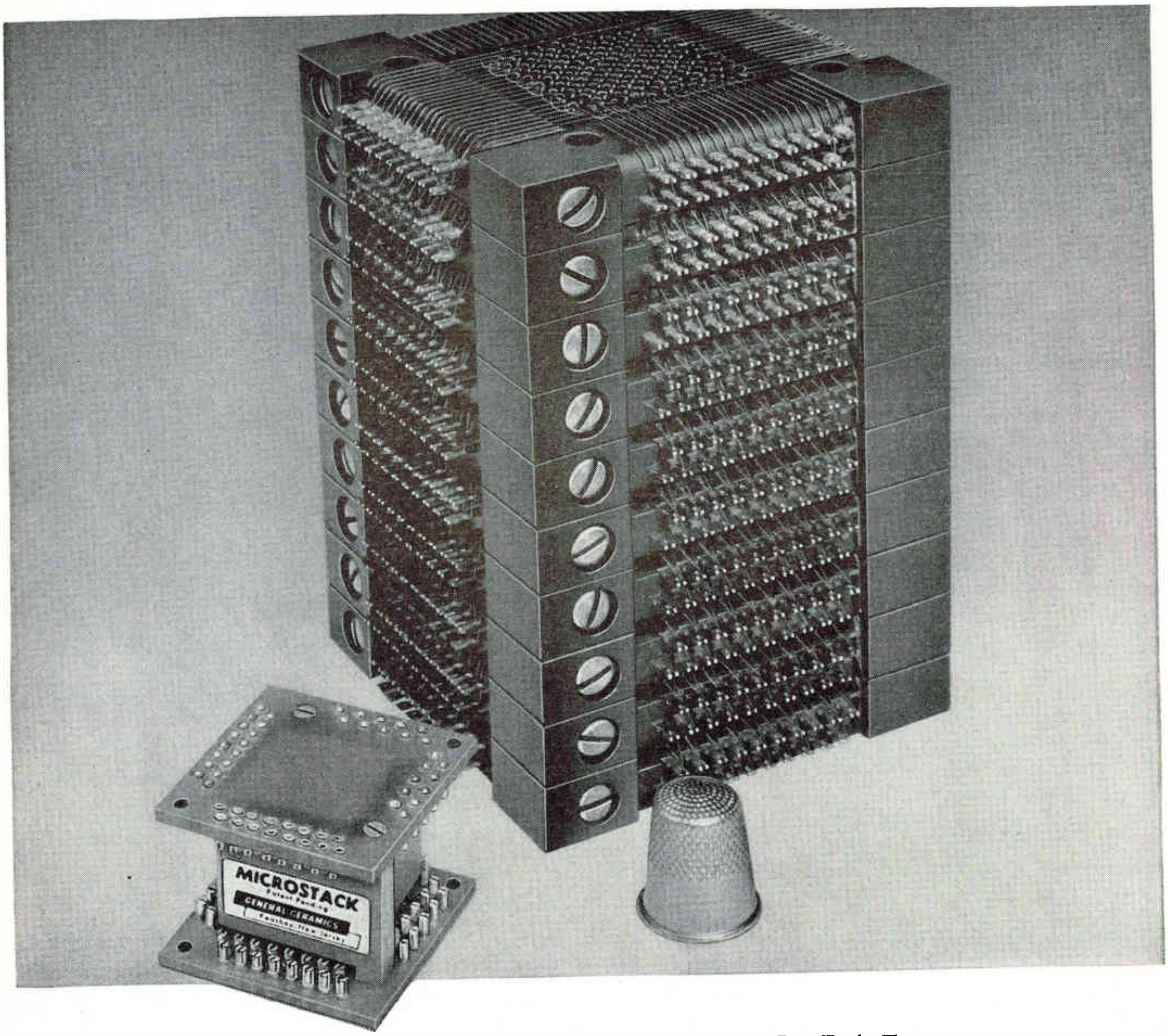
	SHARES (IN 100's)	HIGH	LOW	CLOSE
Gen Electric	731	90⅞	85⅞	90⅞
RCA	713	63¼	59½	62⅜
Collins Radio	647	57	51⅜	53⅜
Varian Assoc	606	46	40⅝	43½
Westinghouse	581	51½	47¼	49⅝
Sperry Rand	531	23¾	22⅞	23⅜
Muntz TV	488	6½	5⅝	6⅛
Elec & Mus Ind	469	6⅞	6⅜	6⅝
Avco Corp	434	13½	12⅞	13¼
Beckman Inst	361	71⅜	65⅛	69¼
Int'l Tel & Tel	359	34½	33⅛	33⅝
Univ Controls	355	15⅞	15⅛	15⅛
Litton Ind	340	62¾	58⅜	61½
Gen Tel & Elec	330	77⅞	76	76¾
Gen Dynamics	309	48⅜	46½	47⅛
Philco Corp	304	30⅜	28⅛	28⅞
Int'l Resistance	292	24½	21	23¼
Raytheon	270	47⅞	45⅝	47⅛
Lear Inc	254	17½	15⅞	17¼
Burroughs	248	30⅜	29⅝	30⅛
Texas Inst	233	171¾	164¼	170½
Reeves Sndcrft	229	10¼	9½	9⅞
Ampex	223	105⅞	98½	103
Zenith	201	101¾	97	98
Dynamics Corp Amer	187	11	10½	10⅞

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

DIVIDEND ANNOUNCEMENTS

	Amount per Share	Date Payable
Friden Inc	$.25	Mar. 10
Instrmnts for Industry	2%	Mar. 1
Leesona Corp	.12½	Mar. 10
Magnavox	.25	Mar. 15

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



...90% of it!

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

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

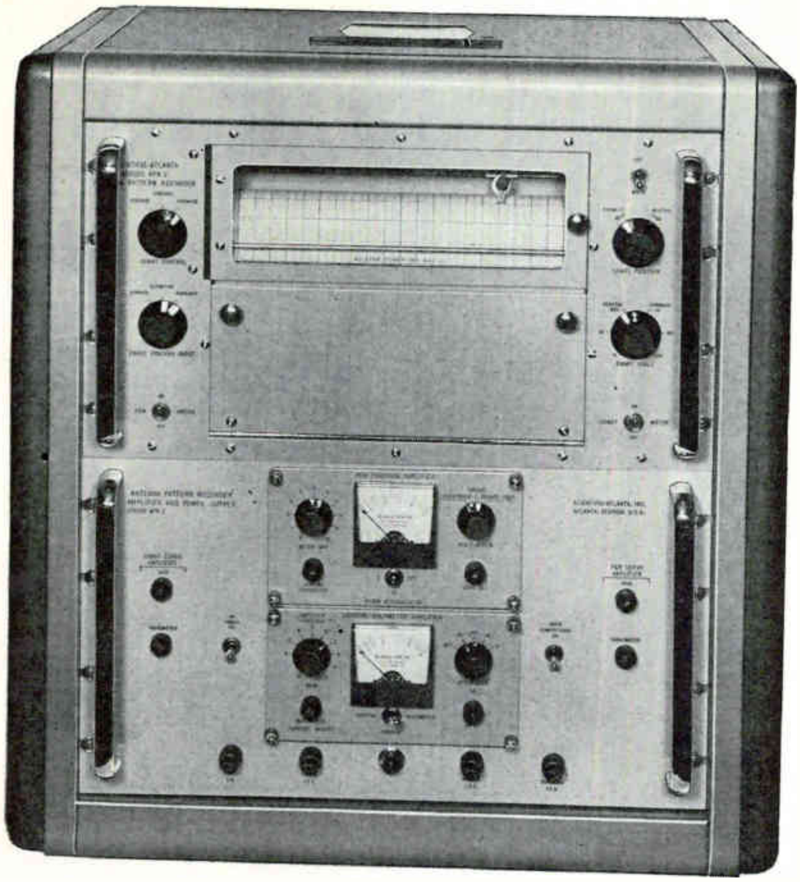
Noise level in the new MICROSTACK is as low as that of conventional types. The new MICROSTACK is available with all standard memory cores. Standard packages are available with coincident current wiring in 10 x 10 x 8, 16 x 16 x 8 and 32 x 32 x 8 arrays.

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

* Trademark

GENERAL CERAMICS
ORIGINATOR OF THE SQUARE LOOP FERRITE

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



THE NEW S·A

ANTENNA PATTERN RECORDER

** Noise suppressor for better S/N ratio * Bolometer burnout protector * DB meter for signal monitoring * Automatic single chart cycle advance*

Scientific-Atlanta's new series of rectangular antenna pattern recorders bring you new standards of performance, reliability and flexibility.

Compare these key features

Writing speed of better than 40 inches per second • Log, linear, or square root pen response obtained with plug-in balance pots • One electronics system drives both polar and rectangular recorder heads • Overload indicator to prevent amplifier saturation • 60 db dynamic range system available • Chart scale expansion of 1:1, 6:1, and 36:1 • Page size recordings optional at extra cost • 100 db gain in bolometer amplifier • Lighted chart • Improved pen mechanism • DC input pre-amplifier available • Plug-in selective filter • Simplified controls.

PRICES, Series APR-20 Rectangular Antenna Pattern Recorders

APR-21 linear, $4100 — APR-22 logarithmic, $4300 — APR-23 linear, logarithmic, $4700 — APR-24 linear, square-root, $4700—APR-25 linear, logarithmic, square-root, $5300.

THESE PLUG-INS MEAN FLEXIBILITY AND EASY SERVICE

New high gain, low noise bolometer—crystal amplifier

New pen function amplifier

New pen balance potentiometer

Call your nearby S-A engineering rep for a demonstration and complete technical information or you may write directly to the factory. Please ask for data sheet Dept. 18

SCIENTIFIC-ATLANTA, INC.

2162 PIEDMONT ROAD, N.E. • ATLANTA 9, GEORGIA

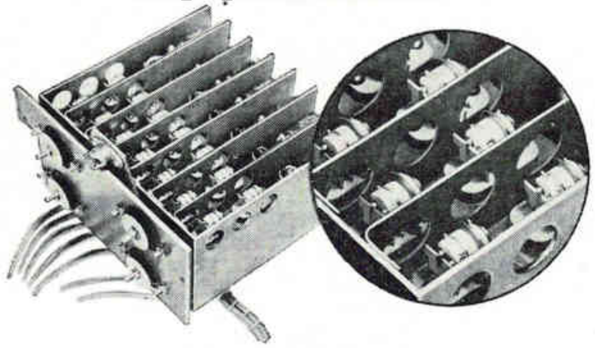
CIRCLE 27 ON READER SERVICE CARD

CIRCLE 28 ON READER SERVICE CARD→

Good electronic design you limit compromise by over a wide spectrum of

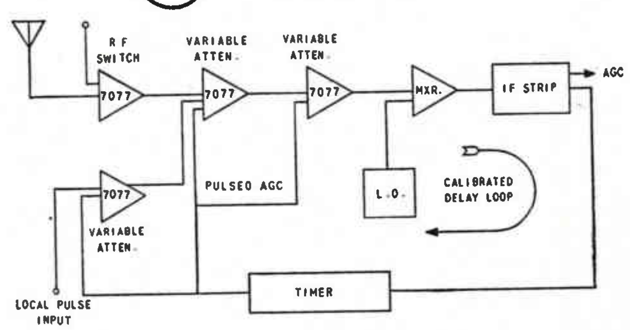
PROOF:  G-E 7077

LOCKHEED



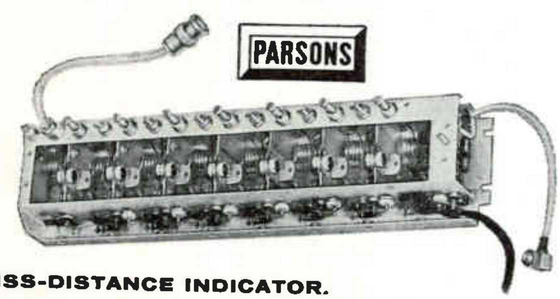
WIDE-BAND TAPE RECORDER.
For Lockheed, California Division, 28 General Electric 7077's serve as pre-amplifiers in a 14-channel 500-kc 60″-per-second tape recorder that stores wide-band information from an air defense exercise five times as rapidly as before. Extreme requirements of frequency, timing accuracy, and reproducibility are met by the 7077's low noise, high impedance, and high G_m. Also, the tube's small size matches the miniaturization needs of the Lockheed tape-recorder equipment.

MOTOROLA

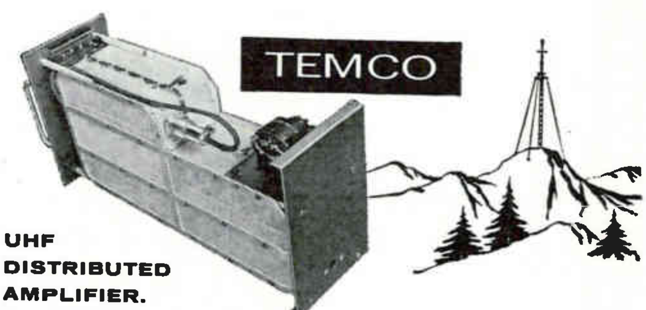


GROUND-SURVEYING RADAR.
Motorola's Western Military Electronics Center in Phoenix uses four General Electric ceramic 7077's for high-speed RF switching and pulse attenuation in a 440-mc distance measuring circuit where timing to *one billionth of a second* is needed for pulse delay measurement. Minimum plate-to-cathode capacitance, high gain, low noise, and a configuration that makes the tube ideal for grounded-grid service, were reasons back of Motorola's choice of the G-E 7077.

involves trade-offs...but using ceramic tubes. meets designers' targets frequency and function.



MISS-DISTANCE INDICATOR.
Ralph M. Parsons Company uses seven General Electric ceramic 7077's in tuned stages as high-gain, low-noise RF amplifiers in its PARAMI system for determining air-intercept missile accuracy. A 324-mc circuit, the Parsons PARAMI system has a gain-bandwidth product approaching the limit of the state of the art.



UHF DISTRIBUTED AMPLIFIER.
Many receivers—one antenna, with Temco Electronics' broadband distributed amplifier. Arranged in six five-stage units, 30 G-E 7077's are used as RF amplifiers, operating over a 750 mc bandwidth, between 250 and 1000-mc. Fills the frequency gap between TWT's and existing distributed amplifiers.

Phone your nearest General Electric Receiving Tube Department Office:
New York: Wisconsin 7-4065, 6, 7, 8 | **Chicago: SPring 7-1600** | **Los Angeles: GRanite 9-7765**

Progress Is Our Most Important Product

GENERAL ELECTRIC

431-202

MARKET RESEARCH

Selecting New Products

Harold C. Buell: P. R. Mallory's new product-minded marketing vice president

PRODUCTS INTRODUCED within the last five years are accounting for 45 percent of the average electronics firm's current sales. A new product's sales contributions generally mount from eight percent of the total one year after introduction to 50 percent in 10 years.

Above figures are taken from a survey made last year by Harold C. Buell, marketing vice president of P. R. Mallory, among 28 electronics firms, with sales ranging from $8 million to $500 million annually. They show the importance of new products to the electronics industry.

Measuring Success

The 28 firms told Buell they brought out an average of nine new products a year ago. Within a five-year period 30 new products were introduced by the typical firm. Over a 10-year period, the number was 53.

Here's a guide for measuring your new product success record. Of products introduced in the last five years, an average of 15 percent were discontinued during the period, survey shows. One firm discontinued 60 percent of its new products over the five year period.

What are the major reasons for discontinuing new products? Market changes and unprofitability topped the list with 10 mentions each. Product obsolescence and inadequate screening were close behind. Other reasons given: inadequate development, competition, lack of proper distribution, production difficulties.

Engineering research is the prime source of new product ideas. It was mentioned by 22 firms, slightly ahead of customers (20 mentions), and the sales department (19). Other idea sources: top management, new product groups, competitors and market research.

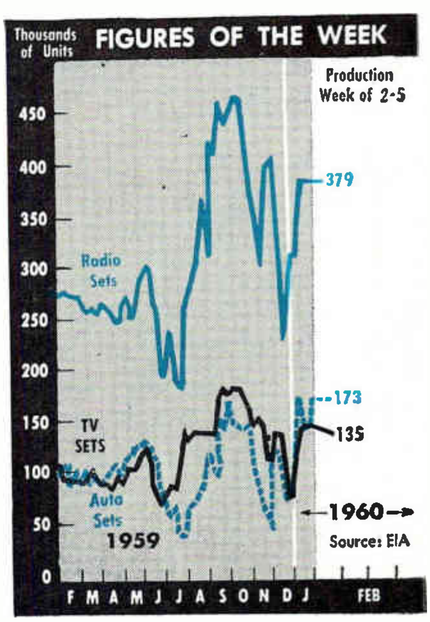
Screening Procedures

Despite the importance of new products to the electronics industry, only 13 of the 28 firms said they had a written procedure for screening and selecting new product ideas.

Committees handle new product screening in 15 firms. Departments handle the function in three firms and individuals in eight. On average, 59 products are screened annually, and 14 get further study.

Profit potential had to be the most important criteria in screening of new products. It was mentioned by 27 firms. Twenty firms listed competitive status. Other frequently-mentioned criteria were compatability with present manufacturing facilities and distribution system, costs of development and marketing.

Studies by engineering and marketing research groups, internal and external, shared top honors in answer to question on methods used to study new product ideas. Both groups were mentioned by 18 firms.

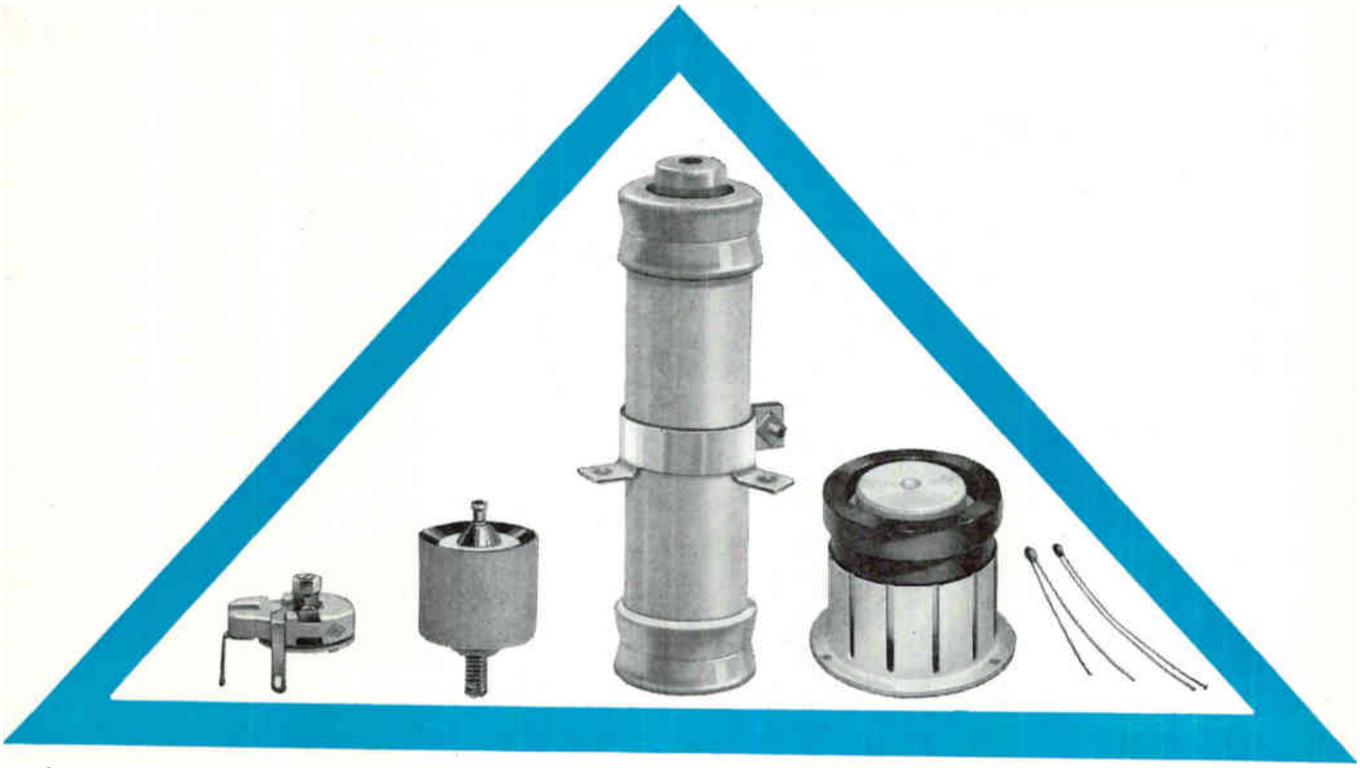


Developing capacitors for unusual situations your job . . . and Centralab's

Centralab CERAMIC CAPACITORS for difficult applications

Ceramic capacitors have almost unlimited capabilities . . . but utilizing their full potential demands expert knowledge *not bound to conventional approaches*. Creative engineering, involving new concepts and new techniques, can broaden your design horizons.

That kind of creative engineering is a CENTRALAB specialty. As specialists in *ceramic* capacitors, CENTRALAB engineers have developed units to meet an enormous variety of difficult size and rating requirements beyond the scope of oil, mica or vacuum capacitors. The unusual designs illustrated here are typical of CENTRALAB's answers to the problems no-one else could solve. A representative group of additional specialized units are described in Bulletin #42-719. Request your free copy of this bulletin today; it will stimulate your thinking towards making full use of the design potential of ceramic capacitors.



Variable Capacitors
600VDCW, capacity ranges to 250 mmf. Compact construction, 15/16" wide, 1 9/16" long, 11/16" deep overall. Temperature compensating units NPO, N650 are standard. Other temperature characteristics available on special order.

Precision Temperature Compensating Capacitors
Hermetically sealed, T.C. ± 10 PPM, capacity tolerance ± 1%. Outer shell grounded. Available in 50-3500 mmf range in NPO. Other T.C. ratings proportional.

High Voltage Capacitor
12KVDCW, 2000 mmf; 30 amps at 30 mc. Unit is 6" long, 2" O.D. Extremely flexible design—can be made to a wide range of dimensions and ratings. Units that operate at 125°C. without derating can be designed.

DC Blocking Capacitor
10KVDCW, 1700 mmf ± 10%; 12 amps at 4 mc, 80 amps at 30 mc. Measures only 4" high and 4" O.D. at base. Ideal for restricted space, high reliability applications. Can be used in parallel to handle large loads.

Ultra-Miniature Capacitor
3VDCW, .01 mmf G.M.V. Capacity change +10° to +85°C., 25% maximum. Approximately 1/8" diameter. For transistor, coupling, by-pass, cathode and other low voltage, high capacity applications.

Centralab D-5947

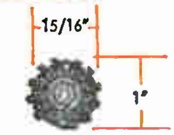
ELECTRONICS DIVISION OF GLOBE-UNION INC.
914B E. KEEFE AVE. • MILWAUKEE 1, WIS.
In Canada: 669 Bayview Ave., Toronto 17, Ont.

VARIABLE RESISTORS • ELECTRONIC SWITCHES • PACKAGED ELECTRONIC CIRCUITS • CERAMIC CAPACITORS • ENGINEERED CERAMICS

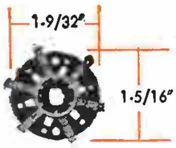
CIRCLE 31 ON READER SERVICE CARD

Widest Option in Low-Power Rotary Switches

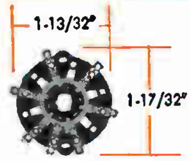
SECTIONS



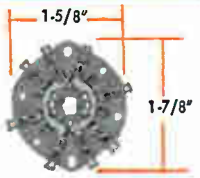
THROW: 30°, 36°, 45°
INSULATION: stator glass silicone; rotor, KEL-F



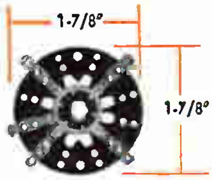
THROW: 30°, 45°, 60°, 90°
INSULATION: phenolic, Mycalex, ceramic



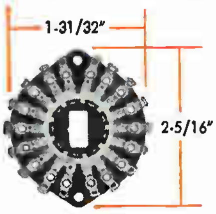
THROW: 25.7°, 30°, 36°, 45°, 60°
INSULATION: phenolic, ceramic



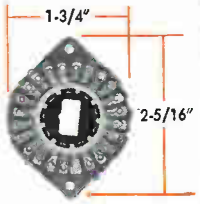
THROW: 18°, 20°, 30°, 36°, 45°, 60°, 90°
INSULATION: phenolic, Mycalex, ceramic



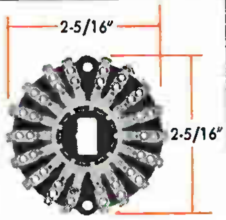
THROW: 30°, 36°, 45°, 60°, 90°
INSULATION: phenolic, Mycalex, ceramic



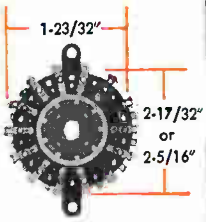
THROW: 20°, 40°
INSULATION: phenolic



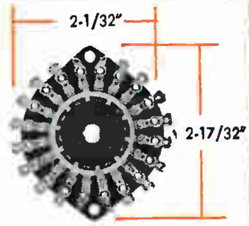
THROW: 15°, 30°
INSULATION: phenolic



THROW: 20°, 40°
INSULATION: phenolic, Mycalex



THROW: 12.85°, 25.7°
INSULATION: phenolic



THROW: 12.85°, 18°, 25.7°, 36°
INSULATION: phenolic

METAL PARTS AND FINISHES

STANDARD COMMERCIAL—Punched steel parts are lead-coated, cold-rolled steel. Parts such as nuts, lockwashers, etc., are cadmium-plated steel. Shafts may be cadmium-plated steel, brass, or aluminum. Brass parts are unplated.

TROPICAL OR 50-HOUR SALT SPRAY MILITARY SPECIFICATIONS—All steel and brass parts are cadmium-plated and chromate-dipped. Stainless steel parts are passivated.

200-HOUR SALT SPRAY MILITARY SPECIFICATIONS—All brass parts are nickel plated. All stainless steel parts are passivated. Shafts, "C" washers and index springs, balls and plates are stainless steel.

CONTACTS

Famous Oak double wiping, high-pressure design. Riveted or eyeleted in place and keyed from turning. Rotors shorting or nonshorting.

TYPE 1—Contacts are spring brass, silver-plated. Rotors are brass, silver-plated. Temperature limit: 100°C constant ambient.

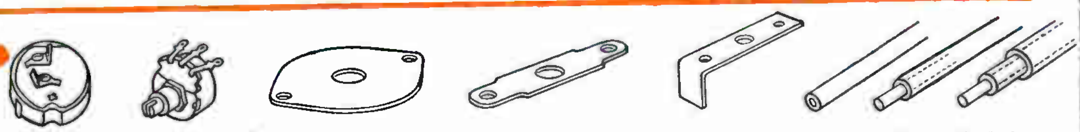
TYPE 2—Contacts, spring tempered-silver alloy. Rotors, coin-silver alloy. Temperature limit: 100°C constant ambient.

TYPE 3—Contacts and rotor blades made of Oak alloy CMS-202. This is a special alloy for high temperature operation to 150°C.

GOLD-PLATED CONTACTS—Type 1 or 2 contacts may be gold-plated .0002" thick. Not to be confused with gold flash.

FOR PRINTED CIRCUITS—Standard Oak contacts with a lug extending from the terminal end. Lug inserts in board for dip soldering.

ACCESSORIES



AC SNAP SWITCHES—36 models for use on most switch types. All are UL approved.

POTENTIOMETERS—Customers' choice. Mounts on rear of Oak switches. Operates by switch shaft or separate concentric shaft.

ELECTROSTATIC SHIELDS—Used between sections. Sizes and shapes for all switches.

BEARING STRAPS—Added shaft support on long switches. Steel, brass, and phenolic.

MOUNTING BRACES—Prevents frame twist on long switches due to torsion.

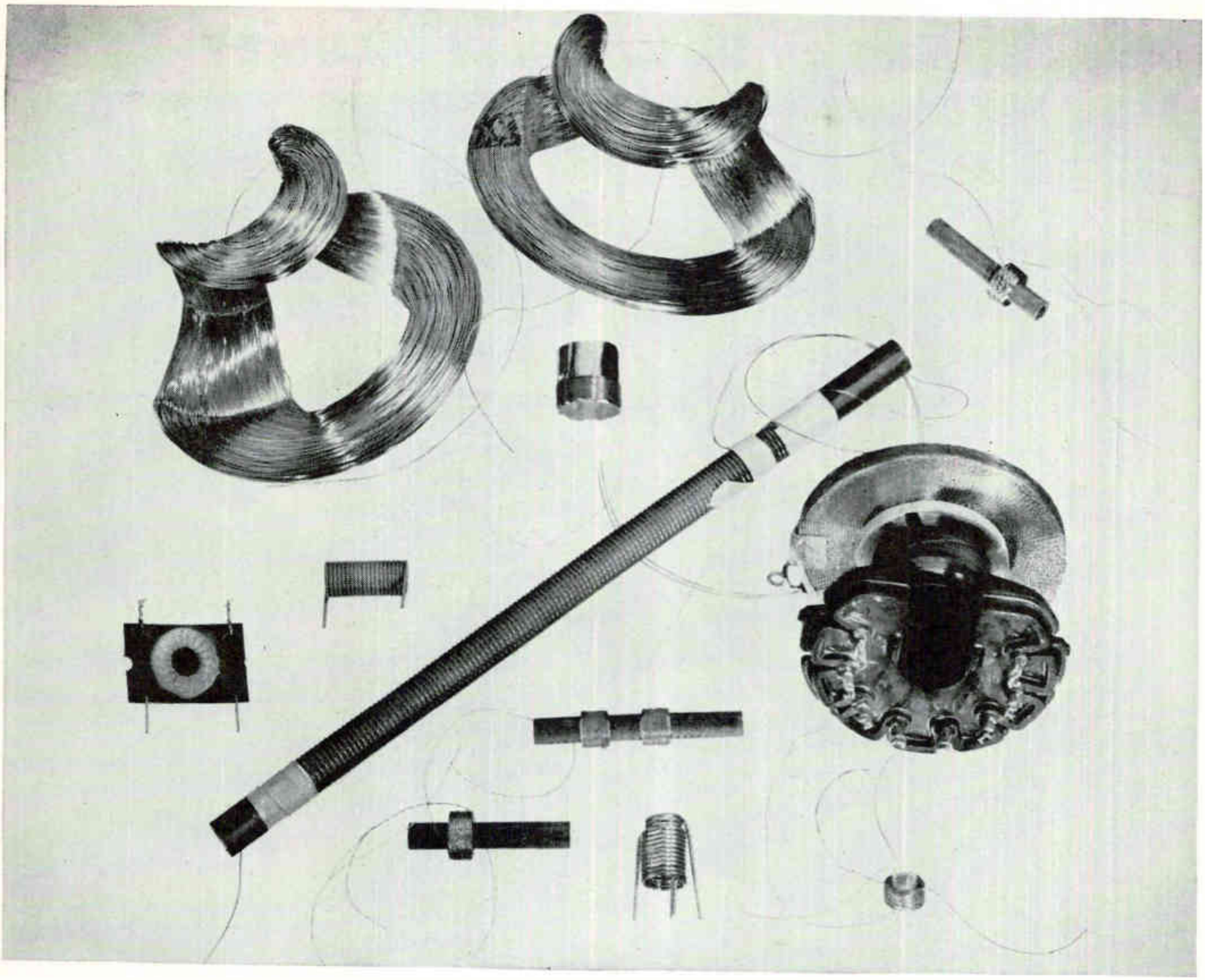
SPECIAL SHAFTS—Hollow, dual-concentric, and triple-concentric for many switches.

OAK MFG. CO.

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

SEND FOR THIS GUIDE CHART TO OAK SWITCHES

Bulletin unfolds to 17" x 22" wall chart (right) which matches 34 rotary switch sections (shown actual size) to corresponding frames. Also contains specifications and dimensions for rotary, pushbutton and lever switches.



General Electric has whatever you need in magnet wire

When it comes to buying fine or ultra-fine magnet wire for the electronic industries, just name your specs and General Electric can match them. For example:

What sizes do you need? G-E magnet wire is available in sizes No. 4 Awg to No. 50 Awg round. These wires meet NEMA standards in every particular yet in many of the smaller sizes General Electric offers maximum overall diameters which are smaller than applicable NEMA standards. G. E. also offers several ultra-fine sizes in addition to the standard Awg series.

What temperature range do you need? Operating temperatures for General Electric ultra-fine magnet wire range from 105 C through 200 C.

What properties do you need? There's a G-E type to meet any property specification. Here are a few:

Solderable: Polyurethane
Polyurethane nylon, polyurethane Butvar
Self-bonding: Formex* Butvar
Polyurethane Butvar
Complementary properties:
Formex nylon, polyurethane nylon

When do you need it? You can get most types and sizes of G-E magnet wire right out of stock, at G-E warehouses spotted all over the country. G-E Plants on both coasts can usually make special types and sizes to order, promptly.

Any more questions? Send for the newest, most comprehensive magnet wire catalog available. To get your copy, simply fill in and mail the coupon below.

General Electric Company
Wire and Cable Department
Section W249-299, Bridgeport 2, Connecticut

☐ Please send me the brand-new G-E magnet wire catalog—the most complete book of its kind available.

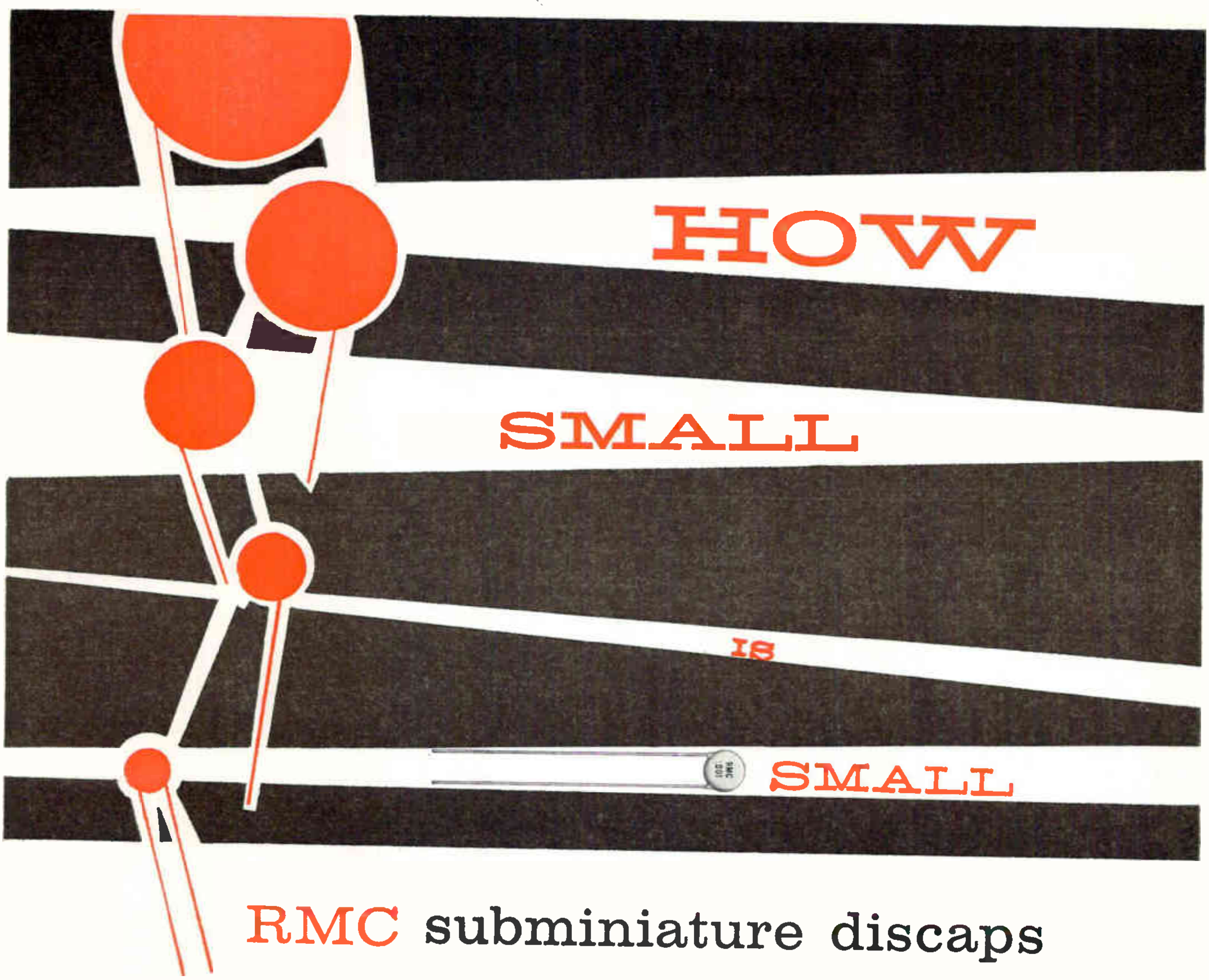
☐ Attached is a description of my problem—what do you suggest?

Name________ Title________
Company________
Address________
City________ Zone____ State________

*Reg. Trade-Mark General Electric Co.

Progress Is Our Most Important Product

GENERAL ELECTRIC



RMC subminiature discaps

Small is a relative term and at RMC subminiature better describes Type SM DISCAPS. These DISCAPS meet the specs of EIA-RS-198 for Z5U ceramic capacitors and are available as described in the table below. Type SM DISCAPS show minimum capacity change between +10°C and +65°C.

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

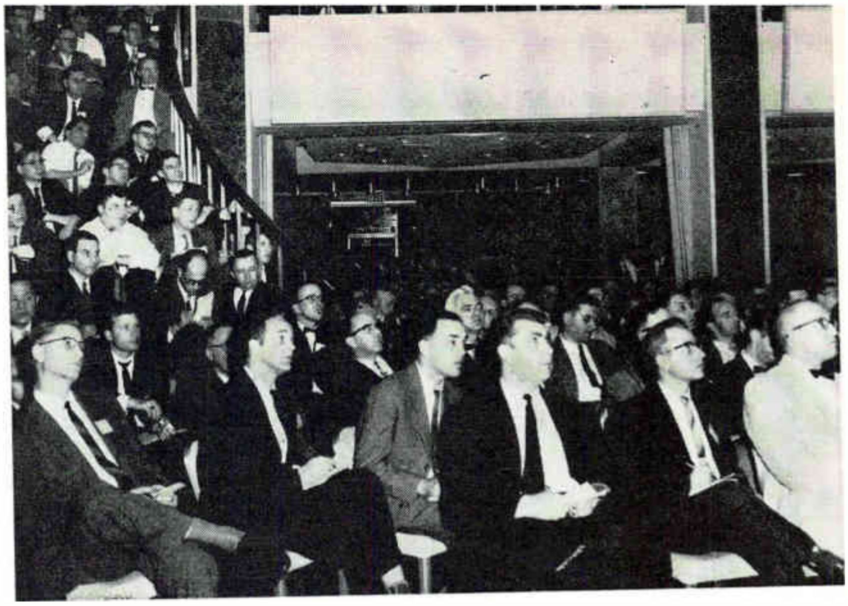
Capacity	Max. Dia.	Max. Lead Len.	Meas. Between Leads	Tolerance
.800	.235	1½"	.150	GMV
.001	.235	1½"	.150	GMV
.0015	.285	1½"	.250	GMV
.005	.390	1½"	.250	±20% +80% −20%
.01	.510	1¼"	.375	±20% +80% −20%
.02	.675	1½"	.375	+80% −20%

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.

CIRCLE 35 ON READER SERVICE CARD



Overflow crowd of 1,000 listens at 9 p.m. to talks on tunnel diode developments at one panel discussion session of Solid-State Circuits Conference in Philadelphia

Diodes: New Market Appeal

Many tunnel diode circuit designs are being devised for a wide range of commercial products—even as research opens new possibilities

NEW SEMICONDUCTOR DIODES based on the tunnel effect delineated by Leo Esaki are being developed and studied so intensively by electronics companies that several commercial implications are now recognized by technical observers.

Computers, communications and the home entertainment field are being singled out by scientists as promising areas of application for tunnel diode circuitry.

However, companies with large R&D groups seem to be methodically investigating all possible fabricating materials and circuit approaches before they invest heavily in extensive product engineering efforts.

Tunnel diode circuit design by many electronics firms, and R&D work by a smaller number, are running concurrently. Some circuit designers attending the Solid-State Circuits Conference in Philadelphia recently told ELECTRONICS they had not worked with tunnel diodes because samples had been too costly. They said now that germanium samples could be bought for as little as $10 apiece, their own management was certain to give them the green light.

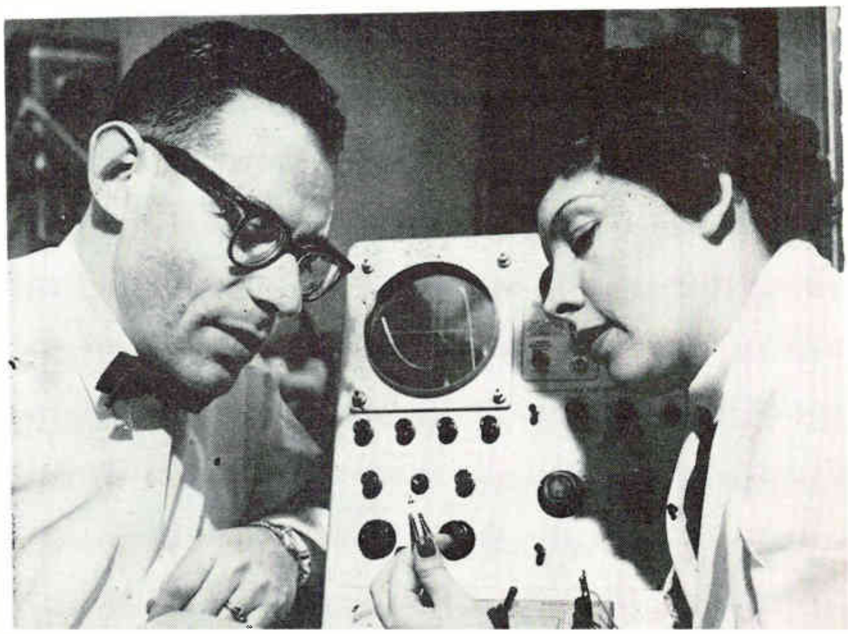
Data on Gallium Arsenide

The intertwining of tunnel diode research and circuit design is pointed up by the fact that GE, which announced price reductions on its germanium samples, has stated publicly that, based on the latest observations by its scientists, gallium arsenide is "the best material so far explored and may be the ultimate material for the best overall performance."

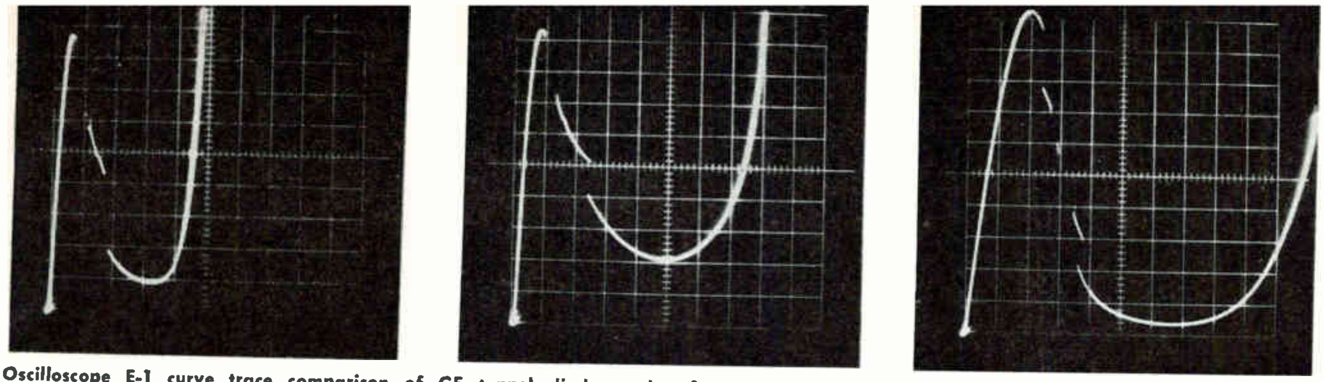
Oscillation frequencies of 4,400-Mc have been obtained, says GE, indicating that frequencies well above 10,000-Mc are possible with gallium arsenide tunnel diodes. The company said new gallium arsenide samples would be available to circuit designers in about six months. Industry interest is high also in other III-V intermetallic compounds.

Joint Research

A number of electronics companies are jointly supporting a basic research program at Battelle Memorial Institute, Columbus, O., which concentrates on the large energy gap of the III-V compounds.



Physicist and a technician examine a new gallium arsenide tunnel diode under test. Characteristic E-I curve is seen on oscilloscope



Oscilloscope E-1 curve trace comparison of GE tunnel diode made of germanium (left), silicon (center) and gallium arsenide

Battelle is putting most of its effort into aluminum antimonide and gallium arsenide, but is studying indium phosphide too. The program began two years ago, and is scheduled to run another two years.

Scientists are acquiring data on thermoelectric, resistive, magnetoresistive and Hall effects.

Outlook for Computers

One new indication of how seriously computer manufacturers are considering application of Esaki diodes as switching elements came from IBM's advanced systems development division in a paper at the Solid-State Circuits Conference.

"Under suitable bias and loading conditions," said the paper, "Esaki diode circuits can perform threshhold logic and binary memory functions and can provide power gain when switched."

Earlier, ELECTRONICS had reported (p 11, Jan. 8) that IBM researcher R. F. Rutz and his colleagues had attained a frequency of oscillation figure of 5,300 Mc at about 1 microvolt. Recently, IBM announced that Leo Esaki has taken a leave of absence from Sony Corp., Tokyo, to join IBM's semiconductor research department in Poughkeepsie, N. Y.

RCA reports it is investigating the use of Esaki tunnel diodes as storage elements. Cycle time of less than 100 nanoseconds has already been achieved.

Some opinion has been expressed that use of tunnel diodes in logic circuits will be limited only by the design limitations of the circuits themselves. New design techniques are required to take into account the fact that the power source may be an integral part of a logic circuit using tunnel diodes.

A GE scientist reports a tunnel diode flip-flop digital circuit, which overcomes the design problem of matching tunnel diode peak current characteristics. He said this circuit work would be shown and described at a conference later this year.

Flexibility of the tunnel diode's performance is noted by another GE scientist. He says that because of its flat frequency response, the same diode can be used to perform different functions at several frequencies. Specifically, he reports that it has operated as an oscillator at one frequency and as an amplifier at a frequency low in comparison to the first.

Several company representatives see Esaki diode computer developments heading towards eventual substitution of the new units for transistors. They predict plug-in modules with simpler circuitry than that presently used.

Communications

Many of the criteria which hold for the feasibility of using tunnel diodes in computers apply as well to electronic telephone switching. Since electronic switching in telephony is still in its R&D stages, Esaki diodes conceivably could be designed into telephone switching systems of the future.

Pulse transmission, including television pulse-code-modulation, is a communications area in which R&D involving Esaki diodes is likely to receive attention.

Masers and parametric amplifiers are expected to get limited competition from Esaki diode devices in the space electronics field and in some microwave communications equipment because of the higher noise level of the latter. Amplifiers using present units would be relatively inefficient, for example, with the conventional sugar-scoop antennas used in the Bell System's transcontinental radio-relay system.

However, it seems plausible that there could be a place for Esaki diode amplifiers in certain parts of microwave systems, where they may operate as high as 30,000 Mc. It is believed they could find use in conjunction with long waveguides in which noise is determined by the temperature of the material (usually copper).

A new broadband amplifier, announced by Bell Telephone Laboratories, makes use of the negative-resistance of an Esaki diode of indium antimonide in combination with nonreciprocal ferrite attenuation in order to achieve a high amplification ratio without self-oscillation.

Bell says the amplifier, which operates above 1,000 Mc, is expected to have applications in radar, microwave radio relay, satellite communications and waveguide transmission systems.

"Power requirements are low and it is expected that the device will be lower in cost and have greater reliability than other methods of achieving comparable signal amplification," says Bell.

Receiver Amplifiers

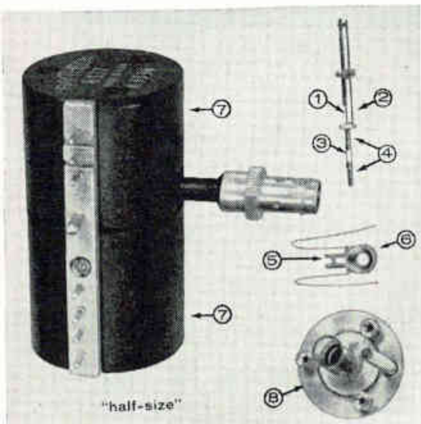
RCA scientists identified with both defense electronic products and home entertainment instruments reported results of recent experiments with tunnel diode amplifiers at the circuits conference. Their principal conclusion: "With tunnel diode circuitry, negative resistance amplifiers can be made practical and useful in various receiver applications."

Small size, potential low cost and fairly simple circuitry were advantages cited. The RCA men see the tunnel diode amplifier as a basic building-block for future microminiaturization.

A noise factor of less than 4 db was measured for one RCA tunnel diode amplifier tested in the experiments.

Nickelonic News

VOL. 1 — DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS — No. 8



Designers insure magnetron reliability with 4 nickel alloys

WALTHAM, MASS: Recently announced by Raytheon Company, the #6177 Magnetron is compactly designed for height finding, other airborne radar uses. Size is small, weight only 1 lb, range is 4261-4300 megacycles at 1 watt.

To insure the magnetron's operating reliability, Raytheon designers use 4 nickel alloys in 13 critical parts. (8 parts are numbered in above photo.) Designers report why:

Electronic Grade "A" Nickel offers outstanding purity in ribbon (1).

Inco "220"* Nickel assures proper outgassing in washer ring (2), tube (3), tube shield (4).

Another nickel-chromium alloy retains non-magnetic characteristics in reed (5), and reed coil support (6).

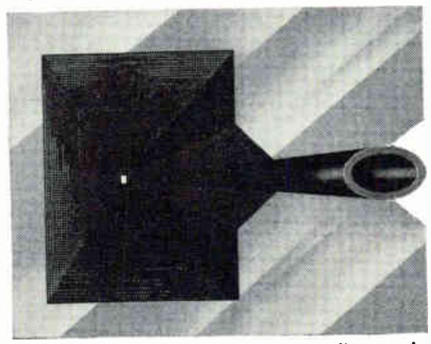
Alnico (nickel-iron alloy) magnets provide stability (7); cupro-nickel pole support provides strength, non-magnetic characteristics (8).

***Pertinent Literature:* Send for 51-B; "Nickel Alloys for Electronic Uses" (see box, below) and T-15; "Engineering Properties of Nickel."**

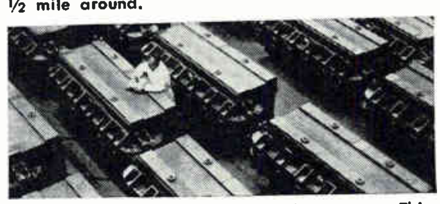
Circle 563 on Reader-Service Card

Metal that acts like air wraps half-mile vacuum

UPTON, N. Y. In the huge new 25-Bev Synchrotron at Brookhaven National Laboratory, Inconel "X"* age-hardenable nickel-chromium alloy – "a metal that acts like air" – is used to contain a ½-mile-long proton beam vacuum cavity.



Tube of low-magnetic Inconel "X" alloy carries Synchrotron's 25-Bev proton beam between magnet jaws. Tube's assembled, in sections, into a circle ½ mile around.



Inspecting one of Synchrotron's 240 magnets. This one weighs about 17 tons. Inconel "X" tube fits into narrowest gap between jaws.

Principal reason for the selection of Inconel "X" alloy, reports Brookhaven, was its high electrical resistivity. This resistivity, about 740 ohms per circular mil-foot, results in the avoidance of high eddy currents. In addition, the low magnetic permeability of Inconel "X" alloy, approximately the same as air, has virtually no effect on the strong magnetic field passing through the tube walls to guide the proton beam.

Inconel "X" also benefits vacuum cavity tube in other ways

Its high structural strength permits thin-wall construction–tensile strength after heat treatment, above 130,000 psi. Other physical properties important to this application–the alloy's low vapor pressure, good degassing, freedom from porosity.

Inconel "X" alloy provides good fabricability, too–tube is formed in sections from 0.078-inch sheet, welded and flanged.

***Pertinent Literature:* Send for 51-B; "Nickel Alloys for Electronic Uses."**

Circle 564 on Reader-Service Card

Monel speeds sound brazing of resistor caps

Close-up of Monel caps soundly brazed to wire winding and leads of semi-finished resistor. Made by Sage Electronics Corporation, 302 N. Goodman St., Rochester 7, N. Y.

ROCHESTER, N. Y.: Monel* nickel-copper alloy now makes possible, fast, sure brazing of connections in resistors designed for severe service by Sage Electronics Corporation (see photo, left).

In the caps, Monel alloy also gives excellent resistance to corrosion in murderous environments... and provides essential strength for anchoring leads.

Monel boosts durability in other electronic components, too

In one magnetron, for example, Monel alloy provides an output flange and mounting plate with the toughness and strength needed for 6000-hr life. In fastenings, Monel alloy stands up against both corrosion and hard knocks. In backing for contact points, Monel alloy contributes important strength and brazing properties.

***Pertinent Literature:* Send for 51-B; "Nickel Alloys for Electronic Uses" and T-5—"Engineering Properties of Monel and 'R' Monel."**

*Inco trademark

Circle 565 on Reader-Service Card

Newly Revised Booklet—"Nickel Alloys for Electronic Uses"—gives you facts on 17 freely available nickel alloys useful in the electronics industry ... facts on typical applications, physical and chemical properties, available mill forms. Ask us for your copy.

Our specialists can help you solve metal problems. Contact your Inco Alloy Products distributor or:

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Electron Tube News ...from SYLVANIA

Sylvania continues to advance the development of new concepts in electronic tubes. 9-T9 is another example! The new "outline" lifts restrictions imposed upon engineers who design equipment to be produced by printed circuit techniques. Now it becomes possible to employ tube assemblies capable of high plate dissipation in printed circuit boards. This can be done with conventional 9-pin sockets widely used in printed circuits. The 9-T9 concept of tube design offers unusual promises of compactness.

9-T9 increases volumetric efficiency of the chassis by eliminating the relatively large octal base of the T9 outline.

9-T9 enables the use of large tube-assemblies in those stages where higher power-dissipation capabilities of the tube are a design necessity to include reliability.

9-T9 maintains compactness of the equipment formerly afforded by tubes fitted with T6-½ header.

NEW SYLVANIA TUBE-TYPES IN 9-T9 DESIGNS!

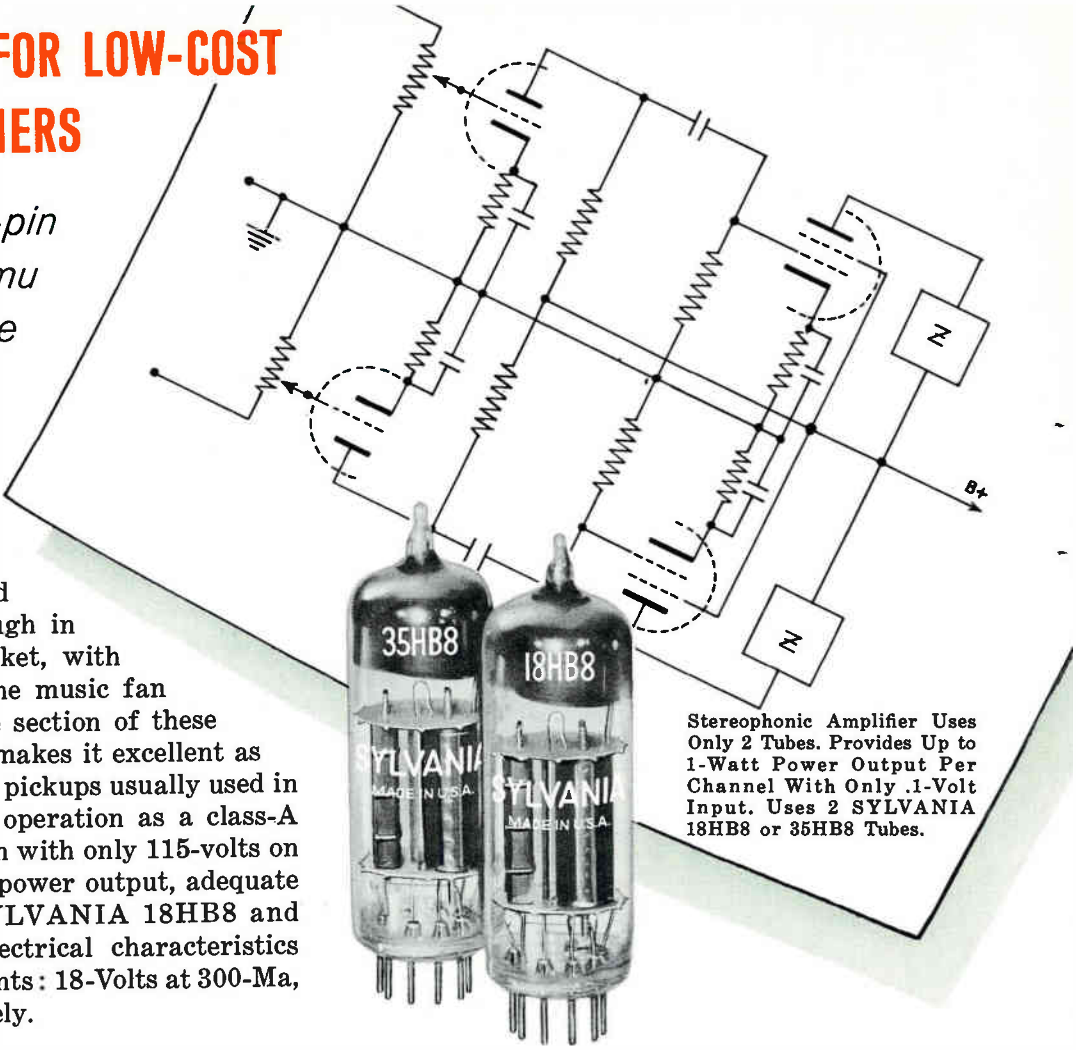
6EW7... double-triode... triode #1 will be intended for service as a vertical deflection oscillator, triode #2 as a vertical deflection amplifier in TV receivers. Note especially the high plate-power dissipation capabilities of triode #2 in this new tube-type as compared to a conventional 9-pin miniature tube. 10EW7 ... identical to 6EW7 in electrical characteristics except for heater power requirements.

New 9-T9 SYLVANIA designs include a beam-power pentode with approximately 5-watts power output in audio amplifier service; a medium-mu triode, beam-power pentode for audio amplifier service in low-cost equipment where power outputs of 1 to 2 watts are required; a medium-mu triode, high perveance beam-power pentode for vertical deflection circuits in TV equipment.

NEW SYLVANIA TUBES FOR LOW-COST STEREOPHONIC AMPLIFIERS

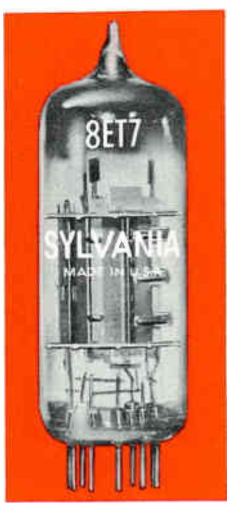
18HB8 and 35HB8 . . . 9-pin miniatures feature high-mu triode and power-pentode in one envelope!

Looking for sales-building record players you can quantity-produce and market? Here are 2 new tube-types that will help you design stereophonic and monophonic amplifiers small enough in cost to reach the "popular" market, with enough power output to please the music fan with a "tight" budget. The triode section of these new tubes has a mu of 100. That makes it excellent as a voltage amplifier for the types of pickups usually used in low-cost phonographs. In typical operation as a class-A audio amplifier, the pentode section with only 115-volts on the plate can deliver up to 1-watt power output, adequate for a small-speaker system. SYLVANIA 18HB8 and 35HB8 are identical in their electrical characteristics except for heater power requirements: 18-Volts at 300-Ma, and 35-Volts at 150-Ma, respectively.



Stereophonic Amplifier Uses Only 2 Tubes. Provides Up to 1-Watt Power Output Per Channel With Only .1-Volt Input. Uses 2 SYLVANIA 18HB8 or 35HB8 Tubes.

NEW SYLVANIA TUBES ANNOUNCED FOR IMPROVED TV-RECEIVER DESIGNS



8ET7 . . . this 9-pin miniature features *duo-diodes* for discriminator or video-detector service and a *pentode section* for video-output service.

6GN8 . . . a 9-pin miniature with a *triode section* for general-purpose use as a voltage amplifier or for service as a sync-separator, and a pentode section for video-output service. The *pentode* section is equipped with a cathode especially designed to provide "cool" operation with resultant extended life and reliability.

8GN8 . . . 9-pin miniature with electrical characteristics identical to SYLVANIA 6GN8 except for heater power requirements.

For further information, contact the Sylvania Field Office nearest you. Sylvania Electronic Tubes, a division of Sylvania Electric Products Inc., 1740 Broadway, New York 19, New York.

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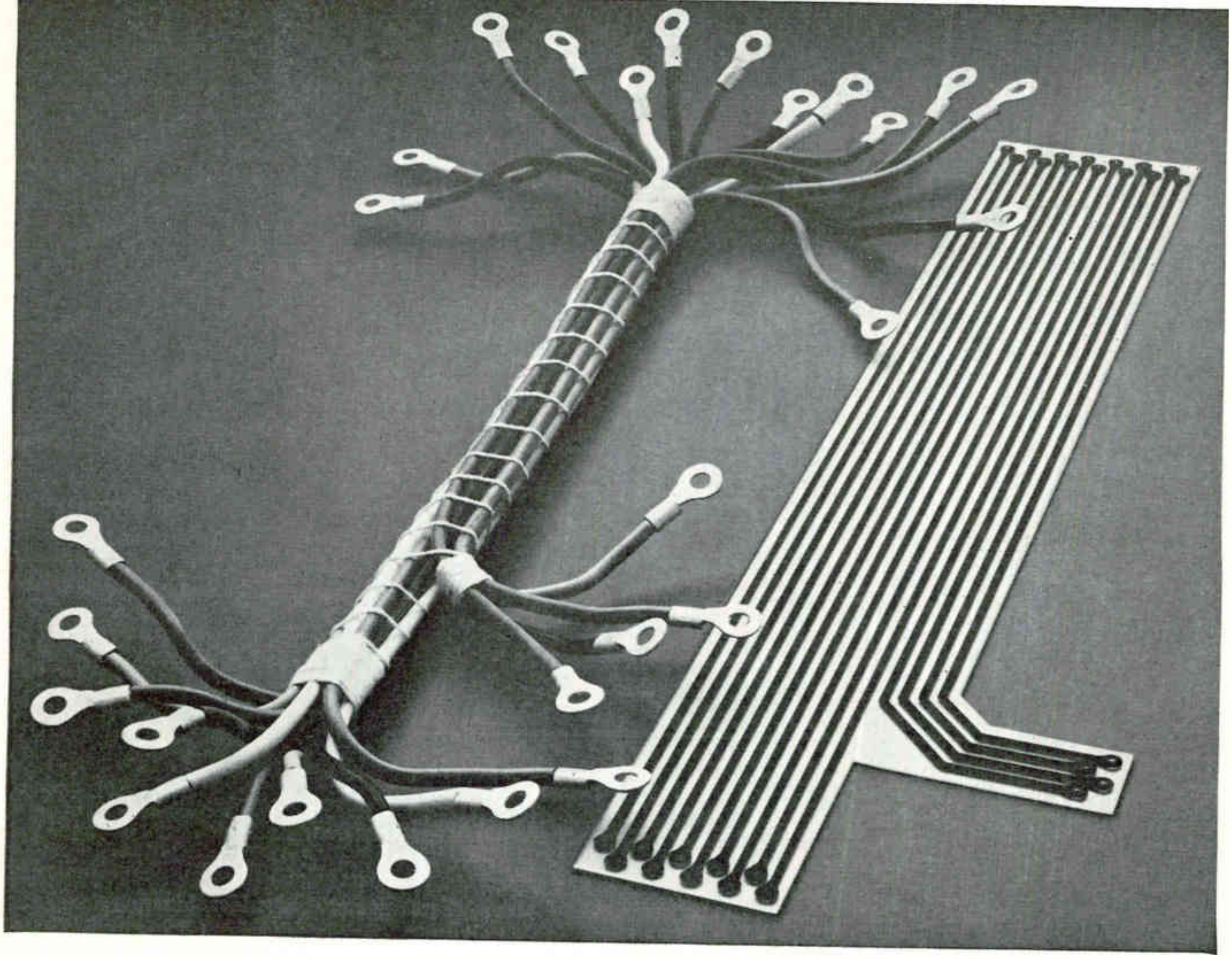
GENERAL SYSTEM



←CIRCLE 40 ON READER SERVICE CARD

CIRCLE 41 ON READER SERVICE CARD

Project Defender Contracts Awarded or Being Negotiated

DESCRIPTION OF WORK	AGENCY	CONTRACTOR	AMOUNT (in thousands)
Information center on high altitude weapons effects	ARDC	Rand Corp.	$ 144.
Reentry physics studies	ARDC	MIT	4,646.
Omnirange digital radar	ARDC	Columbia University	1,328.
Electronically-steerable array radar	ARDC	Bendix	2,144.
Missile range measurements	ARDC	in house	3,435.
Arcania assignment to AFMTC	ARDC	Stanford Research Institute	575.
H-f ionospheric radar research	ONR	in house	535.
Ballistic missile defense system studies	ARDC	Convair	1,375.
Atmospheric ionization studies	ARDC	A. D. Little, Convair	1,435.
Radar discrimination	ARDC	Raytheon	680.
Downrange ship operations	AOMC	RCA	2,700.
High power radar research	AOMC	Cornell Aeronautical Laboratory	1,361.
Advanced radar research	ARDC	MIT	550.
Vertical probe launching	ARDC	in house	397.
Decoy sorting radar	ARDC	Raytheon	1,118.
Microwave radar	ARDC	RCA	850.
Artificial electron cloud study	ASC	Itek	39.
Catalytic effects in discharges	BRL	in house	80.
Design of hypersonic intercept system	ARDC	Convair	1,033.
Hypervelocity impact research	NRL	in house	525.
Hypervelocity impact research	BRL	in house	300.
Photo detachment cross section studies	NBS	in house	30.
Digital phased array radar	AOMC	Sylvania	1,434.
Transmission of ion and atomic beam studies	ASC	Am. M&F	100.
Feasibility studies (satellite defense system and missile phenomenology)	ONR	RCA, GE, Convair, Lockheed, Gen. Dynamics, Republic, Dikewood Corp., Allied Res. Corp.	3,805.
Feasibility studies (space intercept reentry target studies)	AOMC	Solar Aircraft, Bendix, Avco Res. Labs, Raytheon, Convair	3,257.
Feasibility studies (primarily GLIPAR)	ONR	Gen. Dynamics, Stanford Res., Westinghouse, Aeronutronic Systems, Allied Res. Assoc., U. of Chicago, Convair, GE Tempo, Gen. Mills, Hughes, Industrial Res. Assoc., Ramo Wooldridge, RCA, Republic, Technical Operations, Inc.	1,780.

ARDC—Air Research and Development Command; ONR—Office of Naval Research; AOMC—Army Ordnance Missile Command; ASC—Army Signal Corps; BRL—Ballistic Research Laboratories; NBS—National Bureau of Standards

Seeking protection until 1980, U. S. is now probing for

Tomorrow's Space Defense Setup

ATTEMPTS TO COME UP with a "breakthrough" to protect the U. S. from "extra atmospheric offensive vehicles" are proceeding on schedule, says the Advanced Research Projects Agency this week.

Being sought is a new technique that will protect this nation through 1980. Such a system would go far beyond capabilities of Nike-Zeus—anti-missile missile system now under development by the Army.

The study program is called Project Defender. It's being given $106 million, approximately half of the Advanced Research Projects Agency's budget for fiscal year 1960.

Project Defender is master minded by ARPA scientists and specialists from Air Research and Development Command and Army Ordnance Missile Command.

Seek New Concepts

Whereas Nike-Zeus will attempt to intercept an oncoming ballistic missile in the terminal phase of its trajectory, Defender will study new means of destruction from the moment of launch until impact. To do this, all phenomena associated with missile flight must be studied—both the natural and disturbed conditions of the upper atmosphere and the space beyond.

Emphasis in the Defender project is on development of new concepts and the application of new techniques. ARPA will not be satisfied with less than a "breakthrough" system.

Area of study will be wide. By 1980, more than ballistic missiles will be a threat. There may be maneuverable ballistic missiles, missile-launching satellites, or satellites that can be commanded to reenter at specific targets.

Defender covers more than 50 programs in the following areas: missile characteristics throughout the entire trajectory; characteristics of upper atmosphere radar; reentry body identification; destructive mechanism; interception; defense complexes; and exploratory research. (For specific contracts, see table.)

Brig. Gen. Austin W. Betts recently told the House Science and Astronautics Committee: "The study of such things as atomic cross-sections, changing molecular relationships and electron densities is involved. We are experimenting with the release of chemicals at high altitudes and the observation of artificial electron clouds and luminescence in order to determine basic data which will enlighten our understanding of the medium in which our weapon systems and those of the enemy will have to operate."

Pushing State of Art

Defender is pushing the state of the art of radar, infrared and optical sensing, as well as the capability to receive, process, communicate and effectively use data collected by these elements.

An important area of the study is counter-countermeasures: to determine whether a warhead is armed or a dud and to neutralize jamming.

ARPA is currently using existing "laboratories," such as the Atlantic missile range, for obtaining study data. ARDC's JC-131 telemetry aircraft ply the range during missile firings to pick up and record data. Two converted ships—ARDC's *SS Arcania*, Army's *SS American Mariner*—are carrying out the same mission.

Defender's major effort will begin in early 1962 on Roi Namur Island in the South Pacific. From there, two high-powered radars and a data processing system will monitor Nike-Zeus test firings on Kwajalein Atoll 45 miles away, and the IRBM's fired for the Nike-Zeus' practice from Johnston Island, 1,420 miles away.

'Pincushion' Radar

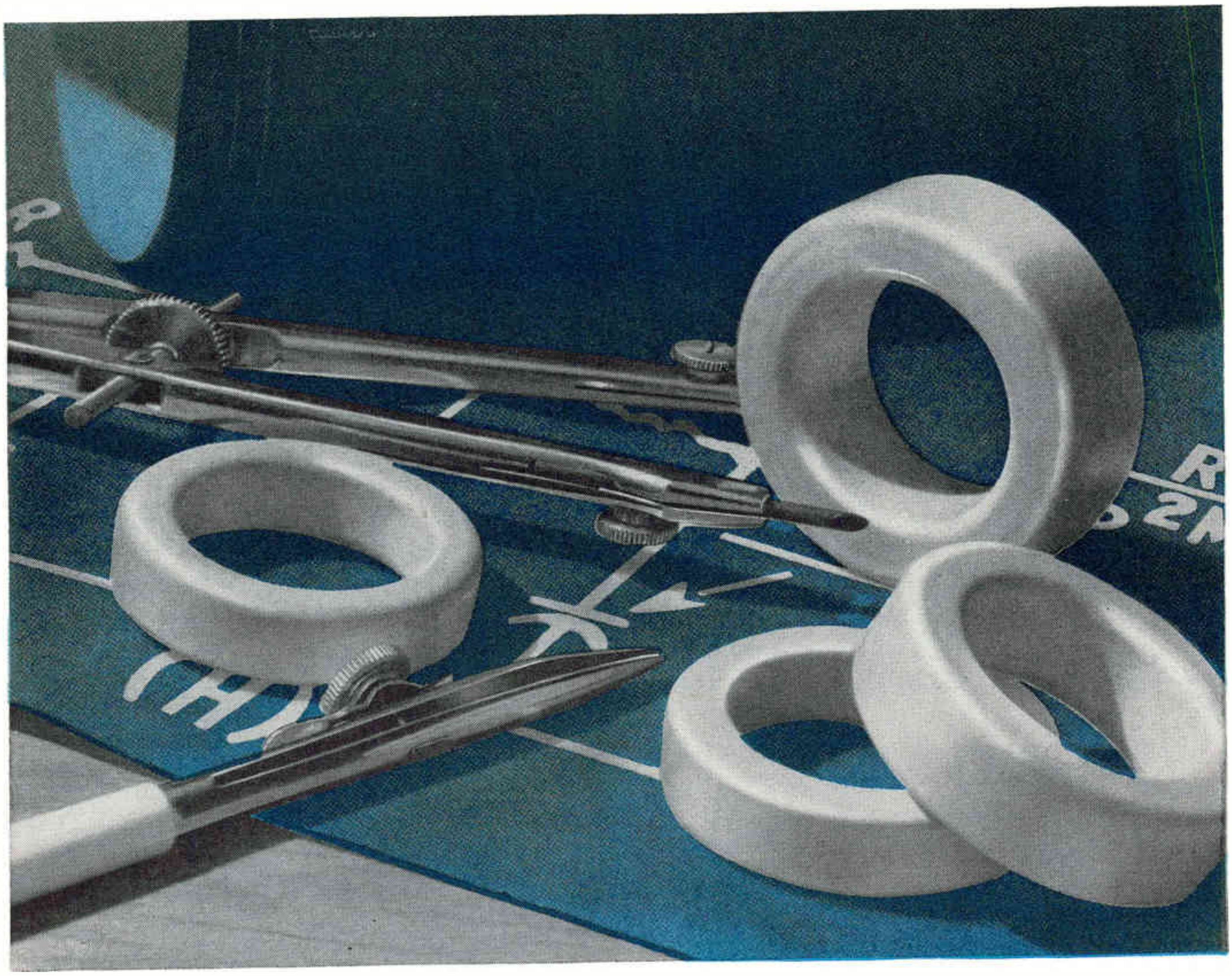
One radar will be an RCA modification of the AN/FPS-49 tracking radar being built for the Ballistic Missile Early Warning System (BMEWS). This unit will be acquired for ARPA by the Army Ordnance Missile Command.

The second radar on order is being built by Raytheon under a $15-million contract. An advanced tracking radar, the 80-ton unit will make microwave measurements of ballistic missiles outside the earth's atmosphere—compiling a billion bits of data on every run.

Named "Pincushion" because of its microwave beam pattern resemblance, the new radar will transmit more than a dozen narrow beams from the parabolic, five-story-high antenna.

Key to Pincushion's power is a series of Amplitron power tubes which make it possible to generate tremendous power levels in a relatively small space. Transmitting and receiving circuitry will be housed in a pair of 17-ft-sq compartments mounted on the back of the antenna. The radar is scheduled for delivery in late 1961.

Total cost of the Roi Namur facility, including the radars, computer installation, support facilities and one year's operation, will range from $75 to $100 million.



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Ions Affect Health, Behavior

Report shows positive ions are harmful, negative ions beneficial. It recommends careful design of gear for use in closed spaces

IONS IN THE AIR may have a marked effect on human health and behavior.

This idea—which has been kicking around the edges of several sciences for years—was recently revived at a symposium on electrical techniques in medicine and biology during the Winter General Meeting of the American Institute of Electrical Engineers.

A report on experiments with air ions in the trachea indicated that positive ions impede the clearing action of the breathing passages, while negative ions speed it up.

The report was delivered by A. P. Kruegar, M.D., of the University of California at Berkeley, and J. C. Beckett of Wesix Electric Heater, San Francisco.

The authors pointed out that, while negative ions have been shown to aid respiration, "this does not mean that negative ions will cure a respiratory ailment." Positive ions, they said, "enhance the susceptibility to trauma, may account for some mucosal irritation, and may set the stage for infection if other conditions are also present.

Problems in Space, Submarines

The report stressed that electrical engineers have a special responsibility in designing gear for use in confined spaces like submarines or spacecraft. Accumulations of positive ions in such a closed atmospheric system could seriously affect the health and wellbeing of crew members.

"Improved measuring devices and techniques," the authors said, have helped establish that "a small quantity of electricity could cause measurable response." Applying the experimental findings awaits completion of controlled clinical studies.

. . . And Department Stores

The experiments by Beckett and Dr. Kruegar reinforce suggestions made last year by S. J. Curtis at a special session on Ionization and Inventories, part of the 39th Annual Convention of the Controllers' Congress.

Curtis, who is security superintendent of giant Detroit department store J. L. Hudson, suggested that ionizers should become standard equipment in department stores as an aid to keep down pilferage. He told the Controllers' Congress that not only health but also emotional wellbeing and mental attitude are influenced by the ion content of air.

Documentation of ion effects on personality and behavior is about 30 years old. Dessauer concluded in 1931 that negative ions are beneficial to health and positive ions harmful. In 1933 at Harvard's School of Public Health, C. P. Yaglou demonstrated that negative ions normalized certain human organisms while positive ions often cause headaches and respiratory infections.

In 1947, Kornblush and Piersol established that the negatively ionized air of spas and health resorts, not the mineral waters or climatological conditions, was principally responsible for therapeutic effects.

In 1950, T. Puck at the University of Colorado reported that viruses carry a negative charge, as does healthy human tissue. Hence, Puck suggested, healthy cells repel virus attacks electrically. If a cell has a positive ion charge, then the disease virus is attracted to the cell and attaches itself to it.

According to a widely held theory, a falling barometer causes the emergence from porous soil of dead air, highly charged with positive ions. This partly accounts for the increased irritability, tiredness, even headaches, experienced by many people before a storm.

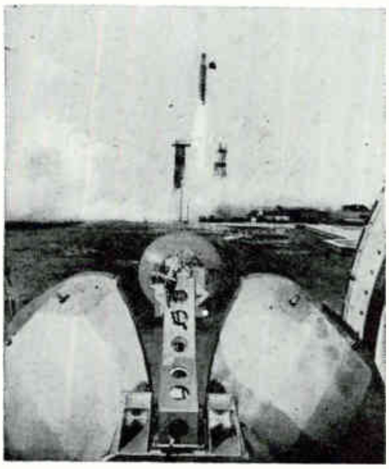
In Germany and Italy, courts of law traditionally take into consideration the sirocco and Fohn winds—positively charged seasonal winds from North Africa and the Alps—and reduce sentences for crimes committed in the Fohn or sirocco season. San Francisco police commissioner T. J. Mellon says "it is recognized that positively ionized air causes an increase in crime."

Ionizers

Positive ionization apparently contributes to the cracking of "fringe personalities." In summer dog days, when the positive ion index climbs, more neurotics slip across into pathological psychosis than at other times. Sex crimes rise, suicides increase in number, as do crimes of violence—and pilferage and shoplifting become serious commercial problems.

Retail-store executives are reportedly intrigued with the practical possibility of reducing shoplifting by artificially controlling ion content of air in their stores. Air is ionized naturally by solar radiation, by nuclear radiation, or by being broken down in an electromagnetic field. Ionizing instruments contain a radioisotope in an electrostatic field, remove positive ions from the air but leave a residuum of negative ions. Equipment would be installed as part of the air-conditioning system.

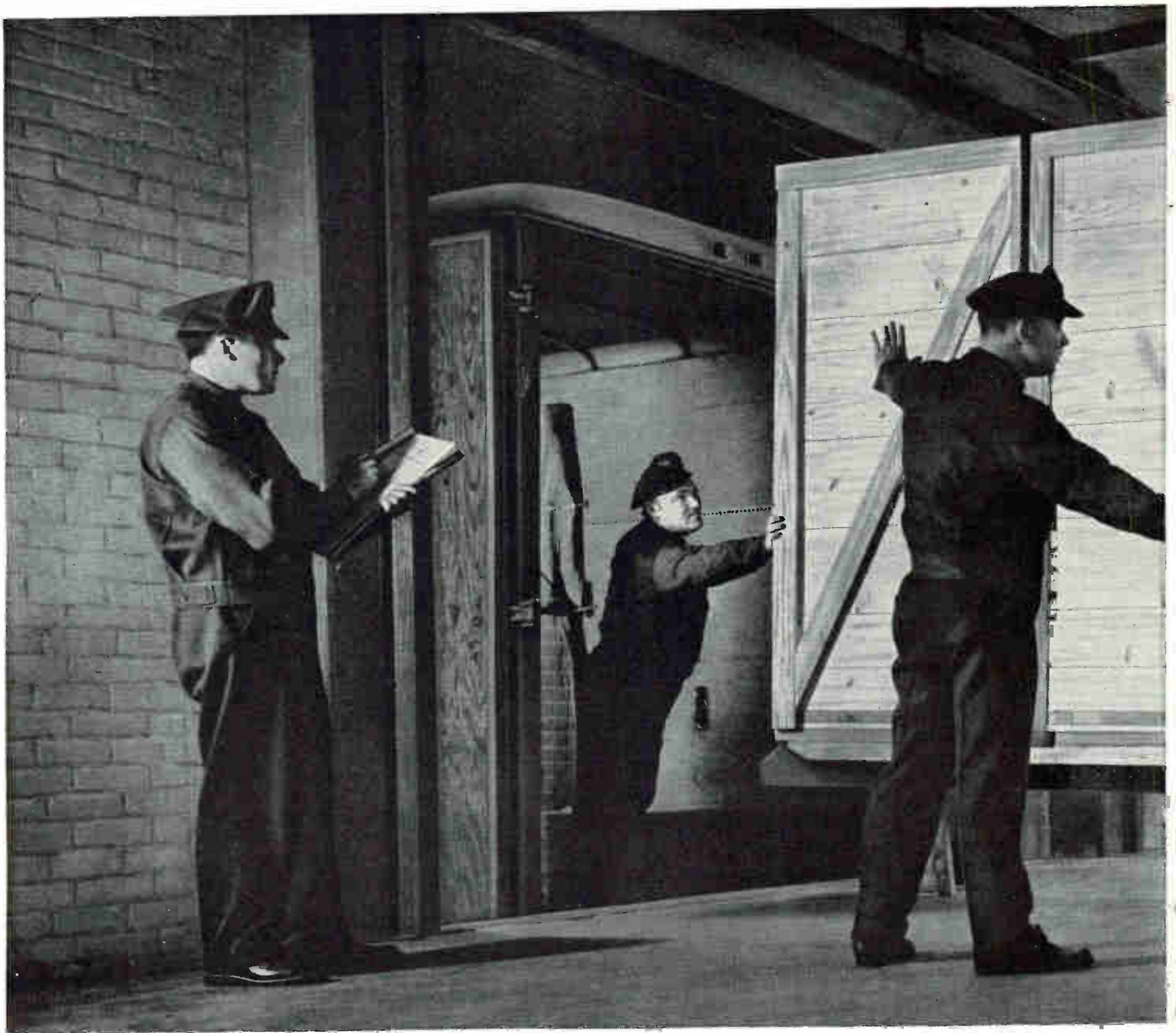
Radar View of Atlas



Composite photo shows how the launching of an Atlas ICBM looks to General Electric's radio-command guidance tracking radar

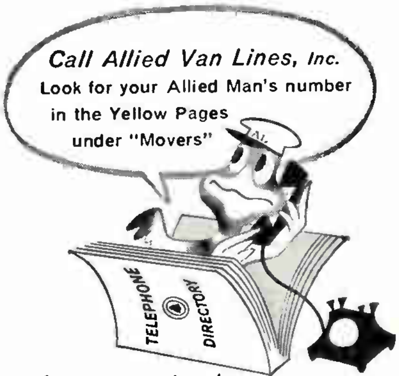
Moving costly equipment?

Trust everything



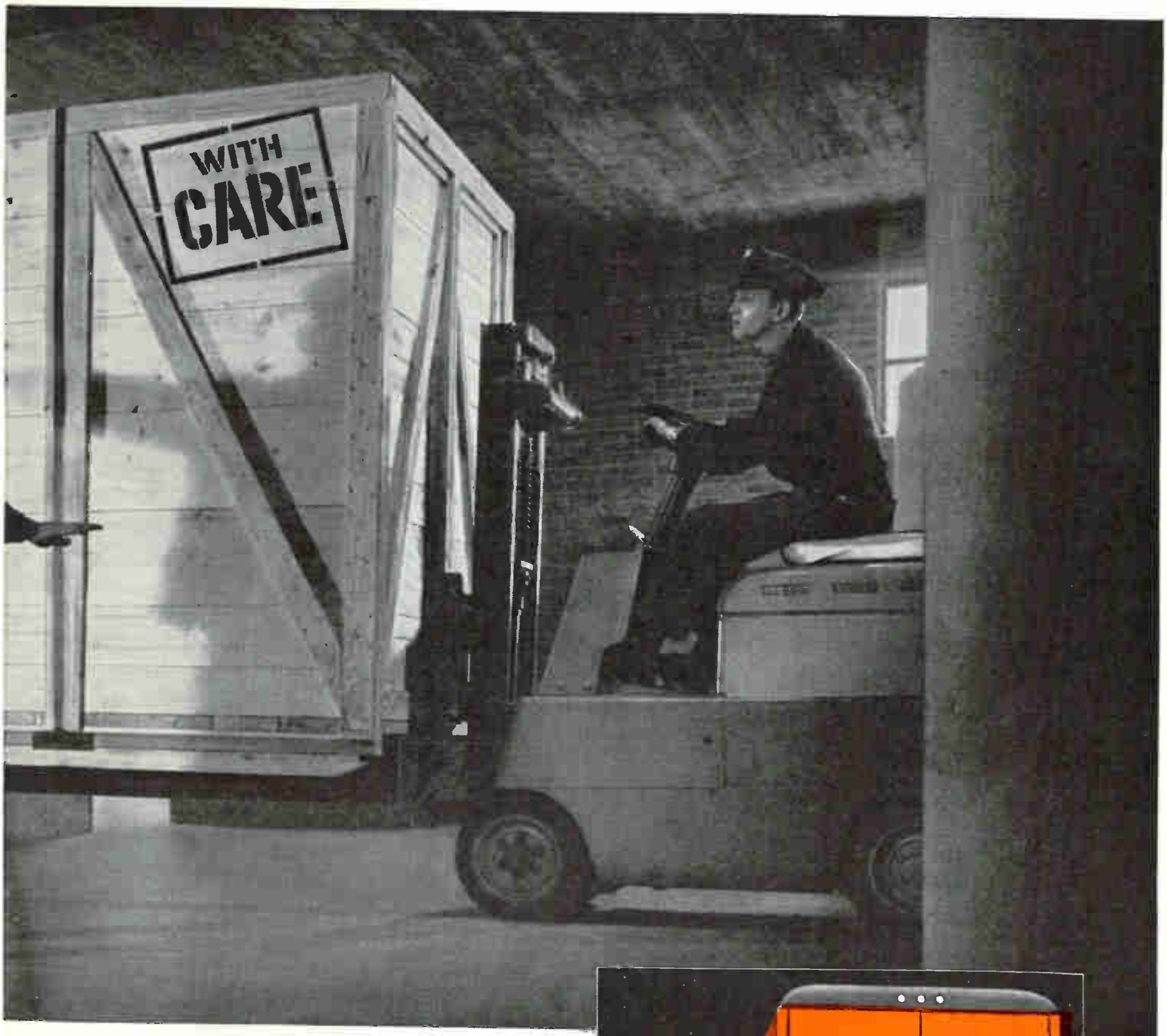
Why you can trust your Allied Man

He moves everything, from electronic equipment and exhibit displays to household goods—and moves them on schedule. You can relax. From start to finish the entire responsibility is in the hands of the world's largest mover.



More people do again and again

to your Allied Man



Extra safety for high-priced equipment

Here's part of a shipment worth one million dollars, for the aviation industry. It rides in a special Allied Van with "air-suspension" springs and was moved from the midwest to its eastern destination in record time. Moving extremely costly and fragile electronic equipment calls for great skill and experience. Here, as on every other moving job—"You can always trust everything to your Allied Man."

CIRCLE 47 ON READER SERVICE CARD

U.S. Tubes Popular

Foreign demand for our tubes, semiconductors should increase, nine-country survey shows

WASHINGTON—Electron tubes and semiconductors manufactured in the United States have a good reputation abroad, and there should be an increasing demand for specialized types and technically advanced designs.

This is the conclusion reached by Business and Defense Services Administration of the U. S. Department of Commerce in a nine-country survey report entitled "Electron Tubes and Semiconductors; Selected European Countries."

The survey was based primarily on information received from the U. S. Foreign Service covering Austria, Belgium, Denmark, France, Italy, Norway, Sweden, Switzerland, and the United Kingdom.

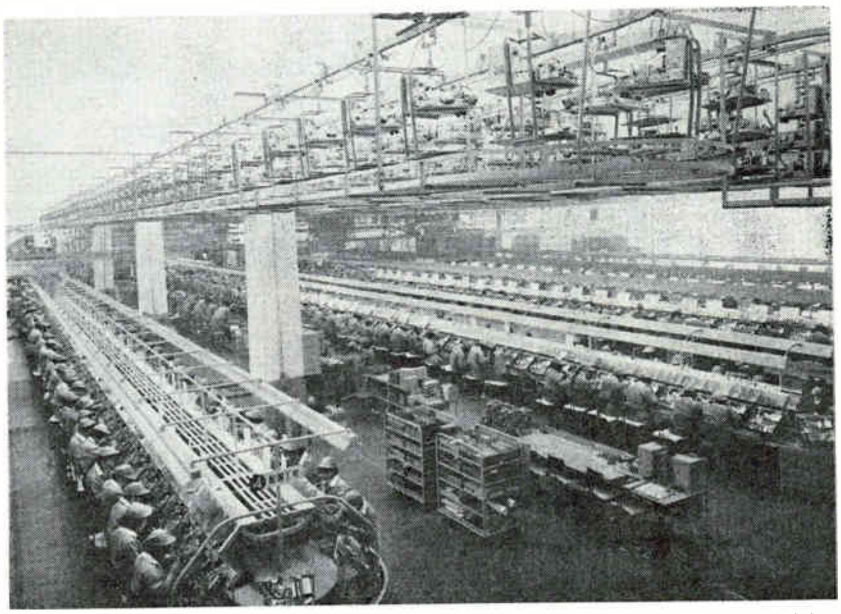
It indicated that American producers are supplementing their U. S.-based marketing operations in some cases by establishing European outlets either through licensing arrangements or by direct investment.

Some highlights of the study:

Austria: The electronics industry, still in early stages of development, represents a potential market for foreign producers of new and technically advanced items. The U. S. suppliers, with recognized quality items, must compete with low prices and easy credit offered by competitors. Austria's electronics trade is largely "oriented towards Netherlands."

Belgium: Manufacture of electron tubes and semiconductors in Belgium is confined to a few firms, much of the output coming from a subsidiary of the Netherlands firm, Philips. The U. S. is expected to continue exporting to Belgium-Luxembourg substantial quantities of transmitting and special-purpose tubes, particularly those of advanced design. Receiving and television picture tubes are subject to stiff price competition and probably will not have an increasing market.

Japan Boosts Tv Set Output



New $5.5-million tv set plant of Matsushita Electric Co., Osaka, Japan, containing 355,844 sq ft of floor space, has just gone into production of 80,000 sets a month, mostly for export to Southeast Asia

Abroad

Denmark: Here the U. S. market is limited because of prices and lack of interchangeability of many U. S. and European tubes.

France: The Netherlands share of this market is increasing, but U. S. producers are likely to retain their strong position. The U. S. was France's principal source for transmitting tubes and a substantial quantity of receiving tubes in the first half of 1959.

Italy: U. S. firms are expanding their direct investment and licensing operations in Italy. In spite of the fast-expanding Italian electronics industry, prospects are considered good for new and advanced types of tubes and transistors.

Norway: No production here. U. S., UK, and Sweden are furnishing a relatively high proportion of Norwegian market for power, special-purpose and transmitting tubes. The Netherlands and West Germany are principal suppliers of receiving tubes.

Sweden: Electronic products from U. S. are usually priced about 20 percent higher than those produced in Sweden and other foreign countries, according to the survey. There is competition in this market from tubes of U. S. design manufactured under license in western Europe and marketed in Sweden.

United Kingdom: Market for relatively specialized types. GB expects to continue shipping large quantities of receiving and special-purpose tubes to U. S. The report indicates that investment possibilities for U. S. firms in GB are favorable.

This report is the first of a series of three publications being prepared in the BDSA Electronics division, and can be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for 25 cents.

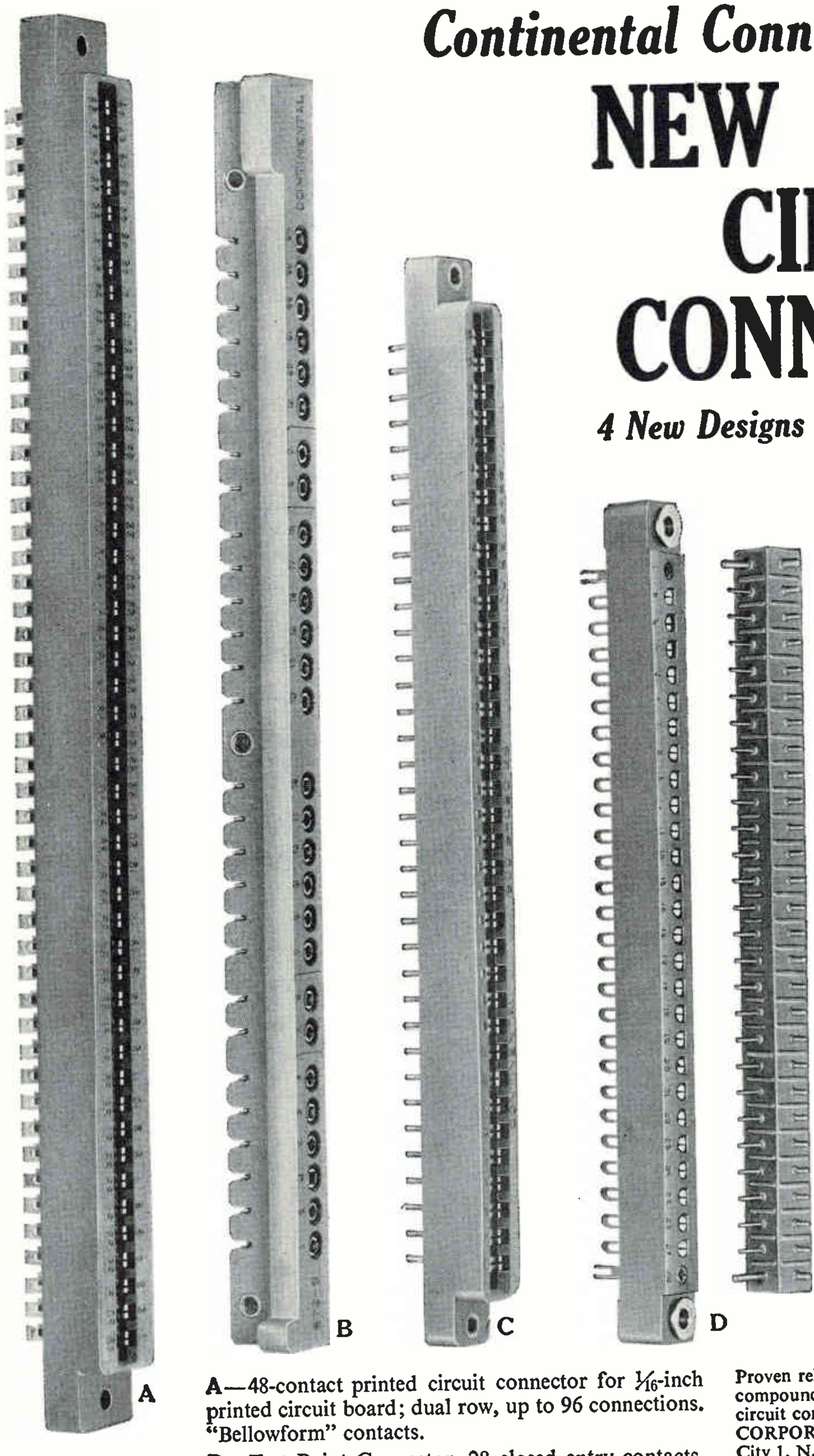
The second in the series, which will be issued shortly, is entitled "Electron Tubes and Semiconductors; Selected Latin American Countries." The third study will cover the remaining significant countries.

CIRCLE 49 ON READER SERVICE CARD→

Continental Connector Announces

NEW PRINTED CIRCUIT CONNECTORS

4 New Designs for Computer Applications



A—48-contact printed circuit connector for 1/16-inch printed circuit board; dual row, up to 96 connections. "Bellowform" contacts.

B—Test Point Connector. 28 closed entry contacts, threaded mounting inserts molded into body. For dip soldering to printed circuit board.

C—36-contact printed circuit connector for 1/16-inch printed circuit board, featuring new "Bellowform" contacts.

D—Right angle plug and socket for dip soldering to printed circuit board; floating mounting bushings, 28 contacts.

Proven reliability . . . high precision . . . choice of molding compounds. Write for details on complete line of printed circuit connectors to Electronics Division, DeJUR-AMSCO CORPORATION, 45-01 Northern Boulevard, Long Island City 1, N. Y. (Exclusive Sales Agents).

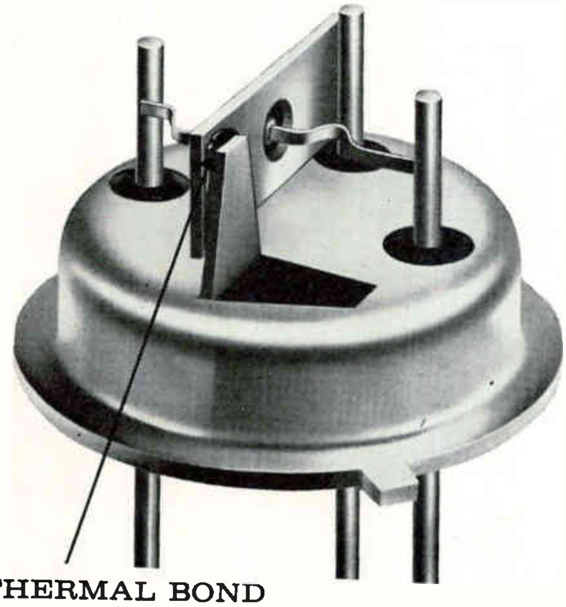
CONTINENTAL CONNECTORS

MANUFACTURED BY CONTINENTAL CONNECTOR CORPORATION, AMERICA'S FASTEST GROWING LINE OF PRECISION CONNECTORS

SEE US AT THE IRE SHOW BOOTHS 2307-2309

5 GUARANTEES

for Tung-Sol 2N1313 Computer Transistor mean new freedom for designers



THERMAL BOND

- GUARANTEED DESIGN CENTER VALUES OF ALL MAJOR PARAMETERS
- GUARANTEED MIN-MAX LIMITS FOR ALL MAJOR PARAMETERS
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- GUARANTEED DISTRIBUTION OF SWITCHING TIMES
- GUARANTEED UNIFORMITY OF EVERY LOT

And there's still another. For a nominal additional charge any specific electrical design characteristic will be 100% guaranteed not to exceed its distribution limits. These guarantees add up to a marked upgrade in circuit design accuracy . . . high reliability in operation . . . and consistent repeat performance. In specifying the Tung-Sol 2N1313 high speed switching transistor, you're selecting a transistor which features an ideal balance of the most wanted characteristics as revealed by a survey of computer designers. You're also choosing a transistor which offers improved performance at lower cost over most of today's popular computer types.

The 2N1313 is designed to meet vigorous military environmental standards. It features "Thermal Bond" construction, exclusive with Tung-Sol. The transistor junction tab is securely joined to the base of the transistor. The bonding material provides high heat dissipation while maintaining complete base-to-case electrical isolation.

Tung-Sol Electric Inc., Newark 4, N. J. SALES OFFICES: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Philadelphia, Pa.; Seattle, Wash.; Montreal, Canada.

Absolute Maximum Ratings (@ 25°C)

BV_{CBO}	−30 Volts
BV_{EBO}	−20 Volts
BV_{CEX} (V_{BE}=0.1V)	−20 Volts
BV_{CEO}	−15 Volts
I_C (continuous)	400mA
I_B (continuous)	50mA
T_j	−65°C to +100°C
P_C	180mW

Typical Characteristics (@ 25°C)

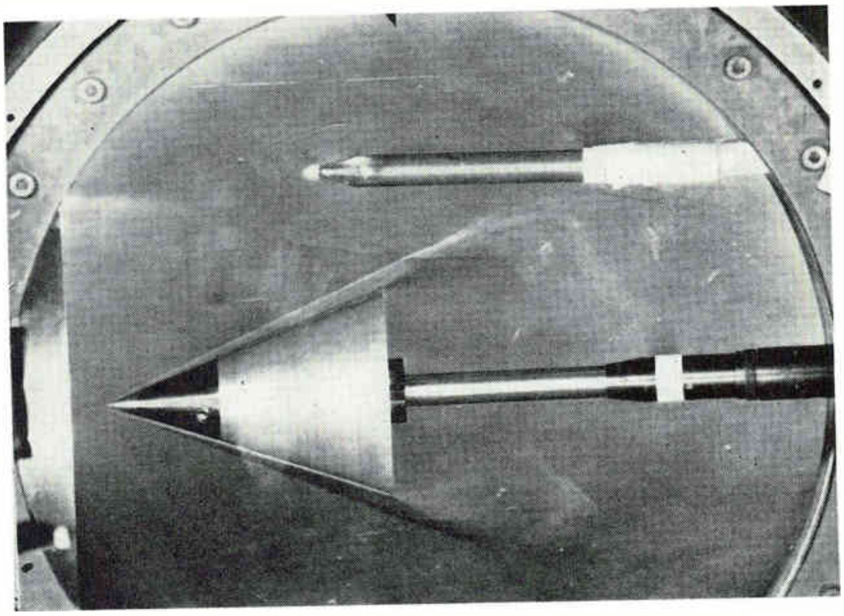
Parameter	Conditions	Min.	Design Center	Max.	Units
I_{CBO}	V_{CB} = −0.5V	—	1.5	2.5	μA
I_{CBO}	V_{CB} = −15V	—	2	3.5	μA
h_{FE}	I_B = 1mA, V_{CE} = −0.25V	40	70	125	
h_{FE}	V_{CE} = −0.35V, I_C = 400mA	20	30	50	
$f_{\alpha b}$	V_{cb} = −6V, I_c = 1mA	6	12	—	Mc
C_{OB}	V_{CB} = −6V, I_E = 1mA, f = 1Mc	9	14	20	μμf
($t_r + t_d$) (rise plus delay time)	I_{B1} (turn on current to base) = 1mA	—	0.45	0.70	μsec
t_s (storage)	I_{B2} (turn off current) = 1mA	—	0.30	0.60	μsec
t_f (fall)	I_C = 10mA, R_L = 1K	—	0.25	0.40	μsec

TUNG-SOL®

CIRCLE 51 ON READER SERVICE CARD

Probes Etch Hi-Mach Airflow

New technique makes patterns of airflow inside hypersonic wind tunnel visible in color



Schlieren photograph shows cone being tested, and above it, one of the probes used by MIT researchers. Probes are used in a new technique for making hi-Mach airflow visible to the naked eye

AIRFLOW patterns around a missile nose cone inside a hypersonic wind tunnel are made visible in brilliant oranges and blues by means of a new technique developed by researchers at the MIT Naval Supersonic Laboratory in Cambridge, Mass.

Use Two Probes

The researchers place two negatively charged probes in the air stream and slightly closer to the model undergoing tests than to the tunnel itself.

The tunnel wall is held at a potential positive with respect to the probes.

As the voltage is increased in the probes to about 1,100 volts, the charge across the airstream excites the molecules to luminescence and makes the flow patterns visible in color to the naked eye.

This phenomenon, postulated in theory but not previously verified in a hypersonic wind tunnel, is not yet clearly understood, say the MIT scientists, but it is apparently analagous to the aurora.

For years, wind tunnel operators have used Schlieren systems for flow visualization, but at the extremely low pressure and densities associated with hypersonic flow there are not enough air molecules to permit good Schlieren observations.

The flow visualization technique was demonstrated recently in conjunction with the anouncement that velocities of more than Mach 7 have been achieved at the NSL tunnel, doubling previous velocity.

Extending Capacity

Systems being developed with higher temperatures and pressures are expected to extend the capacity of the tunnel to about Mach 15.

The NSL supersonic tunnel has been used for nondestructive testing of the North American F100 series, Boeing's Bomarc and the Navy's Sidewinder missiles, the B58 Hustler bomber, the X-15, the experimental B70 aircraft and the Navy's F8U.

Extending existing modulation systems to make more space available in the spectrum, and possibly even broadening the useful spectrum . . . this is a fundamental problem in modern communications. It is the problem to which ITT Laboratories is devoting intensive effort.

At the low end we're designing a new type antenna for very low frequencies. With a conventional antenna this would require a tower more than three miles tall. On the top side — at the high end — we're making radiation pattern surveys for the super high frequency bands. Here the entire antenna consists of a few millimeters of number eighteen copper wire. We're matching these efforts with advances in componentry . . . for instance, the parametric amplifier and now the ingenious ferroelectric converter which converts solar heat to high voltage electricity to power new satellite communications.

If you are a communications engineer who would like to be associated with some of the most significant programs in modern communications development . . . if you would like to work with men who are stretching the spectrum toward direct current at the bottom and the cosmic rays at the top . . . write Manager Professional Staff Relations . . . tell him your interests, your background and the kind of work you would like.

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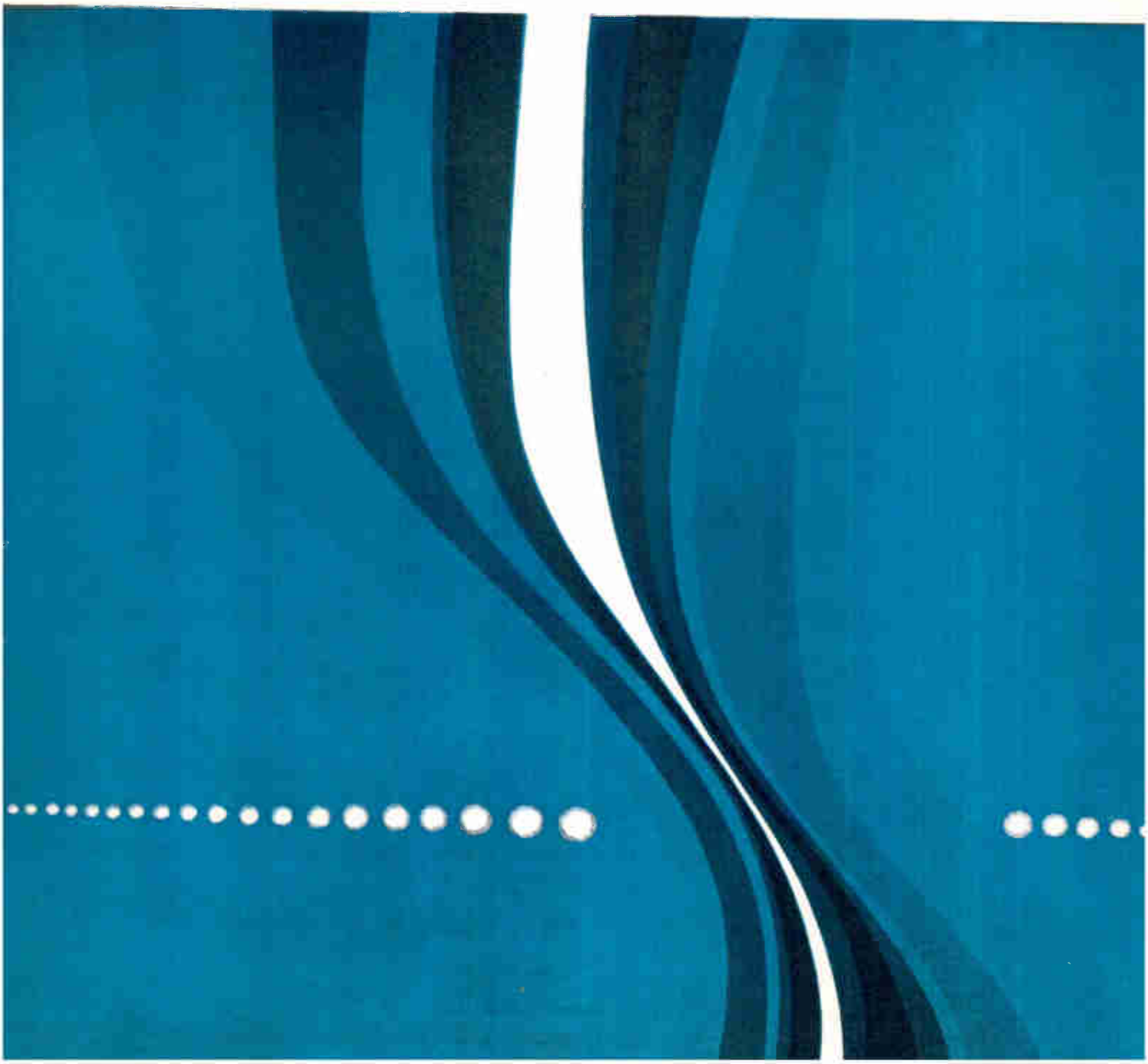


MEETINGS AHEAD

Feb. 25-26: Scintillation Counter Symposium, AIEE, AEC, IRE, NBS, Hotel Shoreham, Wash., D. C.

Mar. 17-18: Synchro Design and Testing Symposium, Bureau of Naval Weapons, Dept. of Navy, Dept. of Commerce Auditorium, Wash., D. C.

Mar. 21-24: Institute of Radio Engineers, International Convention, Coliseum & Waldorf-Astoria Hotel, N. Y. C.

Mar. 24-25: Human Factors in Electronics, PGHF of IRE, Bell Labs Auditorium, N. Y. C.

Apr. 3-7: National Assoc. of Broadcasters, Engineering Conf. Committee, NAB, Conrad Hilton Hotel, Chicago.

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

Apr. 11-13: Protective Relay Engineers, Annual, A&M College of Texas, College Station, Tex.

Apr. 11-14: Weather Radar Conference, American Meteorological Society and Stanford Research Institute, San Francisco.

Apr. 18-19: Electronic Data Processing, ARS, Hotel Alms, Cincinnati, O.

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

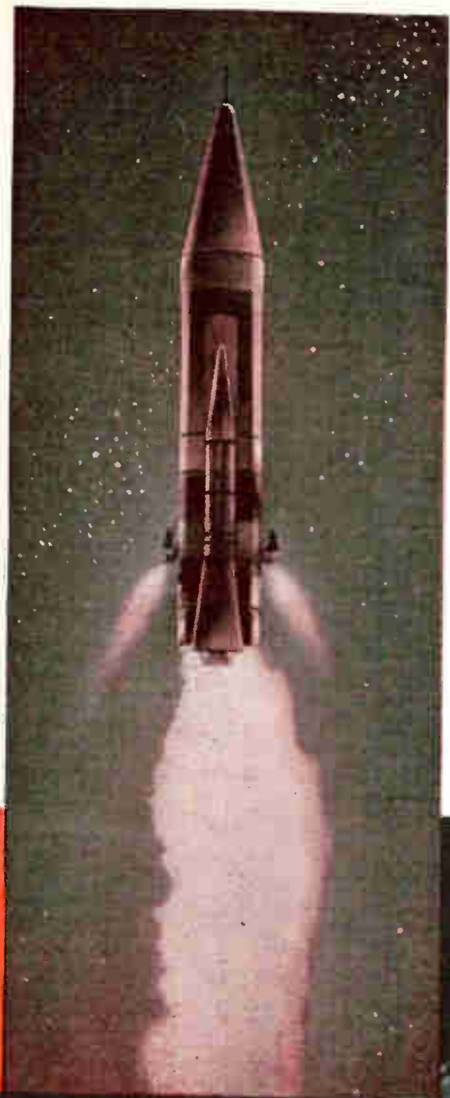
Apr. 19-21: Active Networks & Feedback Systems, International Symposium, Department of Defense Research Agencies, IRE, Engineering Societies Bldg., N. Y. C.

Apr. 20: Quality Control Clinic, ASQC, Univ. of Rochester, Rochester, N. Y.

Aug. 23-26: Western Electronic Show and Convention, WESCON, Ambassador Hotel & Memorial Sports Arena, Los Angeles.

Oct. 10-12: National Electronics Conf., Hotel Sherman, Chicago.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 92.



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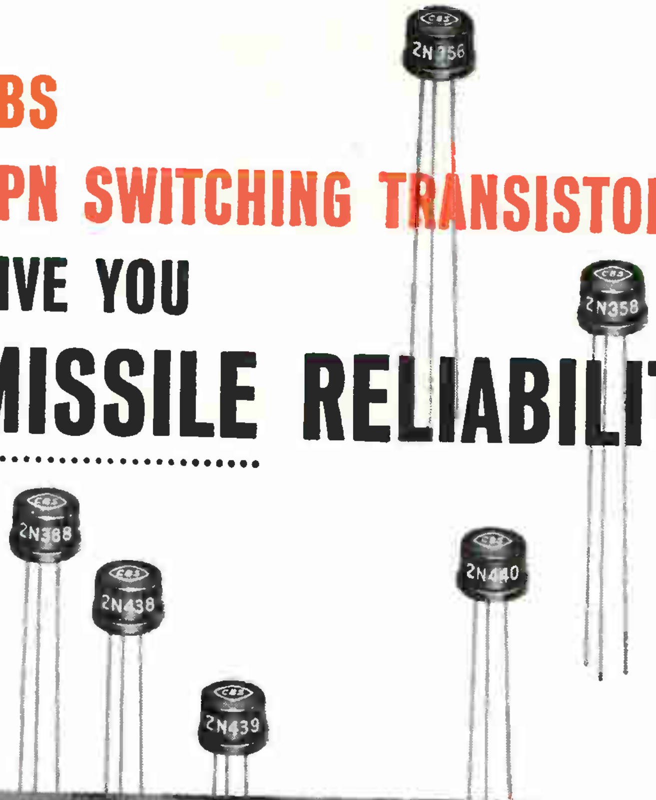
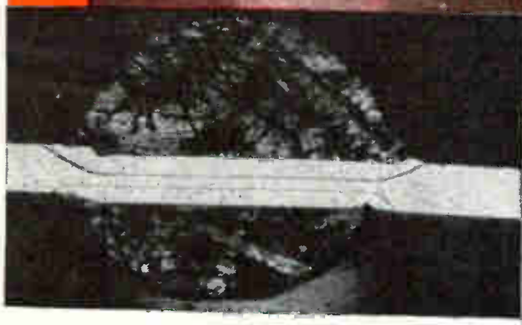
MISSILE RELIABILITY

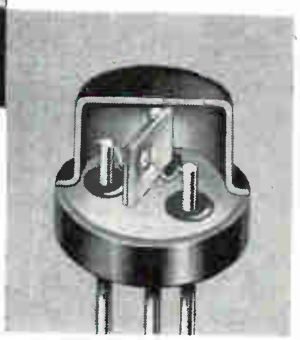


Here Are Some of the Reasons Why . . .

Contamination is eliminated. Baking, surface treatment, electrical testing and package welding are all conducted in dry-boxes at a dewpoint temperature below −90°F.



Flat, even junctions avoid "hotspots." Precise control of time and temperature (±0.03%) of alloying process eliminates localized heating, gives long reliable life. Characteristics are more uniform.



Ruggedness exceeds MIL specification. Severe requirements for shock (1000 g, 1 ms), vibration (10 g, 100-3000 cps) and acceleration (20,000 g) are met by: electronic welding of formed lead wires, horizontal base tab, and welded JEDEC TO-9 case.

CBS NPN switching transistors have proved themselves in flight in many of our important "birds." They have been found to have the advantages of fast switching, high voltage, low cutoff current, and low saturation resistance. All 28 of these CBS transistors exceed the MIL-T-19500A specification.

This same proven reliability under the most adverse environmental conditions is yours for military or industrial core drivers, logic circuits or general switching functions. Write for complete data sheet E-353. Order from your local Manufacturers Warehousing Distributor.

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2N356	2N377	2N438A	2N440A	2N447	2N635	2N1090
2N356A	2N385	2N439	2N444	2N556	2N636	2N1091

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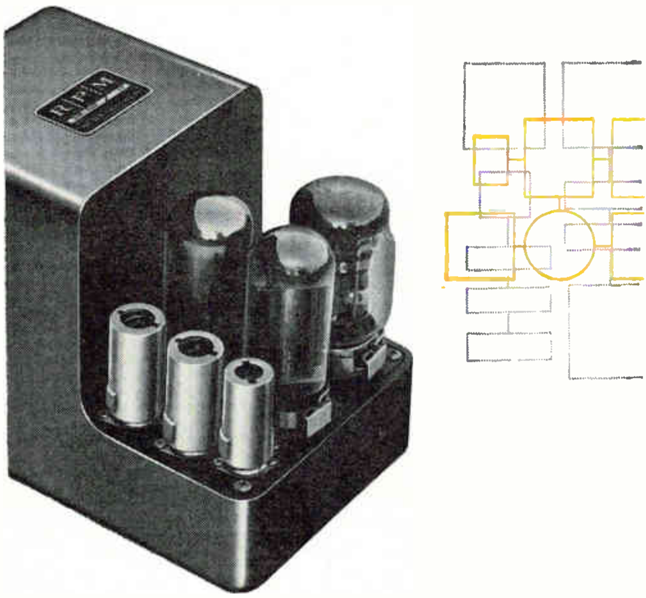
CIRCLE 55 ON READER SERVICE CARD

here's a complete element of your block diagram... now available!

RPM*

*REGULATED POWER MODULE



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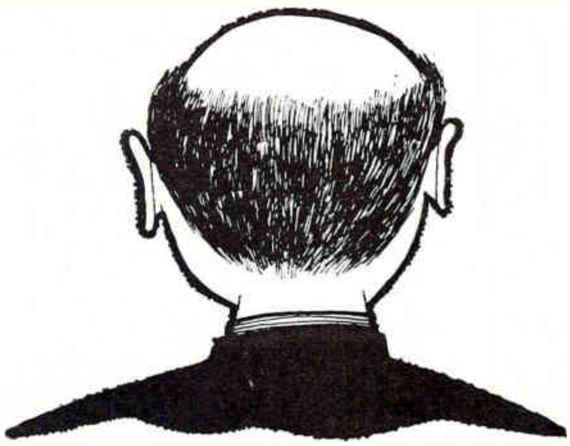
IT'S WHAT'S IN HERE THAT COUNTS



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CIRCLE 201 ON READER SERVICE CARD→

These General Electric transistors meet MIL specs...

	USE	TYPE NO.	MIL SPEC.	MAXIMUM DISSIPATION @ 25°C (mw) P_c	VOLTAGE RATING	T_{STG} MAXIMUM STORAGE TEMP. (°C)	CURRENT GAIN Min. — Max.
SILICON	Amplifier & Computer NPN (Fixed Bed Mounting)	2N333	MIL-T-19500/37A (NAVY)	150	V_{CB} 45	150	h_{fb} .948 — .976
SILICON		2N334	MIL-T-19500/37A (NAVY)	150	V_{CB} 45	150	h_{fb} .948 — .989
SILICON		2N335	MIL-T-19500/37A (NAVY)	150	V_{CB} 45	150	h_{fb} .974 — .989
SILICON	Unijunction NPN (Fixed Bed Mounting)	2N489	MIL-T-19500/75 (USAF)	600	V_{B2E} 60	175	η .51 — .62
SILICON		2N490	MIL-T-19500/75 (USAF)	600	V_{B2E} 60	175	η .51 — .62
SILICON		2N491	MIL-T-19500/75 (USAF)	600	V_{B2E} 60	175	η .56 — .68
SILICON		2N492	MIL-T-19500/75 (USAF)	600	V_{B2E} 60	175	η .56 — .68
SILICON		2N493	MIL-T-19500/75 (USAF)	600	V_{B2E} 60	175	η .62 — .75
SILICON		2N494	MIL-T-19500/75 (USAF)	600	V_{B2E} 60	175	η .62 — .75
GERMANIUM	Audio PNP	2N43A	MIL-T-19500/18 (USAF)	155	V_{CB} 45	100	h_{fb} .968 — .985
GERMANIUM		2N44A	MIL-T-19500/6 (USAF)	155	V_{CB} 45	100	h_{FE} 18 — 43
GERMANIUM	Computer NPN	2N167	MIL-T-19500/11 (USAF)	70	V_{CE} 30	85	h_{FE} 17

For your future military-equipment designs, why not consider the following devices, now being tested for acceptability under military specifications:

	USE	TYPE NO.	MIL. SPEC.	MAXIMUM DISSIPATION @ 25°C (mw) P_c	VOLTAGE RATING	T_{STG} MAXIMUM STORAGE TEMP. (°C)	CURRENT GAIN Min. — Max.
SILICON	Amplifier & Computer NPN (Fixed Bed Mounting)	2N332	MIL-T-19500/37A (NAVY)	150	V_{CB} 45	150	h_{fb} .900 — .953
SILICON		2N337	MIL-T-19500/69A (NAVY)	125	V_{CB} 45	150	h_{FE} 20 — 55
SILICON		2N338	MIL-T-19500/69A (NAVY)	125	V_{CB} 45	150	h_{FE} 45 — 150
GERMANIUM	Audio PNP	2N526	MIL-T-19500/60B (NAVY)	225	V_{CE} 30	100	h_{FE} 53 — 90
GERMANIUM	Computer PNP	2N123	MIL-T-19500/30 (USAF)	150	V_{CB} 20	85	h_{FE} 30 — 150
GERMANIUM		2N396A	MIL-T-19500/64 (NAVY)	150	V_{CB} 30	100	h_{FE} 30 — 150
GERMANIUM		2N404	MIL-T-19500/20 (USAF)	120	V_{CB} 25	85	
GERMANIUM	Computer NPN	2N388	MIL-T-19500/65 (NAVY)	150	V_{CB} 25	100	h_{FE} 60 — 180

Improved Design

General Electric has introduced a series of design improvements which have raised transistor reliability to a new peak. One example is G.E.'s "Fixed Bed Mounting." Almost overnight it changed delicate grown-junction devices into rugged units which far exceed standard military mechanical shock and vibration requirements.

GENERAL ELECTRIC

Tear out this page for ready reference

General Electric rectifiers meet these MIL specs...

DESCRIPTION	TYPE NO.	MIL SPEC.	INVERSE VOLTAGE	MAXIMUM Ioc at T°C	SURGE RATING	MAXIMUM STORAGE TEMP. °C
Germanium Low Current: Alloyed junction type combining very low forward resistance with high back resistance	1N93	MIL-E-1/895B (NAVY)	epx 300	75 ma at 55° amb.	25A (1/120 sec.)	105°
Germanium Low Current: Designed for high operating temperatures and low reverse current.	1N315	MIL-E-1/1088 (USAF)	epx 100	100 ma at 85° amb.	5A (1/120 sec.)	100°
Silicon Low Current: Designed for maximum forward conductance at high operating temperatures (165°C).	1N538 *1N538	MIL-E-1/1089 (USAF) MIL-E-1/1084A	E_b 200 E_b 200	250 ma at 150° amb.	15A (1/120 sec.) 15A (1/120 sec.)	175°
	1N540 *1N540	MIL-E-1/1089 (USAF) MIL-E-1/1085A	E_b 400 E_b 400	250 ma at 150° amb.	15A (1/120 sec.) 15A (1/120 sec.)	175°
	1N547 *1N547	MIL-E-1/1089 (USAF) MIL-E-1/1083A	E_b 600 E_b 600	250 ma at 150° amb.	15A (1/120 sec.) 15A (1/120 sec.)	175°
Silicon Low Current: One of the first stud mounted series.	*1N253	MIL-E-1/1024A	E_b 75	1000 ma at 135° stud	4A (1 sec.)	150°
	*1N255	MIL-E-1/990B	E_b 350	400 ma at 135° stud	1.5A (1 sec.)	150°
	*1N256	MIL-E-1/991B	E_b 500	200 ma at 135° stud	1A (1 sec.)	150°

*JAN spec.

Watch For: 1N254, now being tested for *MIL-E-1/989B; 1N1199-thru-1206 per MIL-E-1/1108 (USAF); 1N645-thru-9 per MIL-E-1/1143 (USAF).

Improved Design

Thermal Fatigue of internal solder joints is another pitfall of semiconductor design overcome by General Electric. Here the solution takes the form of adding "sandwich layers" of very strong metals, chosen so that their thermal expansion coefficients prevent bimetallic distortion while permitting the use of fatigue-free solders. The new design is shown at the far left. The common practice, using soft solder joints and seals, is at near left.

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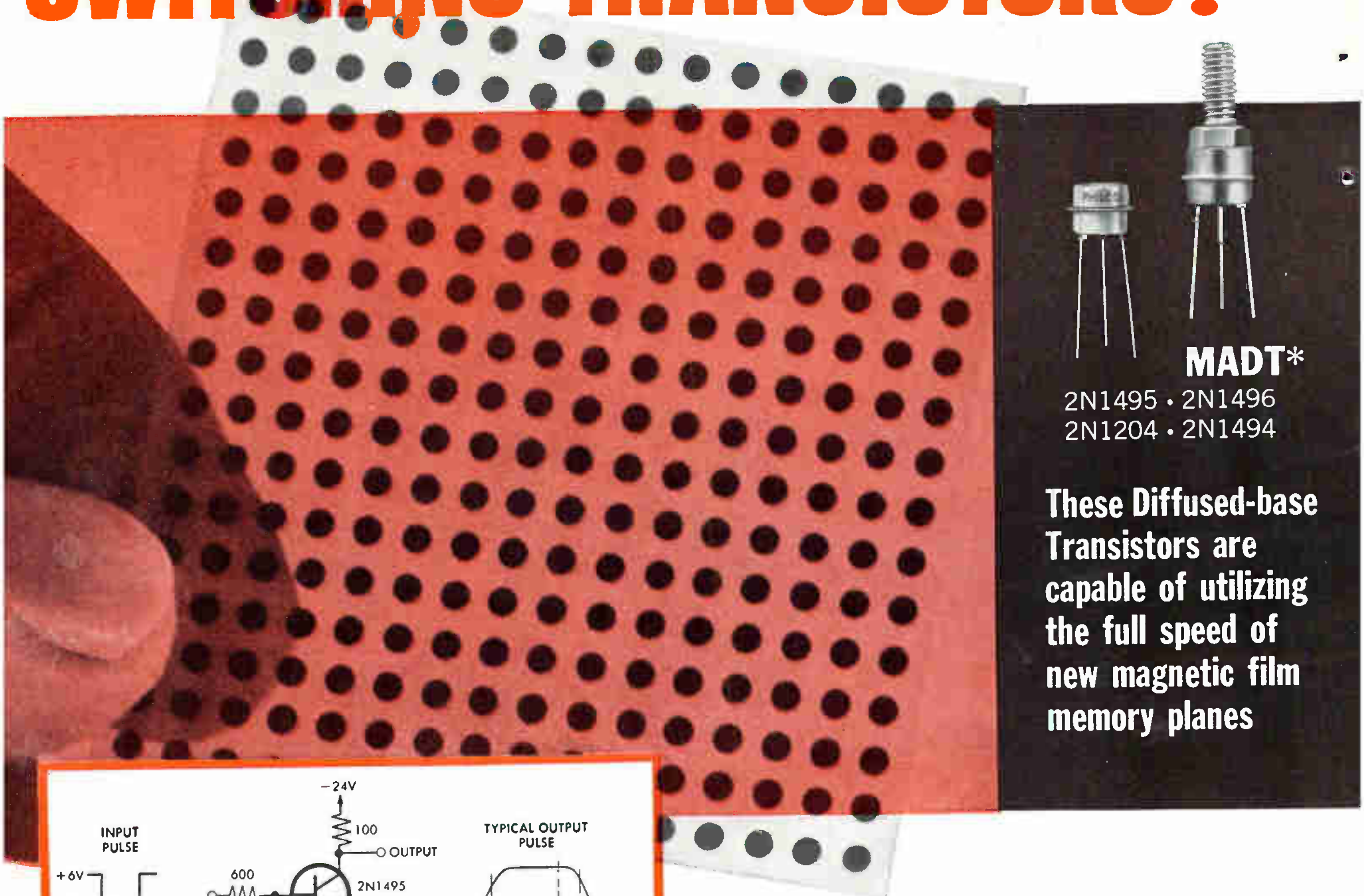
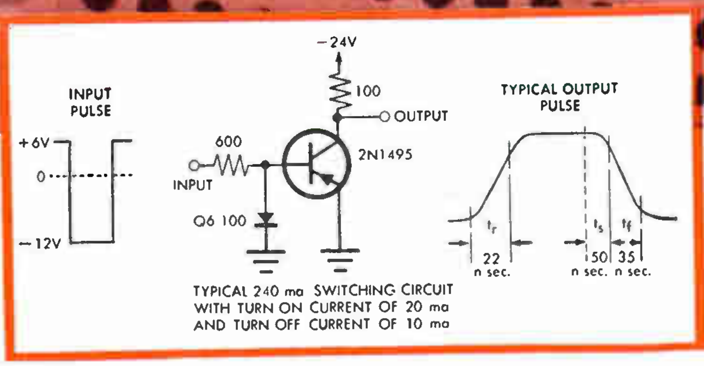
GENERAL ELECTRIC

Semiconductor Products Dept., Syracuse, N. Y.

PHILCO ANNOUNCES

THE FASTEST HIGH-CURRENT SWITCHING TRANSISTORS!





TYPICAL CHARACTERISTICS

TYPE	CASE	P_T @25°amb. (Max)	V_{CES} (Max)	V_{CE}(SAT) $I_C=-200$ma $I_B=-10$ma	V_{BE} $I_C=-200$ma $I_B=-10$ma	h_{FE} $V_{CE}=-1$v $I_C=-200$ma	f_T $V_{CE}=-10$v $I_E=25$ma
2N1495	TO-9	250mw	−30v	0.35v	0.60v	60	320mc
2N1496	TO-31	*0.5w	−30v	0.35v	0.60v	60	320mc
2N1204	TO-9	250mw	−20v	0.35v	0.60v	60	320mc
2N1494	TO-31	*0.5w	−20v	0.35v	0.60v	60	320mc

*At 25°C case temp.

These new Philco MADTs are the result of a revolutionary new development of the Precision-Etch process, which gives high switching speed at high currents. *They are capable of switching 400 milliamperes of current at a 10 mc clock-rate* . . . and are the only transistors available today that permit full utilization of high-speed magnetic film memory planes. The typical f_T of 120 mc at 100 ma makes these units particularly suitable for video drivers, pulse line drivers and other high-current switching circuits. The ultra high-frequency response at the levels normally encountered in current-switching logic circuits, coupled with high dissipation capabilities, makes these units desirable for this class of circuit application.

Both the 2N1495 and 2N1204 are available in studded versions for higher power applications. Typical characteristics are shown in the accompanying table. For complete application data, write Dept. E-260.

*Reg. U. S. Pat. Off.

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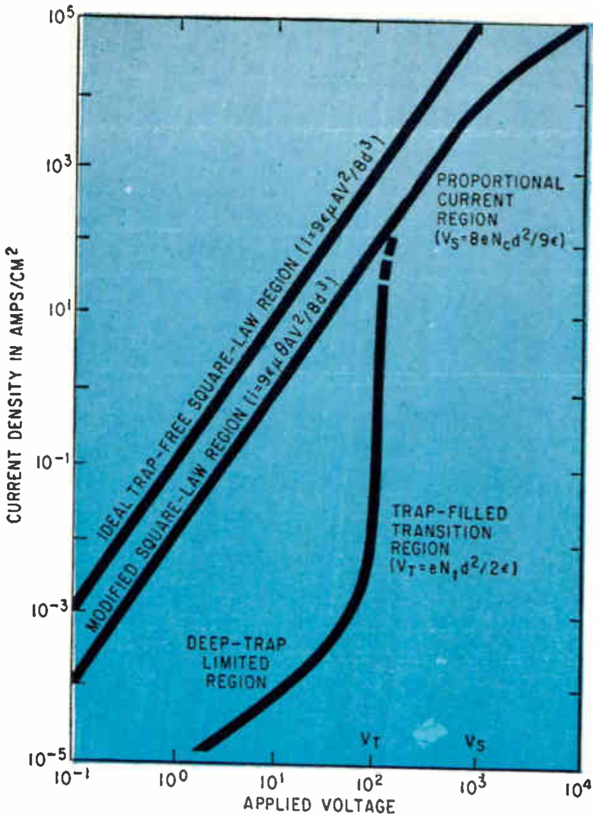

electronics

FEBRUARY 26, 1960

FIG. 1—Steady-current characteristics for space-charge-limited insulators with 10^{15} traps/cm^3 and $d = 10$ microns, $\mu = 0.1 m^2$/v-sec

Solid-State Dielectric Circuit Devices

Controlled current flow in insulators points to new class of devices. Cadmium sulphide diodes have been built and triodes are envisioned

By G. T. WRIGHT, Department of Electrical Engineering, Birmingham University, Birmingham, England

A NEW CLASS of solid-state dielectric devices now being developed is expected to complement semiconductor devices in applications where insensitivity to temperature changes is required, in operation at moderately high voltage or impedance levels and in high-speed switching or high-frequency applications.

These devices are the result of experiments showing that large and controllable currents can be produced in solid insulating materials. Relatively high current densities have been obtained in thin insulating crystals of cadmium sulphide with a few volts applied.

Table I—Symbols

A = Electrode area	V = Applied voltage
d = Electrode spacing	V_o = Threshold voltage
e = Electron charge	V_S = Saturation voltage
N_c = Equilibrium space-charge density in crystal at cathode surface	V_T = Trap-filled transition voltage
N_t = Electron trap density	ϵ = Permittivity
	θ = Trapping factor
	μ = Electron mobility

CURRENT IN INSULATORS—In its pure state, cadmium sulphide is an insulator. Possibility of achieving current flow in insulators rests on the fact that electrons can travel freely through any electric potential field that is periodic in space. The interior of a perfect crystal represents such a periodic potential field; consequently, an electron should be able to travel through it without difficulty. The only condition to be met is that the electron energy be within the allowed energy bands of the crystal.

In normal circumstances, current does not flow through insulators. There are two main reasons for this. First, the allowed bands of insulators seem to be above the energy levels occupied by electrons in metals. This means that, at the contact between a metal and an insulator, there is a step in

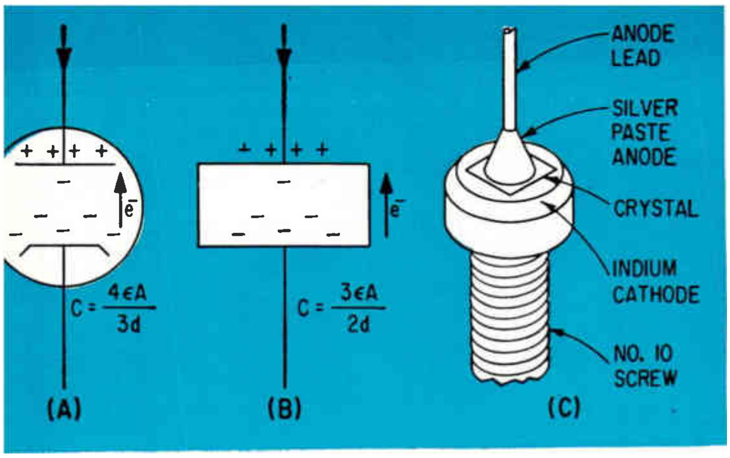

FIG. 2—Thermionic diode (A), dielectric diode (B) are basically capacitors. One form of experimental dielectric diode is shown in (C)

electron potential energy. This step forms a contact potential barrier that prevents large-scale introduction of electrons into the insulator from an external source. Secondly, all real crystals contain lattice defects, some of which are able to act as electron traps. This means that even if small numbers of electrons do manage to enter the crystals, most fall into electron traps and are unable to contribute to current.

Experiments have shown that in the case of cadmium sulphide it is possible to eliminate these obstacles to electron movement and obtain current. Approximate solutions to the equations for current flow in insulators are illustrated in Fig. 1 for various restricted ranges of interest.

DIELECTRIC DIODE—Like the thermionic vacuum diode, the dielectric diode is basically a capacitor in which the negative plate (cathode) can emit electrons into the normally insulating region between the plates. The charge stored on the capacitor is thus continuously in transit between the plates, and current is obtained.

The situation is illustrated in Fig. 2, which compares the thermionic and dielectric diodes on this basis. A difference between the two, however, is that in the dielectric diode some of the charge in the crystal is trapped because even the most carefully grown crystals contain some lattice defects. This is taken into account by saying that, because of trapping, only a fraction, θ, of the total charge in the crystal is free to contribute to current flow. Bearing this in mind, the magnitude of the current is given in each case by the ratio of free charge to transit time.

Diodes made at present are constructed on the open bench from crystals of cadmium sulphide. This material grows quite readily into thin, flat crystal plates by condensing the vapor in nitrogen at a temperature of about 900 C. The transparent, yellow crystal plates, about 30 microns thick, are taken directly from the growing furnace and soldered with indium onto brass stubs which act as heat sinks (Fig. 2C).

Diodes constructed in this way have reverse resistances typically of the order of 10^{10} to 10^{12} ohms; forward currents in the dark are typically in the range of a fraction of a microampere to tens of milliamperes at 10 volts applied, depending on the trap content of the crystal. Steady-current and pulse current characteristics are shown in Fig. 3.

TRAP-LIMITED CURRENT—At small applied voltages the charge injected into the crystal is small. Most of this charge falls into deep-lying traps for which θ is very small and is voltage dependent; thus currents are very small and non-linear. This is the deep-trap limited region in Fig. 1.

As the applied voltage rises, more charge is injected into the crystal and eventually a voltage V_T is reached at which all deep-lying traps are filled. At this point the current rises extremely rapidly towards the theoretical space-charge-limited curve. This is the trap-filled transition region in Fig. 1. For a crystal 30 microns thick with 10^{15} traps/cm³, $V_T \cong 1{,}000$ volts.

In order to obtain useful current at small voltages, traps as deep as this must be reduced in number.

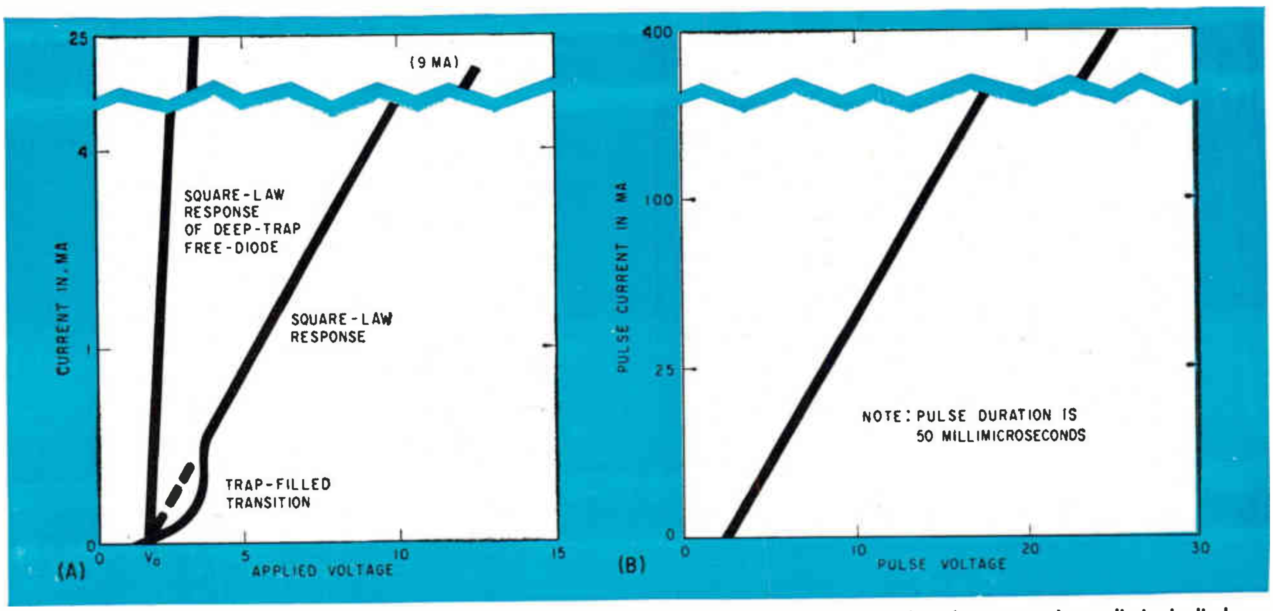

FIG. 3—Steady-current (A) and pulse-current (B) characteristics measured in forward direction for space-charge-limited diodes

Using very careful crystal growing techniques, diodes can now be made with trap-filled transition voltages of the order of a volt or so. This indicates that deep-trap densities have been reduced to levels of the order of 10^{12} to 10^{13} a cubic centimeter.

SQUARE-LAW RESPONSE—When deep traps have been reduced to negligible proportions, the current is space-charge-limited and follows a square-law dependence on applied voltage. In general, however, the crystal may contain large numbers of shallow traps. These are traps which are well above the Fermi level in the crystal, while deep traps are those that are well below it. For shallow traps it is found that the trapping factor may be very near unity; for instance, if the crystal contains 10^{15} traps/cm^3 at a depth of 0.2 ev, then $\theta = 0.9$. In these circumstances θ is independent of voltage and the current follows a modified square-law dependence on voltage lying just below the theoretical square-law curve. Thus, $i = 9 \epsilon \mu \theta AV^2/8 d^3$ and in a crystal with $\epsilon = 10^{-10}$ f/m, $\mu = 0.05$ m^2/V-sec, A = 1 mm^2 and d = 10 microns, the current is theoretically equal to 100 ma at 10 volts applied. This is the modified square law region in Fig. 1.

Many diodes have now been made in which this square-law dependence of current upon voltage has been found. These diodes are effectively free from deep electron traps.

TEMPERATURE SENSITIVITY—Diodes operating under space-charge-limited conditions should be little affected by moderate temperature changes, particularly if the degree of trapping is small. Measurements over the temperature range + 120 C to −190 C show that, in general, there is little variation in diode characteristics above room temperature but that the current at constant voltage increases slowly as temperature falls, as shown in Fig. 4.

FAST-PULSE RESPONSE—Response of these diodes to switch-on and switch-off operation should be extremely rapid. Anticipated response times are of the order of the electron transit time and should be in the range 10^{-11} to 10^{-8} second depending on crystal thickness and applied voltage. This was tested, using very fast voltage pulses. For both switch-on and switch-off operation, the steady state was reached in a time less than three millimicroseconds, which was the response time of the equipment used. Further, an integration of reverse current while being pulsed showed, as expected, that there was no detectable mechanism analogous to hole storage in semiconductor diodes.

SATURATION CURRENT—The proportional current region in Fig. 1 represents saturation current. This occurs at high applied voltages which are sufficient to move the whole cathode space-charge across the crystal. The onset of saturation current occurs at the voltage V_s.

In the proportional current region, the current is given by $i = e \mu N_c AV/d$ and is proportional to the applied voltage. This region has not yet been observed experimentally because power dissipation in the crystal limits the voltages which can be applied.

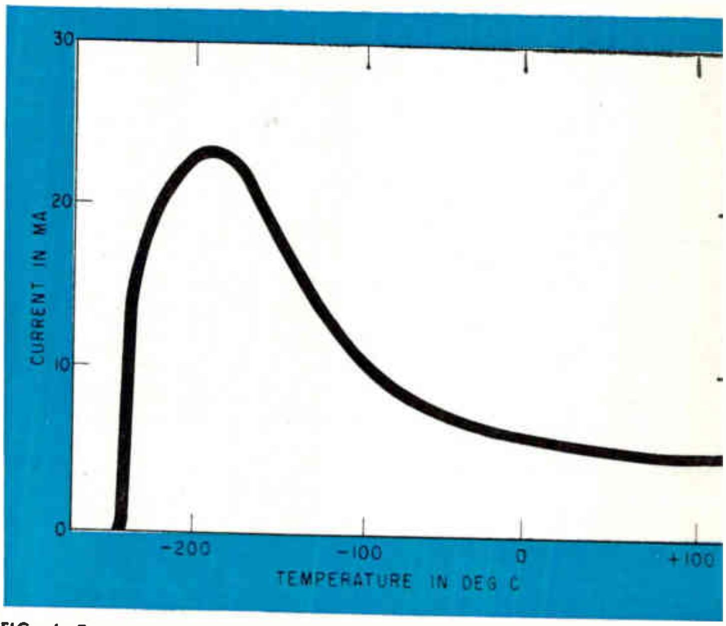

FIG. 4—Temperature variation of forward current at constant 5 v. Rise of current as temperature falls is attributed to change in μ

POTENTIAL APPLICATIONS — Experimental work has shown that space-charge-limited current of practical magnitude can be achieved in insulators.

One of the most interesting space-charge-limited dielectric devices that can be envisaged is that formed by inserting a control grid into the dielectric diode to form a dielectric triode. The small dimensions which this device would have to have introduce many technical problems connected, in particular, with intricate crystal shaping and the precise placing of minute electrodes. However, design calculations indicate that the development of such a device is worthwhile.

The dielectric triode would have the very high input impedance of the vacuum triode and would possess similar anode and grid characteristics, thus enabling it to use the same type of circuits. Gain-bandwidth products approaching 1,000 mc should be realizable and, by using a crystal containing large numbers of shallow electron traps, it should be possible to obtain a mutual conductance rising to high values at high frequencies.

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Designing Transducers

Key element in determining performance of modern sonar systems is the transducer. In this article, data for selection of materials and backing-plate design for a desired beam pattern are given

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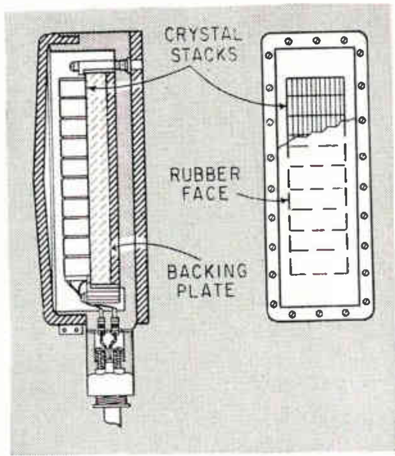

FIG. 1—Typical plane-faced transducer uses ADP crystals surrounded by castor oil, an efficient sound coupler

IMPORTANT CHARACTERISTICS of sonar transducers are resonant frequency, efficiency, voltage response, directivity pattern, power handling capability and impedance. These factors are largely determined by the type, size and mounting of the active elements of the transducer. The three classes of reversible elements generally used in sonar transducers are magnetostrictive, piezoelectric and electrostrictive. Electrodynamic transducers, similar to loudspeakers, are used to some degree at low frequencies.

Transducer Types

Magnetostriction, associated with ferromagnetic metals, iron, nickel, cobalt and alloys of these metals, refers to the change in dimensions of these materials when placed in a magnetic field.

Magnetostrictive transducers are characterized by rugged construction, relatively high weight, high Q, low driving impedance, and narrow bandwidth. The unloaded Q may be several hundred; when the transducer is water loaded, the Q can vary between 5 and 40, with the usual value between 10 and 15. The piezoelectric potential (*piezo*—, Greek combining form for press or pressure + *electric*) in a crystal is directly proportional to the mechanical stimulus producing it.

Of the several hundred types of piezoelectric crystals, only Rochelle salt, lithium sulfate, and ammonium dihydrogen phosphate (ADP) are used to any extent in sonar work. Rochelle salt is little used because of its water-solubility and wide variation of electrical characteristics with temperature. Lithium sulfate is particularly well suited for wide-frequency-band omnidirectional hydrophones.

The majority of crystal sonar transducers, particularly units intended for high-power operation, use ADP crystal elements. These crystals provide high electromechanical coupling, are linear, reversible, have no hysteresis effects, and are extremely stable up to 100 C. They will not dehydrate since they contain no water of crystallization. At operating temperatures, ADP has a higher electromechanical coupling coefficient than any other available nonferroelectric crystal. (See Fig. 1.)

The fundamental resonant frequency of a freely vibrating ADP crystal plate is expressed approximately by

$$f_r = [64.7 - 13.6\,(W/L)^2]/L \qquad (1)$$

where W and L are the width and length (in inches) of the crystal, and f_r is in kc.

Electrostrictive Elements

Electrostriction is defined as the deformation of a dielectric when subjected to an electric field and occurs as a low magnitude effect in all materials. Barium titanate ceramic, a material gaining wide use in sonar transducers, manifests large electrostrictive effects when its molecular electric dipoles are oriented by means of a polarizing voltage. When stressed, barium titanate behaves as though it were piezoelectric and develops potential differences. It is produced by common ceramic techniques and can be shaped into complex forms.

Principal advantages of barium titanate for sonar transducer use are its high dielectric constant and relatively low impedance, resistance to moisture, ruggedness, ability to operate over wide temperature ranges, low relative cost per surface area, and the fact that it can be produced in a great variety of sizes and shapes.

Transducer Materials

A summary of the characteristics of various transducer materials is shown in Table I. The electromechanical coupling coefficient, defined as the ratio of mechanical energy stored to the electrical energy applied, is a measure of the element efficiency and is shown for both the parallel and transverse modes. In the parallel mode, the axes of polarization and stress are in the same

For Sonar Systems

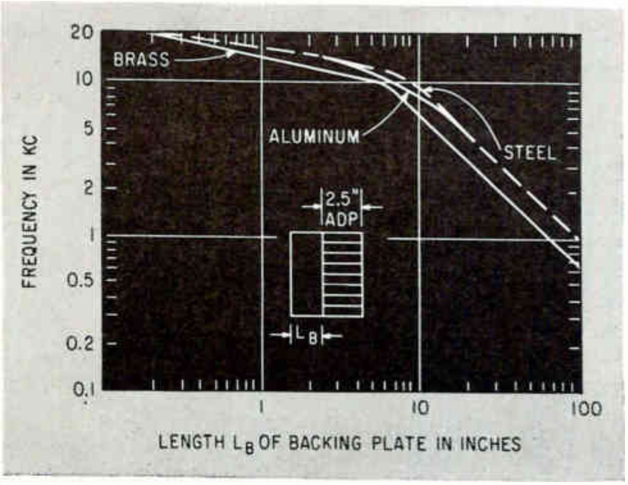

FIG. 2—Resonance design curves for 2½ x 1¼ x ¼-in. ADP crystal with single backing plate

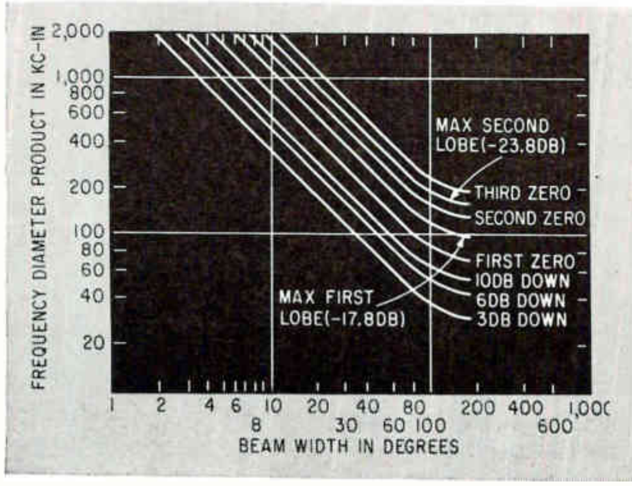

FIG. 3—Chart for determining directivity pattern of a piston radiator in salt water

direction, while in the transverse mode the polarizing axis is at right angles to the stress. Frequency constants listed are for a freely vibrating bar in electric short circuit condition.

Choice of the specific active material to use in a sonar transducer is based on numerous factors and no specific rules can be given. It can be generally stated, however, that above 100 kc barium titanate is usually found most suitable, while in the 10- to 100-kc region all three types—magnetostrictive, piezoelectric, and electrostrictive—can be designed for efficient operation; below 10 kc barium titanate appears to be a convenient material to use. Eddy current losses, which increase as the square of the frequency, limit the operation of magnetostrictive elements at the upper frequencies; the size and weight of these elements become excessive at the lower frequencies.

Backing Plate Elements

In a hydrophone, nonresonant operation is usual since it is desired that the response be flat over a wide frequency range. When a transducer is designed for an active sonar system, the equipment must obtain the maximum possible detection range with the available power and the transducer efficiency has to be considered. For this type of operation, the transducer is designed to operate at or very close to resonance; in high power sonar systems, the transducer voltage or current usually becomes prohibitive if the transducer is operated away from the resonant region.

The basic half-wavelength transducer elements become impractical, however, at the lower frequencies because of their large size. For example, the longest ADP crystal that can be profitably produced is about 3 inches. This will give a resonant frequency of about 21 kc; for lower operating frequencies, the resonance of this element must be modified by the addition of reactive elements or backing plates.

In a design using backing plates, a portion of the crystal is replaced by a metallic plate so that the effective over-all length of the combination element is a half-wavelength. The acoustic reactance of the backing plate viewed from the crystal-backing plate junction is derived from transmission line theory: $Z_B \tan(\omega L_B/V_B) = -Z_C \tan(\omega L_C/V_C)$ where Z = characteristic acoustic impedance, L = length, V = velocity of sound in the material, and $\omega = 2\pi \times$ frequency. Subscripts B and C refer to the backing plate and crystal, respectively. Dimensions of the transducer element can then be calculated from this relationship. Design curves for single backing elements are shown in Fig. 2.

Double Backing Plates

Double backing plates, consisting of two dissimilar materials bonded together, often results in a greater decrease in over-all length of the

Table I—Characteristics of Sonar Transducer Materials

Material	Dielectric Constant	Frequency Constant (kc . . inch)	Electromechanical Coupling Coefficient Parallel	Electromechanical Coupling Coefficient Transverse
ADP, 45 deg Z-cut	15.4	65	——	0.3
Barium titanate	1,700	103	0.48	0.22
Barium titanate with 4 percent lead additive	1,200	105	0.4	0.16
Barium titanate with 5 percent calcium additive	1,200	112	0.44	0.17
Rochelle salt, 45 deg X-cut (20 C)	500	83	——	0.7

Table II—Length of ADP With Backing Plates for 10 kc Resonance

Element	Over-all Length of Element (inches)
ADP alone	6.5
Dural & ADP	2.5 ADP & 7.2 Dural (total = 9.7)
Dural, steel & ADP (double backing plate)	2.5 ADP, 1 Dural, & 1.15 steel (total = 4.65)

element. The savings in element length resulting from the use of these backing plates can be seen in Table II. The bandwidth, impedance, and other characteristics of these elements differ from the corresponding values for a single crystal and must be considered in the ultimate design.

For double backing plate elements, the dimension of the individual plates can be chosen for many materials so that a minimum over-all length is obtained. For the particular case in which a quarter wavelength of crystal is used, the lengths L_1 and L_2 for the shortest over-all length are given as:

$$L_1 = \frac{V_1}{\omega} \tan^{-1} \left\{ \frac{(Z_1/Z_2)\,[(Z_1/Z_2) - (V_2/V_1)]}{(Z_1V_2/Z_2V_1) - 1} \right\}^{\frac{1}{2}}$$

$$L_2 = \frac{V_2}{\omega} \tan^{-1} \left\{ \frac{(Z_1/Z_2)\,[(Z_1V_2/Z_2V_1) - 1]}{(Z_1/Z_2) - (V_2/V_1)} \right\}^{\frac{1}{2}}$$

A variable backing plate transducer with a variable length mercury column as backing plate operates between 48 kc and 90 kc with reasonable efficiency.[1] A comprehensive analysis of multiple backing plate transducers with accompanying design charts has been made.[2]

Directivity Patterns

Relatively narrow beam patterns are used in sonar for target location and sonar transducers are consequently several wavelengths in size. At 20 kc for example, the wavelength of sound in water is about 3 inches and an echo-ranging scanning sonar transducer would have an active dimension of about 15 inches. This would produce a beam pattern whose width at half-power points is 10 degress.

In the forming of directivity patterns, the sonar transducer is analogous to the antenna of a radar system; an interesting similarity arises from the fact that the signal wavelengths of certain radars and sonars are the same. For example, the wavelength of both the electromagnetic radar signal in air at 9,375 mc, X-band, and the acoustic wave in sea water at 47 kc is about 1.25 inches.

Sonar transducers are composed of a large number of closely spaced individual stacks, elements, or crystals. Since the individual spacing is a fraction of a wavelength, the transducer can be assumed to form a smooth radiating surface with dimensions equal to those of the active face of the transducer. Whether this surface is of uniform amplitude or has a prescribed distribution depends on the beam pattern and secondary lobe suppression requirements. The configuration of the transducer active surface is also governed by considerations of efficiency and bandwidth. This requires that the radiation loading be resistive rather than reactive and therefore necessitates a radiating area closely packed with active elements and having linear dimensions of several wavelengths.

Directivity Charts

Sonar transducer directivity patterns can usually be described in any one plane by one of two relationships: the first applies to a line source made up of a large number of points of equal strength and phase separated by very small distances, while the second is for a circular surface source with all parts of the surface vibrating with the same strength and phase. The beam pattern of a plane rectangular source in any normal plane is the same as the product of the directional characteristics of two line sources of dimensions equal to the length and width of the rectangle. For nonsymmetrical transducers, a different beam pattern exists for each possible axis of rotation.

Charts for determining the directivity pattern of circular piston and line transducers are given in Figs. 3 and 4. The following example demonstrates the use of the directivity pattern charts. A circular, flat-faced (circular piston) baffled, depth sounding transducer has an active diameter of 10 inches and is to operate at 30 kc. All parts of the surface are assumed to be vibrating with the same strength and phase. Find the beamwidth of the transducer at the operating frequency.

The frequency-diameter product is 30 kc × 10 inches = 300 kc-inches. Using this value to enter Fig. 3, the beam pattern is determined as tabulated in Table III. The following problem is typical in transducer design.

Design a circular piston (searchlight) type of transducer, resonant at 16 kc, having minor lobes at least 15-db below the major lobe, and a beamwidth of 34 degrees at the 6-db down points. Single ADP crystal plates 2½ x 1¼ x ¼ inches are available for use. The transducer is to be used both as projector and hydrophone and is required to have a minimum receiving response of −80 db/1 volt/microbar and an electrical resistance of less than 600 ohms. With this value of resistance, the transducer voltage will be at a reasonable level when the required power input of 500 watts is applied.

Design Approach

From Fig. 3 the transducer should have an effective radiating diameter of approximately 9.3 inches. The basic half-wavelength resonant frequency of the ADP crystals can be found from Eq. 1 to be 25 kc. The thickness of backing plate required to produce resonance at 16 kilocycle can be found from Fig. 2. If steel is used,

Table III—Beam Pattern from Chart in Fig. 3

Db down from max./response	Total/beamwidth (Deg)
3	12
6	17
10	21
∞ 1st null	28.4
17.8 1st lobe max.	38.3
∞ 2nd null	52.2
23.8 2nd lobe max.	65
∞ 3rd null	81

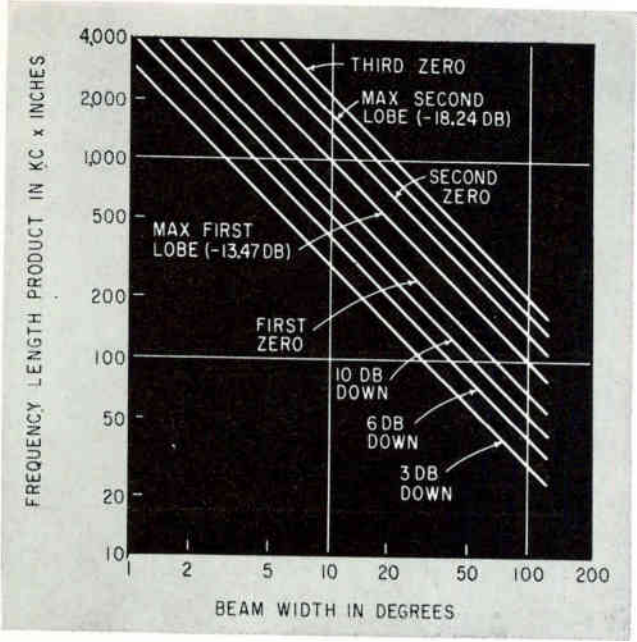

FIG. 4—Chart for calculating the directivity pattern of a line radiator in salt water

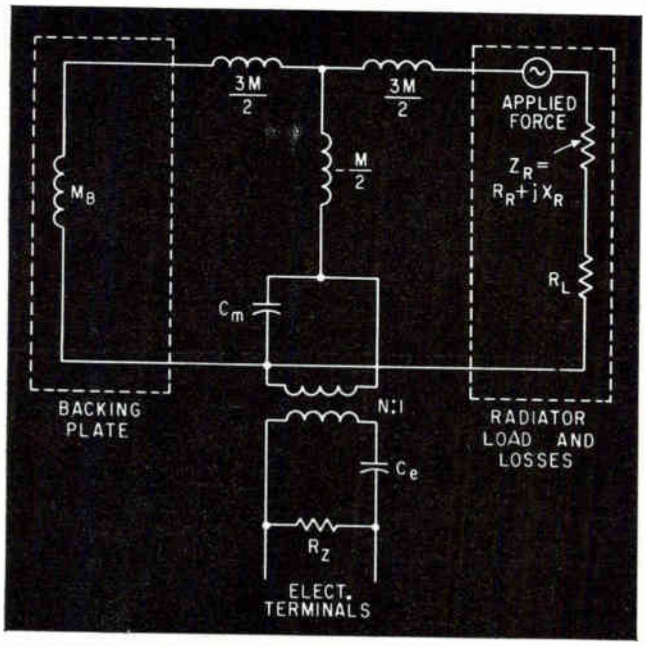

FIG. 5—Equivalent circuit of an individual transducer element with ADP crystals and backing plate

then $Z_B = 39.3 \times 10^5$ gm/cm² sec, $V_B = 5 \times 10^5$ cm/sec, and for the ADP crystal, $Z_c = 5.9 \times 10^5$ gm/cm² sec, $V_c = 3.28 \times 10^5$ cm/sec. The desired resonant frequency can thus be obtained by bonding the ADP crystals to a 1.84 cm (0.725 inch) thick backing plate.

Receiving Response

The receiving response of a transducer is defined as the open circuit voltage at the electrical terminals when an acoustic pressure of 1 dyne/cm² (1 microbar) is applied to its face. In order to calculate the response of the transducer, an equivalent electromechanical circuit, such as shown in Fig. 5, must be obtained. In this circuit: C_e = electrical capacitance = $3.25(LW/T)$, $\mu\mu$f; N = electromechanical transducer ratio = $7.29/W$, volts/Newton; C_m = mechanical compliance = $1.92(L/WT) \times 10^{-9}$, meters/Newton; M = effective mass of crystal = $1.21LWT \times 10^{-2}$, kilograms; Z_R = radiation load = $WT \times 10^{-3}$, kilograms/second; R_L = motional losses = $R_R(1\text{-}E)/(E)$, kilograms/second; M_B = effective mass of backing plate, kilograms; R_Z = electrical losses, ohms; and L,W,T = length, width, and thickness of ADP crystal in inches.

The backing plate can be considered as a lumped mass since at resonance it is only a small fraction of a wavelength in thickness. The radiation load, Z_R, in this case is entirely resistive and equal to the characteristic impedance of water times the active area of the transducer. The applied force corresponding to a pressure of one microbar at the face of an individual crystal is equal to 2.02×10^{-5} Newtons. By assuming low electrical losses, the output voltage can be found by use of Fig. 5 and conventional circuit theory to be approximately −70 db/volt/microbar.

Transmitting Response

The power transmitting response is the pressure (expressed in decibels referred to one microbar) at a distance of one yard from the acoustic axis of the projector when one watt is applied to its electrical terminals. This can be found from $TR = 71.6 + DI + 10 \log E$ where DI = transducer directivity index (18 db for this example, see ELECTRONICS, 33, p 41, February 19, 1960), E = electroacoustic efficiency of transducer (estimated to be 0.55), 71.6 = a conversion factor to convert electric power to acoustic pressure for water at one yard. For this example $TR = 87$ db/microbar/yd. For an input of 500 watts, the maximum transmitted pressure will be 114 db/microbar/yd.

For high efficiency as a projector, the active surface must be closely packed with crystal material. A total of 150 of the available crystals will be used for the active diameter of 9.3 inches.

Electrical Impedance

The electrical impedance looking into the electrical terminals can be calculated from the circuit shown in Fig. 5. The component R_L represents the various motional losses associated with the crystal and has been expressed as a function of the radiation resistance and the estimated efficiency. For a transducer efficiency of 55 percent, the impedance is approximately $300 - j1{,}800$ ohms for the 150 crystals in parallel.

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Unity-Gain Amplifier

An isolation amplifier is described whose gain stability and input impedance characteristics excel over conventional cathode followers

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ADVANTAGES of this isolation amplifier are its simplicity and high order of precision. Normally, the precision provided by these amplifiers can be obtained only by using series or parallel feedback amplifiers.

In a conventional cathode follower (Fig. 1), the effective gain stability factor (δ) is approximately equal to the reciprocal of the amplification factor (μ) of the tube. This factor normally limits the nominal accuracy of transmission to the order of a few percent. In the new circuits (Fig. 2 & 3), δ is approximately equal to the reciprocal of the product of the μ's of the two halves of the tube. Thus, it is possible to obtain a transmission accuracy of a few tenths of one percent with ordinary tubes.

An additional feature of the circuit shown in Fig. 2 is its exceptionally high input impedance. In a normal cathode follower, the input impedance has a minimum value which is determined by the grid-to-plate interelectrode capacitance. For most tubes, this capacitance is a few picofarads. In Fig. 2, however, the plate of the input tube is driven to almost the same potential as the input grid. Hence, the effective input capacitance is greatly reduced. The reduction factor is about equal to the μ of the cascode tube section (V_{1B}). Thus, an effective input capacity of a small fraction of a picofarad can be obtained. This is of particular importance in h-f applications.

No-Load Gain Stability

In the simple cathode follower of Fig. 1, the ideal no-load voltage gain

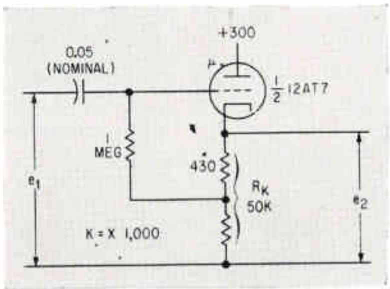


FIG. 1—Conventional cathode follower

(K) at low frequencies is $e_2/e_1 = \mu/(1+\mu)$.

The gain stability factor (δ) of a vacuum-tube circuit as a function of the μ of the tube is

$$\delta = \frac{dK/K}{d\mu/\mu} = \frac{dK}{d\mu} \times \frac{\mu}{K}$$

Thus, δ of a cathode follower is

$$\delta = \frac{(1+\mu) - \mu}{(1+\mu)^2} \times \frac{\mu(1+\mu)}{\mu} \approx \frac{1}{\mu}$$

In Fig. 2A, the output of cathode follower V_{1A} is supplemented by feedback to the grid of V_{1B}, which also acts as a cathode follower. The ideal or no-load gain (K_i) is derived from the equivalent circuit, which is shown in Fig. 2B.

$$\begin{aligned} &e_2 - \mu_1 e_{g1} - \mu_2 e_{g2} = 0 \\ &e_{g1} = e_1 - e_2 \qquad (1) \\ &-e_{g2} + \mu_1 e_{g1} = 0 \\ &e_{g2} = \mu_1(e_1 - e_2) \\ &e_2 - \mu_1(e_1 - e_2) - \mu_1\mu_2(e_1 - e_2) = 0 \\ &e_2(1 + \mu_1 + \mu_1\mu_2) = e_1(\mu_1 + \mu_1\mu_2) \qquad (2) \\ &K_i = \mu_1(1+\mu_2)/[1 + \mu_1(1+\mu_2)] \end{aligned}$$

The ideal gain stability of Fig. 2 may be investigated under three conditions: μ_2 may be assumed constant while μ_1 is variable, μ_1 may be assumed constant while μ_2 is variable, or μ_1 and μ_2 may be considered as equal and varying together.

With μ_2 constant:

$$\delta = \frac{\mu_1[(1+\mu_1+\mu_1\mu_2)(1+\mu_2) - (\mu_1+\mu_1\mu_2)(1+\mu_2)]}{(1+\mu_1+\mu_1\mu_2)^2 \times (\mu_1+\mu_1\mu_2)/(1+\mu_1+\mu_1\mu_2)}$$

$$\delta = 1/(1+\mu_1+\mu_1\mu_2) \approx 1/\mu_1\mu_2$$

Similarly, with μ_1 constant: $\delta \approx 1/\mu_1\mu_2$. If $\mu_1 = \mu_2$

$K_i = \mu(1+\mu)/(1+\mu+\mu^2)$ and $\delta_\mu \approx 2/\mu^2$

Thus the gain stability of the new circuit is greatly improved over that of the cathode follower.

Table I gives ideal-circuit, and other mathematical expressions for the circuits of Fig. 1 and 3; derivations of the expressions for Fig. 3 are similar to the derivations for Fig. 2.

Gain Stability With Load

Now that we have seen what the gain stability of the three circuits is under ideal (no-load) conditions, let us see what can be achieved in a practical circuit. Here we assume a non-zero plate resistance (r_p) and a finite load (R_K).

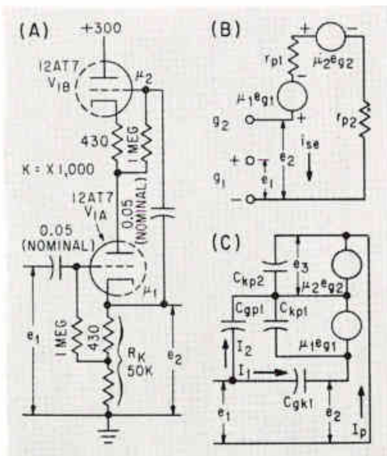


FIG. 2—Isolation amplifier (A) and its equivalent circuits, (B) and (C)

Offers High Stability

Deriving the gain expression for the loaded circuit of Fig. 2:

$$\mu_1 e_{g1} + \mu_2 e_{g2} - i_p(r_{p1} + r_{p2} + R_K) = 0$$
$$e_{g1} = e_1 - i_p R_K$$
$$e_{g2} = \mu_1 e_1 - i_p(r_{p1} + \mu_1 R_K)$$
$$\mu_1(e_1 - i_p R_K) + \mu_2[\mu_1 e_1 - i_p(r_{p1} + \mu_1 R_K)] - i_p(r_{p1} + r_{p2} + R_K) = 0$$
$$e_2 = i_p R_K = \frac{\mu_1 R_K e_1(1+\mu_2)}{r_{p1}(1+\mu_2) + R_K(1+\mu_1+\mu_1\mu_2) + r_{p2}}$$
$$K_e = \mu_1 R_K(1+\mu_2)/[r_{p1}(1+\mu_2) + R_K(1+\mu_1+\mu_1\mu_2) + r_{p2}]$$

Let μ_2 be a constant and assume $r_{p1} = r_{p2}$ and that $\mu_1 = \mu_2$. Now $K/\mu \times \mu/K$ equals

$$\delta = [r_{p1}(1+\mu_2) + R_K + r_{p2}]/[r_{p1}(1+\mu_2) + R_K(1+\mu_1+\mu_1\mu_2) + r_{p2}]$$

If $m = R_K/r_p$,

$$\delta = (2+m+\mu)/[2+\mu+m+(1+\mu+\mu^2)]$$

Let μ_1 be constant; now

$$\delta = \mu(1+m)/\{[2+\mu+m(1+\mu+\mu^2)](1+\mu)\}$$

Let μ_1 and μ_2 vary together:

$$\delta = (2+3\mu+m+2m\mu+\mu^2)/\{1+\mu[2+\mu+m(1+\mu+\mu^2)]\}$$

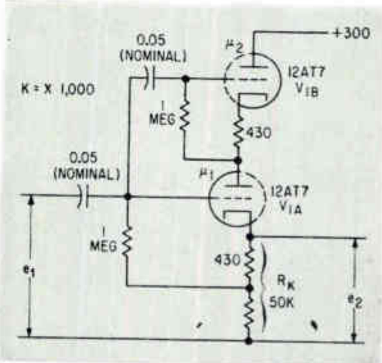


FIG. 3—Analysis of this isolation amplifier is similar to analysis for Fig. 2

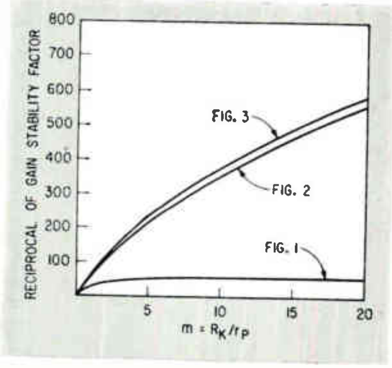


FIG. 4—Curves for Fig. 2 and 3 are for case of μ_1 and μ_2 varying together

Table II compares the reciprocal of gain stability as a function of m for the circuits of Fig. 1, 2 and 3. The curves of Fig. 4 show some of the data of this Table.

Table II shows that variations in μ_1 form the major contribution to gain instability. Ordinarily μ_1 and μ_2 would vary together.

Table I—Equations for Fig. 1 and Fig. 3

Condition(s)	Fig. 1	Fig. 3
$I^{(1)}$	$K_i = \mu/(1+\mu)$	$K_i = (\mu_1+\mu_1\mu_2+\mu_2)/(1+\mu_1+\mu_2+\mu_1\mu_2)$
I, μ_2 const.	$\delta \approx 1/\mu$	$\delta \approx 1/\mu_1\mu_2$
I, μ_1 const.		$\delta \approx 1/\mu_1\mu_2$
I, $\mu_1 = \mu_2$		$K_i = (\mu^2+2\mu)/(1+2\mu+\mu^2)$
I, $\mu_1 = \mu_2^{(2)}$		$\delta \approx 2/\mu^2$
$L^{(3)}$	$K_e = \mu R_K/[r_p+(\mu+1)R_K]$	$K_e = \frac{R_K(\mu_1+\mu_1\mu_2+\mu_2)}{r_{p1}(1+\mu_2)+R_K(1+\mu_1+\mu_2+\mu_1\mu_2)+r_{p2}}$
L, μ_2 const.	$\delta = (r_p+R_K)/(r_p+R_K+\mu R_K)$	$\delta = (2+\mu+m)/[2+\mu+m(1+2\mu+\mu^2)]$
L, μ_1 const.	$= (1+m)/[1+m(1+\mu)]$	$\delta = [2+\mu+m(1+\mu)]/\{(2+\mu)[2+\mu+m(1+2\mu+\mu^2)]\}$
L, $\mu_1 = \mu_2^{(2)}$		$\delta = \frac{4+4\mu+2m+2\mu m+\mu^2}{[(2+\mu)+m(1+2\mu+\mu^2)](2+\mu)}$
Z_o	$Z_o = r_p/1+\mu$	$Z_o = [r_{p2}+r_{p1}(1+\mu_2)]/(1+\mu_1+\mu_1\mu_2+\mu_2)$
C_{in}	$C_{in} \approx C_{gp}+C_{gk}/\mu$	$C_{in} \approx C_{gk1}/\mu_1\mu_2+C_{gp1}/\mu_2+C_{gk2}/\mu_2+C_{gp2}$
C_o	$C_o \approx C_{kp}$	$C_o \approx C_{pk1}/\mu_2$

(1) Ideal (no-load) case; (2) Both μ's vary; (3) Finite load

Table II—Comparison of Gain Stability Reciprocals

m	Fig. 1	Fig. 2 Variation μ_2	Fig. 2 Variation μ_1	Fig. 2 Variation μ_1, μ_2	Fig. 3 Variation μ_2	Fig. 3 Variation μ_1	Fig. 3 Variation μ_1, μ_2
I[1]	51.0	2,601	2,601	2,601	2,500	2,500	2,500
1	26.0	1,350	49.0	47.4	1,330	51.0	49.2
2	34.4	1,750	95.4	90.4	1,755	97.3	94.0
3	38.2	1,965	141.0	130.5	1,990	142.8	135.8
4	41.0	2,090	183.1	171.3	2,120	186.7	171.8
5	42.4	2,180	222.0	207.5	2,165	227.5	211.0
10	46.3	2,370	400.0	348.0	2,382	417.0	365.0
20	49.4	2,480	715.0	547.0	2,500	715.0	572.0

(1) I is the ideal case

Table III—Comparison of Circuits[1]

	Fig 1.	Fig. 2	Fig. 3
$1/\delta$	45	200	215
$C_{in}(\mu\mu f) \approx$	1.5	0.03	1.5
$C_o(\mu\mu f) \approx$	0.5	0.01	0.01
Z_o (ohms) $\approx$	196	204	200

(1) 12AT7 values assumed: $\mu = 50$; $gm = 5 \times 10^{-3}$ mho; $r_p = 10{,}000$ ohms; $C_{gp} = 1.5$, $C_{gk} = 2.2$, $C_{pk} = 0.5$, $\mu\mu f$

Output Impedance

Output impedance (Z_o) of Fig. 2 is e_2/i_{sc}, where e_2 is the no-load output voltage and i_{sc} is the short-circuit output current. From Eq. 2

$$e_2 = e_1\mu_1(1+\mu_2)/[1+\mu_1(1+\mu_2)]$$

Calculating i_{sc} and Z_o,

$$-i_{sc}(r_{p1}+r_{p2}) + \mu_1 e_{g1} + \mu_2 e_{g2} = 0$$
$$e_{g1} = e_1 \quad \text{and} \quad e_{g2} = \mu_1 e_1 - i_{sc} r_{p1}$$
$$-i_{sc}[r_{p1}(\mu_2+1)+r_{p2}] + \mu_1 e_1(1+\mu_2) = 0$$
$$i_{sc} = \mu_1 e_1(1+\mu_2)/[r_{p1}(1+\mu_2)+r_{p2}]$$
$$Z_o = [r_{p2}+r_{p1}(1+\mu_2)]/[1+\mu_1(1+\mu_2)]$$

Output impedances for Fig. 1, 2, and 3 are 196, 204, and 200 ohms, respectively.

Input Capacitance

For Fig. 2C, the l-f input capacitance C_{in} is derived for the no-load case. Using Eq. 1 and 2, and $e_3 = e_2 - \mu_1 e_{g1}$,

$$e_3 = e_1\mu_1\mu_2/(1+\mu_1+\mu_1\mu_2)$$
$$Y_{in} = I_{in}/e_1 = (I_1+I_2)/e_1$$
$$= (e_1-e_2)j\omega C_{gk1}/(e_1) + (e_1-e_3)j\omega C_{gp1}/e_1$$
$$= j\omega C_{gk1}[1/(1+\mu_1+\mu_1\mu_2)] + j\omega C_{gp1}[(1+\mu_1)/(1+\mu_1+\mu_1\mu_2)]$$

$\therefore$ for large μ,

$$C_{in} \approx C_{gk1}/\mu_1\mu_2 + C_{gp1}/\mu_2$$

Therefore the input capacitance of Fig. 2 is less than that of a cathode follower by a factor about equal to the μ of a tube section.

The expressions for the output capacitance (C_o) of Fig. 2 are derived similarly to the input capacitance. The C_o of Fig. 2C is about C_{kp1}/μ_2. About the same result would be obtained for Fig. 3.

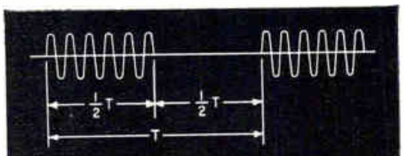
Selective Paging System

Transmitter excites single-wire loop surrounding area to be covered. Receiver attracts attention by buzzer or flashing lamp and may be used as a voice intercom. Up to 45 individual stations may be contacted

By J. G. DeGRAAF, Senior Engineer, NIRA Company, Emmen, Holland

EARLY INDUCTIVE PAGING SYSTEMS had the disadvantage that calls were picked up by all receivers within the transmitter field. This simple transistorized induction paging system uses coded transmissions so that any one of 45 different receivers can be selected.

The receiver attracts the attention of the user by either a built-in buzzer for normal use or a flashing light when carried into noisy areas. By operating a switch on the pocket receiver, a voice message can be received.



FIRST FIGURE	CARRIER FREQ (KC)	SECOND FIGURE	T (SEC)
1	16	1	1/76
2	20.6	2	1/84
3	18	3	1/92
4	24	4	1/100
5	28.8	5	1/111
		6	1/124
		7	1/135
		8	1/147
		9	1/162

FIG. 1—Coding used by calling system. As illustration, receiver 11 uses 16-kc carrier keyed at 1/76 second with 50-kc source

System Requirements

The ideal paging system signal should be received only by the one person to whom the particular call is directed. The calling signal must be restricted to a determined area so that systems operating on similar frequencies may be used in adjacent buildings. The system should have a visual signal for noisy areas. Speech transmission, if any, should be f-m to reduce interference and improve intelligibility. The receiver must be small, self powered and without controls, and its calling signal must be short and automatically switched off to prevent unnecessary annoyance. The absence of persons to be located must be automatically indicated to prevent loss of time. The system must be flexible to meet the requirements of any business.

The system uses a transmitter, control installation and a loop antenna that surrounds the area that requires the paging signals.

Depressing a combination of buttons on the control unit produces a signal in the receiver being paged.

The six-transistor receiver requires a field strength of 50 × 10^{-6} oerstedts and uses two rechargeable batteries of 150 ma hours.

The total current consumption of the receiver is 1.5 ma when a call is not being received. As the capacity of the internal batteries is 150 ma hours, the receiver can operate for about 100 hours before requiring battery recharging.

The calling signal consists of a selected carrier frequency keyed on and off at a selected rate as shown in Fig. 1. For example; receiver number 24 is tuned to a carrier frequency of 20.6 kc at a repetition time of 1/100 of a second.

Signal Transmission

The keyed carrier is applied to a single-wire loop antenna that surrounds the area in which the calls are to be made.

Each receiver is tuned to one of the five available carriers keyed on and off at one of the selected nine rates.

The control unit, shown in Fig. 2, selects the carrier frequency and the repetition time of the transmitted signal. A timing circuit within the control unit shuts off transmission after a predetermined time has elapsed.

The carrier is keyed on and off by a multivibrator. The multivibrator is slightly frequency

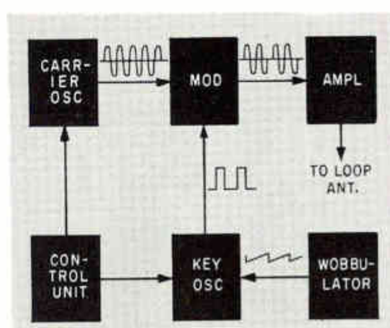


FIG. 2—Basic operation of transmitter

Uses Coded Transmission

modulated by a wobbulator circuit so that its repetition time varies slightly. When this occurs, the keyed signal passes back and forth across the receiver resonant-reed relay frequency, thus causing the buzzer or light to operate intermittently. It has been found that an intermittent signal attracts attention faster and is less disturbing than a continuous signal.

Wobbulating the repetition rate also makes the receiver system independent of slight variation in the keying code due to temperature or component variation. The wobbulated signal could also be coded to produce identifying signals at the receiver. One of these codes is used to announce that a voice message is to be transmitted.

The basic transmitter is shown in Fig. 3. Multivibrator V_1 and V_2 has its frequency determined by the selection of coupling capacitors C_1 and C_2 by the control unit.

The wobbulator is a relaxation sawtooth oscillator consisting of resistor R_1, capacitor C_3 and neon lamp I_1. The sawtooth signal is applied to cathode follower V_4. The signal output of the cathode follower is in the grid return circuit of the multivibrator so that the sawtooth frequency modulates the multivibrator.

The carrier frequency is determined by the tank circuit of oscillator V_5. The carrier frequency and the keying signal are applied to the grids of parallel-connected output tubes V_6 and V_7. The output tubes supply power to the loop antenna. Capacitor C_4 resonates the loop antenna for maximum output.

When a voice signal is to be transmitted, the keying multivibrator is removed from the circuit and the audio is used to frequency-modulate the carrier. To remove shock hazard from the loop antenna, the positive d-c supply for the transmitter is grounded.

Each receiver fits into pocket which charges internal batteries and informs control desk that receiver is not in use

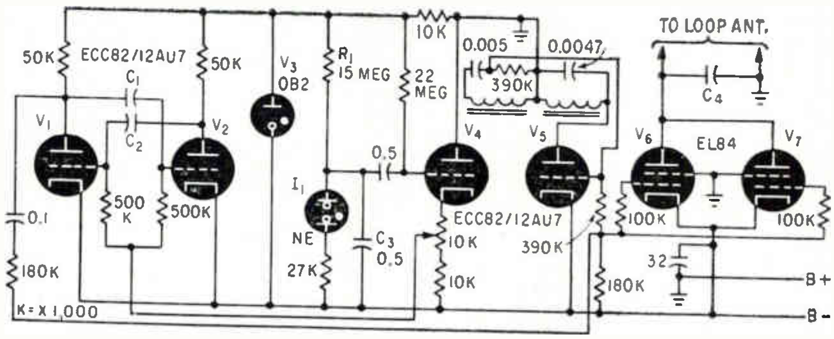


FIG. 3—Multivibrator V_1-V_2 has repetition rate slightly varied by wobbulator

Figure 4 shows the basic operation of the receiver. The keyed r-f carrier is picked up by a ferrite antenna and amplified. The signal is then demodulated and applied to a resonant-reed relay. When the incoming pulse rate is the same frequency as the resonant reed, the relay contacts interrupt current flowing through a miniature loudspeaker to cause an audio tone to be generated. Operating the receiver speech reception pushbutton connects the emitter follower to the output of the detector and the audio signal is then passed to the loudspeaker.

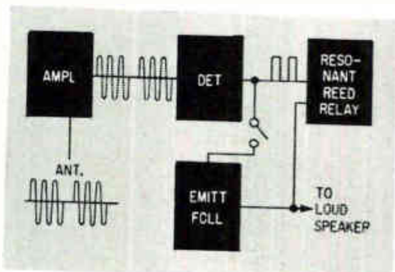


FIG. 4—Basic operation of receiver

The incoming signal is picked up by ferrite antenna L_1 shown in Fig. 5, which is tuned to the chosen carrier frequency. The signal is am-

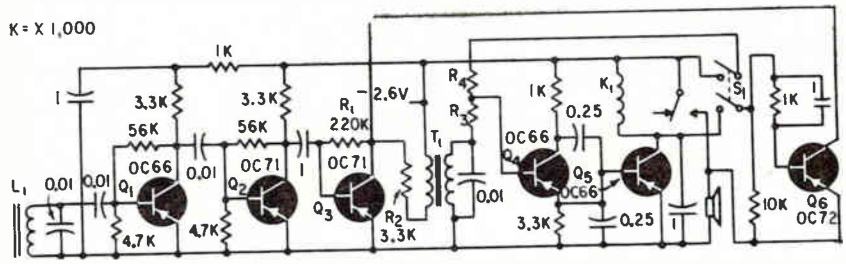


FIG. 5—Five-transistor receiver uses resonant-reed relay for signaling

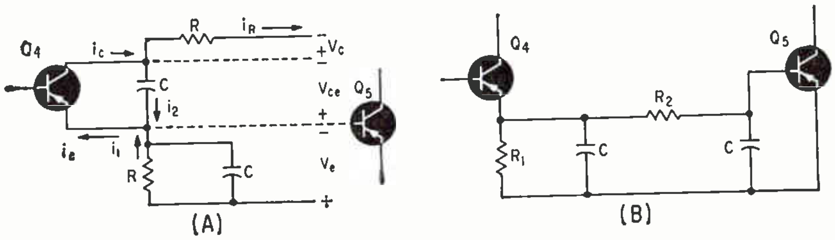


FIG. 6—Detector circuit used to prevent r-f feedback from the resonant-reed relay

plified by Q_1, Q_2 and Q_3. Transistor Q_3 has a high-value base bias resistor R_1 and is coupled to Q_2 through a high-value capacitor. As a result of this high RC value, Q_3 is partially cut off at large signal input voltages thus obtaining a degree of agc.

The collector current of Q_3 flows through the primary winding of tuned transformer T_1. The transformer is tuned to the same carrier frequency as L_1. Resistor R_2, between the collector of Q_3 and the primary of T_1, limits the current flow through the transformer primary.

Selectivity is further improved by the low value of the base resistor R_3. Transistor Q_4 only operates when the signal voltage has reached a certain level.

Detection

Transistor Q_4 operates as an emitter follower. The high input impedance of the transistor has practically no damping effect on the tuned transformer T_1. To prevent oscillation due to feedback between the coil of resonant relay K_1 and the ferrite antenna, the relay coil would have to be shielded. As shielding adds weight, the following method of r-f filtering is used.

In the detector circuit shown in Fig. 6A, $i_e = i_c$, $i_c = i_1 + i_2$ and $i_c = i_R + i_2$. Thus $i_R = i_1$ and $V_e + V_{ce} + V_c = 0$ (a-c voltages), where $V_e = i_1R/(1 + j\omega RC)$, $V_{ce} = -i_2/j\omega C$ and $V_c = i_RR = i_1R$. Then $[i_1R/(1 + j\omega RC) - i_2/j\omega C + i_1R] = 0$, $i_2 = i_c - i_1$, $[i_1(R/C(1 + j\omega RC)] - (i_c/j\omega C) + (i_1/j\omega C) + i_1R = 0$. Thus, $i_1 = i_c(1 + j\omega RC)/[j\omega RC + (1 + j\omega RS)^2]$ and $V_e = i_1R/(1 + j\omega RC) = i_cR/(1 + 3j\omega RC - \omega^2 R^2 C^2)$

Thus, for the high frequencies attenuation is proportional to the square of the frequency. The same attenuation can also be obtained with the filter shown in Fig. 6B.

Since Q_5 has a certain input impedance, the filter of Fig. 6B would also attenuate the lower frequencies due to the voltage divider of R_2 and the input impedance of Q_5. The filter of Fig. 6A does not have this disadvantage nor does it use extra parts.

The detected audio signal is amplified by Q_5 which has the coil of resonant relay K_1 in its collector circuit. When excited, the resonant relay reed vibrates at its natural frequency, thus interrupting the current flow through the loudspeaker to make an audible tone. As the transmitted signal is wobbled back and forth across the resonant reed frequency, the audible frequency will be interrupted. An amplifier with a lamp may be connected in parallel with the loudspeaker to make a visible signal.

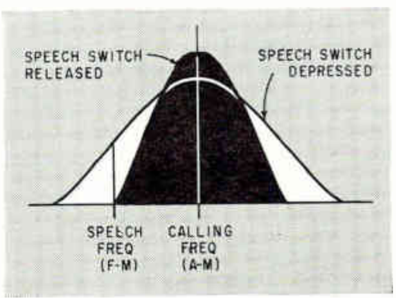


FIG. 7—When Q of tuned circuit is reduced, f-m voice signals can be received

Voice Messages

To receive voice messages, the selectivity of tuned transformer T_1 must be decreased to improve speech reception.

When pushbutton switch S_1 is depressed (see Fig. 5), the upper section connects the base of Q_4 through resistor R_4 to the battery voltage thus causing slight damping of the tuned circuit and biasing Q_4 in such a way that detection is no longer delayed. The lower portion of the switch connects emitter follower Q_6 into the circuit.

At the transmitter installation, the audio signal is used to frequency modulate another carrier slightly displaced in frequency from the a-m calling signal. When the Q of tuned circuit T_1 is reduced by depressing the speech pushbutton, the f-m signal is slope detected as shown in Fig. 7.

When not in use, the receivers are stored in individual pockets on a mounting rack. Each receiver is assigned its own pocket and each pocket has charging contacts so that when the receiver is installed metal strips on the side of the plastic case make contact to charge the receiver internal battery. A buzzer arrangement indicates when the receiver is inserted the wrong way.

When the receiver is installed in its mounting pocket, it closes a switch to inform the control desk that the particular receiver is not in use.

Power Amplifiers Using Electro-Optical Effects

Here is a listing of the 27 power amplifiers that can be designed to use various combinations of electric, radiative and thermal power

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INTEREST IN ELECTRO-OPTICAL effects such as photoconductivity and electroluminescence has grown considerably during recent years because of the possibility of practical applications in electronic circuits. The most useful common criterion for the feasibility of electro-optical solid-state devices is their performance as power amplifiers.

Any power amplifier is based on a control of source power (which brings the device materials to a condition deviating significantly from thermal equilibrium) by means of an input power, resulting in an output power flow. (See Fig. 1). For the sake of brevity we will confine ourselves to three kinds of power: electric (including magnetic and either d-c or a-c up to microwave frequencies), radiative (either quanta onwards from the infrared, or corpuscular) and thermal. These will be denoted by *e*, *r* and *t* respectively.

MORPHOLOGY—Because of the various possibilities of interaction between radiation, heat and charge carriers in semiconductors, the nature of source power, input power and output power may in general be an arbitrary combination of *e*, *r* and *t*. Based upon this phenomenological discrimination, the morphology of 27 possible amplifier types is listed in Table I.

One should bear in mind that in many cases the source power is necessarily of a composite nature.

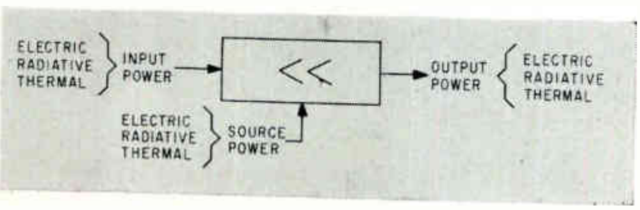

FIG. 1—General scheme of a power amplifier

Thus, for example, the photoconductor has a mainly electric power source, but it would not work if the photoconductor material were not in good thermal contact with a thermal power source, taking out the heat dissipated in the electrical conduction process. Similarly the Lossev effect could give rise to power amplification if with a small bias voltage the additional power needed to have the carriers jump across the barriers is provided by intimate contact with a thermal power source (for example of room temperature). Since this device is at the same time acting as a Peltier cooler, this does not contradict thermodynamics.

Not all combinations are equally interesting. The *e* (..) *r* and *r* (..) *e* combinations, of which electroluminescence and photoconduction are the prototypes, form a special category. To stress the change in nature of power and at the same time to include devices with a gain less than unity, devices in this category will be referred to hereafter as mutators rather than as amplifiers.

MUTATORS—The most striking differences from other existing types arise from the fact that mutators transfer power by quantum or corpuscular radiation, obeying the laws of geometrical optics. This gives rise to two useful features. First, a beam of radiation can give a one-way power transfer from A to B while electrically A and B can be completely disconnected. Second, such a beam can be split into different energetically uncoupled sub-beams while, conversely, beams originating from different sources can be united into a single one without causing crosstalk between the different channels.

Due to the change in nature, the output of such a mutator cannot be fed to the input of the same kind of mutator. Also, internal feedback is negligible. Two different mutators can, however, be used in

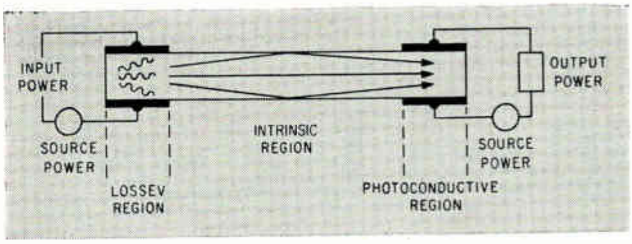

FIG. 2—Electric amplifier can be made by building electroluminescent and photoconductive mutators into same bulk of material

cascade, resulting in two types of "straight" amplifiers. The first is an *e* (..) *r* + *r* (..) *e* electric amplifiers. The second is an *r* (..) *e* + *e* (..) *r* radiation amplifier.

Regenerative feedback and bistable operation is possible with these straight amplifiers. Also, we think that in some respects they may become superior to the competing straight amplifiers listed in Table I, first because of the features mentioned above and second because, in general, a separation of different functions gives more freedom for optimum use.

STATE OF THE ART—We will summarize the state of the art by discussing the amplifier properties mentioned above for the *e (e) r* mutator, based on electroluminescence, and the *r (e) e* mutator, based on photoconduction. As far as technology is concerned, simple and cheap techniques exist for both devices whereby multi-element arrays with electrode-leads can be prepared. These techniques include printing, spray coating and dipping, sometimes followed by sintering at moderate temperatures.

Gain and power output of an *e (e) r* device should be improved. With the Destriau effect, however, no big improvements are to be expected.[1] Therefore, we are concentrating on the Lossev effect. With amplifi-cons[2] and visual display devices, the output and gain for visible radiation should be improved. We think this can best be done by separating the functions of carrier injection and luminescence, such that layers of well-activated luminophors like ZnS can be used as a body material[3]. With mutators for electric circuits, the emission should be preferably in the infrared, where it can be matched to fast photoconductors of high gain. A more practical solution with III-V compounds like GaP seems to be around the corner[4].

The *r (e) e* photoconductors can have high gain and power output but the bandwidth has been up until now much smaller than that of the *e (e) r* devices (approximately 100 cps with CdS, 1,000 cps with CdSe). For operation of the CdSe device, we have developed a red electroluminescent ZnSe powder of high efficiency.

The III-V compounds are also being investigated for the problem of gain-bandwidth products. The gain-bandwidth product is proportional to the mobility and the square of the maximum field strength (which is limited by breakdown and heat dissipation). Thus, we are studying III-V compounds with moderate energy gaps (between 1 ev and 2.5 ev).

OPTICAL MATCHING — With these materials which, in general, have a high refractive index, opti-

Table I—Electro-Optical Power Amplifiers

Input Power	Source Power	Output Power	Examples and Effects On Which Amplifier Is Based
Electric	Electric	Electric	Transistors, Hall effect parametric devices, tunnel effect devices
Electric	Electric	Radiative	Electric modulation of Destriau effect, electric modulation of Lossev effect
Electric	Radiative	Electric	Suhl effect, field quenching of photoconductance
Radiative	Electric	Electric	Photoconductance, infrared quenching of photoconductance, phototransistors
Electric	Electric	Thermal	Ettingshausen effect, magnetic cooling
Electric	Thermal	Electric	Nernst effect
Thermal	Electric	Electric	Temperature dependent impedances
Radiative	Radiative	Radiative	Maser, optical maser, infrared stimulation of phosphorescence
Radiative	Radiative	Electric	Radiative modulation of photovoltaic effect
Radiative	Electric	Radiative	Photoelectroluminescence, radiative modulation of Lossev effect
Electric	Radiative	Radiative	Gudden-Pohl effect, field quenching of fluorescence
Radiative	Radiative	Thermal	Infrared quenching of phosphorescence
Radiative	Thermal	Radiative	Radiative modulation of selective emission
Thermal	Radiative	Radiative	Temperature quenching of fluorescence
Thermal	Thermal	Thermal	Thermal modulation of thermal conductivity
Thermal	Thermal	Electric	Thermal modulation of Seebeck effect
Thermal	Electric	Thermal	Thermal modulation of Peltier effect
Electric	Thermal	Thermal	Righi-Leduc effect
Thermal	Thermal	Radiative	Thermal modulation of selective emission
Thermal	Radiative	Thermal	Temperature quenching of fluorescence
Radiative	Thermal	Thermal	Radiative modulation of thermal conductivity
Electric	Radiative	Thermal	Gudden-Pohl effect, field quenching of fluorescence
Thermal	Electric	Radiative	Thermal quenching of electroluminescence
Radiative	Thermal	Electric	Seebeck effect of photoconduction
Electric	Thermal	Radiative	Lossev effect
Thermal	Radiative	Electric	Thermal modulation of photovoltaic effect
Radiative	Electric	Thermal	Peltier effect of photoconduction

cal matching is difficult to achieve because of the total reflection of radiation at the surface of the material. This drawback could be converted to an advantage by building the *e (e) r* and the *r (e) e* mutator into two parts of the same bulk material, each of which should, of course, be activated according to its own function. (See Fig. 2).

Compared to the transistor, one has here a greater freedom in choosing the material (resulting, for example, in better temperature dependence) and, owing to the radiative link, a better electrical isolation between input and output.

It should be borne in mind, however, that in some applications not too fast a response is wanted. Thus slow CdS photoconductors are useful in amplificons for radar- and X-ray viewing, in automatic brightness control of tv sets (where they are adapted to the response time of the human eye) and in switches in electric musical instruments (where they smooth the transients).

Impedance of the low-ohmic Lossev device can, moreover, be matched much more easily to other low-ohmic, solid-state devices than that of the Destriau device. However, a combination of many Destriau elements in parallel can be matched to a ferrite, for example for tv scanning[4]. Photoconductors can be matched to high as well as to low impedances by variation of electrode geometry.

The problem of cross-talk in cross-bar systems can be solved with non-linear elements. We have added a new type of sprayed and sintered photodiode, based on the combination of a photoconductor and an electret.[5]

LIFETIME—With suitable activation and protection against moisture, sulfide and selenide materials can have an operational life of several thousand hours. It is our experience that trivalent metals[6] are superior to halides for so-called coactivation, as halides give rise to electrolysis.

The temperature stability is in general superior to that of a germanium transistor; for example, CdS, Cu and Ga photoconductors and ZnS, Cu and Al electroluminescent layers can easily stand operating temperatures up to above 80 C.

Noise in these mutators has up until now not been studied very extensively, but we know that in general the mutators discussed will not be of especially low noise. The application will thus not be in low level amplification but rather in switching, logic, memory and other devices operating at not too low a signal power level.

OTHER POSSIBILITIES—It should be borne in mind that tunnel effects can be used for amplification and modulation in a wider sense than in the tunnel diode only. Tunneling from localized levels, lying near one of the electronic bands, which are kept in a non-thermal equilibrium situation by a power source can also give rise to negative resistances and, thus, to switches and amplifiers of a kind different from that of the mutator combinations discussed above.

Glossary of Terms

DESTRIAU EFFECT.—Sustained emission of light by suitable phosphor powders embedded in an insulator and subjected only to the action of an alternating electric field.

ETTINGSHAUSEN EFFECT.—When a metal strip is placed with its plane perpendicular to a magnetic field and an electric current flows longitudinally through the strip, corresponding points on opposite edges come to different temperatures.

GUDDEN-POHL EFFECT.—The momentary illumination produced when an electric field is applied to a phosphor previously excited by ultraviolet radiation.

HALL EFFECT.—When a metal strip is placed with its plane perpendicular to a magnetic field and an electric current flows longitudinally through the strip, a potential difference is developed across the strip.

LOSSEV EFFECT.—Radiation resulting from recombination or charge carriers injected in a ***pn*** or ***pin*** junction biased in the forward direction.

NERNST EFFECT.—When a metal strip is placed with its plane perpendicular to a magnetic field and heat flows through the strip, a potential difference is developed across the strip.

PELTIER EFFECT.—When electric current flows across the junction of two properly chosen materials, an evolution or absorption of heat occurs at the junction.

PHOTOVOLTAIC EFFECT.—When radiant energy, commonly light, is incident upon the junction of two dissimilar materials such as a ***pn*** or metal-semiconductor junction, an electromotive force is produced.

RIGHI-LEDUC EFFECT.—When a metal strip is placed with its plane perpendicular to a magnetic field and heat flows through the strip, a temperature difference is developed across the strip.

SEEBECK EFFECT.—When one junction of two properly chosen materials in a closed circuit is heated with respect to the other junction, an electric current flows across the junction.

SUHL EFFECT.—When a strong transverse magnetic field is applied to an **n**-type semiconducting filament, holes injected into the filament are deflected to the surface where they may recombine rapidly with electrons showing a much reduced lifetime, or be withdrawn by a probe as if conductance had increased.

TUNNEL EFFECT.—The probability that a particle of given potential energy can penetrate a finite barrier of higher potential.

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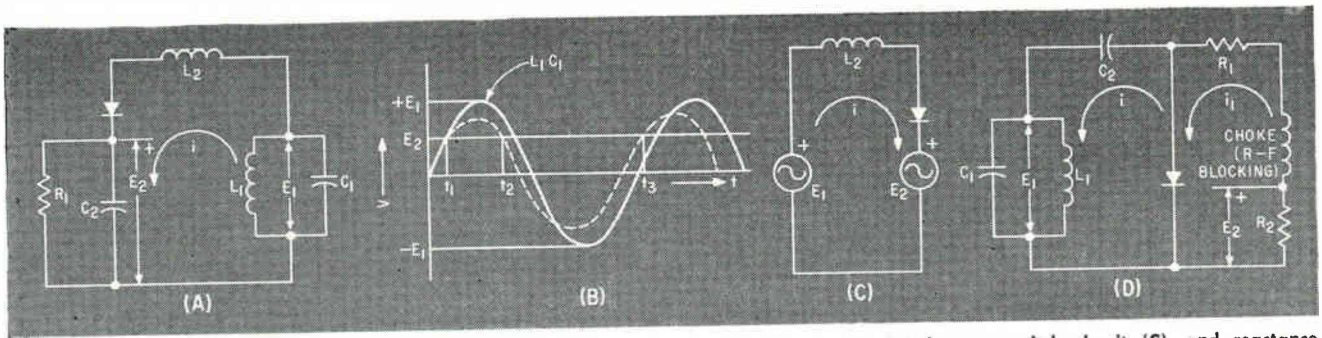


FIG. 1—Reactance-switch modulator using an inductor (A), cycle of operation (B), simplified inductance-switch circuit (C), and reactance-switch modulator using a capacitor (D)

Frequency Modulation By Reactance Switching

With this method, it is possible to use a fixed reactance to frequency-modulate a resonant circuit. Resonant frequency is a function of voltage

By M. MICHAEL BRADY, W. W. Hansen Laboratories of Physics, Stanford University, Stanford, California

MANY METHODS ARE available for producing f-m by varying the resonant frequency of a parallel-resonant circuit. Most methods vary the resonant frequency by varying the magnitude of a reactive element in the circuit (e.g., capacitive microphone across a parallel resonant circuit). Such reactive changes, however, require a change in some physical dimension. Practically, it is more desirable to voltage-control some element of the resonant circuit.

The earliest voltage-controlled frequency modulator was the reactance-tube circuit. Its overall linearity is poor, however; also, it may load the main resonant circuit in an undesirable fashion.

More recently the reverse-biased *pn* junction has been used in f-m circuits. The capacitance associated with a *pn* junction becomes a function of the potential across the junction when a reverse bias is applied. An ordinary junction diode, a specialized voltage-variable capacitance diode,[1] or a transistor[2] may be used. It is possible to obtain very broad-band high-linearity f-m with a reverse-biased *pn* junction; a sweep generator with a 200-kc sweep width at a center frequency of 500 kc has been designed.[3] In such circuits, however, too much a-m may result.

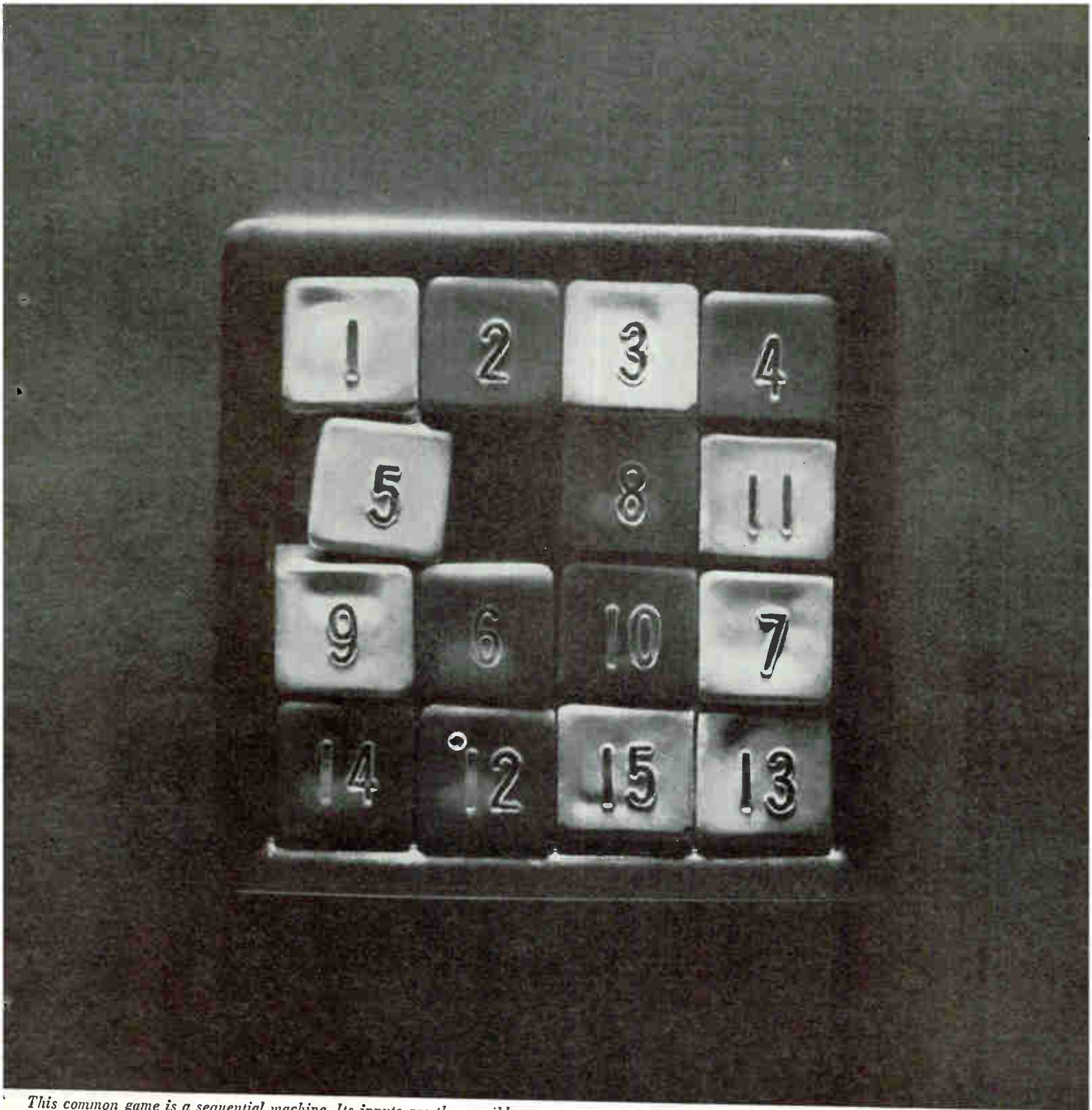
It is possible to use a fixed reactance to frequency-modulate a resonant circuit. A switching circuit can be so arranged that a fixed reactance is switched in parallel with the main resonant circuit during a portion of every cycle; the resonant frequency of the total circuit can then be made a function of the potential or current that controls the switching element. The switching circuit may use a triode,[4] or a diode and may employ either a capacitor or an inductor as the fixed reactance.[5, 6]

The inherent advantages of the reactance-switch type of frequency modulator are that wide frequency deviation with very little a-m is possible, and the circuit is exceedingly simple and uses readily-available components.

Reactance Switching

A practical circuit for reactance-switching frequency control using an inductor is shown in Fig. 1A. Resonant circuit L_1 and C_1 has a frequency of ω_0. Inductor L_2 is switched across the resonant circuit during a portion of each cycle determined by the voltage difference between the resonant circuit voltage E_1 and the controlling voltage E_2. Capacitor C_2 is a bypass at the operating frequency while resistor R_1 loads the controlling signal.

The effective mechanism of the circuit is shown in Fig. 1B. From zero to time t_1, the resonant frequency is ω_0. From t_1 to t_2 inductor L_2 has been switched in parallel with L_1 and the resonant frequency of the circuit is thus raised. From t_2 to t_3 the resonant frequency is again ω_0. Thus, over a number of cycles, the resonant frequency



This common game is a sequential machine. Its inputs are the possible moves at a given state. Its state is the arrangement of numbers at a given time changes as a function of the control potential E_2.

Analysis of the circuit is relatively straightforward. The diode is assumed to be ideal: that is, it is a self-operated switch that closes when its terminal voltage is positive and opens when its terminal voltage is negative.[7] With the ideal diode, then, there are obviously two states of the modulating portion of the circuit. In Fig. 1C, when E_1 is greater than E_2, the diode is conducting and the loop equation for the circuit can be written:

$$Li' = E_1 - E_2 \quad (1)$$

where the prime indicates the first time derivative. When E_2 is greater than E_1, the diode is nonconducting, and the current i is zero. These two states then define the conditions on the current i. Assuming that the voltage E_1 is produced by a sinusoidal voltage generator of constant frequency and amplitude (Fig. 1C), a solution for i may be obtained in terms of a Fourier series through consideration of the necessary boundary conditions. Using the conventional notation for Fourier coefficients and taking only the first terms of the series:

$$i = (E_1/\omega_o L_2)(A_o/2 + A_1 \cos \omega t + B_1 \sin \omega t) \quad (2)$$

E_1 was assumed to be a sinusoid, so the dimensions of the coefficient of $\cos\omega t$ must be susceptance while those of the coefficient of $\sin\omega t$ must be conductance. The A_o term merely defines a steady-state component. The equivalent parallel impedance presented to the main resonant circuit by the modulating circuit may then be written:

$$R_p + jX_p = \omega_o L_2 (1/|B_1| + j/|A_1|) \quad (3)$$

Using a Capacitor

A practical circuit for reactance-switching frequency control using a capacitor is shown in Fig. 1D. The operation of the circuit is fundamentally the same as that of Fig. 1A, except that the frequency is lowered when the capacitor is switched in. The diode is now in parallel instead of in series with the modulating signal source in order that a return path for the steady-state component of the modulating current exist. A choke is provided to isolate the r-f circuit from the modulating circuit.

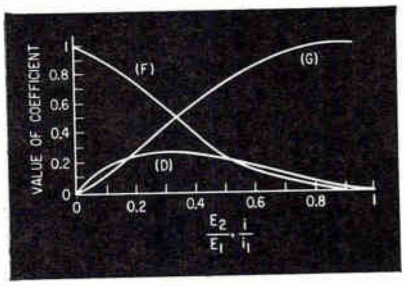


FIG. 2—With Eq. 8 and this plot, the exact frequency deviation to be expected in a practical reactance-switching circuit can be determined

Analysis of the capacitor-switched circuit follows closely that of the inductor-switched circuit. In Fig. 1D the diode will conduct as long as i_1 is greater than i and will be open when i is equal to or greater than i_1. Equation for the loop including C_2 may be written:

$$i = C_2 E'_c \quad (4)$$

where E_c is voltage across C_2. If E_1 is of frequency ω_o, then when the diode is conducting, current i is:

$$i = \omega_o C_2 E'_1 \quad (5)$$

An equation for i, expressed by only the first two terms of a Fourier series, is:

$$i = \omega_o C_2 E_1 (A_o/2 + A_1 \cos \omega t + B_1 \sin \omega t) \quad (6)$$

E_1 was assumed to be a sinusoid, so the dimensions of the coefficient of $\cos\omega t$ must be conductance while those of the coefficient of $\sin\omega t$ must be susceptance. The equivalent parallel impedance presented to the main resonant circuit by the modulating circuit may then be written:

$$R_p - jX_p = (1/\omega_o C_2)(1/|A_1| - j/|B_1|) \quad (7)$$

All that remains to completely describe the behavior of the reactance-switch circuits is to describe the coefficients A_1 and B_1. Letting the coefficients B_1 for the inductance and A_1 for the capacitance equal D, the coefficient A_1 for the inductance equal F and the coefficient B_1 for the capacitance equal G, Eq. 3 and 7 may be re-written:

$$R_p + jX_p = \omega_o L_2 (1/|D| + j/|F|) \quad (8)$$
$$R_p - jX_p = (1/\omega_o C_2)(1/|D| - j/|G|)$$

For the switched inductance, E_2 can vary from zero to E_1; values of E_2 greater than E_1 are meaningless, for the inductor L_2 is then not connected to the resonant circuit during any portion of the operating cycle. Likewise, the current i in the switched capacitance circuit cannot exceed the current i_1. The coefficients D, F and G of Eq. 8 are then plotted against E_2/E_1 or i/i_1 in Fig. 2.

As can be seen from Fig. 2, there is a relatively large linear range of the coefficients F and G, and thus a large range of available linear f-m. It is desirable for the parallel resistance R_p to be as high as possible; therefore, if linear f-m is desired, operation should be at as low a value of E_2/E_1 or i/i_1 as possible.

If the change in resonant frequency $\Delta\omega$ is very small with respect to the resonant frequency determined by $\omega_o = 1/\sqrt{L_1 C_1}$, then the usual approximations ($\omega_o^2 >> \Delta\omega^2$; $\omega_o/(\omega_o + \Delta\omega) \approx 1$) yield the following expressions for frequency deviation (for switched inductance and switched capacitance, respectively):

$$\Delta\omega \approx \omega_o F L_1/2L_2 \quad (9)$$
$$\Delta\omega \approx \omega_o G C_2/2C_1$$

Equation 8 and Fig. 2 can be used to determine the exact frequency deviation to be expected in a practical circuit, while Eq. 9 provides an approximation for small frequency deviations. The reactance-switch circuit has been used successfully.[8] Figure 2 and the method of evaluating the coefficients are derived from the work of G. K. Frölich Hansen of the Danish Atomic Energy Commission Research Establishment Risö, Roskilde, Denmark.

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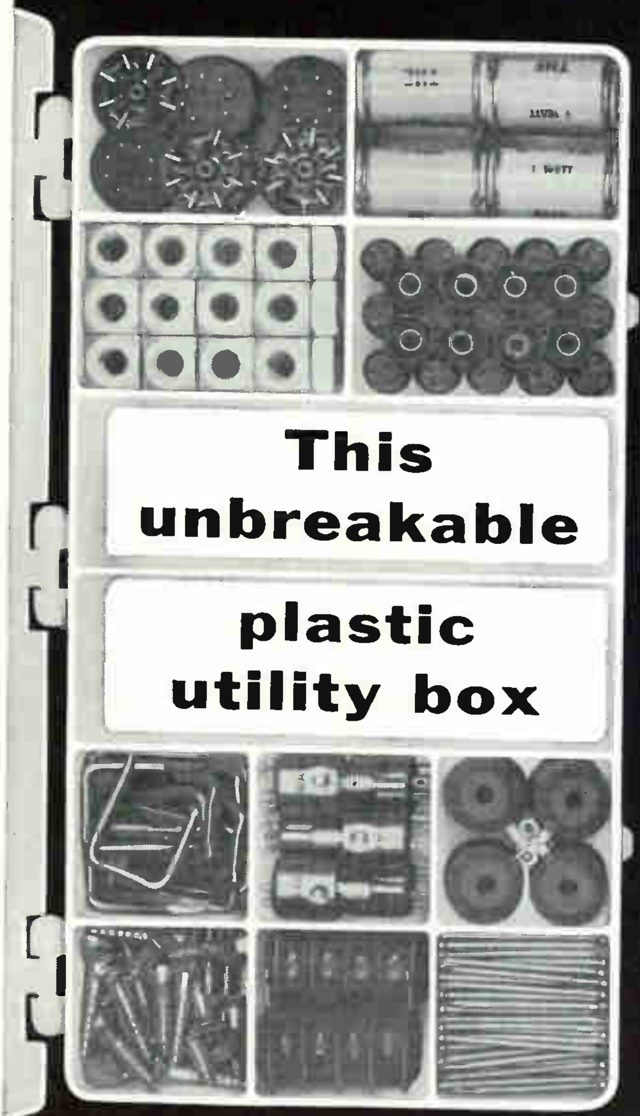

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Thin Film Balanced Modulator

COMPLETELY passive balanced modulator circuits may be evolved using thin (less than one micron) single-domain permalloy film. The proposed modulator was described at the 1960 Winter Convention on Military Electronics by R. L. Samuels and A. A. Read, Electrical Engineering Department and Engineering Experiment Station, Iowa State University of Science and Technology. The work was partly supported by the National Science Foundation.

Ferromagnetic Film

Vacuum deposition of single-domain thin films has led to their application in low-loss inductors in which self-inductance can be varied parametrically at frequencies from d-c to several hundred mc.[1, 2] Availability of such inductors suggested their application in a suppressed-carrier double-sideband modulator.

Films used were of 80-20 permalloy vacuum deposited in the presence of an external magnetic field to a thickness of 2,000 A (2×10^{-5} cm) in the form of disks about 8 mm in diameter. A film so deposited has a low anisotropy in the plane of the film and a very large demagnetizing factor for rotation out of the plane of the film.

The films are essentially single magnetic domain structures. A domain possesses a saturation magnetization vector M per unit volume, which represents the intrinsic magnetic flux density of the material. With no external magnetic fields, M lies in the plane of the film in the easy or rest direction. In the plane of the film but normal to the easy direction is the hard or transverse direction.

Figure 1A shows a coordinate system for a single domain thin film. External fields h_R and h_T along the rest and transverse directions respectively cause M to rotate through angles ϕ and ψ. The equation of motion for M is similar to that of a damped gyro. If h_R is held constant and h_T varied sinusoidally with time, the tip of M precesses, tracing out a path that is essentially a flat ellipse.

The large demagnetizing fields normal to the plane of the film constrain angle ψ. But the low anisotropy provides limited contraining forces in the plane of the film so that ϕ can become quite large. Practically, M can be assumed to move back and forth in the plane of the film. If both h_R and h_T vary rapidly with time, the motion of M can become a complicated Lissajous pattern, but its motion remains essentially in the plane of the film. In practice, rotation out of the plane can be neglected and quasistatic conditions assumed for frequencies below vhf at least.

Modulator Windings

In Fig. 1B the axis of the carrier winding is parallel to the rest direction; the axis of the output winding is parallel to the transverse direction. A modulation winding can be added in parallel with the output winding or the output winding itself used as the modulation winding. Because of the mutually perpendicular orientation, no voltage is induced in the output winding if no currents flow in the modulation or output windings.

Assume that d-c bias current I_b and a carrier current i_c at an angular frequency ω_c flow in the carrier winding. A d-c current flows in a separate modulation winding (not shown) in parallel with the output winding. This current establishes a magnetic field in the transverse direction producing a torque that rotates vector M through an angle ϕ, establishing a flux linkage in the output winding. When M is rotated away from its rest position, the fields established by the a-c carrier current in the carrier winding exert added forces on M, rocking it back and forth around some equilibrium value of ϕ, thus constantly changing the magnetic flux linking the output winding.

Voltage is induced in the output winding at carrier frequency and of amplitude determined largely by the equilibrium angle of rotation established by the amplitude of the d-c current. Nonlinearity in modulation current can be kept small if the maximum angle of ϕ is kept small. A variable capacitor across

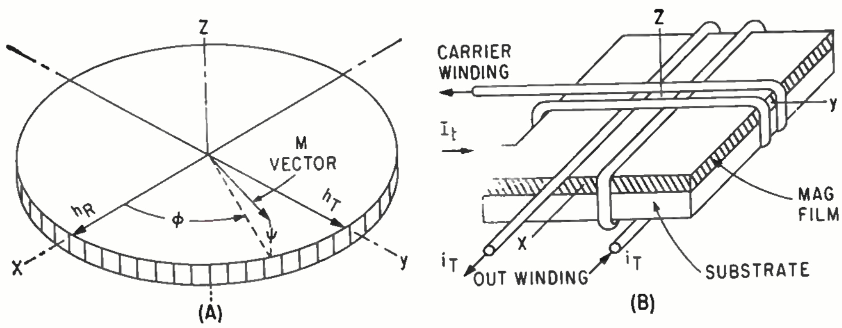


FIG. 1—Coordinate system of single-domain thin film is shown at (A) and alignment of windings at (B)

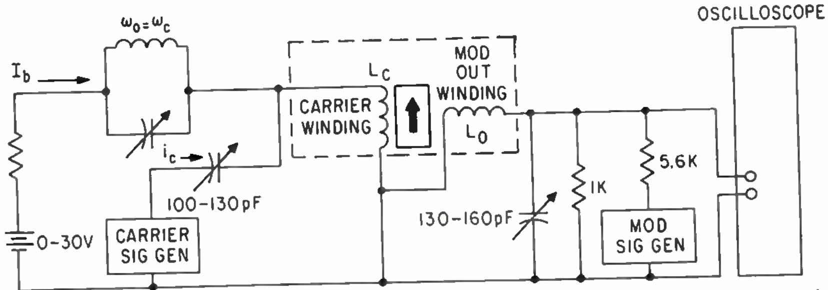
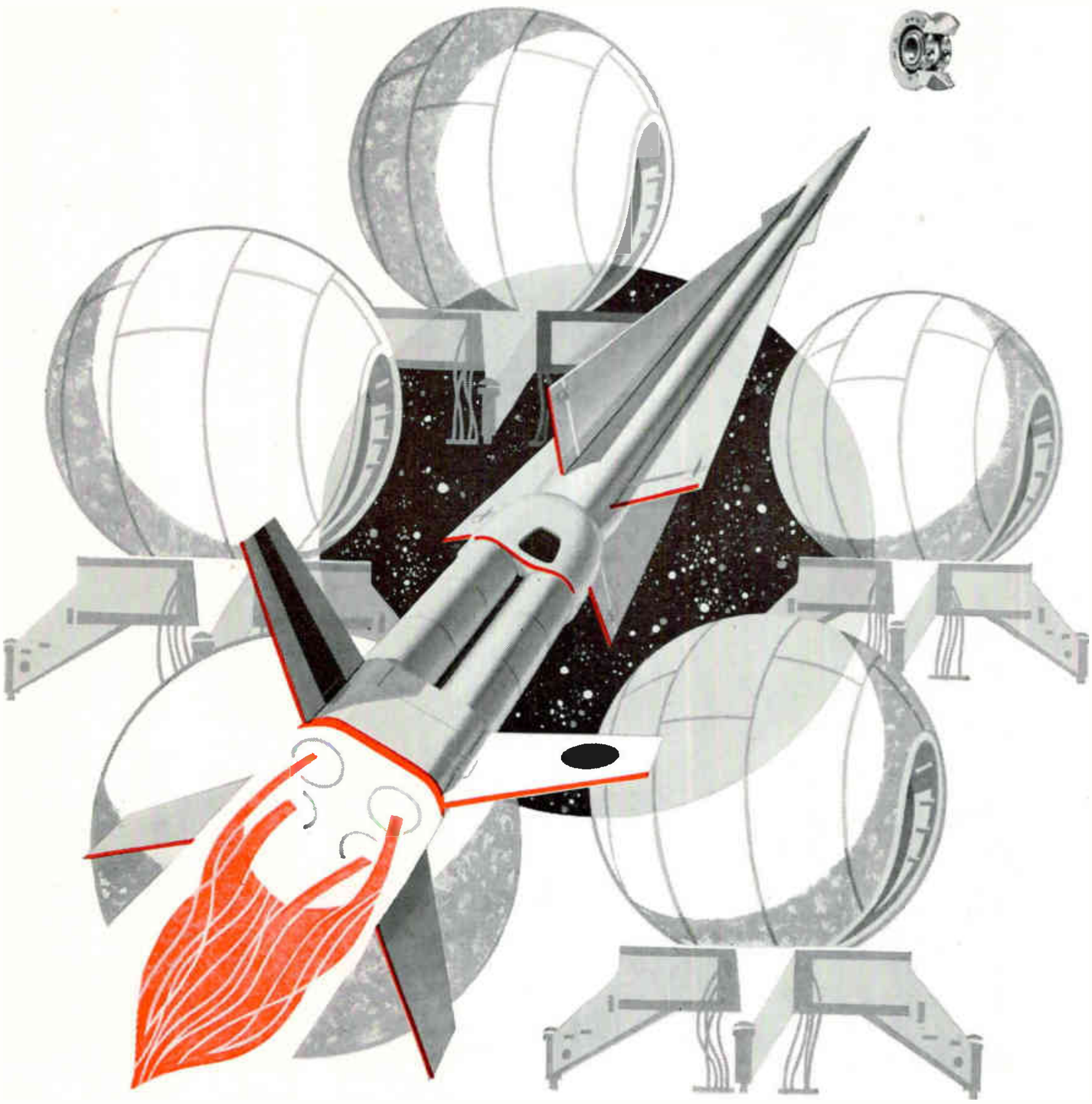


FIG. 2—Single winding was used for both output and modulation in experimental modulator circuit



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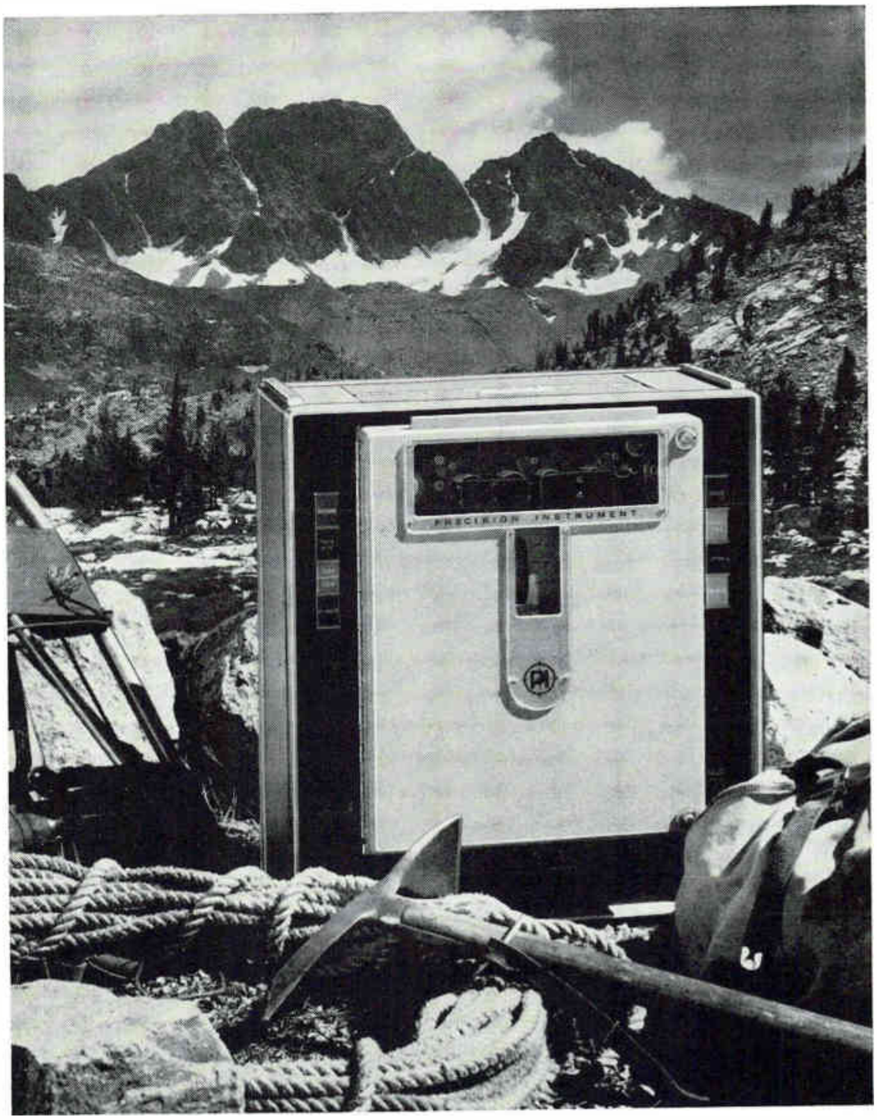


the output terminals can tune output to resonance. The tuned circuit partially suppresses carrier harmonics and increases useful output amplitude.

A time varying modulation current slowly rotates M back and forth around the rest direction while the carrier current rapidly rocks M around its equilibrium position. Thus suppressed-carrier double-sideband modulation is produced.

Experimental Verification

A ferromagnetic film research group at Iowa State University carried out investigations to verify predicted results. A single winding in the arrangement in Fig. 2 was used both as modulation and output winding. Carrier frequency was kept constant at 4 mc. Sinusoidal frequencies from 20 cps to 20 kc and square wave frequencies up to 100 kc were used to modulate the 4-mc carrier. Carrier feedthrough of 2.5 mv peak for zero modulation was measured. Carrier feedthrough measurement with modulation could not be made with the equipment available but there is ample reason to believe that it can be kept very low.

Experimental results generally verify theoretical expectations, but one of the most difficult problems experienced was that of properly aligning the two windings and the film. This problem might be partly overcome by evaporating films that have a much smaller anistropy, making the system less sensitive to alignment. Also sandwitching techniques might be used and the inductors potted to maintain correct alignment.

A balanced modulator should be possible that would be almost completely immune to a wide range of mechanical and thermal environments.

The authors acknowledge the assistance of St. Paul Remington Rand Univac for providing films, to their colleagues at Iowa State University and elsewhere, particularly A. V. Pohm and R. D. Anderson.

REFERENCES

(1) A. A. Read and A. V. Pohm, Magnetic Film Parametric Amplifiers, *Proc Nat Elect Conf*, 15, 1959.
(2) A. A. Read and A. V. Pohm, Parametric Amplifier Uses Thin Films, ELECTRONICS, 32, p 92, Nov. 13, 1959.

Mass Spectrometer Going Into Orbit

MINIATURE mass spectrometer will be orbited in a satellite by the National Aeronautics and Space Administration in 1961. This lightweight instrument is now undergoing prototype testing.

The double-focusing mass spectrometer was designed by Consolidated Systems, a subsidiary of Bell & Howell/Consolidated Electrodynamics Corp. to measure elements in the exosphere. It will be capable of accepting particles from wide entrance angles with energy between ±12 volts. It can measure ions, molecules, atoms and free radicals at altitudes between 150 and 600 miles above the earth.

Atmospheric Structure

Recent rocket firings have given limited data about the structure of the upper atmosphere. The spectrometer will analyze samples for a year. By analyzing neutral particles in addition to ions, scientists may gain a better understanding of the effects of solar and cosmic energies on the gases near our planet. Information will be telemetered to ground receiving stations.

Neutral particles will be ionized by an electron beam outside the satellite shell, accelerated and directed into the magnetic analyzer and separated according to their masses. Ions can be admitted directly into the analyzer when the ionizing beam from a rhenium filament is automatically switched off. The electron beam can be switched on to ionize and thus analyze atoms, molecules and free radicals.

A permanent magnetic will be used to deflect the ions into paths appropriate for their masses.

Cycling

A binary solid-state logic circuit will change potential between ions and molecules. Mass range will be for six constituents (hydrogen atoms, nitrogen and oxygen atoms and molecules, and water vapor), in addition to reference level and total current measurements. An electrometer amplifier will amplify the signal corresponding to ion currents as low as 10^{-16} amp.

Sealed-Off Power Source for S-Band

By ARNOLD HASSE-DUBOSC, President, American Radio Company Inc., New York City

A HIGH-POWER pulsed klystron, originally designed as a power source for a 2 BeV linear accelerator which is actually being built by the Compagnie Generale de TSF for the Paris University in Orsay, has several original aspects that make it useful as a final stage for a long-range radar or in tropospheric scattering communications.

The AX-436 klystron of CSF is an S-band klystron that is sealed-off, operates at low voltage and has no cavity tuning.

Voltage and Load

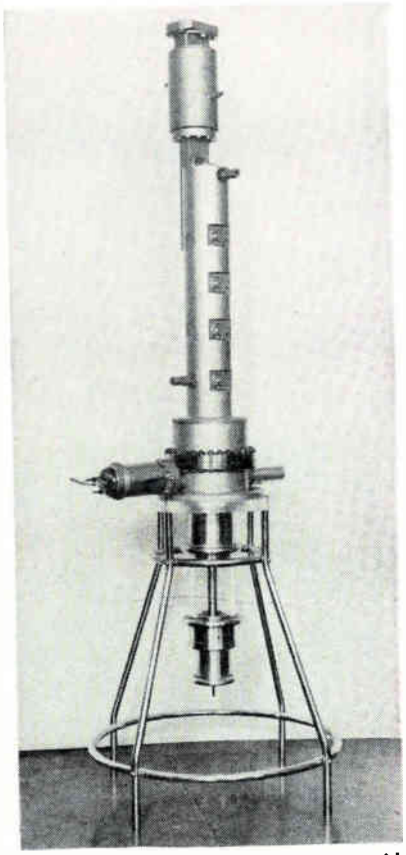
One of the most interesting features of the tube is connected with the low voltage of 250 kv allowed by a beam perveance as high as 2.10^{-6} resulting in a beam impedance of 1,000 ohms. Such voltage and load seem to be the optimum for the minimum cost of modulators, a question of great importance for systems using as much as several tens of tubes. For the tube itself above values involve not only easier insulation and X-rays shielding but also a lower Q of the cavities so that non-critical fixed tuned cavities can be used instead of fragile or cumbersome tunable systems.

The tube is essentially made of a thick cylindrical wall of copper. Cavities and drifts are massive blocks brazed inside the wall; the resulting accuracy of construction secures the possibility of pretuning the cavities at determined frequencies. The blocks are shaped to provide space for water cooling in order that no thermal drift of r-f power can occur.

Tube Recovery

All other components—water-cooled collector, gun, input and output circuits—are assembled by means of removable and bakable tight joints; so the tubes can be recovered at low cost.

A small ceramic seal is used for the UG-496/U coaxial input which is housed in the thickness of the wall. The output power is taken from the output cavity through a circular ceramic window and an S-band waveguide. The window is properly shielded to prevent troubles due to parasitic radiations or discharges. Possibility of gun oscillations has been suppressed by proper design.



Four-cavity klystron, the AX-436, with coils removed

Owing to the longitudinal position of the output circuit above the tube, the outside of the wall is kept clear for introduction of the focusing coils. Any set of coils fits electrically any tube and only minor adjustment of the total current may be required.

A titanium pump is incorporated and allows the tube to be operated sealed off. The main purpose of this pump is to take care of eventual outgassing of the tube during sealed-off operation, resulting in longer life. As the pump acts also as a vacuum gauge, both operations can be manually or automatically switched on.

Power and Efficiency

At the left is a photograph of a tube where the coils have been removed. Figure 1 is a typical plot of the variation of r-f peak power with the voltage (curve *A*); the corresponding efficiency is also plotted (curve *B*).

Average power tests were made up to 5 Kw, although the first accelerator using these tubes requires only 2.5 Kw from each of the sixteen klystrons.

It can be seen that 30 Mw are obtained at a voltage quite lower than 300 kv and that efficiency is higher than 40 percent. Some recent work has confirmed the values of the order of 50 percent obtained in laboratory conditions could be accounted for on production tubes.

Stagger Tuned

The tube has four cavities, the second and the third ones stagger-tuned for optimal efficiency at 3000 Mc. The saturation gain in the 20 Mw range is 43 db.

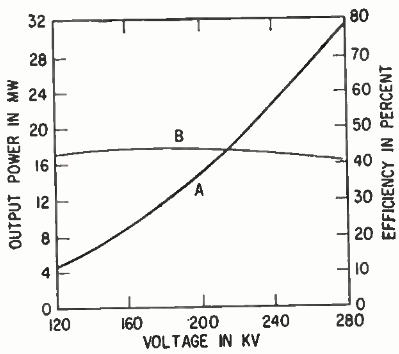
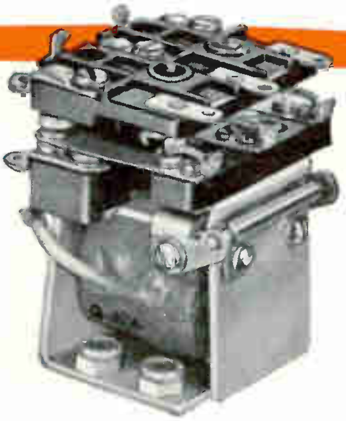


FIG. 1—Peak r-f power (A) and efficiency (B) curves of the pulsed klystron

Though the tube is designed for systems working at fixed frequency, the tube operates satisfactorily over a frequency range of the order of 100 Mc. At a given voltage the output level can be kept constant at 1 db over a fre-

3 STOCK RELAYS

for Day-In Day-Out Reliability



Type
DO
AC-DC

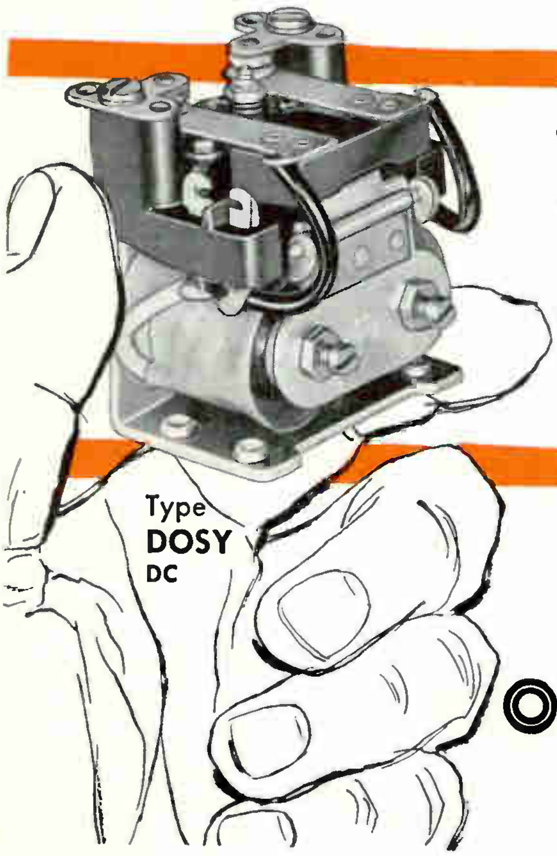
For Severe Shock and Vibration

A rugged relay, particularly adaptable to aircraft and mobile applications. Design of molded parts around contact arms prevents mechanical injury. Available in twenty-three 3-pole and 4-pole types. *Coil Wattage:* 3.00 watts, DC operation; 6.00 watts, 60 cycle AC. Maximum temperature rise 45° C, DC; 75° C, AC. *Coil Operating Voltages:* from 6 to 230 VAC (60 cycles) and 6 to 220 VDC. *Contacts:* Fine silver. Rated for 115 VAC or 32 VDC, non-inductive load. *Weight:* 3-pole, approximately 5 ounces; 4-pole, 6 ounces.

Compact and Lightweight

A general-purpose relay of wide application. Handles loads usually demanded of much larger relays. Meets rigorous aircraft relay standards. Twenty single- and double-pole types. *Coil Wattage:* 2.5 watts, DC; 3 watts, 60 cycle AC. Maximum temperature 45° C, DC; 65° C, AC. *Coil Operating Voltages:* from 6 to 230 VAC (60 cycles) and 6 to 220 VDC. *Contacts:* Fine silver is standard. Rated for 115 VAC or 32 VDC, non-inductive load. *Weight:* Approximately 4 ounces.

Type
DOS
AC-DC



Type
DOSY
DC

Twin Coils for Extra Sensitivity

Similar in construction to Model DOS. The DOSY relay is adaptable to a wide range of electronic applications such as plate circuit controls or as overload or underload controls in DC circuits to signal attainment of predetermined current levels. Four single- and double-pole types. *Coil Wattage:* 1.00 watt, with maximum temperature rise of 45° C. *Contacts:* Fine silver. Rated for 115 VAC or 32 VDC, non-inductive load. *Weight:* Approximately 4½ ounces.

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Also other quality relays of many types

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TAP SWITCHES • R.F. CHOKES
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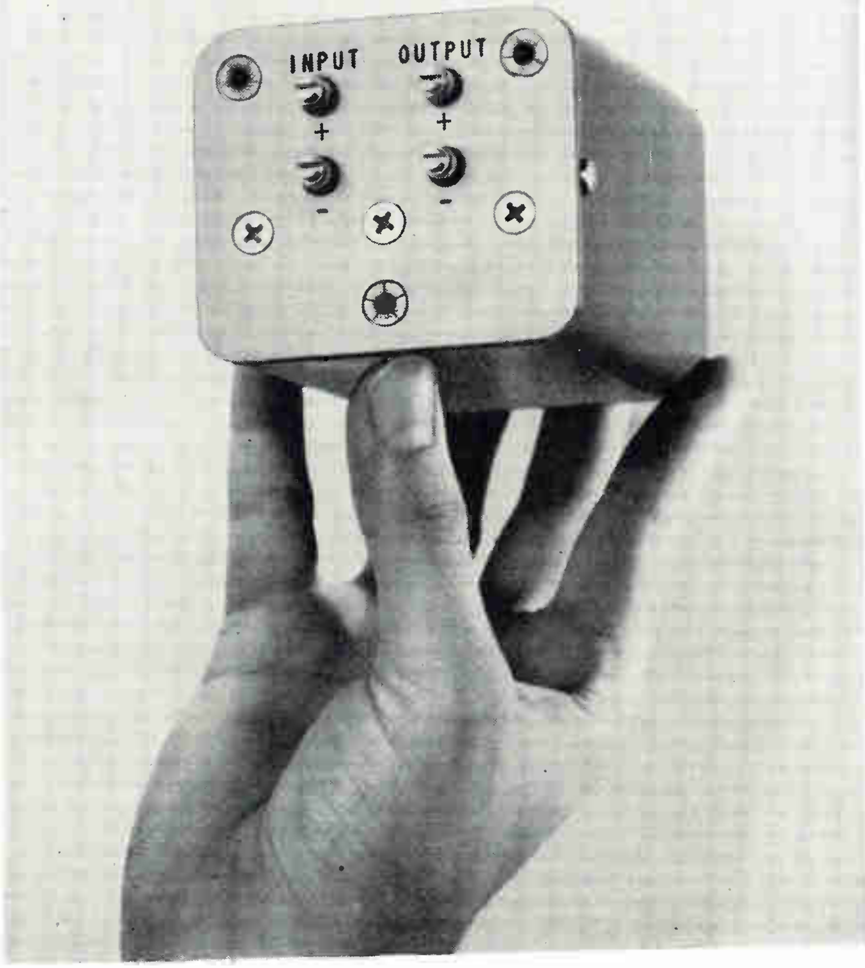

quency range of 2.5 percent by adjusting the input signal. At constant input the bandwidth is 40 Mc.

Ceramic Filters Improve Receiver Selectivity

CERAMIC FILTERS used in the new design of HEATHKIT'S all transistor, multi-band communications-type receiver are claimed to improve selectivity and help reduce size and cost. The i-f amplifier sections contain TRANSFILTERS for shaping the band pass.

Alignment is simplified in the i-f amplifier sections and a fixed narrow band pass is achieved. The new receiver design incorporates two models of the new ceramic filters which were recently introduced by Clevite Electronics Components Division of Clevite Corp for i-f stages of a-m transistor radios.

Conventional receiver design requires a combination of double-tuned and single-tuned i-f transformers to obtain the necessary selectivity. The Heath MOHICAN GC-1 design uses two double-tuned transformers and two each of models TF-01A and TO-01A ceramic filters. According to Heath engineers who designed the unit, its selectivity is 3 kc wide at 6 db down and 25-kc wide at 60 db down.

The ceramic filters set the width of the top portion of the i-f passband and the input and output transformers need only be peaked for maximum gain and skirt selectivity. Resonant frequency of these units is stable ± 0.1 percent from −20C to + 60C and varies only 0.1 percent per decade of time.

Interstage Couplers

The TO-01A ceramic filters are interstage couplers providing impedance coupling between the first and second, and between the second and third i-f transistor stages. These filters combine the functions of impedance transformation and frequency selection of the 445-kc i-f frequency. The TO filter is a ceramic unit with impedance matching characteristics. This piezoelectric disc vibrates at the first overtone of its fundamental radial mode. It forms a four-terminal network with a high impedance and a low-impedance pair of electrodes. The operation of these filters is the same as that of crystal lattice filters.

With appropriate circuit design, the ceramic filter replaces transformer, inductive and capacitive elements used in conventional frequency selective circuits. Band width is 4 to 7 percent at 6 db and insertion loss at 445 kc is 2 db maximum.

Emitter Bypass

The TF-01A filter is an emitter bypass frequency selective element also resonant at 445 kc. In combination with the TO-01A, it gives the receiver's i-f stage selectivity superior to that obtained by four tuned stages in LC circuits.

Thermoelectric Cooling Using Semiconductors

ECONOMIC APPLICATIONS of thermoelectric cooling are now possible using new semiconductor materials such as bismuth selenide, bismuth sulphide, lead and antimony tellurides, claim General Electric Co. Ltd., London.

Cooling units for an automatic dewpoint hygrometer and a cooled baffle for an oil-diffusion vacuum pump are already developed, and work is proceeding on a domestic refrigerator unit.

With a refrigerator, a small rectifier-transformer unit is needed to give the required d-c, but the unit should still be competitive with conventional equipment.

Preparation of semiconductor alloys for thermoelectric use is easier than for transistors as polycrystalline structure is acceptable and the impurity requirements are less stringent by a factor of 10^4 or 10^5. Thermocouples are either cut from ingots or sintered from powder pressings and soldered together.

Temperature difference across the thermocople of 30 to 50 deg. C. is obtained in some applications, but when cooling the air in an enclosure temperature gradients between the junction and the air limit the temperature difference to 20 to 30 deg. C. Many future applications are now under review.

Solve Tin-Nickel Plating Problems

Symptoms and Causes	Cures
Non-adherent deposits, pitting or high-tin deposits traced to organic contaminants	Treat solution with activated carbon in spare tank, allow carbon to settle out, filter and return solution to plating tank
Inorganic contamination caused by lead content >25 ppm, antimony >0.4 g/l, cadmium >1.5 g/l, copper >0.2 g/l, iron >0.5 g/l, zinc >1.5 g/l	Plate out on dummy cathodes at low current densities overnight; minimize carry-over from other processes; use nickel anode hooks and fittings and approved jig coatings
Pitting caused by fine air bubbles at cathodes, bubbles dispersed in solution by filters	Correct filter; or filter only during idle periods, shutting off filter an hour before plating
Solution becomes imbalanced and fails to maintain proportion of 65 tin–35 nickel due to aerial oxidation of stannous tin (stannic tin content above 300 g/l); stress in deposit changes from tensile to compressive; insufficient tin	Reduce stannous tin oxidation by avoiding air agitation, keep filter hoses below solution surface; add stannous chloride and low-lead ammonium bifluoride, correct pH to 2.5 with ammonia; use 28% nickel alloy anodes (add 1 nickel anode for each 3 alloy anodes), or separate tin and nickel anodes
High-tin deposit resulting from bath temperature being too low	Maintain bath at 70 C, +10 C, −5 C (158 F, +18 F, −9 F)
Layering resulting from variations in bath temperature	Cathode agitation, preferably vertical
Chloride buildup in old solution; formation of chloride crystals in filters	Cool solution over weekend in spare tank, filter after crystals form; flush filters with makeup water before daily shutdown
Inefficient filtration; contamination during filtration	Back filter pads with Terylene cloth, filter steadily if possible; use compatible filter linings and stainless steel or nickel fittings
Tin loss from anodes resulting in sludge in tank	Remove tin or alloy anodes if bath is to be idle for several days

PRECAUTIONS THAT should be followed to obtain a satisfactory tin-nickel electroplate were recently reviewed[1] in the quarterly journal of the Tin Research Institute, Greenford, Middlesex, England. The process was introduced by the Institute 8 years ago and is now frequently used in electronics production.

The plating, 65 tin—35 nickel, is bright, hard, nonmagnetic, and has excellent solderability, corrosion resistance and covering power. Deep tubes can be plated inside without internal anodes. The solution is made up of commercially available stannous chloride, nickel chloride and ammonium bifluoride.

Stannous tin content of the solution should be checked every other day by simple titration. Nickel, stannic tin and fluoride can be checked monthly. Accumulated chlorides should be removed by crystallization monthly. Problems and cures reported in the review are summarized in the table.

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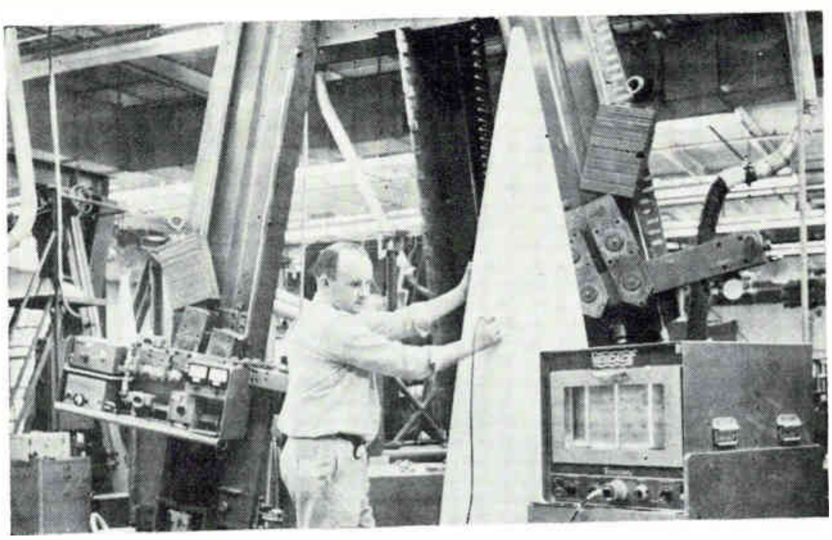
(1) R. M. Angles, Some Practical Aspects of Tin-Nickel Plating, Tin and Its Uses, 48, Autumn, 1959.



Sound Waves Measure Nose Cones

Ultrasonic resonance thickness gage is used by Brunswick-Balke-Collender Co., Marion, Va., to check thicknesses of reinforced radomes and nose cones. Thicknesses range from 0.02 to 0.5 inch and tolerances from 0.001 to 0.005 inch. The gage, made by Branson Ultrasonics, Stamford, Conn., can also be used while the radome is still on a mandrel. The instrument is shown in use on a filament-wound Bomarc nose cone

Electron Beams Weld, Saw, Drill Tiny Holes

ELECTRON BEAM metalworking equipment developed by the Carl Zeiss Foundation, Oberkochen, Germany, was recently demonstrated in New York City. It is expected to find applications in the production of microminiature electronic devices and in fabrication of vacuum evaporation masks.

The electron beam process can be used for surface treating, welding, milling or drilling. The intensity of the beam can be adjusted to heat, melt, fuse or vaporize the material in the target area. Energy intensities as high as 600 megawatts per square inch are obtained. It has been used for working tungsten, hard glass and other difficult materials.

To weld, the parent metal on

A most important development in the instrumentation recorder/reproducer field will be unveiled by Mincom at the IRE Show in New York. It's an all-new system, the **Mincom Model CM-100.** Be there to see it. Wrapped up in one compact rack, CM-100 is a highly versatile all-purpose work-horse, capable of handling practically every instrumentation job (For example: 500 kc at 60 ips, 24 minutes playing time). Built to Mincom's high reliability standards, it's the year's biggest news in magnetic tape recorder/reproducers. **See it at Booth 3923.**

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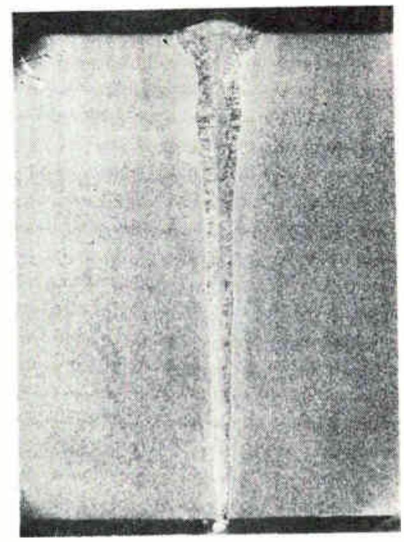


Cross-section of weld made in 0.4-inch-thick stainless steel

either side of the weld zone is melted so that the parent metals will fuse. The configuration of the weld can be electronically controlled. To machine small, odd-shaped holes and cuts, such as those in Fig. 1, the target area is vaporized.

Holes as small as 0.0008 inch have been produced to date. Most of the energy is dissipated in vaporizing the material. A temperature of 11,000 F in the target area, for example, produces a temperature of 500 F at a distance of 1 micron from the cut. The beam is pulsed, with the duration of the pulse adjusted to suit the material being worked.

The equipment consists of an electron gun, beam focusing, monitoring and control elements, a vacuum chamber in which the workpieces are placed, and the operator's viewing apparatus. The beam path can be controlled automatically by relays, magnetic tape or television-type controls (it was reported that a tv picture was reproduced in steel as a laboratory experiment).

Hamilton Standard Division of United Aircraft, Windsor Locks,

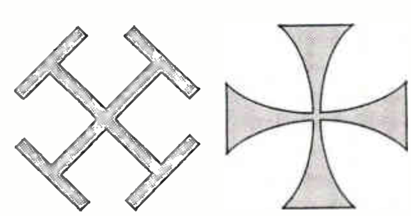


FIG. 1—Cross-section of holes drilled with electron beam. Each profile has an overall width of about 1 mm

Conn., will manufacture the machines this year. They will be available on lease from Hamilton Electrona, Inc., New York, N. Y.

Simulated Transformer Tests Magnetic Sheet

MAGNETIC SHEET material can be tested nondestructively for core loss by passing the sheet through a shell-type transformer in which the core element is replaced by the moving sheet. Yokes are arranged above and below the sheet, providing small air gaps for uniform flux distribution. The magnetizing element is a flat exciting coil over the width of the sheet. A similar coil measures induced voltage. The core loss ration is measured and indicated by a light-beam wattmeter. A machine which tests 2 to 5 tons of material an hour by this method is in use in Hungary, according to a report (European Technical Digest 2646) by the European Productivity Agency, Paris, France. The method is also reported in use in the U. S.

Photocell Monitors Diameter of Wire

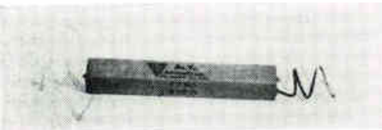
PHOTOELECTRIC DEVICE, servo-controlled to monitor the diameter of wire as it is drawn, has been developed by the Central Laboratory for Automation, Moscow, USSR, McGraw-Hill World News reports.

A plate with two slots is provided with a light source on one side and a photocell with lenses on the other. The wire passes in front of the first slot, which is equipped with a servo-driven shutter. The second slot is a smaller, reference slot whose light passage area equals the normal light passage area of the first slot and wire.

The light beam is chopped by an oscillating mask so that it alternately passed through the slots. If slot areas are equal, the photocell produces equal current pulses. If slot areas are unequal, pulses are unequal. The error signal is amplified to drive the first slot's shutter servomotor. The shutter is moved until the two light passage areas are balanced, providing for indication of wire diameter variation.

2 OCTOBER 1959 SOLAR ECLIPSE, PHOTOGRAPHED FROM McDONNELL F101B VOODOO AT 45,000 FT.

On The Market



Miniature Delay Line for computers

AD-YU ELECTRONICS LAB., INC., 249 Terhune Ave., Passaic, N. J. Type 7C series was developed to meet the need for compact delay lines with low attenuation, linear phase shift characteristics, and wide bandwidth in many applications such as computers, radar and power circuits. Some of the features are hermetically sealed construction, operating temperature ranging from −35 C to +125 C with 500-v peak working voltage, and temperature coefficient 0.005 percent per deg C. Rise time is 7 percent of the time delay fc most types. Frequency response over 10 mc bandwidth with attenı ation less than 1.2 db per μsec d lay at low frequencies. Size is in. by ½ in. sq, 3¾ in. long, for uni having 1 μsec delay or less. Tin delays range from 0.1 μsec up to 1 μsec, and impedances range fro 150 ohms to 1,000 ohms.

CIRCLE 301 ON READER SERVICE CAI

Microvoltmeter transistorized

SMITH-FLORENCE, INC., 4228-23rd Ave. West, Seattle 99, Wash. Model 951 is a differential voltmeter which compares a precise internal voltage with the unknown voltage to be measured. Since the two voltages are adjusted to be equal, no current will flow from the unknown into

the instrument, thus the input impedance is determined by the leakage resistance of the internal insulation. Unit is capable of mea uring voltages between 10 v aı 1 μv. The null indicating meter o erates over seven ranges, fro 10 v full scale to 10 μv full scale. I strument accuracy is 0.01 perce +0.5 μv in differential mode. Inp impedance at null is infinite. Dri is less than 0.5 μv on null indicatc Price is $1,350.

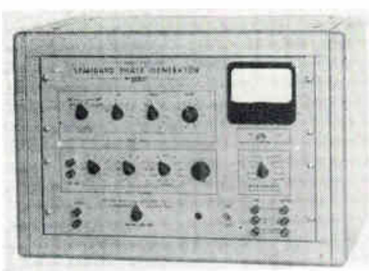
CIRCLE 302 ON READER SERVICE CAI

Power Supply compact unit

SOLIDYNE, 7460 Girard Ave., La Jolla, Calif., announces a well regulated d-c power supply designed primarily for transistor circuit work and other applications where recurrent spikes and other transients would damage equipment under test. Voltage and current meters are provided for accurate setting of output voltage and continuous monitoring of load currents. Voltage output is adjustable from 5 to 35 v with a maximum current of 2 amperes. Either the positive or negative terminal may be grounded or the output can be floating. Regulation is better than 0.1 percent and

variation in output voltage is nev more than 30 mv. Ripple is he down to less than 1 mv.

CIRCLE 303 ON READER SERVICE CA



Phase Generator 0.1 to 135,000 cps

DYTRONICS, 78 Sunnyside Lane, Columbus 14, Ohio. Model 410 offers both a phase shifter and a phase difference generator operating with high accuracy over a range from 5 cps to 135,000 cps. By the addition of an external capacitor the low-frequency limit can be e tended below 0.1 cps. Accuracy ov the a-f spectrum is 0.1 deg wi decreasing accuracy above and l low the audio range. Instrume can be used for the calibration phase measuring instruments or a phase measuring device when us with an external phase detector.

CIRCLE 304 ON READER SERVICE CA

Waveguide Switches 2.6 to 90 kmc

DEMORNAY-BONARDI, 780 S. Arroyo Parkway, Pasadena, Calif. New E-plane waveguide switches are used to transfer the connection be-

tween waveguides. Transfer m be direct or by remote control. T switch types are supplied. One i 2-way exchange, which switches common waveguide to either ad cent waveguide. Disconnected wa guide is terminated in a match

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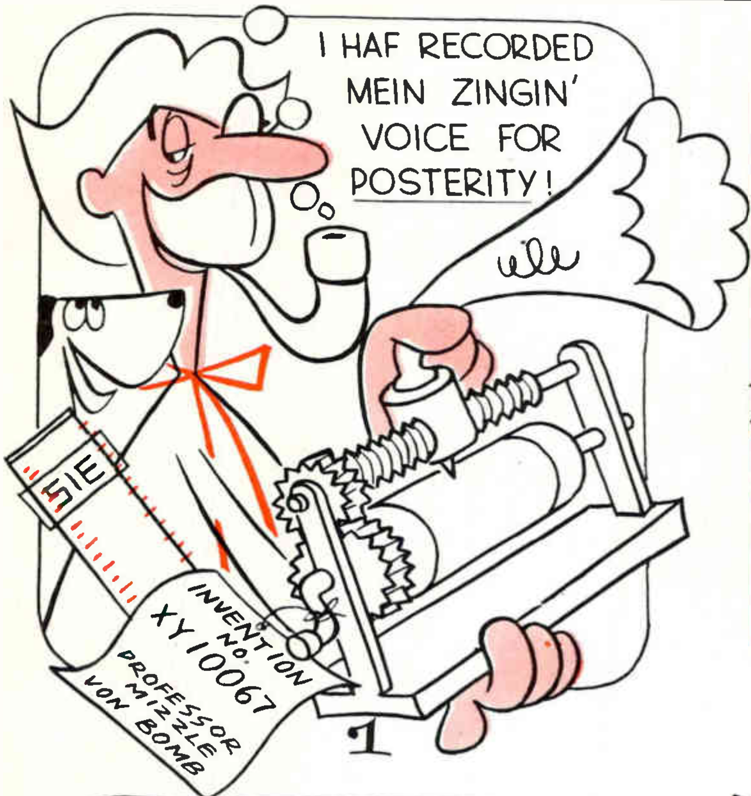

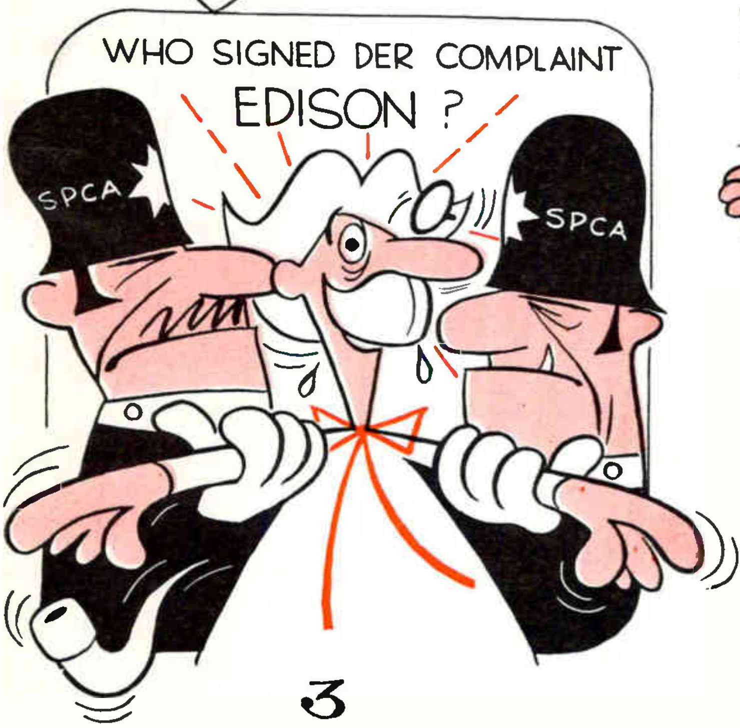

IMACHIN' TAKING A DOG'S VORD OVER MEIN!

If Professor von Bomb had run a frequency curve before torturing his dog, he might be out of captivity now. SIE's ARP-2A Audio Response Plotter records everything in the audio range in chart form in seconds — keeps the SPCA from the door.

Frequency coverage	20-20,000 cps
AC signal levels, linear	0-40 db
DC volts, linear	0-1 v
Maximum sensitivity	10 mv full scale

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load. The second is a 4-way exchange, which switches two pairs of waveguides. The switches are used in measurement set-ups, and in experimental and operational systems. All units are plated nickel over silver and copper. Sizes range from 2.6 to 90 kmc. Prices are $591 to $919, depending on size.

CIRCLE 305 ON READER SERVICE CARD

Fabricator
improved version

WALES-STRIPPIT, INC., 225 South Buell Road, Akron, N. Y. Model 15A Strippit fabricator is designed for punching, notching and nibbling, particularly for prototype work, short or medium production runs. This latest version features a new Electro-Hydramatic head which is the part of the machine controlling the power stroke of the ram. This feature eliminates the need for pressurized air required on earlier models, thus simplifying the design of the control mechanism. Fabricator punches round or shaped holes up to 3½ in. in diameter in any sheet material (including p-c boards) up to ¼ in. mild steel. Maximum notching capacity is 5 in. by 5 in. in ⅛ in. mild steel, and it will do straight line or contour shearing at 165 strokes per minute in ⅛ in. mild steel.

CIRCLE 306 ON READER SERVICE CARD

Paints and Pastes
many uses

MATERIALS FOR ELECTRONICS, INC., 152-25 138th Ave., Jamaica, N. Y. Time tested paints and pastes (silver, gold, platinum) have been developed for the coating of ceram-

ics, mica, plastics, etc. Manufactured by DeGussa, the preparations can be used in the manufacture of capacitors, coils, oscillators, printed circuits, and in high frequency engineering. They can be applied by brush, spray-gun, dipping, or screen printing, and are supplied ready for use in air-dry and fire-on types. All coatings are solderable and can be electroplated.

CIRCLE 307 ON READER SERVICE CARD

Miniature Relays
for a-c uses

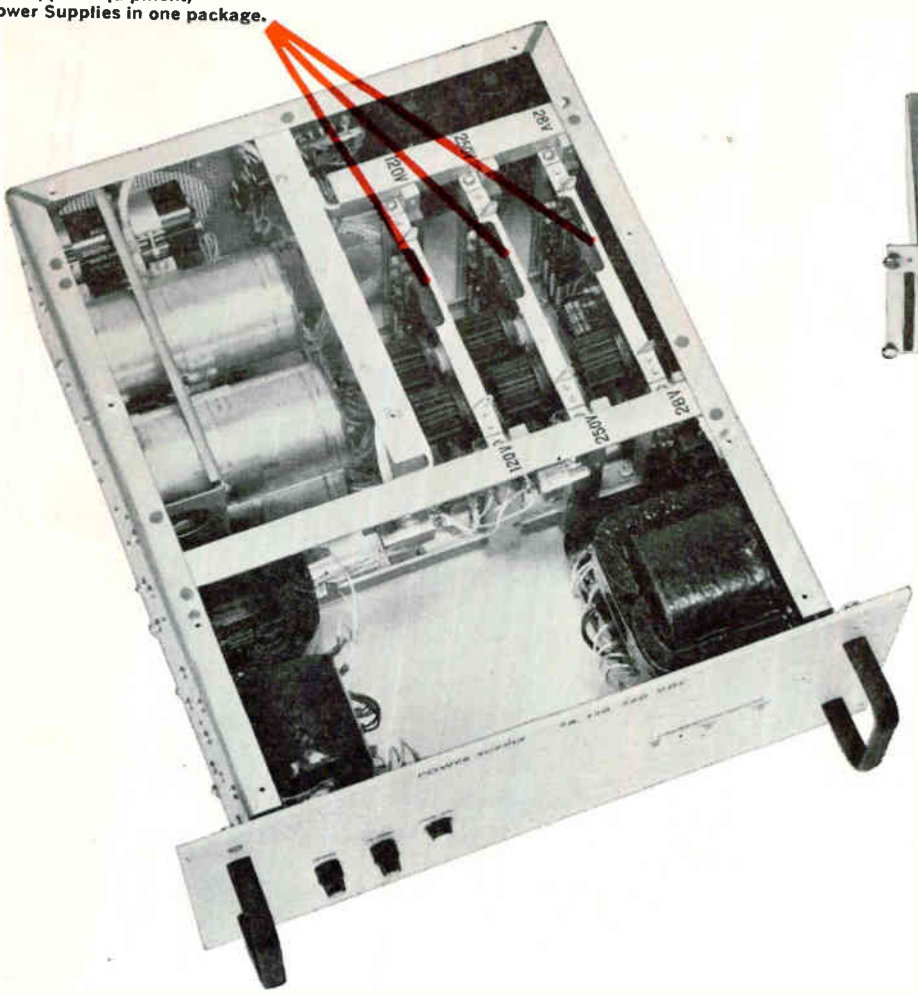
THE HART MFG. CO., 202 Bartholomew Ave., Hartford, Conn. "Diamond H" series RA and SA are hermetically sealed, aircraft-missile type relays for a-c applications. Either half-wave or full-wave silicon diode rectifiers are installed in the sealed case to provide for use of up to 125 v, a-c, on the coil. Units are available with shock and vibration resistances of 30 and 50 g and for temperature ranges from −65 C to 125 C. Designed and ruggedly built to provide reliable, chatter-free performance, the units are available in a wide variety of standard mounting arrangements, including AN type connector mounting.

CIRCLE 308 ON READER SERVICE CARD

Teflon Film Tape
varied applications

PERMACEL, New Brunswick, N. J. Type 423 Teflon film tape is a two mil Teflon film with a pressure-sensitive adhesive. It can be used in electrical applications for holding and insulating where a class

Model pictured is a unique design, developed by Hydro-Aire Electronics for ground support equipment, which combines three AC/DC Power Supplies in one package.



Another *New* Hydro-Aire Product for the *Aircraft*, *Missile Support*, *Missile* and *Electronics* Industries

The AC/DC Power Supply shown is typical of many new electronic products being developed, engineered and produced by Hydro-Aire—a name well known for quality, reliability and fast delivery. The unit illustrated is one of a unique family of fixed voltage, transistorized, power supplies. Through unusual design, Hydro-Aire engineers have combined three power supplies into a single package. The same basic circuit allows regulated outputs over a wide range. Range is determined by selection of transistorized, printed circuit, plug-in modules.

Characteristics Model #50-121

Input: 120 ± 5 % VAC
Outputs: 28 VDC @ 2.5 amp; 120 VDC @ 250 ma; 250 VDC @ 500 ma
Regulation: ±0.1% for combined temperature, time and load variations
Temperature: −10°F to +125°F operating; −54°F to +165°F non-operating
Ripple: 5 millivolts RMS (maximum)
Size: 8¾ x 17 x 20 (for 19″ rack mounting)
Weight: approximately 70 lbs.

Write for Catalog Order your copy of our new Electronics catalog. It contains detailed facts, specifications. Send for your copy today—on your letterhead, please.

HYDRO-AIRE
BURBANK, CALIFORNIA
Division of CRANE CO.

Solid-state devices include time delay relays, voltage regulators, power supplies, inverters. Rotating components: motors, tachometers, generators.

CIRCLE 97 ON READER SERVICE CARD

superb new
NULL DETECTOR

The new Keithley 151, incorporating a unique photo-conductive modulator of Keithley design, is useful wherever a suspension galvanometer can be used, and where a galvanometer is not sufficiently sensitive, fast or rugged. Currents as low as 2 x 10^{-13} ampere can be detected.

Ranges: 11 linear ranges in 1x and 3x steps, from 100 μv to 10 v f.s.; 5 non-linear ranges, 0.001 to 10 v f.s., each covering three decades.

Accuracy: Linear ranges, ±3% of f.s.; non-linear, ±10% of input.

Input Resistance: 10 megohms on all ranges. Max. power sensitivity over 10^{-17} watt.

Response Speed: On 100 μv range, 2.5-sec.; 1-sec. on all others.

Noise: Below 2% f.s. all ranges.

Zero Drift: Less than 10 μv per day.

Output: 10 volts at 1 ma f.s.

Price: 151 Cabinet Model . $395.00
151R Rack Model . $385.00

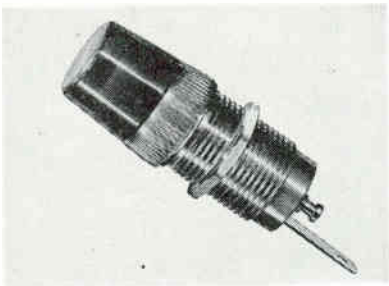
For full details write:

KEITHLEY INSTRUMENTS

12415 EUCLID AVENUE
CLEVELAND 6, OHIO

180 C tape is required; for coil wrapping and as a conductor insulation for armature and field coils. For industrial applications, Permacel 423 is anti-stick, self-lubricating, temperature and corrosion resistant. It is readily printable with ordinary printing inks. An interliner is provided to facilitate the die-cutting of Permacel 423 into any desired shape.

CIRCLE 309 ON READER SERVICE CARD

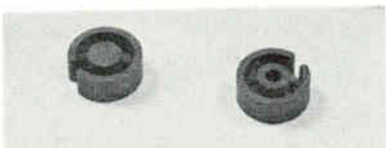


Tiny Lampholder two-terminal

THE SLOAN CO., 4029 Burbank Blvd., Burbank, Calif. New Color-Lite two-terminal, subminiature lampholder is designed for use with both neon and incandescent bulbs. It mounts in a 7/16 in. hole. Unit features the engineered lens and promotes uniformity of panel design and uniform light distribution. Major applications of the model 856 include missile test stands, aircraft, computers, laboratory and production line and quality control equipment.

CIRCLE 310 ON READER SERVICE CARD

Pot Cores 3/8 in. diameter



FERROXCUBE CORP. OF AMERICA, Saugerties, N. Y. Type 332P (3/8 in. diameter) pot cores, now being used for pulse transformers and kindred applications, are designed to meet the assembly and mounting requirements of all component manufacturers and are available in several varieties, including one which has a hole in its center post to accept a No. 1 screw. Samples, in sufficient

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CIRCLE 204 ON READER SERVICE CARD

from ***PSI...Very High Voltage Cartridge Rectifiers***

NO VOLTAGE DERATING

over entire TEMPERATURE RANGE

−55°C to 150°C!

EXTREMELY RUGGED • NON-METALLIC "COLD" CASE • WIRE-IN LEADS • EASY-TO-MOUNT • USE IN PRINTED CIRCUITS

No need to "over specify" for voltage derating considerations! These PSI 1N1730 and 1N2382 silicon rectifier series provide the lowest voltage drop, the highest current ratings and best reverse leakage characteristics of any available types.

The component diode strings are welded and packaged in non-metallic cases. The units are compact, light weight and easy to mount. With no heat sink requirements they are particularly suited to printed circuit board applications.

Electrical Specifications

	MAXIMUM RATINGS				ELECTRICAL CHARACTERISTICS		
EIA TYPE NUMBER	Peak Inverse Voltage (v)	Maximum RMS Input Voltage* (v)	Maximum Average Rect. Current* (mA) @ 25°C	Maximum Average Rect. Current* (mA) @ 100°C	Max. DC Fwd. Voltage Drop @ 100mA DC @ 25°C	Max. DC Rev. Current @ Rated PIV (μa) @ 25°C	Max. DC Rev. Current @ Rated PIV (μa) @ 100°C
1N1730	1000	700	200	100	5	10	100
1N1731	1500	1050	200	100	5	10	100
1N1732	2000	1400	200	100	9	10	100
1N1733	3000	2100	150	75	12	10	100
1N1734	5000	3500	100	50	18	10	100
1N2382	4000	2800	150	75	18	10	100
1N2383	6000	4200	100	50	27	10	100
1N2384	8000	5600	70	35	27	10	100
1N2385	10000	7000	70	35	39	10	100

* Resistive or inductive load.
OTHER SPECIFICATIONS:
Continuous DC voltage same as PIV.
Maximum surge current (8msec.) at 100°C: 2.5 amperes.
Operating temperature range: −55°C to 150°C.

Nine types...1,000 to 10,000 VOLTS!

FAST DELIVERY... IN PRODUCTION QUANTITIES!

Phone, wire or write for detailed specifications, curves, prices and delivery schedules.

Also ask about the extensive line of PSI Standard and Special Encapsulations . . . Ring Modulators, Bridge Rectifiers, Matched Pairs and Quads.

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PSI Authorized Distributors from coast-to-coast can supply up to 999 units at factory prices. See Distributor List in adjacent column.

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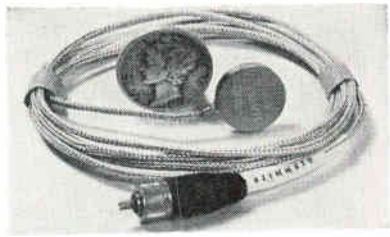
12955 Chadron Avenue, Hawthorne, California quantities to enable research and development engineers to conduct investigations in the light of their own specific application requirements, will be furnished promptly on request.

CIRCLE 311 ON READER SERVICE CARD



Accelerometer self-generating

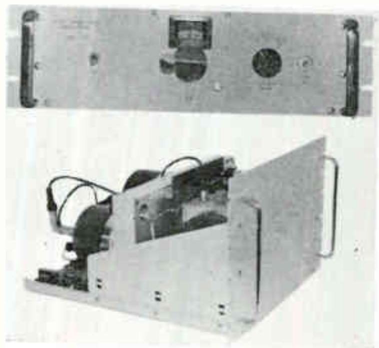
GULTON INDUSTRIES, INC., 212 Durham Ave., Metuchen, N. J. Model A-3109 accelerometer is less than 0.1 in. in height, 0.5 in. in diameter, and weighs ¾ gram. It is particularly suited for use in wind tunnel testing of simulated aircraft where weight is an important factor in selecting an instrument to determine wing flutter, tab buzz or control system response. The minute profile of the accelerometer permits it to be inserted between the skin and strut of a plane or missile. It can also be built into many types of electronic gear as a permanent installation. Housed in aluminum it has an acceleration range of 0.5 to 500 g, a useful frequency range of 3 to 4,000 cps, and a sensitivity of 2 mv/g minimum. Operating range is −65 F to +250 F. Resonant frequency is 12 kc minimum.

CIRCLE 312 ON READER SERVICE CARD

Commutators motor driven

COMPUTER INSTRUMENTS CORP., 92 Madison Ave., Hempstead, L. I., N. Y. Model MG215 is an 18 segment commutator designed to be driven to a minimum life of 30,000,000 revolutions at a rate of 1,000 rpm by the 50 v d-c motor, and gear assembly. Speeds are available from 100 rpm to 3,000 rpm with a-c or d-c motors. Units are available from a 5 segments commutator in a ⅞ in. diameter or a 50 segment commutator in a 5 in. diameter. Any number of gangs may be mounted. Line should be of interest to engineers engaged in work involving telemetering, sampling, data scanning, time sharing and multiplexing.

CIRCLE 313 ON READER SERVICE CARD



Signal Source
remote tuned

SCIENTIFIC-ATLANTA, INC., 2162 Piedmont Road, N. E., Atlanta 9, Ga. Model SS305 signal source is primarily designed to provide a source of remotely tunable r-f power for antenna pattern ranges. Suited to remote tuning, control, and band switching at distances of more than a mile, it covers the frequency range from 50 to 2,000 mc calibrated to an accuracy of ±2.0 percent. Instrument provides a minimum r-f power output of 80 mw across an impedance of 50 ohms. This output can be sine or square wave modulated. A convenient servo null lamp indicates completion of tuning. The SS305 can be retuned to a given frequency with an accuracy of ±0.5 percent. Price is $3,850.

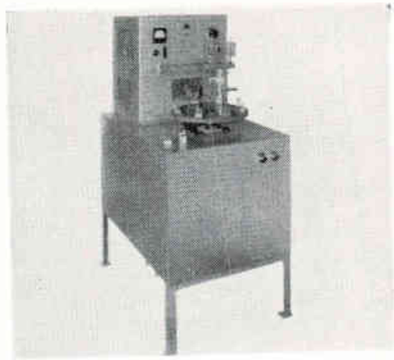
CIRCLE 314 ON READER SERVICE CARD

Military Diodes
silicon glass

SILICON TRANSISTOR CORP., Carle Place, L. I., N. Y., has available seven diodes designed to meet latest military specs. Three of the silicon glass diodes are general purpose types and four are fast switching. The general purpose types are:

JAN 1N457, −8, and −9. The fast switching are Signal Corps types 1N662, 1N663, 1N643 MIL and 1N658.

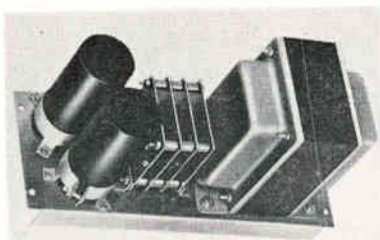
CIRCLE 315 ON READER SERVICE CARD



Crystal Can Solderer automatic

REEVE ELECTRONICS, INC., 609 W. Lake St., Chicago 6, Ill., announces the Reevelec automatic miniature crystal can solderer. The unit, consisting of an induction heating generator with special tooling, eliminates time and expense of soldering miniature crystal cans and also provides a remarkable decrease in rejects, due to heat caused frequency changes. The soldering job is 95 to 100 percent efficient in the elimination of leakers. No flux enters the can to cause crystal damage.

CIRCLE 316 ON READER SERVICE CARD



D-C Power Supplies modular units

DRESSEN-BARNES CORP., 250 N. Vinedo Ave., Pasadena, Calif. Ten modular d-c power supplies with outputs ranging from 28 v d-c, 2 amperes, to 500 v d-c, 300 ma, are now available with silicon rectifiers. Nine of these supplies are also available for 50 to 400 cycle operation. The modules are for use individually or with the company's multiple output rack mounting kits.

CIRCLE 317 ON READER SERVICE CARD

Literature of the Week

A-C CAPACITORS. General Electric Co., Schenectady 5, N. Y. Bulletin GEA-6789A, four pages, provides detailed information on general purpose a-c capacitors used for improving motor performance and power factor.

CIRCLE 380 ON READER SERVICE CARD

TRANSISTOR CHOPPER. Airpax Electronics Inc., Cambridge Division, Cambridge, Md. Bulletin C-98 describes type 6025 transistor chopper, with self-contained drive transformer, having spdt switching action for operation over a chopping range from 50 to 5,000 cps.

CIRCLE 381 ON READER SERVICE CARD

SELENIUM RECTIFIERS. Radio Receptor Co., Inc., 240 Wythe Ave., Brooklyn 11, N. Y. Flat type selenium rectifiers are described in bulletin 295, an 8-page brochure presenting the basic rectifier information, product description, and methods of selecting the right rectifier for a circuit. Prices are included.

CIRCLE 382 ON READER SERVICE CARD

VIDEO TAPE HANDLING. Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. Proper handling and storage of video tape are discussed in "Video Talk" Bulletin No. 1, now available.

CIRCLE 383 ON READER SERVICE CARD

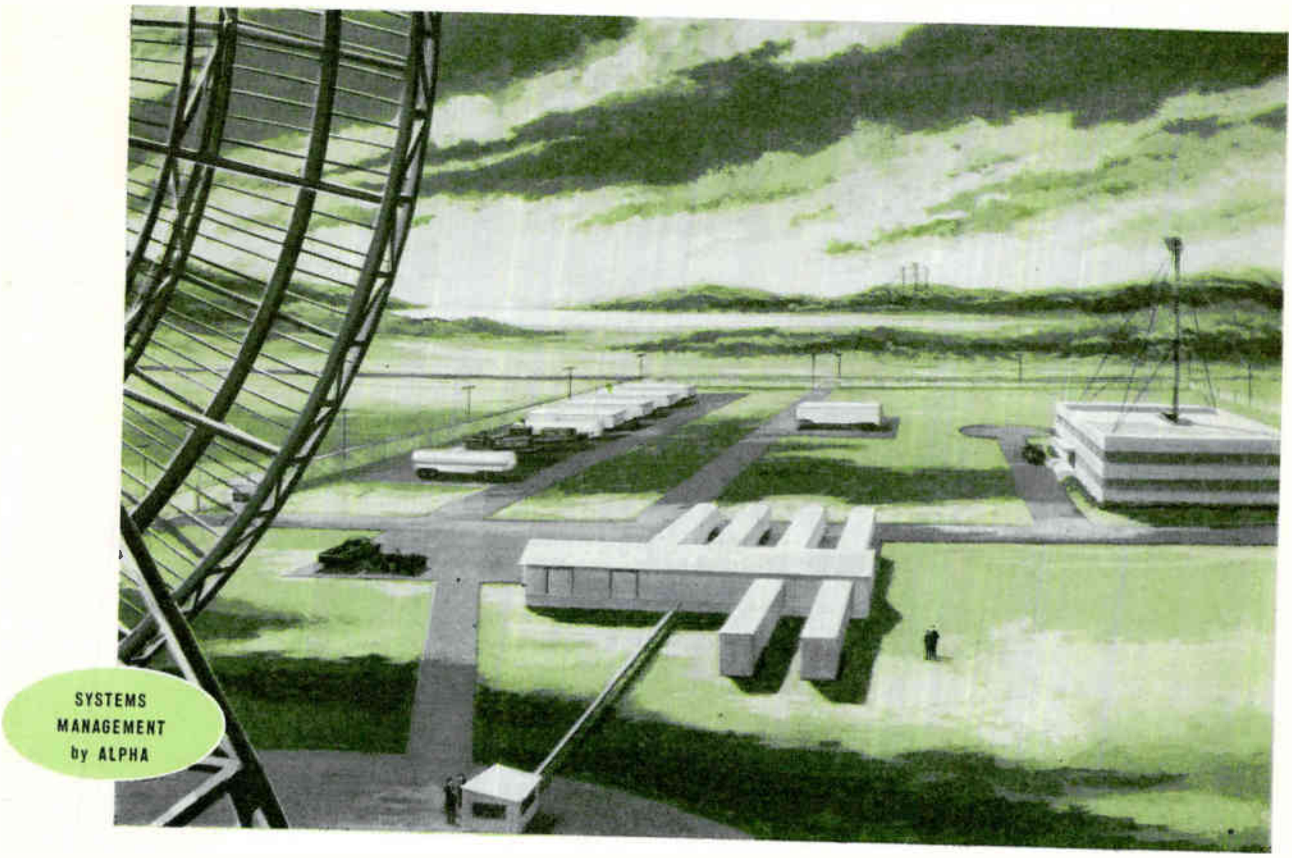
PULSE TRANSFORMERS. Valor Instruments, Inc., 13214 Crenshaw, Gardena, Calif. Bulletin PT160 describes in detail a line of miniature pulse transformers for blocking oscillator pulse coupling, inverting and impedance matching.

CIRCLE 384 ON READER SERVICE CARD

MAGNETIC TRIGGERS. Avion Division of ACF Industries, Inc., 11 Park Place, Paramus, N. J., offers a four-page brochure on its complete line of magnetic triggers for silicon controlled rectifiers.

CIRCLE 385 ON READER SERVICE CARD

GAS CHROMATOGRAPH. Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne and Windrim Aves., Philadelphia 44,



ONE STATION TWO TALENTS

1. Stations with the *dual* capability of tracking earth satellites *and* deep space probes are being engineered and constructed by Alpha Corporation as part of Alpha ground-based surveillance systems for space research. A station tells the user the location of the vehicle . . . collects and processes telemetered data . . . transmits command communications. Alpha integrated communications systems link each tracking station to a computing facility, providing a complete surveillance complex for all locative and communications functions.

More than 600 designers, engineers, scientists, and constructors are teamed and oriented at Alpha Corporation to assume total management responsibility world-wide for complete projects of the magnitude described. These specialists select the most dependable equipments and services from industry to provide the ultimate in systems reliability.

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Pa. Instrumentation data sheet 10.15-20 describes how the F&M model 202 gas chromatograph, employing an ElectroniK recorder, has increased the speed, scope and accuracy of gas chromatographic analysis.

WAVEGUIDE DATA. Narda Microwave Corp., 118-160 Herricks Road, Mineola, N. Y. A new "Standard Waveguide Data Chart", featuring military as well as EIA designation numbers, shows virtually all required electrical as well as mechanical parameters for waveguides in use today.
CIRCLE 386 ON READER SERVICE CARD

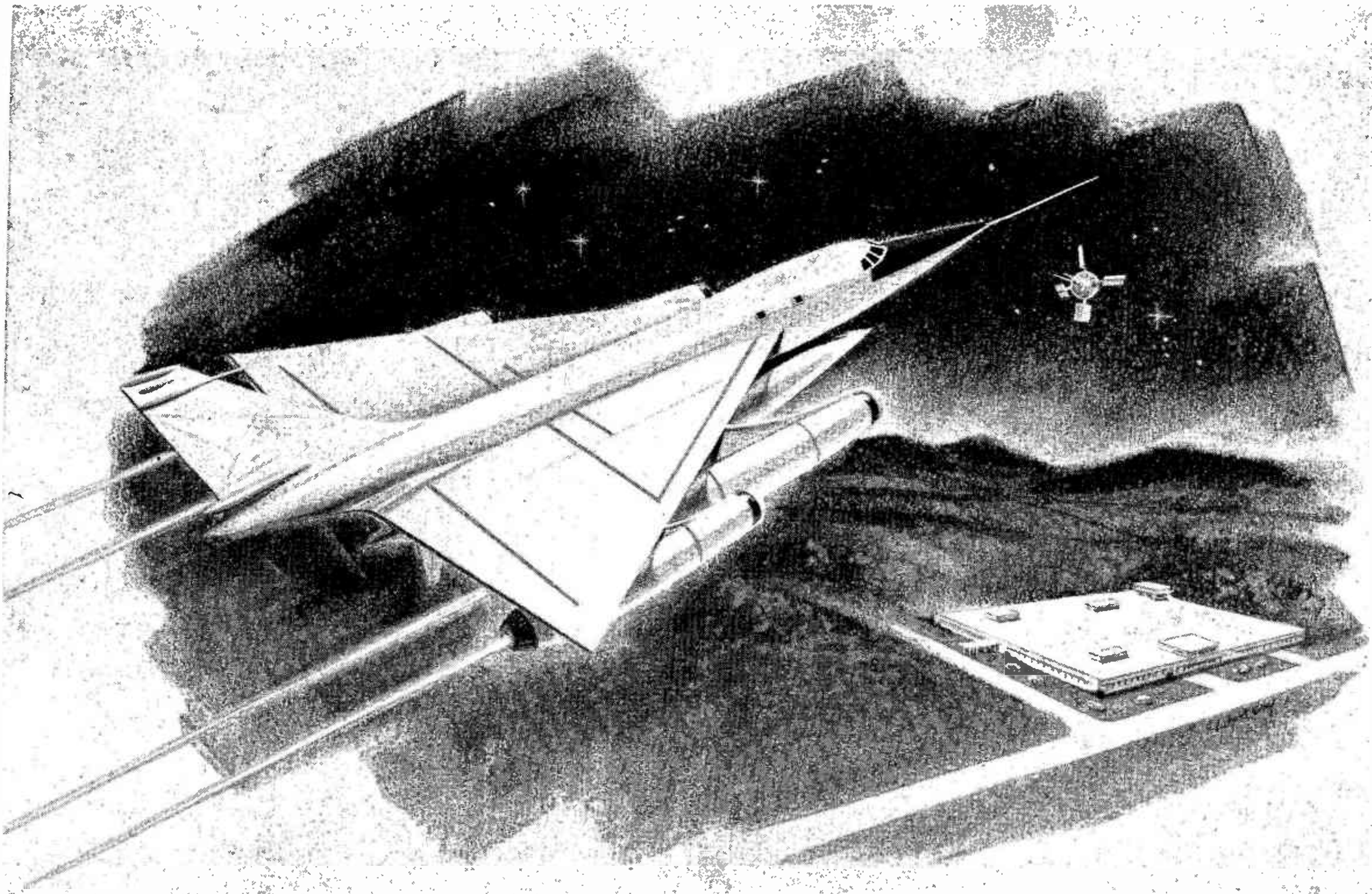
WAFER CAPACITORS. Corning Glass Works, Bradford, Pa., has available four-page data sheets describing glass-dielectric wafer capacitors. Reference File CE-1.02 should be requested on company letterhead.

GALVANOMETER. Photovolt Corp., 95 Madison Ave., New York 16, N. Y. Bulletin 965 describes model 45 multiple-reflection galvanometer for the indication of minute d-c currents and voltages in research and in production laboratories.
CIRCLE 387 ON READER SERVICE CARD

CAPABILITIES BROCHURE. Adler Electronics, Inc., One Le Fevre Lane, New Rochelle, N. Y. An illustrated 4-page brochure describes recent major projects and capabilities of the company's Communications Systems Division.
CIRCLE 388 ON READER SERVICE CARD

SEALS AND FASTENERS. A. P. M. Corp., 252 Hawthorne Ave., Yonkers, N. Y. A 16-page general catalog (359A) illustrates and describes the company's entire line of high-pressure, vibration-resistant seals and fasteners.
CIRCLE 389 ON READER SERVICE CARD

SOLID STATE POWER PACKS. Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J. Bulletin 20-1059 provides full descriptive material on a newly introduced line of high current, miniaturized, solid state power packs.
CIRCLE 390 ON READER SERVICE CARD



Expanding a capability . . .

Raytheon's Airborne Electronic Subdivision this month occupies a new multi-million dollar research and development laboratory.

Creative effort within this new facility will be directed at featherweight transistorized Doppler radars; altimetry and terrain clearance techniques; satellite weather radar studies; airborne early warning radars; missile boost, flight and terminal guidance problems; radiometry; and other areas.

Like the B-58's sophisticated search and Doppler radars, the systems, subsystems or equipments developed will find application in manned aircraft, missiles, drones, and a variety of space carriers.

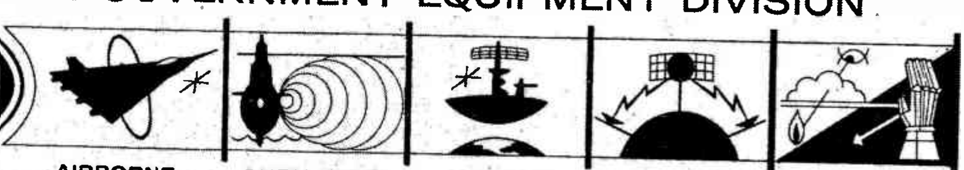
To engineers and scientists with particular interest in this work, the new laboratory offers complete professional satisfaction in an academic environment. For immediate information on select staff appointments, write Mr. Donald H. Sweet, Engineering & Executive Placement, Raytheon, 624 P. Worcester Road, Framingham, Mass. (suburban Boston).

AIRBORNE ELECTRONIC

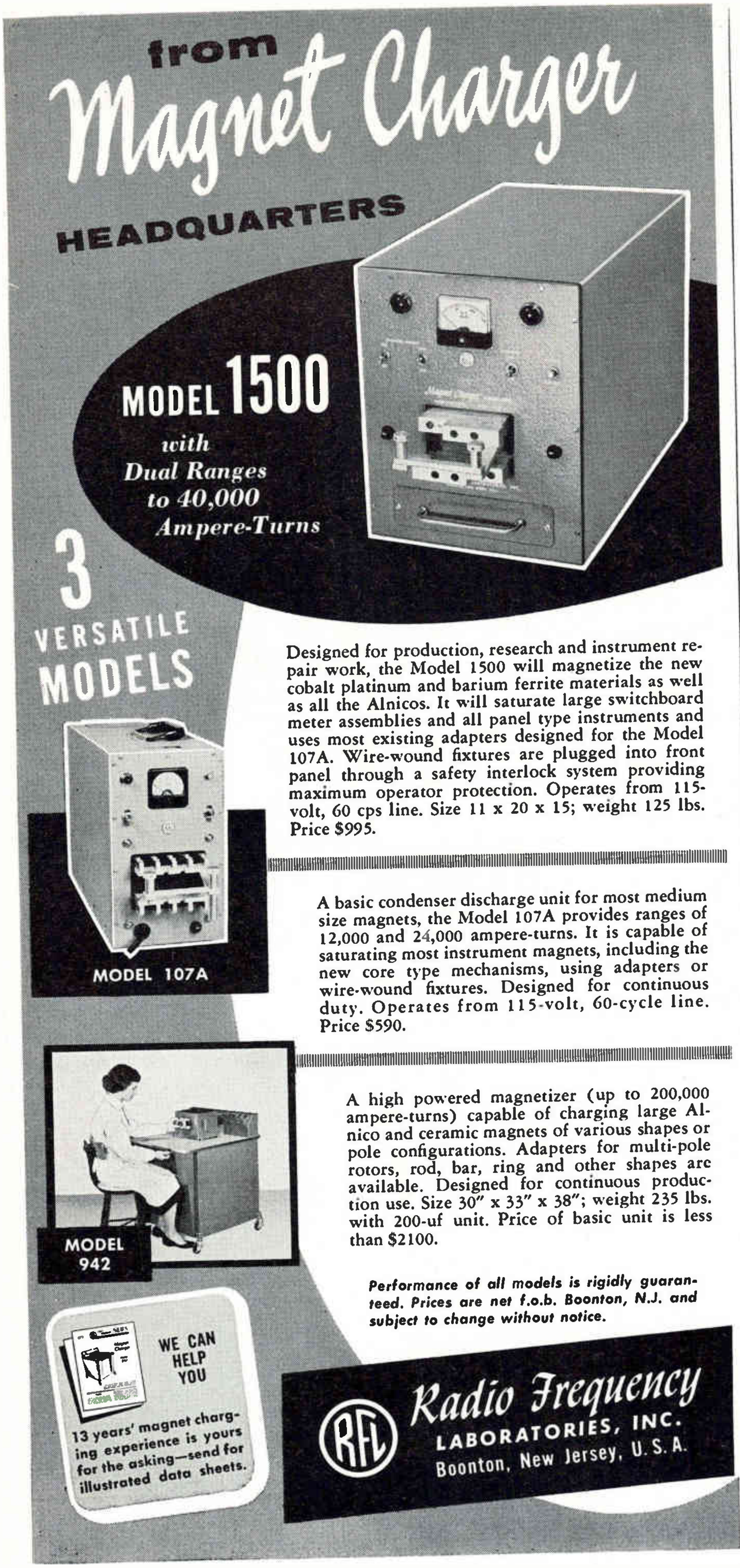
GOVERNMENT EQUIPMENT DIVISION

RAYTHEON

EXCELLENCE IN ELECTRONICS



AIRBORNE ELECTRONIC | SUBMARINE SIGNAL | SYSTEMS MANAGEMENT | HEAVY ELECTRONIC | SANTA BARBARA



NEW BOOKS

The Properties, Physics and Design of Semiconductor Devices

By J. N. SHIVE.

D. Van Nostrand Co., Inc., Princeton, N. J., 1959, 487 p, $9.75.

THIS BOOK is another of the Bell Laboratories series related to semiconductor devices including the more classic materials. The book is divided into two sections. Part I encompassing Chapters 1-14 presents a discussion on various semiconductor devices from an empirical point of view. The practice followed by the author in this section of the book is a description of the devices, their characteristics and properties followed by typical applications. Part II, Chapters 15-25, discusses solid state electronics leading to an understanding of the device physics and ultimately to design principles.

The text has been prepared for the advanced undergraduate and graduate student. In addition, it is supposed to serve as an introduction to interested potential semiconductor workers possessing a technical background.

This is a unique book coming into a most rapid moving technical area. It covers material not normally covered by modern semiconductor texts, particular reference being directed to the treatment of thermistors, selenium and copper oxide varistors, subjects with which many semiconductor engineers possess only a passing familiarity. This book should have preceded its famous ancestors, the three "Transistor Technology Volumes."—BERNARD REICH, *U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J.*

Accident Prevention Manual For Industrial Operations

By R. J. SULLIVAN, et al.

National Safety Council, Chicago, Ill., 1959, 1,542 p, $15.50.

THIS MEATY, expanded and revised fourth edition of the National

Safety Council's industrial safety practices manual is based on the experiences of some 7,000 firms and 46 years. Except for a brief historical look at industrial safety and the staggering cost of industrial accidents (15,000 lives and $4 billion a year), it is packed with specific techniques for reducing injury and occupational ailments, and safety management information.

Since the topic is so broad, the specialist in electrical or radiation hazards won't find every available detail on the subject. As a day-to-day reference for the safety man, production engineer or plant manager, the manual should prove invaluable. Most safety organization practices, machine safety and materials handling precautions discussed are relevant to electronics production equipment and methods.

Where detailed information is generally useful, such as in the design and use of machine tool guards, the information is plentiful. The chapters on industrial hygiene and industrial poisons, concluding with a 25-page table of chemical hazards, are especially useful. In it are included most of the solvents, etchants, chemicals and materials used in the fabrication of electronic devices. A chapter concentrating on atomic radiation and its biological effects, is new.

Managerial aspects of safety are summarized in sections on safety organization, education and human relations; insurance and compensation laws and procedures in the various states; accident records keeping, use and cost analysis; and in-plant medical services. Organizations and officials which can assist in solving safety problems, or which can provide standards and educational material, are also listed. —G. S.

The Radio Amateur's Handbook

By the ARRL HEADQUARTERS STAFF.

The American Radio Relay League, Inc., West Hartford, Conn., 1960, 728 *p (including catalog section and* 16-*p index)*, $3.50.

THE ARRL HANDBOOK, 37th edition, has come a long way since 1928 when we discovered a thin, rebound copy of the first edition at the local public library. Then known as Handy's Handy Handbook (after F. E. Handy, first compiler and long-time communications manager of the League) this perennial-to-be altered our adolescent and adult life completely. Out of our attic listening post went the crystal set tuned to KDKA; in came a regenerative short-wave receiver with Lorentz coils, Hartley oscillator-transmitter with a 201-A tube and B-eliminator power supply. At age 15 we had our own ham call, a Federal Radio Commission station and operator license on the wall.

Hundreds of thousands of people around the world have felt the impact of this book since it made its appearance in 1926. Many radio amateurs have grown into the industry as engineers, technicians and communicators. The armed forces use it as a training text.

Industry engineers and technicians find the Handbook's comprehensive tube and transistor tables valuable in that within one text they get the data contained in a dozen manufacturers' manuals. Moreover, they have in one text more than a score of chapters on practical two-way radio communication plus understandable theory.

The 1960 version of the Handbook comes in a sprightly two-toned green paperboard cover with about ten percent revision over its 1959 predecessor. It's too early yet to determine whether the colorful cover will pass the stain tests of workbench soldering flux, chain-smoking engineers or avid dinner-table-reading pursuers of the hobby, but the engineer-ham board of editors of the ARRL Handbook aren't too worried. They are well over the three million mark in distribution—probably a world's record for a radio text.—H.M.McK., W1CEG/2

Circuit Theory of Linear Noisy Networks

By H. A. HAUS and R. B. ADLER.

Technology Press of the Massachusetts Institute of Technology and John Wiley and Sons, Inc., New York, 1959, 79 *p*, $4.50.

THIS book is the second of a series designed to fill a need in science and engineering for systematic publication of research studies largeer in scope than a journal article and less ambitious than a finished book. Authors designate their book as a monograph written to present reativlely recent work in a comparatively undeveloped field.

This monograph is concerned with describing the noise performance of a two-terminal pair amplifier. More specifically, it is concerned with the problem of isolating the study of noise performance from specific physical mechanisms. In the course of the study represented by the book, it was recognized that matrix algebra and a proper eigenvalue formulation would be needed. It became possible to furnish a single number to characterize amplifier noise performance on the basis of signal-to-noise criterion. Resulting theory clears up questions of the noise performance of low-gain amplifiers (that is, the effect upon noise performance of degenerative feedback) and provides the first systematic treatment of the noise performance of negative resistance amplifiers.

The authors are sensitive to the question of an optimum-noise criterion and admit that such a criterion will serve primarily to indicate the extent to which a given design fails to achieve best noise performance. That is, one may not attempt to realize the optimum noise performance directly, but instead use it as a guide to detect onset of diminishing returns in efforts to improve noise performance.

The book deals with impedance-matrix representations of linear networks and formulations of the characteristic-noise matrix. Canonical forms of linear noisy networks are developed, the purpose of these forms being to exhibit those essential noise characteristics which are invariant under all lossless network transformations which preserve the number of terminal pairs. Noise measure and an analysis of the network realization of optimum amplifier noise performance are also treated.

This book is elegantly written and well organized. It is a significant contribution to the analysis of noisy networks by matrix methods.—LEONARD S. SCHWARTZ, *New York University, College of Engineering, New York.*

THUMBNAIL REVIEWS

Design of Transistorized Circuits for Digital Computers. By Abraham I. Pressman, John F. Rider Publisher, Inc., N. Y., 1959, 324 p, $9.95. This book gives a brief account of the fundamentals of logic circuits and transistors, a more complete account of diode gating and transistor switching. Detailed examples show how to design diode-transistor and all-transistor logic circuits. Though math is simple, many topics are treated too concisely to call this an intermediate-level text.

The Electric Arc. By J. M. Somerville, John Wiley & Sons, Inc., New York, 1959, 150 p, $2.50. This monograph is for the nonspecialist, giving a concise account of the physical processes which operate to allow the passage of large electric currents through a gaseous medium, and across the junctions between gases and metallic conductors. Much of this material has not previously been available in English. This is not a reference book, thus no attempt is made to give any comprehensive account of the numerous technological applications of arcs. There are a large number of references, mostly to recent work.

English-Spanish Comprehensive Technical Dictionary. By L. L. Sell, McGraw-Hill Book Co., Inc., 1959, 1,079 p, $35.00. This large volume contains over 400,000 technical terms and expressions on atomic and nuclear engineering, industrial electronics, automation, analog and digital computers, data processing, business machines, microwaves, telecommunication, facsimile, guided missiles, satellites, and the like.

Inventions Patents and Their Management. By A. K. Berle and L. S. de Camp, D. Van Nostrand Co., Inc., Princeton, N. J., 1959, 602 p, $12.50. The sub-title of this book is "How to develop, protect and profit from new products and new processes." Subject matter is covered in twenty-four chapters, including one chapter each on trade marks and copyrights. Many practical points about the patent system are brought out and many case histories are cited.

This is not a book devoted strictly to patent law. As the authors point out, a patent is worth to the holder as much as he can realize from it, either by licensing, outright sale or by exploiting it himself. There are tricks and pitfalls no matter how the inventor proceeds and a great deal of time and money can be lost by simple ignorance. The practical, profitable approach to inventing is emphasized.

No mention is made of the differences that may be peculiar to specific industries and the electronics industry is not even listed in the index. Although too expensive for those only casually interested in the subject, the book can fill a nitch in many company libraries.

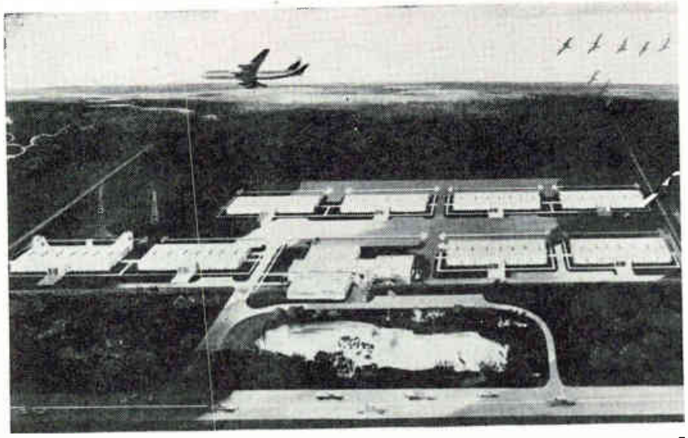
Notes on the Quantum Theory of Angular Momentum. By E. Feenberg and G. E. Pake, Stanford University Press, Stanford, Calif., 1959, 56 p, $1.25. Originally written to assist graduate students in reading research papers on atomic, molecular and nuclear structure, these notes constitute a review, on an elementary level, of material usually included in a one-year course in quantum theory. Also, matrix elements of scalar, vector and tensor operators are computed and applied to derive several useful relations in theory of magnetic moments, electric quadruple moments and dipole transition probabilities.

Nuclear Technology For Engineers. By R. Hobart Ellis, Jr., McGraw-Hill Book Co., Inc., New York, 1959, 283 p, $9.80. This book starts with the theory of radioactivity and goes on to describe methods for detecting and measuring radiation; interesting applications of radionuclides as tracers in medical and other spheres are then outlined. Sources of high-level radiation are next discussed and put to more uses than the reader might have envisaged. Two final sections deal with nuclear fission and nuclear fusion. The value of the book (which is fairly expensive) lies in the techniques presented, rather than in the theory which it develops.

A Treatise on Algebraic Plane Curves. By J. L. Coolidge, Dover Publications, Inc., New York, 1959, 513 p, $2.45. Advanced students and teachers will welcome this unabridged reprint of one of the few full coverages of this subject in English. An account is given of the present status of the theory of algebraic plane curves and their relations to various fields of geometry and analysis.

Experimental Music. By L. A. Hiller, Jr., and L. M. Isaacson, McGraw-Hill Book Co., Inc., New York, 1959, 197 p, $6. Treats in detail techniques used to produce music by means of electronic automatic high-speed digital computers. Since book is for musicians and general readers, the text is essentially nontechnical although some knowledge of statistics and probability would be helpful.

The Birth of a New Physics. By I. B. Cohen, Doubleday & Co., Inc., New York, 1960, 200 p, $0.95. Written primarily for students, this book discusses the search for a new physics to describe the dynamics of a moving universe. A major aim of book is to indicate the penetrating force and deep effect that a single idea may have in altering the whole structure of science.



Uses 'Engineering Modules'

To MEET existing and anticipated needs for additional engineering, manufacturing and administrative facilities, Radiation, Inc., Melbourne, Fla., has undertaken a long-range expansion program.

The company has acquired a 60-acre tract five miles south of the present facility and an option on an adjacent 60 acres. The new plant complex consists of a group of medium-sized buildings, called "engineering modules". Each module will have 22,000 sq ft of work space. Three of these modules are already in operation. The 37,000-sq-ft administration building, recently completed, will serve as national headquarters for the firm.

Manufacturing done by the company is essentially assembly of components, augmented by specialized precise machine work. The real core of the company is engineering accompanied by development and limited production of complex electronic equipment generally keyed to the limits of the state of the art.

The new plant makes it possible to adapt general-purpose buildings to specialized work with complete provisions for flexibility during growth—and even during retrenchment—with the least possible financial risk. The company is growing, the art is progressing and this plant can vary to accept any reasonably foreseen changes with practically unlimited expansion, company officials claim.

Some of the most advanced architectural features include: orientation of buildings for best natural light and minimum air conditioning load, easily accessible, large, paved parking areas for each module, special acoustical treatment, a comfortable and "open look" in the administration building's customer reception area, partitions that can be relocated and special roof-installed antenna testing facilities.

Acoustica Hires O.E. Mattiat

APPOINTMENT of Oskar E. Mattiat as chief scientist of Acoustica Associates, Inc., of Plainview, N. Y., and Los Angeles, was recently announced.

Mattiat has been engaged in the development of acoustic systems and piezoelectric devices since 1934 at the German General Electric Co. in Berlin, the Clevite Research Center in Cleveland and, more recently, at the Astrophysics Development Corp. division of Curtiss-Wright Corp. in Santa Barbara, Calif.

At Acoustica, which manufactures ultrasonic cleaning, gaging and processing systems, he will be responsible for all developments in the fields of piezoelectric and magnetostrictive ceramic materials.

According to Robert L. Rod, president, the addition of Mattiat to the Acoustica staff will permit an increased effort to be made in the areas of improved ceramics capable of use in the nation's space and submarine warfare programs, as well as in areas involving such products as microphones, phono pickup cartridges, earphones and measuring devices which make use of these novel ceramic materials.

EFCON Employs Project Engineer

JOSEPH SIPOVIC was recently named project engineer of the Film Capacitor division of EFCON, Inc., New York, N. Y.

Formerly chief engineer with the Condenser Products division of New Haven Clock & Watch Co., Sipovic comes to EFCON with a quarter century's experience in the capacitor field at Condensor Products and at Micamold Electronics Mfg. Corp.

Name G.A. Peck SIE President

GEORGE A. PECK has been named president of Southwestern Industrial Electronics, Inc., of Houston. He succeeds Keith R. Beeman, who

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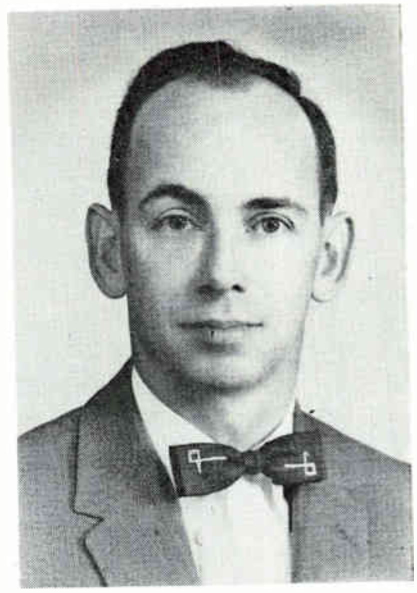
resigned to accept new position with SIE's parent firm, Dresser Industries, Inc.

Peck had been vice president and general manager of Stromberg Carlson's Electronics division.

Beeman, in his new position with Dresser, will be engaged primarily in investigating new product possibilities and in broadening the application of Dresser's present products line both in seismic, instrumentation and the general electronics field.



GE Promotes Woolaver

THE GENERAL ELECTRIC CO., Syracuse, N. Y., recently promoted Arling Woolaver to transistor product sales manager in the Semiconductor Products department. He had been the department's district sales manager for New Jersey and eastern Pennsylvania.

In his new position, Woolaver replaces C. J. Goodman who was recently appointed eastern regional sales manager for the department.

Two Elected to Ling-Altec Board

JAMES O. WELDON and Lee D. Webster have been elected to the board of directors of Ling-Altec Electronics, Inc. The new directors were also named to the executive committee, and Webster was promoted from vice president to executive vice president.

Weldon is president of Continental Electronics Mfg. Co., which was founded in 1947 in Dallas and became a subsidiary of Ling-Altec last year.

Webster joined Ling-Altec as vice president, secretary and treasurer in 1958.

News of Reps

MECO (Measurement Equipment Co., Inc.) is a new rep organization located in Wakefield, Mass., to serve the electronics and related industries in the New England area. The company, founded by **Donald A. Jenkins** and **John Riley,** will specialize in the fields of microwave instrumentation and systems components, laboratory and special purpose power supplies, signal sources, and digital equipment.

Appointment of **S. B. M. Associates** of Rochester and Albany, N. Y., as sales rep for the Shockley Transistor Corp., Palo Alto, Calif., is announced. Rep firm will cover New York State, with the exception of New York City, Westchester County and Long Island.

Longstreet Smith Associates, Inc., sales reps for Mid-Eastern Electronics, Inc., have opened a new office in Albuquerque. They will handle Mid-Eastern's line of power supplies, ultra high resistance measuring instruments and test equipment for all of New Mexico.

Television Communication Products, Inc., Dallas, Texas, has been named authorized field engineering and sales rep for Adler Electronics, Inc., New Rochelle, N. Y., in the states of Texas, Oklahoma, Kansas, Missouri, Arkansas, Louisiana.

Bussmann Mfg. Division of McGraw-Edison Co., Newark, N. J., announces the appointment of **Art Cerf & Co.,** of Newark, N. J., as rep covering upper New York State, New Jersey, eastern Pennsylvania, Maryland, District of Columbia, and Virginia.

COMMENT

Information Retrieval

A short item in the Electronics Newsletter (p 11, Dec. 18 '59) has given rise to considerable interest in this office. The paragraph which begins "Chemistry information retrieval . . ." describes certain USSR developments in a field of research in which we are seriously involved.

The Patent Office and the National Bureau of Standards have, for several years, been engaged in a joint research project in the field of information retrieval. A considerable portion of the joint effort has been concentrated on the development of a system known as Haystaq, which uses a general-purpose computer to perform searches of large document files for chemical information. For about a year and a half the Haystaq team has directed its attention to the searching of chemical structures, based largely on a topological tracing techniques . . .

HERBERT R. KOLLER
U. S. PATENT OFFICE
WASHINGTON, D. C.

A brief discussion of the Haystaq project, not referring to it by that name, appeared in Research & Development, p 124, Feb. 12, with the headline "Computer Searches for Patents."

Minification

I answer your call for takers, and support your well-reasoned statement justifying the use of *miniaturize* instead of *minify* (Comment, p 104, Jan. 22).

In the process of language development, usage certainly exerts a more powerful influence than the dictum of the purist. This is inevitable; in the interchange of ideas, man's needs are better taken care of by a clear understanding of words rather than by their grammatical rigor . . .

JOHN J. RIVERA
IT&T LABORATORIES
NUTLEY, N. J.

. . . Mr. Frank C. Smith Jr. of Southwestern Industrial Electronics was quoted as supporting promotion of the word *minify*. Some years ago I staged an ardent, albeit ineffective, one-man campaign among ad agency personnel

handling electronics accounts and various others in the electronics industry for this same cause. Despite my protests, the word *miniaturize,* ugly and deformed as it is, seemed to grow in acceptance. The battle may have been lost by now, but I would like to go on record in support of Mr. Smith's motion.

My basis for calling the word deformed is that *miniaturize* is compounded of a Latin prefix and a Greek suffix. Both parts should at least be drawn from related languages if a word is to be a proper word. Thus only two possibilities emerge: either a completely Greek-rooted word, which would give us *micronitize,* or a completely Latin-derived word, which would be the far simpler and more pleasant *minify.*

Five years of usage may have established the twisted, ungainly and cacophonic *miniaturize* as the preferred form. However, many of us in the world who still value language will be indebted to you for any plugs you might give to minification.

DAN MEYER

DRESSER INDUSTRIES
DALLAS

Shift Register

I have read with interest the article "Six Ways to Use Magnetic Shift Register Elements," by J. Porter, in your Jan. 15 issue (p 80). The article provided a useful comparative description of several of the shift-register circuits currently available.

Unfortunately, an error has occurred in Table I of the article that is of great enough magnitude to warp the comparison rather seriously. The output voltage of the voltage controlled shift register should be listed as 3.0 volts instead of 0.3 volts. Since 0.3 volts would be considered totally inadequate by most shift-register users, whereas 3.0 volts is usually satisfactory, it is felt that the voltage controlled shift register is not fairly presented in this tabulation . . .

B. F. WAGNER

GENERAL ELECTRIC
SYRACUSE, N. Y.

Author Porter regrets what turns out to have been a typist's error; he missed it and so did we.

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LET'S FACE FACTS

FIELD ENGINEERS Thumbing through the pages of this magazine points up a salient fact—there's a field engineer shortage, or at least, there's a shortage of good ones. The only investment an engineer has to make in order to change jobs is a short resume, a 4¢ stamp and an envelope. But what does the new job mean? Does it mean more routine work in a different location, and a few extra dollars in the paycheck; or does it mean the opportunity to utilize all your skills in a position where you can really move ahead? ● If the job turns out to be the former, you've spun your wheels professionally. On the other hand, if the job requires real use of your technical talent, and it's with a growing, wide-awake organization, then your future is just about what you make of it. ● This brings us to what we want to say about our organization—General Electric's fast-moving Ordnance Department. We're not Utopia for a field engineer, but who is? We're fast on our feet, and we want field engineers who can keep the present hardware going while formulating new equipment and systems concepts. There's plenty of opportunity to employ "blue sky" thinking as long as you can plug it into a solid engineering approach. Field engineers are important to our future because they deal directly with our customers, and success in this area means just one thing—more business for us. ● If you're convinced you've got to change jobs, why not let us tell you how a field engineering position with Ordnance Department will lead quickly to an advanced position in R&D, manufacturing, marketing or product service management. ● **Immediate assignments** are available on such advanced weapons systems as Polaris, and the Atlas Tracker Antenna—if you have a BSEE or BSME with 2-4 years experience in electronics weapons systems, computers, transistors, gyros, ballistics, telemetry, data analysis or servo systems. ● Assignments are principally at domestic bases that include Portsmouth, N. H.; Charleston, S. C.; Newport News, Va.; Key West and Cape Canaveral, Fla.; Mare Island (S. F.) and Sunnyvale, Calif. ● **Please write, including salary requirements to: Mr. R. G. O'Brien, Rm. 69WH.**

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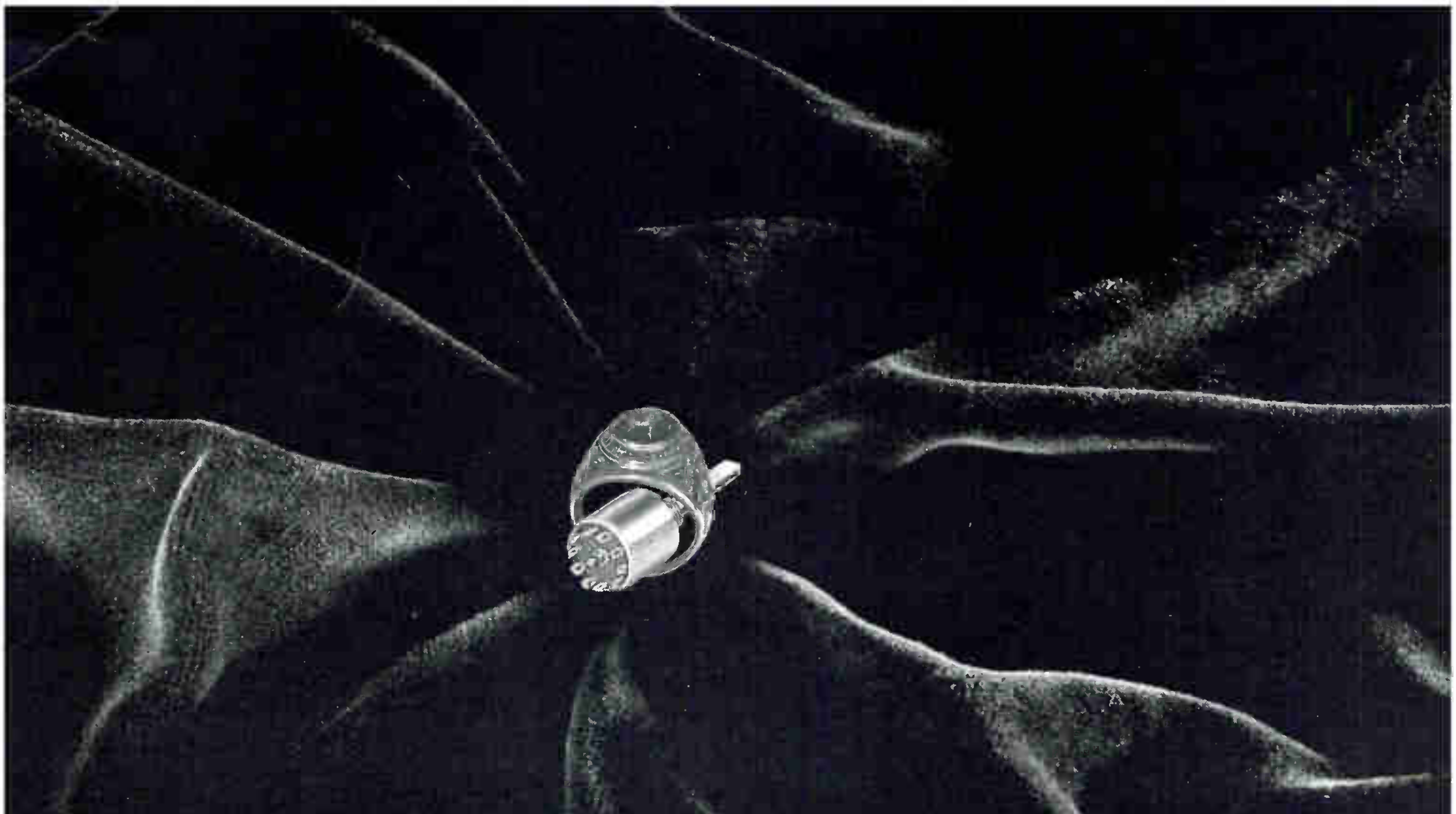

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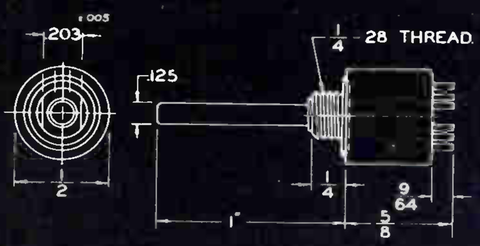

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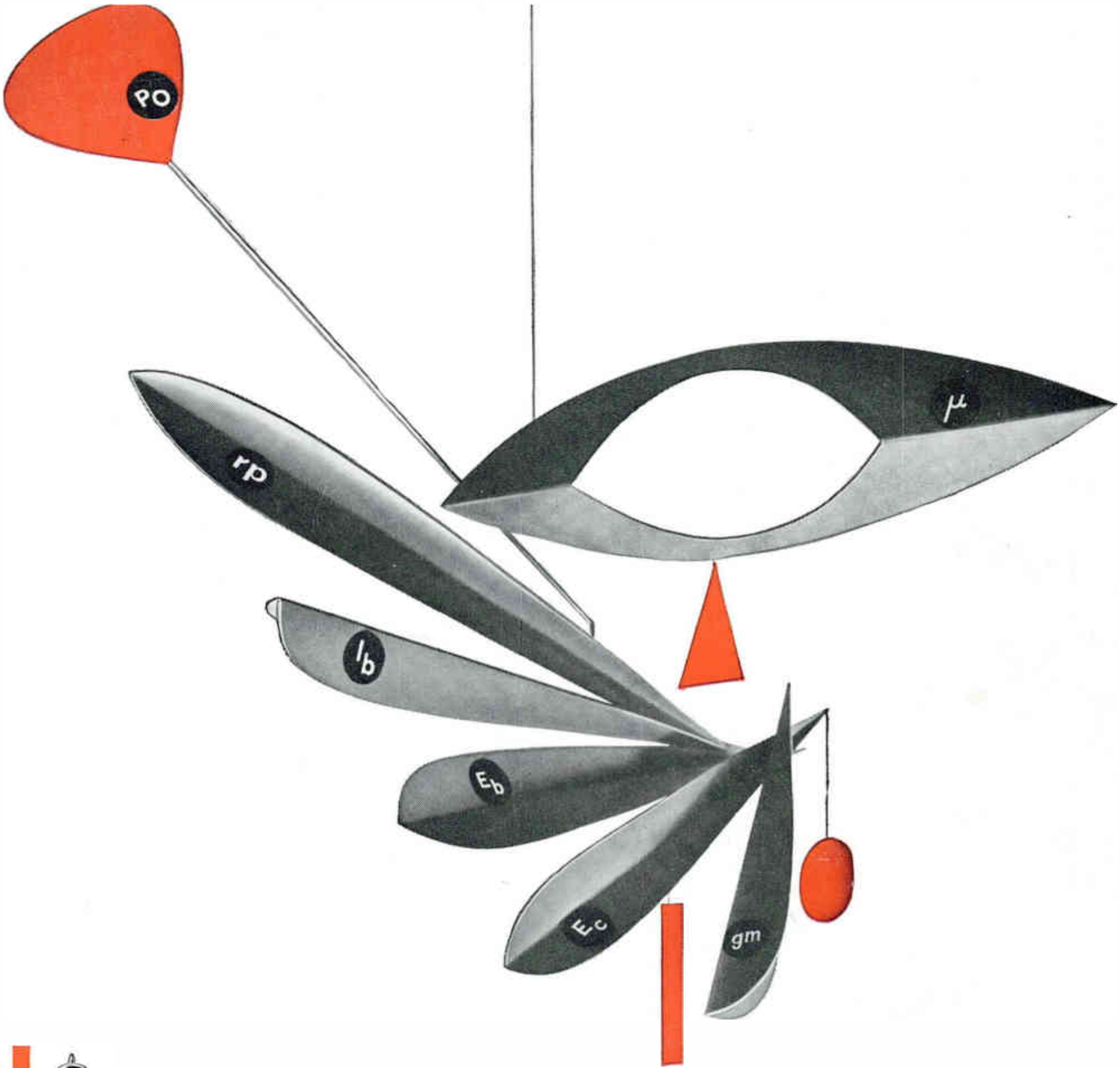

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